FOOD COLOURS
A STUDY OF THE EFFECTS OF REGULATION

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In the 1960s the benefits of government regulation of technology were believed to outweigh any costs. But recent studies have claimed that regulation has negative effects on innovation, health and consumer choice. This case study on food colours examines such claims.

EFFECTS ON HEALTH were measured by allocating a hazard rating to each colour. The negative list of 1925 removed three harmful colours which were rapidly replaced, so the benefits were short-lived. Had a proposed ban been adopted in the 1860s it would have prevented many years exposure to hazardous mineral colours. The positive list of 1957 reduced the proportion of harmful coal tar dyes from 54% of the total to 20%. Regulations brought a greater reduction in hazard levels than voluntary trade action. Delays in the introduction of a positive list created a significant hazard burden.

EFFECTS ON INNOVATION were assessed from patents and discovery dates. Until the 1950s food colours were adopted from textile colours. The major period of innovation for coal tar colours was between 1856 and 1910, finishing well before regulations were made in 1957, so regulations cannot be blamed for the decline. Regulations appear to have spurred the development of at least one new coal tar dye, and many new plant colours, creating a new sector of the dye industry.

EFFECTS ON CONSUMER CHOICE were assessed by case studies. Coloured milk, for example, was banned despite its popularity. Regulations have restricted choice, but have removed from the market foods that were nutritionally impoverished and poor value for money. Compositional regulations provided health protection because they reduced total exposure to colours from certain staple foods. Restricting colours to a smaller range of foods would be an effective way of coping with problems of quality and imperfect toxicological knowledge today.

KEY WORDS:

Regulation
Food colours
Hazards
Innovation

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CHAPTER 1

INTRODUCTION AND SUMMARY

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1.1 Introduction

This study evaluates the effects of government regulations on food colours. It asesses the effects on health, innovation and consumer choice. For each of these areas it has been claimed that regulations have had negative effects. This study examines such claims, and compares the relative efficacy of regulation and voluntary controls by manufacturers.

Chapter 1 describes why it is important to assess the effects of regulation. It provides an outline of current government policies on regulation. It describes public concern about food colours and the way in which they are controlled. It summarises some of the findings of this thesis.

Chapter 2 outlines claims about the negative effects of regulations, the theories that have been put forward to explain them, and the methods that have been used to measure effects. It defines different types of technological regulation and describes the regulations that have been introduced for food colours.

Chapter 3 provides a summary of government activity on colours. It documents the origins and aims of legislation on colours. It describes the development of general food laws in the nineteenth century and of specific controls on colours in the twentieth century. It outlines the public concerns about fraud and safety that forced government action.

Chapter 4 describes the benefits of colours to food and chemical manufacturers. It charts the introduction of new colours and the dominance of different groups over time. It assesses the effects of colour regulations on industrial innovation.

Chapter 5 investigates the importance of colour to consumers. It assesses the relationship between added colours and nutrition, food quality, cost and choice. It assesses the effects of regulations on quality and choice.

Chapter 6 assesses the health hazards from colours and the changes in hazard levels over time. It examines the effects of colour regulations on health. It attempts to measure the hazards removed by regulations and the loss of health due to delays in the introduction of legislation. It evaluates the degree of protection given by the negative list, the positive list, and the voluntary action of manufacturers.

Chapter 7 discusses the policy implications of the information presented in previous chapters and makes recommendations for improvements to the current system by which colours are evaluated. It considers the relevance of the study to other areas of technology.

IMPORTANCE OF STUDYING REGULATIONS

1.2 Deregulation Policies

Numerous complaints have been made by manufacturers in recent years about the cost of regulations. F J Lawton of the Food Manufacturers' Federation, for example, has complained that:

> Legislation is expensive in time, in enforcement, and for the actual manufacturer who has to comply with the legislation (1).

Alan Holmes, Director of the Leatherhead Food Research Association, has expressed concern at the amount of legislation that the food industry has to deal with. In 1985 he estimated that the number of conditions controlling the use of additives was 445 in the UK, 4,814 in the EEC and 1,466 in the USA. There were at least 350 conditions controlling the composition of foods (2).

Increasing concern about the cost of legislation has led both the UK and EEC to set up units to assess the impact of laws on business. In the UK government departments now have to complete a 17 point 'compliance cost assessment' for every proposed regulation that affects business. The assessment attempts to quantify the cost to business and central and local government. Since June 1986 in the EEC every legislative proposal made by the Commission has had to be accompanied by an assessment of the cost, to business, of compliance (3).

In the UK, few new regulations controlling the manufacture and processing of food have been made in recent years. The Ministry of Agriculture's policy has been to refrain from introducing any new standards specifying the composition of food and to rely increasingly on label information to protect the consumer. In the EEC a major change in policy has been proposed by the Commission. The new policy will stop further attempts to set regulations controlling the quality of food. Following the UK's lead, the European Commission feels that information can be the primary tool for protecting the public. In future regulations will only be made on issues considered by the Commission to be necessary for public health.

In the 1950s and 1960s it was generally accepted that, although regulations on technology imposed costs on industry, there were significant benefits to the public that cancelled out these costs. Legislation was introduced to control aspects of a number of technological areas, such as vehicle safety, air pollution, consumer goods and workplace hazards.

The new swing away from state intervention is based not just on the old complaint of the burden of cost on industry but also on a new argument: that regulation does not even benefit the public. Peltzman, for example, has argued that car safety legislation has increased road deaths and the total number of accidents (4). He has argued that regulations controlling the safety of medicines have left a greater number of people in ill-health than would have been injured by the introduction of new uncontrolled drugs (5). Auliciems and Burton have claimed that air pollution controls have had no significant effect (see chapter 2) (6).

Claims are now being made about dysbenefits from food regulations. Compositional standards and colour regulations have been criticised for stunting innovation and affecting consumers adversely by restricting choice. The Ministry of Agriculture has responded increasingly to such claims. In negotiations with the EEC it has fought strongly against compositional standards and against tighter safety regulations in a number of food areas. A few examples are given below:

a) MAFF has consistently argued against a reduction in the number of colour additives permitted in food. It has fought for, and gained, special derogations to allow UK manufacturers to continue to use colours banned (on grounds of need and/or safety) by other countries. MAFF has succeeded recently in persuading the Commission to add new colours to the European permitted list.

b) MAFF has argued strongly against banning hormones in meat, on the grounds that there is no proof of harm. Other EEC countries have decided to ban hormones as a precautionary measure. The UK government is challenging this regulation in the European Court.

c) MAFF has argued strongly against the introduction of low limits on the migration of chemicals from packaging into food. Again, this is on the grounds that there is no proof of harm from higher levels, and that low levels would place an unnecessary restriction on trade activity.

MAFF has recently abolished 38 legal standards that specified the minimum meat content of many meat products. In recent white papers on deregulation the government has announced its intentions for some other food areas. It aims to:

a) 'liberalise' arrangements for the importation of veterinary medicines;

b) remove compositional regulations from soft drinks; and,

c) remove compositional standards on cream and cheese (7).

It has been claimed that the public as well as business will benefit from these changes, although evidence for this is lacking. At the centenary celebration of the 1875 Food Act Lord Zuckerman posed a question that is still relevant today:

> It has often been stated that legislation is expensive. May I ask a question? Is there any yardstick by which one can

> measure the diminishing returns from further expenditure on legislation in this field? At the beginning, no doubt, the results [of the Food Acts] were enormous; are the results measurable today? (8)

In this thesis, Lord Zuckerman's final question has been applied to the regulations that control food colours. Rather than focussing on the area which the government has already attempted to measure - the financial costs to industry - this study attempts to assess the effects of regulations on health, consumer choice and industrial innovation.

1.3 Public Concern About Colours

Public concern about food colours has grown enormously since 1985. A survey in 1986 found that 80% of women felt many additives were harmful and should be banned (9). Fifteen years earlier the majority of people had felt the use of colours in processed food to be acceptable (10). Concern about allergic reactions to colours, the adequacy of testing assessments, and excessive government secrecy have contributed to a situation where over half of consumers have lost confidence in the system of control on colours. Recently, only 30% of women agreed with the statement that 'all additives must be all right otherwise food producers wouldn't be allowed to use them' (11). Studies conducted by the Ministry of Agriculture and a major retailer revealed a high level of belief that colours were not currently controlled by legislation (12).

It is therefore useful to examine, as this study does, whether regulations on colours have had any benefits for the public, and whether the industry's complaints about stunted innovation have been overstated. It is also useful to assess which types of regulation have been most effective, so that public interest campaigns can defend or attempt to gain more of these.

SUMMARY OF FINDINGS

1.4 Demands for Controls on Colours

The history of controls on colours is one of reluctant governments being forced eventually to intervene in trade matters under considerable pressure from the public and some trade sectors. Concern about the safety of mineral colours first became a public issue in 1820. A chemist, Fredrick Accum published details of ill-health caused by lead colours and deaths caused by copper colours, described in chapter 3. His call for 'government interference' was supported by many sections of the public. But the government and traders succeeded in staving off any controls. Factors preventing the introduction of laws controlling the use of colours and other harmful or fraudulent adulterants in the first half of the nineteenth century included the following:

a) The state's policy of interfering in business affairs as little as possible;

b) A highly competitive food trade where adulteration was almost a necessary practice among traders;

c) High duties on some staple foods;

d) The acceptability of highly coloured food to the public;

e) Lack of concerted public pressure on government;

f) Lack of verified scientific methods for detecting adulteration;

g) Difficulties in proving the extent of harm or fraud caused by colours and other adulterants;

h) In cases where ill-health or death was traced to colours the guilty manufacturer or retailer was often put out of business, so the trade could claim that market forces were reducing the use of harmful colours;

i) The trade claimed that the public was not being cheated because they could distinguish diluted or bulked-out foods, and chose to buy them because they were cheaper.

Most of these factors remained obstacles to the introduction of specific legislation on colours after the general anti-adulteration acts were finally established between 1860 and 1880.

1.5 Regulatory Cycles

In the years following Accum's revelations there was a regular cycle of:

a) New evidence of fraudulent or harmful colours
b) Public outcry
c) Trade defence
d) Government filibuster.

Occasionally the evidence was so compelling, public outcry so strong, and trade pressure so great against 'unfair practices' that government was forced to impose some legislative controls. The legislation was often portrayed as a public protection measure. In fact, the prime goal was usually to make rules to establish 'fair' trading: defining which trade practices were acceptable and which were not. If public health and protection had been the priority then the principles and powers of the laws would have been quite different. Nevertheless, the legislation, once it was made enforceable, tended to have significant benefits for the public as well as some sections of the food trade.

Legislation made in the 1870s and 1880s established some general principles of trade relating to colours: that harmful colours should not be added to food and that foods should be of the quality expected by the purchaser. Not surprisingly, there followed considerable debates about the interpretation of these principles. For example, which colours were to be considered harmful, and at what levels in food?

On the issue of harmful colours, clear regulatory cycles occurred in the twentieth century, at about 22 year intervals. The pattern of government activity is shown in table 1.1 below. Preceding each phase of government activity there was a build-up of dissatisfaction among traders and enforcement officers about the current state of controls, and a public campaign about health and/or fraud (see chapter 3). The government response was to ask an expert committee to investigate colours. In the early 1900s the committee recommended a prohibition on certain colours (a negative list) and, later, a list of permitted colours (a positive list). The recommendations made by the committees were not acted on until the following cycle of government action, creating an approximate 22 year lag between committee recommendations and their adoption in legislation. In each cycle, calls for regulation were staved off by traders claiming that intervention was not justifiable: that there was no proof of harm for most colours and that the industry could adequately control the use of harmful colours. Examples were given where traders had voluntarily withdrawn harmful colours. Yet this was found to be unsatisfactory because eventually demands for regulation built up again.

TABLE 1.1 : CYCLES OF REGULATORY ACTIVITY ON COLOURS IN THE TWENTIETH CENTURY

Year	Recommendation of committee	Government action
1901	Negative list	No action
1924	Positive list	Negative list
1955	Positive list	Positive list

1.6 Criteria for Decision-making

Once a positive list of colours had been established in 1957 the official definition of the problem changed. Prior to the 1950s one issue had been whether intervention was justified given the inadequate state of knowledge in a number of areas:

a) The definition of added colours - their function and chemical composition;

b) The level of hazard - extent of use and interpretation of safety data;

c) Enforcement ability - clear detection and identification tests;

d) 'Need' for colours - weighing the demands of industry for a wide range of colours against concerns about safety and deception.

After the positive list was introduced assessments became institutionalised. Criteria were established for judging 'need' and safety. These changed surprisingly little in the following thirty years. Chapters 4, 5 and 6 have examined the outcome of these developments on health, food choice and innovation.

1.7 Effects of Regulations on Health

Chapter 6 examines the effects of colour regulations on health and assesses the relative effects of regulations and voluntary trade action in reducing hazards. Using a measurement of the hazardousness of colours based on official assessments, the negative and positive lists were found to have had a significant effect in removing harmful colours from use. The negative list of 1925 had a negligible effect on plant colours. It can be considered to have had a positive effect in removing two harmful coal tar colours and one harmful mineral colour. However, the two coal tar colours were rapidly replaced by similar colours that were probably harmful, so the benefit was short-lived. The harmful mineral colour was not replaced at all in some products, so the regulations produced a longer-term benefit here.

The negative list would have had more impact if it had banned a large number of colours or if it had been introduced at a much earlier stage. In some countries certain colours were banned from the 1860s and earlier. If proposals for a ban had been taken up in the 1860s a great many years of low level exposure to hazardous mineral colours would have been prevented.

The major limitation to a negative list is that it permits a very wide range of colours, some of which may be harmful. In theory, a positive list overcomes this problem by vetting colours before they are permitted for use in food. A series of assessments in chapter 6 demonstrates that the positive list was a significant improvement in practice as well as in theory. The regulations in 1957 had an enormous effect on the coal tar colours. They reduced the proportion of harmful and possibly harmful dyes from 54% of the total to 20%. The regulations brought a much greater reduction in hazard levels than voluntary trade action. During a period of trade control (1926 to 1956) the number of harmful coal tar colours was reduced slightly. On the introduction of regulations in 1957 there was a far greater drop in the proportion of hazardous colours.

The positive list made little difference to the mineral and plant colours. Most mineral colours had become commercially insignificant. Plant colours were used only in a small range of foods. These colours had largely been replaced by coal tar dyes between 1890 and 1920.

The delay in introduction of the positive list led to a preventable burden of hazard being carried by the public and workers in the food industry for many years. Had a permitted list been introduced in 1855 when suggested at a select comittee inquiry it would have prevented the use of many poisonous mineral colours. A positive list introduced at any time before the 1920s would have had a significant effect on plant and mineral colours.

An identifiable and enforceable positive list of coal tar dyes could have been introduced soon after the turn of the century. This would have reduced the hazard burden slightly, although the degree of effect would have depended on the actual colours chosen. Lack of adequate toxicological research meant that choosing colours for a positive list was in many cases a gamble until the 1940s. Before this time it would have been difficult to choose colours that could be guaranteed to be of low risk.

Changes to the positive list after 1957 indicate that it was undesirable (for health) to permit any colours for which there was not adequate proof of safety. This is shown by the number of colours which had to be withdrawn from the permitted list. The difficulties of toxicological assessments meant that the public would have been far better protected if the need for colours had been strictly assessed, and the use of colours had been kept to the absolute minimum.

Chapter 5 shows that compositional regulations can bring significant health benefits too. The regulations banning colours from staple foods like milk and tea provide examples of this. Compositional standards and restricted uses for colours can provide additonal protection to a permitted list because they reduce total exposure to colours, particularly in staple foods. Given the very imperfect state of toxicological information compositional standards offer a useful means of reducing hazards.

1.8 Effects of Regulations on Innovation

Chapter 4 assesses the impact of colour regulations on innovation in the dye industry. The needs of the food industry have not been, until recently, a driving force behind innovation in the colour industry. From ancient times, the textile industry has shaped developments in colours. The early food colours were textile dyes. This remained the situation until the 1950s.

Certainly regulations have had an effect on colour innovation. Certain colours have not been explored at all for possible food use because of doubts about their safety and the cost of large amounts of toxicology testing. But this has not prevented the dye industry developing the colours for non-food purposes. It has been claimed that colour regulations introduced in the 1950s stunted or stopped the development of new food colours. It is true that few new coal tar dyes were developed after 1957. But an examination of innovation in that sector of the dye industry shows that the chemistry of such colours had been so thoroughly explored by that stage that there were few new chemical entities that had not already been made. The major period of innovation for coal tar dyes was from 1856 to 1910, finishing well before the introduction of regulations in the 1950s (see chapter 4). In the 1970s when complaints about regulation became strong, the dye industry overall had reached a trough that had little to do with food colour regulations.

Rather than stunting innovation, regulation appears to have spurred the development of at least one new coal tar dye, tailor-made to meet trade and regulatory requirements. The development of a series of new plant colours for food has also created a whole new sector of the dye industry. In the late 1950s, for the first time, new colour sources were created specifically for food rather than for textiles.

Innovation involves not only the development of new chemicals and sources but also of new applications for existing colours. Colour regulations have not stunted this area of innovation. As chapter 4 shows, the number of patents for new applications has been almost as high as the number for new colour sources, since the 1960s.

1.9 Effects of Regulations on Consumer Choice

Chapter 5 assesses the effects of colour regulations on consumer choice, in terms of the range of colours and foods available, and the quality and nutritional value of food.

Colour regulations have had little impact on the range of hues used in food in the UK. Regulators have permitted a wide spectrum of colours. This is not the case in some other countries, such as Norway, where hues have been limited by stricter controls on coal tar dyes. In such countries plant colours have, until recently, offered only a narrow range of hues (mainly oranges and yellows). Removal of many more colours from the UK's permitted list would affect the appearance of some foods. The colour combinations would be less sophisticated and consumer choice would be restricted.

To what extent would such a restriction matter to the public? Little useful data are available. Certainly, colour is very important to the enjoyment of food, and is a useful indicator of flavour, age and quality. Most natural foods are very colourful. Chapter 5 describes the importance of these factors.

An examination of changes in the use of colours at different periods shows that the public can get used to changes in the colour of the foods they buy and eat. Colour changes are in fact made surprisingly often by manufacturers. The colour judged to be appropriate for a food at one time or for one social group is not necessarily the same for another. Milk, for example, was mostly coloured yellow at the turn of the century, and people preferred it that way; they had become accustomed to it. Now, bright yellow milk would be considered unacceptable by most people. The colouring of milk was banned by regulations in 1922. Certainly this restricted choice: coloured milk became illegal. But it offered other advantages. It became more difficult for dairies to fraudulently dilute milk with water or to remove the cream without declaring it. It also removed some hazardous colours from a staple food. So under certain circumstances, where there is a risk to health or people are liable to be defrauded, there are benefits to be gained from restricting choice.

Chapter 5 also examines the factors affecting food choice. The choice of foods available to a person is decided to a considerable degree before the final act of choice in a shop or canteen. Individual preference is the last step in a long chain of factors such as national income, socio-economic status, structure of the retail industry, transport provision, urbanisation and advertising.

Chapter 5 asseses whether the removal of regulations increases consumer choice. The government recently removed standards specifying the minimum meat content of many meat products. The public was to be protected by the provision of information about the meat content on product labels. While opening the door to a new range of products this policy has had a number of disadvantages:

a) It has failed to protect the quality of meat products - the meat content decreased when statutory minima were removed. In the same period the meat content of the few products still protected by regulation remained unchanged.

b) The public got poor value for money - the price of products did not decrease in line with the meat content; in some cases consumers were paying as much for coloured water, coloured rusk or fat, as for meat.

c) The administrative burden on businesses was not even removed. The labelling of meat products became much more complex.

d) In future even the benefit of a new, wider range of meat products may disappear. The new poor quality products may drive out middle quality products, and may lead eventually to a reduced choice. It is too soon to assess this, but the problem has already arisen among ham products. This is discussed in chapter 5.

1.10 Policy Implications

Food manufacturers and retailers constantly complain about regulations but in fact some benefit from regulations and have even demanded them at times. In principle, as long as no business in a market is disadvantaged or gains an unfair advantage from regulations, traders have little legitimate ground for complaint. In practice however, regulations confer advantages on certain types of traders, for example those already using the colours selected for the positive list of 1957. But it is likely that the unfairness created by regulation is less than the unfairness of a free market. Traders themselves complained strongly about the unfairness of the free market situation where firms coloured and debased foods, passing them off as the real thing. The development of regulations on colours has shown that the state has been obliged against its wishes to intervene in certain business affairs, sometimes to control 'unfairness' defined so by the trade. Traders were able to put their own house in order only where it was technically and economically easy for them to do so. So the efficacy of self-regulation was limited.

Of the different types of regulations, negative lists offer the least protection to the public. Positive lists are a great improvement. Combined with a positive list, compositional regulations limiting the use of colours to certain foods offer the strongest protection. Such restrictions do however limit consumer choice. But since they tend to remove from the market the very poorest quality foods this can be considered a benefit, especially since such foods tend not only to be nutritionally impoverished but also to be poor value for money. Restricting colours to a smaller range of foods would be an effective way of coping with problems of poor quality food and imperfect toxicological knowledge today.

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CHAPTER 2

THEORIES OF REGULATION

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2.1 Introduction

Many claims and counter-claims have been made about the effects of regulations. The UK and US governments have favoured the removal of regulations in recent years. The shift in policy has been accompanied by a number of academic studies which claim to demonstrate the negative effects of regulations. But in fact little is known about their effects; few areas have been investigated in depth. William Shepherd recently complained that

> We do not really know <u>how well</u> regulation has performed, nor is there agreement on how our assessments ought to be based. Even more embarassing than this, we do not even know what effects - good or bad - regulatory policies have had (1).

This chapter summarises some of the claims that have been made about the negative effects of regulation. It describes some of the different types of regulations and defines regulations controlling colours. It also examines methods of assessing their effects.

2.2 NEGATIVE EFFECTS OF REGULATIONS

Claims about the negative effects of regulations can be divided into two areas: effects on health and effects on innovation and choice. These are discussed below.

2.3 a) Negative Effects on Health

Jordan has suggested that

> Overall, remarkably little of the evidence suggests that consumers are protected by regulation (2).

Peltzman has argued that regulations may not just be ineffective, in preventing ill-health, but they may actually create ill-health. In a study on drug safety, for example, he argued that legislation slowed the introduction of useful new drugs, leaving a larger number of people in ill-health than would have been injured by the occasional thalidomide style disaster (3).

Peltzman has also studied the effects of car safety regulations on health (4). He claimed that regulations may have increased the accident rate by encouraging drivers to take more risks because they perceived themselves to be safer. This 'risk compensation hypothesis' has become a major theme in studies advocating deregulation (5).

Peltzman argued that car safety regulations have been ineffective, costly, and entirely the wrong mechanism. His study on car safety assumed that unregulated market forces would have produced a significant decline in the road death rate. He concluded that better steps to improve safety would have been taken voluntarily by manufacturers.

This line of argument against regulation is one that applies to the safety of colour additives. Chapters 3 and 6 investigate the action taken voluntarily by manufacturers to remove hazardous colours from food, to see whether regulation was superfluous. The merits of different types of regulation are also discussed since the efficacy of the permitted (positive) list in controlling the safety of colours has recently been challenged and the negative list promoted instead.

> It was thought, some fifteen years ago, that the positive list system alone would be more suitable to protect the health of the consumer. As a matter of fact this would probably have been the case, had the absolute concept of positive lists alone proved to be practical in its application. Experience has shown, however, that in fact this is not so and that its application raises endless difficulties and complications. The pretended superiority of the system as regards safety is, therefore, by no means a recognised fact (6).

2.4 b) Negative Effects on Innovation and Choice

The regulatory process has frequently been criticised on the grounds of loss of the benefits of innovation. For example in the areas of transport, drugs and chemicals, regulations have been portrayed as direct barriers to innovation (7). At a symposium on vehicle regulation in 1978 Norman Alpert (of Exxon Research and Engineering) complained that:

> Government regulation is having a strong, negative impact on the innovative process. The expense of regulation so preoccupies the management and financial resources of companies that the innovative process is set aside. The more regulation you have, therefore, the less innovative an industry tends to be (8).

In the area of food colours the permitted list has been heavily criticised. In 1975 B J R Havelock of ICI complained about the restrictive effects of the positive list on innovation; he expressed concern at

> The lack of incentive, or the increasing lack of incentive, to development. The law seems to become more and more detailed and restrictive and less general. The original Act said that if you did not harm people that was all right; nowadays you have to get products on a list before you may use them (9).

More recently, Verner Wheelock of Bradford University, has said:

> It should also be recognised that if controls on additives become excessivly stringent then industrial concerns are less likely to develop new additives (10).

Many have portrayed regulation as a barrier to capital accumulation, arguing that it reduces investment, inhibits R&D and innovation, contributes to inflation, distorts the market, and is an unnecessary extra burden during economic recession. These economic costs are portrayed as social costs since they reduce economic growth and therefore reduce 'social wellbeing' (11). For example, it has been stated that there is a limit to the amount of regulation the economy can absorb at a given time and that we are close to that limit (12).

Food regulations have been criticised for their social cost. Regulations specifying the contents of products (compositional standards) have come under heavy attack on the grounds not only of stunting innovation but of restricting consumer choice.

David Roberts, a chief Trading Standards Officer, paraphrased the feelings of the food industry on this issue in 1982:

> Those who argue the case can clearly demonstrate that, in some areas at least, the existence of standards has prevented them from developing foods which the customer would have been

> prepared to purchase. For example, many meat product manufacturers point out the inflexible iron corset that the Canned Meat Product Regulations of 1967 has encased them in .... Similarly, the soft drinks industry claim it cannot develop new products due to the provisions of the Soft Drink Regulations....
>
> Those who advocate the abolition of standards, usually adopt the argument that standards are an outdated concept, and can be replaced by informative labelling ... Thus, they go on, the consumer will have the best of both worlds. He or she will know exactly what it is they are buying, and the opportunity to obtain new products will exist because the manufacturers will be set free and will seek to exploit the gaps that they contend are present for new products (13).

The Consumers' Association has supported the policy of removing compositional standards from most foods. Daphne Grose, a representative of the CA, said in 1983 that her organisation believed in the policy of controlling a few staple foods and traditional foods (by setting compositional standards) but, in general, relying on labelling. This has been MAFF's policy since World War II, with increased emphasis on labelling in recent years. Daphne Grose has claimed that

> This policy, when working properly, should permit innovation, encourage choice, competition and fair trading ... as a policy it should produce fewer mandatory compositional requirements, more labelling requirements and far greater freedom for innovation (14).

And George Jupe, head of food standards at MAFF in 1985 confirmed that this is the view of many manufacturers:

> Manufacturers say they dislike regulations. Compositional regulations in particular are criticised on the ground that they inhibit innovation (15).

Various writers have claimed that regulation affects innovation adversely by slowing it down, distorting it or stopping it altogether. Chapter 4 examines the effects of colour regulations on innovation in the food and chemical industries; chapter 5 assesses their effects on consumer choice; and chapter 7 examines the policy implications.

2.5 EXPLANATION OF NEGATIVE EFFECTS

Government regulation was assumed to be effective in protecting the public while the dominant view of regulation was that it was introduced at the behest of consumers or workers (16). In 1955 Bernstein first put forward the Perversion hypothesis - the idea that although regulation is supposed to protect consumers and workers, it somehow gets perverted so that producers/employers benefit instead (17). This view has been echoed in the conclusions of some assessments of regulation effects.

The most common explanation for the claimed ineffectiveness of regulation is the strong influence of industry on the decision-making process. There is a wide range of views about the industry-regulatory relationship, ranging from views of regulatory bodies as autonomous, to being totally under a regulated industry's control.

A variety of theories have been put forward to explain why regulations have not been sufficiently effective in protecting the public. These theories can be divided into three main schools of thought, based on models of regulatory bodies as:

a) Autonomous regulators
b) Open to influence
c) Serving industry.

2.6 a) Autonomous Regulators

This school of thought sees regulators as the prime beneficiaries of regulation. Ellis Hawley has noted the

> Recent tendencies toward seeing regulatory operations as 'businesses' or 'industries' working actively to broaden and sustain the demand for their products (18).

Lester Lave, for example, has suggested that regulation may become ineffective because

> Bureaucracies develop a vested interest in surviving and in expanding their role (19).

This school tends to complain that regulatory bodies have been given too much power and are themselves the main beneficiaries of regulation.

Regulators are criticised for making decisions most suited to their own bureaucratic needs. James Wilson, for example, has accused them of ignoring the needs of interest groups (20).

2.7 b) Open to Influence

The second school of thought portrays regulators as a neutral body open to influence by a variety of interest groups. Most feel that industrial groups predominate because they have greater power and resources to influence, but that regulations can benefit the public whenever they exhert influence.

Nader for example, gives instances of the restraining influence of industry on regulators:

> The director of the Office of Highway Safety in the Bureau of Public Roads... and the Chief of the Division of Accident Prevention...say that the influence of the automobile industry on their operations restrains how far they dare go in criticising or warning the public of vehicle design hazards (21).
>
> The Interstate Commerce Commission has been delaying the release of a tyre accident study until those groups at whom it is primarily directed pre-screen the material in detail and resolve any differences before it is made public (22).

Some models pinpoint the lack of consumer or worker input to the regulatory decision-making process as the reason for ill-effects. Salaman and Wamsley, for example, have written of the Food and Drug Administration, that

> Lacking active support from the masses of consumers whose interest tends to be diffuse and unfocussed, such agencies as the Food and Drug Administration had to reach an accomodation with the handful of producers directly affected by their actions. Since the relevant legislators faced much the same pattern of interest, the result was a cozy triumvirate of legislators, industry and agency - with the consumer conspicuously absent (23).

Others criticse the decision-making structure itself. Stigler, for example, argues that regulatory bodies are inevitably open to capture by any interest group. He feels that regulatory bodies are neutral and capture by one group or another is to be expected because the decision-making process entails bargaining between different interest groups (24). Some writers, such as Posner, think the system is sufficiently neutral to allow consumer interests to sometimes prevail over producer interests (25).

2.8 c) Serving Industry

The third school of thought sees industry as the sole beneficiaries of regulation (26). It suggests that industry actually initiates regulatory activity, controlling the regulators and regulations:

> As a rule, regulation is acquired by the industry and is designed and operated primarily for its benefit (27).

Regulation is actively sought by some sectors of industry because, as Friedland & Leone argue for example, it can benefit small waste producers at the expense of larger ones, or restrict the entry of new rivals into an industry (28). The influence of industrial groups in actively shaping legislation has been argued by Cranston, for example. He points out that large corporations are consulted by regulators about their safety practices, which are then often adopted as standards for the industry:

> Consumer legislation is mostly a codification of the practices already adopted by certain businesses (29).

Therefore, he argues, it will not necessarily be appropriate to worker or consumer needs.

This is illustrated by a comment made by a CBI official about the Roben's report on occupational health and safety:

> The Report has come down remarkably close to the line [we] suggested ... [so] it was felt that 'comment' could wait until the Government came up with firm recommendations for legislation ... if the Report was accepted any comment would be a duplication of our evidence (30).

Freeman et al suggest that regulation inevitably serves industry because the regulatory process is

> A political process entailing bargaining between parties of unequal power (31),

and industrial power is always greatest.

Some take a different view and see regulators not just being influenced always by industry but the state actively working on behalf of sectors of industry or capital. In this school of thought industry is seen as a dominant force because, as Vogel says, it is

> Not simply another interest group: its role [is] actually more akin to that of a ruling class or dominant elite (32).

Andrew Blowers has summarised this position:

> Business is able to penetrate all levels of political decision making and, by strategies of manipulation, information control and sanctions, is able to define the political agenda and resist controls or financial penalties that threaten its continued prosperity (33).

For example, Labour Research concluded in a review of the Roben's Report on occupational safety that the committee had joined in 'a conspiracy with the supine inspectorates to weaken still further safety legislation' (34).

2.9 POLICY OPTIONS

The solutions put forward to the various models of regulatory failure vary widely, but can be divided into two broad schools of thought: those who favour deregulation and those who favour continued but improved forms of state intervention.

2.10 a) Deregulation

Those who favour deregulation argue that regulation is expensive and inefficient as well as failing to benefit the public. They frequently have a profound belief in the benefits of a free market system and see any government intervention as automatically increasing costs and reducing efficiency (thereby reducing the overall wellbeing of society) (35). This view is not a pure resurgence of a crude nineteenth century form of economic liberalism. One source seems to have been welfare economics, particularly the 'Pareto concept' or compensation principle (36). Criticisms of, and alternatives to, regulation put forward by deregulators tend to use cost-benefit analysis or the compensation method (37). Many promote Pareto-based models of decision-making as a description of how market forces can and should work.

One of the most vocal proponents of this view has been Sam Peltzman, an economist from the University of Chicago, who has conducted several studies on the effects of regulation. His view is shared by Freeman, for example, who sees the need for measures that

> Would reduce the scope for administrative discretion and bargaining (38).

ie. measures that by-pass the need for regulatory agencies and are based on market forces. Kneese and Schulze have argued that only market mechanisms can deal effectively with the complexity of issues involved:

> The blunt instrument of central regulatory controls is not an effective legislative device ... Relying on a central regulatory bureaucracy to carry out social policy simply will not work: there are too many actors, too much technical knowledge, too many different circumstances to be grasped by a regulatory agency (39).

A policy of deregulation has the following implications:

a) The illegitimacy of direct state intervention in the production/consumption process, except to set conditions for free competition.

b) Renewed emphasis on after-the-event <u>compensation</u> for ill-health resulting from exposure to hazards.

c) Increased emphasis on the <u>right</u> of firms (and government bodies) to pollute or injure, reestablishing the Buyer Beware principle, and putting the onus on individuals to protect themselves from hazards by being well-informed and making the 'correct' buying decisions.

d) Increased emphasis on the (short-term) needs of capital, and increased dependance on the cash nexus.

e) Emphasis on the view of technology as a pure progressive force, with hazards a minor side-effect.

The efficiency claimed for market mechanisms rests on the assumption that all social groups have the resources, and are equally free, to choose to protect themselves from hazards. In practice market mechanisms (such as competition, litigation) can be effective in reducing hazards - but it is an erratic, often slow mechanism, which perpetuates inequalities in the distribution of health and choice among social groups.

2.11 b) Improved State Intervention

The second school of thought, covering a very wide range of perspectives, feels that regulation can be salvaged and improved (40). Just as some free-market proponents criticise the regulatory structure as being an inappropriate mechanism for dealing with the problem, so from environmentalists and socialists comes a fundamental critique of the regulatory process. Knapp, for example, suggests that environmental regulation

> Achieves not much more than the passing on to consumers or to society as a whole the costs of 'cleanliness' without really coming to terms with the serious problems raised by the current disruption of our environment (41)

ie. the disruption caused by business enterprise and goals of profit ruling production decisions (42).

It is suggested that regulation can only ever be a partial policy because it attempts to control only the hazards of technology rather than the direction of technological change itself or the democracy of the process of control (43). Regulation has been described as classdiscriminatory in its technical standards, structure, process and ideology. Claus Offe, for example, has described the production of regulation as an attempt by a capitalist state to reduce the likelihood of the appearance of conflict. It depoliticises conflict and hazards (44).

Policies of improved state intervention to control technology carry the following implications and assumptions:

a) The necessity of state intervention in the production process.

b) The right of people not to be exposed to certain types of technology or levels of hazard.

c) Limiting technological hazards by establishing standards.

d) Significant involvement of affected groups in the decision-making process.

e) Acknowledgement of some basic shortcomings in the market system. For some writers this amounts to emphasis on longer-term needs of capital; for others to the adoption of socialist organisation and economics.

f) Controlling the direction of future technological developments.

Much of the debate about the merits of regulatory processes is really about who benefits from regulation. Do the main benefits really go to the public (as is often the claimed aim of legislators) or do they go to certain sectors of industry or even to regulators themselves? It is clear that sectors of industry sometimes defend or even fight to gain particular regulations. Chapter 3 investigates some of the industrial and professional groups that actively campaigned for regulations on food colours, and the benefits they felt they would gain. It includes a description of the role of science and experts, as well as covering debates on the legitimacy and desirability of intervention by the state.

2.12 DEFINITIONS OF REGULATION

Regulation is often portrayed as homogeneous, but in fact a wide range of regulatory mechanisms have been developed. The following section outlines the differences between acts and regulations, describes the main groups of controls, and defines the regulations that have been introduced for food colours.

Regulations are usually distinguishable from Acts in the following ways:

ACTS usually contain elements of 'procedural' law, prescribing systems of enforcement, and 'substantive' law, creating or altering general rights and powers or duties. The principles or standards outlined in acts are usually generic.

REGULATIONS are subordinate pieces of legislation made under powers given by Acts, often to clarify points of principle. They are specific rather than generic; they usually prescribe detailed standards and controls.

The Food Act, for example, makes it an offence to add harmful substances to food. Regulations made under powers given to Ministers by the Act specify that certain colours may or may not be used (45). They represent an attempt to clarify the application of the Act in a particular area.

2.13 Types of Control on Technology

Regulations introduced to control many kinds of technologies can be divided into a number of types, according to the sphere they attempt to influence.

1. Prohibiting Use of Technology

a) Pre-marketing Assessments:
Controls of this sort require the technology to pass certain assessments to gain approval before they can be marketed. Pharmaceutical products, for example, have to pass tests for efficacy and safety before they can

be licensed; food colours have to pass assessments on need and safety before they can be added to the permitted list.

b) Post-marketing Prohibitions:
Technologies may be prohibited after they have been on the market for some time. Some colours have been banned from certain foods or all food by, for example, compositional standards or a negative list.

2. Technical and Procedural Controls on Use

Safety devices and treatments are legally required for some technologies. These can aim to protect after an accident occurs, (eg. seat belts in cars), or they can aim to prevent accidents (eg. machinery guards). Procedural requirements include safety checks, safety training and supervision. Some affect the operator and some affect the technology. For food colours such controls include purity specifications, restrictions on the quantities added to the product and restrictions on the range of foods to which they may be added.

3. Information

Many technological regulations also require information to be presented to the user or operator, to identify the technology, to warn about hazards or to give guidance for safe use. Colours are required to be labelled as suitable for food in the manufacturing environment; they have to be identified by name or E number on the finished product. In the USA some products must carry a warning that a certain colour, Tartrazine (E102), may provoke intolerant reactions.

4. Facilitating Regulations

Regulations may be introduced to promote a change-over to a less hazardous technology. Such regulations are rare. One example is the scheme of grants introduced by government to enable householders to convert from coal and wood fired heating (which created much pollution) to central heating. Facilitating regulations have not been introduced for food colours.

5. Enforcement Procedures

Regulations generally outline enforcement procedures and penalties, or refer to provisions in the Act. This applies to the regulations that have been introduced for colours.

2.14 REGULATIONS INTRODUCED FOR COLOURS

Regulations introduced to control the use of colours can be divided into eight types, described below.

1. Negative list of colours

A negative list bans named colours from all food. The list may be any length. A negative list banning a few colours was introduced in 1925.

2. Positive list

A positive or permitted list defines the colours that are permitted for use in food. No colours other than those on the list may be used, although there may be a few loopholes (46). The list can be any length. A positive list was introduced in 1957.

3. Declaration of functional group

A statement that colour has been added can be required on labels or counter displays to inform the consumer. From the 1940s the phrase 'added colour' had to be declared on most pre-packed foods.

4. Declaration of named colour

Individual colours can be identified in place of, or as well as, the generic or functional group. Designated names were first recommended in 1954. These and the alternative EEC E number system were introduced fully into the UK for most pre-packed foods in July 1986. This scheme required the functional group and the name or code number of a colour to be declared, for example, 'colour: Amaranth' or 'colour: E123'.

5. Standards of purity

The purity and chemical composition of a colour can be specified. Limits were placed on the quantity of contaminants such as arsenic, lead, and copper in the early 1900s. Voluntary British Standards specified the chemical composition and levels of impurities of colours from the 1950s. In the 1960s some specifications were included in regulations.

6. Compositional standards and restricted uses

There are two main types of compositional standard. 'Exclusive' standards prescribe the ingredients of a food and prevent foods that look similar being marketed. No compositional standards of this sort have been made in the UK. Examples are found in Europe: ancient German controls on beer have taken this form. The second type of compositional standards are 'reserved descriptions' which specify that any food called by a certain name must contain a minimum proportion of certain ingredients and must not contain specified additives. In the UK some foods like bread, milk, flour, cheese, jam and chocolate have had their composition regulated - usually minimum proportions of the main ingredients are specified. In many cases the use of colour is controlled - either by prohibiting all colours or permitting specific ones. For example, bread regulations allow only Caramel colourings (E150) to be added to bread; dairy regulations allow only Annatto and a few other plant-based colours to be added to cheese and butter.

Another type of regulation may also restrict the use of colours to particular foods. Sometimes the regulations specifying the permitted colours may state that particular ones may only be used for certain purposes. Lithol rubine, for example, has been restricted to the rind of hard cheese ; aluminium and gold have been restricted to dragees and sugar-coated flour confectionery.

7. Protection for particular population groups

The exposure of certain groups of the population to colours can be reduced. Regulations to be introduced in late 1987 will prohibit colours from foods specially made for infants (ie. baby foods). This was first recommended by an advisory committee (FACC) in 1979.

8. **Maximum levels of use**

Regulations can limit the quantity of colour (in parts per million) allowed in particular foods. Regulations of this sort are about to be made in the UK. They have existed in a few other countries for many years.

2.15 METHODS OF ASSESSING THE EFFECTS OF REGULATIONS

Many researchers have focussed on the processes and pressure groups behind regulations in order to gain information about who benefits from them. While this approach is very necessary and informative it often needs to be supplemented by evaluations of the concrete effects of regulations. For example, a regulation set up to protect the interests of one section of industry may actually bring significant benefits to other social groups, despite the fact that such benefits were not the rationale behind the new law.

A number of studies have attempted to measure the effects, rather than to evaluate processes. Apart from the large number of studies in the area of vehicle safety, most areas of technology are served only by case studies (or sometimes only anecdotes). A few systematic studies of empirical data have been carried out. The benefits and limitations of some of their methodologies have been assessed for their usefulness to my own studies on colours presented in chapters 5 and 6. These methods are summarised below.

1. **Using enforcement data**

Studies of the number of inspections, infringements and prosecutions have sometimes formed the basis of assessments of the effects of legislation. John Burnett and Ingeborg Paulus, for example, have examined such data to assess the effects of the Food Acts of the late 1800s (47). These studies provide more information about enforcement policies and resources rather than the actual effects of legislation.

They do provide interesting information about trends in the proportion of adulterated food. But this data is not objective because definitions of adulteration changed (see chapter 3). I have used enforcement data only occasionally in my assessments, to supplement other data.

2. Measuring health effects

a) One method is to produce a balance sheet of health 'forgone' and health obtained by regulation. This can be done using crude cost assessments (e.g. Peltzman (48)), or it can be done in a more sophisticated way taking in more than monetary factors. I have used the concept of 'health forgone' to produce a measure of the burden of hazard experienced as a result of the delay in introducing regulations. This is described in chapter 6.

b) Health assessments have been made on population groups at a single point in time, after legislation. P Baxter has compared two occupational groups exposed to a chemical hazard before and after legislation (49). This can be useful since it gives a method of establishing a reasonable (though far from perfect) control group *post hoc*. It is also suitable for hazards with a long gestation period, such as carcinogens. The method would have been useful to my study but I found no suitable data that differentiated exposure to different colours or groups of colours.

c) Trends in health or hazard indicators over periods of time have been analysed. For example, Alan Irwin has examined death rates from car accidents between 1970 and 1980, a period of changing regulations. He adjusted the figures for the changing population levels, number of vehicles and distance travelled (50). Fred Steward used data on the therapeutic significance of new pharmaceutical products to assess claims that regulations had led to a loss of health. He divided new products into four groups according to significance and plotted the number per year for the years before and after the introduction of regulations (51). In collating views on the significance to health Steward found some bias in information according to its source. He concluded a range of views should be used to give a reasonably objective assessment.

This is a very useful method if sufficient data are available. The method of plotting, year by year, the number of substances according to some rating scheme (in this case of safety) was used in chapter 6. I attempted to use a range of views for assessing the safety of colours, but for the majority of colours only one or two views were available, from rather similar sources. I compensated for lack of objectivity by allocating a hazard rating retrospectively and holding it constant over time. (The method is described in chapter 6).

d) Statistical trend extrapolation has been used by Peltzman to assess the effects of car safety regulations (52). He regressed traffic death rates on a set of variables which he considered to influence drivers' demands for risky driving. The regressions for an assumed pre-regulatory period were projected to produce an expected death-rate in the later period. The expected rates were then compared with the actual rates. This was done for two sets of variables: time series data and cross-sectional data. This method is open to considerable distortion, if for example some variables are highly correlated or important variables are omitted. I did not use regression models for this reason.

e) Where substances are vetted for safety before marketing the proportion that are withdrawn for safety reasons after marketing can be used as a measure of the effects of regulation. Fred Steward developed this method to examine the effects of drug regulations (53). He compared the numbers withdrawn in the years before and after the introduction of regulations. I have used the concept of monitoring reasons for withdrawal in assessing the changes to the permitted list of colours after 1957. The usefulness of Steward's method to my study is limited because a direct comparison cannot be made between the reasons for withdrawal before and after regulation; nevertheless an amended version of this method is used.

f) Comparisons of trends of several health indicators in different geographical areas, over the same time period, have been made by several authors. F Zimring, for example, has examined the effects of firearm controls in US states with different regulations (54). Fred Steward has assessed trends in the therapeutic significance of new pharmaceutical products in the UK and USA (55). This has limitations in that there are many differences in culture and process that may explain differences in effects. I have made some international comparisons of the regulations on food colours, usually as an indicator of what was technically and politically possible, rather than as an assessment of effects. International regulations cannot be used to assess the health hazards of colours without background information since industrial need and tradition are as important as toxicity data in regulating colours.

3. Measuring effects on innovation

a) Fred Steward has compiled data on the introduction of new pharmaceutical products for periods of time before and after regulations (56). His method allows a comparison of trends as well as changes at the time of regulation. Steward also examined alternative explanations for the reduction in innovation, such as the research policy of drug companies, and scientific technical limitations to innovation. I used Steward's methods in chapter 4 to assess the effects of regulation on industrial innovation.

The methods I have used are described in detail in the appropriate chapters.

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36 The Pareto principle is based on the idea that costs and benefits are objectively quantifiable and can be or tend to be redistributed so that injured groups are compensated by groups benefitting from any particular change - ao the net effect of the change is beneficial ie. a 'social improvement'.

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CHAPTER 3

DEVELOPMENT OF GOVERNMENT REGULATIONS ON FOOD COLOURS

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DEVELOPMENT OF GOVERNMENT REGULATIONS ON FOOD COLOURS

3.1 Introduction

This chapter provides an outline of the wide variety of legislation on colours. It identifies cycles of regulatory activity. The first part of the chapter charts early controls on colours and the establishment of general laws in the nineteenth century. It describes proposals for negative lists, positive lists and other regulations, and their predicted effects on trade, innovation, health and food quality. It looks at the debates about the merits of voluntary action versus government intervention, and the technical and political barriers to the introduction of regulations. It charts scientific and medical concerns about ill-health and fraud connected with the use of colours. The second part focuses on the development of colour regulations in the twentieth century.

The focus of this thesis is on the effects of regulation, rather than on the groups and processes that generated and shaped the laws. Therefore this chapter does not provide a history of the very complex debates, alliances and battles fought over food safety and quality. John Burnett, Ingeborg Paulus and others have researched parts of this topic (particularly for the nineteenth century) (1), although much research remains to be done. So this chapter aims to provide a record of the proposals for and predicted merits of regulation, to provide a background to the assessments of chapters 4, 5 and 6.

SITUATION PRIOR TO 1850

3.2 Early Controls on Colours

Early attempts to control the use of colours grew out of concerns about fraud rather than hazards. For example, citizens of Athens were sufficiently concerned about adulteration to appoint a special inspector of wines (2). According to Pliny wine was also tampered with in ancient Rome. Some wines from Gaul were artificially coloured with aloes and other drugs (3).

In England, the first action to suppress adulteration was taken by the guilds which saw that there were trade advantages in maintaining purity of the goods sold by guild members (4). The Guild of Pepperers (suppliers of spices) was very active during the reigns of Henry II and III, introducing rules to control adulteration by its members. Adding coloured dust or flour to spices and pepper (a widely-used preservative) was common because spices were expensive and often in short supply (5).

In the sixteenth century a common and cheap adulterant of beer was water; its addition was often disguised with colours (such as burnt sugar) and flavours. Many towns appointed ale inspectors. For bread, national legislation was needed and introduced at an early stage. The Assize of Bread in the thirteenth century attempted to regulate the price and composition of bread.

In countries such as France and Germany legislation controlling colours was introduced early for certain staple foods. In Paris, an edict issued in 1396 forbade the colouring of butter (6). Other laws of the thirteenth and fourteenth centuries forbade the colouring or adulteration of wine, beer and flour (7).

Legislation was introduced in Britain in the 1700s for a few selected commodities. In 1725 an Act prohibited the adulteration of tea - nothing (including colours) was to be added or mixed with it (8). In 1731 a further Act prescribed a penalty for 'sophisticating' tea with colours such as Terra Japonica, molasses, clay, sugar and Logwood (9). In the same period a fine was introduced for similar adulteration of coffee (10). An Act of Parliament during the reign of George III (11) prohibited chemists, grocers and druggists from supplying colours and other adulterants to brewers (12).

The controls exercised by the guilds and those imposed by law were not effective because the science of detecting adulteration had not kept pace with technological developments (13); sampling and testing still relied primarily on taste, smell and feel. Also, there was no proper system of independent, locally-based inspection and enforcement.

3.3 Growth in Adulteration

Systematic adulteration of food was practised far more (and in a greater range of foods) in the 1800s than in the 1700s. In rural areas householders were often their own bakers, brewers and butchers. In small communities a brewer, baker or grocer caught defrauding people would quickly lose custom. But in the new towns consumers and producers were separated; adulteration was much easier to practise. The growing towns did not have the necessary official system of inspection and enforcement to prevent adulteration.

New techniques of adulteration were publicised in trade books and leaflets. R Shannon, for example, gave some handy tips on wine colouration in A Practical Treatise on Brewing, Distilling and Rectification in 1805:

> Burnt sugar gives a fine amber colour from the lightest shade to the deepness of old brandy; oak chips the same and also an astringency. Yellow saunders a fine citron colour and grateful aromatic scent. Sassafras, a strawberry colour and a fine aromatic but peculiar scent. Red saunders, brazilli and logwood [give] red and purplish red with a sweet sub-astringent taste. To these colour ingredients, we may add turnsole, cochineal, mulberries, elderberries, brambleberries, barberries etc... (14).1

Another significant development contributing to the growth in adulteration in the early nineteenth century was the widespread acceptance of a free market policy. The adoption of policies promoted by Adam Smith and others led to the removal of many legal controls on trade (15).

3.4 Scientific Concern About Colours

In 1820 a book by Frederick Accum, A Treatise on Adulterations of Food, and Culinary Poisons, became a best-seller. His scientific analyses of foods for the preceding twenty years demonstrated that much food and drink was adulterated. He highlighted the fact that adulteration was not just a fraud on the pocket but that some adulterants were a significant health risk. He described as poisons the red lead added to cayenne pepper and sauces, and the 'greening' of pickles with copper. Accum was also concerned about injurious contaminants in harmless colours, such as red lead adulterating inferior vermilion; sap-green (from buckthorn berries) being brightened by copper (16). He also listed non-poisonous frauds, among them the colours turmeric (in mustard), Venetian red (in anchovy sauce) and caramel colouring (in beer) (17). Accum had criticised the prevailing view that adulteration was 'acceptable trade practice' (18). He felt adulteration to be unacceptable and called for government 'interference' to control it (19).

In 1833 Dr O'Shaughnessy also highlighted the problem of poisonous colours in sugar confectionery in The Lancet. He said:

> It is my principal aim to lay before the public and the medical profession a calm, dispassionate statement of the existence of various poisons (gamboge, lead, copper, mercury, and chromate of lead) in several articles of confectionery, the preparation of which, from their peculiar attractions to the younger branches of the community, has grown into a separate and most extensive branch of manufacture (20).

3.5 Government Response: Free Market Policy

Despite the huge amount of public interest in Accum's book and similar revelations there was no significant government action on the issue of adulteration. Accum had been accused of removing pages from library books, which undermined his credibility. But much more important than this was the prevailing philosophy that unacceptable forms of adulteration were best solved by free competition.

Adulteration at this time was recognised as a problem; it was mentioned in passing by several Parliamentary committees, but there was no government inquiry into adulteration in the early part of the nineteenth century. It was felt that the appropriate means of dealing with adulteration was to open food trade to free competition. Following a government committee report on bread in 1815, for example, the ancient Bread Assizes controlling the ingredients of bread were abolished (21).

Government controls on a few selected commodities continued, and were partly enforced. An Act of 1816, for example, prohibited colourings in beer (22). Between 1812 and 1819, 27 brewers' druggist shops in London were convicted for selling illegal substances, including colours, for brewing; in 1819 alone there were almost one hundred convictions of brewers and brewers' druggists under the Excise laws for using *Cocculus indicus* and other cheap substitutes to bulk out beer; and there were 11 convictions of grocers for selling fake or bulked out tea in five months of 1818 (23). Colourings played a significant role in these types of adulteration, by masking dilution and substitution. These convictions were not in opposition to the general free market policy. The concern here was much more with preventing the evasion of excise duty than protecting the public from adulteration. The Customs and Excise Department had a large staff of nearly 5000 inspectors to enforce the excise law, but it did not effectively prevent adulteration of even the small range of commodities on which duty was paid (24).

Burnett has demonstrated that the government's policy of promoting free competition in fact promoted rather than discouraged adulteration (25). Monopoly had not been a feature of the food trade in the early decades of the century when adulteration first increased. Government policies produced excessive competition which actually forced traders into adulteration (26), such as adding colours to mask the dilution of beer.

Public concern about adulteration did not die down completely after Accum's book; it was mentioned in a number of academic and reference books as well as popular books in the following decades (27). Some working class groups, such as the Rochdale Pioneers, set up co-operatives to provide unadulterated food at reasonable prices. They found that people had become accustomed to the taste and colour of adulterated products and did not necessarily like the pure foods immediately. The Co-op employed educators to teach the public about the merits of pure food, and to encourage them to accept their unaccustomed colour and flavour. Trade reactions in this period were mainly defensive, denying the prevalence of adulteration and its possible harmful effects.

3.6 DEVELOPMENT OF GENERAL FOOD LAWS 1850-1880.

The creation and shaping of food laws in response to public, medical, municipal and trade pressure has been described by John Burnett and Ingeborg Paulus (28). The following sections outline the major changes in government and trade controls, the scientific concerns about hazards, and debates about the effects of regulations in relation to food colours.

The publication of a book by John Mitchell, a reputable chemist, in 1848 started another wave of public outcry about adulteration. His book noted the use of many food adulterants, including the use of at least ten colours.

In the late 1840s the Customs and Excise (Board of Trade) were criticised publicly for failing to control adulteration. The government defended their record by claiming that the necessary scientific methods of detecting adulteration were not available. Dr Arthur Hassall, a chemical analyst and medical doctor, refuted this claim in a paper in the Lancet in 1850, and set out to prove that detection was possible. Arthur Hassall and Thomas Wakley (the editor, of the Lancet) set up a watch-dog group called the Analytical Sanitary Commission. The Lancet published regular reports of its food analyses, and the names of offending traders, between 1851 and 1854.

The role of colouring matters in systematic fraud was revealed month after month in the Lancet, and spread by popular papers. Coloured foods included diluted milk, spices, pickles, bottled fruit and vegetables, anchovies, potted meat and fish, essence of lobster and shrimp, preserves and jellies and sugar confectionery. The list of foods found by Hassall and his team to contain colours is given in table H.1 in appendix H.

Their reports showed that the majority of foods were adulterated in some way; even some shops supplying the rich sold adulterated foods. Hassall pointed out that the practice of adding colour did more than add extra appeal or attractiveness:

> [One] form of adulteration consists in the addition of colouring matters of various kinds, with a view to heighten the colour, and, as it is considered, to improve the appearance of the articles, as well as to conceal other forms of adulteration. This is a very prevalent adulteration, and it is the most objectionable and reprehensible of all, because substances are frequently employed, for the purpose of imparting colour, possessing highly deleterious and even in some cases poisonous properties, as various preparations of lead, copper, mercury, and arsenic (29).

He named as 'some of the deadliest and most virulent of known poisons' the following colours: chromates of potash and lead, carbonate of lead, red oxide of lead, bisulphuret of mercury or vermillion, the three Brunswick greens and the carbonate, acetate and arsenite of copper (30).

Poisoning could sometimes be acute. Accum had mentioned cases of people dying after prodigious consumption of pickles coloured with copper. A Dr Percival gave an account in Medical Transactions of

> A young lady who amused herself while her hair was dressing with eating samphire pickles impregnated with copper. She soon complained of pain in the stomach ... and in nine days ... death relieved her from her suffering (31).

Recipe books actually recommended copper for brightening the colour. Many of the other mineral colours detected by the Lancet's team were considered by them to be harmful. Hassall pointed out that

> Scarcely a year passes by but several cases are recorded of poisoning by articles of coloured confectionery (32).

He also pointed out longer-term hazards. Though the quantitites used were low, some of the colours (e.g. lead, copper, mercury and arsenic) could accumulate in the body and have slow and insidious effects. Children eating cheap coloured confectionery were particularly at risk from hazardous mineral colours.

3.7 Call for Government Intervention

Hassall and his team called for government controls: a system of analysts for detecting adulterated articles and penalties (fines and imprisonment) for adulteration (33). Hassall's work was taken seriously because it was based on his own meticulous investigations, not the second-hand stories that many earlier writers had relied upon. The scientific reports of Hassall and other new researchers were popularised by newspapers and helped fuel a massive, popular anti-adulteration movement pressing for government action. Even the rich realised their wealth no longer gave them immunity from adulteration. The Lancet's team had found harmful mineral colours in high quality confectionery, although such colours were much more prevalent in inferior quality goods eaten by the poor. It was possibly the Lancet's report of the widespread use of poisonous colours in confectionery in 1954 that finally stimulated some government activity. The government was forced to establish a Select Committee on the Adulteration of Food, Drink and Drugs in 1855. The role played by colours formed a significant part of the Committee's investigation. Arthur Hassall was the first witness to be called. The Committee's chair was sympathetic to the campaigners.

TABLE 3.1 : HASSALL'S LIST OF INJURIOUS COLOURS AND PROPOSED PERMITTED LIST, 1861

Source: Arthur Hassall <u>Adulterations Detected - or Plain Instructions for the Discovery of Frauds in Food and Medicine</u> Longman, Green, Longman and Roberts, London, 1861, 2nd edition, compiled from p11-17, 20-21, 490-498.

KEY:
The listed colours were detected in food in the 1850s.
- Hassall considered the colour should be prohibited
+ Hassall considered the colour could be permitted
* Hassall considered the colour to be injurious

Colour	Hue	In Hassall's view: Could permit (+) Should prohibit (-)	Injurious (*)
ARTIFICIAL COLOURS			
None mentioned			
PLANT PROCUCTS			
Annatto	Yellow		
Beetroot juice	Red		
Bilberries	Red		
Brazil wood	Red	+	
Brazil wood lake	Red	+	
Caramel (Burnt sugar or black jack)	Brown		
Carmine	Red	+	
Carmine lake	Red	+	
Carrot	Yellow		
Catechu (mainly tannin)	Brown		
Cayenne	Orange		*
Elderberry juice	Red		

Colour	Hue	In Hassall's view: Could permit (+) Should prohibit (-)	Injurious (*)
French berries	Yellow	+	
French berry lake (Yellow lake)	Yellow	+	
Fustic wood	Yellow	+	
Fustic wood lake	Yellow	+	
Gamboge	Yellow	-	*
Indigo	Blue	+/-	*
Logwood	Red	+	
Liquorice	Black		
Litmus	Blue	+/-	
Madder root	Brown/Red		
Madder purple	Purple	+	
Mangold	Brown		
Persian berries	Yellow	+	
Persian berry lake	Yellow	+	
Quercitron bark	Yellow	+	
Quercitron bark lake	Yellow	+	
Saffron	Yellow	+	
Sap green (juice of Rhamnus catharticus berries)	Green	+/-	
Treacle	Brown		
Turmeric	Yellow	+	
Turnip	Yellow		
Elderberry juice	Red		

Colour	Hue	In Hassall's view: Could permit (+) Should prohibit (-)	Injurious (*)
ANIMAL PRODUCTS			
Baked horse's liver	Brown		
Burnt blood	Brown		
Cochineal	Red	+	
Cochineal lakes	Red	+	
MIXTURES & UNKNOWNS			
Chinese yellow	Yellow		
Dutch pink (a vegetable dye plus chalk or carbonate of lime)	Yellow		
Pink madder lake	Red	+	
Rose pink (Logwood plus carbonate of lime)	Red		
MINERAL/METALLIC PRODUCTS			
Alkali	Yellow		
Alum	White		*
Antwerp blue (a preparation/modification of Prussian blue with chalk)	Blue	-	*
Artificial ultramarine (German ultramarine, similar to natural ultramarine)	Blue		*
Bichromate of potash	Yellow		
Blue verditer (sesquicarbonate of copper)	Blue	-	
Bole armenian (Red ferruginous earth)	Red	-	*
Brick dust	Brown		

Colour	Hue	In Hassall's view: Could permit (+) Should prohibit (-)	Injurious (*)
Brunswick green deep (oxychloride of copper)	Green	-	*
Brunswick green middle (oxychloride of copper)	Green	-	*
Brunswick green pale (oxychloride of copper)	Green	-	*
Burnt umber	Brown		
Carbonate of lime	White		
Carbonate of magnesia	White		
Chalk	White		
China clay	White		
Chromates of potash	Yellow		*
Chrome deep (Bright or canary chrome, a lead chromate)	Yellow	-	
Chrome lemon (a lead chromate)	Yellow	-	
Chrome orange (a lead chromate)	Yellow	-	
Cobalt	Blue	-	
Copper bronze (alloy of copper and zinc)	Metallic	-	*
Emerald green (Scheele's green or arsenite of copper)	Green	-	*
False brunswick green deep (mixture of chromates of lead and indigo or possibly Prussian blue)	Green	-	*
False brunswick green middle (mixture of chromates of lead and indigo or possibly Prussian blue)	Green	-	*

Colour	Hue	In Hassall's view: Could permit (+) Should prohibit (-)	Injurious (*)
False brunswick green pale (mixture of chromates of lead and indigo or possibly Prussian blue)	Green	-	*
False verditer (Subsulphate of copper and chalk)	Green	-	
French chalk (Soapstone, a species of talc)	White		
Fuchsine (Acetate of copper)	Green		
Fuller's earth	Brown		
Gold bronze (alloy of copper and zinc)	Metallic	-	
Gypsum			
Indian red	Red		
Iodide of lead	Yellow	-	
Iodide of mercury	Red	-	
King's yellow (Sulphuret of arsenicum with lime & sulphur)	Yellow	-	
Massicot (Protoxide of lead)	Yellow	-	
Mineral green (Green verditer or subcarbonate of copper)	Green	-	
Naples yellow (Sulphuret of antimony)	Yellow	-	
Plaster of Paris (hydrated sulphate of lime or mineral white)	White		*
Plumbago (Black lead or graphite)	Black		*
Potash	White		

Colour	Hue	In Hassall's view: Could permit (+) Should prohibit (-)	Injurious (*)
Prussian blue (Ferrocyanide of iron)	Blue	-	*
Red lead (Minimum or red oxide of lead)	Red	-	*
Red ochre (Red ferruginous earth)	Red	-	*
Red orpiment (Realgar or bisulphuret of arsenic)	Red	-	
Salt	White		
Sienna (Brown ferruginous earths)	Brown	-	*
Silver bronze (alloy of copper and zinc)	Metallic	-	
Smalt (a glass of cobalt)	Blue	-	
Sulphate of copper (Blue vitriol)	Green		*
Sulphate of iron			*
Terra alba (Sulphate of lime)	White		
Ultramarine (double silicate of alumina & soda with sulphuret of sodium)	Blue	-	*
Umber (Brown ferruginous earths)	Brown	-	*
Vandyke brown (Brown ferruginous earths)	Brown	-	*
Venetian red (Red ferruginous earth)	Red	-	*
Verdigris (diacetate of copper)	Green	-	*

Colour	Hue	In Hassall's view: Could permit (+) Should prohibit (-)	Injurious (*)
Verditer (Carbonate of copper)	Green		*
Vermilion (Cinnabar or bisulphuret of mercury)	Red	-	*
White lead (Carbonate of lead)	White	-	*
Yellow ochre (ferruginous earth)	Yellow	-	*
Yellow orpiment (Sulphuret of arsenicum)	Yellow	-	*

Hassall and a few other physicians and chemists called for government to regulate the use of colours by banning harmful ones and establishing a list of acceptable ones. The permitted list suggested by Hassall and others is shown in table 3.1. The colours marked '+' were considered acceptable; colours marked '*' were considered unacceptable 'on the ground that they are all more or less dangerous to the public health, and most of them absolutely poisonous' (34).

3.8 Debate About a Permitted List

The evidence and arguments put forward in favour of a permitted list of colours set the scene for debates that would continue for over 100 years. The main themes of the debate at the time of the Select Committee in 1855 are outlined below.

a) Fraud

Some physicians and analytical chemists were concerned about the way in which colours misled the public about the quality of food. While acknowledging as legitimate (though not necessarily approving of) the practice of adding colours to please the eye, they pointed out two ways in which colours could deceive:

i) by falsely improving the appearance of foods so they appeared better than they were;

ii) by disguising other adulteration, such as the use of cheap or substitute ingredients or processes.

They were concerned that nearly all types of food were affected.

The trade dismissed concerns about fraud. They claimed that adding colours was a legitimate and customary trade practice; the public was not deceived; they chose to buy coloured items. They claimed that fraud on the revenue was already controlled, so colour regulations were not necessary.

b) Harm

There was strong agreement among medical witnesses about the colours that could be considered harmful. The majority of mineral colours and one plant colour were considered injurious (see table 3.1). Concern was also expressed about the contaminants in some harmless plant colours. Most mineral colours were agreed to pose a risk even at the low doses used in food.

The trade and some analysts claimed that there was no longer any health risk because manufacturers had stopped using harmful colours. For example, Mr Blackwell, of Crosse & Blackwell, had stopped 'coppering' pickles after the *Lancet*'s reports about its harmful effects. They argued there was no need for controls.

c) Extent of Use

Some chemists claimed that the use of harmful mineral colours had not stopped. Other chemists and the trade claimed that harmful adulteration was a thing of the past and that harmless vegetable colours were used almost exclusively (35). The latter claim was in fact incorrect, but made regulation seem superfluous.

d) Consumer Demand

The trade groups argued that they were merely responding to the public's desire for coloured foods and cheaper foods. The use of colours turned harmless and nutritious, but cheap, ingredients into acceptable food. They claimed the poor benefitted. Colours were agreed, by both sides, to reduce the cost of food. But some chemists (eg. Hassall) felt that the poor did not necessarily get good value for money from adulterated food: they could pay relatively high prices for poor goods.

e) Technical Need

Some chemists pointed out that harmful mineral colours could be banned because there was a viable alternative. Plant colours were harmless, cheap and simple to use. Hassall's proposed permitted list (table 3.1) took account of the number of colours of a particular hue that were available; he considered indigo, for example, to be injurious when contaminated yet included it in the list of colours to be permitted, presumably to give manufacturers an alternative blue.

f) Foreign Comparison

General anti-adulteration laws of France and the USA, and a French permitted list of colours, were held up as possible models for the UK to adopt. The trade objected. They felt there was no justification for state intervention. They also claimed that the foreign laws had not been particularly satisfactory.

g) Scientific Expertise and Methods

There was disagreement between experts about the extent of adulteration. Hassall was required by the Select Committee to prove the reliability of his findings. The reliability of detection methods became an important issue of debate later in the century.

h) Role of the State

Views on the acceptability of state intervention in the form of controls on colours were diverse. Physicians, such as Medical Officers of Health, were primarily concerned about health issues. They defined adulteration as any practice injurious to health. A number of them supported the idea of banning harmful colours, or having a permitted list as in France.

The physicians who were also chemical analysts took a stronger line. They defined adulteration as fraudulent and injurious practices. They wanted a permitted list of colours. They also wanted laws that would prevent deceitful use of colours.

The analysts of the Inland Revenue defined adulteration as fraud on the revenue (36). They did not see the need for a change in the law.

Traders defined adulteration as 'trade practices'. They defended the status quo and argued against controls; saying that

> No more stringent measures than those now in force could be adopted, without enhancing the cost of the necessities of life, and without such injurious, vexatious, and inquisitorial interference with trade as would be totally in

> variance with the more enlightened policy of all recent legislation, and as such would most materially prevent the development of the system of freedom of commerce, to establish which has of late years been the constant study and aim of the Legislature (37).

3.9 Conclusions of the Select Committee

The Inquiry produced the first official recognition of colour adulteration as a significant problem. The Select Committee concluded that fraudulent adulteration prevailed widely (though witnesses disagreed about the extent) and that harmful colours, though used less than before, were still used.

> Not only is the public health thus exposed to danger, and pecuniary fraud committed on the whole community, but the public morality is tainted, and the high commercial character of this country seriously lowered both at home and in the eyes of foreign countries (38).

Adulteration affected the poor much more than the rich. They highlighted the lack of choice faced by the poor, who did not have

> The same power to protect themselves against such frauds as their rich neighbours; they are necessarily limited to such means of purchase as are afforded by the immediate locality in which they reside, and are, moreover, often bound to one dealer by the facilities of credit which he affords them (39).

The combination of public moral outrage and the testimony of scientists (such as Hassall, Accum, Mitchell, O'Shaughnessy and Phillips of the Excise) had confirmed to the Select Committee that anti-adulteration legislation had become imperative (40). Despite trade objections, the Committee recommended that the state should step in and establish new legislation. The trade felt that the best cause was to 'leave the buyer to take care of himself' (41). The Committee pointed out that this was not always possible; there were many adulterations which were impossible for the buyer to detect. They made the following recommendations for protecting the public and honest traders.

a) A general anti-adulteration law should be introduced along the lines of foreign laws (e.g. France, Germany) to prevent deception or injury to health.

b) Rather than extending the role of the Inland Revenue, a system for detecting and preventing adulteration should be set up within local authorities.

c) It would be difficult and unwise to prohibit innocuous adulterations that reduced the price of food. But Parliament might consider requiring mixtures to be labelled differently to pure foods.

d) For colours, particularly in confectionery, the Committee recommended a negative list:

> Authority should be given to Local Boards of Health, or other governing bodies, to forbid the use, for colouring, of all mineral matter and all poisonous vegetable matter (42).

These recommendations were a compromise between the demands of the public and some public health campaigners on the one hand and traders on the other. They were remarkably sympathetic towards the campaigners. Nevertheless, for colours, the Committee could in theory have recommended any of a number of other specific measures:

a) A total ban on colours

Hassall was clearly opposed to all colouring of food:

> We altogether object to the practice of colouring articles of consumption of all kinds and descriptions; while it merely gratifies the sense of sight, it serves to conceal other adulterations, and is attended in a variety of ways with the greatest danger to health (43).

But a ban represented an unacceptably high level of interference in trade. It could only be justified on grounds of preventing severe injury to health. The fact that public pressure and voluntary trade action had already reduced the use of harmful colours meant that intervention of this sort was not even considered.

b) A ban on colours in certain foods

Laws (that were not properly enforced) already banned colours from tea, bread and coffee, and permitted only caramel colouring in beer. In other countries similar laws existed; in France, for example, colours had been banned from butter for centuries. The Committee could have extended such controls to various staple foods, but this level of intervention could not be justified. Also the Committee did not want the current ineffectual enforcement system, run by the Inland Revenue, to be extended. Focussing on particular commodities might have bolstered that system.

c) A declaration of added colour

There was a precedent for pure foods to be marked or labelled differently to mixed ones: a law required bread made from wheatflour only to be marked 'M' (44). A marking scheme was not considered in detail by the Committee, although they were in favour of some distinction being made between pure foods and mixtures.

d) A positive list for colours

The Committee was aware of the Parisian positive list. They recommended only a ban on harmful colours - a negative list. The Committee's prime concern was preventing injury. Either the Committee failed to recognise the difference between a positive and negative list, or, more likely, they felt the former to be an unjustified intervention.

e) Court of Reference

The actual colours to be banned by a negative list would not have been disputed by the majority of medical practitioners who gave evidence to the inquiry. There was widespread agreement about which colours were harmful. There was therefore no issue at this stage about who should decide which colours were harmful.

3.10 Government Inaction

The government was unable to act on the recommendations of the Select Committee without causing itself problems. As Paulus has put it: how was Parliament to reconcile the competing interests of the traders, the medical profession, and revenue scientists,

> Without alienating important financial supporters, and without making its own civil servants look incompetent?... Non-action was the only feasible way by which the government of the day could extricate itself... (45).

The inquiry led to the official recognition of adulteration as a problem but no clear definition of unacceptable frauds and no immediate action. The fact that the use of harmful mineral colours had diminished was sufficient excuse for no action on colours. Government could claim that traders were putting their own house in order. Chapter 6 assesses whether this was the case.

3.11 First Anti-adulteration Act

Between 1857 and 1859 there were five unsuccessful Parliamentary Bills on adulteration. The campaign was sustained by the Social Science Association in Birmingham and other public and scientific groups. It took a public outcry following the death of seventeen people from adulterated lozenges (46) to force the first anti-adulteration Act. 'An Act for Preventing the Adulteration of Articles of Food or Drink' was passed in 1860 (47) despite the fact that the new Whig government was not in favour of food legislation. When traders saw that an Act was inevitable they altered their stance to exert pressure on government for a measure that would be least detrimental to their interests (48).

The new Act was the first general law outlining principles for fair trading in food. The Act made it an offence to add injurious ingredients and to knowingly sell as 'pure' any food or drink which was adulterated. It allowed local authorities to appoint Public Analysts to examine samples of food and drink brought to them by the public, but the responsibility for controlling adulteration was entirely optional. Only seven analysts were appointed and only one took offenders to court and got convictions (49). However, the Act was important in one respect; it represented acceptance of the principle that adulteration was a problem requiring control and that there was a necessary role for the state - but only in so far as ensuring that sellers allowed buyers to be aware of what they were buying so that buyers could 'choose' to protect themselves.

3.12 Effects of the 1860 Act

The anti-adulteration Act of 1860 was not effective in stopping ill-health from colours, although there was a very significant drop in adulteration between 1850 and 1870.

Arthur Hassall considered that the important factor was not the Act but the work of the Lancet's Analytical Sanitary Commission in identifying and publishing the names of sellers of adulterated food, and the publicity surrounding the hearings of the Select Committee of 1855 (50). His analyses of food clearly showed a reduction in the amount of adulteration in the London area in the 1850s and early 1860s. In 1861 Hassall said:

> Serious as the results recorded in these analyses [of 1861] really are, we have reason to believe that, some years since, things were even worse, and that nothing was more common than to meet with articles of sugar confectionery coloured with verdigris or acetate of copper, with the verditers or carbonates of copper, and with mineral green or arsenite of copper, all of which are virulent poisons (51).

Hassall's claim about the effectiveness of the Lancet's policy of publishing the names of London traders is supported by the fact that adulteration in London dropped while remaining high or growing in some other cities. Adulteration remained a significant problem in most urban areas.

Another reason for the significant drop in the use of metallic colours in the late 1850s and early 1860s was the availability of new colours, the coal tar dyes produced by companies such as Perkin's (set up in 1856) and imported from France, as described in chapter 4. It is possible that at least five coal tar colours could have been in use although Hassall does not mention coal tar colours in his report of 1861.

These events and the 1860 Act had no significant effect on the number of colours in use. Hassall found 33 plant colours, 63 mineral colours, 4 plant/mineral mixtures and 4 animal extracts in food in the 1860s. There was almost no change in the range since his earlier surveys of the 1850s (52).

3.13 Renewed Calls for a Permitted List

Hassall continued to highlight the effects of colours on public health. Of the adulterants he considered to be injurious the vast majority were colours. The year after the 1860 Act Hassall felt the need to publish the permitted list of colours suggested at the time of the Select Committee (see table 3.1), and to renew the call for its introduction.

He listed the injurious colours he had detected since his report in 1855:

> This list ... contains the names of some of the most virulant poisons. Sometimes the quantities of these substances used is so considerable that immediate ill effects are produced: thus, as has already been stated, not a year passes but that serious, and even fatal, accidents arise out of the practice so recklessly pursued of colouring sugar confectionary with poisonous pigments. More frequently the effects are more slowly developed: the substances, although taken perhaps in but minute quantity, gradually and insidiously deteriorate the health, giving rise frequently, amongst other maladies, to various forms of dyspepsia or indigestion: sometimes, as in the case of lead, copper, mercury, and arsenic, they accumulate in the system until at length serious consequences are produced (53).

Though the use of harmful colours had diminished the risk continued. Hassall described in graphic terms the continuing chronic risk from colours consumed daily in small quantities via many common foods:

> It doubtless does sometimes occur, that the same person, in the course of a single day, receives into his stomach some eight or ten [injurious colours]. Thus, with the potted meats and fish, anchovies, red sauces, or cayenne, taken at breakfast, he would consume more or less bole Armenian, Venetian red, red lead, or even bisulphuret of mercury. .... This is no fanciful or exaggerated picture, but one based upon the results derived from the repeated analysis of different articles as furnished to the consumer (54).

3.14 Effects of 1872 Amendment

1868 to 1871 saw four unsuccessful attempts to strengthen the Act before a successful amendment in 1872. It made the appointment of Public Analysts mandatory. It gave local authority inspectors powers to procure samples of food and drink for analysis. It also required Analysts to make quarterly reports to local authorities. However, enforcement of the Act remained patchy.

Despite complaints from traders, the 1872 Act brought clear benefits for the public in several towns where inspectors and analysts had been appointed. Three analysts reported a further fall in the use of injurious colours. The sale of poisonous coloured confectionery was reported to have been stopped by successful prosecutions in Dublin. Foods containing high or medium levels of injurious colours were no longer common in London. The mineral colours had been largely replaced by old plant colours and new coal tar colours developed for the textile industry. All were agreed that the new colours were harmless as long as they were not contaminated, and were a very significant improvement on former practices.

A Select Committee was set up in 1874 to examine the 1872 Act because both traders and analysts were disgruntled by conflicting court decisions. An unexpected ruling on the coloring of tea prompted traders to mount a campaign about the lack of uniform definitions of adulteration (55). But the Select Committee found the situation for colours satisfactory and was thus under no significant pressure to recommend a permitted list defining acceptable colours. Hassall was isolated in his continued call for a special ban on mineral colours. The general view was that the problem of harmful colours had been resolved. The Committee felt the public were being cheated rather than poisoned. The issue of low quantities of harmful colours was put to one side. The only remaining issue was of defining when the use of colours constituted fraud. This was still left to the judgement of individual analysts and courts. But the Select Committee hearings seemed to crystallise a consensus that condoned, as 'tradition', the use of plant and coal tar colourings for most purposes except to mask blatantly fraudulent substitutions of ingredients. From this time to the end of the century colours were not a sufficiently important issue for any major surveys or reports to be undertaken by the Medical Officers of Health responsible for enforcing the food Acts. The only food subjects on which they reported were hygiene (food poisoning) and preservatives (56).

3.15 Need for Standards and Definitions

The need for a legal definition of adulteration and acceptable colours remained (57). The Society of Public Analysts was set up in 1874 to attempt to resolve the problem of conflicting court decisions by setting standards for some foods (58). They set quantitative limits on certain ingredients. If the quantity of the chief ingredient fell below a specified level the foods was considered a mixture and the seller could be prosecuted if there was some attempt to deceive purchasers that it was a mixture. But these standards were not adopted by all analysts, so the problem of a lack of uniformity remained.

The recommendations of the 1874 Select Committee were taken up in the form of the 1875 Sale of Food and Drugs Act. This Act formed the basis of today's law on food. It introduced for the first time the following clause, attempting to define adulteration in more detail:

> No person shall sell to the prejudice of the purchaser any article of food or any drug which is not of the nature, substance and quality of the article demanded by such purchaser...[except for cases]...where any matter or ingredient not injurious to health has been added to the food or drug because the same is required for the production or preparation thereof as an article of commerce and not fraudulently to increase the bulk, weight or measure of the food or drug, or conceal the inferior quality thereof (59).

This meant it was acceptable to sell adulterated mixtures (eg. coffee diluted with chicory and colours) if they were declared as mixtures.

The Act prohibited the addition of injurious substances to food. Colours were mentioned specifically:

> No person shall mix, colour, stain or powder...any article of food with any ingredient or material so as to render the article injurious to health, with intent that the same may be sold in that state (60).

No rules were made to say which substances were to be considered injurious. There was still no clear distinction between adulteration and acceptable trade practice. Key clauses were open to wide interpretation: enforcement officers and courts defined 'nature, substance and quality' and 'demanded by the purchaser' in a multitude of ways. They faced the same sort of problem that had perhaps originally forced the state to prescribe the composition of bread. Despite complaints from all sides about conflicting decisions on what constituted adulteration, the option of prescribing standards for foods was not acted on. The Government would probably have upset traders even more by attempting to define standards than by leaving ambiguities. The existing system meant that dissatisfaction was directed at local authority public analysts rather than at central government.

3.16 Effective Laws or Legalised Adulteration?

The 1875 Act made the appointment of Public Analysts by local authorities mandatory; but enforcement of the Act was not made mandatory. Little improved (61) and enforcement remained patchy. In

1874 a judge had ruled that the *mens rea* clause did not apply to key parts of the Act, and it was therefore an offence to sell adulterated food whether done knowingly or not (62). This allowed more prosecutions to be brought by keen officers, and gave the Act a deterrent effect.

A Local Government Board report of 1880-81 stated that some large towns had still not appointed public analysts because adulteration was not suspected to exist and they did not wish to harrass local tradespeople (63). However this defensive stance was now a minority position. According to Ingeborg Paulus the recent amendments to the law meant it became enforceable in 1880 (64). Table 3.2 gives the data on enforcement compiled by Paulus from Local Government Board reports. Up to 1873 the food Acts were rather ineffectual. Public pressure had been much more effective in bringing down levels of adulteration. Between 1873 and 1879 the laws were enforced in a patchy manner amidst much trade complaint. Table 3.2 shows that as a result of the 1879 amendment significant numbers of analysts were appointed. From this time onwards the proportion of samples defined as adulterated fell steadily from 17% in 1879 to 9% in 1900. John Burnett has also assessed the effects of the food Acts. He compiled statistics from Local Government Board reports on the adulteration of bread, shown in table 3.3. These data also show a steady decline in the proportion of adulterated bread, from 7.3% in 1879 to 0.7% in 1900.

The figures given in tables 3.2 and 3.3 probably overestimate the proportion of 'adulterated' food because inspectors took a greater proportion of samples from shops where they suspected illegalities. On the other hand the data underestimate the actual extent of adulteration because they include only the cases legally defined as adulteration. The preceding sections have shown that this included only the worst excesses. For colours, for example, 'adulteration' usually included only some of the mineral colours. Nevertheless, tables 3.2 and 3.3 do show a steady downward trend in cases of 'adulteration'.

The significant fall in adulteration from 1880 or 1883 did not apply to all colours. While the proportion of some coloured foods may have fallen, certain products such as sweets and soft drinks remained highly coloured. There was a further shift away from certain mineral colours which were generally acknowledged to be harmful. In 1888 Alexander Wynter Blyth, a public analyst, reported that with the exception of

TABLE 3.2 : FOOD & DRUG ACT ADMINISTRATION RESULTS, 1878-1930

Source: I Paulus <u>The Search for Pure Food</u> Martin Robertson, London 1974 p.105. (Compiled from Local Government Reports, 1878 - 1930)

Year	Analysts' appoint-ments	Samples taken	Samples adulterated (%)	Samples adulterated	Proceedings	Convictions	Total fines (£ sterling)	Average fines (shillings)
1878	153	14,706	19	2,826				
1879	201	16,191	17	2,782				
1880		17,049	15	2,535				
1881	237	17,673	16	2,772				
1882	260	17,823	15	2,613				
1883	263	19,439	15	2,931				
1884	265	19,648	15	2,955				
1885	267	22,951	14	3,311				
1886	267	23,230	13	3,076				
1887	267	23,596	12	2,813				
1888	270	24,440	13	3,134	1,307		1,884	29
1889	276	26,344	11	2,836	1,337		1,782	27
1890	228	26,954	12	3,096	1,691		2,309	27
1891	231	27,465	11	2,781	1,952		2,835	29
1892	235	29,028	11	3,540	2,139		2,878	31
1893	236	32,447	12	4,009	2,537		3,824	36
1894	237	37,233	13	4,793	3,174	2,687	5,091	37
1895	238	39,516	10	4,060	2,836	2,427	4,320	35
1896	238	43,962	9	4,093	2,724	2,313	4,136	35
1897	239	45,555	9	4,202	2,808	2,349	3,614	30
1898	240	46,856	9	4,383	2,777	2,314	3,683	31
1899	240	49,555	9	4,319	2,685	2,256	4,131	36
1900	242	53,056	9	4,970	3,110	2,608	6,257	48
1901	237	62,858	9	5,503	3,321	2,673	6,226	47
1905	231	84,678	9	7,173	3,707	2,777	6,528	47
1910	233	98,544	8	7,427	3,235	2,408	5,537	46
1911	233	100,749	8	8,510	3,500	2,432	5,767	47
1912	233	103,221	8	9,170	3,571	2,505	5,923	47
1913	233	108,174	8	9,307	3,365	2,292	5,346	46
1914	234	110,111	8	9,090	3,268	2,155	5,665	52
1919	236	101,140	8					
1920	236	111,797	7					
1925		118,930	6					
1930		136,515	5					

TABLE 3.3 : STATISTICS OF BREAD ADULTERATION 1877-1914

Source: J Burnett Plenty & Want Methuen, London 1979 p.264. (Compiled from quarterly reports of public analysts to the Local Government Board).

Year	Number of samples analysed	Adulterated	Percentage adulterated	Percentage of all articles adulterated
1877	998	74	7·4	19·2
1878	921	66	7·1	17·2
1879	1,287	95	7·3	14·8
1880	1,096	70	6·4	15·7
1881	1,037	49	4·7	14·7
1882	1,204	77	6·4	15·1
1883	1,041	28	2·7	15·0
1884	1,217	24	2·0	14·4
1885	1,168	31	2·7	13·2
1886	991	32	3·2	11·9
1887	872	17	1·9	12·8
1888	689	4	0·6	10·8
1889	952	21	2·2	11·9
1890	689	5	0·7	11·2
1891	799	8	1·0	12·2
1892	804	3	0·4	12·4
1893	698	1	0·1	12·9
1894	653	9	1·4	10·3
1895	575	10	1·7	9·3
1896	625	1	0·2	9·2
1897	630	9	1·4	9·4
1898	717	6	0·8	8·7
1899	597	3	0·5	9·4
1900	437	3	0·7	8·8
1901	530	4	0·8	8·8
1902	552	2	0·4	8·7
1903	561	0	0	7·9
1904	473	1	0·2	8·5
1905	463	1	0·2	8·2
1906	373	1	0·3	9·3
1907	528	4	0·8	8·1
1908	394	4	1·0	8·5
1909	352	2	0·6	7·5
1910	327	0	0	8·2
1911	618	1	0·2	8·7
1912	414	0	0	8·4
1913	405	4	1·0	8·2
1914	No statistics available.			

salts of lead and copper the poisonous mineral colours were rarely found in food, and that there had been a great improvement in recent years. The poisonous colours that had been eliminated with the help of the food Acts were compounds of arsenic, chromium and zinc (65). They were replaced by plant colours which were probably safer overall, and by coal tar colours that were initially thought to be harmless by the experts of the day, such as Arthur Hassall, but which later caused concern. Disagreement over the definition of adulteration meant that foods coloured with non-mineral colours would not have been considered adulterated by many food enforcement officers. And the same colour would be considered adulteration in one foodstuff but not in another.

DEBATES ABOUT NEW COLOURS

3.17 Introduction of Coal Tar Colours

Colours did not become a government issue again until the end of the century. The new colours, the coal tar colours, did, however, become a topic of debate among analysts and medical practitioners.

When Hassall first noted the introduction of coal tar colours (some time between 1861 and 1876) he did not consider them to be harmful. He saw them as an improvement on the poisonous metallic colours because they were not acutely toxic. Problems with some coal tar colours were raised in the 1880s. Fred Steward has provided a history of the debates about the safety of some coal tar colours from that time to 1957 (66).

When introduced into food in the 1860s and 70s, the coal tar dyes were thought to be safe as long as they were not contaminated (the contaminant was usually arsenic). The colours were considered harmless for at least three reasons:

a) Compared to the mineral colours, such as arsenic and lead chromate, which could cause overt signs of poisoning soon after consumption, the coal tar colours seemed innocuous.

b) In 1860 tests on Magenta had shown it to be apparently safe.

c) Leading campaigners in the fight over harmful mineral colours, probably persuaded by the information above, declared coal tar colours to be safe if not contaminated (67). This is likely to have influenced people who might otherwise have been concerned.

Table 4.4 in chapter 4 lists the comments made about the growth in the use of coal tar colours from the 1860s onwards. By 1876 coal tar colours were 'much used', with 'every tint being imitated' (68).

3.18 Doubts about Safety

After at least ten years common use, two papers were published which cast doubt on the safety of certain coal tar dyes. In a French medical journal (in 1886) Cazeneuve & Lepine concluded from their studies that the nitro derivatives of coal tar (e.g. Picric Acid) were especially poisonous; that Safranine and Methylene blue were virulentpoisons, producing gastric intestinal disturbances; and that some coal tar colours were tolerated well by humans, dogs and guinea pigs, without any noticeable disturbances and at rather high doses. The authors listed 7 such colours: Purple, Fast yellow, Yellow NS, Roccellin, Ponceau R, Bordeaux B and Orange I. They were concerned at the widespread use of harmful coal tar colours in wine and other food in France. They recommended a short permitted list of colours (69).

Pfeffer examined the effects of some colours on living cells. His work was published between 1886 and 1888. He concluded that Methyl violet, Cyanin, Eosine, Methylene green and Nigrosine were poisonous; Methylene blue, Bismarck brown, Magenta, Safranine and Methyl orange were slightly poisonous; and Tropaeolin 000, Tropaeolin 00 and Rosolic acid were not poisonous (70).

In 1888 an abstract of a German study was published in England. The study on a rabbit and a dog showed that Victoria yellow (dinitrocresol), used as a substitute for Saffron, was fatal at relatively low doses. The author concluded:

> Surely the use of this colouring matter should not be allowed (71).

By 1890 (after more than 15 years common use) some British analysts expressed publicly their concern about coal tar colours. In 1891 the Society of Swiss Analytical Chemists drew up a list of harmful coal tar colours which should not be permitted. The English analysts were probably aware of this and similar activities. Concerns were fuelled in 1893 by the publication of a translation of Theodor Weyl's toxicological studies that demonstrated many adverse effects of coal tar colours on animals. Weyl proposed a legal list of permitted colours. In the following year another Select Committee was set up to investigate adulteration. It was set up mainly due to pressure from butter traders whose livelihood was threatened by the new margarine industry. There was also some pressure from analysts and medical practitioners concerned about coal tar colours, but this seems to have been of much less importance to the Committee than the battle between the traders.

3.19 Trade Battles over Colouring

The fifth Select Committee on adulteration sat between 1894 and 1896. The committee drew attention to the difficulty of administering the Act because of the different interpretations of 'nature, substance and quality' - exacerbated in court cases by aggressively defensive traders and by the professional rivalry between public analysts and government chemists. The committee recommended that standards or definitions of foods should be established. They recognised that this proposal implied that it would be an offence to sell items failing to comply with the standards unless accompanied by a declaration of inferiority (72). They recommended that a specially constituted scientific body should be set up to fix standards and be empowered to make Orders on the quality and purity of food. Such regulations would have affected colours. These recommendations were not made law.

Some butter traders called for colouring of margarine or butter/margarine mixtures to be prohibited where it misled the consumer and thus affected the trade of 'honest' (ie pure butter) traders. On the issue of colourings, the emphasis was almost entirely on fraud and its effects on trade rather than possible public injury. The complaints of butter traders were summarised by Andrew Brown, an Irish butter merchant:

> Margarine, and margarine compounded with butter, being goods that by colouring can ... be made to look so much like genuine butter that the consumer (not being an expert) is imposed upon and defrauded, and the butter trade is losing so much of consumption, and so much of discredit to the butter trade, by the use and experience of those who are defrauded,

> by having sold to them a very inferior article of food instead of pure butter (73).

He noted that the various acts that had been adopoted to prevent margarine and mixtures from being sold as butter had not served the desired purpose, and recommended that a new law should stop this fraud.

Trade views on the acceptability of colouring and the role of government varied. The following suggestions were made.

a) Ban on colour in some foods

Some butter traders called for the colouring of margarine to be banned. For example, C Stewart, a French butter shipper, argued in this way:

> The colour of butter given to margarine should be prohibited. Let margarine keep its natural colour, which is very different from that of butter. Why has it ever been coloured yellow, if not with a view to pass it as butter and facilitate the fraud (74).

Some English traders, following the example of a campaign against margarine by French butter traders, set up the Dairy Produce Defence Association. They took the view that colouring of margarine should be prohibited (75).

The committee would have been aware that some other countries had banned colours from certain foods. In France colouring was prohibited from butter; in Germany it was forbidden in wine (76).

b) Colour marking

Some proposed that margarine should be required by law to be coloured in a way that distinguished it from butter. For example, Andrew Brown, the butter merchant suggested that:

> Margarine, being a manufactured article, may and should be made of a colour different from the colour of butter, and should not be of such a colour as would lead the purchaser to be defrauded (77).

The Committee was told about the Danish law that required margarine to be coloured a specific shade in order to protect the dairy trade (78).

Margarine was required by one American state to be coloured pink to distinguish it from butter.

c) Labels/Protected Names

Other traders proposed that foods should be properly defined and labelled. John Rogers, a grocer representing the London Chamber of Commerce was in favour of proportions of ingredients being declared on labels (79). Some traders argued that declaring ingredients would injure trade; they preferred solutions other than labelling.

John Rogers provided a counter-argument: his own firm declared ingredients. They lost trade because other firms did not label food contents. If all firms had to label ingredients, as they had to do for spirits, none would be disadvantaged (80).

d) Maintain the status quo

Margarine traders were opposed to government intervention in commerce. They used examples of contradictory results from public analysts to demonstrate the unworkable and unfair state of law. The Deputy Principal of the Government Chemist Labs., thought, like the margarine manufacturers, that the law should remain unchanged; that colour should be allowed in margarine (81). Their justifications for continued colouring of margarine were:

a) Public demand
b) Tradition
c) Reduced cost of food to the poor.

The validity of these claims is examined in Chapter 5.

e) Positive List

Though the Committee did not make a thorough investigation of the new problem posed by coal tar colours there were several proposals for regulations. Some traders were in favour of parliamentary controls on colours, as in France and Germany. John Rogers, representing the Chamber of Commerce, took the view that the substances used as colourings should be specified (82).

f) Negative List

Alexander Wynter Blyth, Vice-President of the Society of Public Analysts, recommended a negative list, banning harmful colours. Other leading analysts, such as Cassal, had made the same proposal.

The Committee did not take up proposals for special controls on colours. They accepted reports made by analysts that the food Acts had been very beneficial in preventing the use of injurious mineral colours (83). The Committee recognised that some coal tar dyes were harmful (84). They took the view that section 3 of the 1875 Act gave sufficient protection against harmful colours and that no special laws on colours need be made. The Select Committee made a recommendation in favour of the butter trade and against the wishes of the margarine trade. They recommended that the colouring of margarine to imitate butter should be prohibited (85). Decisions about injurious colours were thrown back to public analysts.

The final report in 1896 concluded that there was general agreement that it had been appropriate for the government to intervene in the form of a general food act. The trade request was for 'more efficient, clearer and uniform and compulsory' enforcement of the Act (86). Adulteration became defined as unfair trade practice rather than fraud against the consumer.

3.20 Coping with Limitations in Toxicology & Chemistry

Decisions about the coal tar colours that were to be considered harmful were made in an *ad hoc* way. The Society of Public Analysts attempted increasingly to provide guidance to analysts and manufacturers. For example, in 1888 Alexander Wynter Blyth, Vice-President of the Society of Public Analysts, stated in his manual for analysts that colours he considered harmful were impure aniline colours and certain other coal tar colours such as Picric acid (87). He was not more specific than this about the colours that were harmful. But concern was focussed mainly on one distinctive group, the nitro class of colours, highlighted in early studies on safety. In 1887 The Analyst (journal of the Society of Public Analysts) published some methods for detecting colours of the nitro group (Victoria yellow, Manchester yellow) and some aniline yellows, suggesting growing interest in their detection (88).

By 1890 vocal analysts such as Otto Hehner and Charles Cassal took the view that one group, the nitro colours such as Victoria yellow and Manchester yellow, were of a poisonous nature (89). But it was difficult for analysts to prove in court that such colours were injurious. Fred Steward has pointed out that this resulted in debates about the toxicity of coal tar colours being conducted outside the court arena (90).

Coal tar colours posed a number of problems that the contemporary legal controls were unable to deal with. There were fundamental scientific problems that were unresolved and many technical arguments were put up against proposals for negative or positive lists or other standards. These are described below.

a) <u>New detection techniques</u>

Innovation in techniques of adulteration moved faster than techniques of detection. At the 1895 Committee hearings a grocer representing the Chamber of Commerce described the changes:

> In the old days, before the 'Lancet' inquiry, the adulterators worked on a small scale, and were more or less bunglers. They are now men of science and work wholesale, and, having microscopic and chemical analysis to dread, they use their knowledge to defeat the checks which science places upon their criminal practices (91).

The chair of the Select Committee added that:

> You have to set science to catch science in this case (92).

But analysts were not well resourced - there was reluctance in many towns to raise rates. The Laboratory of the Government Chemist, which would have made a suitable national centre for developing analytical techniques, but this had not been one of their priorities.

b) <u>Reliability of Identification Methods</u>

From the time that analysts first took cases to court their results were challenged (on the grounds of reliability of the techniques employed and individual competence). There were many occasions during Select Committee hearings and court cases where experts frankly contradicted each other. In the identification of colours the pioneering analysts of the 1850 and 1860s were meticulous. Their evidence of the extent of adulteration was more accurate than the claims of other groups. Hassall, for example, was well aware that the government was able to dismiss claims about the extent of adulteration prior to 1850 because of the dubious quality of analysis. In his work for the Analytical Sanitary Commission, Hassall examined 20-40 samples of the same article before he proclaimed it adulterated and published the name of the trader. Proof of the reliability of his method lies in the fact that no trader named by the Lancet had ever challenged his findings on colours (93).

While only plant and mineral colours were available it would have been reasonably straightforward, in terms of accurate identification, to introduce a positive or negative list of colours. Once the coal tar colours were adopted identification became a real problem and government had a legitimate excuse for not making regulations.

Scientific theories about the chemistry of coal tar colours were so inadequate it hindered innovation in the dyestuffs industry in the UK. Despite calls by dyers for a scheme for proper identification of colours, no systematic scheme was available till 1894, when Arthur Green published a translation of a German scheme. The Green tables, up-dated in 1904, remained the major source of information until 1924 when the Colour Index was published (see discussion in Chapter 4 and list of early dye and colour manuals in appendix G).

Analysts were certainly interested in identifying coal tar colours. Wynter Blyth's manual of 1888 presented a series of identification tests.

As far as accurate identification was concerned, the government could have introduced regulations for plant and mineral colours from 1851/4. For the coal tar colours they could probably have introduced a short negative list (of nitro colours) from the early 1890s. A positive list could have been accurately identified from 1904.

c) Dose and safety

Quantifying the dose of colours in food posed another problem. Under the food acts, analysts had to be able to measure with reasonable accuracy the proportion of colour in a sample; then they had to decide whether this dose could be shown to be injurious in court.

For most of the mineral colours (and the plant colour, Gamboge) which were increasingly accepted, even by magistrates, to be acutely toxic, establishing whether the dose was harmful was not often required. A consensus was reached relatively quickly over the harmfulness of mineral colours themselves. But for the coal tar colours and copper (a particular mineral colour that manufacturers fought to keep) dose became a big issue of debate. This is discussed later in this chapter.

Most of the pioneer analysts, such as Hassall, were medically qualified and were sufficiently knowledgable to make judgements about the safety of mineral colours. The acute toxicity of mineral colours made consensus a relatively easy task in the 1860s. Arguments were based more on whether the extent of adulteration was significant rather than the individual question of dose. But Hassall did point out in the 1850s the cumulative effect of small doses.

By the 1880s when concern was expressed about the safety of coal tar colours, the profession of public analysts had become specialised and few analysts were trained in medicine. Judging the safety of colours became a task that was inappropriate for analysts. However, Medical Officers of Health, also responsible for enforcing the food Acts, were medically trained. Although they were in some ways an appropriate professional group to make judgements on safety, there are few records of Medical Officers of Health taking part in the debate. But dosage would not have been a significant problem to enforcement officers if the government had introduced a positive or negative list. Any detectable amount of a banned colour in a food would them have been an offence.

Toxicology, the study of poisoning, was becoming, in the 1880s and 1890s, a specialised subject. The assessment of chronic toxicity was a new problem. By the 1890s some tests had been developed to study chronic toxicity. There are studies from the late 1880s of colours being fed to animals at low levels for relatively long periods (94). The significance of animal studies was always open to dispute.

Nevertheless, government could have devised criteria for deciding which colours were acceptable and which were not from about 1893 (95). A government interested in putting public health above short-term trade interests could have prescribed and carried out test procedures on the coal tar colours in use, using the best available techniques at the time. Protective policies could have been introduced despite the limitations of toxicology. Colours producing injury to animals below a certain dosage could have been ruled unacceptable and banned on grounds of caution.

d) Purity

Purity was an issue of safety for plant and coal tar colours. Hassall highlighted the problem of harmful contaminants in two plant colours and of arsenic contaminants in coal tar dyes.

Had the government wished to set standards of purity for colours, adequate tests were available for plant colours from 1861 (or earlier). Tests were available for arsenic contaminants in the same period. As far as other contaminants were concerned, the government could have prescribed acceptable methods of preparing coal tar dyes for food, thus preventing contamination, from the 1890s and possibly earlier.

e) Uniformity of tests

One reason for different analysts producing different results was the lack of standardised analytical tests. Disputes between analysts and government chemists and between analysts themselves could have been reduced by the establishment of nationally-recognised tests. An advisory committee made up of both groups might have been established, to set regularly up-dated standards. These could have been given legal sanction if necessary, as happened almost a century later when the EEC encountered a similar problem.

It is true that there were many scientific and technical barriers to the early introduction of detailed regulations on colours. But most of these barriers were surmountable. The real barriers to the introduction of regulations in the nineteenth century were economic and political.

3.21 Government Action, 1850-1899

Table 3.4 summarises the belated action taken by governments during the eighteenth century on food colours. It shows that from the 1850s to 1899 there were five minor and six major reports made to parliament about food colours and other adulterants. Flurries of unsuccessful Bills usually followed each government inquiry. There were at least 25 Bills to establish or amend general food laws. There were eight Acts and amendments relevant to food colours between 1860 and 1899.

This represents a considerable amount of government activity. Much of it was empty activity to salve public concern and keep industrial supporters contented. But some of it produced significant improvements by preventing the worst excesses of adulteration with colours.

By the end of the century there was a genuine need for some amendment to the food Act. However, as usual the government was unwilling to intervene further in trade activities, unless pushed by public outcry or powerful sections of the trade. The difficulty of bringing a successful prosecution deterred analysts from the attempt. Many magistrates were biased in favour of traders (they were often traders themselves) and gave them the benefit of any doubt.

Some traders voluntarily stopped using or selling harmful coal tar colours. There was a wide range of alternative ones available, so there was no great difficulty in avoiding a small group of them. Other manufacturers continued to use any colour that suited them most, arguing that the tiny doses used in food could not possibly be harmful. The effects on health are assessed in chapter 6.

The recommendation of the 1855 Select Committee for a negative list or some other form of regulation became very relevant. But there was insufficient pressure on government to force any action in the final years of the century.

TABLE 3.4 : SUMMARY OF GOVERNMENT ACTIVITY ON THE USE OF FOOD COLOURS 1855 - 1899

Compiled from government reports listed in the table and General Alphabetical Index to the Bills, Reports, Estimates, Accounts and Papers Printed by Order of the House of Commons 1852-1899 HMSO London 1909, p597; Ingeborg Paulus The Search for Pure Food Martin Robertson, London, 1974, p136-9; M Miller Danger! Additives at Work London Food commission, London 1985, p163.

DATE	GOVERNMENT COMMITTEE OR REPORT	LAW OR REGULATION
1853	Return of the Number of Inspections, Seizures or Prosecutions by Excise, for Detecting the Adulteration of Tea, Tobacco, Pepper and Coffee	
1855	Return of the Number of Detections made of Adulteration of Tea, Coffee, Cocoa, Chocolate and Pepper, 1844 to...1855	
1855-56	SELECT COMMITTEE ON THE ADULTERATION OF FOOD, DRINK AND DRUGS (FIRST) Report on the Adulteration of Food, Drinks and Drugs: First, Second, and Final Report	
1857		UNSUCCESSFUL PARLIAMENTARY BILL ON FOOD ADULTERATION: Prevention of Adulteration of Food or Drink
1858		TWO UNSUCCESSFUL BILLS ON ADULTERATION
1859		TWO UNSUCCESSFUL BILLS ON ADULTERATION: Prevention of Adulteration of Food or Drink
1860		ADULTERATION OF FOOD AND DRINK ACT
1868		UNSUCCESSFUL AMENDMENT BILL: Adulteration of Food or Drink Act Amendment

DATE	GOVERNMENT COMMITTEE OR REPORT	LAW OR REGULATION
1869	*Return of Number of Persons Convicted of Adulterating Food and Drink under provisions of the Revenue Acts in Metropolitan Districts 1866 to 1868*	UNSUCCESSFUL AMENDMENT BILL: Adulteration of Food or Drink Act Amendment
1870		UNSUCCESSFUL AMENDMENT BILL: Adulteration of Food or Drink Act Amendment
1871		UNSUCCESSFUL AMENDMENT BILL: Adulteration of Food, Drugs and Drink Act
1872		AMENDMENT OF ADULTERATION OF FOOD AND DRINK ACT 1860: Adulteration of Food, Drugs and Drink Act
1873	*Return of Number of Analysts Appointed under Adulteration of Food Act 1872*	
1874	SELECT COMMITTEE INQUIRY ON 1872 ACT (SECOND): *Report on Adulteration of Food Act 1872*	
1875		SALE OF FOOD AND DRUGS ACT
1875		PUBLIC HEALTH ACT
1877		UNSUCCESSFUL AMENDMENT BILL: Sale of Food and Drugs Act Amendment
1878		UNSUCCESSFUL AMENDMENT BILL: Sale of Food and Drugs Act Amendment
1879	SELECT COMMITTEE INQUIRY (THIRD): *Report on Sale of Food and Drugs Act 1875*	
1879		AMENDMENT TO MAKE 1875 ACT ENFORCEABLE
1886		TWO UNSUCCESSFUL BILLS ON MARGARINE/BUTTER

DATE	GOVERNMENT COMMITTEE OR REPORT	LAW OR REGULATION
1887	SELECT COMMITTEE INQUIRY (FOURTH)	
1887		MARGARINE ACT
1888	Returns of Convictions...in 1886, 1887...under Food and Drugs Act etc.	LOCAL GOVERNMENT ACT
1891		AMENDMENT BILLS TO 1875 & 1888 ACTS: Sale of Food and Drugs Act Amendment
1892		AMENDMENT BILLS: Sale of Food and Drugs Act Amendment
1893		AMENDMENT BILLS: Sale of Food and Drugs Act Amendment; Margarine Act 1887 Amendment
1894	SELECT COMMITTEE INQUIRY (FIFTH): Report on Food Products Adulteration	AMENDMENT BILLS: Sale of Food and drugs Act Amendment; Food Adulteration Bill; Margarine etc Amendment
1895	SELECT COMMITTEE INQUIRY (FIFTH CONTINUED): Report on Food Products Adulteration	
1896	SELECT COMMITTEE INQUIRY (FIFTH CONTINUED): Report on Food Products Adulteration	
1896		PUBLIC HEALTH ACT
1897		TWO AMENDMENT BILLS: similar to the original Sale of Food and Drugs Bill
1898		TWO AMENDMENT BILLS: Agricultural Products etc (Adulteration) Act
1899		SALE OF FOOD AND DRUGS ACT

3.22 LEGALISED ADULTERATION WITH COLOURS

A book recently published by MAFF, Food Quality and Safety - A Century of Progress, suggests that the food acts of the late nineteenth century had enormous impact, so that:

> By 1900 bread, flour, tea and sugar were as pure as could be wished (96).

But this was not strictly the case. The situation in 1900 in regard to colours showed that although adulteration with overtly poisonous colours was stopped by the laws of the late 1800s, the practice of adulterating foods with toxic colours was reduced but not stopped, and fraud on the pocket received legal sanction. There followed a situation of legalised adulteration with colours.

The remainder of this chapter describes the actions taken by central government and its advisory bodies concerning the control of colours from 1900 when colours were first treated separately from other groups of additives. The main regulatory mechanisms eventually developed for colours in the twentieth century can be divided into eight types, and have been described in section 2.14.

INTRODUCTION OF A NEGATIVE LIST

3.23 Departmental Committee Investigation

At the turn of the century there was a public campaign against 'legalised adulteration'. This campaign was fuelled by a disaster in 1900 in which about 70 people died. The culprit was found to be arsenic in beer (97). Medical Officers of Health and analysts were also concerned over the enormous rise in a new form of adulteration, the use of possibly injurious chemical preservatives. All this, combined with growing dissatisfaction from traders and enforcement officers with the 1899 Act, forced the government to take some action. They set up a committee to investigate preservatives and colours. Instead of a select committee they chose a group outside Parliament for the first time, to act in an advisory capacity.

The inquiry of 1901 highlighted many of the points for and against regulation of colours that had been raised since problems with coal tar colours were first noted. The Departmental Committee's remit was to examine the extent of use of colours, whether they were injurious and at what dose (98). They found that coal tar colours had replaced mineral and plant colours to a great extent. They were often cheaper and technically superior. Of the plant colours Annatto was still widely used in dairy products. A mineral colour, copper sulphate, was still extensively used in preserved vegetables. A few other mineral and plant colours were used occasionally (see table C.1 in appendix C for a list of the colours in use). Colours were predominantly used in 'low class' products.

Asked whether any of the colours were likely to be so harmful to health that they should be prohibited, limited or declared, analysts such as Wynter Blyth and Cassal felt that the amounts of colours were small so there was little danger to public health. Some analysts advocated that regulations should specify harmful and harmless colours. Physiologists also wished to see the regulation of any colours which had a possibly harmful effect. They recognised that harm might be done even though scientists at the time had no way of measuring it (100). Concern was expressed by some medical witnesses about the unknown effects of substances foreign to the human body. But no evidence was given to the committee about safety tests on colours other than copper. Scientific witnesses disagreed over whether copper sulphate should be banned. Most agreed that if it were to be allowed still, its presence should be declared.

The remit of the committee was to investigate effects on public health. Nevertheless, they commented briefly on fraud aspects too. They gave an example of the failure of margarine labelling to protect the consumer from deception in all cases. But they felt that since there was a demand and established markets for highly coloured, lightly coloured and uncoloured foods, there was no reason to interfere in customs of trade where harmless colours were used.

The committee preferred foods in their natural colours. Although some of the substances used to colour confectionery and sweetmeats were highly poisonous in themselves, they were used in infinitesimal proportions, and the committee felt there was no evidence of injury (101).

They recommended that preservatives and colours be banned from one staple food, milk. This recommendation was taken up and made into regulations. The committee also recommended that copper be banned, although one member of the committee disagreed strongly on the grounds that the appetising appearance of food is important to nutrition. His argument about the nutritive value of added colour was one that was constantly repeated throughout the twentieth century until today. This argument is examined in chapter 5. It is interesting to note from surveys conducted at the time that some canned vegetables were not coloured. However, the government did not want to upset industrial interests and the ban on copper was not made.

Both the Departmental committee of 1901 and the Royal Commission on Arsenical Poisoning (of the same time) endorsed the 1896 Select Committee's proposal to establish a committee to set national standards. They recommended a 'court of reference' made up of scientists to give authoritative rulings on the safety of colours and impurities. (Advisory committees of experts had existed in French cities for many years.) Failing this they recommended that the Local Government Board should be given powers to ban any harmful colour. The government did not adopt their suggestions. The reason for not introducing a negative list was that there was no proof of harm from coal tar colours. In reality, as Fred Steward has pointed out, this amounted to a grosslack of information or appropriate studies, rather than any positive proof (102).

3.24 1924 Departmental Committee

Colours returned to the government's agenda in the 1920s. A Departmental Committee was set up by the Ministry of Health in 1923 to examine whether (and at what levels) preservatives and colours were harmful and whether the presence of these additives and the quantities in food should be declared (103).

It is clear from the remit of the committee that the concern in government at this time centred on the interpretation of 'injurious' under the food Act. The effects of colours on food quality were not thoroughly assessed. The emphasis on health was much the same as in 1901. The remit to investigate declarations marked a new emphasis on labelling as a means of ensuring fair trade and consumer protection.

The departmental Committee reiterated the long-standing problem, that:

> The present position of the law in regard to preservatives and colouring matters is far from satisfactory.... The proof that a preservative or colouring matter mixed with an article renders it injurious to health is not an easy, inexpensive or expeditious matter and, when established in one instance or in one Court, is not necessarily effective in other instances or in other Courts (104).

The Committee concluded in its report of 1924:

> Whatever may be the actual measures of control taken in regard to the addition of preservatives and colouring matters to food, it is eminently desirable that it should be clearly embodied in Regulations having the force of law (105).

It was felt this would be appreciated by both traders and local authorities. Most of the inquiry was concerned with preservatives rather than colours.

The Committee heard that two British firms had sold more than 40 tons of coal tar colours for food purposes between 1 July 1922 and 30 June 1923. These were by no means the only firms in the trade. They calculated that the proportion of colour in food was about 1/30,000 usually, and rarely, as high as 1/2,000 or low as 1/500,000. These figures were similar to reports in 1901. They felt the total quantity of food which was coloured was enormous. There were 90 distinct coal tar colours supplied by just one company (see tables C.2 and C.3 in appendix C for lists of colours).

On the issue of safety the Committee acknowledged the known toxicity of many synthetic organic colours used for non-food purposes. They felt that for food dyes there was no adequate information on their physiological effects. They felt that the proper course was to consider each colour individually and for government to approve it only if the evidence demonstrated its harmless character. There was a strong emphasis on the public health role played by preservatives in the prevention of food poisoning. The cosmetic function of colours was clearly very different to preservatives yet the committee did not seem to take account of this when assessing risk.

They said on the issue of quality that it was not in their remit to comment on which foods should be allowed to be coloured. Nevertheless they pointed out that:

> It is evident that colour is frequently used to cover up objectionable or inferior materials, or to give a factitious appearance, so that the articles so coloured masquerade for something which thay are not (106).

The Committee made several recommendations for controls. The items relating to colours were:

1. The use of Copper salts to colour peas and other vegetables should be prohibited. This recommendation repeated the 1901 Committee's view.

2. A schedule should be issued by the Minister of Health to provide a permitted list of colours; the list to be subject to revision as required.

3. If a permitted list of colours were produced as suggested, then 'so far as health considerations are concerned, a declaration of their use need [not] be required'.

4. On the issue of impurities in colours, that arsenic should be limited to 1/100th of a grain and the combined total of tin, lead, copper and zinc should be limited to 20ppm.

They also made some general recommendations for improving food law and enforcement, as several committees had done before them, such as altering the law to make it easier to prosecute the actual offender - rather than an innocent retailer.

The Departmental Committee, like the Committee in 1901, argued strongly for standards specifying the use of colours. While the earlier committee called for a negative list, this committee recommended a positive list. They felt that:

> If this were done, traders and the public generally would know what was permissible and what was not and there would be no conflict of expert evidence on the question of whether the amount of preservative or colouring matter was or was not injurious to health (107).

Fred Steward has pointed out that the committee drew heavily on the fact that other countries had adopted the positive list approach. Their view that evidence of safety should be obtained was

> A complete shift in emphasis placing the burden of proof on harmlessness rather than harmfulness (108).

3.25 Negative list of colours

1925 Public Health (Preservatives etc in Food) Regulations created a positive list for preservatives (109). They were restricted to certain foods and "contains preservative" had to be declared on food labels. The Departmental Committee had recommended a permitted list for colours and felt a declaration of added colour was not necessary if this were done. But both recommendations were ignored. The government and traders feltthat a negative list would allow greater freedom for enterprise and innovation. The production or sale of food containing any of just 14 listed colours was prohibited. This list banned most mineral colours including copper, one plant colour and five coal tar colours (see table 3.5). A sixth coal tar colour was proposed for the list but withdrawn. There would have been trade pressure to keep it because it was a common colour. At the committee hearings it was also claimed to be harmful only when contaminated (see chapter 6). Making a negative list rather than a positive list saved the long and difficult task of making a detailed assessment of the biological effects of each of the synthetic colours in use, and, as the Departmental Committee itself had recognised, was more convenient to the trade (110). The effects of these regulations on hazards to the public are assessed in chapter 6.

3.26 COMPOSITIONAL STANDARDS FOR FOOD

In 1924 a Departmental Committee on Composition and Description of Food (the Willis Committee) recommended that the law should be altered to allow more definitions or standards to be set, or declarations of

TABLE 3.5 : COLOURING MATTER PROHIBITED FROM FOOD BY THE PUBLIC HEALTH (PRESERVATIVES ETC. IN FOOD) REGULATIONS 1925 (SI 1925 No 775)

1924 CI No	Name
COAL TAR COLOURS	
12	Aurantia
724	Aurine
9	Manchester yellow
7	Picric acid
8	Victoria yellow
PLANT COLOURS	
	Gamboge
METALLIC COLOURS	
Compounds of any of the following metals:	
	Antimony
	Arsenic
	Cadmium
	Chromium
	Copper
	Mercury
	Lead
	Zinc

composition to be required. The Committee did not think that the case for an extension of standards or definitions to all foods had been made:

> The power to fix standards or definitions should only be used where it is shown that it is necessary for the protection of the public health (including nutrition) or the protection of the pocket of the consumer (111).

Nevertheless the Committee recommended that standards should be prescribed for the protection of the pocket of the consumer. They felt the sale of products failing to meet the standards (except under most stringent labelling conditions) would endanger the protection of the public.

In 1938 all existing food Acts were repealed and replaced by the Food and Drug Act. Adopting the recommendation of the Willis Committee, the Minister of Health was given power to make regulations more easily. However, these powers were not taken up significantly (112).

3.27 Wartime Controls on Composition

Before the Food and Drug Act came into operation World War II began. Food shortages during the war created the need for controls on composition, labelling, distribution and pricing of food. This required establishing some kind of standard to identify foods and to control substitutes. Legal measures included the Food Substitutes Order of 1941. To prevent adulteration and misdescription enforcement by local authorities was strengthened. A new principle of food law was introduced by the Defence (Sale of Food) Regulations 1943. These gave powers to the Minister of Food (similar to those given to the Minister of Health by the Food and Drug Act) to make regulations prescribing labelling and minimum standards of composition for foods. Butterworth suggests that all previous legislation had created powers concerning adulteration and misdescription; these new powers concerned quality.

3.28 Permanent Advisory Committee on Standards

An Interdepartmental Committee on Food Standards was set up to advise the Minister on standards in 1943 or 1944. It appears the Willis Committee had been useful and the practice of having scientific advisors on standards had become established. Recommendations of the Committee were taken up and Orders establishing compositional standards were made for baking powder, liquid coffee essence, mustard, salad cream and self-raising flour; items prone to adulteration with cheap substitutes. An unusual step was taken in the Food Standards (Preserves) Order 1944 which set standards for jam and prohibited the addition of any colour to 'fresh fruit standard jam' and 'fresh fruit standard marmalade'. The other standards did not prohibit colours.

To attempt to protect purchasers and ensure fair conditions for trading, labelling requirements were introduced for many packaged foods. A Labelling of Food Order was made in 1944 requiring packed food (with a few exemptions) to carry the following information:

Name and address of manufacturer or packer,
Common or usual name of food,
List of ingredients,
Minimum quantity/weight of contents.

Provisions also controlled claims of the presence of ingredients of special food value, such as egg, which was open to substitution by substances like colours and emulsifiers. A number of Codes of Practice were set up - intended to ensure that descriptions of foods on labels were accurate. Some of these Codes contained standards of composition.

After the war a number of regulations were immediately made to establish standards of compostion for specific foods such as bread, tomato ketchup, milk. This was primarily to control the use of cheap substitutes. Few direct hazard controls were made. In 1947 some more responsibilities (under the Food and Drug Act) were transferred from the Ministry of Health to the Ministry of Food. The Ministry of Food decided to set up the Food Standards Committee (FSC) in 1947 to continue the functions of the Interdepartmental Committee, but with added scope. The committee's terms of reference were to advise on regulations controlling composition and labelling 'for preventing danger to health, loss of nutritive value or otherwise protecting purchasers'.

The committee included representatives of the Ministry of Health, the Departments of Health for Scotland, the Medical Research Council, the

Dept of the Government Chemist, two members nominated by the Food Manufacturers' Federation and the Cooperative Union respectively, two members nominated by the Association of Public Analysts and one nominated by the Government of Northern Ireland. There were no consumer representatives.

Legally acceptable cases of debasement or adulteration were not highlighted by the committee's method of monitoring and determining priorities. Many foods would have contained added colour, for example, but this was not mentioned in the reports unless the colour was prohibited from a food or was not declared on the label. In Autumn 1957, for example, a sample of marzipan was noted to have contained undeclared colouring. There were not many examples of infringements involving colours, which is not surprising since manufacturers had so many colours to use legally.

To aid the FSC the Preservatives Sub-committee (PC) was set up in January 1951 to review the Public Health (Preservatives etc in Food) Regulations and to recommend amendments when desirable. The PC covered the use of a wide range of additives: preservatives, colours, antioxidants, anti-mould agents, emulsifiers (including stabilisers, anti-staling and foaming agents). It was responsible for assessing the acute and chronic toxicity, uses and chemical composition of the additives under review. It started its review of colours in November 1951.

3.29 Colours and Quality

The Preservatives Sub-Committee mentioned in their major report on colours of 1954 that colours were probably first introduced to mask a deficiency of ingredients such as eggs or butter, chocolate or fruit and to improve the appearance of products where the original colour had deteriorated during manufacture. They felt 'their main purpose to-day is to give a more attractive appearance to foods' (113).

On the issue of food quality they said that provided the colours had no deleterious effects on health they could see no objection to their use to replace natural colour lost during processing, to standardise appearance or simply to render a product more attractive. They said it was generally accepted to be physiologically sound that food should be presented in as attractive a form as possible (114). This claim about the nutritional benefits of colours had also been made in the 1901 committee hearings.

They considered the idea of prohibiting colours from particular classes of food, but considered it unlikely that the public were misled by colours about the quality of food. They thought that colouring that had become traditional was acceptable. For example, while they did not object to the colouring of jam they felt the dyeing of smoked fish could have been challenged originally when first introduced in the 1920s (115). In 1953 the regulations controlling standards for jam had been revised, and the prohibition on adding colour to standard fresh fruit jam lifted. There had been a controversy over whether colour should be permitted again in fresh fruit jam and marmalade. But the committee felt strongly that raw and unprocessed foods like meat, fish, fruit and vegetables should not be permitted to have colours added to them.

3.30 A POSITIVE LIST FOR COLOURS

The 1955 Food and Drug Act was essentially a re-enactment of the 1928 and 1938 Acts. It endorsed the powers created by the Defence (Sale of Food) Regulations 1943 by permitting the nature or substance of food to be determined by standards. Ministers were given powers to prohibit or regulate the addition of certain substances, such as colours. The Act referred to the desirability of minimising the addition of substances of no nutritional value. This led to the introduction later of an assessment of the need for colours.

In March 1950 a Joint Committee of the Society of Public Analysts and the Food Group of the Sociey of the Chemical Industry called for a permitted list of colours and ressurected the recommendation of the 1924 Departmental Committee for a court of reference to examine the safety of each colour. The SCI wanted manufacturers to be involved in the process. The Preservatives Sub-Committee asked manufacturers to submit details of the colours used in food and views on regulation.

The PC outlined the arguments for and against changing from a negative list to a positive list. They reported the following arguments put forward in favour of a positive list:

a) A positive list would give greater protection to food manufacturers. By using only the permitted colours they would be free from the risk of prosecution.

b) A permitted list would afford greater protection to the public, since merely prohibiting the use of colours known to be harmful leaves many for which there is little toxicological information. In their assessment, the Pharmacology Panel found that insufficient information was available for 51% of the coal tar colours in use.

c) Further expensive toxicological research would be required for comparatively few colours.

d) Provision could be made for the list to be revised.

e) Most other countries who had studied the problem had favoured the principle of a positive list and these had operated successfully for years (116).

The debate over the merits of the negative and positive list systems had surfaced at several periods prior to 1954. In 1933, for example, Food Manufacture had carried out a debate on the issue. The arguments put forward were very similar to those reported by the PC in 1954, with the following additions:

f) The adoption of a list similar to that of the USA, for example, by the UK and all its colonial markets would facilitate the UK export trade and promote inter-Empire trade.

g) The colour manufacturers would be saved time and money by having a definite list. They would be able to reduce overheads by producing a smaller range of colours in bulk.

h) The public and dieticians would know (within limits) what range of colours was being used in food.

i) A permitted could may be of sufficient length to meet every shade and technical function the manufacturer and public required (117).

The advisory committe of 1954 listed the following arguments in favour of retaining the negative list system:

a) The negative list system had operated successfully since 1925. Injurious colours were covered by the Sale of Food and Drugs Act.

b) There as no evidence of human illness due to consumption of colours in food. Adverse effects in animal tests were not necessarily relevant to human exposure.

c) The negative list gave a wide range of shades and technical performance and gave the manufacturers the necessary freedom of choice.

d) The system allowed food made for export also to be sold in the UK.

e) The negative list was flexible and could be extended to include any colour proven harmful (118).

The food manufacturers who expressed their views in 1933 had given similar arguments with the following additions:

f) Any change to the current system might adversely affect the business of manufacturers who had developed special shades with which their products had become identified.

g) A negative list gave more scope to manufacturers to develop new colours and 'appetising' shades which would be of nutritional benefit.

h) The work of public analysts was much simpler because they had to examine products for a relatively short list of prohibited colours only.

i) There were no tests to determine whether the small doses of colours were injurious?

j) The negative list was in keeping with food law and English Common Law: that a colour is innocent until proven guilty.

k) Testing and research for a permitted list would inflict an enormous and unjustifiable expense on industry.

l) Positive lists in other countries appeared chiefly to be protectionist weapons for preventing the entry of foreign goods.

m) For colour manufacturers bulk production of a few dyes would probably be less profitable than the sale of specialised colours at 'fancy prices' (119).

The advisory committee of 1954 rejected most of these arguments. They gave their own reasons why the negative list should be changed to a positive list:

i) Controls must be designed to safeguard public health as effectively as possible. The negative list does not meet this requirement. Prudence suggests that ideally only colours for which there is adequate experimental evidence of harmlessness should be permitted to be used in foods.

ii) During the last twenty years evidence has accumulated which indicates that certain coal tar colours are carcinogenic to experimental animals. These colours are not currently prohibited. The number of coal tar colours is very large and new ones are constantly being introduced. The majority are not manufactured specifically for food and may be undesirable. For most colours there is insufficient information to judge whether they are safe when consumed over long periods.

iii) For effective control, a negative list would need to include all coal tar colours known or suspected to be harmful. This would be a cumbersome procedure. Control could be more easily achieved by specifying the colours which may be used.

iv) Permitted lists have operated successfully in countries such as the USA and Canada. But colours should be put on a UK list because of their harmlessness rather than because they are on the list of another country (120).

The Preservatives Sub-Committee and the Food Standards Committee came down firmly in favour of a positive list for colours.

The task of assessing safety was delegated to a Pharmacology Panel made up of the medical members of the Preservatives Sub-Committee. They divided colours into three classes (see table I.1 in appendix I) according to their opinion of their safety. They chose 32 coal tar colours (from about 100) as suitable for a permitted list on the basis of need and safety. On the issue of safety they said:

> It is obvious that in the interests of public health only colours which will not have any deleterious effects when consumed over long periods should be used in foods (121).

The committee was very aware of the legislation in other countries and made comparisons between that and legislation in the UK and the possibilities for further controls. They considered the question of fixing limits on the amount of colour that could be added to food, and felt this would serve no useful purpose. They recommended that standards of composition and purity be established for each colour. The Sub-Committee was not unanimous on the issue of labelling, but most felt it would be desirable to extend it from prepacked food to all other foods including exempted ones like alcoholic drinks and ones for which a standard had already been prescribed. They recognised that the 1924 committee had not considered labelling in the context of the possibility of shoppers being misled about the nature or quality of a food. But they did not take this point further. The committee considered that no controls over the trade sale of colours need be made, other than labelling with the 'appropriate designation' and an indication that the colour was for food.

3.31 Introduction of a Positive List

The FSC's recommendations were put out for comment. A few additional colours were submitted by manufacturers for assessment. After a follow-up report and consultation with traders, the government acted on the committee's recommendation to create a positive list. In 1957, regulations specified the 30 coal tar colours, 16 plant colours and 7 mineral colours that could legally be used in food (122).

This reduced the number of coal tar colours used in food by two thirds, from approximately 100 to 30. (See table A.5 in appendix A for the names of colours on the permitted list and table I.1 in appendix I for the colours previously used and no longer permitted). The regulations also prohibited the addition of colour to raw and unprocessed meat, game, poultry, fish, fruit and vegetables (except for surface marking and for citrus fruit), and prescribed the labels for the sale of colours to manufacturers.

Fred Steward has commented on the significance of these events:

> The desire to practically implement a form of control based on the permitted list took precedence over the more general issues of testing. The strength of this was that the fundamental debates over the desirability of this form of control were resolved by 1957 and set the pattern for subsequent control of food additives in general. Its weakness was that the definition of the need for colours which had not been adequately tested rested primarily on an interpretation of 'reasonable trade requirements' worked out in a relatively close dialogue between the committee and the industry (123).

3.32 STANDARDS VERSUS LABELLING AND CODES OF PRACTICE

After the war there was much emphasis on voluntary codes of practice. The Ministry of Food had produced a number of booklets on labelling and codes of practice agreed by the Ministry and industry.

In September 1953 there was again a debate within the Ministry and elsewhere about the role of standards and the extent to which one could allow them to be eroded by the sale of sub-standard products that were labelled as such. In an internal, confidential report on the issue the FSC reiterated the view of the Willis Committee from the 1930s that the sale of sub-standard products would not protect the pocket of the consumer. Protecting the pocket of the consumer had been the primary aim of setting standards, they argued. They emphasised that setting minimum standards had now become established policy. Obviously the Committee felt the principle of standards to be under considerable threat.

The FSC gave an example of the need for standards. A sausage with 50% beef content was sold at 2s per lb. One at 25% beef should sell at approximately 1s per lb since the main cost was in the meat. A trader might do a roaring trade in 25% meat sausages selling at 1s 6d per lb since in taste (and colour) the consumer could not easily distinguish between the two types of sausage, particularly with the use of such additives as sodium glutamate and red dyes.

The FSC was obviously upset at the challenge to the principle of setting standards and concluded:

> Any further lowering of the existing standards would, we imagine, be regarded as unthinkable (124).

In 1954 the FSC again felt the need to defend standards against labelling or codes of practice as means of protecting the consumer. In an internal policy report they said they took the view that standards were necessary to protect the public. They regretted the fact that:

> The historical accident by which most of the standards prescribed by the Minister of Food originated in war time controls has perhaps created the impression that standards are not relevant to peace-time conditions of free competition and plentiful supplies (125).

The FSC concluded the report:

> ...Statutory standards, which either define or specify the minimum essential ingredients of foods, represented in general the best means of protecting the consumer. They recognised, however, that in some instances labelling or Codes of Practice might be the only practicable form of control (126).

Obviously standards were acceptable only to some manufacturers, otherwise there would have been no challenge to them. By 1954 the Committee had recommended standards for coffee mixtures, cream, curry powder, edible gelatine, fish cakes, fish paste, ice cream, margarine, meat paste, preserves, saccharin tablets, soft drinks, suet, tomato ketchup and table jellies. It was a matter of 'convenience' to make standards as Rules and Orders under the Defence (Sale of Food) Regulations rather than making Regulations under the Food and Drugs Act 1938 s.8. This meant it was all within the power of the Minister of Food to whom FSC reported; using the Act would have required the approval of the Ministers of Health, who might have been even less sympathetic.

By 1954 standards had been prescribed under the Food and Drugs Act 1938 for milk, skimmed and separated milk, condensed milk, dried milk and artificial cream. Limitations on water content had been set for butter, margarine, milk blended butter, whisky, brandy, rum and gin. In this period existing standards were amended but few new standards were created for previously unregulated foods.

Also by 1954 a number of Codes of Practice had been made involving standards of composition for the following foods: cocoa and drinking chocolate, fish paste, meat paste, canned soups, malted milk, biscuits, horseradish cream, butter sweets.

The emphasis on voluntary codes was reduced in 1955 then unofficially re-established in 1959 when the local authorities set up the Joint Advisory Commmittee to clarify interpretation of the law and to negotiate and revise codes of practice. This policy was continued during the 1960s and 1970s by the renamed Local Authorities Joint Advisory Committee (127).

3.33 PURITY STANDARDS FOR COLOURS

The need for some control on the purity of colours had been remarked upon by the PC in 1954 and at almost every government inquiry since 1855. Hassall, for example, had a lot to say about the problem of contaminants in the mid 1800s. Limits on arsenic and metal contaminants were deemed desirable by the 1901 and 1924 committee reports respectively. In fact, purity was a predominant area of inquiry for the 1924 committee. Some manufacturers in the 1900s made significant attempts to remove contaminants voluntarily. Some manufacturers started to produce specially purified colours in dedicated plant around 1925.

Voluntary codes of practice for purity were established later by the Society of Public Analysts and a trade association. In 1942 manufacturers claimed that food colours were specially purified (128). But in 1954 the majority of colours were still not made specially for food, according to the Preservatives Sub-Committee (129).

The real drive in the UK for setting specifications for colours came from the WHO/FAO JECFA committee which started to draw up specifications in order to identify and assess the safety of colours in the 1950s. From the mid 1950s several British Standards were established for colours. The Standards were voluntary. In 1954 for example, a British Standard was set for annatto used in dairy products. It controlled the specification and purity of the colouring (130). In the 1960s (see table 3.6) British Standards laid down specifications for the amounts of subsidiary dyes in coal tar food colours and the methods for determining them (131). British Standards were set for other types of colours such as Caramel, Carmine, Channel black and synthetic β-carotene between 1965 and 1967 (132).

Specifications for a number of colours were included in the 1966 UK regulations. Specifications were set for most colours when the EEC Directive was adopted in 1973. These were considered by COT in 1979 to no longer adequately describe the colours. Improved specifications were recommended by FACC in 1979, which have yet to be made into regulations. The proposed EEC Directive on colours contains new specifications. If introduced it could have significant effects on some colours. UK manufacturers of one type of Caramel have claimed that they will not be able to meet the more stringent specification. If the Directive is introduced unamended it will force production of a purer form of Caramel, which will probably be beneficial since there have been toxicological problems with some of its contaminants.

3.34 AMENDMENTS TO THE POSITIVE LIST

The recommendation of the 1954 FSC report that the permitted list should be reviewed within five years was acted on, and a review started in 1960.

TABLE 3.6 : BRITISH STANDARDS FOR COAL TAR COLOURS IN 1969

Colour	British Standard in force in 1969 (BS: Year)
Amaranth	3341:1961
Black 7984	-
Black PN	4354:1968
Brilliant blue	-
Brown FK	-
Carmoisine	3343:1961
Chocolate brown FB	-
Chocolate brown HT	-
Erythrosine	4138:1967
Fast red E	4287:1968
Fast yellow AB	-
Green S	4153:1967
Indanthrene blue	-
Indigo carmine	4143:1967
Methyl violet	-
Oil yellow GG	-
Oil yellow XP	-
Orange G	3612:1962
Orange RN	-
Patent blue V	-
Pigment rubine	-
Ponceau 4R	3342:1961
Ponceau SX	3613:1963
Quinoline yellow	-
Red 2G	3611:1963
Red 6B	3780:1964
Red 10B	3610:1963
Red FB	-
Sunset yellow FCF	3340:1961
Tartrazine	3211:1960
Violet 6B	-
Violet BNP	-
Yellow 2G	3614:1963

The FSC report was published in 1964. They said:

> We have appreciated that the proposed list of permitted coal-tar colours would not contain any blue colour which would be technically satisfactory for certain requirements of the trade. The evidence available on brilliant blue FCF and blue VRS suggests probable toxicity and as we have already recommended in the report, these colours ought not to be allowed in food (133).

The report led to a modification of the colour regulations in 1966 (134). The list of permitted colours was reduced in total by the addition of one and elimination of six coal tar colours. See table E.1 in appendix E for the list and its development over the following years.

An amendment was made to the regulations in 1970, deleting Ponceau 2R, a red coal tar colour (135). In 1973 further amendments were made to give effect to the UK's obligations under the EEC Directive of 1962 which required harmonisation of permitted colours (136). Of a total of 24 coal tar colours, seven were new to the UK:

Quinoline yellow
Patent blue V
Brilliant blue FCF
Fast yellow AB
Indanthrene blue
Pigment rubine - for surface marking only
Methyl violet - for surface marking only.

Seven coal tar colours were also banned:

Fast red E
Oil yellow GG
Oil yellow XP
Red 6B
Red 10B
Red FB
Violet BNP

By this time the shape of the permitted list in the UK was determined primarily by the EEC, although the UK's officials continued to fight for special derogations to allow UK manufacturers to continue to use some colours not permitted by the EEC overall. The UK was given special permission by a directive to continue to use Brown FK, Brown HT, Red 2G and Yellow 2G.

In 1975 one coal tar colour, Crocein orange, was banned (137). In 1976 five further colours were banned (138):

Black 7984	)	
Fast yellow AB	)	three coal tar colours
Indanthrene blue	)	
Burnt umber	)	two natural colours
Orchil	)	

In 1978 the list of coal tar colours was reduced from 20 to 18 by a ban on Chocolate brown FB and Orange G. One type of carbon black (channel black) was prohibied. A new natural colour, riboflavin-5'-phosphate was permitted (139). The effects of all these changes to the list are assessed in Chapter 6.

Tables E.1, E.2 and E.3 in appendix E show the changes to the permitted list. There have been no changes since 1978. Tables A.1 and A.4 show the work of the Food Standards Committee on colours compared to other groups of additives. There were no more reports on colours than on other major groups of additives. But more amendments were made to the colours regulations than to other groups.

3.35 Recent Reports on Colours

The Food Additives and Contaminants Committee (FACC) and Committee on Toxicity (COT), which had taken over advisory work on additives, started a review of colouring regulations in 1974. Their interim report was published in 1979 (140). COT said they would like to see a reduction in the use of colours and recommended more toxicological studies and regularly-updated information about the intake of colours (141). The FACC recommended:

a) A prohibition on the use of colour in baby foods

b) That new specifications for purity be set

c) Further toxicological studies on certain colours, within five years.

d) A possible ban on the use of methyl violet to mark citrus fruit.

The FACC also argued for stricter controls on the use of colours and promised a future report on this. No regulations were made in response to the report. Industry voluntarily phased out the use of colours in baby food.

The FACC review of colours was continued after the publication of the 1979 report. FACC had felt unable to recommend how extensive controls on colours should be without more detailed information on levels of use. Existing dietary surveys were entirely inadequate because they were not sufficiently detailed. A Working Party on Food Colours was set up in 1979 under the Steering Group on Food Surveillance (part of the scientific branch of MAFF) to provide information. The Working Party requested food manufacturers to declare on a survey form the quantities of coloured ingredients added to defined food products. To preserve commercial confidentiality the forms were returned via trade associations. The survey was carried out in 1980 and, after analysis, submitted to FACC in 1983. The results of the survey were not published until 1987.

FACC and FSC were merged in 1983 to form the Food Advisory Committee. There are several possible reasons for this: the FSC had produced some consumer-oriented reports criticising practices such as adding excess water (to meat and other foods) and misleading claims and labels. They recommended stricter controls of these practices. Their recommendations were ignored by the Minister. MAFF and the food industry had been brought into much closer communication by the EEC - they had united against what they saw as a common threat. The industry started to communicate to MAFF much more information about its practices, so that the Ministry could argue their corner in the European debates. As a result, a cosy relationship developed between MAFF and the industry. Consumer organisations were consulted in a token manner.

3.36 Procedure for Evaluating Colours

Table 3.7 shows the current process of evaluating a food colour. The procedure has changed little since the introduction of a permitted list. The Food Advisory Committee (FAC, formerly FACC) is responsible for reviewing colours regularly and evaluating potential new ones. Colours are evaluated on the basis of need and safety, outlined below. Reviews are not as regular as they were originally intended to be.

a) <u>Assessment of need</u>

FAC judges 'need' on the basis of a variety of factors, such as:

i) Supposed consumer demand.

ii) Technological need (eg. if the colour allows a change in processing technique or produces an effect not already available).

iii) Economic need (eg. if the colour allows a product to be produced more cheaply or to have a longer shelf life).

Manufacturers are responsible for producing evidence of need. Sometimes they put considerable resources into producing sophisticated submissions. 'Need' is discussed in chapter 5.

b) <u>Assessment of safety</u>

The Committee on Toxicity (COT) judges the safety-in-use of colours. The committee considers evidence of safety from:

i) Research produced by the company making the submission.

ii) Research performed by the British Industrial Biological Research Association (BIBRA) or other industry research associations.

iii) Recommendations of the WHO/FAO Joint Expert Committee on Food Additives and the European Commission's Scientific Committee for Food.

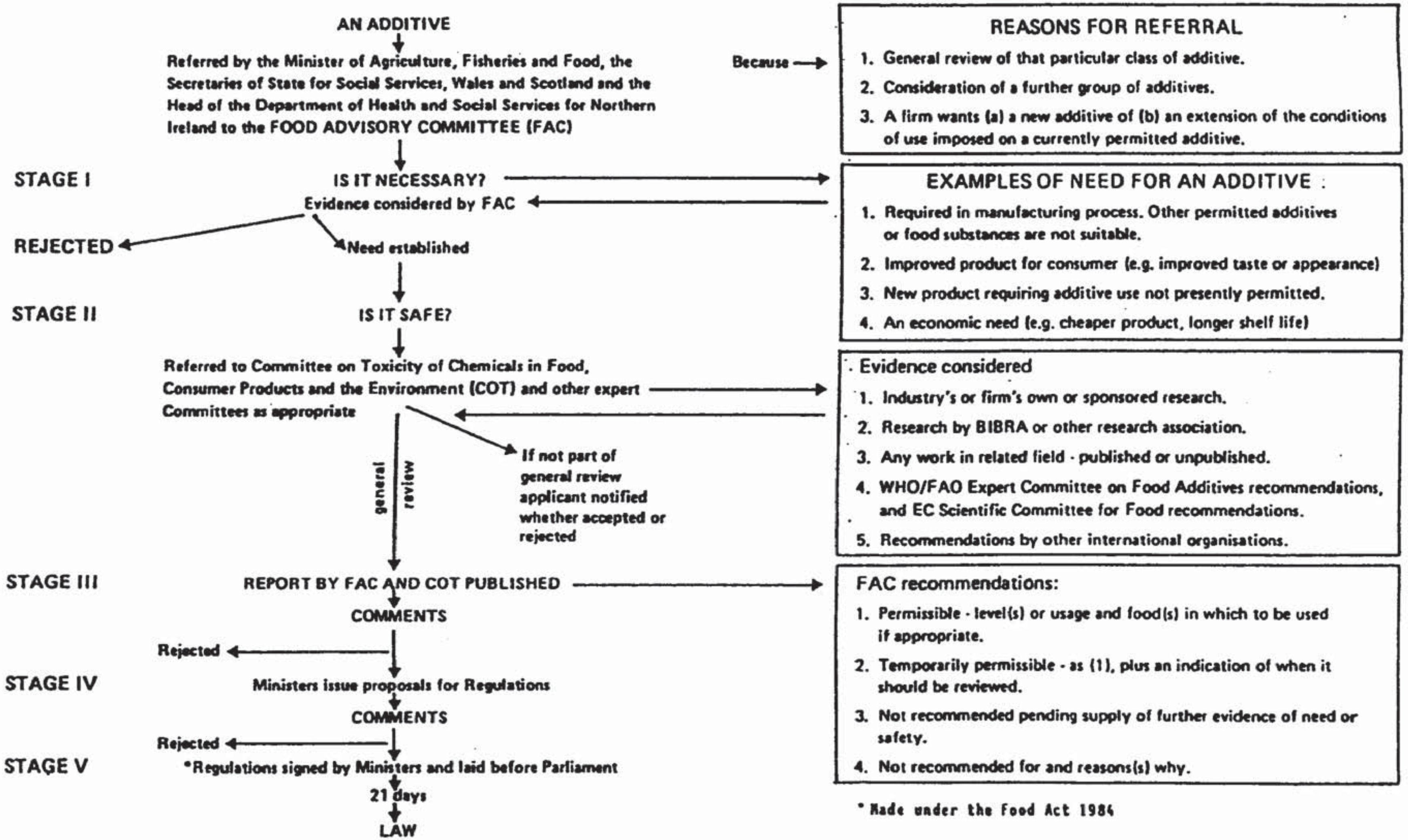
iv) Recommendations of foreign governments.

v) Other published or unpublished material.

A proposed new colour is put through routine sets of tests comprising animal feeding studies, bacterial and tissue culture tests. Animal studies involve feeding animals (usually rats and mice and one large species of mammal) large amounts of the colour for a short time and small amounts for a long time. The aim is to see whether acute or chronic poisoning shows up, whether there are detectable signs of cancer or reproductive problems, and to identify the level at which there is no observable effect. Tests on bacteria are performed as a screen for substances that may contribute to cancer or other effects by damaging

TABLE 3.7 : THE PROCESS OF EVALUATING A FOOD COLOUR

Source: MAFF, Standards Division, 1984.



Note: Similar regulations are normally made by the Secretary of State for Scotland and by the Head of the Department of Health and Social Services for Northern Ireland under the appropriate Food and Drugs Acts applying to those countries.

genetic material. Tests on tissue cultures are performed to investigate specific toxic effects. Occasionally, tests may be performed on humans.

The extent of testing required for any particular colour will vary according to factors such as anticipated levels of use, knowledge of prior human exposure and potential toxicity of its chemical structure. Test results are assessed by the company that wishes to produce the colour. Their report is then evaluated by COT. Any areas of controversy are passed by COT to an appropriate specialist committee for comment. For example, if the mutagenicity is equivocal the Committee on Mutagenicity may be asked to evaluate the issue. COT classifies the colour according to one of the following groups, and reports its opinions to FAC:

Group A: Additives that the available evidence suggests are acceptable for use in food.

Group B: Additives that on the available evidence may be regarded meanwhile as provisionally acceptable for use in food, but about which further information is necessary and which must be reviewed within a specified time.

Group C: Additives for which the available evidence suggests possible toxicity and which ought not to be allowed in food without evidence establishing their acceptability.

Group D: Additives for which the available evidence suggests probable toxicity and which ought not to be allowed in food.

Group E: Additives for which the available evidence is inadequate to enable an opinion to be expressed as to their suitability for use in food.

Group F: Additives for which no information on toxicity is available.

FAC then makes recommendations to the Minister about whether a particular colour should be allowed and whether any restrictions should be made on its use. FAC's reports do not commit the Minister to action. Their suggestions are open to representations and consultations by interested parties before the Minister decides whether and how to amend the regulations.

3.37 Current Recommendations

The final report on colours promised by FACC did not appear until 1987 (142). Their views on the issues of need and safety are discussed in chapter 7. They recommended that:

a) Some colours should be prohibited: two coal tar colours (Yellow 2G and Methyl violet, the latter being used for surface marking only) and five natural colours for which there was little information about safety.

b) Three coal tar colours should be restricted to one class of food: Red 2G to meat products and meat analogues only; Erythrosine (E127) to cocktail and glace cherries only; Brown FK to smoked and cured fish only.

c) The voluntary ban on colours in baby food should be made statutory (excluding nutrients).

d) For the first time, quantity limits should be introduced.

e) Colours added to animal feed to colour egg yolks and the flesh of farmed salmon and trout should be declared on the food when sold.

f) Further research should be made into the safety of caramel, curcumin and nine other colours; an up-to-date survey on consumption of colours; and an examination of the use of the terms 'natural' and 'artificial' on food labels.

The remaining coal tar colours were finally given full toxicological approval by COT.

The Minister announced on the day the report was published that he would put the following recommendations into regulations:

a) Prohibiting the use of colours in baby food.

b) Prohibiting the use of Yellow 2G for any food purpose and the use of Methyl violet for marking skins of citrus fruit.

All uses of these colours had virtually stopped so the Minister could be safe knowing that no significant industrial group would object. He could also be seen to be responding to a wave of public concern about additives that started in late 1985. The research that the committee had called for (point f above) had already been initiated by MAFF and industrial interests. The remaining recommendations were put out for comment, as usual, and may or may not be made into regulations.

3.38 OVERVIEW OF GOVERNMENT ACTIVITY

The history of government action on colourings as a specific group of additives began around 1900. Interpreting the terms used in the food Act caused considerable debate well into the twentieth century. The responsibility for colours moved from the Ministry of Health to a Ministry of Food and then of Agriculture, eventually. A scientific advisory committee structure was established. There were enormous changes in technical and organisational aspects of the food industry (eg. the change of control of the food industry from manufacturers to large retailers; new food and colour technology; a cheapened food policy). The government failed to amend the law sufficiently to keep pace with these developments.

Table 3.8 summarises government activity on colours during the twentieth century. There were six major inquiries into the use of colours, plus several subsidiary reports on the issue of compositional standards. More amendments were made to the regulations on colours than any other group of additives. Harmonisation with the EEC had a significant impact in this area. Agreement over a permitted list of colours was not possible among the Member States.

The only occasion on which the government acted quickly on the advice of its advisory bodies was in 1957 when it established the positive list recommended a mere two years previously. In most cases there was a lag of about 22 years.

TABLE 3.8 : SUMMARY OF GOVERNMENT ACTIVITY ON THE USE OF FOOD COLOURS 1901 - 1987

Compiled from government reports listed in the table and M Miller Danger! Additives at Work London Food commission, London 1985, p163.

DATE	GOVERNMENT COMMITTEE OR REPORT	LAW OR REGULATION
1901	DEPARTMENTAL COMMITTEE INQUIRY INTO PRESERVATIVES AND COLOURS Report of the Departmental Committee appointed to inquire into the Use of Preservatives and Colouring Matters	
1901		FIRST SALE OF MILK REGULATIONS
1902		SALE OF BUTTER REGULATIONS
1907		PUBLIC HEALTH (REGULATIONS AS TO FOOD) ACT
1907		BUTTER AND MARGARINE AMENDMENT ACT prohibited preservatives in butter and margarine
1916-21	FIRST MINISTRY OF FOOD	
1923	DEPARTMENTAL COMMITTEE INQUIRY INTO COLOURS	
1924	DEPARTMENTAL COMMITTEE Report on Preservatives and Colouring Matters.. (Ministry of Health)	
1925		NEGATIVE LIST FOR COLOURS The Public Health (Preservatives etc in Food) Regulations 1925 (32 SI 1925 No 775)
1928		FOOD AND DRUGS (ADULTERATION) ACT consolidating the 1875 Act
1931	ESTABLISHED DEPT. COMMITTEE ON COMPOSITION AND DESCRIPTION OF FOOD (WILLIS COMMITTEE)	

DATE	GOVERNMENT COMMITTEE OR REPORT	LAW OR REGULATION
1938		FOOD AND DRUGS ACT consolidating act
1939-	SECOND MINISTRY OF FOOD	
1943		DEFENCE (SALE OF FOOD) REGULATIONS
1943?	INTERDEPARTMENTAL COMMITTEE ON FOOD STANDARDS	
1944		LABELLING OF FOOD ORDER
1947	ESTABLISHED FOOD STANDARDS COMMITTEE	
1951	ESTABLISHED PRESERVATIVES SUB-COMMITTEE UNDER F.S.C. TO REVIEW ADDITIVES	
1951	FOOD STANDARDS COMMITTEE REVIEW ON COLOURS STARTED	
1954		FOOD AND DRUGS AMENDMENT ACT
1954	FOOD STANDARDS COMMITTEE REPORT <u>Report on Colouring Matters: Recommendations relating to the use of colouring matters in food</u>	
1954-	SOME STANDARDS OF PURITY ESTABLISHED	
1955		FOOD AND DRUGS ACT
1955	FOOD STANDARDS COMMITTEE REPORT <u>Supplementary Report on Colouring Matters: Recommendations relating to the use of colouring matters in foods</u>	
	MINISTRY OF FOOD MOVED TO MINISTRY OF AGRICULTURE	
1957		REGULATIONS ON COLOURING MATTER IN FOOD (SI 1957 No 1066)
1960-64	FOOD STANDARDS COMMITTEE REVIEW OF 1957 COLOURS REGULATIONS	
1962		EEC COUNCIL DIRECTIVE ON COLOURS

DATE	GOVERNMENT COMMITTEE OR REPORT	LAW OR REGULATION
1964	FOOD ADDITIVES AND CONTAMINANTS COMMITTEE ESTABLISHED	
1964	FOOD STANDARDS COMMITTEE <u>Report..on 1957 regs</u> (FSC/FAC/REP/4)	
1965	ADVISORY WORK ON ADDITIVES MOVED TO FACC	
1965		AMENDMENT TO EEC DIRECTIVE (65/469/EEC, OJ P 178 26.10.65 p2793)
1966		REGULATIONS ON COLOURING MATTER IN FOOD specifications set (SI 1966 No 1203)
1967		AMENDMENT TO EEC DIRECTIVE (67/653/EEC, OJ P 263 30.10.67 p4)
1968		AMENDMENT TO EEC DIRECTIVE (68/419/EEC, OJ L 309 24.12.68 p24)
1970		AMENDMENT TO 1966 COLOUR REGULATIONS (SI 1970 No 1102)
1970		AMENDMENT TO EEC DIRECTIVE (70/358/EEC, OJ L 157 18.07.70 p36)
1972		EUROPEAN COMMUNITIES ACT UK joined the EEC
1973		REGULATIONS ON COLOURING MATTER IN FOOD implementing the amended 1962 EEC Directive (The Colouring Matter in Food Regulations 1973 SI 1973 No 1340)
1973		AMENDMENT TO EEC DIRECTIVE (OJ L 002 01.01.73 p1)

DATE	GOVERNMENT COMMITTEE OR REPORT	LAW OR REGULATION
1974		REGULATIONS AFFECTING COLOURS (The Preservatives in Food Regulations 1974 SI 1974 No 1119)
1974	FOOD ADDITIVES AND CONTAMINANTS COMMITTEE STARTED REVIEW of 1973 colour regulations EEC SCIENTIFIC COMMITTEE FOR FOOD PUBLISHED ADIs FOR COLOURS (SCF First Series)	
1975		AMENDMENT TO 1973 COLOUR REGULATIONS (The Colouring Matter in Food (Amendment) Regulations 1975 SI 1975 No 1488)
1976		AMENDMENT TO 1973 COLOUR REGULATIONS (The Colouring Matter in Food (Amendment) Regulations 1976 SI 1976 No 2086)
1976		AMENDMENT TO EEC DIRECTIVE (76/399/EEC, OJ L 108 26.04. 76 p19)
1977	FOOD ADDITIVES AND CONTAMINANTS COMMITTEE REPORT ON SULPHUR DIOXIDE Representation for the use of sulphur dioxide as an alternative to permitted colouring matter in canned garden peas (FAC/REP/23)	
1978		AMENDMENT TO 1973 COLOUR REGULATIONS (The Colouring Matter in Food (Amendment) Regulations 1978 ST 1978 No 1787)
1978		AMENDMENT TO EEC DIRECTIVE (78/144/EEC, OJ L 044 15.02. 78 p20)

DATE	GOVERNMENT COMMITTEE OR REPORT	LAW OR REGULATION
1979	FOOD ADDITIVES AND CONTAMINANTS COMMITTEE REPORT ON 1973 COLOUR REGULATIONS (Interim Report on the Review of the Colouring Matter in Food Regulations 1973 FAC/REP/29)	
1979	WORKING PARTY ON FOOD COLOURS ESTABLISHED Under the Steering Group on Food Surveillance	
1980	SURVEY OF LEVELS OF COLOUR IN USE by MAFF	
1981		AMENDMENT TO EEC DIRECTIVE (81/020/EEC, OJ L 043 14.02. 81 p11)
1983	F.A.C.C. AND F.S.C. MERGED TO FORM FOOD ADVISORY COMMITTEE FOOD ADVISORY COMMITTEE REVIEW OF 1973 COLOURS REGULATIONS	
1985		AMENDMENT TO EEC DIRECTIVE (85/007/EEC, OJ L 002 03.01. 85 p22)
1985		PROPOSED 8th AMENDMENT TO EEC DIRECTIVE harmonising EEC list (COM(85)474)
1987	FOOD ADVISORY COMMITTEE REPORT ON COLOURS	
1987	REPORT ON SURVEY OF COLOUR USAGE by MAFF	
1987?		AMENDMENT TO 1973 COLOURS REGULATIONS
1988?		NEW COLOUR REGULATIONS

On the issue of harmful colours, clear regulatory cycles occurred in the twentieth century, at about twenty-two year intervals. The pattern of government activity is shown in table 3.9 below. Preceding each phase of government activity, there was a build-up of dissatisfaction among traders and enforcement officers about the current state of controls, and a public campaign. Government response each time was to ask an expert committee to investigate claims. They recommended a prohibition on certain colours (a negative list) and later, a list of permitted colours (a positive list). The recommendations made by the committees were not acted on until the following cycle of government action, creating an approximate twenty-two year lag between committee recommendations and their adoption in legislation. In each cycle, calls for regulation were staved off by traders claiming that intervention was unnecessary: the industry could adequately control the use of harmful colours. Examples were given where traders had voluntarily withdrawn harmful colours. Yet each time, the problem resurfaced.

Once a positive list for colours had been established, the official definition of the problem changed. Prior to the 1950s one issue had been whether intervention was justified given the state of knowledge about:

a) The definition of added colours - their function and chemical composition.

b) The level of hazard - the extent of use and interpretation of safety data.

c) Enforcement ability - clear detection and identification tests.

d) 'Need' - weighing the demands of industry for a wide range of colours against the demands of the public.

After the positive list was introduced, assessments became institutionalised. Criteria were established for judging 'need' and safety. These changed suprisingly little in the following thirty years. Chapters 5 and 6 examine the outcome of these debates and official assessments of need and safety.

TABLE 3.9 : CYCLES OF REGULATORY ACTIVITY ON COLOURS

Year	Recommendation of Committee	Action
1856	Negative list; Anti-adulteration law	No action. Deaths in 1860 led to adulteration Act.
1874	No regulations needed	No action
1896	No regulations needed	No action
1901	Negative list	No action
1924	Positive list	Negative list
1955	Positive list	Positive list

NOTES AND REFERENCES FOR CHAPTER 3

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2 A Wynter Blyth Foods: Their Composition and Analysis Charles Griffin, London 1888 p4.

3 ibid.

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6 Daniel M Marmion Handbook of US Colorants wiley, New York 1984 p3.

7 A Wynter Blyth op cit p12-13.

8 Act of 11 George I c30.

9 1874 Select Committee Report on Adulteration of Food Act 1872 in Parliamentary Papers HMSO, London 1874, vol VI, p243, paragraph 1.

10 An Act of 1718.

11 Act of 56 George III c2.

12 F Accum A Treatise on Adulterations of Food, and Culinary Poisons Longmen, Hurst, Rees, Orme and Brown, London, 1820 p161-162.

13 Butterworth's op cit section A3.

14 Cited in J Walford op cit p5.

15 J Burnett op cit p109-110.

16 F Accum op cit p315-6.

17 ibid p167.

18 ibid p15-16.

19 ibid.

20 Arthur Hassall Adulterations Detected Longman, Green, Longman and Roberts, London 1861 p484.

21 From the Report of a Committee of the House of Commons on the Laws relating to the Manufacture, Sale and Assize of bread 1815, cited in Burnett op cit p111.

22 In 1847 brewers were permitted to use a sugar liquor (caramel) for darkening beer (Act of 10 Vict, c5)

23 J Burnett op cit p109, 103; F Accum op cit p163-5.

24 J Burnett op cit p111.

25 ibid p114.

26 ibid p112.

27 Examples of academic and reference books mentioning adulteration: J A Paris A Treatise on Diet 1826; J R McCulloch A Dictionary, Practical, Theoretical and Historical of Commerce and Commercial Navigation 1834; A Ure A Dictionary of Chemistry and Mineralogy 1835; J Pereira A Treatise of Food and Diet 1843. Popular books included Deadly Adulteration and Slow Poisoning Unmasked: or Disease and Death in the Pot and Bottle by 'an enemy to Fraud and Villany' c1830-31; J Wood in the System of Adulteration and Fraud now Prevailing in Trade 1852. - source: J Burnett op cit p107, 116. Hassall also mentions the works of Normandy, Chevalier, M M Jules-Garnier and Harel - source: A Hassall op cit 1855 piii.

28 J Burnett op cit; and I Paulus op cit.

29 A Hassall's evidence to the 1855 Select Committee on the Adulteration of Food, Drink and Drugs Report on Adulteration of Food, Drink and Drugs in Parliamentary Papers HMSO, London 1854-55 vol VIII, piii.

30 ibid pxxiv

31 Medical Transactions vol iv p80 cited by A Hassall 1861 op cit p405-6.

32 1855 Select Committee op cit pxxxiv.

33 ibid pxxxix.

34 A Hassall 1861 op cit p489-491. It is possible that Hassall just reproduced the Council of Paris list, but this seems doubtful because France and the UK probably used some different colours.

35 John Mitchell, analytical chemist, Parliamentary Papers HMSO, London 1856 vol VIII, paragraph 1180.

36 I Paulus op cit p25-26.

37 Parliamentary Papers HMSO, London 1856 vol VIII, pxxv.

38 ibid piii.

39 ibid piv.

40 Hassall 1861 op cit p3

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42 ibid pviii.

43 A Hassall 1861 op cit p492.

44 ibid piv.

45 I Paulus _op cit_ p27.

46 The deaths occurred in Bradford in October 1858. Two hundred people were poisoned. For an account of the outcry see the references given by I Paulus _op cit_ p45 n25.

47 Act of 23 and 24 VICT. c84.

48 I Paulus _op cit_ p28.

49 MAFF _Food Quality and Safety: A Century of Progress_ HMSO, London 1976 p5.

50 A Hassall 1861 _op cit_ p3.

51 _ibid_ p492.

52 Arthur Hassall _Food: Its Adulterations, and the Methods for Their Detection_ Longmans, Green and Co. London 1876. See also A Hassall 1861 _op cit_.

53 A Hassall 1861 _op cit_ p20; see also p19-21.

54 _ibid_ p22.

55 I Paulus _op cit_ p33.

56 Reports of the chief Medical Officer of Health in _Parliamentary Papers_ HMSO, London 1858 - 1899.

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59 Sale of Food and Drugs Act 1875 section 6.

60 _ibid_ section 3.

61 I Paulus _op cit_ p60.

62 _ibid_ p61.

63 MAFF _op cit_ p6.

64 I Paulus _op cit_ p104.

65 A Wynter Blythe _op cit_ p81.

66 H F Steward _Adversary and Advisory Processes in the Assessment and Control of Food Additives_ unpublished PhD thesis, University of Manchester, Manchester 1978.

67 For example, A Hassall 1876 _op cit_ p258.

68 _ibid_ p258.

69 Cazeneuve & Lepin _Bulletin de l'Academie de Medicine_ 27 April 1886 p643 cited in B C Hesse _Coal Tar Colors used in Food Products_ US Dept

Agriculture, Bureau of Chemistry Bulletin No 147, Government Printing Office, Washington DC 1912 p42-3.

70 Pfeffer Untersuchungen aus dem Botanishen Institut zu Tuebingen 1886-88 vol 2 p179-331 cited in Hesse ibid p51-2.

71 Cited in H F Steward op cit p96.

72 Unpublished internal report of the Food Standards Committee, record from the Public Records Office, Kew (FSC/POL/19).

73 Parliamentary Papers HMSO, London 1895 vol X, appendix 6, p372.

74 ibid appendix 7, p373.

75 Parliamentary Papers HMSO, London 1894 vol XII, paragraph 1061.

76 A Wynter Blyth op cit p14-17.

77 Parliamentary Papers HMSO, London 1895 vol X, appendix 6, p372.

78 A standard set of shades was prescribed on a colour table in the regulations. Margarine was also sold in distinctive oval containers and the law also required detailed records of the manufacture, import and export of each pound of margarine. 1895 ibid appendix 10 p381.

79 ibid paragraph 5882.

80 ibid paragraph 5763-4.

81 Parliamentary Papers 1894 op cit paragraph 960-966.

82 Parliamentary Papers 1895 op cit paragraph 5877-8.

83 Parliamentary Papers HMSO, London 1896 vol IX, paragraph 4.

84 ibid pvi.

85 ibid pxlii.

86 I Paulus op cit p80 and 81.

87 A Wynter Blyth op cit p81.

88 H F Steward op cit p86 note 10.

89 ibid p96.

90 ibid p105.

91 Parliamentary Papers 1895 op cit

92 ibid

93 Parliamentary Papers 1854-55 op cit paragraphs 9 and 11.

94 Cazeneuve and Lepin op cit.

95 Based on Theodor Weyl Handbuch der Hygiene Munich 1896.

96 MAFF *op cit* p6.

97 *British Medical Journal* 24 November 1900; J Burnett *op cit* p267.

98 Committee on Food Preservatives *Report of the Departmental Committee Appointed to Inquire into the Use of Preservatives and Colouring Matters in the Preservation and Colouring of Food* HMSO, London 1901.

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100 *ibid* pxxiv.

101 *ibid* pxxii.

102 F Steward *op cit* p104.

103 Ministry of Health *Final report of the Departmental Committee on the use of Preservatives and Colouring Matters in Food* HMSO, London, 1924 p4.

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106 *ibid*.

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108 F Steward *op cit* p107.

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112 Butterworth *op cit*.

113 Ministry of Food 1954 *op cit* p3.

114 *ibid* p5.

115 *ibid* p6.

116 *ibid* p7.

117 'Food colours: should the law be changed?' *Food Manufacture* London, December 1933 p412-3.

118 Ministry of Food 1954 *op cit*.

119 *food Manufacture op cit*.

120 Ministry of Food 1954 *op cit* p8.

121 ibid.

122 The Colouring Matter in Food Regulations, SI 1957 No 1066.

123 F Steward op cit.

124 Unpublished Food Standard Committee report Suggested Provision for Sub-standard Products FSC/POL/14 September 1953.

125 Unpublished Food Standards Committee report FSC/POL/19, August 1954 p1.

126 ibid p6.

127 Butterworth op cit.

128 'Colours in food' Nature vol 149, 16 May 1942, p537-8.

129 Ministry of Food 1954 op cit.

130 Britsh Standards Institution 'Annatto for dairy products' BS 2450:1954, BSI, London, 1954.

131 Britsh Standards Institution 'Methods for the analysis of water-soluble coal-tar dyes permitted for use in foods' BS 3210:1960, BSI, London, 1960.

132 British Standards Institution 'Caramel for use in foodstuffs' BS 3874:1965; 'Carmine for use in foodstuffs' BS 3916:1965; 'Channel black for use in foodstuffs' BS 4173: 1967; 'Synthetic β-carotene for use in foodstuffs' BS 4179:1967, BSI, London.

133 Ministry of Agriculture, Fisheries and Food, Food Standards Committee Report on Colouring Matters HMSO, London 1964.

134 SI 1966 No 1203.

135 SI 1970 No 1102.

136 SI 1973 No 1340.

137 SI 1975 No 1488.

138 SI 1976 No 2086.

139 SI 1978 No 1787.

140 Ministry of Agriculture, Fisheries and Food, Food Additives and Contaminants Committee Interim Report on the Review of the Colouring Matter in Food Regulations 1973 HMSO, London, 1979.

141 ibid paragraph 12.

142 Ministry of Agriculture, Fisheries and Food, Food Advisory Committee Final Report on the Review of the Colouring Matter in Food Regulations 1973 HMSO, London, 1987.

CHAPTER 4

FOOD COLOURS: INDUSTRIAL INNOVATION AND DEMAND

CHAPTER 4
FOOD COLOURS: INDUSTRIAL INNOVATION AND DEMAND

4.1 Introduction

This chapter describes the benefits of colours to food and chemical manufacturers. It shows that the main drive behind the increased use of colours has come from the food and chemical industries rather than from public demand.

This chapter identifies the colours used in food between 1850 and 1987, and charts the development and introduction of new colours. It examines the dominance of the three classes of colours at different periods. The range and type of colours available for use in food has traditionally been determined by innovation dominated by the needs of the textile industry. But recently, despite claims to the contrary, food colours themselves have become a significant new area of innovation for the dye industry. This chapter charts the relationship between innovation in the dye industry and the use of colours in food. It also examines the effect of regulations on innovation. The method used to assess these effects is based on a methodology developed by Fred Steward, outlined in chapter 2 (1).

BENEFITS OF COLOURS TO INDUSTRY

This section examines the advantages gained by food manufacturers and chemical manufacturers from the use of colours in food.

4.2 Benefits to Food Industry

Colours offer food manufacturers and retailers a variety of benefits. In the last century chemicals were used to reduce costs of production, to improve the appearance of goods, and as one method of coping with urbanisation and problems of distribution. Examples of the use of colour included:

a) Disguising substitute ingredients, poor quality food and 'bulking', for example, adding caramel to beer to disguise the fact that it had been diluted; using arsenic sulphide to give the appearance of egg in bath buns.

b) Replacing colour lost during processing, for example, adding copper sulphate to tinned peas; adding colours to jam to mitigate the bleaching effects of preservatives.

c) Giving foods greater appeal to increase sales, for example, putting red lead in cheese and colours in confectionery.

As the proportion of processed foods in the diet increased, so did the use of colours. In the inter-war years of this century, colours and other additives were used to help produce standardised packaged foods, with extended shelf-lives, to supply a national mass market. From the 1950s the used of additives burgeoned again as the proportion of processed food increased to its current level of 75% of the average diet.

> At the end of the Second World War there were fewer than 1000 different food products. Now there are ten times that number. Almost three quarters of them have been processed in some way (2).

Manufacturers have become increasingly dependant on colours and other additives:

> The increasing replacement of fresh foods by manufactured 'convenience' foods has been accompanied by the use of foods additives as, for example, preservatives, anti-oxidants and colouring agents (3).

Processed foods are heavily dependant on the use of additives. Additives are put into processed fruit, meat and vegetables, for example, to replace colour, flavour and texture lost during processing and storage. Refined white flour is bleached and artificially matured by treatment with potassium bromate or chlorine dioxide. And additives can be used to give texture and colour to the waste 'meat' (ground-up bones, rind, fat and offal) that helps boost the declared 'meat' content of some pies and sausages. Colours and other additives are an integral part of food technology. The post-war increase in processed foods apparently led to a ten-fold increase in the use of colours between 1955 and 1985 (4). Todays range of functions for colours is considerably wider than in the last century, but is still firmly based on the production, preservation and storage requirements of food manufacturers and retailers.

There are numerous factors shaping the general direction and rate of developments (including methods of processing and types of products) within the food industry which have led to increasing dependence on colours and other additives. Significant factors include the following:

a) Profit margins have often been tight and battles between companies for market share in any food sector are fierce. The search for new products or new technologies to shave costs or preserve profit margins has been intense.

b) Concentration of power in food manufacturing and retailing has increased. For example, in 1985, just 4 companies controlled about 65% of the market for bread products (5). In London, just 5 multiple retailers controlled 68% of the market for packaged grocery sales (6).

c) Multiple retailers have acquired considerable power over the rest of the food industry. Many manufacturers now produce a high proportion of retailers 'own label' foods, and have become dependant upon them. For example, 80% of the production of one well-known soft drinks manufacturer is now made for retailers' own brands (7).

d) The overall size of the market for food is more or less static in Western countries, since there is a limit to the amount we can eat. In response, food firms have tried to increase their market share and the proportion of value added to their goods.

e) Surpluses of many primary foods in the West have tended to drive down world prices - although this has been held off, to some extent, by stockpiling.

f) Since the 1970s, many UK food companies have been attempting to cope with EEC policies and their effects. One effect has been an increase in the use of food grown in Britain, which may be more expensive than equivalent imported food, because the EEC operates behind some tariff barriers.

Food manufacturers have responded to the pressures outlined above, and to similar pressures in the past, in four main ways, by:

a) Increasing the proportion of value-adding, in order to increase profit margins.

b) Increasing the substitution of cheap or 'waste' ingredients, synthetic substances and water, for food, to cut production costs.

c) Investing in product diversification and innovation, to enlarge market shares or exploit new markets.

d) Increasing their control over food ingredients and finished products.

All these responses have involved the use of more colours - both in the past, and currently. When each 'response' is examined in turn, the useful role played by colours for manufacturers and retailers can clearly be seen.

4.3 a) Value-adding

Where the market for food is limited and there is overproduction of primary foods, a major way of retaining profit margins or increasing market share is to turn primary foods into highly processed products. In 1971 an industry journal, the Food Engineer, recommended food manufacturers to

> Shy away from price-oriented commodity items and look to highly manufactured products in the decade ahead. The more additive-addicted food created, the higher will be the profit margin (8).

One area where this has occurred significantly is in frozen foods. There has been a trend away from the relatively cheap, basic, minimally-treated frozen foods towards expensive, highly processed 'convenience' dishes and complete meals (9). A frozen meal of this kind may easily contain over 10 different additives - to help process the raw food materials, to replace qualities lost during processing, to bind extra water into the meat or fish or to add other 'bulk', and to stabilise the product while it sits in the freezer - to stop the texture deteriorating, perhaps, or to stop water and fats separating. Colours may help this product in several ways:

a) Replacing colour lost (particularly from fruit and vegetables) during processing.

b) Ensuring the product has the expected level of colour at the end of its protracted life.

c) Mitigating colour-loss resulting from added water and other cheap 'bulking' ingredients (discussed below).

A recent market research report made this comment about the importance of additives like colours:

> A number of different types of food additives, both flavouring and non-flavouring, play a central role in the development of value added meat products, the only way forward for the meat industry today (10).

4.4 b) Substitution

Colours and other additives are sometimes used as direct substitutes for more expensive ingredients and processes. They also allow poor quality or waste food substances, or foods of inappropriate nutritional value, to be substituted for better food. The substitution lowers costs of production. In this and the last century, for example, yellow colours were added to baked products instead of egg.

A contemporary example of a direct substitution is the replacement of cheese and tomato by yellow and red colours and 'cheese' and tomato flavourings, in foods such as pizza. One American manufacturer has advertised their synthetic tomato flavour thus:

> Cooked, ripe tomato flavour offered in either dry or liquid form ... is recommended for use in soups, sauces, dips, salad dressings and convenience foods ... 1 pound replaces the

flavour and aroma of 1,200-1,600 pounds [of] tomato juice, at a cost of $5 (11).

Chemical preservatives have been used to replace more expensive processes. Their use has sometimes required colour to be added. Sulphites, for example, have been widely used to preserve fruit pulp imported from the Mediterranean for products such as jam and fruit drink. Sulphites bleach the fruit, so colours are added to compensate. It is possible to import fruit in a non-sulphited condition. Such fruit would be processed under more hygienic conditions in the country of origin and preserved by heat treatment or freezing. Colours would not then be required.

The cost advantages of chemical preservatives may be diminishing, however. A market report on food additives recently commented:

> The market for preservatives and anti-oxidants is under attack as better manufacturing techniques are reducing the need for these materials and the physiological action of anti-oxidants is under investigation in many countries (12).

A third example of substitution is where additives are used to allow the incorporation of poor quality or waste ingredients, or even water, into food. They can mitigate the colour-loss resulting from dilution with water or bulking of meat products with fat and rusk. They can also give extra colour to compensate for the inclusion of old, or heavily-processed or poor quality fruit, vegetables and meat.

4.5 c) Diversification and innovation

Where total market size is limited, one way a company can increase production is by increasing its market share at the expense of other firms. Many firms have chosen product diversification as a means of achieving this. In the biscuit sector, for example, several companies have specialised in producing a wide range of products. They can produce new lines very quickly because they make relatively small batches. Diversification has meant the use of a wide variety of flavours and colours providing a range of biscuits from the same basic recipe and pattern. High levels of colour have sometimes been used to emphasise superficial differences between products in the same range (13).

A similar trend exists in the crisps sector:

> Although the crisp sector is the largest of the snack market in terms of value, sales have remained fairly static. As a result, crisp manufacturers have been forced to look to new products, flavours and processing technologies to revitalise the market (14).

Colours provided crisp manufacturers with a means of emphasising the different 'flavours' in a range. The use of colours to make superficial differences to create a 'range' of products has been of benefit to manufacturers throughout the 1800s as well as the 1900s, for products such as confectionary, and for most processed foods.

Innovation allows companies to exploit new markets too. The recent expressed need of consumers for healthier foods has been translated by manufacturers into a new market with many new products which are not necessarily better in terms of nutrition and health. In the dairy sector, for example, a lot of research has been put into new products, partly because of political embarrassment at the over-production of milk within the EEC, and partly to exploit the new health-conscious market. The result has been a flurry of value-added milk products. A market report recently made these comments about the products:

> The success of these convenience products (e.g. yoghurt drinks) has been accompanied by an increasing consumer attraction to the idea of 'natural' foods: but this attraction has not actually led to increased consumption of, for example, fresh fruit or milk. To some extent, what we are seeing is the adoption of the 'natural' banner by new foods which (however nutritious) are actually artificial (15).

Many of the new 'health' foods contain lots of additives. Low-fat yoghurt is regarded by many as a 'natural' or 'health' food, yet many contain added colour, flavouring and emulsifier. Often these are chemicals that have some equivalent in nature and can be called 'natural' on labels. 'Natural' colours are increasingly replacing coal tar colours. In some cases the level of colouring has been reduced too.

Innovation involves new processes as well as new products. New processes developed to cut production costs or develop new foods have generally been reliant on additives. Additives are an integral part of the technology for the Chorleywood process, which has cut the cost and time of bread-making in the 1960s. Caramel colour is used to make the white product look like brown bread. In all food sectors where product or process innovation has occurred, innovation has been heavily reliant on the use of colours.

4.6 d) Control

Colours and other additives have allowed manufacturers a high degree of control over their products. They allow, for example, the creation of very long shelf-lives. They give manufacturers and retailers more control over supplies and suppliers.

Since the 1930s or earlier, manufacturers of brand name products have been keen to standardise their output so that the content of each batch looks the same to consumers. However, basic food materials vary according to season and source. Additives give manufacturers the ability to alter texture, colour and flavour to meet a fixed standard.

They also allow manufacturers more choice in their purchase of raw materials, making them less reliant on particular sources, giving them increased power over suppliers. Margarine, for example, can be made from fish or vegetable oils, depending upon which are cheapest. The oils have their natural colour and flavour removed. Then colours and flavours are added to produce a standard product.

Colours can also give manufacturers increased control over processing. For example, colours can be mixed with minor additives and colour levels used to monitor the quantities of the other additives. Colour can also indicate whether mixing of ingredients has been adequate.

The desire for extra technical control has been one reason why many manufacturers have used synthetic colours rather than naturally-occurring ones. A synthetic colour is a standard product, whereas a naturally-occurring one (or its extract) will vary enormously according to plant variety, season and source. It is easier to control the degree and shade of colouring by using synthetic colours.

A long shelf-life is another important element of control over the product and the market. Multiple retailers (with a few notable exceptions) have demanded a long shelf-life for many food products. Retailers and manufacturers, though faced with a choice of techniques, have often used additives to achieve this. Additives such as preservatives and antioxidants are used to stop microbial growth and slow down the process of decay and rancidity; emulsifiers, stabilisers, texture modifiers and antioxidants are used to 'stabilise' the product during its long shelf-life, to stop oil and water components separating, colours fading or textures deteriorating. Colours have been used to mask the effects of many of these additions.

It is obvious from the discussion above that food manufacturers and retailers have become technologically and economically dependant on the use of colours and draw significant benefits from them.

Despite recent moves by major retailers to remove or replace some colours (in response to public concern), the trend of developments in the food industry indicates continued use of colours in many products. The food industry has considerable interest in maintaining the status of colours as substances allowed in food. The industry has strong lobbying power in the area of food additive controls. Significantly, the food industry is well represented on the various government bodies that advise Ministers about food additive controls.

4.7 Benefits to Food Additive Manufacturers

Not only do retailers and manufacturers benefit from using colours, but another significant industrial sector benefits too. This is the group of companies that manufactures, imports and sells food colours.

Growth in the use of colours has created a new industry with its own distinctive characteristics. It encompasses parts of the chemical industry and parts of the food industry, as well as the 'concentrates' sector that lies in-between. Some of the major companies are listed in table 4.1 below.

TABLE 4.1 : COMPANIES MANUFACTURING OR SUPPLYING FOOD COLOURS

Compiled from:

Food Manufacture <u>Ingredient & Machinery Survey</u> Morgan-Grampian, London 1983 p15-18; Kompass Trade Directory 1987 vol 1 p82; F M Rowe <u>Colour Index</u>, Society of Dyers & Colourists, Bradford, 1924 & 1928.

Company	Suppling or Manufacturing				Type of colour			
	1980s	1950s	1920s	1800s	Mineral & Metallic	Coal Tar	Plant & Animal	Caramel
ABM Brewing	/						/	
American Aniline Products			/			/		
D F Anstead	/				/	/	/	
F R Benson	/						/	
S & W Beresford	/							/
Biddle, Sawyer & Co	/						/	
Burton Son & Sanders	/							
Bush Boake Allen (owned by Union Camp Corp, USA)	/							/
W J Bush		/				/		
Butterfield Labs	/					/	/	
Clarke Nickolls & Coombs			/				/	
Clayton Aniline			/			/		
Colorcon (American-owned)	/					/		
Cooke Tweedale & Lindsay	/					/		
Horace Cory	/					/	/	
CPC (UK) (owned by CPC International, USA)	/							/
Dohler	/						/	
Falcon Crest Products	/							/
Felton Worldwide	/							/
Food Ingredient Services	/					/		/
Gilman & Spencer (owned by Pauls Flavours & Fragrances)	/							/
Ch. Goldrei, Foucard	/							
Gray's Dyes & Colours			/			/		
Hay-Lambert (owned by CPC (UK))	/							/
ICI	/					/		

Company	Suppling or Manufacturing				Type of colour			
	1980s	1950s	1920s	1800s	Mineral & Metallic	Coal Tar	Plant & Animal	Caramel
H Kohnstamm (UK) (American owned)	/					/	/	
KWR Chemicals	/					/	/	/
Langdales			/				/	
London Dye Manufacturing			/				/	
T Lucas	/					/		
MCC foods	/					/		
Marschall Div. of Miles Labs (owned by Bayer AG, W Germany)	/						/	/
Miles Laboratories (owned by Bayer AG, W Germany)	/						/	
Overseal Foods	/						/	
Pauls Flavours & Fragrances (owned by Harrison & Crosfield PLC)	/							/
Pointing	/					/	/	/
PPF International	/						/	
L J Rickards	/						/	
Roche Products	/						/	
Semmons Taylor	/						/	
R S Stokvis	/					/	/	
Swel Foods	/						/	
Tate & Lyle Refineries	/						/	
Unbar Rothon	/					/	/	
United Yeast (owned by Guiness PLC)	/							/
Wallace Supplies (owned by Guiness PLC)	/							/
Williams (Hounslow) (owned by an American company since 1969 or earlier)	/	/	/			/		
Williamson	/					/		
Zimmermann Hobbs							/	

Currently, over 41 companies manufacture or supply food colours in the UK. They range from small firms to transnational giants like ICI and Hoffman-La Roche. Some of the companies offering colours in the mid 1980s also made colours in the 1920s (see table 4.1).

Many current suppliers specialise in particular colour areas. Some, such as Williamson and Bush Boake & Allen, specialise in caramel colouring. Other companies, such as the large firms of Williams (Hounslow), Colorcon and Pointing, have specialised in coal tar colours. Williams has been one of the major firms producing coal tar colours since the 1920s and earlier. Roche and others have specialised in the 'naturals' market, producing synthetic versions of substances such as carotene. Hoffman-La Roche led the innovatory research on synthetic carotenes in the 1950s. (See section 4.13 below). A number of the suppliers of 'natural' colours have been based on the continent or foreign-owned, reflecting the continental preference for such colours.

The majority of current companies supply colours for a wide range of foods. Some, however, have specialised in supplying colours suitable for particular foods. Burton Son & Sanders, T J Wallace and Cooke Tweedale & Lindsay provide colours only for baking and confectionery. They provide the colours that would be able to withstand those particular manufacturing processes. Horace Cory & Co provide colours only for soft drinks; while T Lucas & Co provide them for meat products.

A substantial proportion of colours are sold to flavour companies or the concentrates sector, for blending into ready-prepared additive mixtures. Food Ingredient Services, for example, make coloured mixtures for meat products. They also make up mixtures to customer specifications. Most colour companies offer a special service, adapting colours to meet the particular processing requirements of one customer. This is an important service in the natural colours sector because these colours can pose many more technical problems. But making colours specially for one customer is traditional practice for other colour sectors too.

4.8 Recent market values

The few available figures for the market value of colours are given in table 4.2 (below). The value of the UK market for food colours almost doubled between 1979 and 1983/85, if the available figures are reliable. I think it is more likely that the 1979 figures were underestimates. The DTI figures for the same period, for a small number of companies, show a steady rise, rather than the dramatic upward leap indicated by table 4.2.

The largest part of the market is for caramel - this now makes up perhaps 90% of the UK market. Coal tar colours have traditionally been the next largest group, followed by the 'naturals' (plant colours and cochineal) which may have made up only 1-2% (16). In the last year, the proportion of natural colours has grown enormously. Sales of coal tar colours from Williams (which had over 50% of the market in 1979) were reported to have dropped by 50% in 1986 as public concern about dyes forced manufacturers to remove them or replace them with 'naturals'.

The value of the UK market for colours in 1983 was estimated to be £11-13 million. In 1986 the UK market for caramels alone was valued at £12-15 million. Exports for some firms are significant. CPC (UK) Ltd export about 40% of their caramel (some to growing markets in third world countries). In relation to the colour industry as a whole, food colours represent a small but significant market. In 1969 Williams (Hounslow) who made dyes for food alone were included in a very short list of major colour producers in a government report on the dye industry (17).

Control of the industry is concentrated in some sectors. For example, CPC (UK) produces about 14,000 (almost half) of the 30,000 or so tonnes of caramel produced currently in a year (18). And in 1979, Williams (Hounslow) reportedly held over 60% of the coal tar market (19).

TABLE 4.2: CONSUMPTION AND MARKET VALUE OF FOOD COLOURS IN THE UK

Compiled from:
J Walford Developments in Food Colours -1 Applied Science, London 1980 p22; 1924 Dept Committee report (amount from 2 firms alone); IMRA symposium 1985; Industrial Aids Ltd Depth Survey of the Additives Industry IAL, London 1979 (with 1983 amendments); D Conning Food Manufacture June 1986 p73; M Miller & A Burroughs 'Survey of the caramel industry' London Food Commission Briefing Paper, LFC, London 1987.

Year	Tonnage (& Market Value (£m)) Synthetic	Natural	Caramel	Total
1923	40 +			
1977	450			
1979	c 700	c 700		
(Market value:	4.5-5	1.5-2)		
1982	495			
1983	c 700 (4%)	c 700 (4%)	15,000 (92%)	16,400
(Market value:	2-3 (21%)	1-2 (12%)	8 (67%)	11-13)
1985	400 (4%)	190 (2%)	9,000 (94%)	9,590
(Market value:				12?)
1986	700			
1986	1,000?	1,000?	18,000 (90%)	
(Market value:			12-15)	

4.9 CHANGES IN FOOD COLOURS, 1850 - 1987

The tonnage of colours used in food each year has probably risen steadily. Table 4.2 shows the available figures for consumption of colours in the UK. The reason for growth this century has not been due to the invention of totally new chemicals but to manufacturers using colours in a wider range of foods and to the public eating a greater proportion of processed food.

The figures for UK consumption of food colours are patchy so it is not useful to produce a graph showing the pattern of growth over the past 100 years. However, a graph is available showing the consumption pattern in the USA (table 4.3). It is generally recognised that eating trends in the USA are good indicators of trends in the UK - allowing an approximate 10 year lag. It seems reasonable to assume that consumption patterns in the UK were similar to those shown in table 4.3 taking into account the 10 year lag. This table seems to indicate that government regulation of food colours did not stop a very considerable increase in use. Nor did the lack of radically new hues prevent an increase in consumption.

Table 4.4 summarises reports made about the extent of use of the three classes of colours between 1850 and 1987 in the UK. Mineral colours, widely used in the 1850s, had become rare (except for copper and lead salts) twenty-five years later. By 1920 copper was almost the sole mineral colour and it disappeared around 1925. Mineral colours have been almost insignificant from that time.

Coal tar colours were introduced in increasing numbers between the late 1850s and 1876. By 1895 a wide range was reported to be used, in almost all coloured foods. They remained widely used, gradually replacing mineral colours and many plant colours. Their use increased especially between the 1920s and 1950s. In the mid 1950s there was increased concern about the safety of tar colours and about the restrictions of a permitted list. This probably produced a slight swing away from the coal tar dyes to plant colours. From the 1880s coal tar colours remained the predominant class of colours (except for Caramel) until the late 1980s, when they were partially replaced by plant colours.

TABLE 4.3 : USA FOOD COLOUR CONSUMPTION, 1940-1977

Source: Brewster & M Jacobson The Changing American Diet Center for Science in the Public Interest, Washington DC 1978 Fig 11.

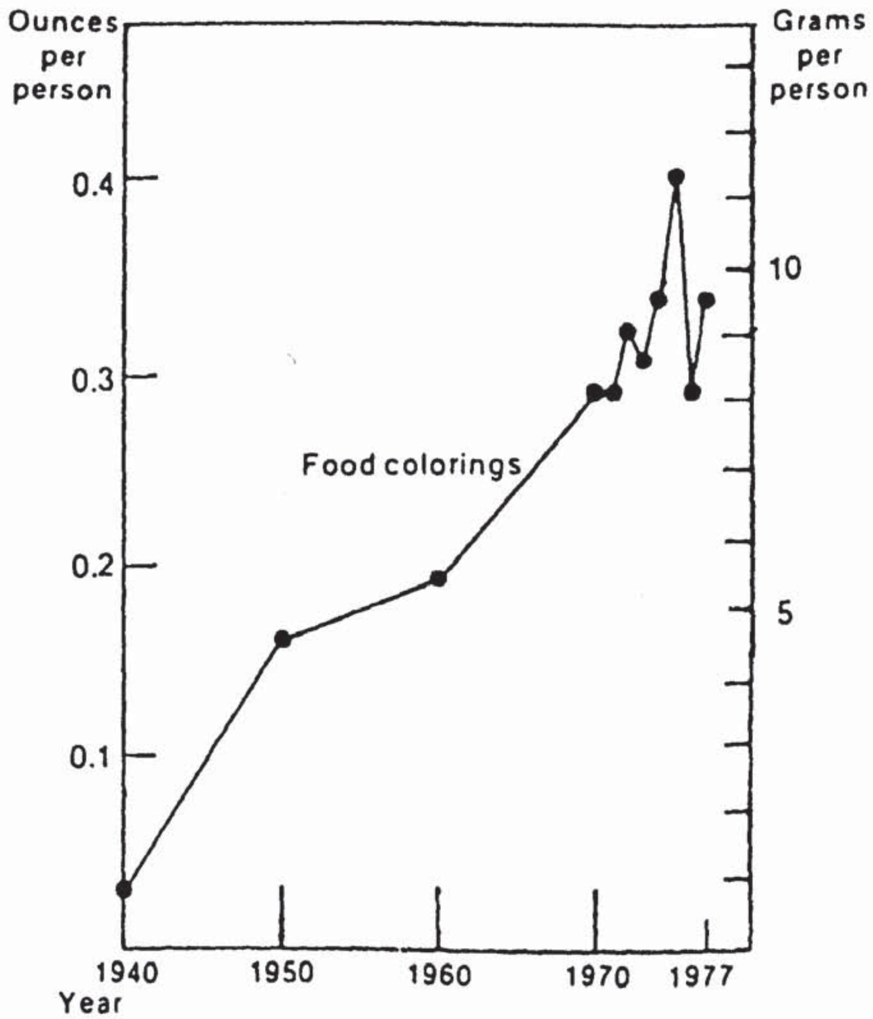


TABLE 4.4 : COMMENTS ON THE USE OF COLOURS IN FOOD, 1850 - 1987

Compilation of reports of the extent and type of colours used in food

Year (Reference)	Mineral	Coal Tar	Plant/Animal
1850s (20)	Large range widely used	None reported	Large range widely used
1855 (21)	Widespread use of colours; more coloured confectionery than 3 years before		
	Large range; slightly diminished use		Large range; increased use
1860 (22)	Poisonour colours still very common		
1876 (23)	Large range; used moderately	Much used; 'every tint imitated'	Large range; much used
1888 (24)	Rarely used except Pb & Cu salts	Widely used	Large range; widely used
1895 (25)	Cu used; others 'never' used	In almost all coloured foods. About 254 distinct colours available (not all suitable for food).	Still used. Many replaced by coal tar colours.
1901 (26)	Occasional use Cu common.	Used extensively; found in over 4000 food samples.	Very common; gradually being superceeded by coal tar colours.
1912 (27)	Not common	Every shade; many foods coloured.	Numerous; many foods coloured.
1912 (28)	Poisonous mineral colours still sometimes used in confectionery	Many available and used	Many shades available and used
1917 (29)	Prussian blue occasionally		

Year (Reference)	Mineral	Coal Tar	Plant/Animal
1920 (30)	Cu almost sole colour. Harmful minerals almost completely replaced.	Ever increasing use; superior to plant colours. Some unsafe; picric acid used occasionally.	Numerous; Gamboge occasionally used. Annatto extensively used.
1921 (31)		Martindale named a few harmless colours.	
1924 (32)	Cu salts	Enormous quantity of food coloured; increase on earlier periods.	
		90 distinct colours from 1 firm. 40 tons from 2 firms.	Vegetable colours 'practically gone out of use'.
1925 (33)		Martindale's first list of colours considered harmless.	
1935 (34)		Few manufactured foods are not artificially coloured.	
1936 (35)			Enormous decrease in use, due to coal tar colours; but a number still common.
1954 (36)	Iron oxides; rarely used.	Very widely used; about 100 colours.	Common use for limited range of foods
1940-1977 (37)	Iron oxides	Use of colours increased ten-fold as amount of processed food increased.	
1980 (38)	Rarely used	Very widely used	Widely used; caramel about 98% of all colour.
1987	Iron oxides & some metals rarely used	Widely used, but falling	Widely used; increasingly replacing coal tar colours.

A large range of plant colours was widely used in the 1850s. The extent of use dropped in the following decades, as they were replaced by coal tar colours, although the range of plant colours remained wide until the late 1880s. The numbers dropped but some colours, such as Annatto, remained widely used because there were no appropriate substitutes. In the 1930s their use decreased enormously, although a small number remained dominant in particular products, especially dairy products. Ancient dyes such as Madder & Logwood disappeared. The situation remained like this until the late 1980s when plant colours started to replace coal tar dyes in many products.

There are few complete lists of the individual colours used between 1850 and 1987. Public analysts, Medical Officers of Health, trade manuals and journals, and government reports at various times have provided information about some of the colours. Tables D.1, D.3 and D.4 in appendix D list the dates when particular colours were reported as used in food. Unfortunately, complete lists are available only for the 1850s-60s and mid 1950s. So the number of colours in use in the intervening periods is under-represented.

Tables E.1, E.2, and E.3 in appendix E list the colours permitted (and in most cases also used) in food between 1957 and 1987.

Information from these tables has been summarised in tables 4.5, 4.6 and 4.7. Surprisingly, prior to 1957, there is a good correlation between reports of the extent of use of colours (i.e. proportion of foods in which colours were used) and the number of individual colours reported to be in use. The histograms in table 4.5 - 4.7 correspond to the verbal reports of extent of use in table 4.4, and the summaries given for each class of colours in the paragraphs above.

TABLE 4.5 : NUMBER OF COAL TAR COLOURS IN USE BETWEEN 1850 AND 1987

Number of colours in use

Compiled from table I.6 in appendix I

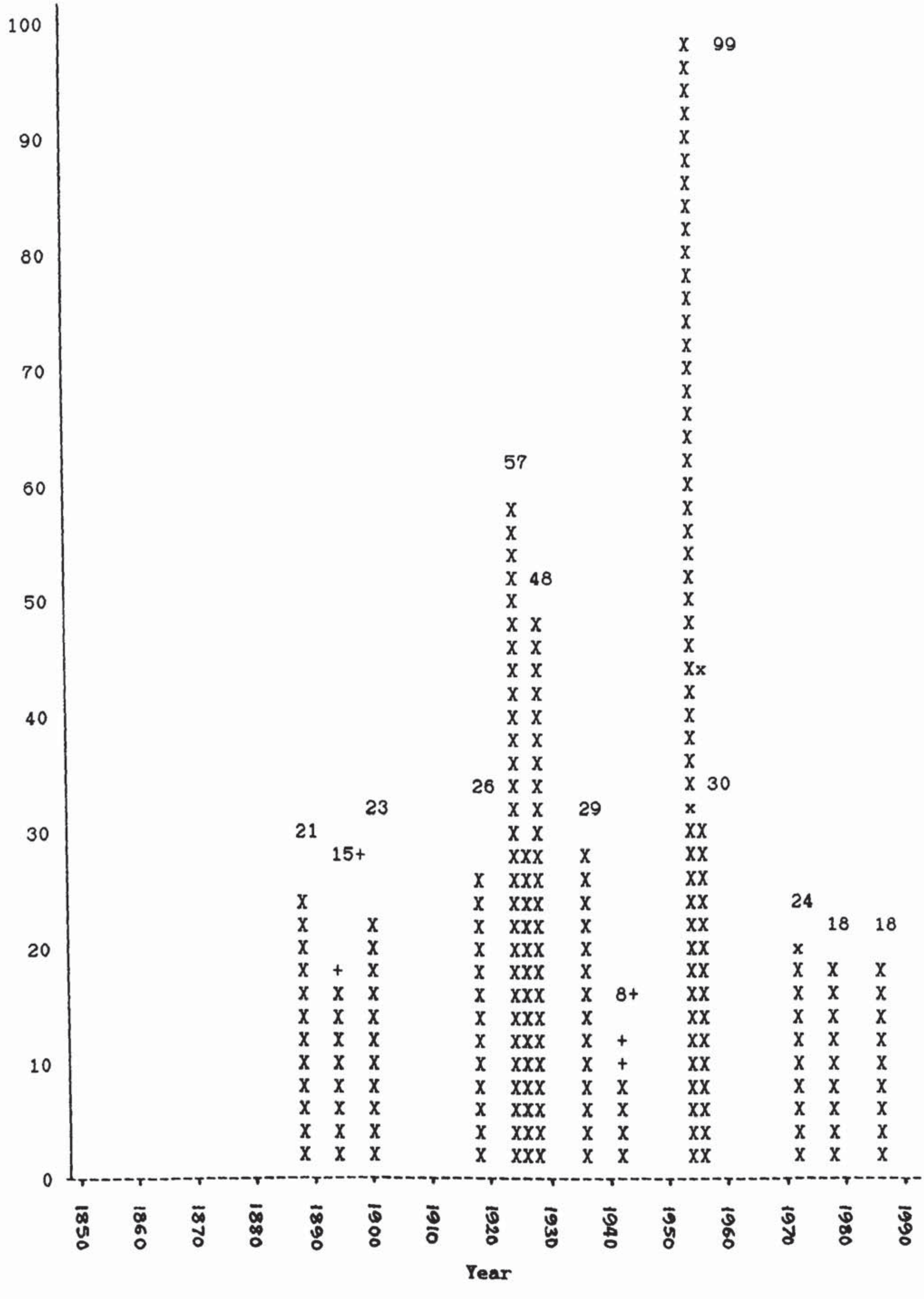


TABLE 4.6 : NUMBER OF MINERAL AND METALLIC COLOURS IN USE BETWEEN 1850 AND 1987

Compiled from table I.7 in appendix I

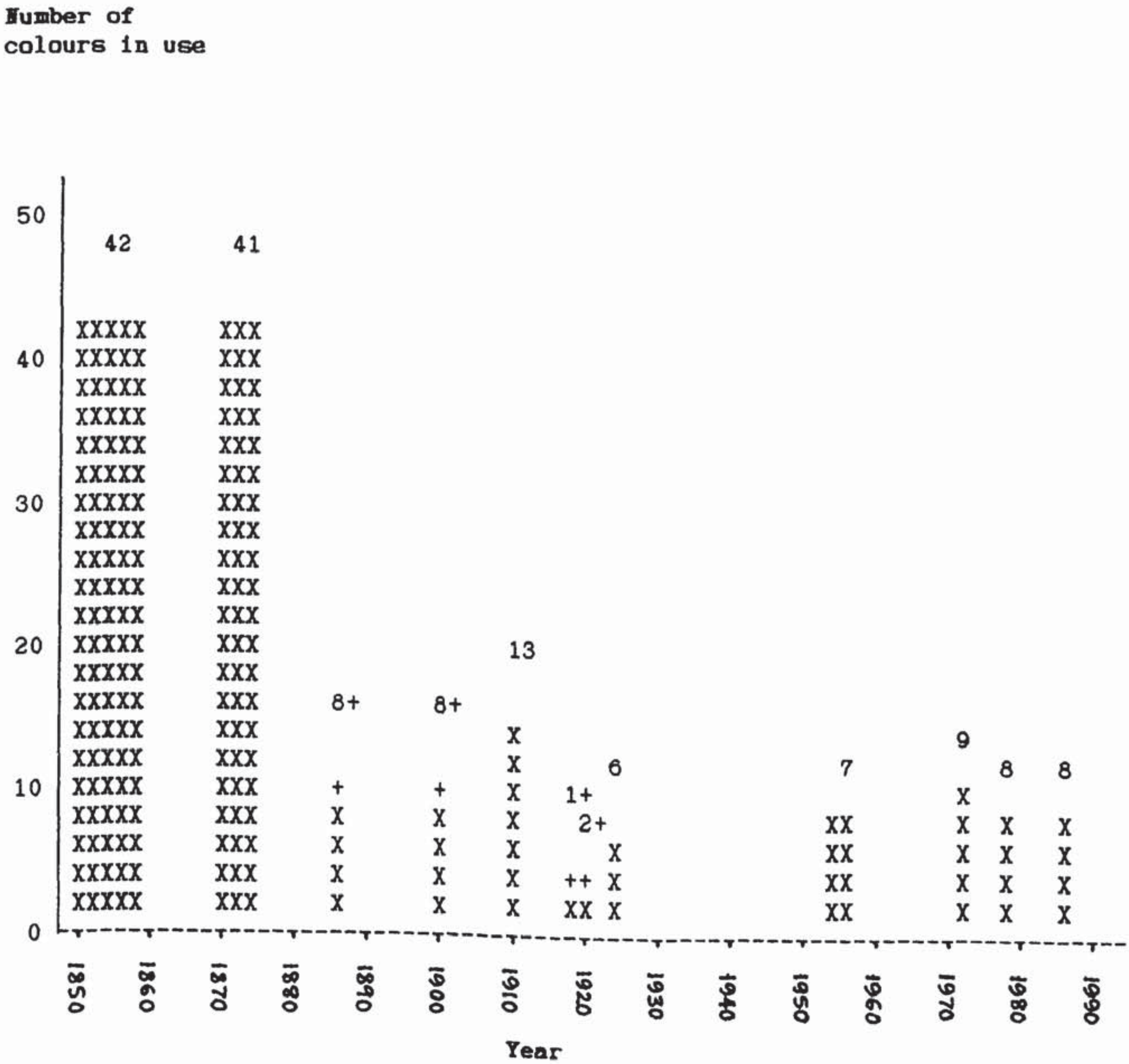
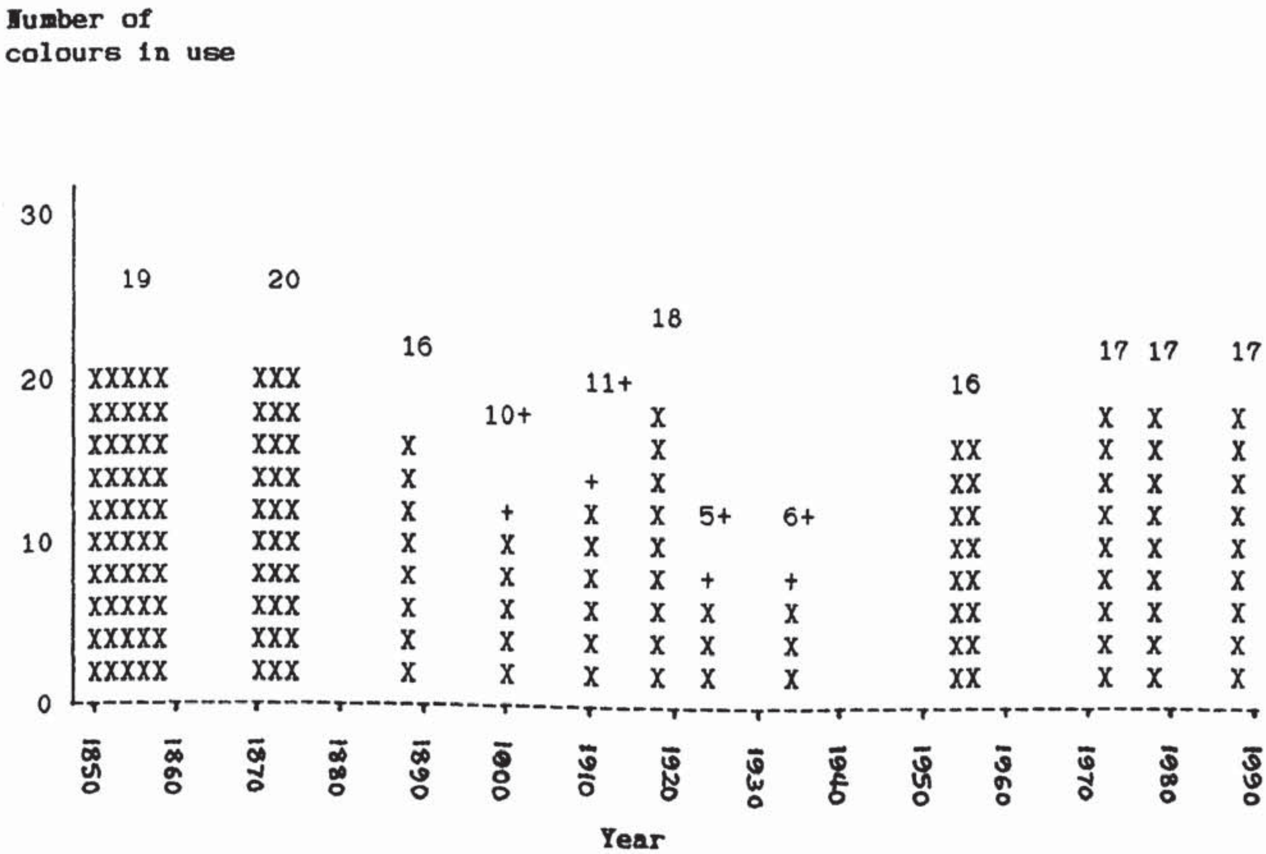


TABLE 4.7 : NUMBER OF PLANT COLOURS IN USE BETWEEN 1850 AND 1987

Compiled from table I.8 in appendix I



4.10 Ancient Plant, Animal and Mineral Colours

Most colours used in food were originally developed for other purposes. The earliest use of naturally-occurring colours was probably for body decoration in burial rites. Red ochre (used in the nineteenth century for colouring food) has been found on the head and breast of some European Neanderthal corpses (39). Another early use of natural colours was for painting prey on cave walls. Paintings in Lascaux dating from about 15 000 BC were made with red and yellow ochres, soot and white clay - all colours used later for food. Ultramarine, which became a popular food dye in the nineteenth century, was in use in 4,000 BC for painting (40).

In the Bronze Age a completely new class of dyes was developed for textiles. These were superior to the earlier pigments which tended to crack when applied to fabric. Some dyes detected on ancient textiles are annatto, safflower and saffron (which is not very good for textiles because it is not fast to light) and madder (which has excellent fastness and was a techniclly sophisticated development used c 1700 BC) (41). All these were used later for food.

The early naturally-occurring dyes were mainly reds, yellows and browns. The ancient Egyptians developed a much wider range of colours, especially blues and greens. By this stage colours had become important for colouring textiles as well as for decorating buildings, and some were produced on a commercial scale (42).

Logwood, a purple vegetable extract was developed by the Mexicans. When it was first imported into the UK there was considerable opposition to its use by some dyers' guilds becuse it lacked good fastness. Its use was prohibited by an Act of Parliament in 1580 (43). This was possibly the first legal control imposed on colours in Britain. Logwood's fastness was improved in the seventeenth century by different mordants and until recently it was used industrially as a textile dye. In the 1800s it was used in food.

Through the eighteenth and nineteenth centuries developments in the natural dye industry mainly took the form of improvements to existing dyes rather than the discovery of new ones. Methods of extraction were improved; new mordants were found to improve fastness; synthetic copies of popular vegetable and mineral dyes were made to reduce the cost of production; artificial dyes derived from mineral colours were made for the first time. For example, the first synthetic organic dye was made in 1740. It was Indigo carmine, an indigoid made by treating indigo salts with sulphuric acid. It was manufactured by Barth and sold under the name of Saxe blue. Originally it was made from naturally-occurring Indigo: later it was made from a coal tar product. Synthetic copies of some naturally-occurring colours were never made, presumably because it was not economical. For example, Cochineal and Logwood were never produced synthetically on an industrial scale (44).

4.11 Plant and Mineral Extracts Used as Food Colourants

Certain foods have been coloured for centuries. Paintings in Egyptian tombs from 1500 BC depict the making of coloured confectionery (45). Pliny wrote that wine and bread were frequently coloured with fruit berries and White earth (46) - a subject about which Accum also complained over 2000 years later in 1820. Cochineal (a red insect extract) is one of the oldest colours and was probably cultivated as early as the tenth century in Central America (47). It was possibly used in food by the Aztecs. It was brought to Europe in the middle ages and first introduced to the UK around 1518 (48). It was soon used in food and it is still on the permitted list of food colours in the UK today. In the twelfth century sugar coloured pink and purple was imported as a luxury item into Europe from Alexandria. The colours were probably Madder (a red vegetable extract) and Tyrian purple (an animal dye) and Kermes (a red insect extract similar to cochineal). These were ancient dyes, known to have been used (for non-food purposes - but possibly for food too) in Egypt and around the Mediterranean since 1000 BC (49). A banquet in the late Middle Ages might well have been graced with 'a swan with silvered body and gilt beak served on a green pastry pond' (50).

It is likely that colours were first added to foods for religious purposes : in ritual foods left at altars or in special foods eaten during religious festivals. Outside religious pracices colours were used to produce luxury items to entertain or impress - such as the coloured sugar and the gilded swan in the Middle Ages. Colours were also used from early times to mask adulterated food - giving Pliny cause to complain about coloured wine and bread.

There are few records of the dates when particular plants and minerals (or their extracts) were first discovered or used for colouring food. Writers on food adulteration in the nineteenth century mentioned a few colours by name. Fredrick Accum, for example, mentioned Vermillion, Red lead, white clay, Sap green and copper compounds in 1820 (51); Dr O'Shaughnessy listed Gamboge, lead, copper, mercury and chromate of lead in 1833 (52); John Mitchell reported Indigo, Prussian blue, Turmeric, copper carbonate, Dutch pink, lead chromate, chalk, pipe clay, Rose pink and Black lead in 1848 (53). The most exhaustive list of food colours in use in the middle of the nineteenth century can be drawn from the analytical reports of Arthur Hassall, shown in table 3.1. According to Hassall's research there were 33 plant colours, 63 mineral colours, 4 plant/mineral mixtures, and 4 animal colours used by the food industry in the 1850s; a total of 104 colours. Some of these colours were quite sophisticated derivations of the naturally-occurring material. Tables D.3 and D.4 list by name the mineral and plant colours that have been reported to have been used in food between 1850 and 1954.

4.12 Innovation in the 1800s and 1900s

It is probable that all the naturally-occurring colours used in food in the eighteenth and nineteenth centuries were centuries old. But there were new colours derived from natural materials which often required quite complicated chemical processing. Most of these would have been developed for textiles; some for printing and paints. I have not seen any evidence that suggests new natural colours were invented or manufactured especially for food before 1950. From 1925 some natural dyes may have been adapted specially for food. In the 1950s a new development programme was started by firms, such as Hoffman-La Roche, to produce new dyes derived from, or similar to, natural materials - specially for use in food.

Table 4.6 shows the number of mineral colours in use between 1850 and 1987. The high numbers used in the 1850s and 1870s had dropped considerably by the 1890s. The numbers remained low. No new mineral colours were developed, although old colours that had dropped from use were made available for use by additions to the permitted list in the 1970s. The effects of these changes on hazard levels are discussed in chapter 6.

Table 4.7 shows the number of plant and animal colours in use between 1850 and 1987. Throughout this period the number of colours remained more or less constant. The extent of use dropped around the turn of the century and again from the 1920s. In the 1950s the number available for use (on the permitted list) went up. New plant colours became available from the 1960s. These developments are described later in this chapter.

In the late 1800s and early 1900s coal tar colours gradually replaced plant colours because they had clear advantages over 'natural' colours. A trade reference book in the 1970s listed the following disadvantages of plant and animal colours:

a) More expensive; typically twenty to fifty times more costly.
b) Variable.
c) Not available in sufficiently large quantities at present.
d) Accompanied by inappropriate aromas or flavours.
e) Less intense unless purified or isolated, requiring a high level of use.
f) Not as stable to heat or light.
g) Hygroscopic if water soluble.
h) Useful in specific products rather than generally.
i) Incompatible with other ingredients in some cases (54).

The natural colours also provided a narrow range of hues compared to the coal tar colours.

Despite their drawbacks considerable innovation occurred among natural colours from the late 1950s. Prior to this some improvements were made to existing dyes made from natural materials, and synthetic copies of naturally-occurring colours were made. There were several strands to these developments;

a) Experimentation with further naturally-occurring colours

b) Experimentation with mixtures

c) Development of lakes

d) Improvement of extraction techniques

e) Improvement of mordants

(especially experimentation to find better mordants to improve the fastness of colours. eg. Logwood)

f) Synthetic copies of vegetable and mineral colours

(primarily to create a cheaper version. Also to improve control over specification/composition of end product).

Most of these strands had been developed to a certain point hundreds of years or even centuries earlier, as many natural colours were considerably improved and altered for textiles from the earliest times that dyeing was practised.

4.13 Effects of Regulations on Plant Colours

From the late 1950s there was a renewed attempt to improve natural colours. The progressive reduction in the number of coal tar colours permitted in food forced manufacturers to turn to natural colours as alternatives. J Walford, from ICI Organics Division in Manchester, has commented that,

> The trend in government thinking towards the use of natural colours in place of synthetic colours, together with an increasing consumer interest in food additives gave impetus to the research (55).

As a result research was done to extract new colours from natural sources and to produce methods of manufacturing natural colours synthetically and economically. Much of this work occurred in the USA where government controls were more stringent for coal tar colours, and a range of only seven was permitted.

In 1956 a new branch of colour chemistry was created as a result of the synthesis of β-carotene by Hoffman-La Roche (56). Natural carotenoids such as Saffron, Xanthophyll, Carotene and Annatto had long been in use. Synthetic carotenoids developed after 1956 included β-apo-8'-carotenal, ethyl β-apo-8'-carotenoate, Rhodoxanthin and Canthaxanthin. Lycopene had reached the pilot-plant stage by 1973. These developments were classed as 'nature-identical' colours.

Significant work was done to improve the performance of colours. For example, of 13 patents listed (57) for 'nature-identical' carotenoids between 1966 and 1971, four were for new carotenoid colours; three were for alternative methods of production; three were for methods of improved yield; one for water soluble forms; one for an analytical method for annatto; and one for better colour fastness of Canthaxanthin in refrigerated processed cheese.

Among the carotenoids not considered to be nature-identical Eastman Kodak Co developed some compounds in which vitamin A derivatives provided only half of the molecule, the other half coming from aromatic and hetrerocyclic compounds, starting with chemicals such as cinnamaldehyde and acetone. In 1966 and 1967 Eastman Kodak filed four US patents for these compounds (58). In 1967 a British patent was filed by the Institut Chainoi Promyshlennosti for a whole range of food colours from tea extract. Considerable effort was expended by companies, particularly Hoffmann-La Roche, to find further synthetic carotenoids in the early 1970s (59).

Table 4.8 gives the number of patents of natural food colours between 1969 and 1984. Data on other classes of colours are included for comparison. For almost all the plant colours for which information is available, the number of patents went up from the period in 1971-75 to 1976-81 (60). Patents for coal tar colours went up marginally in comparison. It is interesting to note a rise in the number of patents for iron compounds. This represents a revival of interest in an ancient group of mineral colours.

The groups of colours for which most patents were filed between 1969 and 1984 were the carotenoids (20%), anthocyanins (13%) and *Monascus* (10%). The number of patents more than doubled in the two periods. The first and second groups are ancient plant colours; the third, *Monascus*, is a new product to the West, although it has been traditionally grown on rice and used in food in the Orient. The new developments are all technologically sophisticated and very far removed from the traditional products. But it is interesting to note that the vast majority of patents were filed for colours coming from sources that were used in the nineteenth century for colouring food, and for hundreds of years before that for other purposes and sometimes for food too.

The 1960s saw a major shift in the colour industry in that the work carried out on colours for food was thought likely to lead to advances in the colouration of non-food substances (61) - instead of the usual pattern of colours being developed primarily for textiles.

The main improvements up to 1979 were among the carotenoids, anthocyanins and betalaines. At that time the other natural colours such as chlorophylls, Cochineal, carminic acid, Annatto, Turmeric, Saffron and Curcumin still had significant disadvantages such as higher cost, poorer technical performance and unwanted odour or taste. Their use at the end of the 1970s was therefore limited to specialised foods only (62).

Currently there is great emphasis on developing new food colours that can be labelled as natural or nature-identical, for example Shikonin and related fungal colours in Japan. Another major development is in colours that do not have to be declared on labels. One of the early tricks developed by farmers was to feed colours to hens to make bright yellow yolks and to farmed salmon and trout to produce pink flesh. Biotechnologists are now breeding strains of soft fruit that have a very high colour content, to save manufacturers having to declare added colour in products such as jam.

The effect of the 1957 regulations on food colours has been to produce a whole new branch of the colour industry and of the dye industry. This is described later.

Table 4.8 : **PATENTS FOR FOOD COLOURS FOR VARIOUS PERIODS BETWEEN 1969 & 1984**

Source: F J Francis 'Future Trends' in J Walford (ed) Developments in food Colours - 2 Elsevier, Amsterdam 1984 p236 and F J Francis 'Lesser known food colours' Food Technology April 1987 p63.

Type of Colour	Number of Patents 1971-75	1976-81	1969-84
PLANT & ANIMAL SOURCES			
Carotenoids	6+	14+	78
Paprika			(24)
Citrus, tomatoes & Carrots			(17)
Synthetic			(17)
Miscellaneous			(20)
Anthocyanins	4	11	49
Grapes			(12)
Miscellaneous			(37)
Monascus	0	9	38
Annatto			23
Chlorophyll			16
Haems	2	4	15
Caramel	6	2	14
Anthraquinones & naphthoquinones			12
Cochineal, Carmine, Lac, Kermes, Alkannet			
Turmeric			12
Phycocyanins			10
Carthamin (Safflower)			10
Flavanoids			10
Cacao			9
OTHER SOURCES			
Iron Compounds	3	5	6
Coal Tar Type	8	9	30
Linked Polymers			21
Miscellaneous			30
Totals	40 a	86 a	383

Note a: The figures in columns 1 and 2 do not add up to the totals. The totals are correct, but a more detailed breakdown could not be presented

DEVELOPMENT OF COAL TAR COLOURS

4.14 Birth of the Coal Tar Dye Industry

The major period of innovation and industrial growth for the coal tar dye industry (including food colourings) was 1875 to 1900.

The first synthetic organic dye to be produced commercially was probably picric acid, a yellow dye discovered by Woulfe in 1771. In 1845 it was manufactured by French dyers from phenol for dyeing silk at a fraction of the cost of contemporary dyes. By 1887 it was reported to be used in food. Another of the very early dyes (also recorded as being used for food) was Aurine, a red-yellow triarylmethane, discovered by Runge in 1834 (63).

The birth of the synthetic dye industry in the UK dates from 1856 when the first factory to produce coal-tar dyes on a commercial scale was set up by William Perkin in Greenford, London. A synthetic dye industry was already beginning to be established in France at this time. When Perkin patented his first dye, Mauveine, French silk dyers who manufactured picric acid were able to use their experience of large-scale dye manufacture to advantage, and marketed Mauveine before Perkin's firm did. Aniline colours like Mauveine were not fast - sunshine destroyed them - so there were limits to their usefulness. All the dyes discovered before 1869 suffered this drawback. Fastness remained a problem until well into the twentieth century.

Between 1850 and 1880 France and, slightly later, Britain were the countries where dye development took place. Until 1870 Germany made very little contribution. But from 1886 German production of new dyes and processes became prodigious. The Swiss dyemaking industry burgeoned too. The French and British industries reached their peak around 1874, after which their output was overtaken by German and Swiss manufacturers. Table 4.9 shows the number of patents filed by dye-making companies in Britain and Germany between 1856 and 1900. The British dye industry only recovered during the First World War.

One reason for the surge in German output was that the German chemists were able to use effectively new theories about the ring structure of

TABLE 4.9 : PATENTS FILED BY BRITISH AND GERMAN DYE COMPANIES, 1856-1900

Source: K McLaren The Colour Science of Dyes and Pigments, Adam Hilger, 1986, p.17

Period	Patents filed by dye-makers British	German
1856-66	141	0
1866-76	59	0
1886-1900	86	948

benzene. The French and British chemists were less able to make use of it because the level of theoretical training was less advanced. Also the German and Swiss firms were better financed (64)

In the UK the lack of a theoretical base for the industry meant that the initial phase of discovery and production that started in 1856 had dropped off by the mid 1870s (65). Kekule's hypothesis about the cyclic nature of benzene, put forward in 1867, clarified much of the chemistry. The theory was exploited rapidly in Germany where scientific training was superior. From the mid to late 1870s a belated surge in new dyes started in the UK, with colours such as Chrysoidine. The initiative remained with Germany, however. In 1883 Ivan Leninstein, president of the Manchester section of the Society of the Chemical Industry, bemoaned the decline of the UK coal tar colour industry and suggested the industry should create a professorship because the lack of specialists in organic colour chemistry left a dearth of significant research (66).

4.15 Coal Tar Colours Used in Food

Most of the important colours mentioned in histories of the dye industry were later reported to be used in food. It is reasonable to assume that wherever the price and technical qualities were appropriate, the new dyes were immediately taken up by the food industry and used until superior dyes became available. Certainly, many of the dyes discovered in the 1860s and the 1870s were reported in food when Wynter Blythe first named some coal tar colours in 1887. One of these had been discovered as recently as 1883 (see tables D.1 and J.1 in appendices).

The dates on which coal tar colours used in food were discovered are given in appendix J. Table 4.10 shows the maximum possible periods of use for each coal tar colour reported to be used in food at some time. It assumes the earliest possible date of introduction to be one year after the discovery date. Table 4.10 is arranged by chemical class. It is interesting to note that for each chemical class the period of innovation was spread out over time. Patterns of innovation are discussed in more detail below.

Aniline dyes were used in the food industry almost as soon as the first colour was discovered in 1856. Apparently the earliest coal tar colours used in food were the Alizarine colours, which replaced the Madder plant extracts. But their shades were dull and their use restricted initially. Basic colours were then introduced because they had brighter hues and greater adaptability to food processors' needs. But they had the disadvantages of a bitter taste and staining on the tongue! They were quickly replaced by acid dyes as the latter developed. Apparently, the first extensive application of coal tar colours began with the custard powder industry, and the benefits encouraged other sectors, especially the confectionery sector, to adopt the colours (67).

Unfortunately there are no complete early records of the actual dyes used. Only the trade was interested in keeping lists - chiefly lists of dyes offered for sale by any company. The many Select Committees inquiring into adulteration in the latter part of the nineteenth century did not attempt to gather or record comprehensive lists (68). The analyst Hassall conducted the most comprehensive surveys of colours, from samples taken over many years. He published the names of many of the vegetable and mineral colours he detected in food in the 1850s and 1860s. He did not however identify the coal tar colours he detected in his later studies. He did furnish us with some information about the rate at which coal tar colours had been introduced into food. Hassall's book, Food: Its Adulterations and the Methods for Their Detection, published in 1876, reproduced the lists of natural colours that he had

TABLE 4.10 : COAL TAR COLOURS DIVIDED BY CHEMICAL CONSTITUTION
DATES OF INTRODUCTION AND REMOVAL OF COAL TAR COLOURS, 1870 - 1987

Compiled from tables D1, D.2, and J.1

KEY:
X Possible period of use in food

Chemical Class, Colour, Colour Index No.	1870	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980
	Possible Period of use in food											
Nitroso dyes 10000-10299												
10020 Naphtol green B		X	X	X	X	X	X	X	X			
Nitro dyes 10300-10999												
10305 Picric acid	X	X	X	X	X	X						
10310 Victoria yellow	X	X	X	X	X	X						
10315 Manchester yellow	X	X	X	X	X	X						
10316 Napthol yellow S		X	X	X	X	X	X	X	X	X		
10360 Aurantia	X	X	X	X	X	X						
Monoazo dyes 11000-19999												
11000 Aminoazobenzene	X	X	X	X	X	X	X	X	X			
11020 Butter yellow	X	X	X	X	X	X	X					
11160 Aminoazotoluene	X	X	X	X	X	X	X					
11270 Chrysoidine	X	X	X	X	X	X	X	X	X			
11390 Oil yellow OB				X	X	X	X	X	X			
11660 Hansa yellow 5G					X	X	X	X	X			
11680 Hansa yellow G					X	X	X	X	X			
11710 Hansa yellow 10G					X	X	X	X	X			
11860 Oil yellow HA			X	X	X	X	X	X	X			
11920 Oil yellow GG	X	X	X	X	X	X	X	X	X	X	X	
12055 Sudan I		X	X	X	X	X	X	X	X			
12100 Oil orange TX	X	X	X	X	X	X	X	X	X			
12140 Sudan II		X	X	X	X	X	X	X	X			
12150 Sudan red G				X	X	X	X	X	X			
12155?Sudan R							X	X	X			
12700?Fat yellow GS		? X	X	X	X	X	X	X	X			
12740 Oil yellow XP						X	X	X	X	X	X	
13011 Yellow RFS		X	X	X	X	X	X	X	X	X		
13015 Acid yellow G	X	X	X	X	X	X	X	X	X		XX	
13065 Metanil yellow		X	X	X	X	X	X	X	X			
13090 Citron orange		X	X	X	X	X	X	X	X			
14270 Chrysoine	X	X	X	X	X	X	X	X	X			
14600 Orange I	X	X	X	X	X	X	X	X	X			
14700 Ponceau SX									X	X		
14720 Carmoisine		X	X	X	X	X	X	X	X	X	X	X
14730 Double brilliant scarlet		X	X	X	X	X	X	X	X			
14780 Red FB			X	X	X	X	X	X	X	X	X	
15510 Orange II	X	X	X	X	X	X	X	X	X			
15620 Rocceline	X	X	X	X	X	X	X	X	X			
15850 Lithol rubine BK								?...	X		X	X
15970 Orange RN		X	X	X	X	X	X	X	X	X	X	
15985 Sunset yellow FCF							X	X	X	X	X	X

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                                     Possible Period of use in food
Chemical Class,
Colour,
Colour Index No.         1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980
--------------------------------------------------------------------------------------

16035 Allura red
16045 Fast red E             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
16150 Ponceau 2R             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
16155 Ponceau 3R             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
16180 Acid bordeau B         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
16185 Amaranth               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
16230 Orange G               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
16250 Ponceau cryst. 6R        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
16255 Ponceau 4R             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
17200 Red 10B                      XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
18050 Red 2G                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
18055 Red 6B                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
18965 Yellow 2G                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
19140 Tartrazine                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Disazo dyes        20000-29999
20170 Resorcine brown         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
20281 Yellow RY                                        XXXXXXXXXXXXXXXXXX
20285 Chocolate brown HT            ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
21000 Bismarck brown G  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
21010 Bismark brown          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
21110 Permanent orange G                     XXXXXXXXXXXXXXXXXXXXXXX
21670 Coomassie navy blue            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
22120 Congo red                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
22500 Bordeaux extra           XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
22580?Direct black               ?XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
22610 Direct blue 2B               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
23500 Benzopurpurine 4B         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
26100 Sudan III              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
26105 Sudan IV                                                   ...X
27290 Brilliant croceine       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
27755 Black 7984                                                        XXXXX
28440 Brilliant black BN        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Triazo dyes        30000-34999

Polyazo            35000-36999
35445 Black 5410                                               .....X

Azoic              37000-39999
37130 Fast scarlet salt R                    XXXXXXXXXXXXXXXXXXXXXXX
37275 Fast red salt AL                         XXXXXXXXXXXXXXXXXXXXX
37530 Naphthol AS-OL                                XXXXXXXXXXXXXXXXX

Diphenylmethane    41000-41999
41000 Auramine                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Triarylmethane     42000-44999
42000 Malachite green       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
42036 Turquoise blue G             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

Chemical Class, Colour, Colour Index No.	1870	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980
42040 Brilliant green cryst.			X	X	X	X	X	X	X			
42045 Blue VRS				X	X	X	X	X	X	X		
42051 Patent blue V			X	X	X	X	X	X	X		X	X
42053 Fast green FCF						X	X	X	X			
42085 Acid green GG		X	X	X	X	X	X	X	X			
42090 Brilliant blue FCF			X	X	X	X	X	X	X		X	X
42095 Light green SF		X	X	X	X	X	X	X	X			
42510 Magenta	X	X	X	X	X	X	X	X	X			
42535 Methyl violet	X	X	X	X	X	X	X	X	X		X	X
42580 Violet BNP								? ...	X	X	X	
42615 Acid violet 4BN			X	X	X	X	X	X	X			
42640 Acid violet 6B			X	X	X	X	X	X	X			
42650 Violet 5BN			X	X	X	X	X	X	X			
42755 Soluble blue [b]	X	X	X	X	X	X	X	X	X			
42780 Soluble blue [a]	X	X	X	X	X	X	X	X	X			
42685 Acid magenta II	X	X	X	X	X	X	X	X	X			
42765 Alkali blue	X	X	X	X	X	X	X	X	X			
43535 Cyanol			X	X	X	X	X	X	X			
43800 Aurine	X	X	X	X	X	X						
44040 Victoria blue R												
44045 Victoria blue B												
44090 Green S		X	X	X	X	X	X	X	X	X	X	X
45100 Xylene red B				X	X	X	X	X	X			
Xanthene 45000-45999												
45150 Rhodamine G			X	X	X	X	X	X	X			
45160 Rhodamine 6G			X	X	X	X	X	X	X			
45170 Rhodamine B		X	X	X	X	X	X	X	X			
45380 Eosine	X	X	X	X	X	X	X	X	X			
45400 Eosine scarlet	X	X	X	X	X	X	X	X	X			
45405 Phloxine	X	X	X	X	X	X	X	X	X			
45430 Erythrosine	X	X	X	X	X	X	X	X	X	X	X	X
45440 Rose bengal		X	X	X	X	X	X	X	X			
Acridine 46000-46999												
46045 Phosphine	X	X	X	X	X	X	X	X	X			
Quinoline 47000-47999												
47005 Quinoline yellow		X	X	X	X	X	X	X	X		X	X
Azine 50000-50999												
50400 Induline spirit	X	X	X	X	X	X	X	X	X			
50405 Induline	X	X	X	X	X	X	X	X	X			
50415 Nigrosine spirit	X	X	X	X	X	X	X	X	X			
50420 Nigrosine	X	X	X	X	X	X	X	X	X			
Thiazine 52000-52999												
52015 Methylene blue	X	X	X	X	X	X	X	X	X			
Anthraquinone 58000-72999												
69800 Idanthrene blue				X	X	X	X	X	X		X	

(Column headings: Possible Period of use in food)

Chemical Class, Colour, Colour Index No.	1870	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980
	Possible Period of use in food											
Indigoid 73000-73999												
73015 Indigo carmine	X	X	X	X	X	X	X	X	X	X	X	X
73360 Helindone pink					X	X	X	X	X			
Phthalocyanine 74000-74999												
74260 Phthalocyanine green								X	X			
No CI number												
Acid violet S4B												
Baking brown			X	X	X	X	X	X	X			
Baking brown AW									X			
Benzyl bordeau B			X	X	X	X	X	X	X			
Brown FK					....	X	X	X	X	X	X	X
Chlorazol sky blue			X	X	X	X	X	X	X			
Chocolate brown FB				X	X	X	X	X	X	X	X	
Crispin black G									...X			
Croceine scarlet 5R		X	X	X	X	X	X	X	X			
Fast yellow R		X	X	X	X	X	X	X	X			
Helio red					X	X	X	X	X			
Heliotrope	X	X	X	X	X	X	X	X	X			
Indian red	X	X	X	X	X	X	X	X	X			
Methyl orange		X	X	X	X	X	X	X	X			
Naphthol AS-OG							?	X	X			
Oil red 2R				X	X	X	X	X	X			
Oil yellow AB			X	X	X	X	X	X	X			
Orange R			X	X	X	X	X	X	X			
Patent blue A			X	X	X	X	X	X	X			
Rose pink			?	X	X	X	X	X	X			
Saffranine	X	X	X	X	X	X	X	X	X			
Sudan blue II									...X			
Sulfon red B									...X			

published in his 1861 report, with a few additions that were the result of his more recent analyses. He felt the range of colours in use had not diminished since 1861. The significant change reported by Hassall in 1876 was the use of coal tar colours (which, incidentally, he saw as an improvement) :

> A great variety of colours are now prepared from coal tar, nearly every tint being imitated (69).

So 20 years after the first coal tar dye had been produced on a commercial scale in the UK a large number of coal tar colours had already replaced vegetable and mineral pigments in a wide range of foods. As the synthetic dye industry developed manufacturers had looked for markets in addition to textiles.

Two decades later in 1895 the analyst Alexander Wynter Blyth told the Select Committee on Food Products Adulteration that :

> There are according to the most recent list something like 254 distinct coal-tar colours in commerce to be bought now (70).

All of these were available to the food industry but not all of them were used. I have not been able to trace the particular list he referred to, but it is likely to have been a dyers manual. Appendix G contains a list of many of the colour trade manuals produced at that time. Records of some of the actual coal tar colours used in food are available from 1887. Table D.1 in appendix D lists the colours reported to be in use in various years to 1954. Considerable changes can be seen during these years: many colours came into use briefly before apparently being dropped. A fraction of these changes were due to government regulation. This is discussed in Chapter 6. The vast majority of changes were under the control of the trade as they sought for improved technical properties.

4.16 Ousting Mineral and Plant Colours

The synthetic dyes were technically and economically superior to the older natural dyes. According to Griffiths, for most purposes,

> The economic incentives were such that by the beginning of the twentieth century the natural dyes were almost totally ousted (71).

But this ousting process did not begin as soon as the first dye was produced. The records for colours in food demonstrate the persistance of plant and mineral colours (see tables D.3 and D.4 in appendix D). Some of the early coal tar colours were not as good as the old natural ones. Slater's manual of 1870 (a trade guide for dyers) gave some examples of the problems:

a) Aniline red did not give a crimson as good as the crimsons obtained from Cochineal (an ancient insect extract). Aniline red was considered inferior in beauty and purity to Magenta (another coal tar colour). But Aniline red was lower in price (72).

b) Synthetic ultramarine was 'now a common article of commerce' although it was a decidedly less beautiful blue and was less stable. But because of its low price it was extensively used (73).

c) Alizarine, a coal tar colour chemically similar to the extract of Madder root, had not been introduced on a large scale in 1870. Slater doubted that it could entirely replace the complex variety of shades from Madder; it would need several new dyes to replace the old vegetable dye (74).

It is interesting to note that just six years later imports of Madder had dropped considerably as synthetic colours replaced it. Table 4.11 shows a reduction of 70% between 1874 and 1876. A professor of chemistry from Durham University remarked in 1879 that this 'almost unique discovery' of how to synthesise a replacement for a vegetable colour:

> should have produced so considerable an effect on commerce, destroying an old industry and creating many new ones (75).

TABLE 4.11 : IMPORT VALUES OF MADDER ROOT, 1874-1876

Source : James Johnston <u>The Chemistry of Common Life</u> William Blackwood, Edinburgh 1879 p.494

Year	Value of Imports
1874	£ 800,000
1875	£ 411,000
1876	£ 239,000

Other synthetic substitutes for plant colours were reported to be too expensive in the late 1870s. For example, the production of the coal tar colour Indigo Carmine, a synthetic copy of the ancient Indigo plant colour, was apparently 'too costly and elaborate a process to be commercially available' in 1879 (76).

As more coal tar dyes were developed it became clear that many of them eventually offered distinct advantages over the old plant and mineral colours:

a) A far wider range of hues
b) Lower cost
c) Improved fastness (eventually)
d) Stability during food processing and storage.

Fastness was a considerable problem for the early coal tar dyes, particularly the aniline dyes. By 1900 fastness had improved, but it was still taken for granted that colours exposed to light (whether in food or fabric) would fade. James Morton, a furnishings manufacturer experimented with coloured samples in his greenhouse from 1904. By 1914 he had selected a wide variety of dyes that were fast (77). These dyes then tended to replace the more transient dyes. This may explain, in part, the changes seen in the food industry in their choice of colours in this period.

By 1920 it was reported that:

> Aniline [ie. coal tar] colours are largely employed. They are more readily soluble, cheaper (in consideration of the amount employed), and they withstand the effect of light and time better than the ordinary vegetable colours available (78).

The natural colours had not been completely ousted. A small number were still used for specific foods. Cochineal was said to be commonly used in 1920, for example. Annatto was very extensively used in butter and cheese. The mineral colours, except for copper, had been almost completely replaced (79). Tables 4.4 - 4.7 chart the changing levels of use of the three classes of food colour.

The Colour Index and other trade literature helped manufacturers to choose dyes with the appropriate properties such as light fastness (useful in glass or other transparent packaging), stability to preservatives, stability to heat (eg. in canning or baking), stability to alkali (eg. in baked goods), stability to acid (eg. in jam, soft drinks, pickles), and solubility (eg. in fat for margarine and butter).

Food colours were drawn almost exclusively from the range of colours developed and produced on a commercial scale for textiles. Griffiths has commented:

> The textile industry is the principal user of dyes, and thus has dominated thinking in dyestuff research. This was true for the first commercially successful synthetic dye (aniline purple, or mauveine, discovered by Perkin in 1856), and has been true for all major developments in dye chemistry since (80).

This was true until recent times. A small number of colours, such as Allura red and synthetic carotenes were developed principally for food use in the 1960s, and the new boom of synthetic 'natural' food colours started in the late 1970s and 1980s.

4.17 Coal Tar Colours 1913-1969

After the decline of the UK coal tar industry in the late nineteenth century, supplies of dyes for all purposes were imported from Germany. In 1913 only about 1/5th of UK requirements were supplied by the UK and Swiss manufacturers; the vast majority were from Germany. This was a cause of great concern to the Government, especially on the outbreak of war. In 1913 UK industries with an output valued at £200m p.a. were dependent on 18,000 tons (£2m worth) of imported dyes (81). Though the value of imports was relatively small the production and exports dependant on them was enormous.

In 1920 the Government decided to introduce regulations to reduce UK dependance on imported dyes. Imports of dyes and pigments were prohibited except where a British equivalent was not available, in which case it was permitted under licence (82). This system of protection was seen by the government to become 'outdated' as the UK dye industry grew stronger. In 1960 it was replaced by a 33.3% tariff on imports, reduced to 26% in 1968 and 15% in 1972 (83). Under this scheme of limited protection the UK industry has grown, but less quickly than the UK market. The UK market for dyes (for textiles, packaging and plastics etc.) doubled in volume between the mid 1950s and mid 1960s. In the late 1960s imports had increased again and supplied almost one third of the UK market. Switzerland and West Germany were the largest suppliers (84). Government's fostering of the dye industry may have contributed to the upsurge in use of coal tar colours between 1920 and 1950.

4.18 Purity of Dyes

After the first negative list was introduced in the UK in 1925 manufacturers of colours began to offer products made in plant specially dedicated to food colours. Previously colours of standard textile quality were selected for food use from general purpose manufacturers (85). A range of water-soluble dyes had been examined and a number, mainly of the acidic type used for dyeing wool, had been selected by manufacturers because of their ability to withstand food processing and storage conditions. Examples included were Tartrazine, Sunset yellow, Carmoisine (86). These were made specially pure for food after 1925 by some suppliers. The USA set the standards for purity to some extent, by their regulations from 1909 onwards. In the early 1950s European manufacturers took the initiative in improving the quality of food dyes by improving specifications and levels of contaminants & intermediates to provide products equal to those of the USA manufacturers, which were considered to be the best available. This appears to be a case of legislation in one country influencing manufacture in other countries - presumably because of public and professional concern and the desire of Europeans to export products to the USA. In the UK this might also have been because of pressure from the debate about the need for a permitted list in 1954. Perhaps manufacturers were trying to demonstrate to legislators that they were responsible and were capable of putting their house in order themselves. Controls on purity are discussed in chapter 3. Specifications for purity were put into regulations in the 1960s because there was concern that some manufacturers did not comply with the voluntary British Standards developed in the 1950s.

By the late 1970s it was claimed that food colours were produced to a high level of purity, 'in many cases significantly better than required by law' (87). Strict quality control was claimed to be carried out in areas which included the following:

a) Raw materials
b) Reagents used in processing
c) Solvents used in extraction or crystallisation
d) Maintenance and cleanliness of manufacturing plant
e) Unreacted intermediates
f) By-products formed during some manufacture (88).

4.19 Effects of Regulations on Coal Tar Colours

Table 4.12 clearly shows that the major period of innovation of coal tar colours used for food was from 1856 to 1914. The major commercial incentive for innovation of coal tar colours was the need of the textile industry not that of the food industry. The major exception to this rule was the development of Allura red AC in the USA. It was patented in 1967 and 1969, after much work by the Allied Chemical Corporation.

TABLE 4.12 : DATES OF FIRST SYNTHESIS OF COAL TAR DYES USED FOR FOOD IN THE UK

Compiled from information given in Colour Index 1924, 1928, 1971, 1975. (table F.1 in appendix F)

1970-1974	
1965-1969	
1960-1964	
1955-1959	
1950-1954	0
1945-1949	
1940-1944	
1935-1939	000
1930-1934	0
1925-1929	0
1920-1924	00
1915-1919	
1910-1914	0000
1905-1909	0000000
1900-1904	00000
1895-1899	0000
1890-1894	0000000000000
1885-1889	00000000
1880-1884	0000000000000000000
1875-1879	000000000000000000000000000000000000
1870-1874	00
1865-1869	0000
1860-1864	0000000000
1855-1859	00000
1850-1854	
1845-1849	
1840-1844	
1835-1839	
1830-1834	0
1825-1829	
1820-1824	
1815-1819	
1810-1814	
1805-1809	
1800-1804	
1795-1799	
1790-1794	
1785-1789	
1780-1784	
1775-1779	
1770-1774	0

0 5 10 15 20 25 30 35 40

Number of dyes invented in any 5 year period

Note: 14 colours excluded because dates of first synthesis unknown or indefinite.

It was developed primarily because the government had placed restrictions on the use of Ponceau SX. Allura red had reasonably good technical properties; it was reasonably stable to sulphite, ascorbic acid, heat and light, was not corrosive to containers and had good solubility in water. The attempt to find other new food dyes that could fit the technical needs of the industry and pass government safety criteria led to the development of several new azo compounds, mainly red in colour, by the Allied ChemicalCorporation and Unilever, patented between 1966 and 1969 (89). Every component of these colours was sulphonated to ensure that any breakdown products would be water-soluble. This was seen to be a major safety feature. In addition, technical advantages such as resistance to bleaching by sulphite preservatives, retention of hue over a range of pH values and stability to heat were built into the compounds (90).

Table 4.13 shows the number of patents for food colours of the coal tar type between 1971 and 1981. The seven US patents between 1975-81 include five related patents for linked polymer colours. The rise in number of patents for the USA was not quite as dramatic as it appears. The low number of patents for most countries has been ascribed to the

TABLE 4.13 PATENTS FOR COAL TAR TYPE FOOD COLOURS, 1971-1981.

Source: F J Francis 'Future Trends' in J Walford (ed) Developments in Food Colours - 2 Elsevier, Amsterdam 1984 p 235-6.

Country	Number of Patents 1971-75	1976-81	Total
UK	2	2	4
USA	2	7	9
W. Germany	1	0	1
Netherlands	1	0	1
Japan	1	0	1
Soviet Union	1	0	1
Totals	8	9	17

'high degree of concern' about colours. The total number of patents issued for coal tar type colours potentially for food between 1964 and 1984 was 30 (91). This was quite a significant number considering the decline in innovation in coal tar dyes for other purposes (described later).

Much work on colours in the 1960s was concerned with altering colours to make them in a form suitable for specific applications. In a selection of 8 colour patents listed between 1966 and 1967 the developments were for the following applications: dyes that dissolved faster; dispersions of optimum size for use in sugar-coating; conversion of water-soluble dyes to oil-soluble compounds; heat-stable colours for oils and fats made from water-soluble dyes and polyglycerol esters; improved stability of ethyl auramine for applications such as food wrappers; water-resistant inks for marking food surfaces; method of preventing discolouration in dyed cherries; and the colour-coating of walnut shells (92). The number of patents for applications compared to new sources of colours is discussed below.

TABLE 4.14 : PATENTS FOR FOOD COLOURS & APPLICATIONS, 1969-1984

Source: F.J. Francis 'Lesser-known food colorants' Food Technology April 1987 p.63

Type of Patent	Number of Patents 1969-78	1979-84	Total
Colour sources	210	217	427
Colour applications	134	136	270
Totals	344	353	697

Note: The figures include some duplications of patents.

4.20 Recent Innovation In All Classes of Colours

Table 4.14 shows the number of patents between 1969 and 1984 that referred to potential new food colours and new applications. For both periods from 1969-78 and 1979-84 the number of colours exceeded the number of applications. There was little change between the two periods (a slight rise in number).

Table 4.15 divides the recent food colour patents by country. Japan led the field for number of patents for new colours (42%) and new applications (41%). The USA, W. Germany, UK, and Soviet Union followed, with progressively lower numbers.

In the late 1970s the manufacture of coal tar colours was concentrated in three areas of the world:

Europe - 11 major producers
North & Central America - 7 major producers
Japan - 4 major producers

Some colours were also produced in Eastern Europe and the People's Republic of China (93). It is interesting to note how this compares with the consumption of synthetic food colours in different parts of the world, shown in table 4.16.

TABLE 4.15 : DISTRIBUTION OF PATENTS FOR FOOD COLOURS BY COUNTRIES, 1969-84

Source: F J Francis 'Lesser-known food colorants' Food Technology April 1987 p63.

Country	New Colour Sources	New Applications	Total
Japan	158	95	253
United States	85	63	148
Germany	34	27	61
Britain	26	19	45
Russia	29	5	34
France	15	3	18
Hungary	17	0	17
Canada	4	5	9
Netherlands	1	5	6
Europe	2	4	6
Switzerland	1	5	6
Czechoslovakia	4	1	5
Austria	0	1	1
South Africa	0	1	1
World	1	0	1
Total	377	234	611

Note: Numbers exclude obvious duplications.

TABLE 4.16 : WORLD CONSUMPTION OF SYNTHETIC FOOD COLOURS

Source: J Walford Developments in Food Colours - 1 Applied Science, London 1980 p22

	Consumption (Tonnes of pure colour/year)	
Country	1977	1982 (estimate)
UK	450	495
Western Europe	1050	1160
Eastern europe	200	240
USA	2300	2540
South America	540	870
Australasia	230	255
Asia	1030	1315
Africa	490	625
Total	6290	7500

4.21 CLAIMED EFFECTS OF REGULATION ON INNOVATION

In the 1920s one of the major arguments against a positive list was that it would stunt innovation. After the negative list had been introduced possible adverse effects on new developments remained a significant reason for keeping a negative list rather than changing to a positive list approach. Concern about this is still expressed today. In recent years many complaints have been made about the inhibiting effect of regulations on innovation. For example, C McClelland (from a marketing company) argued in 1977 that regulations made it too expensive to develop new natural colours. If a new development cannot be marketed under existing regulations, he said,

> Color manufacturers are reluctant to attempt to obtain a new regulation unless they have a strong proprietary position, because once a new regulation is promulgated, anyone can market products under it. Consequently, there is not much incentive to invest in the toxicology required to support a petition for a new regulation (94).

J E Noonan, the vice-president of a US coal tar colour manufacture, complained at the same time that

> The problems and costs to industry in terms of time and money resulting from extended regulatory actions over the past four years are incalculable. Food companies manufacturing products containing color additves have been, and continue to dance to the tune of regulatory action (95).

These and similar claims about the disastrous effects of colour regulations turned out to be grossly exaggerated.

Innovation of coal tar colours was not significantly stunted by food regulations. The main period of innovation was 1856-1914 as seen in Table 4.12. The major commercial incentive for innovation of coal tar colours has long been the demands of the textile industry, not the food industry. One minor exception to the rule was Allura Red and a few others where regulation actually spurred the development of these two coal tar colours especially for food use.

Food regulations did not affect the innovation of natural colours until the 1960s, and again in the late 1980s. Effects on innovation in the 1980s were primarily due to pressure of public opinion and their buying decisions rather than to regulatory action. But the products of innovation in the earlier period, in response to regulation, were adopted to a great extent from 1985.

The vast majority of natural colours were developed centuries ago. Refinements of the colours were first made primarily to meet the needs of the textile industry. However, since the 1960s regulations on colours have provoked rather than inhibited innovation of natural colours. Plant colours were not particularly fast, so there was little incentive to develop them for the textile industry. The food industry's needs have been the determinant, in recent years and have actually created a new sector in the dye industry.

Food colour regulations did not slow down the innovation of dyes for non-food purposes. When the development of food dyes slowed in the 1950s, partly due to the expense of safety testing and technologists own doubts about the safety of coal tar colours, this did not stop the development of dyes for non-food uses, so innovation in the dyestuffs industry continued. Sections 4.19 and 4.22 clearly show that innovation in the dye industry in recent decades has been slowing down for a number of reasons unrelated to food regulations, such as

> The unavoidable fact that there is a natural limit to the number of dyes needed by the textile industry (96).

The search for new or improved natural food colours has been one of the few growth areas. It helped to boost the fine chemicals industry in the 1960s and again in the 1980s.

4.22 Innovation in the Dyes and Pigments Industry

It is necessary to look at developments in food colours in the context of developments in the whole dye industry. Griffiths has suggested that,

> Although the first 50 years after mauvine saw the introduction of more new chromogens than in any period since, the true golden age of dye chemistry was in the 1950s and 60s, for during this period the number of new dye structures introduced onto the market was the highest ever seen. However, from 1970 onwards there has been a steady decline in

new introductions, and this trend is likely to continue indefinitely (97).

Table 4.17 shows the average number of new dyes (listed in the Colour Index) which were marketed between 1850 and 1984. (The peak in 1974 was due to a new requirement of the Japanese government for Japanese firms to register in the Colour Index the dyes produced over many years.) The main period of innovation was between 1950 and 1974, with a smaller peak between 1978 and 1980. So Griffith's assessment of the peak periods was not quite correct.

New developments in natural colours made significant contributions to both peaks. Table 4.18 shows that food colours (primarily natural ones - see table 4.8) were at least 8% of all new colours in the period from 1969-78. The proportion grew to over 29% for the period 1979-84. The later period demonstrates the growing importance of food colour research as a source of new chemical entities for the colour industry.

There has been a relative decline in the overall number of new chemical entities since the early 1970s. Griffiths attributes this decline to several factors: the increase in oil prices and recession hitting the dye and textile industries particularly severely; the introduction of stricter toxicological test requirements for new products; the fact that there is a natural limit to the number of dyes needed by the textile industry; and that dye science has reached the stage where further improvements in performance and economics are likely to be minimal (98). In 1960, White of ICI Dyestuffs Division estimated that in the whole world there were about 1000 chemists seeking new dyes and he seriously doubted if the 'unsatisfied needs of the textile industry [could] sustain such an army of speculative dye chemists' (99). Since 1974 seven major American chemical companies have withdrawn from the dye-making industry (100).

Rather than contributing to the decline, the area of food colours has provided a new boost to the chemicals industry. Public concern about coal tar colours in 1985 and 1986 has led to an enormous growth in the 'natural' colour industry and in new applications.

TABLE 4.17 : NEW DYES MARKETED BETWEEN 1850 AND 1984.

Source: K McLaren The Colour Science of Dyes & Pigments Adam Hilger, Bristol, 1986, p.21.

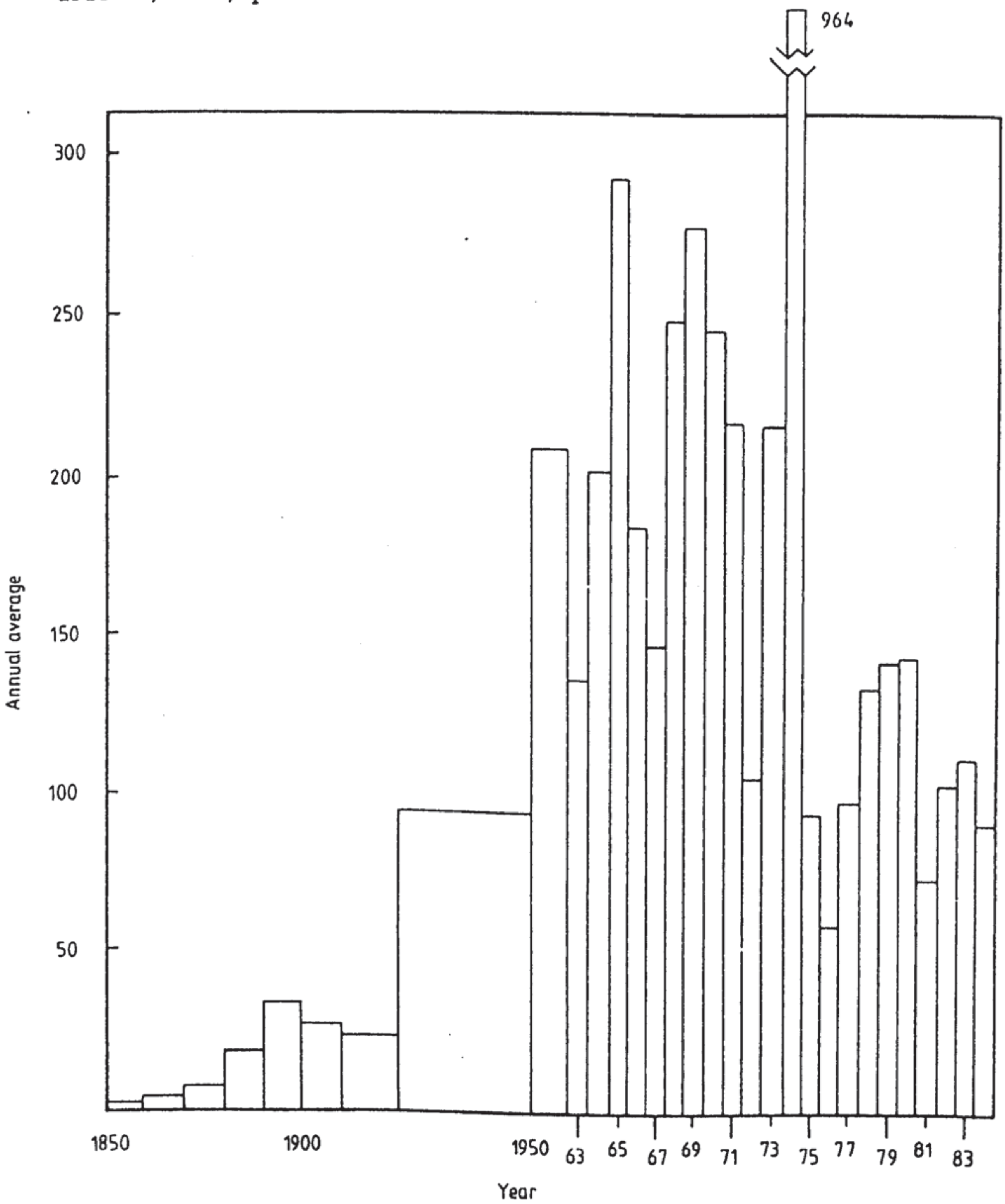

TABLE 4.18 : NEW FOOD COLOUR PATENTS AS A PROPORTION OF ALL NEW COLOUR CHEMICAL ENTITIES

Compiled from tables 4.15 and 4.17

Period	All New Dyes Marketed	Food Colours (No. Patents)	Food Colours as Proportion of Dyes
1969-78	c.2399	185	8%
1979-84	c. 658	192	29%
Totals	c.3057	377	

Note: The number of food colour patents has been adjusted to exclude obvious duplications

4.23 Research and Development Expenditure

Capital expenditure in the dye and pigment section declined from 1970-1976 in relation to the chemical industry overall. Table 4.19 shows the decline from 7.5% to 5.5% in six years. In 1977 there was a sudden rise to 8%. No published information is available about investment in R and D. Traditionally, this has been high, according to the Economic Development Corporation (101). In 1969 it was reported that a typical manufacturer spent 5% of turnover on R and D and 2-3% of turnover on technical services to launch products and advise on use (102). ICI complained in 1969 of the need for major investment to replace much old plant and to extend capacity to take advantage of the expanding world market (103). By 1981, as a result of declining profitability in the current economic conditions, dye and pigment companies reported that investment in R and D had been considerably reduced (104). The drop in innovation can be partly attributed to the drop in R and D investment.

4.24 Future of the Colour Industry

Holbro gave in 1962 the example of Ciba (a Swiss firm) which had synthesised more than 10,000 dyes but only manufactured twelve of them (105). In 1965 Rattee estimated the total number of dyes to be three million (106). At that time the number of dyes marketed was approximately 6,000. That meant that the number of marketed dyes was a tiny fraction of the total produced in the laboratory - about 0.2%. By 1984 the situation had changed little. Griffiths estimated that at least three million different dye and pigment structures had been synthesized since the beginnings of the synthetic dye industry. Only a small fraction of these, around 10,000 (0.3%), had satisfied commercial requirements and been marketed (107).

Although fewer than ten synthetic dyes can be used to produce the entire palette of colours for food there are many more than ten required by manufacturers for technical reasons. Different dyes are required, for example, according to the acidity of the food or according to the amount of light to which it will be exposed. New applications and refinements for colours remain a significant area of research as the patents in Tables 4.14 and 4.15 demonstrate. In 1984 the future for original dye research was seen to lie in producing dyes tailor-made for very specific applications. This means high-value, small production work for speciality chemical manufacturers. This is very much the way in which the food colour industry is already organised. It looks as though the food colour industry will be seen as an increasingly important sector of the dye industry, if recent trends continue.

4.25 SUMMARY

Government regulation did not attempt to stop a very considerable increase in the use of food colours. Nor did the lack of radically new hues prevent an increase in consumption. The tonnage of colours has probably risen steadily. The tonnage of synthetic colours alone rose from over 40 tonnes in 1923 to 400-700 tonnes in 1983.

Increased use of colours in this century has not been due to the invention of new chemical entities but to manufacturers using colours in

TABLE 4.19 : CAPITAL EXPENDITURE IN DYES AND PIGMENTS SECTOR OF CHEMICAL INDUSTRY

Source: Department of Trade and Industry, Chemical EDC Industrial Review Dyestuffs and Pigments 1981 p7.

Year	Capital Expenditure (£m)	
	Dyes and Pigments	% of Chemical Industry
1970	29	7.5
1971	23	6.0
1972	18	6.5
1973	16	6.5
1974	23	6.5
1975	36	6.5
1976	36	5.5
1977	64	8.0
1978	82	7.5

a wider range of foods (creating a wider range of products) and the public consuming a greater proportion of processed food. The post-war increase in processed food to the current level of 75% of the average diet led to an estimated ten-fold increase in the use of colours between 1955 and 1985. (Consumption may rise for differnt reasons in the late 1980s in the UK. As natural colours replace coal tar ones, greater amounts of pigment are required to achieve the same colouring effect).

a) Effects of the negative list on innovation

The short negative list introduced in 1925 did not have a significant effect on the overall number or type of colours in use, except in banning Copper. The ban on two coal tar colours probably had no significant effect on innovation, because ther was a large pool of alternatives to draw on. One can speculate that it may have provoked some research on applications. It is likely that the ban on Copper may have provoked research to identify a replacement green colour for tinned vegetables and pickles. Further research is needed here.

b) Effects of permitted list on innovation of all food colours

The permitted list introduced in 1957 reduced the number of colours from about 123 to 53, and established criteria for screening future additions. Despite claims that regulation had stunted innovation, there was a steady number of patents for food colours from the late 1960s onwards. Between the periods of 1969-78 and 1979-84 the number of worldwide patents increased marginally from 210 to 217 for colour sources (table 4.14). Colour application patents also rose marginally from 134 to 136. Figures for earlier periods have not been collected, but it is likely that they rose after the regulations, as the following paragraphs indicate.

c) Effects of permitted list on innovation of coal tar colours

The coal tar dye industry dates from 1856. Table 4.12 showed that the major period of innovation of coal tar colours used in food was from 1856 to 1914 and was over well before regulations were introduced in 1957.

While the expense of testing colours for safety was expected to limit the number of additions to the permitted list, in fact 8 coal tar colours were added between 1957 and 1987. None of these was a new colour. In the USA one totally new colour (Allura red) was adopted.

Most food colours have been drawn from dyes created for other purposes (textiles primarily). The development of Allura red in the USA, patented in 1967 and 1969, was a major exception. It was developed especially for food primarily because the government had placed restrictions on the use of Ponceau SX. The search for other dyes with appropriate technical properties which could meet the government's safety criteria led to the development of several other new azo compounds, patented between 1966 and 1969.

Table 4.8 showed that worldwide there were 30 patents for new coal tar food colours between 1964 and 1984. These were developed in countries which had introduced permitted lists.

Innovation in the form of new applications for existing colours might have been restricted by the fact that regulations reduced the pool of coal tar colours from 100 to 30. But on the other hand this may have provoked more intensive work on the short list of 30 colours.

d) Effects of permitted list on innovation of natural colours

The vast majority of natural colours were developed centuries ago and many refinements made primarily to meet the needs of the textile industry. There is no evidence to suggest that new natural colours were invented especially for food before 1950. It is conceivable that from the 1880s some may have been technically improved and from 1925 some may have been made specially pure.

From the late 1950s several companies started research programmes to develop new natural colours and to improve the technical performance and reduce the cost of existing plant colours. Much work occurred in the USA where government controls were more stringent for coal tar colours (only 7 permitted). It would be interesting to compare the number of patents and length of permitted lists for a range of countries, such as the USA and Japan.

In 1956 a new branch of colour chemistry was created, due to food regulations and concern about the safety of coal tar colours. At least 5 synthetic carotenoids were developed between 1956 and 1973. The number of patents for new sources of plant colours went up from 18+ in 1971-75 to 40+ in 1976-81. The number of patents more than doubled in the two periods. Patents for new coal tar colours went up marginally in comparison.

Rather than stunting overall innovation, the 1960s post-regulatory period saw a major shift in the colours industry in that the work carried out on food colours was thought likely to lead to advances in the colouration of non-food substances - insead of the usual pattern of development primarily for textiles.

4.26 Effects of changes in the dye and pigment industry

i) Innovation rate in dye industry

There has been a relative decline in the number of new dyes (for all purposes) since the early 1970s. This has been attributed to factors such as increased oil prices and recession, the introduction of stricter toxicological test requirements for new products; the natural limit to the number of dyes needed by the textile industry; dye science has reached a point where further improvements in performance and economics are likely to be minimal. The number of new dyes marketed for all purposes dropped from approximately 2399 in 1969-78 to about 658 in 1979-84; a drop of about 72%. In the same periods the number of patents for food colours rose slightly from 185 to 192 - an increase of over 3% (table 4.18). The dye industry has not been subjected to the same regulatory controls as food colours, so these figures provide a comparison of innovation rates in unregulated and regulated areas. Clearly in this instance regulation did not stunt innovation.

ii) Relationship between research and marketable products

Discovery of a dye does not make a commercial product. The total number of dyes synthesised in laboratories was estimated to be three million in 1965. Only a tiny fraction was marketed: 6,000 (about 0.2%). By 1984 the situation had changed little. It was estimated that of the three million or so dyes that had ever been synthesised, only about 10,000 (0.3%) had satisfied commercial requirements and been marketed. At this rate (basing calculations on patent data alone) one might expect food colour patents to have yielded 1.1 new marketable food colours. In fact there has been a number of new natural colours adopted since 1969 in the UK.

iii) Resources put into R&D

In 1969 it was reported that a typical manufacturer spent 5% of turanover on R&D and 2-3% on turnover on technical services to launch products and advise on use. By 1981, as a result of declining profitability in the current economic conditions, dye and pigment companies reported that investment in R&D had been considerably reduced. The drop in innovation could possibly be partly attributed to the drop in R&D investment. This could be explored further by relating R&D expenditure to numbers of patents in the dye industry and food colour sector.

iv) R&D effort outstripping market need in some areas

In 1960 it was estimated that there were about 1000 chemists seeking new dyes worldwide, and it was doubted that the unsatisfied needs of the textile industry could sustain such an army of speculative dye chemists. Between 1974 and 1982 seven major American chemical companies withdrew from the dye-making industry.

Rather than contributing to the decline, the area of natural food colours has provided a new boost to the chemical industry. As a proportion of all dye patents, food colour patents have risen from an estimated 8% in 1969-78 to an estimated 29% in 1978-84.

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CHAPTER 5

COLOURS AND THE PUBLIC INTEREST

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5.1 Introduction

This chapter describes the importance of colour to consumers. Studies of the perception of food show that colours have useful functions for the public. However, added colours can also mislead about the age, quality and nutritional value of foods.

Regulations have controlled the range of colours available (positive and negative lists) and the foods in which they are used (compositional standards, reserved descriptions, restricted uses). The effect of these regulations on health is assessed in chapter 6. This chapter examines their effects on food quality and choice.

IMPORTANCE OF COLOUR IN FOOD

5.2 Flavour Identification

A number of experiments have shown the importance of colour in the identification of flavour. For example, in a test conducted in the 1970s most people thought a pink-coloured, banana-flavoured dessert was 'strawberry flavour' (1). Studies conducted in 1979 showed that correct recognition of flavour was influenced more by the appearance of drinks than by the taste. A group of consumers was presented with four different fruit drinks and asked to identify them on the basis of taste and appearance and on appearance alone. The four drinks were presented first without added colour and then with colours 'appropriate' to the flavour (2). The results are given in table 5.1 below. Added colour raised the proportion of correct identifications of flavour. Judged by appearance alone the percentage of correct identifications rose from 69% to 100% for orange; 22% to 91% for grapefruit; and 31% to 91% for pineapple. The correct identification of lemon drinks remained unchanged at 63%. Judged by taste and appearance, the proportion of correct identifications rose in every case when the drinks contained added colour.

TABLE 5.1 : IDENTIFICATION OF FRUIT DRINKS BY APPEARANCE AND TASTE

Survey of responses of 32 consumer judges in September 1979.
Source: D Hicks in JN Counsell (ed) Natural Colours for Food and Other Uses Applied Science, Barking, 1981 p44.

	% CORRECT IDENTIFICATION			
DRINK	Uncoloured, judged by appearance alone	Uncoloured, judged by appearance and taste	Coloured, judged by appearance alone	Coloured, judged by appearance and taste
Orange	69	72	100	100
Lemon	63	78	63	91
Grapefruit	22	56	91	88
Pineapple	31	72	91	88
Average % correct identification	46	70	78	89

The results of this study have been supported by similar studies on other products. In the late 1970s trained tasters were presented with white chocolate-flavoured ice-cream and brown vanilla-flavoured ice-cream. Almost all the tasters identified the white as vanilla and the brown as chocolate flavour. Similar tests were conducted with children using unusual flavours for red and yellow jellies. Regardless of the flavour, the jellies were judged by their colour: red jellies were identified as strawberry and yellow jellies as lemon (3).

Cooked vegetables have been tested for colour perception too. Tasters presented with perfectly cooked cabbage coloured brown or pale green thought it was overcooked. The brown-coloured cabbage was rated low on flavour (4).

Numerous studies have demonstrated the role played by colour in the identification of flavour (5). By 1936 the strong degree of association between colours and flavours was well recognised by the food industry. Table 5.2 lists the flavours associated with particular colours in 1980.

An association between colour and flavour is not surprising since unprocessed food is often distinctly coloured and the expectation of colour has been fostered. The main groups of colours that are found in fresh foods are (6):

Anthocyanins: in fruits, rhubarb, aubergine, asparagus.

Carotenoids: in fish, eggs, crustacean, dairy products, vegetables, fruit, cereals.

Chlorophylls: in green vegetables, green fruit.

Flavonoids: in vegetables, fruit.

Haemes: in meat, fish.

Melanoidins: in heated foods, syrups.

Colour also influences other perceptions about food. Qualitative studies have shown that coloured solutions are perceived to have more intense flavour than colourless solutions. A study in 1982 on soft drinks found that the perception of sweetness increased approximately 2% - 12% with increasing colour. The perceived sweetness was influenced by feelings of pleasantness and colour acceptability (7). It has also been reported that the addition of yellow food colours to red fruit-flavoured drinks decreased the perceived flavour by 3% - 5% and sweetness by approximately 2%. Adding more of the colour 'appropriate' to the flavour (in this case extra red) increased the perception of sweetness of the drinks by approximately 5% - 10% (8). Numerous studies have demonstrated this point (9). Researchers at the University of

TABLE 5.2 : FLAVOURS ASSOCIATED WITH PARTICULAR COLOURS IN 1980

Source: J Walford Developments in Food Colours - 1 Applied Science, London 1980 p3.

Colour	Associated flavour
YELLOWS	
Pale golden yellow	Apricot
Light dull gold	Peach
Golden yellow	Honey
Greenish or canary yellow	Lemon
Greenish yellow	Pineapple
Yellow-green	Mint
ORANGES	
Bright reddish orange	Orange
REDS	
Light red	Clove
Bright bluish red	Cherry
Bright bluish red	Raspberry
Bright bluish pink	Strawberry
Dark red	Cassia
Dark bluish red	Blackberry
Dark bluish red	Blackcurrant
BROWNS	
Golden brown	Butterscotch
Dark reddish brown	Chocolate
Dark blackish brown	Liquorice
GREENS	
Bright bluish green	Lime
Bright green	Pistachio
Medium green	Spearmint
BLUES	
Reddish navy	Plum
Dark navy	Prune
WHITES	
White	Peppermint

Massachusetts have developed precise schemes for measuring and quantifying changes in colour and the corresponding shifts in human perception of the flavour.

5.3 Older Studies on Colour and Flavour

Studies in 1936 first confirmed objectively to food manufacturers the large number of people who relied on colour to identify flavour. A large manufacturer asked 60 people drawn from many occupations to identify the flavour of four jellies. The colours and flavours are shown in table 5.3.

TABLE 5.3 : TRIAL ON COLOUR AND FLAVOUR IN JELLIES, 1936

Source: H Silman 'Food colours' Food Manufacture June 1936 p202.

The colour and flavour combinations of four jellies were as follows:

COLOUR	FLAVOUR
Yellow	Vanilla
Amber	Lime
Red	Lemon
Green	Orange

The results of identifications were as follows:

CORRECT IDENTIFICATION (Marks out of 100)	NUMBER OF PEOPLE SCORING MARK
100%	1
75-99%	4
59-74%	17
25-49%	22
0-24%	16

Only one person identified all the flavours correctly. Most (63%) correctly identified the flavour in less than half the samples. The same tasters were given tan-coloured biscuits flavoured with vanilla and chocolate, over half the tasters thought the vanilla biscuits were unflavoured. But more people were correct than incorrect. The results are given in table 5.4.

TABLE 5.4 : TRIAL ON COLOUR AND FLAVOUR IN BISCUITS, 1936

Source: H Silman 'Food colours' <u>Food Manufacture</u> June 1936 p202.

Brown coloured biscuits were flavoured eith chocolate and vanilla. 60 people were asked to identify the flavour. The results were as follows:

IDENTIFICATION	CHOCOLATE FLAVOUR BISCUITS	VANILLA FLAVOUR BISCUITS
Correct	25 (42%)	17 (28%)
Incorrect	7 (12%)	8 (13%)
"No flavour"	28 (47%)	35 (58%)

By 1936 it had also been recognised by manufacturers that a slight change in colour could lead to complaints from users of a deterioration in flavour (10). Even the colour used for packaging certain foods affects the perception of flavour (11). Manufacturers have also found that emphasised colours help customers to easily differentiate between 'flavours' in a range of drinks on the shop shelf (12). Coloured packaging can also help with a rapid identification of flavour type. Colours also contribute to the image and identity of many brand name products, and help make them instantly recognisable, which saves time for shoppers. Colours can have other useful functions, for example, they can help people make judgements about the correct level of dilution of a fruit squash or alcoholic drink (13). This benefit depends on the concentration of brands of drink remaining fairly standard. Margarine and butter provide another example of colour indicating the concentration of a food. It is easy to judge the desired amount of yellow margarine or butter spread on white bread (14). It would be less easy if the margarine were left in its uncoloured state.

5.4 Appeal and Acceptability

Colour is also very important to the enjoyment of food. A colourless dish such as white fish, potatoes and cauliflower, is well known to be unappetising. It has been reported by institutional caterers that such dishes meet with a high degree of rejection and there is a large proportion of wastage. A variety of colour on a plate enhances visual appeal.

Colour is also important for fun foods, treats and celebration foods. R J Soukup from General Foods Corporation, for example, has warned:

> The psychological importance of color should not be underestimated. The enjoyment of candy treats, beverages and desserts is, of course, enhanced by the stimulation of our visual as well as other senses (15).

Many sweets, desserts and cakes provide enjoyment from being highly coloured. This aspect is particularly important to children. Most children have a marked preference for brightly coloured foods when given a choice. Brightly coloured foods such as sweets were particularly popular with children and young people in the 1850s as well as today (16).

R H Watson, a nutritionist, has examined the extent to which it is possible to vary the colour of foods without reducing acceptability.

Watson experimented with a group of students. He asked them to select a meal from a range of ordinary foods (such as bread, butter, savoury rice). The amount eaten by each was recorded. A week later the students were required to select a meal from the same range of foods which had now been coloured; the apple juice was red, the butter was brown, the savoury rice was green, for example. He found little reduction in the amount of food consumed. A week later the students were presented with a choice of normal and coloured foods. There were marked differences between individuals in the extent to which they found the coloured foods acceptable. Some refused them completely whereas others took almost half their food in the peculiar coloured form (17).

Watson also examined the reactions of a group of school children to foods in their natural state and coloured by eight colours. The children were asked to list their order of preference. The most preferred colour was yellow, followed by orange then red. Blue was last on the list, despite the fact that most children had said it was their favourite colour (in general) (18). Other studies have confirmed a marked distaste for blue foods. It has been suggested that this aversion is connected with the role colours play in indicating the microbiological quality of food. Blue is almost the sole colour which is not found among untreated fresh foods.

Watson also found that it was more acceptable to vary the shape of food than its colour. For example, potato was acceptable in many fancy shapes (stars, teeth, chips, etc.) but was less acceptable when containing unusual colours (19). He concluded that

> Because of the strong role played by colour in identifiying foods and in assessing whether or not they are fit to eat, foods should only be prepared in their natural colours (20).

By this, he meant that expected colours should be restored with additives if necessary. But Watson has qualified this statement by identifying a division of meals into two parts. His statement applied to the savoury part of a meal, usually regarded as the nutritious part. The sweet or dessert is normally regarded more as a treat or 'fun' event. For these foods, as with certain celebration foods like cake, it is acceptable to use unaccustomed colours. It is also acceptable for drinks to be made in a variety of unusual colours.

The aversion to artificially coloured savoury foods is predominantly cultural. In India and China it is customary to give bright colour to certain meat dishes, for example. Such highly coloured savoury dishes have become very acceptable in the UK, because they are seen as part of a particular cuisine. The same bright colouring of a traditional English dish like roast beef would be unacceptable to many who are accustomed to plain beef.

5.5 Benefits to the Consumer

Safeway Stores asserted in 1986 that:

> It is really for consumer benefit that certain additives are incorporated into food allowing the maintenance of an enjoyable and nutritious diet which is safe, economical and abundant (21).

Hicks, a technologist from Beecham Products, produced a paper in 1981 outlining, from the industry perspective, the need for colouring agents in food. He said:

> The most important technical benefits of added colourings are found where the natural colourings of the food are unstable after harvesting or in processing or storage or in use. Colourings can be used to restore the expected appearance to foodstuffs whose natural colourings have been lost due to breakdown in storage or processing (22).

These are cosmetic purposes rather than technological ones. As well as restoring lost colour, Hicks argued that colourings were needed to create standardised products and to give information about quality - because consumers expect this and base their buying decisions on it.

Hicks listed their benefits for the public:

a) Improved appearance, flavour, and enjoyment of food.
b) Better information to the consumer on the characteristics of the food, particularly its flavour and condition.
c) Some assistance in how much to use and how long to store food.
d) Reduced cost and improved quality through manufacturer benefits.
e) Improved stability and reduced waste in storage (23).

Other benefits that have been claimed recently for colours are:

f) Promotion of good health by making nutritious foods attractive to the consumer.
g) Creation of celebration foods (24).

Advantages claimed for the consumer in the 1930s were similar, though less sophisticated (25):

a) Appeal to the palate.

b) Attractive appearance.

c) Nutritional benefits from attractive appearance.

d) Identification of flavour.

e) Range of hues.

Other than appeal, the main benefits from colours that have been claimed for consumers can be summarised as follows:

1) Improved nutrition

2) Reduced cost

3) Improved choice

These three claims are examined in turn.

5.6 Claims of Improved Nutrition

One long-standing argument in favour of added colour has been that colour is important to nutrition. One member of the 1901 Departmental Committee defended the use of copper sulphate on the grounds that it gave nutritional value by making food more attractive (26). In 1936 Harold Silman repeated this point in Food Manufacture:

> Synthetic colours are, indeed, highly desirable ingredients in foodstuffs on account of the great part they play in rendering them appealing to the palate. An attractive appearance in foods is desirable from a nutritional point of view (27).

Some manufacturers argued against a positive list in 1936, on the grounds that

> A prohibited list gives far more scope to the manufacturer to exercise his ingenuity in the development of 'appetising' shades which have a beneficial dietetic significance (28).

In 1954 the argument about the nutritional value of colours had much effect. The Preservatives Sub-Committee used it to justify the continued use of colour in a wide range of foods:

> It is generally accepted to be physiologically sound that food should be presented in as attractive a form as possible,

> and without the addition of colour many foods would have a drab and unattractive appearance (29).

This argument was reiterated recently in two major books on food colours published in 1980 and 1984, which claimed that

> An unappetising colour may adversely affect digestion thus influencing the nutritional value of the food (30);

and that synthetic colours

> Promote good health by making nutritious foods attractive to the consumer (31).

R J Soukup from General Foods Corporation has put forward a futuristic version of this argument:

> Man is now on the threshold of an era of prefabricated main meal items where the attributes of foods must be supplied to add acceptability to nutritional quality. Imagine a prefabricated protein meat substitute with no color, no flavor, and a nondescript texture (32).

One important factor in nutrition is the consumption of a wide range of foods in order to get an adequate variety of nutrients. There is no doubt that developments during the 1950s and 1960s radically altered and increased the range of foods available in the UK. But by 1964 nutritionists expressed doubts about the changes, as well as expressing approval of the wider choice (made available by such changes as improved transportation and preservation techniques). J C McKenzie and J Yudkin, for example, pointed out that

> Unexpected restrictions in availability are beginning to be seen in the wealthier countries, with the growth of supermarkets and their tendency to reduce the number of brands of particular foods which they offer (33).

The problem lay in the fact that food diversity could be more apparent than real. Many new processed foods of the 1960s and 1970s were (and still are) made from ingredients that are bulky, cheap, and highly controllable. Sugar, fat and refined starch have thus become the major ingredients of a large proportion of foods, and of the average diet. Colours have a crucial role to play in these products: giving colour where little or none existed. There is a limit to the amount of refined starch, sugar and fat that people would eat. On their own, they have as much appeal as a bag of flour or of sugar. But when colours, flavours and texture modifiers are added, their appeal increases considerably, and some people can actually eat too much of these sorts of food. In the past decade the typical Western diet - high in fat, sugar and refined starch - has been linked with a range of diseases. Before the war, diet-related disease was primarily due to lack of food. The new dietary diseases are due to overconsumption, or, more precisely, overconsumption of some factors and underconsumption of others. Current diet-related diseases include coronary heart disease, stroke, cancers of the breast, stomach and colon, maturity-onset diabetes and dental caries (34). But as before, these are diseases mainly of poverty rather than of affluence (35).

Colour is related to inadequate nutrition and dietary disease in two ways, namely:

a) Dilution and substitution

b) Narrow diets

These problems are described below.

5.7 a) Dilution and substitution

Colours can replace nutritious food ingredients. Orange colours can be used in drinks in place of orange fruit; red colours can replace tomatoes. Substitutions of this sort were commonplace in the 1850s (see table H.1 in appendix H) and remain so today. As a result, valuable vitamins and minerals are lost. Coal tar colours have no nutritional value in themselves. Only about two colours of the many hundred that have been used have any direct nutritional value: Riboflavin and some types of Carotene are vitamins. In the vast majority of cases, the substitution of colours for food ingredients has produced nutrient loss.

A rare study on the effects of colour and nutrition has been carried out on animals. Rats were fed a purified low fibre diet to which were added Amaranth (a red coal tar colour), a sweetener (cyclamate) and an emulsifier, individually and in combination. It was found that supplements of any one of the three additives had little deleterious effect. But combined supplements of Amaranth and the other additives produced a marked retardation in weight increment, an 'unthrifty' appearance of the fur, alopecia and extensive diarrhoea (36). The researchers concluded that there appeared to be some synergistic effect between the additives in combination with a low fibre diet.

Colours can have other effects on nutrients. In some cases staple foods such as beer and milk have been literally diluted with water. The dilution is masked by colours. This form of adulteration had particularly dire consequences for people on low incomes in the 1800s and early 1900s. The dilution of food contributed to malnutrition when people already had too little to eat. Dilution today probably still adversely affects groups of people on low incomes (37). (For other groups the major problem with dilution is one of fraud rather than nutrition, discussed later.)

5.8 b) Narrow diet

Colours tend to be used in foods of inappropriate or poor nutritional value. Colourants make foods that are high in fat, sugar and fibre-stripped starches much more palatable and attractive than they otherwise would be. Added colours encourage people to eat more of these types of foods, and thus contribute to the problem of inappropriate nutrition and its legacy of preventable diseases, such as coronary heart disease and cancer of the breast and colon.

Some meat products (for example, pate, luncheon meat, sausage) traditionally contain the minimum permissible amount of lean meat. The rest of the product is made up of a high volume of cheap substances like fat or rusk. But the consumer is not generally aware of this because it is legal to add combinations of red, brown and yellow colours to the non-meat parts to help make them look like lean meat. Practices of this kind contribute to the overconsumption of fat in the UK.

Current nutritional advice is to reduce consumption of fat, salt and sugar, and to increase fibre levels and eat a wide diversity of foods in order to get a balanced and adequate diet (38). Colours and other cosmetic additives allow the public to think they are getting a diversity of nutrients when in reality they are eating many of the same food ingredients dressed up to look like different foods. These basic ingredients are often fat, fibre-stripped starch and sugar. Table 5.5

shows the ingredients of a typical dessert mix of the 1980s. The three main ingredients are fat, sugar and modified starch. Table 5.6 shows a typical instant soup mix. The main ingredients of the soup are the same as the dessert mix. Yet most people would expect the soup to be more nutritious. The two products look and taste different primarily because of the sophisticated use of colour, flavour and texture additives. A large proportion of modern foods are made in this way. As a result consumers can feel that they are eating a diversity of foods and nutrients because the foods look and taste different when in fact they are not.

The Food Advisory Committee recently considered the role of colours, and reported in 1987 that colours allow the public to have 'an adequate and varied diet' (39). Yet they offered no evidence for this view. The available evidence indicates that colours have helped many people to consume a narrow and inadequate diet.

D Hicks of Beecham Products has attempted to defend the use of colourants on nutritional grounds. He pointed out that two plant colours (rarely used at the time) were vitamins. He also reported that dark colours could act as sun screens in transparent packs. This could protect vitamins, flavourings and other ingredients. He acknowledged the validity of the argument that colours have contributed to inappropriate diets and made the following logical point:

> If added colourings can be used to encourage the consumption of 'undesirable' food, they can equally well be used to encourage the consumption of desirable foods. When nutritionists reach a consensus on the desirability or otherwise of different foods (which is far from the case at present) manufacturers will be better able to assist in the attainment of agreed dietary goals if they are able to use food colourings (40).

A nutritional consensus was achieved to some extent in 1983 by the Health Education Council's NACNE committee which included industrial and academic representatives (41). Hicks' argument is based on the assumption that the food industry is free from economic constraints and can choose to use any ingredients. But ingredients such as fat, sugar and starch are used because they are so cheap, plentiful and controllable. Foods containing plenty of nutrients and fibre are not cheap or easily controllable. There are few viable alternatives to fat,

TABLE 5.5 : INGREDIENTS OF A TYPICAL DESSERT MIX, 1987

TABLE 5.6 : INGREDIENTS OF A TYPICAL INSTANT SOUP MIX, 1987

Aston University

Illustration removed for copyright restrictions starch and sugar at present, although his argument may possibly be put into practice in small ways in the future.

Hicks himself has expressed the real concern of manufacturers at the prospect of greater restrictions on the use of colours on nutritional grounds.

> Where manufacturers are not free to add colourings to foods which consumers like and expect to be coloured, the balance of consumer demand between unprocessed and processed foods is likely to be disturbed in favour of the fresh foods with consequent loss of the advantages of nutritional and flavour variety, cost and convenience offered by processed foods (42).

From the manufacturers point of view, this would mean a smaller proportion of sales derived from added-value goods. Many manufacturers would be concerned at this because they have developed such products as a major source of profit (see chapter 4). The consequences to consumers of removing colours from certain foods are examined below. It is doubtful that the public would be disadvantaged in nutritional terms.

5.9 Claims of Decreased Cost

In the 1800s it was claimed that the public benefitted from colours because they reduced the cost of food. Very recently this claim has been reiterated. R K Johnson listed as one of the advantages of synthetic colours the fact that they

> Help to hold down the cost of food since the normal appearance of wholesome, colourful foods can be retained or can be restored if colour is lost during processing (43).

Colours have undoubtedly helped to hold down the cost of some foods by reducing wastage and making otherwise unsaleable ingredients saleable. Costs have also been reduced where colours have replaced relatively expensive ingredients, such as fruit.

But colours have undoubtedly contributed to the cost of some foods. Colours themselves are not cheap, although they are cheaper than many food ingredients. Colours are used predominantly in added value products. These can be poor value for money, providing few nutrients per £. Few studies are available of the relationship between colour and value for money. A survey of coloured food conducted by L B Greenwich in 1987 found there were some price differences between coloured and uncoloured products (44). They found one sample of processed peas without colour was more expensive than peas with colour. Jam and squash without added colour were also more expensive. Fish fingers with 'natural' colouring were more expensive than those with coal tar colours. Some examples of the relationship between colour and cost are examined below.

5.10 a) Fruit products

The Greenwich survey pointed out that jam and fruit squash without added colour were higher priced than those with colour. The prices of fruit-based products do indicate that for some foods added colour is related to price. This is due to the fact that colour is actually substituting for fruit. Colourants are cheaper than fruit. This is in contrast to tinned peas (described in (d) below) where the colour is an addition rather than a substitution.

Jam without added colour usually has a high fruit content and is therefore relatively expensive. It can be made with less fruit (and more sugar); but then it has a less intense and more brown colour than the public are used to. The colour tends to become more brown with age. So standard low-fruit jams are only available with added colour. One manufacturer of colours has informed me that it is possible to make standard jam without destroying so much of the original colour of the fruit. But this requires tighter control on processing, which would probably be an extra cost.

Fruit drinks without added colour are more expensive than drinks with colour. Again, this is because colourants are cheaper and substitute for fruit. Manufacturers, such as Mandora, who have recently produced 'no colour added' squashes found they were only able to do so by increasing the fruit content of their drinks from around 10% to 30%. Where fruits were pale anyway, such as lemon, it was easier to remove or reduce colourings without adding to the cost significantly. Increasing the fruit content raises the cost to manufacturers, and the price charged to the public.

5.11 b) Cakes

In response to public concern about additives a major cake manufacturer recently reviewed their use of colourants. They found they were able to save money by reducing the use of colour. They found that their use of colour had become excessive, being added at every stage. They reduced the levels of some colourants, and eliminated others altogether. They made these changes gradually so there was no sudden colour change in the products. Colours, though cheaper than ingredients like eggs and fruit, are an extra cost in themselves.

5.12 c) Meat products

One study has been conducted on the relationship between price and the meat content of ham. Many hams are bulked out with water. One might argue that this is justifiable if the consumer is aware of the difference in quality between hams, and if the price is lowered in consequence of the reduced meat content. Water, after all, costs manufacturers less than meat. The recent study of hams carried out by the London Borough of Greenwich found that though the water content varied from 0% to 35% among different brands, there was no correlation between price per lb and water or meat content (45). This surprising finding has been endorsed by a study of the water content of frozen prawns. Again, it found there was no correlation between price and the amount of added water (46). So the savings of substituting water for meat were were not often passed on to the public for these products. Given the role of colours in masking dilution and substitution, it is likely that colours contribute to the kind of legalised fraud indicated above. So although colours can technically reduce the cost of food, these cost savings sometimes benefit the manufacturer or retailer rather than being passed on to the consumer.

A bakers' manual published in 1927 took the following view about the cost of 'sophistications':

> It is difficult to define the border line between 'adulteration' and 'improvement'. If the object of additions to foods is to enhance their apparent value to the consumer, and this is done at a cost to the manufacturer proportionately small in relation to the enhanced price which

the consumer is required to pay, then the addition may be considered as in the nature of an adulterant (47).

5.13 d) Tinned peas

I have recently surveyed the price of a selection of canned peas offered by one large independent store and one supermarket chain in 1987. Table 5.7 gives the results. The cheapest peas were uncoloured among the range offered by the independent grocer. Uncoloured peas were also amongst the cheapest offered by the chain store. The most expensive peas (excluding the coloured Smedley's which were relatively high-priced because of the smaller sized tin) were ones containing colour. But price comparisions of this sort are difficult because factors other than colour also contribute to the price: the quality of the peas, other additives (eg salt, sugar, flavourings) and processing. However, one item provided a direct comparison. There were two types of Sainsbury's marrow fat peas. They were identical in price and composition (including the nutritional breakdown). One contained colour and the other did not. This survey suggests that added colouring has little effect on the price of canned peas, and that claims of reduced cost are misleading.

5.14 COLOURS AND CHOICE

The 1901 Departmental Committee reported that there were markets for highly coloured, lightly coloured and uncoloured goods. They saw no reason to interfere with this situation (48). Since the early 1800s when a significant proportion of food contained added colour, consumers have had the choice of buying coloured or uncoloured food. One of the major justifications for continuing to allow colours in many foods in 1901, 1924 and 1954 was that there was a demand for them: the public often preferred coloured to uncoloured items, or preferred a range of shades.

The sections below examine the effects of regulations on the range of hues and foods, and examine some of the factors determining food choice.

TABLE 5.7 : TINNED PEAS: RELATIONSHIP BETWEEN COLOUR AND COST, 1987

Survey of tinned peas available in an independent supermarket and a large chain of supermarkets, London, 1987.

Brand	Added colour	Other additives	Price per tin	Weight	Price per 100g
INDEPENDENT STORE					
Bonduelle (garden)	No	Yes	33p	400g	8.3p
Smedley (garden)	Yes	Yes	19p	145g	13.1p
Del Monte (garden)	No	No	28p	300g	9.3p
Hartley (garden)	Yes	Yes	29p	284g	10.2p
Talpe (petit pois)	No	Yes	36p	410g	8.8p
SUPERMARKET CHAIN					
Sainsbury (garden)	Yes	Yes	18p	298g	6.0p
Morton (garden)	Yes	Yes	20p	300g	6.6p
Sainsbury (marrowfat)	Yes	Yes	12p	283g	4.0p
Sainsbury (marrowfat)	No	Yes	12p	283g	4.0p
Farrows (marrowfat)	Yes	Yes	14p	284g	5.0p
Sainsbury	Yes	Yes	12p	283g	4.0p

5.15 Preference for Added Colour

Table 5.8 shows the results of a study of consumer preference for coloured and uncoloured drinks in 1974. The study showed the group had a clear preference for coloured lime and blackcurrant drinks, but no strong feeling about the coloured orange drink.

A century ago in the 1860s the Cooperative Society, which was set up to provide unadulterated food at reasonable prices, found that many people preferred the colour of adulterated food to pure food. And in London around 1900 the use of yellow colourants in milk was so common that people often refused to buy uncoloured milk because it looked 'unnatural' (49).

Hassall said in 1861 that

> One reason assigned in defence of many adulterations is that they are practised in obedience to the wishes and tastes of the public ... (50).

The 1901 Departmental Committee felt copper colours in preserved vegetables to be highly undesirable but pointed out the strong public demand:

> The public have got in into their heads that vegetables ought to be green, and green they insist upon having them (51).

It is sometimes suggested that the reason why the quality of British food became so appalling compared to, say, France, is because urban labourers lost their rural roots early and rapidly, during industrialisation. In large towns food was out of their control. But in fact, both urban <u>and</u> rural labourers lost their 'roots' and ability to grow fresh food. During the enclosures rural labourers lost land and access to firewood. They became dependent on mean wages (52). Stephen Mennell suggests that all this allowed the public to be sold poor quality food and to be obliged to become accustomed to it (53).

In the 1800s the poor were blamed for promoting adulteration by buying adulterated food. But in practice their choice was often limited. They

TABLE 5.8 : CONSUMER PREFERENCE FOR COLOURED AND UNCOLOURED SOFT DRINKS, 1974

Source: D Hicks 'The importance of colour to the food manufcturer' in J N Counsell Natural Colours for Food and Other Uses Applied Science, london 1981, p43.

Date and location of research: December 1974, in 12 towns in England.

	Consumer ratings (%)							
	Concentrated drinks						*Sparkling glucose drink (227 interviews)*	
	Blackcurrant syrup (204 interviews)		*Orange squash (207 interviews)*		*Lime cordial (209 interviews)*			
	Coloured	*No added colouring*	*Coloured*	*No added colouring*	*Coloured*	*No added colouring*	*Coloured*	*No added colouring*
Appearance in bottle								
attractive	91	60	71	64	90	14	86	32
unattractive	2	20	13	14	2	51	5	37
Appearance in glass (concentrates diluted)								
attractive	91	42	75	47	61	15	92	27
unattractive	2	43	11	31	13	58	4	43
Taste								
liked	86	75	82	80	86	84	92	76
disliked	7	13	13	11	7	6	3	14
Overall preference	58	22	43	42	46	31	56	23

could only buy what was available in the shops. Many were tied by debt to one shop-keeper. Even today, when consumers have apparently limitless choice, choice is in fact highly structured. The factors affecting food choice are outlined below:

5.16 a) National income

In countries with a low national income a high proportion of fibre and starchy foods and a low proportion of animal fat and meat is eaten. In countries with a high national income a much greater proportion of sugar and animal (especially dairy) fats is eaten. Table 5.9 shows the relationship between animal product consumption and income in selected

OECD countries. Table 5.10 shows the rise in animal consumption that occurs with rises in national income. According to David Blandford, in virtually all countries that have experienced a rise in income in the past 30 years therehas been a decline in the importance of vegetable products (such as cereals) (54). So state of industrialisation and national income of a country is one of the factors determining what people eat.

5.17 **b) Concentration of the food industry**

In the 1800s decisions about which foods to make and what ingredients to use rested with thousands of small and medium sized manufacturers. The food industry has gradually concentrated in this century in the hands of a few major retailers. Concentration started in the inter-war period. It increased dramatically between 1958 and 1972, when the total number of food firms in the UK fell by 40% (55). By 1982 five supermarket groups sold 50% of packaged groceries. In London, in 1984, five groups controlled 68% of packaged groceries (56). This means that the decisions about the majority of foods available to the public are now made by a very small number of people and the buying policies of a few large retailers.

Christopher Driver has commented on the effect of this change:

> In theory, a supermarket or hypermarket... presents maximum choice, with 6,000 'lines' displayed on shelves, compared with perhaps 600 in a well-stocked corner grocery store... While apparent choice of products has widened, choice within a particular range of foods may narrow, because the sheer size of the market precludes extremes of taste and favours the common (not necessarily the lowest common) denominator (57).

The choice of foods of varying quality has been diminished. Ham provides one example. Excessive competition and lax legal standards have almost eradicated the middle market for ham. The choice now is between very expensive hams made in the traditional manner, and cheap rubbery, waterised and re-textured hams. In supermarkets there is sometimes not even this choice: they often offer only the latter type of ham.

TABLE 5.9 : RELATIONSHIP BETWEEN ANIMAL PRODUCT CONSUMPTION AND INCOME IN SELECTED O.E.C.D. COUNTRIES FOR 1960 - 1980

Source: D Blandford in C Ritson (ed) The Food Consumer Wiley, Chichester 1986, p30.

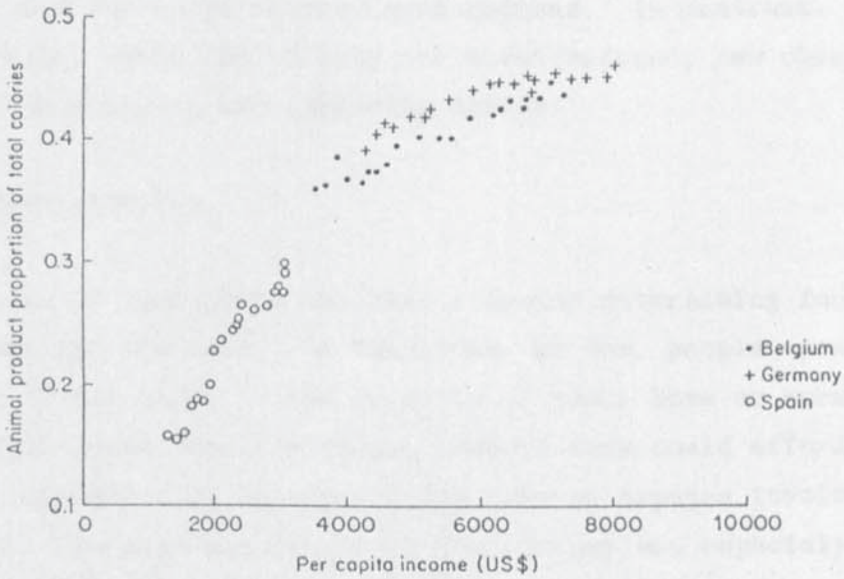
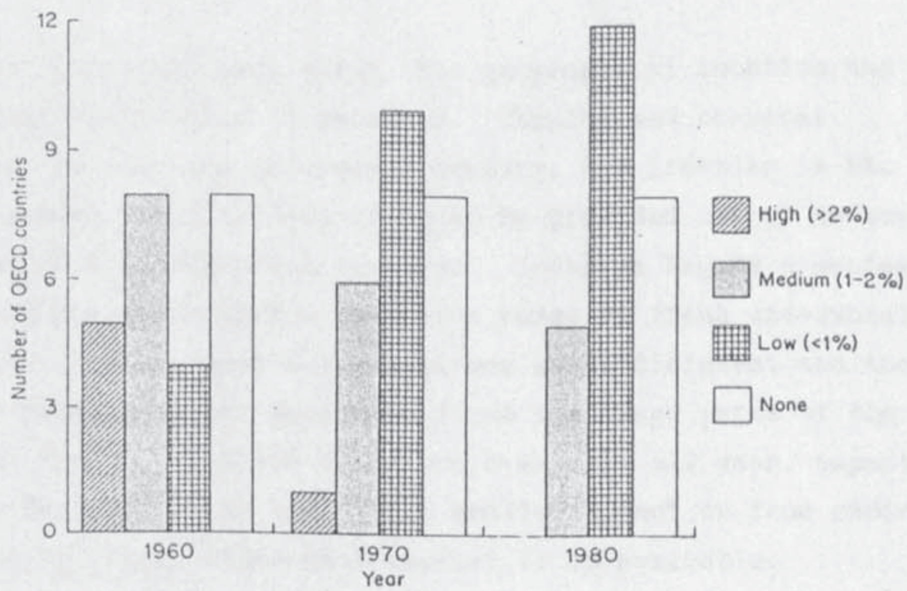


TABLE 5.10 : RESPONSE OF ANIMAL PRODUCT CONSUMPTION TO CHANGES IN INCOME

Source: D Blandford in C Ritson (ed) The Food Consumer Wiley, Chichester 1986, p30.



Cheese provides another example where the changed structure of the food industry has reduced variety and choice. In the late 1900s many local cheeses were made. By the 1950s the number was reduced to about half a dozen (58). In the late 1970s a number of old cheeses were revived. But many of the revived cheeses in the UK are poor copies of the originals, and the range remains much reduced. In contrast, at the same time in France, where the variety was never reduced, new cheeses were developed, maintaining and improving choice.

5.18 c) Accessibility

Accessibility of food shops has been a factor determining food choice in this century and the last. In the 1800s, as now, people were usually restricted to the shops in the locality of their home or workplace. Travelling to better quality shops, even if they could afford the food, was out of the question because of the time or expense involved in travelling. The ease and length of the journey was especialy important given the heavy weights involved in carrying food home. Today, people with cars and a monthly income are favoured by the big 'one-stop' food shopping policies of retailers. People reliant on public transport or on weekly incomes are not able to take advantage of the savings that can be made because the facilities are not available to them (59).

5.19 d) Climate

Preservation techniques have meant that geographical location has less impact on food choice than it once had. Canning and chemical preservatives in the late nineteenth century, and freezing in the twentieth century, have allowed foods to be provided out of season and to be transported to different climates. Today, a highly organised retail industry ensures that a very wide range of fresh unseasonal foods are available. In the last century it was quite different and the public were obliged to eat preserved foods for large parts of the year. Today a wide variety of fresh foods are available all year, especially in cities. So climate now has a much smaller effect on food choice, affecting it by price rather than whether it is available.

5.20 e) Biological factors

Humans are omnivorous and can draw on a wide variety of sources of food. There is little evidence for genetically determined food choice. Christopher Driver has examined the wide range of nutritious potential foods, such as coypu, cat, horse and fungi indigenous to the UK. But these are traditionally shunned, though welcome in other cultures (60). We have failed to make use of good sources of nutrients, and in this sense our choice of food is not driven by biological expediency. There does appear to be one area, however, where humans may have an innate preference for a particular type of food. Studies on infants demonstrate that there may be an innate preference for sweet foods and a rejection of bitter foods (61).

5.21 f) Socio-economic factors

There are distinct class differences in diet. For example, wealthier groups currently eat more fresh fruit and vegetables (which are relatively expensive), while groups on lower incomes eat more sugar and fat. Tim Lang and Issy Cole-Hamilton have demonstrated that people on low incomes are forced to buy less food and often of poorer quality. Food is a flexible item in the household budget, unlike rent and debt repayments (62). For many people, the price of a food item is the prime factor determining choice.

In the nineteenth century there were enormous differences between the food eaten by the rich and poor. The poor suffered starvation and the brunt of adulteration. There were no facilities for them to grow food, keep pigs, brew or bake in the new towns. The rich ate better quality foods and made ostentatious displays of wealth and waste in their cuisine (63). Wealth was not a shield from adulterated food in the early and mid 1800s. But adulterated food never made up the majority of the diet of the rich in the way it did of the poor. The rich continued to be subject to low levels of adulterated food in the late 1800s. When the worst excesses of adulteration were removed by the 1880s the food of the poor suffered legalised adulteration. In the twentieth century this pattern continued. The poor in Rowntree's study of 1901, for example, ate a narrow diet of processed foods such as bread, tinned milk, sugar, hashed beef, pickles, marmalade and cheese (64). Most of the cheaper versions of these products were debased in some way. During the early 1900s the choice of foods increased for urban labourers, but the nutritional quality of the diet became worse (65).

From the 1930s the amount of tinned vegetables and tinned meats increased ammong people on low incomes because they were relatively cheap (66). These products tended to have added colours in them. In the 1950s and 1960s there was a new emphasis on value-adding and convenience foods. Excessive competition between supermarkets led to more price-cutting at the expense of quality. This reinforced the split market between the food for the rich and poor.

5.22 g) Advertising

Advertising, packaging and other forms of persuasive communication also help to determine food choice. On the one hand, as Jim Tomlinson has rightly pointed out

> Consumers are not blank sheets of paper upon which anything can be written (67).

The role of advertising in shaping consumer wants has been emphasised too heavily by some writers. Consumers clearly do have an impact on the food products that are sold. A significant number of new food products have failed to sell well despite large advertising budgets, and have been withdrawn from the market. On the other hand, advertisements obviously have some impact, and the food industry finds it worth spending over £300 million per annum (currently) on advertising. Food advertising seems to work not so much by implanting completely new attitudes but by re-directing existing attitudes, using imagery, stressing links with special occasions and rituals, and by being a source of information and authority (68).

5.23 h) Individual preference

Many food preferences are learned. Several studies have demonstrated that the foods people find preferable are usually just those to which they are most accustomed (69). Before an individual performs his or, more usually, her act of choice in a shop, all the factors outlined above will have already selected out a range of foods. At this late stage the individual makes a choice from the goods available, based on factors such as price and convenience.

5.24 i) Colour

Attractive food appearance is created by many factors. Important factors determining the visual character are colour, shape, texture, gloss, translucency and mode of presentation (70). Colour is just one of the factors affecting the physical appearance of food.

Studies on preference for added colour, described above, show that it is a factor affecting choice, for some foods. Retailers have responded to the preference for added colour shown in such studies. Sometimes, as table 5.8 shows, the preference is marginal. Nevertheless, the economic pressure to get maximum sales per square foot of shelf space has meant that retailers have from the 1950s to the mid 1980s only offered one option: the coloured item. This left the preference of a large minority uncatered for.

The results in table 5.8 show that the tasters had no preference for coloured orange drink. Despite this, the manufacturers decided to add colour to the orange drink anyway because it allowed customers easily to differentiate between a range of drinks on the supermarket shelf (71).

5.25 Range of Foods

A survey carried out by the London Borough of Greenwich in 1987 examined the food choices available in five large supermarkets (72). Table 5.11 gives a summary of the proportion of coloured items offered for some foods typically eaten by children. The stores offered, on average, four items of each food for the public to choose from. In the vast majority of cases (82% on average) these foods contained added colour. For the blackcurrant drink, vanilla ice cream and canned strawberries, there was no option to buy uncoloured items in any of the five supermarkets. This lack of choice was not due to technical problems. All three food items can be made free from added colour. One supermarket chain unusually offered only uncoloured items for one food: no coloured lemon squash was available. But in general the uncoloured items were a mere 18% of the total and the choice was restricted to one or none per foodstuff. There are factors other than colour that differentiate between products. Among uncoloured products 'choice' (ie. more than one item) existed only in two isolated cases, that was only 6% of cases.

Few data are available on the proportion of coloured foods in earlier periods. However, in 1901 the Laboratory of the Government Chemist carried out a large survey, presented in table 5.12. It shows that over 50% of margarine, cheese, cordials, fruit syrups, sauces and ketchups were coloured. For most foods there was apparently a choice of coloured or uncoloured versions, although the data gives no indication of the range available in particular shops. It is likely that the coloured

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TABLE 5.11 : SURVEY OF COLOURED AND UNCOLOURED FOOD AVAILABLE IN SUPERMARKETS, 1987

Compiled from: Environmental Health Department The Use and Control of Colouring Matter London Borough of Greenwich, London, March 1987.

	Number of coloured items / Total number of items			
Foodstuff	Presto	Sainsbury	Tesco	Safeway
Orrange squash	6 / 6	7? / 8	4 / 6	5 / 6
Lemon squash		4? / 5	2 / 3	0 / 3
Blackcurrant drink	4 / 4	4 / 4	4 / 4	3 / 3
Fish fingers	5 / 6	3 / 3	5 / 5	4 / 4
Apricot jam	2 / 3	4? / 4	1 / 2	
Banana yoghurt	3 / 4	3 / 4	2 / 3	1 / 1
Vanilla ice cream	5 / 5	3 / 3	2 / 2	1 / 1
Tinned Processed peas	5 / 6	6 / 7		8 / 9
Tinned strawberries	2 / 2	2 / 2	2 / 2	2 / 2

TABLE 5.12 : PROPORTION OF FOODS CONTAINING ADDED COLOUR c.1900

Source: Summary of samples of food (both home and imported products) examined by the Government Chemist's Laboratory, Committee on Food Preservatives Report of the Departmantal Committee... HMSO, London 1901, appendix XII, table N, p368.

Food	Total number sampled	Colouring matter: Coal tars	Plant prod.	Animal prod.	Mineral product	Percentage coloured %
Milk	296	-	3	-	-	1.0 d
Cream	290	9	1	-	-	3.4
Butter	364	40	87	-	-	34.9
Margarine	133	100 a	15	-	-	81.9
Cheese	196	5 b	107	-	-	56.6
Condensed milk	86	-	-	-	-	0
Bacon	210	-	-	-	-	0 c
Ham	185	-	-	-	-	0 c
Sausages	226	72	1	1	-	32.7
Potted meats	165	27	2	-	3	19.4
Preserved meats	135	-	-	1	-	0.7
Prawn	56	6	-	-	-	10.7
Fresh fish	43	-	-	-	-	0
Preserved fish	44	-	-	-	1	2.3
Meat jellies	25	3	-	1	-	16.0
Meat extracts	50	-	-	-	-	0
Pork pies	48	-	-	-	-	0
Fruit jellies	28	9	-	4	-	46.4
Lard	52	-	-	-	-	0
Jam	150	10	-	-	-	6.7
Preserved fruits	48	4	-	-	2	12.5
Fruit pulp	10	-	-	-	-	0
Preserved vegetables	49	-	-	-	17	34.7
Lime and lemon juice	78	1	-	-	-	1.3
Cordials	24	12	-	2	-	58.3
Fruit syrups	23	12	-	1	-	56.5
Temperance drinks	769	56	-	1	-	7.4
Imported beers	100	-	-	-	-	0
Wines and beers	32	-	-	-	-	0 d
Vinegar	77	-	-	-	-	0 d
Sauces and ketchups	10	5	3	-	-	80.0
Spices	22	-	2	-	2	18.2
Soups	49	1	-	-	-	2.0
Sugars	149	24	-	-	-	16.1
Misc (eg invalid food)	29	2	-	-	-	6.9
Totals	4251	398	221	11	25	15.2

Notes:

a 6 of these contained both vegetable and coal tar yellows
b 1 of these contained both vegetable and coal tar yellows
c Saltpetre has obviously been discounted
d Other sources have reported use of colours in this food

items would have been concentrated in shops servicing the poorer groups in society. For such groups choice was likely to be restricted to coloured items for certain foods. Interestingly, for those who wished to buy coloured foods, for a few foods such as fruit pulp and imported beer, there was no option to buy coloured versions.

Tables 5.11 and 5.12 are not directly comparable, but they do suggest that the foods that were predominantly (sometimes exclusively) coloured in 1987 were less often coloured in 1901. It appears that the option to buy uncoloured food had largely disappeared from supermarkets. Table 4.4 in chapter 4 indicates that the proportion of food with added colour increased significantly in the 1920s and 1930s.

In 1935 A G Kay stated in Food Manufacture that:

> The use of harmless edible colours has become so general and the wide range of products in which they are used so varied that it is very difficult to name many manufactured foods which are not artificialy coloured (73).

In the 1950s and 1960s the proportion of coloured food burgeoned because new foods were produced with added colour. The following sections examine the extent to which colour regulations affected the range of hues and range of foods available to the public.

5.26 Effects of Regulations on Range of Hues

There are about 7,000,000 variations of colours distinguishable by the human eye (74). Subtle differences in the shades of colours are therefore detectable. A full range of colours available for foods is therefore of benefit to the public because it allows many sophisticated and pleasing hues to be produced.

In 1939 A G Kemp warned in Food Manufacture of the restrictive effect a positive list might have on the range of hues available. He discussed the USA's positive list and recommended that a similar list should not be introduced in the UK. He complained that the USA's positive list of 17 coal tar colours was so short that it was impossible to produce certain shades from the permitted colours:

> In England, no seaside resort is complete without its 'Rock', and the one colour used above all others for this purpose is Rhodamine. There is no colour to replace it with any degree of success, but Rhodamine finds no place on the USA list, and there are many similar examples. Further, no account is taken of the purposes to which the foodstuff colours are put. What would our producers of breakfast sausage do to obtain a scarlet colour to shade the skins of their produce? Where could a black colour be obtained for the many trades which need it? (75)

Table 5.13 shows the number of coal tar colours of each hue on the USA's permitted list of 1939. The list was indeed very short (17 colours) compared to the range available in the UK at the same time, which consisted of around 100 coal tar colours. Table 5.14 shows the number

TABLE 5.13 : NUMBER OF COAL TAR COLOURS OF EACH HUE PERMITTED IN THE U.S.A., 1909 - 1984

Compiled from:
Daniel M Marmion <u>Handbood of US Colorants for Foods, Drugs and Cosmetics</u> Wiley, New York 1984, p17; A G Kemp 'Food colour regulations in USA' <u>Food Manufacture</u> 1 December 1939, p392.

	Number of colours / Year				
Hue	1909	1925	1939	1960	1984
Red	3	3	4	4	1
Orange	1	1	2	0	1
Yellow	1	4	6	2	2
Green	1	2	3	3	1
Blue	1	1	2	2	2
Violet	0	0	0	1	0
Total	7	11	17	12	7

of coal tar colours of each hue available in the UK at various times. (The list for 1936 is not complete; the list of 1954 is a better guide to the colours available in 1939.) Had the USA's positive list been introduced into the UK, as Mr Kemp feared, the number of red coal tar colours would have been reduced by 89%; oranges would have been reduced by 75%; yellows by 68%; greens by 57%; blues by 85%; violets by 100%; blacks by 100%; and browns by 100%. This would have been a very drastic reduction. It is possible to make most of the colours in the spectrum from about seven dyes. However, some colours would not be stable in certain foods or processes. So in practice, more colours than seven are required if a wide range of foods is to be coloured in sophisticated shades. If the USA's list had been introduced into the UK in 1939 it

TABLE 5.14 : NUMBER OF HUES OF COAL TAR ORIGIN USED BETWEEN 1850 AND 1957 IN THE U.K.

Compiled from tables D.1 and B.1 in appendices D and B.

	Number of colours / Year						
Hue	1850	1901	1924	1928	1936	1954	1957
Red	0	10	20	16	11	35	12
Orange	0	2	3	7	5	8	3
Yellow	0	6	19	9	7	19	7
Green	0	0	4	3	1	7	1
Blue	0	1	7	3	2	13	2
Violet	0	0	2	0	0	5	1
Black	0	0	2	4	1	5	1
Brown	0	1	3	4	2	8	3
Total	0	20	60	50	29	100	30

would have provided a choice among the most common shades - the reds, oranges and yellows, but would have eliminated violet, black and brown. The latter could probably have been created by combining other colours. Manufacturers and the public would probably still have been able to have had reasonably sophisticated shades. Table 5.15 shows that the current UK list contains 16 coal tar colours. Manufacturers are able to create from just 16 coal tar colours a very wide range of subtle and garish colours. This indicates that Mr Kemp's warning about the detrimental effects of the USA's positive list of 1939 was rather exaggerated.

TABLE 5.15 : NUMBER OF HUES OF COAL TAR ORIGIN AVAILABLE TO MANUFACTURERS BETWEEN 1957 AND 1987 IN THE U.K.

Compiled from table E.1 in appendix E.

	Number of colours / Year				
Hue	1957	1966	1978	1987	1988?
Red	12	11	5	5	6
Orange	3	3	1	1	1
Yellow	7	4	3	3	2
Green	1	1	1	1	1
Blue	2	0	3	3	3
Violet	1	1	0	0	0
Black	1	2	1	1	1
Brown	3	3	2	2	2
Total	30	25	16	16	16

Note: Lithol rubine and Methyl violet have been omitted because they are restricted to cheese rind and meat marking, respectively.

When a positive list was eventually introduced into the UK in 1957 the Preservatives Sub-Committee and civil servants were very careful to ensure that a wide range of hues would be available. When making their recommendations for the list they took account of the number of each hue and they gave the industry plenty of scope for comment. The result is shown in table 5.14. The number of colours was reduced from about 100 to 30. The red colours were reduced by 66%; oranges by 63%; yellows by 63%; greens by 86%; blues by 85%; violets by 80%; blacks by 80%; and browns by 63%. These were very significant reductions. But they were far less drastic than the reductions that would have been caused by the USA's list of 1939. Given the wide consultation with industrial interests in 1954 and 1955 it is very likely that the 1957 positive list caused little reduction in the range of hues seen by the public, because the list offered the full range of hues and probably also offered colours suitable for most technical processes and conditions. As well as the coal tar colours there were a few plant and mineral colours. These tended to be browns and oranges and were used for very specific foods. The orange/yellow plant colour Annatto, for example, was mainly used in dairy products in the 1950s. The range of plant and mineral colours was not affected by the positive list of 1957.

Amendments to the positive list gradually reduced the range of hues. Table 5.15 shows the changes between 1957 and 1978. The number of coal tar colours was almost halved, from 30 to 16. The number of red dyes was reduced by 58%; oranges by 67%; yellows by 57%; violets by 100%; and browns by 33%. The number of blues was increased by 33%; while the number of greens and blacks remained unchanged. In 1978 D Hicks of Beecham Products complained about the effects of regulations on the range of colours:

> Many parts of the colour spectrum cannot now be reached with stable permitted colours ... The list of permitted colours, already short, is being reduced each year (76).

The positive list was not reduced after 1978; possibly as a result of opinions such as that above. Yet innovations since Hick's complaint in 1978 have enabled this small range of colours to be used for a great many new applications. This process is typical. In 1954, for example, the Preservatives Sub-Committee recommended banning 'oil yellow' coal tar colours from margarine. The only substitute that was technically viable was carotene. It was reported that Annatto was not suitable for colouring margarine. Significant technical changes have been made since then. Annatto is now the main colour for margarine. Chapter 4 gives details of the large number of patents in recent years for new applications for colours.

In response to very recent suggestions that some coal tar colours should be banned because they cause intolerant reactions in a minority of people, manufacturers have said that the shades consumers see in processed foods could become quite crude compared to the ones we are accustomed to. They hold up as examples the unsophisticated shades found in the USA where only seven coal tar dyes are now permitted (see table 5.13). Undoubtedly, a ban on further coal tar colours in the UK would affect adversely the sophisticated and subtle shades that some consumers currently enjoy (77). However, it is possible they may be prepared to forgo this pleasure in order to remove the hazards presented to health (see chapter 6). Section 5.32 shows that the 'demand' for colour can change.

UK manufacturers currently have a choice of about 50 individual colours, many of which can be used in a wide range of foods. The recent EEC proposal, if adopted, will increase the range of coal tar colours available to manufacturers in the rest of Europe and will shorten the UK list very slightly. However, for some years (and at present) most European manufacturers have had fewer hues available to them, because the EEC and national governments have approved fewer substances. Table 5.16 shows the legal status of coal tar colours in European countries. The EEC has approved only 11 coal tar colours while the UK has approved 16. In the United States only 7 have been approved.

The fact that both industry and consumers in an industrialised country can cope without any of the bright 'artificial' colours at all is demonstrated by the situation in Norway. In 1978 the government in Norway prohibited the use of all the coal tar colours because they were concerned at the intolerant reactions experienced by an estimated 0.03% - 0.15% of the population. Table 5.17 shows the number of hues of all types (ie. including plant and mineral colours) permitted in Norway compared to the UK. Sweden banned the azo dyes (a group of coal tar

TABLE 5.16 : INTERNATIONAL STATUS OF COAL TAR COLOURS APPROVED BY THE U.K., 1986

Source: M Miller in M Miller and E Millstone Report on Colour Additives Food Additives Campaign Team, London 1987, p14.

KEY: * INDICATES COLOUR PROHIBITED IN FOOD (colours used for surface colouring only are omitted)

COLOUR	U.K.	AUSTRIA	BELGIUM	DENMARK	EIRE	FRANCE	GREECE	ITALY	NETHERLANDS	NORWAY	SPAIN	SWEDEN	SWITZERLAND	WEST GERMANY	U.S.A.	JAPAN	CANADA	FINLAND
E102 TARTRAZINE		*								*								*
E104 QUINOLINE YELLOW										*					*	*	*	
_ 107 YELLOW 2G		*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*
E110 SUNSET YELLOW										*								*
E122 CARMOISINE		※								*		*			*	*	*	*
E123 AMARANTH		※								*					*			*
E124 PONCEAU 4R										*					*		*	
E127 ERYTHROSINE										*								
- 128 RED 2G		*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*
E131 PATENT BLUE V										*					*	*	*	
E132 INDIGO CARMINE										*								
- 133 BRILLIANT BLUE		*	*			*	*	*		*	*	*	*	*				
E142 GREEN S										*		*			*	*	*	*
E151 BLACK PN										*					*	*	*	*
- 154 BROWN FK		*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*
- 155 BROWN HT		*	*	*		*	*	*		*	*	*	*	*	*	*	*	*
- 129 ALLURA RED	*	*	*	*	*	*	*	*	*	*	*	*	?	*		*		*
No additional artificial colours:	0	0	0	0	0	0			0	0		1		0	1	4	2	
Total No. artificial colours (except surface colours)	16	8	11	12	16	11			13	0		10		11	7	11	9	

colours) and restricted other coal tar colours to very few foods in 1980. Again, this was because of the government's concern about allergic reactions. This demonstrates that the public can adjust to a smaller range of hues and to processed foods that are not brightly coloured.

TABLE 5.17 : NUMBER OF HUES PERMITTED IN THE U.K. AND NORWAY IN 1986

Source: Food legislation of Norway and UK

Hue	UK	Norway
Red	12	4
Orange/yellow	21	8
Green	3	2
Brown	4	1
Black/purple	3	1
Blue	4	0
White	2	2
Metallic	3	0
Total	52	18

Note:
The anthocyanins, iron oxides and paprika oleoresins have each been counted as one hue (for both countries).
The two types of carotenes have been counted as two colours.
Spices and odd pure colouring principles have been omitted.

COLOURS AND QUALITY

5.27 Misleading the Consumer

At the 1895 Select Committee on Adulteration trade views varied, as to whether the colouring of food misled the consumer. For example, C Stewart, a butter shipper, argued that it could amount to fraud:

> The colour of butter given to margaine should be prohibited. Let margarine keep its natural colour, which is very different from that of butter. Why has it ever been coloured yellow, if not with a view to pass it as butter and facilitate the fraud. We do not ask for the suppression of margarine, but we ask for it to be sold as such, and that no facility is afforded to fraud (78).

Hassall pointed out many of the ways in which colour was used to mislead about quality (see chapter 3, and the foods containing colour in the 1850s in table H.1 in appendix H). Colours were still used in a very similar range of foods in 1901, and in a much wider range of foods in 1983 (see table H.2 in appendix H). Jam, for example, was reported by Hassall in 1861, to have red colourants added 'especially where the fruit is damaged or of inferior quality' (79). The fraud was not stopped. In 1938 Martindale said

> The need for improvement in the conditons of manufacture and the quality of jam has been felt for some time (80).

Voluntary standards were established for jam in 1930. These allowed the use of colours. But the standards were not adhered to. Regulations were introduced for a 'superior' grade of jam in 1934. It had to contain select fresh fruit and was not allowed to contain any colourant. The regulations were removed in the 1950s. The quality of jam was poor in the late 1950s and 1960s. Much imported, sulphited fruit pulp was used. The sulphite bleached the pulp. Colours were added to combat the bleaching effect and to allow lower levels of fruit to be used. In Austria and Sweden colours have long been prohibited from single-fruit jam because it has been recognised that colours allow inferior fruit or other bulking aids to be used.

In 1934 a public analyst bemoaned what he termed the 'food faking complex' and 'an orgy of either dyeing or bleaching'. In a passage reminiscent of Hassall he noted the colours in a typical meal:

> Our bread, for instance, is bleached, but the butter on it is dyed. White sugar is bleached or dyed blue to appear bleached. Coffee beans are dyed and command a higher price thereby. Kippers are partially smoked but completely dyed. Haddock fillets are practically painted. The jam with which we round off the highly chromatic breakfast is made of well-bleached sugar, glucose, and pulp, and is finally dyed (81).

In 1941 D Bagnall, a public analyst, also expressed concern at the use of colours to imitate articles of superior quality. He gave examples of brown colour being used in place of cocoa in 'chocolate' cake and biscuits, and of yellow in place of egg (82). An article in Food Manufacture in 1935 recommended Tartrazine & Orange II for a 'rich egg shade' in cakes and biscuits (83). A bakers' manual in 1911 mentioned the wide range of 'egg-yellow colourings' available as egg substitute (84). The practice of substituting colouring for egg continues today.

The London Food Commission has recently argued that the public suffers a number of disadvantages as a result of such practices (85). Their arguments can be summarised as follows: colour additives are mainly used to replace colour lost during processing or to create the impression that particular ingredients (such as strawberries or tomatoes) have been used when they are present only in small quantities or are not present at all. The latter use cannot be regarded as misleading when consumers are fully informed and aware of the true nature of the contents, but in some instances it is clear that they are misled. In the last century there were no requirements for manufacturers to declare added colour. Today, even with relatively sophisticated labelling requirements, many people do not know the difference between 'strwawberry flavour' and 'strawberry flavoured' desserts or between 'orange flavour' and 'orange flavoured' products. The 'flavoured' products contain some of the named food. The 'flavour' products contain only colour and flavour mimicking a food ingredient. Colourants help maintain the illusion that a particular food has been used. Without the added colour the difference in quality between the two products would be very obvious.

Some types of food have threatened health. The appearance of fresh meat, for example, was often 'improved' in the nineteenth century. Later, Dr E F Erhardt reported to a meeting of the Society of the Chemical Industry in 1926 that

> A solution of red colouring matter was pumped into imported meat to give it a fresh 'bloody' appearance (86).

This practice was not merely a matter of fraud (passing old meat off as fresh) but may have had consequences for health because of the risk of food poisoning. The addition of colours to fresh meat was banned by regulations in 1957. But colouring of cooked and processed meats was allowed to continue. Many sausages and other cheap meat products have contained added colours since the 1800s.

Red colours give the impression that the products contain a greater proportion of lean meat, or is fresher than it actually is. In France no colours are allowed in meat products. In Germany colours are permitted in some sausage skins only.

Dr Drake-Law commented in 1926 on the original purpose of colouring food:

> Colours were first introduced in the foodstuffs industry as a substitute for more expensive materials such as eggs, butter, chocolate, and fruit, or to improve the appearance of some product, the original colour of which had deteriorated during manufacture (87).

He claimed colours were no longer used for fraudulent purposes in the 1920s:

> They are now largely used, however, to give an atttractive appearance to finished goods without reference to their natural ingredients. Some firms go so far as to make up their products to match the decorative scheme of their showrooms or window display (88).

The 1924 Departmental Committee took a different view of the purpose of colouring:

> It is evident that colour is frequently used to cover up objectionable or inferior materials, or to give a factitious

> appearance, so that the articles so coloured masquerade for something which they are not (89).

But they acknowledged the public acceptability of colouring. In 1954 the Preservatives Sub-Committee also questioned the function of added colour. They recorded the disadvantages:

> We realised that colour could be used to mask the use of inferior ingredients or to give a false impression of quality (90).

But they felt there were benefits as well. They outlined the circumstances in which they regarded colouring to be acceptable:

> We see no objection to their use to replace natural colour lost during processing, to standardise appearance or simply to render a product more attractive (91).

They acknowledged there was no sharp dividing line between the use of colour in the acceptable ways outlined above and their use to mask inferior ingredients or to give a false impression of quality. But they concluded that the colouring of food had become so widely accepted that it was unlikely that purchasers were misled (92). They did not support the idea of banning all colours or prohibiting them from certain foods because they felt the Food and Drugs Act already offered sufficient protection against the fraudulent use of colour. But clearly the Acts had failed in this respect for many years.

By the 1970s the position had changed little. In 1976 the EEC's Economic and Social Committee reported that while some member states wanted 'as many colouring matters as possible to be authorised', other member states were:

> Opposed in principle to the use of colouring matters which are unnecessary and have no technological justification, other than giving products a more pleasing appearance. In the view of these members the use of colouring matters to this end amounts to deceit....These members hold the view that colouring matters are not 'useful additives', within the meaning of the definition used by WHO and the FAO (93).

Accordingly, some other European countries have tended to restrict the use of colours much more than the UK. (More examples of this are given in chapter 7.)

5.28 Effect of Food Standards

Regulations have prescribed the composition of certain foods, such as bread and milk, and have restricted the use of colours to particular foods. These regulations have had an effect on choice.

5.29 a) Restricted uses

The 1957 regulations restricted the use of alminium and silver to the surface of dragees and sugar-coated flour confectionery (94). Regulations in 1973 restricted the use of a red coal tar colour, Lithol rubine, to cheese rind. The restriction on choice was probably outweighed by safety benefits. Concern for safety was the reason for the restriction.

5.30 b) Protected foods

Certain foods have had all colourings prohibited from them. The 1957 colour regulations did not only introduce a positive list. They also prohibited all added colour from the following raw and unprocessed foods:

Meat
Game
Poultry
Fish
Fruit
Vegetables.

In addition, the 1966 colour regulations prohibited colours from the following processed foods:

Tea
Coffee beans
Ground coffee
Coffee essence
White bread
Soda bread
Cream

Condensed milk
Dried milk.

Little information is available on the impact of these regulations. No information is available about the extent to which any of these foods was coloured immediately before regulations were made. In earlier periods there were reports that some raw unprocessed foods had colours added to them. It has already been mentioned that in 1926 it was reported that red colours were added to imported meat (95). In the case of meat such additions tended to mask deterioaration and were highly undesirable, if not dangerous, because of the increased risk of food poisoning. The Preservative Sub-Committee of 1954 reported that, to the best of their knowledge, colours were not added to raw, unprocessed foods (96). However, I think it is likely that red colours were still sometimes added to meat by butchers. Butchers have persistently attempted to keep raw meat looking red. In the 1960s, for example, an additive that prevented oxidation of the blood (and a change from red to brown) was widely used by butchers. (It was classed as a processing aid rather than a colourant, and was banned eventually.) Currently, special gases are used for packaging meat in supermarkets to achieve the same effect. And butchers are still occasionally prosecuted for adding sulphite preservatives to mince. The sulphite not only extends the shelf-life but keeps the mince looking red and fresh. These practices suggest strong pressures and desires to keep meat red. It is possible, therefore, that the 1957 prohibition had a restrictive effect on what was available to consumers. Whatever the direct effect, the regulations cetainly restricted consumer choice in the sense that coloured raw and unprocessed foods could no longer be sold legally. But despite the restriction on choice this was a sensible precaution in view of the risk of food poisoning. It also reduced fraud by preventing the public having old meat passed off as fresh.

Of the processed foods listed above, tea, coffee and white bread were commonly coloured in the mid and late 1800s (97). In 1901, the proportion of coloured samples was reported to be 3.4% for cream and 0% for condensed milk (see table 5.12). Again, it is not known whether the 1966 regulations actively banned colours from any of the processed foods. But, as with the fresh foods, the action certainly restricted the option for colouring and therefore restricted consumer choice. But the restriction offered some benefits. For example, colours were often used in the nineteenth century to mask inferior or recycled tea, not just to add 'appeal'.

5.31 c) **Compositional standards**

The composition of certain foods such as milk, jam and bread has been prescribed by regulations. The regulations have required that a minimum percentage of the characterising ingredients must be present in the food in order for it to be called by a certain name. The Standard for jam, for example, requires any product sold under that name to contain more than a specified amount of sugar and fruit. Some Standards have also controlled the use of colour. In the case of bread and beer, no colour except caramel may be used. For butter, cheese and margarine, coal tar colours may not be used. Occasionally, colour has been banned altogether. Colours were banned from 'fresh fruit' jam, for example, from 1944 to 1953. And colours were banned from milk in 1922.

Yellow colours were commonly added to milk in London around 1900 to mask the fact that it had been diluted or had the cream removed 98). Most of the foods for which standards were prescribed were prone to adulteration. Although the bans and restrictions reduced choice, they probably removed from the market the items that were of the poorest quality or that were very poor value for money.

Compositional standards, in fact, have helped to protect the quality of products. The standards have always been set at rather a low level, but without them there would certanly have been a greater downward spiral in quality. There are no direct measures of the effects of colour regulations on quality, but one interesting experiment occurred recently. MAFF removed many of the Standards that required meat products to contain minimum proportions of meat. They adopted a new policy of 'informative labelling' instead. This policy is a form of deregulation, throwing all the onus for monitoring food and protecting themselves back onto the public. As a result of the change in policy, the meat content of most products fell significantly for every deregulated product, as table 5.18 shows. The average drop in meat content was 33%.

TABLE 5.18 : EFFECT OF REMOVING LEGAL STANDARDS FROM MEAT PRODUCTS

Source: Survey conducted by the Trading Standards Department, County Council, Shropshire, 1986.

Product	Minimum meat content under old Standards	New declared meat content after Standards removed
Turkey breasts in jelly	80 %	70 %
Meat rounds (beef burger)	80 %	52 %
Braised kidneys in gravy	75 %	70 %
Roast chicken and gravy	75 %	45 %
Turkey and ham loaf	65 %	60 %
Mince beef with onions and gravy	50 %	47 %
Minced beef and onion	50 %	36 %
Minced beef with onions and gravy	50 %	25 %
Minced steak & kidneys with onion and gravy	50 %	25 %
Economy minced beef with onions and gravy pie filling	35 %	33 %
Chicken casserole	35 %	11 %
Beef casserole	35 %	15.5 %
Beef curry	35 %	15 %
Meat balls in gravy	35 %	22 %
Curried beef	35 %	25 %
Chicken casserole	35 %	20 %
Savoury mince	35 %	20 %
Irish stew: Brand A	35 %	25 %
Brand B	35 %	15 %
Brand C	35 %	23 %
Brand D	35 %	19 %
Economy irish stew	35 %	15 %

5.32 CHANGES IN THE DEMAND FOR COLOURS

By the 1960s the idea of removing colourants from food was regarded as certain commerical suicide. When one large retailer removed added colours from canned peas, canned strawberries and jam, many consumers were very critical of the khaki-coloured peas, the straw coloured strawberries and the dull red-brown jam. Sales of the products fell by about 40%. The retailer restored the colour additives (at a lower level) and it took about two years to regain the original level of sales (99).

In past years a number of retailers and manufacturers have made similar trials, with similar results. And their experiences have made a considerable impression on manufacturers and the extent to which they have argued that added colours were essential. As recently as 1985 Safeway Stores (a major retail chain), in a leaflet on additives, mentioned the problem of uncoloured khaki peas and brown strawberries, and said:

> Previous trials have demonstrated that food in this state is simply not acceptable to the majority of the public and repeat sales have been minimal (100).

Most of the trials removing colours in the 1960s and 1970s were not well designed because little attempt was made to inform customers why their peas and jam were suddenly not the colours they were used to, and people understandably assumed there was something wrong. It is to be expected that an unfamiiliar colour in a processed food arouses distrust in consumers - precisely because people do use colour as an indicator of quality, and consumers have been encouraged to expect a standardised appearance from batch to batch.

Consumers' views on added colours have altered radically at various periods. A consumer attitude survey in 1971 found the majority of consumers felt that the addition of colours to processed food was acceptable (101). In contrast, a survey conducted by a large retailer in 1986 found that 80% of women shoppers felt many additives were harmful and should be banned. Views had changed because of concern about nutrition, diet-related diseases and the safety of additives, and a desire to eat fewer refined foods and more fresh foods. While recognising that some additives were essential, the vast majority in 1986 felt there would be no need for many additives if manufacturers took more care in making food (102). As a result of changed attitudes a positive market advantage developed for foods that were free from added colour. Retailers and manufacturers found positive commercial benefits to be gained from either:

i) removing colourings altogether (sometimes in gradual stages over a period of months, or

ii) reducing the levels of colourings added to food, or

iii) replacing coal tar colours with less controversial alternatives.

In the past two years major retailers have removed dyes from many of their own label products, in response to consumer demand. In 1986 alone Sainsburys removed colourants from 95 products. Safeway intend to remove 20 colour additives (mainly coal tar colours) from all of their products. They have found consumers accept less coloured processed foods more readily, positively welcoming them in many instances. This shows a revolution in consumer attitudes to food colours since the 1960s and earlier.

The considerable reduction in consumer demand for colours demonstrates that 'preference' for highly coloured food is more a product of attitude and culture than an inherent preference.

When in the 1860s the Cooperative Society found that many people preferred the colour of adulterated foods to pure ones, the Society refused to sell adulterated food in response to this 'demand', despite serious pressure. They pointed out that people could develop a preference for unadulterated foods. Some members' preferences had changed:

> They had learned the nature of good flour when they had it; their tastes were better educated than that of many gentlemen of the middle class (103).

The Co-op chose to employ people to educate the public about the benefits of unadulterated food (104). It has already been mentioned that in London around 1900 the use of yellow colourings to disguise skimmed and watered milk was so common that people often refused to buy unskimmed, unadulterated milk because they thought it looked unnatural

(105). Later, in 1922, the addition of colour to milk was banned. Presumeably the public soon became used to the altered colour. Now, yellowed milk would be treated with suspicion.

There are also different attitudes to the colouring of food in different countries. In countries such as Sweden where colours have been more strictly controlled there is a lower preference for coloured food than in the UK (106). The implications of this for assessing the 'need' for colours are discussed below.

5.33 ASSESSING THE NEED FOR COLOURS

The Food and Drugs Act of 1955 introduced for the first time a clear requirement for Ministers to minimise the use of non-nutritional substances, such as colours, in food. It stated that:

> Ministers shall have regard to the desirability of restricting, so far as practicable, the use of substances of no nutritional value as foods or as ingredients of foods (107).

As a result of this clause a formal assessment of the 'need' for colours was introduced into the decision-making process. The terms of reference of the advisory committees therefore included a requirement to assess the need for colours when they were evaluated for safety (108).

Dr Nathan Goldenberg, a long-serving member of one of the advisory committees said in 1977:

> On a strictly purist basis, the answer to the question - 'Do we need colouring matter to be added to foods?' - is 'No, we do not'. They are indeed not needed in the same technological sense as preservatives or antioxidants. The vast majority of our foods would still have the same quality and the same flavour without added colours as they do now with them (109).

However, he went on to say that colours were needed in practice because of consumer demand.

When the Food Advisory Committee (FAC) recently re-assessed the need for colours they gave approval to over fifty individual colours, only two of which have nutritional value (namely riboflavin and carotene, which are vitamins). The addition of colour to certain foods can be seen to be aesthetically desirable or even necessary. A number of foods like fizzy drinks, dessert mixes, sweets, and similar foods would be almost totally unpalatable without added colour, because they often have no colour of their own. Fizzy drinks without colour would be merely sugared water, for example.

However, for certain other products the lack of a genuine technical need for colourants has been demonstrated by recent actions of major retailers and manufacturers. They have successfully eliminated colourants from foods such as sausages, fruit juice, squash, crisps, chips, fish fingers, kippers, yoghurt, bread, tinned vegetables and tinned fruit. It is difficult to justify the advisory committee's view that added colours are still technically essential to these products. The following examples highlight this fact.

A survey conducted in 1987 by The Food Additive Campaign Team (FACT, a campaign group) produced information on some of the foods that can technically be made without added colour. They reported that almost all brands of 'pure' fruit juice, for example, now contained no added colour; three years ago most had been coloured. Some tinned snack meals were free from added colour, while very similar ones were not (110). Their survey illustrated that, for such foods, added colours are not technically necessary. The fact that alternatives have already become very successful in the market and have become the predominant product in a few cases, indicates that added colours may not even be commercially necessary in certain foods any more. 'Pure' fruit juice provides an example of this.

Some local authorities (for example, Birmingham, Gloucester, Cleveland) have removed selected colours from meals served in schools and social service meals. The New York school meals organisers have managed to eliminate all coal tar colours from the meals served in over 800 schools. At the same time they improved the nutritional quality of the meals.

The Food Advisory Committee recommended in 1987 that a few colours should be restricted. They recommended that Erythrosine should be restricted to cocktail and glace cherries. Erythrosine is acknowledged to have caused thyroid tumours in rodents fed high doses. FACT's survey revealed that alternative colours were already used in some brands of cocktail cherries, glace cherries, and cherry tarts. One brand of canned cherries contained no added colour (111). So Erythrosine cannot be justified as technically necessary to these products.

The advisory committee gave full clearance to Brown FK in 1987 despite repeated studies indicating mutagenicity, but not carcinogenicity, in laboratory tests. The committee recommended restricting Brown FK to smoked and cured fish only. But smoked fish is already available in some supermarkets without Brown FK. Some manufacturers use alternative colours; some add no colours at all. This demonstrates that the advisory committee's assessments of need have not been rigorous. They have failed to implement the Food Act's principle about the desirability of keeping non-nutritional substances to a minimum. In this respect the approach of the advisory committees has remained consistent since the positive list was first drawn up. Fred Steward has pointed out that at that time

> Its weakness was that the definition of the need for colours which had not been adequately tested rested primarily on an interpretation of 'reasonable trade requirements' worked out in a relatively close dialogue between the committee and the industry (112).

5.34 International comparison of need

The Departmental Committee in 1924 collected information about the permitted lists of other countries. The UK was one of the few industrialised countries that did not have such regulations. This remained the case until 1957. Table 5.19 compares the colours allowed in the UK in 1936 with those permitted in several other countries. It is surprising that the UK 'needed' so many colours compared to other countries like the USA and Canada. When a permitted list was finally introduced it was much longer than that of most other countries.

Table 5.16 showed the legal status of coal tar colours in various countries in 1986. The EEC has approved only 12 colours while the UK has approved 17. In the USA only 7 coal tar colours have been approved.

TABLE 5.19: INTERNATIONAL COMPARISON OF PERMITTED COAL TAR COLOURS, 1936

Source: Harold Silman 'Food colours' Food Manufacture June 1936, p204.

Colour.	Dyestuff.	C.I. No.	Canada.	New Zealand.	Australia.	U.S.A.	France.	Denmark.
Red ...	Amaranth AS	184	*	*	*	*	*	—
	Bordeaux B	88	—	—	—	—	*	*
	Brilliant Scarlet 4R	185	—	*	—	—	*	—
	Geranine 2GS Red 2G	31	—	—	*	—	—	—
	Erythrosine AS	773	*	*	*	*	*	*
	Rhodamine B	749	—	—	*	—	—	—
	Carmoisine WS	185	—	—	*	—	*	—
	Ponceau 2R	79	—	—	*	—	*	*
	Ponceau 3R	80	*	*	*[1]	—	*	*
	Sudan I	24	*	—	—	—	—	—
Yellow ...	Orange I	150	*	*	*	*	*	*
	Sunset Yellow FCS	—	—	—	—	*	—	—
	Naphthol Yellow FYS	10	*	*	*	*	*	—
	Tartrazine AS	640	*	*	*	*	—	—
	Oil Yellow AB	22	*	*	*[1]	*	—	—
	Oil Yellow OB	61	*	*	*[1]	*	—	—
Green ...	Light Green SF	670	*	*	*[1]	*	*	—
	Guinea Green B	606	—	—	*	—	—	—
	Fast Green FCF	—	—	—	*[1]	*	—	—
Blue ...	Indigo Carmine XS	1180	*	*	*	*	*	*
	Patent Blue	712	—	—	—	—	*	—
	Brilliant Blue FCF	—	*	—	*	—	—	—
	Soluble Blue	707	—	—	*	—	*	*
	Blue AS Patent blu A	714	—	*	—	—	*	—

[1] Except Queensland and South Australia.

It is difficult to argue that the UK has a genuine technical need for 17 coal tar colours when American manufacturers (also locked into highly refined products) manage with only 7. Consumers in industrialised societies can obviously cope without the very sophisticated colour combinations now used in the UK. Current data on plant colours has not been compiled. But the situation for plant colours in 1974 was similar, though less marked, as table 5.20 demonstrates. The UK and Eire permitted a longer list of plant colours than any other country. The situation for mineral colours in 1974 was not the same: the UK had a list of only average length compared to other countries, as table 5.21 shows.

In its 1987 report the FAC failed, like past committees, to take adequate account of the greater protection given to consumers by other governments. UK manufacturers still have a choice of more than 50 individual colours, most of which can be used in a very wide range of foods. However, for many years most European manufacturers have had fewer colours available to them, because the EEC and national governments have approved fewer substances. In Norway the total number of permitted colours is now 19; in Sweden it is 31; in Austria it is 32; while in the UK it is over 50. The UK and Eire have the longest list of permitted colours in Europe.

The fact that both industry and consumers could cope without any of the bright coal tar colours is demonstrated by the situation in Norway. In 1978 the Norwegian government prohibited the use of all artificial colours and people there have adjusted to processed foods that are not brightly coloured.

Another significant difference between controls in the UK and abroad is the fact that permitted colours are restricted to far fewer foods in many other countries. Amaranth, for example, is allowed in a wide range of foods in the UK. It has long been one of the most common colours. A survey in 1985 found it in many foods including jam, breadcrumbs, blackcherry yoghurt, pickled beetroot, chocolate cake, swiss roll, tarts, instant pot rice, instant soups, raspberry flavour mousse, jellies, quick-setting jellies, tinned fruit fillings, ice-cream, ice-pops, tomato ketchup, strawberry flavour syrups, soft drinks and squashes (113). In contrast, in France and Italy it is restricted to

TABLE 5.20: INTERNATIONAL COMPARISON OF PERMITTED PLANT AND ANIMAL COLOURS, 1974

Compiled primarily from T E Furia Food Additves Tables CRC, Cleveland 1975 Appendix 1, amended where appropriate.

KEY:
/ Permitted
X Not permitted

		COUNTRY									
COLOUR		U.K.	Austria	Belgium	Canada	Denmark	Eire	Finland	France	Italy	Luxembourg
Alkannet		/	X	X	/	/	/	/	X	X	X
Annatto	E160b	/	/	/	/	/	/	/	/	/	/
Anthocyanin	E163	/	/	/	/	/	/	X	/	/	/
β-apo-carotene	E160c	/	/	/	/	/	/	/	/	/	/
β-apo-carotenic acid	E160f	/	/	/	/	/	/	/	/	/	/
Betanin	E162	/	/	/	/	/	/	X	/	/	/
Brazil wood		X	X	X	X	X	X	X	X	X	X
Canthaxanthin	E161g	/	/	/	/	/	/	/	/	/	/
Capsanthin	E160c	/	/	/	X	/	/	/	/	/	/
Caramel	E150	/	/	/	/	/1	/	/	/	/	/
Carbon black	E153	/	X	/	/	/	/	/	/	/	/
Carotenes	E160a	/	/	/	/	/	/	/	/	/	/
Chlorophyll	E140	/	/	/	/	/	/	/	/	/	/
Cochineal	E120	/	/	/	/	X	/	/	/	/	/
Copper chlorophyllin	E141	/	/	/	X	/	/	/	/	/	/
Cryptoxanthin	E161c	/	/	/	/	/	/	/	/	/	/
Curcumins	E100	/	/	/	/	/	/	/	/	/	/

COLOUR		COUNTRY Netherlands	Norway	Portugal	Spain	Sweden	Switzerland	W. Germany	U.S.A.	Japan
Alkannet		/	X	/	X	/	/	X	?	/
Annatto	E160b	/	/	/	/	/	/	/	/	/
Anthocyanin	E163	/	/	/	X	X	/	/	/	/
β-apo-carotene	E160c	/	/	/	/	/	/	/	/	X
β-apo-carotenic acid	E160f	/	/	/	/	/	/	/	X	X
Betanin	E162	/	X	/	X	X	X	/	X	/
Brazil wood		X	X	/	X	X	X	X	X	X
Canthaxanthin	E161g	/	/	/	/	X	/	/	/	/
Capsanthin	E160c	/	/	/	X	X	X	/	X	/
Caramel	E150	/	/	/	/	/	/	/	/	/
Carbon black	E153	/	X	/	X	/	/	/	X	/
Carotenes	E160a	/	/	/	/	/	/	/	/	/
Chlorophyll	E140	/	/	/	/	/	/	/	?	/
Cochineal	E120	/	X	/	X	/	/	/	/	/
Copper chlorophyllin	E141	/	X	/	X	/	/	/	X	/
Cryptoxanthin	E161c	/	X	/	X	/	X	/	X	/
Curcumins	E100	/	/	/	X	/	/	/	/	/

1 Denmark distinguished between E150a and E150b (ammonia caramel) - but <u>FA</u> does not say whether one is restricted.

COLOUR		U.K.	Austria	Belgium	Canada	Denmark	Eire	Finland	France	Italy	Luxembourg
Flavoxanthin	E161a	/	/	/	/	/	/	/	/	/	/
Fustic		X	X	X	X	X	X	X	X	X	X
Indigo		/	X	X	X	X	/	X	X	X	X
Logwood		X	X	X	X	X	X	X	X	X	X
Lutein	E161b	/	/	/	/	/	/	/	/	/	/
Lycopene	E160d	/	/	/	X	/	/	/	/	/	/
Orchil	E121	/	/	/	/	/	/	X	/	/	/
Osage orange		X	X	X	X	X	X	X	X	X	X 2
Paprika		/	X	X	/	X	/	X	X	X	X
Paprika oleoresin		X?	X	X	X	X	X	X	X	X	X
Persian berry		/	X	X	X	X	/	X	X	X	X
Quercitron		X	X	X	X	X	X	X	X	X	X
Rhodoxanthin	E161f	/	/	/	/	/	/	/	/	/	/
Riboflavin	E101	/	/	/	/	/	/	/	/	/	/
Rubixanthin	E161d	/	/	/	/	/	/	/	/	/	/
Saffron (crocin)		/	/	X	/	X	/	X	X	X	X
Sandlewood		/	X	X	/	X	/	/3	X	X	X
Violoxanthin	E161c	/	/	/	/	/	/	/	/	/	/
Extract of edible fruit or vegetable		/	X	/	X	/	/	/	/	/	/

(Column heading above the country columns: COUNTRY)

2 Permitted only for colouring eggshells and in some cases for stamping meat rind or cheese rind.
3 Not the chemically modified form

COLOUR		Netherlands	Norway	Portugal	Spain	Sweden	Switzerland	W. Germany	U.S.A.	Japan
		COUNTRY								
Flavoxanthin	E161a	/	X	/	X	/	/	/	X	/
Fustic		X	X	/	X	X	X	X	X	X
Indigo		X	X	X	X	X	X	X	X	X
Logwood		X	X	/	X	X	X	X	X	/
Lutein	E161b	/	/	/	X	X	X	/	X	/
Lycopene	E160d	/	/	/	X	/	X	/	X	/
Orchil	E121	/	X	/	X	X	/	/	X	X
Osage orange		X	X	X	X	X	/	X	X	X
Paprika		X	X	X	/	X	/	X	/	/
Paprika oleoresin		X	X	X	X	X	X	X	/	/
Persian berry		X	X	/	X	X	/	X	X	X
Quercitron		X	X	/	X	X	X	X	X	X
Rhodoxanthin	E161f	/	/	/	X	X	X	/	X	/
Riboflavin	E101	/	X	X	/	/	/	/	/	/
Rubixanthin	E161d	/	/	/	X	X	X	/	X	/
Saffron (crocin)		X	/	X	X	X	/	X	/	X
Sandlewood		X	X	/	X	X	/	X	X	X
Violoxanthin	E161c	/	/	/	X	X	X	/	X	/
Extract of edible fruit or vegetable		/	X	X	X	X	/	/	X	/

TABLE 5.21: INTERNATIONAL COMPARISON OF PERMITTED MINERAL AND METALLIC COLOURS, 1974

Compiled primarily from T E Furia Food Additives Tables CRC, Cleveland 1975; amended as appropriate.

KEY:

/ Permitted

X Not permitted

COLOUR		U.K.	Austria	Belgium	Canada	Denmark	Eire	Finland	France	Italy	Luxembourg
Aluminium	E173	/	/	/	/	/	/	X	/	/	/
Burnt umber	E181	/	/	/	X	/	/	X	/	/	/
Ca carbonate	E170	?	/	/	X	/	/	X	/	/	/
Ca sulphate		X	/	X	X	X	X	X	X	X	X 1
Carbon black		/	X	X	/	X	/	X	X	X	X
Copper		X	X	X	X	X	X	X	X	X	X
Ferrous gulconate		X	X	X	X	X	X	X	X	X	X
Gold	E175	/2	/	/	X	/	/2	X	/	/	/
Iron oxides	E172	/	/	/	/	/	/	X	/	/	/
Sienna earth		X	X	X	X	X	X	X	X	X	X
Silver	E174	/	/	/	/	/	/	X	/	/	/
Terre verte		X	X	X	X	X	X	X	X	X	X 1
Tin		X	X	X	X	X	X	X	X	X	X
Titanium dioxide	E171	/	/	/	/	/	/	/	/	/	/
Ultramarine		/	X	X	X	X	/	X	X	X	X
Any mineral colouring		X	/	/	X	/	X	X	/	/	/

1 For colouring eggshells and stamping the rind of meat.

2 For surface colouring only eg. dragees.

COLOUR		Netherlands	Norway	Portugal	Spain	Sweden	Switzerland	W. Germany	U.S.A.	Japan
					COUNTRY					
Aluminium	E173	/	/	X	X	/	/	/	X	X
Burnt umber	E181	/	X	/2	X	X	/	/	X	X
Ca carbonate	E170	/	X	/2	X	X	/	/	X	/
Ca sulphate		X	X	X	X	X	/	X	X	X
Carbon black		X	X	X	X	X	/	X	/	/
Copper		X	/3	X	X	X	X	X	X	X
Ferrous gulconate		X	X	X	X	X	X	X	X	X
Gold	E175	/	/3	/2	/	/2	/	/	X	/
Iron oxides	E172	/	X	X	X	X	/	/	X	/
Sienna earth		X	X	X	X	X	/	X	X	X
Silver	E174	/	/	/2	X	/	/	/	X	/
Terre verte		X	X	X	X	X	/	X	X	X
Tin		X	/3	X	X	X	X	X	X	X
Titanium dioxide	E171	/	/	X	X	/	/	/	/	X
Ultramarine		X	X	X	X	X	/	X	X	X
Any mineral colouring		/	X	X	X	X	X	/	X	X

2 For surface colouring only eg. dragees.
3 For decorating pastry, confectionery, chocolate cakes and marzipan only.

caviar and a few other foods. It is also severely restricted in Austria and Sweden, because of concern about controversial adverse results in animal tests.

Tartrazine is another very common colour in the UK. Here, the 1985 survey found it in many foods including breadcrumbs, tinned pras, broad beans, green beans, fish fingers, fish cakes, fish crumbles, smoked fish, breaded fish, treated scallops, cakes, tarts, swiss roll, biscuits, sweets, cake mixes, cake decorations, mixed peel, marzipan, ice-cream, wafers and cones, custard powder, custard type fillings, non-dairy cream, coffee whitener, packet soups, instant soups, packet savoury rice, pot casseroles, packet pudding mixes, mousses, tinned fruit pie fillings, jellies, gravy granules, instant sauces, cheese sauce mixes, fruity sauces, strawberry and banana milk shake syrups, tandoori paste, mint sauce, pickles, piccalilli, salad cream, crisps, cocktail cherries, instant hot chocolate drink, soft drinks and fruit squashes. In contrast, Tartrazine is allowed only in cocktail cherries, spirits, vermouth and spiced fortified wines in Sweden. Since 1900 and earlier, other countries have restricted colours to fewer foods than the UK.

In the UK caramel colour is still permitted in bread, and many colours are permitted in most processed foods such as meat products and fruit products. In contrast, France does not permit any colours to be added to meat products or most canned fruit and vegetables. Austria and Sweden do not permit added colours in meat products, bread, fruit juice and single-fruit jam. The quality and nutritive value of many foods in the UK has suffered because the use of cosmetic additives has allowed inferior, inappropriate or imitation ingredients to be used. The situation abroad indicates that, technically, it is quite possible to produce and sell foods with far less use of added colour.

International comparisons and surveys of coloured and uncoloured food in the UK demonstrate some of the foods in which added colours are not strictly needed. In some countries the following foods are not allowed to contain any colourants:

Bread
Meat products

Fish products

Breakfast cereals and flakes

Jams, marmalades

Other processed fruit

Fruit juices and high-juice fruit drinks

Some dessert mixes

Tomato ketchup

Canned vegetables

Most canned fruit

Frozen vegetables

Added colour could be prohibited from these foods in the UK. But some products might cost more as a result, at least initially.

5.35 Increasing Range of Alternatives

Banning some colours and restricting the rest to fewer foods would not mean that consumers would have to put up with dull food. It would be of nutritional benefit for consumers to eat more fresh food, especially fruit and vegetables, and these are very colourful. This is likely to happen if colours are restricted to fewer foods - as one industry representative has predicted. Many processed foods could remain reasonably colourful without the excessive use of added colour. For example, more foods could be packaged in light-proof containers, so slowing down the loss of some colours. The shelf-lives of some products could be reduced so that colours (and nutrients) would not have time to deteriorate significantly. Some foods could be preserved differently, for example by freezing rather than by canning, so their indiginous colour would not be destroyed by severe processing. This would also benefit the consumer by destroying fewer vitamins. The consumption of a lower proportion of highly refined foods - necessary for public health - would significantly reduce the need for added colour. If the use of colours were to be restricted the colour of a food could once again become a reliable indicator of quality.

In its assessment of colours, published in 1987, the Food Advisory Committee failed to take account of the many possible alternatives and new developments that have and could reduce consumers' and industry's reliance on colourants.

5.36 SUMMARY

a) Effects of regulations on choice of coloured and uncoloured foods

It is probable that foods that were predominantly (sometimes exclusively) coloured in 1987 were less often coloured in 1901. In 1901 a large survey showed that over 50% of common grocery items such as margarine, cheese, cordials and ketchup were coloured. Coloured items would often have been concentrated in shops servicing low income groups. There are no comparable surveys available. But a survey based on one supermarket in 1987 found that 82% of products popular with children contained added colour. Uncoloured products were a mere 18% of the total, and the choice (in the sense of the option to select from at least two items) existed in 6% of cases. Unfortunately these findings are not comparable to the 1901 data, because the latter covered foods purchased from many sources. Other figures suggest that there was a major increase in the proportion of coloured food between 1901 and 1987. This is backed up by the change in consumption of synthetic colours, estimated to have gone up from over 40 tonnes in 1923 to 400-700 in the mid 1980s. But these changes cannot be ascribed to regulations. The reduction of choice among uncoloured foods and increase of choice among coloured foods was due to the policies of manufacturers and retail chains, and public attitude to colours.

If regulations had been much more stringent they might have significantly reduced choice among coloured items, if, for example, colours had been prohibited from all staple foods.

Regulations in 1957 banned colours from fresh meat, fish, fruit, vegetables, tea, coffee beans, white bread, cream and dried milk. Compositional standards introduced at other dates also banned colours from certain products. It is not possible to measure the actual effects of these regulations on choice, because data on the extent to which such foods were coloured immediately before regulations were made are not available. For example, in 1901 3.4% of cream samples were coloured. It is not known what proportion was coloured in 1956. Nevertheless, regulations did remove the option to buy coloured items, so the regulations reduced choice at least in theory.

b) Effects on range of hues

Manufacturers' warnings that a positive list would restrict the range of hues unacceptabley were exaggerated. The UK's negative list of 1925 reduced the number of colours by a negligible amount and negligible effect on the range of hues, except in removing a green (copper) used in tinned peas. Presumeably it took manufacturers a little time to develop a replacement, and in the meantime the option to buy coloured peas was eliminated. More research is needed to clarify this point.

The positive list of 1957 did not affect the number of plant and mineral hues, although these were commercially insignificant anyway. It drastically reduced the number of coal tar colours from 100 to 30. While the number of each hue was reduced it is unlikely that there were any significant effects on the range of hues seen by the public. The advisory committee that drew up the permitted list had been very careful to meet the desire of manufacturers for a full range of hues. The only food that was possibly affected was margarine, because no alternative to oil yellow was available. Although it was reported at the time that annatto was not suitable for colouring margarine, it has since been adapted and has become the main colour for margarine.

The range of coal tar colours was cut by a further 50% between 1957 and 1978/1987. But further research enabled the small range of colours to be used for a great many applications.

Future bans on coal tar colours may adversely affect the range of hues seen by the public. But already many new hues are being developed among the natural colours. The voluntary move away from coal tar colours has allowed naturals to be used for a much wider range of purposes, and has increased overall choice. Some products, such as fruit juice and drinks, can now be purchased uncoloured or with coal tar or natural colours. Until a few years ago in the UK such products were only available with coal tar colours or, occasionally, uncoloured.

c) Effect of regulations on quality

Regulations banning colours from particular foodstuffs have helped to protect the quality of such foods by limiting the use of substitute or inferior ingredients. For exmaple, colouring matter has been prohibited from fresh meat since 1957 because regulators acknowledged the hazard of microbial food poisoning from old meat coloured and passed off as fresh. When regulations prohibiting colour from jam were removed in the 1950s the quality of jam deteriorated. In some other countries colours have long been prohibited from products open to debasement, such as meat products (in West Germany, France), single fruit jam (in Austria, Sweden), and brown bread (in France and Germany).

Nevertheless, the restrictions probably also removed from the market some of the items of the poorest quality or that were poor value for money. The regulations offered benefits in terms of quality and in some cases, health, where hazardous colours were prohibited.

Colour is important to the enjoyment of food. However added colours are not the only way of achieving colour, so are not in themselves essential to the enjoyment of food. Vegetables, meat and fruit are naturally colourful, giving a wide range of colour to any dish. In nutritional terms it would be of benefit to many people to eat more fresh food. Added colours only become necessary where heavy processing, old age or heat treatments have destroyed or reduced the colours occurring naturally in foods, or where highly refined colourless ingredients form the basis of a product.

The benefits and disadvantages of added colours can be summarised as follows. Added colours help consumers to identify flavour; they aid in the correct dilution of foods; they help to produce foods that would not otherwise be available or saleable; they reduce the cost of some products. The disbenefits of added colours are that they mislead the public about the source and quantity of ingredients and flavours; about nutritional quality; and about the age and microbiological status of food. Added colours can also allow manufacturers to charge inflated prices. People on low incomes are particularly affected by these disadvantages. In contrast, foods without added colour offer more benefits and few of the dysbenefits of foods with added colour.

Choice in itself is often portrayed as 'A Good Thing'. And in theory unlimited choice for consumers is highly desirable. But two crucial questions about choice need to be addressed. As Alan Irwin has pointed out 'who makes the choice?' and 'choice among what options?' (114). The latter is important because there is little value in the freedom to choose amongst a wide range of foods that are, for example, predominantly of poor nutritional quality, or unsafe, or poor value for money. In the early 1900s, for example, urban labourers experienced an improved variety and choice of food products; but the new foods were worse in nutritional value (115). Choice for its own sake is a rather inappropriate goal. The freedom to choose is only one of a number of factors contributing to human well-being. Sometimes it may be desirable to restrict choice in order to protect other factors such as health. A recent survey of public attitudes to additives suggests that large sections of the public (80%) might probably prefer to have their choice restricted to some extent than to continue to be exposed to potentially harmful additives (116). Tim Lang, director of the London Food Commission, has summed up the desirable goals of a food supply: that food should be safe, nutritious, enjoyable, convenient, and available at prices all social groups can afford. It should also be produced under decent working condititons (117).

This leads to the second crucial question of 'who makes the choice?'. The factors determining food choice have been examined earlier. In practice a high degree of 'choice' does not occur. The role played by the individual in choosing food is comparatively small because food choice is highly structured.

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CHAPTER 6

EFFECTS OF COLOUR REGULATIONS ON HEALTH

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6.1 INTRODUCTION

This chapter examines the effects of colour regulations on health. It assesses the relative degree of protection afforded by the negative list, the positive list and the voluntary action of manufacturers. It attempts to measure the health hazards removed by regulation and the loss of health due to delays in the introduction of regulation.

This assessment is important because of claims that have been made about the merits of regulations. For many years colour regulations were not introduced because it was felt that, firstly, it was not appropriate for the state to intervene in the matter because the trade voluntarily stopped using harmful colours and could continue to regulate its own affairs, and secondly, that the remaining colours posed no significant health risk so there was no need for regulation. These two main arguments against regulation are summarised below and discussed in more detail in chapters 2 and 3. A third important argument against regulation has been made recently in the context of other areas of consumer safety. In the case of vehicle and drug safety, for example, studies have purported to show that regulations are ineffective and do not bring any significant benefits to health. These arguments have been described in chapter 2.

6.2 SUMMARY OF ARGUMENTS AGAINST THE REGULATION OF COLOURS

Chapter 2 outlines some of the claims made about the negative effects of regulation. The section below provides a summary of the arguments against safety regulations on colours. The arguments are:

a) Self-regulation is adequate

b) There is insufficient evidence of harm.

6.3 'Self-regulation Is Adequate'

In the nineteenth century calls for a negative or positive list of colours were countered by the claim that traders were acting responsibly, without state interference, by voluntarily removing harmful colours from use. Later it was felt that the combination of voluntary action and the Food and Drug Acts offered sufficient protection.

A number of instances demonstrated that some sections of the trade were acting responsibly:

6.4 a) Voluntary withdrawals of harmful colours

Many manufacturers stopped using toxic metallic colours before the food laws were introduced. The select committee inquiries of the nineteenth century were impressed by the changes manufacturers had made in the use of colours after 1850. In the twentieth century a number of colours were also withdrawn voluntarily by manufacturers because of concern about the possible health effects. Examples of such colours include: Aurine and Picric acid (1) before the introduction of the negative list in 1925, and Aminoazotoluene (2), Oil orange E (3), Benzopurpurine 4B and the Oil yellows (4) like Butter yellow (5) before the positive list in 1957. A number of manufacturers conducted their own toxicological trials on colours (6).

6.5 b) Trade guidance and standards

Further proof of the trade acting responsibly is shown by the advice given by trade manuals and trade associations. Many trade manuals gave information about 'acceptable' colours. A number of bakers' and confectioners' manuals, for example, warned manufacturers of certain harmful colours and gave lists of ones considered harmless. Lists of safe colours were published in the twentieth century in books such as <u>The Technology of Breadmaking</u> (1911), <u>The Manufacture of Preserved Foods and Sweetmeats</u> (1912), <u>Confectioners' Raw Materials</u> (1921) (7). Trade journals, such as <u>Food Manufacture</u> occasionally published lists of 'harmless' colours (8). Sometimes manuals just listed colours that were 'suitable' for food without explicitly mentioning safety, such as <u>The Bread and Biscuit Baker's Assistant</u> (1902) (9).

Some trade associations and professional bodies of the food and chemical industry also drew up lists of acceptable colours. The Society of Dyers and Colourists' Colour Index (1924 & 1928) gave a list of colours suitable for food use.

Some trade associations in the nineteenth century acted vigorously to re-establish the 'good name' of their profession and stamp out adulteration. The Milk Journal published the names of those found adulterating milk (10). The Manchester and Salford Master Bakers' Association summoned three bakers for adulterating bread (11). Later a large bakers' trade association set up its own standards and attempted to enforce them with a reasonable degree of success.

In the twentieth century trade associations worked jointly with public analysts to produce voluntary standards of purity for colours.

Sometimes today it is claimed that the trade itself is the most effective force in ensuring safety. Alan Holmes, director of the Leatherhead Food Research Association said, in 1985, that fear of adverse publicity ensured traders acted responsibly:

> The consumer is no longer protected primarily by the legislation or by the enforcement officers. The primary protection of the consumer is the good name of the manufacturer (12).

6.6 'There is Insufficient Evidence of Harm'

The second major argument against the introduction of regulations was that there was no evidence of real harm from colours or that the level of risk was insignificant. It was suggested that regulation was premature without proof of actual harm. For example the call from a public analyst, Cassal, for controls on coal tar colours in 1890 was countered by the lack of evidence of harm (13). Similarly in 1954, when the Food Standards Committee considered the need for a permitted list they report one of the industry's main objections to be that food manufacturers had received no complaints of illness due to consumption of colours (14).

Statements made at various times in support of the safety of colours (discussed in more detail in chapter 3) can be summarised briefly by the following headings, with examples drawn from a discussion which took place at the Society of the Chemical Industry in 1926:

a) Colours are safe at the low levels at which they are eaten

The meeting was told by the speaker, Dr Drake-Law, that 'It is often stated that the amount of colour used in foodstuffs is so small that the question of harmfulness does not enter into consideration' (15).

b) Many years of use is evidence of safety

The Factory Inspectorate had recently reported that Bismarck brown was a cause of increased levels of dermatitis in dye factories. During the discussion Mr W Woolcock and Mr Thomas (16) challenged the report and pointed to one worker's experience of handling dyes for 50 years without suffering dermatitis (17).

c) There is no evidence of human harm

Mr H Lovely dismissed the idea of a positive list because he 'had not come across a single case of any harm accruing from the use of aniline dyes in foodstuffs' (18).

d) Animal tests are not entirely relevant to humans

Adverse results in animal tests did not necessarily mean a colour was a risk to humans, Dr Drake-Law said that 'tests on animals did not give reliable information' (19).

e) Animal tests demonstrate no harm from colours

Mr Thornley reported that he had made extensive tests on dyes used in margarine on behalf of some manufacturers of colours. The animals had shown no adverse health effects and this 'showed that some colours were harmless....Many other dyes had been tested similarly, and had been found equally harmless' (20).

f) Colours are only harmful when contaminated

Dr Levinstein gave his view that the dermatitis which sometimes occurred in dyeworks was 'generally caused by some impurity in the dyestuff' not by the dyestuff itself (21). Dr Drake-Law considered many coal tar colours to be harmless in themselves but made toxic by contaminants. He gave as an example Orange II which became toxic when dried on copper trays (22).

g) Harmful colours have already been identified and removed

Dr Drake-Law stated that 'toxic colours are few in number, and are well known' (23).

There was only one argument that was not mentioned in this discussion, but was raised against regulations on other occasions:

h) Colours are less toxic than some natural foods

J Drake of BIBRA (an industry-funded safety testing association) has said:

> For every adverse report ...there exist others which suggest that any untoward effects of colourings in food generally are likely to be miniscule in comparison with other potential hazards to health arising, for example, from microbiological sources (24).

These were the main arguments used for many years to delay the introduction of regulations, and, once the negative list had been introd uced, to attempt to prevent the introduction of a positive list. After 1925 it was argued that it was difficult to prove safety; it was easier to demonstrate harm, and therefore a negative list was preferable to a positive one. A second argument in favour of maintaining a negative list rather than introducing a positive list was that the negative list system worked well; it had proven itself.

6.7 Coping with Inadequate Toxicological Information

Throughout, one angle of the debate to which the state was particularly responsive was that it was premature to act before proof of harm had been established; that there was no scientific basis for regulation. The fact that there was no adequate scientific basis for assessing the safety of colours till long after 1925 has been demonstrated by Fred Steward's review of the debates. He states:

> The difficulty in developing approaches to the evaluation of chronic toxicity was to underpin the problems in regulatory intervention (25).

Despite the lack of clear information the state could have chosen to act in a precautionary way, as many other countries had done, on the basis of the best available knowledge. The government could have conducted a survey like Hesse in the USA in the early 1900s. It could even have conducted its own toxicological testing programme. As early as 1893 the government could have established procedures for taking precautionary regulatory action on chronic toxicity. The problem of coping with inadequate toxicological information is discussed in chapters 3 and 7.

The effects of the delay in the introduction of negative and positive lists are assessed below. The extent to which early intervention based on inadequate information would have been helpful is also explored. This chapter also seeks to answer two fundamental questions raised by debates concerning regulations; namely: were regulations successful in removing harmful colours, and were they more effective than voluntary trade action?

6.8 METHODOLOGY

There is no objective or direct way of measuring the ill-health prevented or caused by colour regulations. Evidence is mainly circumstantial. It is possible, however, to assess levels of hazard from colours and to measure the relative effects of regulatory activity in different periods.

For the regulations of 1925 and 1957 this chapter assesses the four factors listed below, using a series of techniques:

1. **Colours affected by regulation**
   This involves identifying which banned colours were still in use, to see which colours were actively banned.

2. **Changes in the level of hazard**
   This involves classifying colours in high and low risk groups and quantifying the number in each category removed by regulations. The proportion of high and low risk colours before and after regulation are compared. Hazard levels are measured using four sets of data:
   a) contemporary hazard assessments
   b) retrospective hazard assessments
   c) carcinogenicity studies
   d) allergy studies
   These four hazard schemes are described later.

3. **Voluntary trade activity**

This involves listing the colours withdrawn voluntarily by manufacturers. Changes in the use of high and low risk colours in the years leading up to regulation are measured. Changes in the popularity of certain colours are also assessed.

4. **Effects of delay**

This involves identifying early dates at which regulations could have been introduced, by comparison with other countries. The burden of hazard caused by the delay in introducing regulations is measured by two schemes:

a) the available hazard burden

b) hazard burden scores.

The two schemes are described later.

6.9 Measuring Hazard Levels

A series of historical comparisons permit an assessment of the level of hazard before and after regulations were made, giving some indication of the change in hazard levels brought about by regulation. The health hazards from colours have been estimated using a variety of parameters, since there is no single suitable method or set of data. Hazard levels are measured using four sets of data:

i) **Contemporary hazard assessments**

Tables I.3, I.4 and I.5 in appendix I list a series of assessments of the safety of the three groups of food colours, between 1855 and 1987. The assessments have been standardised into five ratings, as follows:

A Acceptable for food (Low risk)

B Possibly acceptable (Medium risk)

C Possibly harmful (High risk)

D Harmful (High risk)

E Insufficient information to make an assessment (Medium risk)

The data are used to evaluate the effects of regulations and trade activity in the context of percieved hazards. For example, in 1954 and 1955 a MAFF sub-committee assessed the safety of about 100 coal tar colours (26). Their review gives one measure of the hazard presented by colours. It has a number of drawbacks, however: it has been superceded to some extent by later toxicological studies, and it does not cover many colours used at other periods. The data provide a contemporary assessment of the effects of the 1957 regulations on coal tar colours.

ii) Retrospective hazard rating

A second hazard rating scheme has been produced from a compilation of the assessments made by official organisations such as the Joint Expert Committee on Food Additives (JECFA, of the World Health Organisation and Food and Agriculture Organisation), the UK government's Public Health Laboratory and Martindale's Extra Pharmacopaeia. Major assessments of the safety of coal tar colours have been undertaken by JECFA. In the 1960s and 1970s they reviewed most of the toxicological data available, and produced ADIs (Acceptable Daily Intake figures), a quantitative rating of the suitability of some colours for food use. Some others they considered to be unsuitable on safety grounds, and did not allocate ADIs. A table of JECFA's ADIs is given in Appendix I.

JECFA assessed many more colours than other authorites, but did not assess all the colours that were once used in the UK. To provide a more complete picture I have combined the JECFA assessments with those available from other official sources. For each colour the most recent official assessment has been taken as the 'hazard rating' and forms the basis of many of the assessments in this chapter. Tables I.3, I.4 and I.5 in appendix I give the latest hazard ratings of the coal tar, mineral and plant colours.

The ratings are as follows:

A Acceptable for food (Low risk)

B Possibly acceptable (Medium risk)

C Possibly harmful (High risk)

D Harmful (High risk)

E Insufficient information to make an assessment (Medium risk)

There are several limitations to this system:

a) Occasionally the scheme produces a rating that is possibly incorrect. For example, Bordeaux extra (table I.3 in appendix I) is rated 'A' because there has been no assessment since 1890; it should probably be rated 'E'.

b) A few colours remained without any hazard rating, so have been given an E-rating.

c) I have translated the assessments of official bodies to produce a uniform rating system; interpretation was straightforward in the majority of cases. The references to table I.3 describe the conversions made.

d) For early periods I occasionally had to make assumptions about the range of colours to which an assessment was intended to apply. For example, I have applied the C-rating for 'copper compounds' to all the copper compounds in use at the time. Such assumptions may have produced inappropriate hazard ratings for a very small number of colours.

e) The overall level of hazard tends to be underestimated. A recent official assessment of 'A' does not necessarily mean a colour is safe and without hazard. Brown FK, for example, is rated 'A', yet two of its components are consistently genotoxic to bacteria. The DHSS's Committee on Toxicity has considered it 'acceptable' on the understanding that it probably will not be extensively used in food. Individuals with impaired immune systems or people exposed occupationally to large amounts of the dye may be at risk. Ideas of acceptable standards of safety and testing change over time. They also vary according to the group making the assessment. In 1964, for example, two bodies (JECFA and the Pharmacology Panel) assessed over 44 colours. Their views on the colours diverged so much that there was only one colour which both bodies agreed had satisfied all the toxicological requirements (27).

f) There are also considerable methodological problems associated with the conduct, interpretation and extrapolation of animal tests, so that an adverse result does not necessarily mean there is any human hazard (28). However, this information is the best that we are likely to have, given the immense difficulty of conducting epidemiological trials on consumer exposure to colours (29). Moreover, expert committees within the UK, and more independent bodies such as the International Agency for Research on Cancer, take the view that adverse results in animal tests should be taken as evidence of a risk to humans (30).

iii) Carcinogenicity studies

Studies of the carcinogenic potential of colours have been collated from a wide variety of sources to provide another measure of the possible hazard from certain dyes. The data have been used in the same way as the hazard ratings to assess the change in levels of risk brought about by the regulations. The assessment is limited by lack of data for many colours. The significance of animal tests to humans is discussed in section 6.52.

iv) Allergy studies

Data on intolerant reactions to colours provide an alternative assessment of the health effects of colours and regulations. This is described in section 6.54. Again, the assessment is limited by a lack of data for some colours.

The four hazard assessments outlined above have been used to create a series of measures of the health risks carried by the public which are described at appropriate points in this chapter.

6.10 Comparing Hazard Levels Before and After Regulations

One of the main methods by which I assess the effects of regulation is by using the four hazard assessment schemes outlined above to measure and compare the levels of hazard before and after regulation. I also look at the trends in hazard levels leading up to regulation in case there was a downward trend anyway.

It would have been informative to include a measure of the actual quantities of individual colours to which the public were exposed. Unfortunately, few data on public exposure are available. Available data give information on the quantities put into certain products rather than the amounts consumed by individuals or populations. I have used reports where available to assess the extent to which, for example, copper was still used before it was banned. To compensate for lack of data for other colours I have analysed the relative proportions of high, medium and low risk colours in use, rather than focussing merely on the numbers in each category. The changes in the proportions of these groups form the basis of many assessments in this chapter.

6.11 Calculating the Hazard Burden

The retrospective hazard rating has been used to create two assessment schemes (summarised below) which take account of the length of time for which colours were used. These are used to calculate the burden of hazard created by food colours during various periods. This allows comparison between periods of regulatory control and trade control. It also gives a measure of the hazard that might have been prevented by the earlier introduction of regulations.

a) Hazard burden scores

For each colour, the scheme allocates a score to represent the number of times the colour was reported to be in use. The score indicates the length of time for which the public was exposed to the colour. The scores are combined with data about the safety of colours (the hazard ratings described in section 6.9 (ii) above) to provide a measure of the total burden of hazard experienced by the public from 1850-1987. The scores are divided into five time periods so that comparisons can be made between different periods. Adjusted scores are used instead of actual figures to compensate for slight differences in the length of the periods of time. A drawback with this scheme is that it may underestimate the risk because it is based only on the colours that were reported to be in use at particular times. More colours would in fact have been used. Nevertheless, this problem is overcome to some extent by the fact that changes in proportions are analysed instead of absolute numbers.

b) Hazard burden from available colours

The second scheme also combines hazard ratings with a measure of the length of time colours were in use. The date of discovery of each colour is used to calculate the length of time for which it was available for use. This scheme is only applied to the 100 coal tar colours in use in 1954/5, to provide an alternative measurement of the effects of the 1957 regulations, and of the hazard burden created by the delay in introducing regulations. The scheme's drawback is that it overestimates the risk because it assumes colours reported to be in use in 1954/5 were available for use at most times after their discovery, unless reported as not used. Lack of precise recordings of colours used in food unfortunately prevents more precise measurement. The actual burden of hazard probably lies between the two schemes presented.

6.12 International Comparison of Regulations

Some countries introduced regulations many years before the UK. An estimate is made of the loss of health in the UK caused by the delay in introducing controls. This provides another method of measuring the effects of regulation on health. It is calculated by quantifying the 'excess' number of years the hazards from colours were experienced in the UK before the introduction of a negative or positive list.

This chapter continues with a description of the changing number of harmful colours in use between 1850 and 1987, followed by an assessment of the effects of the negative list and the positive list.

6.13 HARMFUL COLOURS, FROM 1850 TO 1987

Tables 6.1, 6.2 and 6.3 show the changing number of harmful and possibly harmful colours used in food at various times between 1850 and 1987. The tables are based on 'C' and 'D' colours produced by the system of retrospective hazard rating described in section 6.9 above, and on the tables of colours reported to be used in food in (tables D.1, D.3 and D.4. The number of harmful colours presented in the following tables is lower than it would have been in reality because:

a) the number of colours in use was under-reported, and
b) only the high risk (C and D-rated) colours have been included. In fact, the E and B-rated colours, and possibly the A-rated colours, may also have presented a hazard.

6.14 Coal Tar Colours

Table 6.1 shows that the number of harmful coal tar colours used in food rose steeply from the 1880s and then fell to small numbers after 1957. It appears to have reached a peak in 1955, but the actual peak in the number of colours was probably reached at some point before 1955 (as demonstrated in Chapter 4). The relatively high number in 1955 is due to the exhaustive list of colours collected by a committee review at the time. Manufacturers for the first time gave a complete list of the colours they were using, so they could be assessed and possibly included in a positive list. Manufacturers had not been faced with such incentive before, and many of the early lists were incomplete.

The upward gradient of harmful colours from the 1880s corresponds to the invention and introduction of increasing numbers of coal tar colours. Some harmful colours, such as Picric acid and Magenta, are likely to have been used well before the 1870s. Whilst detailed records are not available, one can assume that many coal tar dyes would have been used in food soon after their first commercial production (31). It is likely therefore that there would have been a steady exponential rise in the number of hazardous colours in use from the 19850s to the 1880s. (Chapter 7 examines the relationship between discovery date, chemical structure, and the safety of dyes.)

At two points on the chart (in table 6.1), at 1891 and 1942 (marked +), there are very low numbers of harmful colours. This is caused by reports that gave the names of only a few of the colours in use. These low points do not represent a sudden drop in the number of colours in use.

After 1955 there was a real and dramatic fall in the number of colours, due to the introduction of a permitted list. Amendments to the permitted list further reduced the number of high risk colours. The effects of the permitted list are examined in detail in sections 6.33 - 6.40 and 6.51 - 6.61.

6.15 High Risk Mineral Colours

The pattern for mineral and metallic colours (table 6.2) is quite different. In the 1840s and 50s the use of harmful mineral colours was at its peak. In the late 1860s, despite a drop in the extent to which colours were used as the proportion of adulterated food fell, there was no significant drop in the range of mineral colours used. The number of mineral colours dropped significantly in the 1880s as coal tar colours provided technically superior replacements. The rise in number around 1910 may have been real or may have been due to more thorough reporting. Food adulteration dropped at the turn of the century and then rose again in the 1920s. The disappearance of the final D-rated mineral colour (copper sulphate) in 1925 was due to the 1925 regulations. The effects of the regulations are discussed in detail in sections 6.24 - 6.27 and 6.41 - 6.45.

6.16 High Risk Plant Colours

The number of plant and animal colours classed as harmful has always been low (see table 6.3). This is partly due to the fact that these colours have traditionally been considered safe, so insufficient toxicological testing has been done. Like the mineral colours, the use of plant colours peaked in the 1840s and 50s, but carried on into the 1860s and 70s, replacing mineral colours to some extent. The final D-rated plant colour (Gamboge) was used occasionally until about 1920. This is discussed in section 6.28 - 6.31. Another possibly harmful

TABLE 6.1 : NUMBER OF HARMFUL COAL TAR COLOURS IN USE BETWEEN 1850 AND 1987

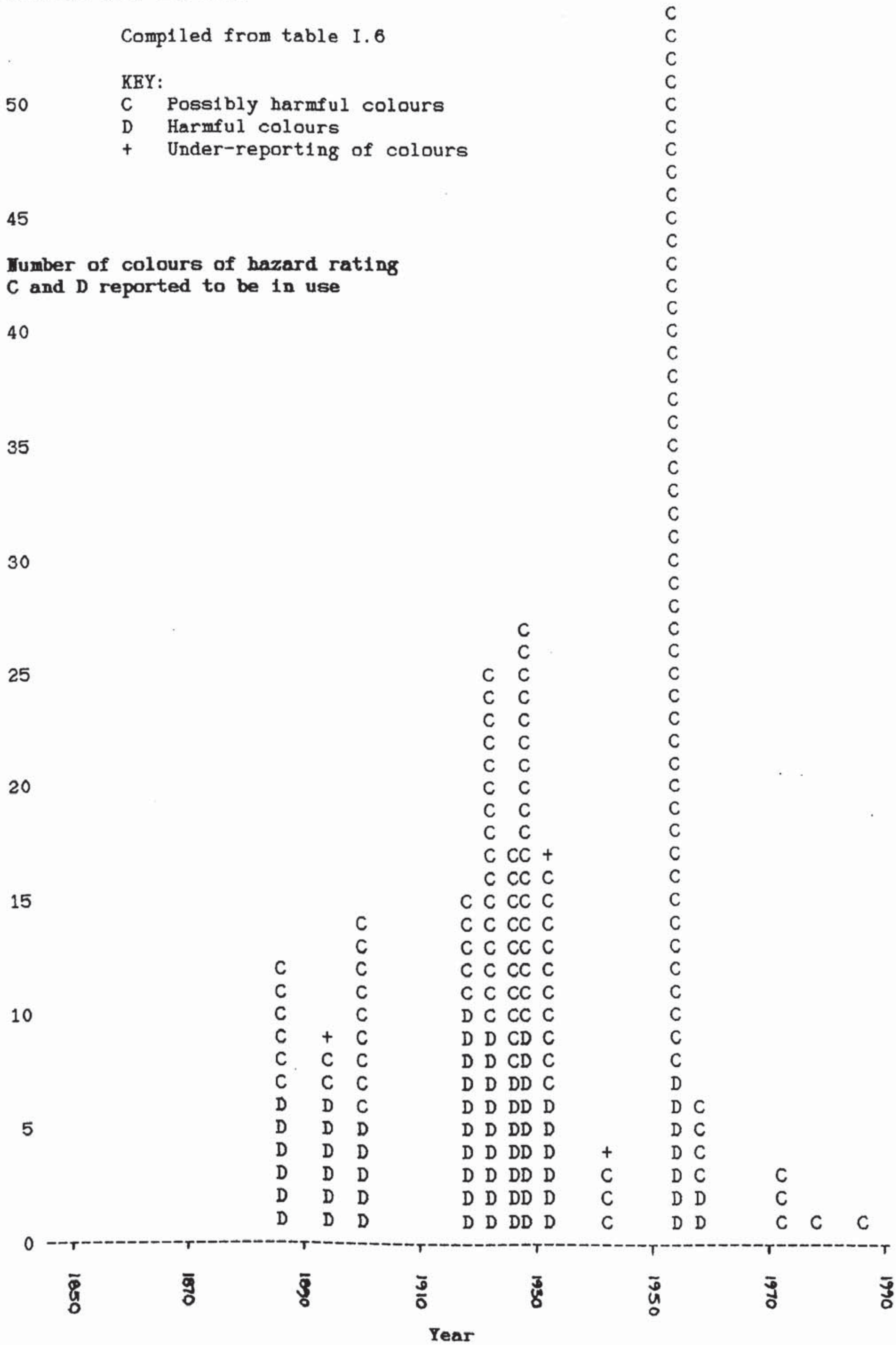


TABLE 6.2: NUMBER OF HARMFUL MINERAL AND METALLIC COLOURS IN USE BETWEEN 1850 AND 1987

Number of colours of hazard rating C and D reported to be in use

Compiled from table I.7

KEY:
C   Possibly harmful colours [none reported]
D   Harmful colours
\-   No C or D-rated colours reported

Number of C and D-rated colours in use

```
20    DDDDD      DDD
19    DDDDD      DDD
18    DDDDD      DDD
17    DDDDD      DDD
16    DDDDD      DDD
15    DDDDD      DDD
14    DDDDD      DDD
13    DDDDD      DDD
12    DDDDD      DDD
11    DDDDD      DDD
10    DDDDD      DDD
 9    DDDDD      DDD
 8    DDDDD      DDD
 7    DDDDD      DDD      D           D
 6    DDDDD      DDD      D           D
 5    DDDDD      DDD      D           D
 4    DDDDD      DDD      D      D    D
 3    DDDDD      DDD      D      D    D
 2    DDDDD      DDD      D      D    D
 1    DDDDD      DDD      D      D    D   DD D                     -  -       -  -  -
 0  --T----------T----------T----------T----------T----------T----------T----------T
      1850       1870       1890       1910       1930       1950       1970       1990
                                         Year
```

TABLE 6.3 : NUMBER OF HARMFUL PLANT AND ANIMAL COLOURS IN USE BETWEEN 1850 AND 1987

Histogram showing the number of colours rated C and D reported to be in use at dates between 1850 and 1987

Compiled from table I.8

KEY:
C   Possibly harmful colour
D   Harmful colour
-   No harmful colours reported

Number of C and D-rated Colours in use

```
3

2    CCCCC      CCC
     CCCCC      CCC
1    DDDDD      DDD       D        D      C    D                        C C
     DDDDD      DDD       D        D      C    D _                      C C       _    _    _
0  --T----------T---------T----------T----------T----------T-----------T---------T---
     1850       1870      1890       1910       1930       1950        1970      1990
```

Year

colour (Quercitron) was used sometimes until it was finally banned by regulations after 1957 (section 6.65).

6.17 EFFECTS OF NEGATIVE LIST

This section examines the effects of the 1925 Public Health (Preservatives etc. in Food) Regulations, which prohibited some colours (32). It established a 'negative' list of colours, prohibiting the use of selected colours and continuing to allow the use of any others. The list banned fourteen colours which had been widely accepted to be injurious and had largely been controlled already under the Food and Drugs Acts (see discussion in Chapter 3). The 1925 negative list mainly codified accepted trade practice.

The three main groups of colours were affected differently by the negative list. The effects are assessed below.

6.18 EFFECTS ON COAL TAR COLOURS

The negative list had little effect on the range of coal tar colours in use - it reduced the number of at least sixty by only five. The significant issues surrounding the regulations are whether the banned colours were hazardous, whether they were still extensively used, and what burden of hazard existed around the time of the regulations? I have made four separate assessments of the effects of the regulations on health in an attempt to answer these questions.

6.19 Assessment 1: Colours affected

The banned coal tar colours are listed in table 6.4 below. All had been generally agreed by offical sources to be harmful to health. Only two of the five were still in use when the regulations were made, as table 6.4 shows. It was recommended that a sixth colour (Orange II) be banned, but after reports that the colour was not harmful when uncontaminated, and possibly under pressure from traders claiming it to be essential, the colour was not banned. The negative list of 1925 did not ban some other colours regarded as harmful at the time, such as Bismarck brown (33).

TABLE 6.4 : COAL TAR COLOURS BANNED BY 1925 REGULATIONS

Compiled from table I.3 and table D.1

KEY:

C Possibly harmful

D Harmful

Colour	Hazard assessments (Year) 1890	1912	1920	1925	Estimated extent of use prior to regulations
BANNED COLOURS:					
Aurantia	D	D			Reported use 1901 Assume not used in 1924.
Aurine		C			Reported use 1887. No longer used by 1924
Manchester yellow	D	D	D	D	Reported use 1887, 1895, 1901, 1919. Still used in 1924.
Picric acid	D	D	D		Reported use 1887 and occasional use 1919. No longer used by 1924
Victoria yellow	D	D	D	D	Reported use 1887, 1895, 1919. Assume used in 1924.
COLOUR PROPOSED FOR BAN BUT NOT BANNED:					
Orange II	D	C			Reported use 1924

6.20 Assessment 2: Retrospective hazard assessment

Table 6.5 shows the number of coal tar colours reported to be in use in several periods before and after the regulations. The rise and fall in numbers probably reflects under-reporting of colours, rather than any significant change in the number of colours in use. Although there was another phase of replacement of plant colours by technically superior coal tar colours in the 1920s, which might have increased the range in use, concerns about safety would have removed some colours. Table D.1 in Appendix D shows that there were changes in the actual colours used; for example, only 46% of the colours reported in 1924 were also reported in 1928. This large change was probably due to three factors: significant under-reporting of the colours actually used in the two periods; developments in the technical performance of colours and requirements of manufacturers; a new pressure on manufacturers to avoid colours considered hazardous, brought about by debates surrounding the introduction of a negative list. (These factors are examined in assessment 3.)

Table 6.5 divides the colours according to the retrospective hazard rating (A - E) and measures the changes in each hazard group over time. Comparing 1924 and 1928 (periods before and after the 1925 regulations where there was a more complete record of colours used) there was no change in the total number of colours rated 'D' and a slight increase in the number of colours rated 'C'. So despite the removal of two D-rated coal tar colours by the 1925 regulations, they were quickly replaced by other harmful colours. The number of low risk (A-rated) colours was reduced very slightly. The number of medium risk (B and E-rated) colours was significantly reduced. Table 6.6 shows these changes.

It is necessary to examine changes in the proportions of high and low risk groups. Table 6.7 shows the trends in the proportion of each group from 1919 to 1928. The proportion of D-rated colours fell by one half, while the proportion of C-rated colours doubled. Overall there was only a very slight reduction in high risk colours: from 58% to 56% of the total. The proportion went up slightly immediately after 1925. The B-rated colours dropped from use altogether, while the E-rated colours increased; so the proportion of medium risk colours dropped a small

TABLE 6.5: EFFECT OF 1925 REGULATIONS ON COAL TAR COLOURS: NUMBER & RATING OF COLOURS IN USE BEFORE AND AFTER REGULATIONS

Compiled from table D.1 and table I.3

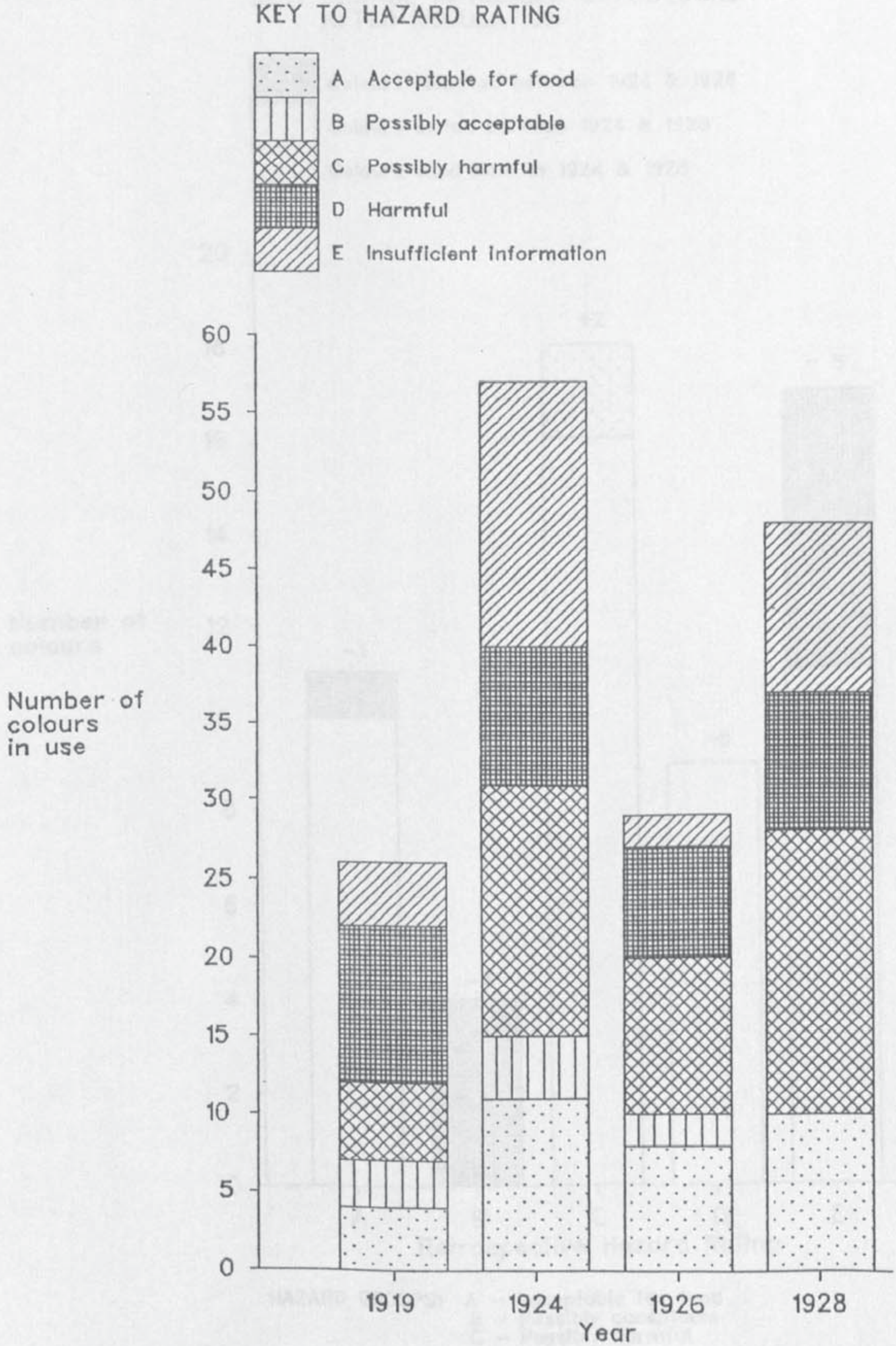


TABLE 6.6 : NUMBER OF COAL TAR COLOURS REMOVED AT THE TIME OF THE NEGATIVE LIST OF 1925

This histogram compares the number of coal tar colours in each hazard group reported to be in use in 1924 and 1928

Compiled from table D.1 and table I.3

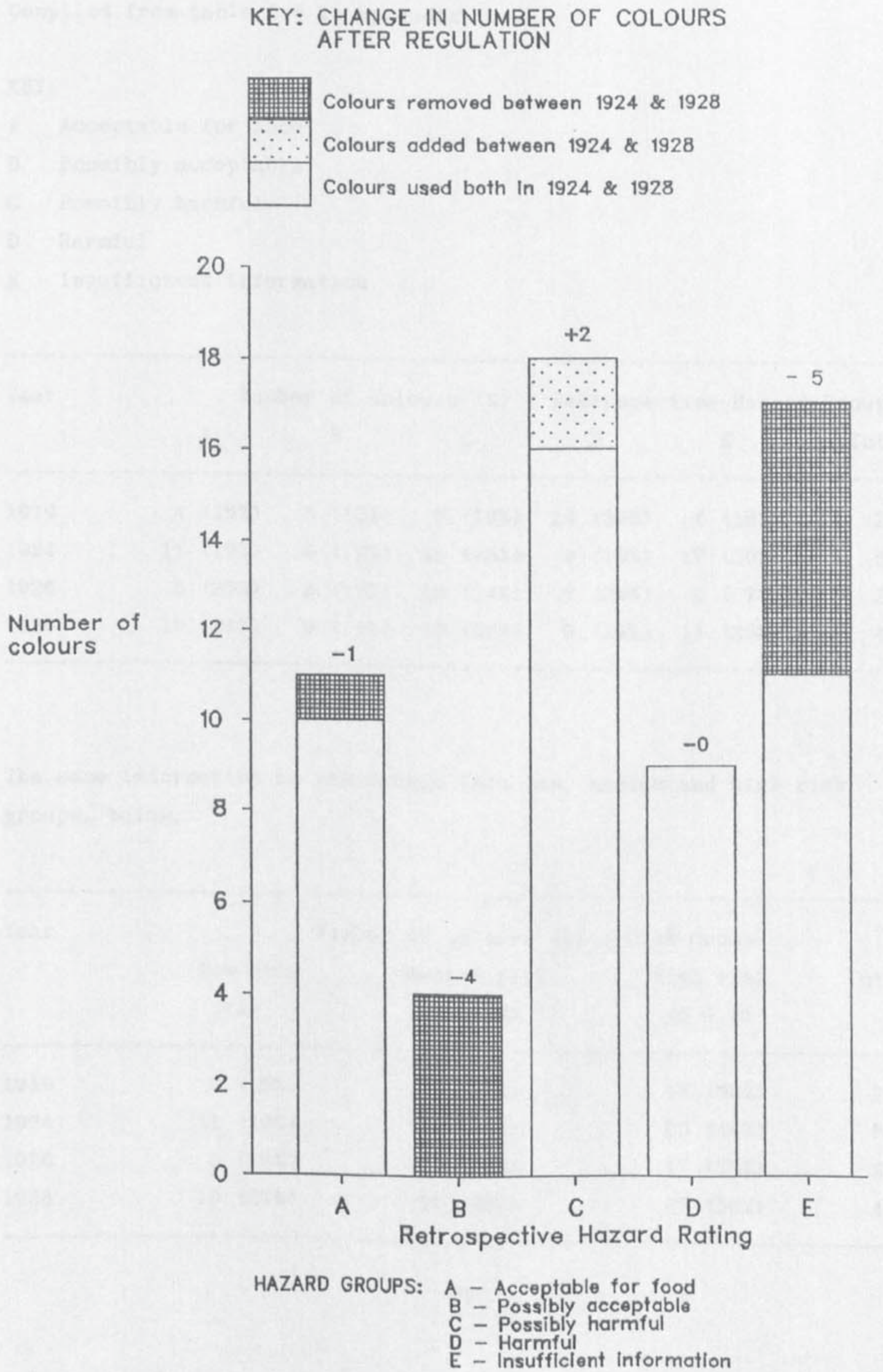


TABLE 6.7 : COAL TAR COLOURS: TRENDS IN THE PROPORTIONS OF HAZARD GROUPS, 1919 - 1928

Compiled from table I.6 in appendix I.

KEY:

A Acceptable for food

B Possibly acceptable

C Possibly harmful

D Harmful

E Insufficient information

Year	Number of Colours (%) / Retrospective Hazard Group					
	A	B	C	D	E	Total
1919	4 (15%)	3 (12%)	5 (19%)	10 (39%)	4 (15%)	26
1924	11 (19%)	4 (7%)	16 (28%)	9 (16%)	17 (30%)	57
1926	8 (28%)	2 (7%)	10 (34%)	7 (24%)	2 (7%)	29
1928	10 (21%)	0 (0%)	18 (37%)	9 (19%)	11 (23%)	48

The same information is rearranged into low, medium and high risk groups, below:

Year	Number of colours (%) / Risk Group			
	Low risk (A)	Medium risk (B + E)	High risk (C + D)	Total
1919	4 (15%)	7 (27%)	15 (58%)	26
1924	11 (19%)	21 (37%)	25 (44%)	57
1926	8 (28%)	4 (14%)	17 (59%)	29
1928	10 (21%)	11 (23%)	27 (56%)	48

amount from 27% to 23%. The proportion of low risk (A-rated colours) rose more significantly from 15% to 21% in the nine-year period, rising to 28% immediately after the regulations in 1926.

The changes shown in tables 6.5 and 6.7 put the small effects of the regulations, shown in assessment 1, into a wider framework. The two D-rated colours removed by the regulations were rapidly replaced. Overall, when their effects on health are judged retrospectively, the changes around the time of the regulations were beneficial. But the regulations themselves had no direct effect on hazard levels.

6.21 Assessment 3: Action by Traders

Around the time regulations were introduced manufacturers voluntarily reduced the use of some colours that were seen to be health risks. Martindale's Pharmacopaeia of 1925 lists the colours considered by various authorities (34) to be harmless and harmful (35). Of the colours viewed favourably, twenty were reported to be in use before and after the regulations, six were reported only before the regulations, and five were reported in use only after the regulations. Of those considered poisonous, two were used both before and after regulations, four were used only before (two of which were banned) and one was used only after (36). The fact that more harmful colours were dropped than taken up suggests some small voluntary move away from colours that were considered harmful at the time.

The extent of use of certain colours changed around 1925. Table 6.8 shows some of the colours used in large quantities in 1922/23 and reported to be 'in great demand' by the industry in 1926. There appear to be considerable changes from one period to the next. Only 2 (11%) of the popular colours in 1922/3 were still popular in 1926. Dr Drake-Law said in 1926 that these colours were popular because they were on the USA's permitted list. They were economically important because the UK's principle colonies, which were export markets, had adopted the US list. The colours were also 'recognised as harmless throughout the world' and this was important in case of disputes in law courts (37).

TABLE 6.8 : CHANGE IN COMMON COLOURS BETWEEN 1922/3 AND 1926

Compiled from:

1 List of colours supplied by Williams of Hounslow to the Departmental Committee of 1924, reproduced in table C.2 in appendix C.

2 Table D.1 in appendix D.

3 H Drake-Law 'Colours in foodstuffs' Journal of the Society of the Chemical Industry 1926 vol XLV reprint p7-8.

4 Assessment of 1925 or 1912 from table I.3 in appendix I.

Colour	Common in 1922/3 (1)	Used in 1924 (2)	Common in 1926 (3)	Used in 1928 (2)	Contemporary hazard assessment (4)
Acid green GG		/	/	/	A
Amaranth	/	/	/	/	A
Bismarck brown	/	/		/	C
Bismarck brown G	/	/		/	C
Carmoisine	/	/		/	A
Erythrosine		/	/	/	A
Indigo carmine			/	/	A
Light green SF		/	/	/	A
Metanil yellow	/	/			D
Naphthol yellow S		/	/	/	A
Nigrosine	/	/		/	A
Oil yellow AB			/	/	[A]
Oil yellow OB			/	/	[A]
Orange I		/	/	/	A
Orange II	/	/		/	C / A
Ponceau 2R	/	/		/	A
Ponceau 3R		/	/	/	A
Tartrazine	/	/	/	/	A

So there were pressures on manufacturers, especially exporters, to change to this list of colours. This did not mean these colours were used exclusively. Table D.1 in appendix D shows that a great many other colours were also used. Table 6.8 shows that although the popularity of certain colours changed enormously, the range of colours changed only a small extent. 14 (78%) of the popular colours were used both before and after 1925. Three popular colours (17%), considered safe, were used only in the later period, suggesting a swing towards safer colours. But three 'safe' popular colours from the earlier period were dropped from common use in the later period. One popular colour (5.5%), considered harmful by contemporary assessments, was used only in the earlier period. Two colours (11%) considered harmful were popular in the early period and were no longer popular but still used in the later period. A third colour (Orange II), about which there may have been doubt, although it was 'cleared' of harmfulness during the Departmental Committee hearings of 1924, was also dropped from common use. This shows some correlation between contemporary views on safety and the choice of colours by manufacturers. However, the degree of this is probably exaggerated. The set of colours reported to be popular in 1926 might partly have been wishful thinking on the part of Dr Drake-Law, who was very keen to demonstrate how responsible manufacturers were (38). But Orange II and Ponceau 2R, which were popular in 1922/23, but reportedly unpopular in 1926, were again popular in the 1930s. It suggests that they perhaps never dropped from popularity, and that Dr Drake-Law's list should have included more colours. The changes were possibly less dramatic than table 6.8 indicates.

Tables 6.6 and 6.7 (described in assessment 2) showed the overall changes that occurred between 1919 and 1928. When assessed retrospectively, the proportion of low risk colours increased relative to the medium risk colours. The proportion of high risk colours remained about the same, despite the ban on two of them. These changes were primarily the result of the voluntary action of manufacturers. The effects of the debates preceding the regulations had more effect than the regulations themselves.

6.22 Assessment 4: Effects of delay

It is informative to assess the burden of hazard experienced by the public due to the delay in removing the 5 colours banned by the 1925 regulations. A Paris Ordinance of 1890 had banned coal tar colours such as Magenta, Methylene blue, and colours of the nitro group such as Naphthol yellow and Victoria yellow (39). The UK could have introduced a similar law in 1890 had there been the political will. Taking the four colours banned both in the UK in 1925 and in France in 1890, one can calculate the hazard burden created by their 'excess' use from 1890 onwards. Table 6.9 shows there were probably more than 98 years of unnecessary exposure to the four D-rated colours. However, assessment 2 shows that had the colours been banned they probably would have been replaced by equally hazardous colours so one can assume that an early introduction of the negative list would have had a negligible effect on health.

TABLE 6.9 : ESTIMATE OF NUMBER OF YEARS UNNECESSARY EXPOSURE TO HARMFUL COLOURS BECAUSE OF DELAY IN INTRODUCING REGULATIONS

Compiled from tables D.1 and J.1 in appendices D and J.

KEY:

a Use reported to be occasional by 1919

Colour	Year of discovery	Period of likely use between 1890-1925	Probable No. years of use
Aurantia	1873	c 1901	1+
Manchester yellow	1856	1890 - 1924	34
Picric acid	1771	1890 - 1919 a	29
Victoria yellow	1869	1890 - 1924?	34
Total number of years use between 1890 and 1924:			more than 98

6.23 Evaluation of Effects on Coal Tar Colours

While actively removing two harmful coal tar colours from use (as shown by assessment 1) the 1925 regulations continued to permit a range of other harmful colours (as shown by assessment 2). So the effect of the negative list was negligible. Manufacturers voluntarily reduced the use of colours considered harmful at the time (assessment 3). Applying the retrospective hazard assessment, the proportion of high risk colours remained about the same in 1919 and 1928. The proportion of low risk colours increased and medium risk colours fell (assessment 2).

Depending on the colours chosen, there might have been benefits if a much greater number of coal tar colours had been banned, or if a negative list had been introduced many years earlier (assessment 4). But the state of toxicological knowledge was so under-developed that there is a chance this might have resulted in increased use of high risk colours. In the absence of a complete toxicological survey the only two policies that would have guaranteed a significant reduction in the hazard from coal tar colours would have been:

a) A complete ban on all coal tar colours
b) A ban on the use of colours in staple foods, by compositional standards, reserved descriptions, restricted uses, or similar forms of regulation.

This is discussed in chapter 7.

6.24 EFFECTS ON MINERAL COLOURS

The 1925 regulations finally banned compounds of eight metals agreed by most authorities for the previous twenty years to be harmful, although there was considerable debate about the harmfulness of the low levels actually used in food.

6.25 Assessment 1: Colours affected

Table D.3 in appendix D shows that most of the metallic colours widely used in the first half of the nineteenth century were no longer used in food well before they were banned in 1925. Copper sulphate was the only one significantly affected by the regulations. In 1920 Henry Kenwood of the Public Health Laboratory reported that:

> At the present day the sulphate of copper affords practically the sole important instance of the use of mineral agents in the coloration of food (40).

Some manufacturers argued very determinedly against a ban on copper sulphate during the hearings of the 1924 Departmental Committee. It was obviously still commercially important. The ban was actively responsible for preventing continued significant exposure to copper colouring.

Tables 6.10 and 6.11 show the colours removed between 1924 and 1954 (the earliest year for which data are available after 1925). The only change that occurred was the removal of one D-rated colour, copper sulphate.

6.26 Assessment 2: Trends before regulation

Table 6.12 compares the proportions of harmful colours reported to be in use in the years before the 1925 regulations, to assess the relative effects of regulations and voluntary trade action. There was a significant change during this period. The proportion of low and medium risk colours rose (after an initial drop in low risk colours). The proportion of high risk colours decreased enormously, from 50% of mineral colours in 1901 to 17% in 1924. The dramatic drop just before the regulations might have been partly due to manufacturers adjusting their practices knowing that regulations were imminent after the government inquiry. But other significant changes occurred before this: manufacturers finally replaced the few remaining mineral colours with coal tar colours, which were technically superior and cheaper.

6.27 Assessment 3: Effects of delay

The UK government could have introduced a negative list for mineral colours many years before 1925. This was technically possible but politically unacceptable to traders and government. Some countries had a negative list banning mineral colours in the 1850s. Arthur Hassall in 1861 reported that:

TABLE 6.10 : EFFECT OF 1925 REGULATIONS ON MINERAL AND METALLIC COLOURS: NUMBER & RATING OF COLOURS IN USE BEFORE AND AFTER REGULATIONS

Histogram comparing the number of colours of each hazard rating reported to be in use in 1921-1924 and 1954. Unfortunately, data are not available for the period immediately after the regulations.

Compiled from table D.3 and table I.4

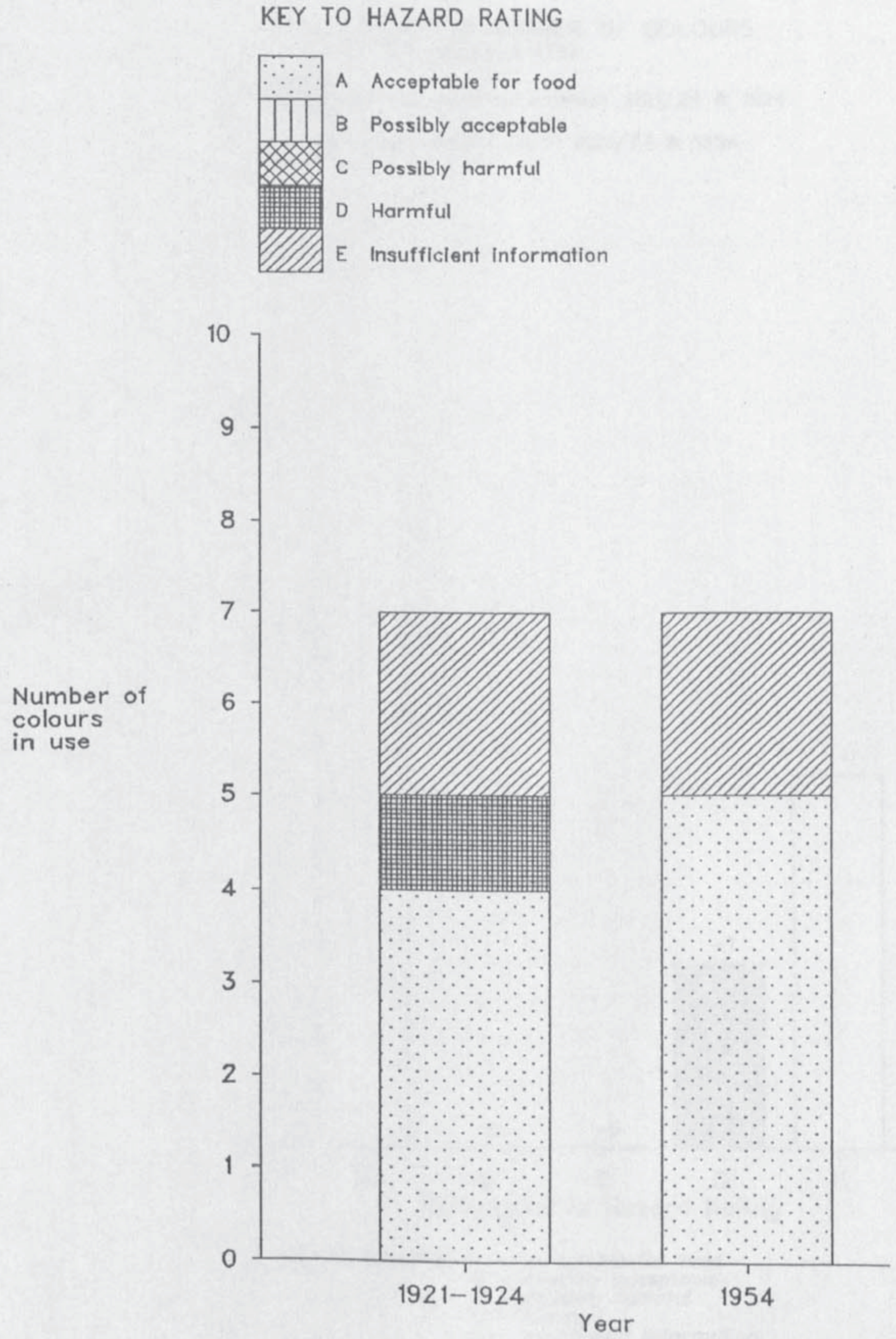


TABLE 6.11 : NUMBER OF MINERAL AND METALLIC COLOURS REMOVED BY THE NEGATIVE LIST OF 1925

Compiled from table D.3 and table I.4

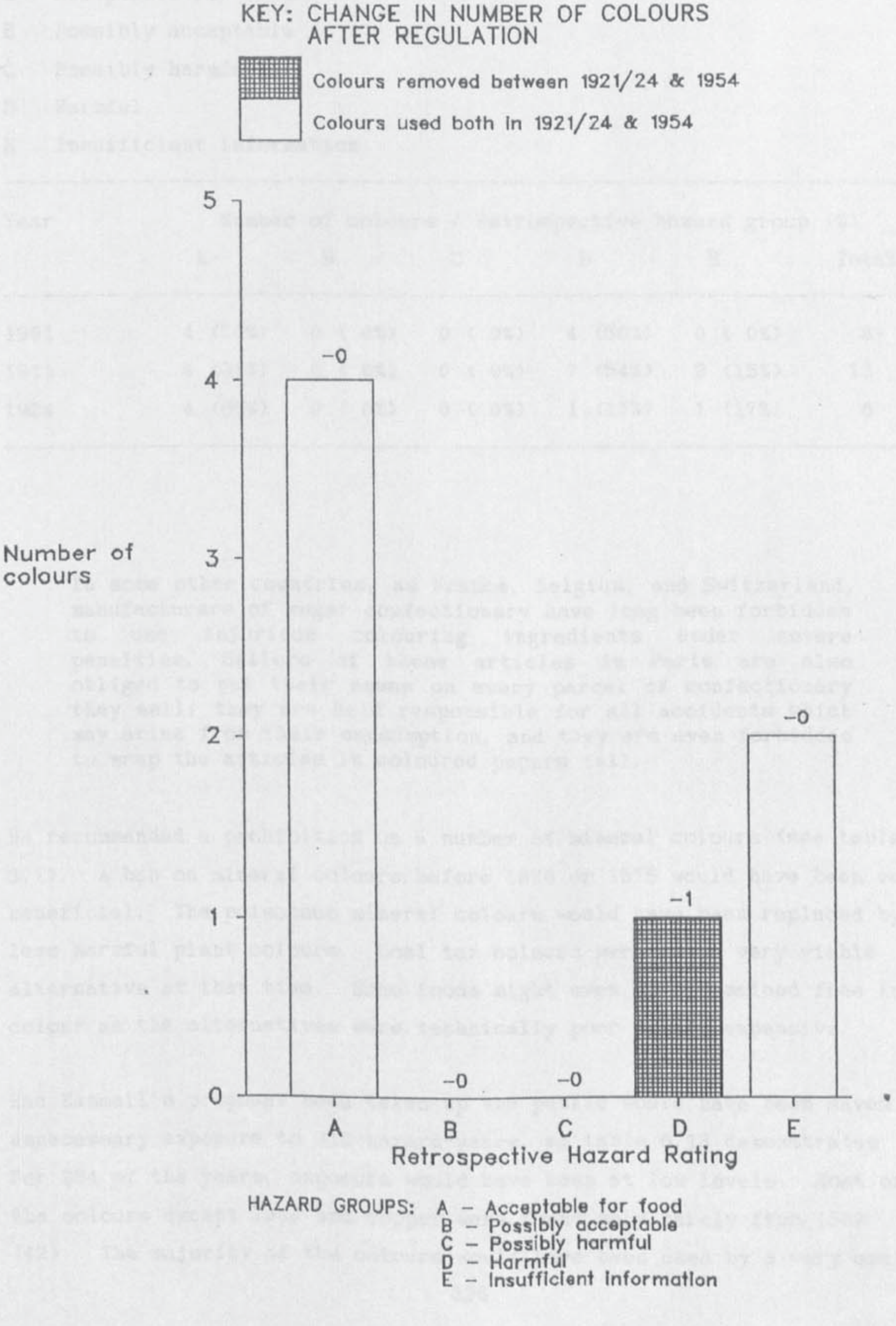


TABLE 6.12 : MINERAL COLOURS: TRENDS IN HAZARD GROUPS, 1901 - 1924

Compiled from table I.7 in appendix I.

KEY:

A Acceptable for food

B Possibly acceptable

C Possibly harmful

D Harmful

E Insufficient information

Year	Number of colours / Retrospective hazard group (%)					
	A	B	C	D	E	Total
1901	4 (50%)	0 (0%)	0 (0%)	4 (50%)	0 (0%)	8+
1911	4 (31%)	0 (0%)	0 (0%)	7 (54%)	2 (15%)	13
1924	4 (66%)	0 (0%)	0 (0%)	1 (17%)	1 (17%)	6

> In some other countries, as France, Belgium, and Switzerland, manufacturers of sugar confectionery have long been forbidden to use injurious colouring ingredients under severe penalties. Sellers of these articles in Paris are also obliged to put their names on every parcel of confectionery they sell; they are held responsible for all accidents which may arise from their consumption, and they are even forbidden to wrap the articles in coloured papers (41).

He recommended a prohibition on a number of mineral colours (see table 3.1). A ban on mineral colours before 1870 or 1875 would have been very beneficial. The poisonous mineral colours would have been replaced by less harmful plant colours. Coal tar colours were not a very viable alternative at that time. Some foods might even have remained free from colour as the alternatives were technically poor or too expensive.

Had Hassall's proposal been taken up the public would have been saved unnecessary exposure to 318 hazard-years, as table 6.13 demonstrates. For 254 of the years, exposure would have been at low levels. Most of the colours except lead and copper were found only rarely from 1887 (42). The majority of the colours would have been used by a very small

TABLE 6.13 : NUMBER OF YEARS USE OF SOME MINERAL COLOURS BANNED IN 1925

This list includes the colours Hassall proposed should be banned in 1861 that were banned eventually in 1925

Compiled from table 3.1 and directory of mineral colours in appendix B.

Metal compounds	Estimated period of use between 1861 and 1925	Number of years use
Antimony	1861 - 1875	14
Arsenic	1861 - 1911	50
Chromium	1861 - 1911	50
Copper	1861 - 1925	64
Lead	1861 - 1901	40
Mercury	1861 - 1911	50
Zinc	1861 - 1911	50
	Total:	318

number of manufacturers. But consistent use by a very small number of manufacturers may have meant the the hazard was concentrated in a very small number of consumers, and may have been relatively high for them. Certainly, a very considerable exposure of 64 years to copper could have been prevented.

6.28 Assessment 4: Trade action

The use of copper declined after 1852 (43). But it was then used more extensively from 1895 in canned vegetables (44). Its use seems to have become more significant as the canning industry grew. Table 6.14 summarises reports of the extent to which copper was used in food between 1755 and 1924. It was probably used continuously throughout this period in pickled and preserved vegetables. The peak periods of use were probably in 1840-1852, 1860-1880 and 1904-1924. The actual quantities (in parts per million) in products varied enormously, according to reports, although levels are likely to have dropped in 1852 and again in the early 1880s after adverse reports. In 1888 Wynter Blyth, a public analyst, reported that it was used in small quantities in products. Analysts in 1913-14 and 1921-22 reported levels of use ranging from 0.01 to 3.70 grains per lb (45). Variation among similar products showed it was used at higher levels by some manufacturers than was necessary to achieve the desired colouring effect.

Coppering foods like pickles and tinned peas had become a traditional practice among manufacturers by the time regulations were introduced in 1925. Table 6.14 shows that there was great fluctuation in the proportion of peas that were coppered in the two decades leading up to 1925, ranging from 40% to 100%. The proportion would have varied in different parts of the country. But most of the figures given in table 6.14 were from the same area. The sample size was low, and this may account for the fluctuation. There appears to have been a slight drop in the proportion between 1916 and 1921. In the following year, shortly before the regulations, there appears to have been a large increase to 83%. It seems that these manufacturers did not take any significant action to eliminate the use of copper. Some attempted to use low levels to reduce the hazard. This was encouraged by some prosecutions under the Food Acts against manufacturers who had used very high levels of copper.

Table 6.13 shows that manufacturers had stopped using the other mineral colours well before regulations were introduced. Their use decreased because of:

a) opinions about the harmfulness of some of the colours,
b) some successful prosecutions under the Food Acts,
c) the technical advantages offered by coal tar colours.

The latter point may have been the most significant factor.

Voluntary trade action was responsible for the removal of most harmful mineral colour. The regulations actively removed only one such colour.

TABLE 6.14 : USE OF COPPER AS A FOOD COLOUR, 1755 - 1924

Compiled from:

1 H F Steward Adversary and Advisory Processes in the Assessment and Control of Food Additives unpublished PhD thesis, University of Manchester, Manchester, July 1978, p110-111

2 J C Drummond & A Wilbraham The Englishman's Food Jonathan Cape, London 1958 p195-6

3 The Lancet Laboratory's submission to the 1901 Departmental Committee p377-8

4 F Vacher The Food Inspector's Handbook Sanitary Publishing Co, London 1913 p219

5 Evidence from LB Kensington to the Departmental Committee 1924 (PRO: MH56/18 p7)

6 Select Commmittee on Food Adulteration 1895 Parliamentary Paper 1895 vol x p356

7 Departmental Committee report 1901 p368

8 H R Kenwood Public Health Laboratory Work (Chemistry) Lewis, London 1920 p382

9 Departmental Committee report 1924 para 177

10 A Wynter Blyth Foods: Composition and Analysis Charles Griffin, London 1888, p81

11 A Hassall's evidence to Select Committee 1855 Parliamentary Papers 1854-5 vol VIII para 65

Year	Reported Level of Use
1755 (2)	Copper vessels sometimes used for food
1758 (2)	Cu compounds sometimes added to pickles
1852 (3)	Cu found in varying amounts in pickles and in 82% (27/33 samples) of bottled fruit and vegetables
1855 (11)	Cu compounds found in sugar confectionery, pickles, bottled fruit and vegetables, dried and crystallised fruit.
1861-65 (3)	Cu employed to a very large extent in green preserved fruit and vegetables
1877 (1)	Cu found in 100% (9/9 samples) of preserved peas in London

Year	Reported Level of Use
1877 (1)	One manufacturer used Cu; otherwise rare
1888 (10)	Cu used (not rare)
1895 (6)	Cu used
1901 (1,7)	Cu found in 36% (17/47 samples) of preserved vegetables; Cu 'extensively used'
1904 (5)	Cu found in 100% (6/6 samples) of pickles and tinned vegetables in Kensington
1905-13 (1)	Cu found in 45% of peas
1906 (5)	Cu found in 56% (9/16 samples) of tinned vegetables (other than peas) in Kensington
1907-16 (1)	Cu found in 90% of peas in Birmingham
1907 (5)	Cu found in 67% (8/12 samples) of tinned peas and 50% (2/4) vegetables in Kensington
1910 (5)	Cu found in 0% (5 samples) of tinned vegetables (other than peas) in Kensington
1913 (4)	Cu still used frequently in pickles and tinned vegetables; considered to be an adulteration by some
1915 (5)	Cu found in 100% (6/6 samples) of tinned peas in Kensington
1916 (5)	Cu found in 42% (11/26 samples) of tinned peas in Kensington
1918 (5)	Cu found in 63% (5/8 samples) of tinned peas and 0% (5 samples) of other tinned vegetables in Kensington
1920-21 (1)	Cu found in 40% of peas
1920 (8)	Cu 'important' mineral colour
1922 (5)	Cu found in 83% (5/6 samples) of tinned peas in Kensington
1924 (9)	Cu used

6.29 EFFECTS ON PLANT COLOURS

The negative list of 1925 finally banned one harmful plant colour, Gamboge. Gamboge was reported to be used occasionally in 1887 and 1919 (see table D.4). There are no reports for 1924; its use may have been occasional or may have ceased altogether by the time regulations were made. So the regulations can be considered to have had a negligible effect in removing hazardous plant colours.

6.30 Assessment 1: Before and after regulation

Table 6.15 attempts to compare the number of harmful plant colours reported to be in use before and after the 1925 regulations. Unfortunately, no complete data are available after 1925 until 1954. There was a reduction in the number of colours in use, from 20 to 16, as ancient colours such as Logwood and Madder were finally completely replaced by coal tar colours. In table 6.15 changes in hazards are assessed using the retrospective rating. The table shows only one D-rated colour (Gamboge) which was probably dropped from use before the regulations (as described above). One possibly harmful colour (the group of Quercitron extracts) was used both before and after the regulations. Table 6.16 shows that the only other significant change was a drop of two E-rated and two A-rated colours. But this was not due to regulations.

6.31 Assessment 2: Trends before regulation

Table 6.17 shows the changes that occurred among plant colours in the years before the 1925 regulations. The proportion of hish risk (C and D-rated) colours decreased steadily from 10% to zero between 1901 and 1924, as they were finally replaced by technically superior C.T. colours. The proportion of medium risk (B and E-rated) colours decreased from a high level of 73% in 1911 to 20% in 1924. The proportion of low risk colours decreased initially between 1901 and 1911, then increased enormously to 80% in 1924. This shows a significant reduction in hazard levels brought about by voluntary trade action. However, this was more an accident due to the technical properties of the colours than to good intentions on the part of

TABLE 6.15 : EFFECT OF 1925 REGULATIONS ON PLANT AND ANIMAL COLOURS: NUMBER & RATING OF COLOURS IN USE BEFORE AND AFTER REGULATIONS

This histogram compares the number of colours of each hazard rating (A-E) reported to be in use in 1919-1923 and 1954. Unfortunately no data are available immediately after the regulations.

Compiled from table D.4 and table I.5

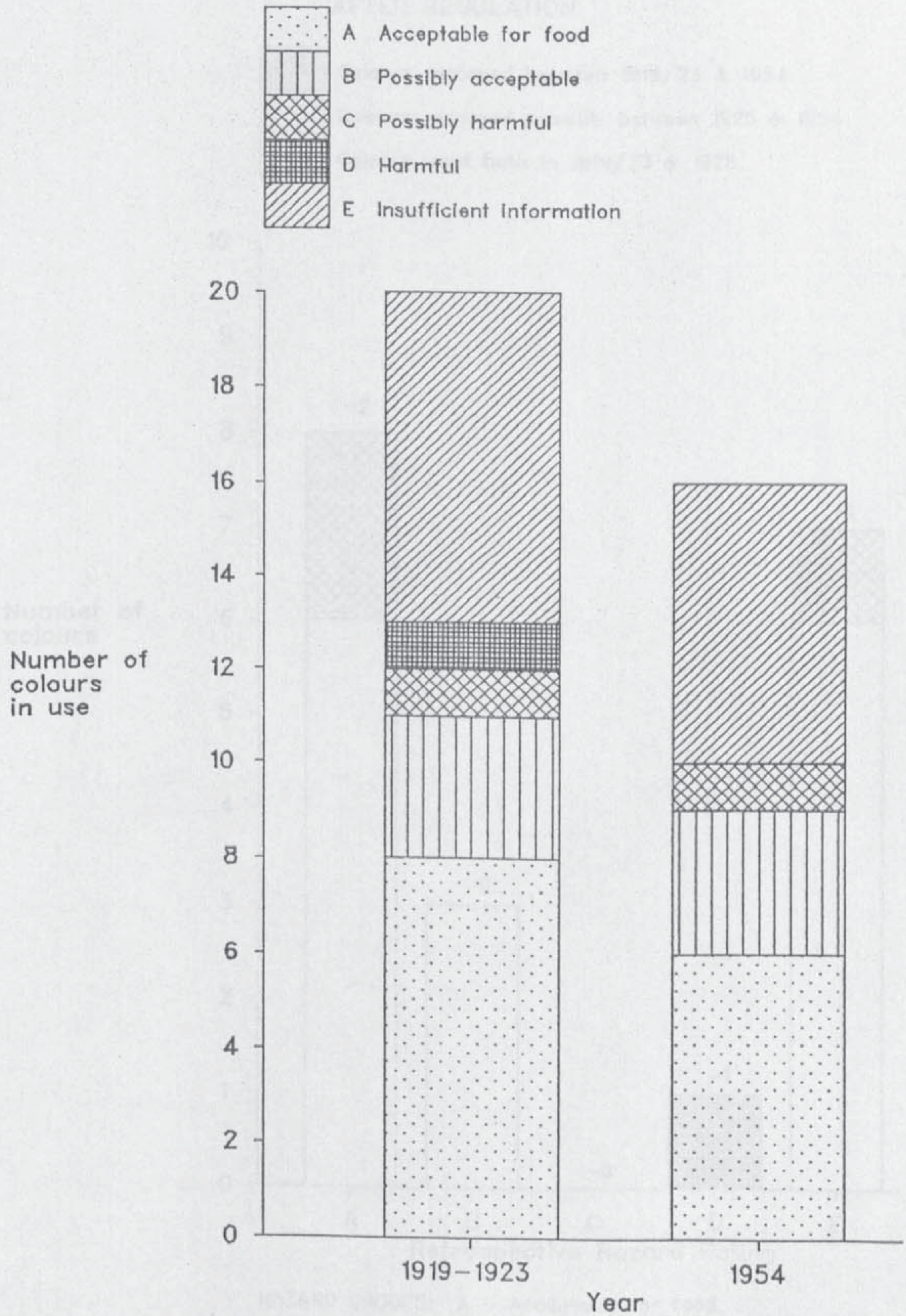


TABLE 6.16 : NUMBER OF PLANT AND ANIMAL COLOURS REMOVED BY NEGATIVE LIST OF 1925

This histogram divides the plant and animal colours by hazard rating (A-E) and demonstrates the number removed by and remaining after the 1925 regulations

Compiled from table D.4 and table I.5

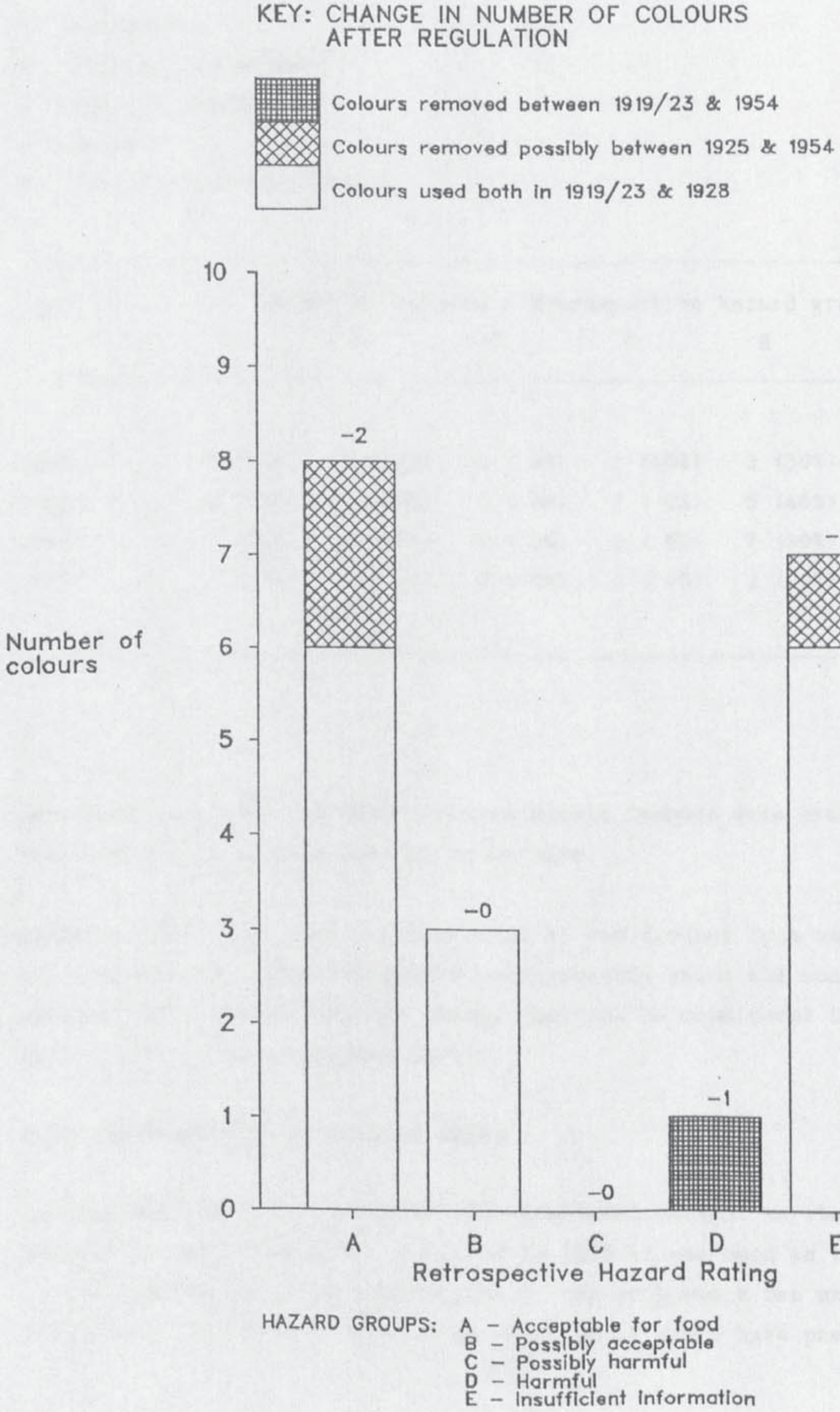


TABLE 6.17 : PLANT COLOURS: TRENDS IN HAZARD GROUPS, 1901 - 1924

Compiled from table I.8 in appendix I.

KEY:

A Acceptable

B Possibly acceptable

C Possibly harmful

D Harmful

E Insufficient information

Year	Number of colours / Retrospective hazard group (%)					
	A	B	C	D	E	Total
1901	5 (50%)	1 (10%)	0 (0%)	1 (10%)	3 (30%)	10
1911	2 (18%)	3 (27%)	1 (9%)	0 (0%)	5 (46%)	11
1919	7 (39%)	3 (17%)	0 (0%)	1 (5%)	7 (39%)	18
1924	4 (80%)	0 (0%)	0 (0%)	0 (0%)	1 (20%)	5+

manufacturers. All the plant colours except Gamboge were considered at the time and in earlier periods to be safe.

Gamboge, as we have seen in assessment 1, was dropped from use before the regulations. This change was predominantly under the control of manufacturers and is the only change that can be considered to have been partly due to concerns about safety.

6.32 Assessment 3: Effects of delay

Gamboge was the single plant colour considered harmful in itself by Hassall in the 1860s (46). He found in 1855 it was used in 11% (11 out of 101 samples) of sugar confectionery. He proposed a ban on it in 1861. Had a ban been introduced at the time it would have prevented 40 years use, plus another 18 or so years of occasional exposure (see table D.4 in appendix D).

6.33 Evaluation of the Negative List

The negative list of 1925 had a negligible effect on plant colours. It can be considered to have had a beneficial effect by removing two harmful coal tar colours and one harmful mineral colour. Manufacturers would have continued using these colours if they had not been banned. However, the coal tar colours were replaced by colours that were not necessarily less harmful, so the benefit was short-lived.

Trends before and after the regulations show there was a voluntary move away from coal tar colours considered harmful around 1925. Judged retrospectively, the changes produced a negligible reduction in the proportion of high risk colours. The proportion of low risk colours increased while medium risk colours fell. So voluntary trade action did bring some benefits.

In the UK a negative list was introduced so late and banned so few colours that it did not have much impact. But it is clear from experience in some countries that the negative list was useful when introduced early. It discouraged the use of colours in food when technically viable alternatives were not available. It also helped to set a precedent for the early introduction of a positive list in some countries.

The under-development of toxicological science meant that the early introduction of a negative list would have been useful for plant and mineral colours only. The health effects of a ban on a short or long list of coal tar colours would have been a gamble. It could have produced a greater proportion of high risk colours. In the absence of a thorough government sponsored toxicological survey the only policies that would have guaranteed a significant reduction in the hazards from coal tar colours were:

a) A complete ban on all coal tar colours
b) A ban on the use of colours in staple foods, by compositional standards, reserved descriptions, restricted uses, or similar forms of regulation.

6.34 EFFECTS OF POSITIVE LIST

In contrast to the negative list, the positive list introduced in 1957 had an enormous effect on the colours that could be used in food and the amount of protection given to public health by the state. It did not affect the three main classes of colours equally. The following sections discuss the effects on each group of colours in turn. For each, a variety of assessments are made. Then, some special areas are investigated: carcinogenic and allergenic hazards.

6.35 EFFECTS ON COAL TAR COLOURS

The permitted list of 1957 had a significant effect on the coal tar colours. It reduced the number of coal tar food colours by 70%, from 100 to 30. Below, I present a series of assessments of the effects on hazard levels and an evaluation of regulations as opposed to general trends in the choice of colours by the food and chemical industry.

6.36 Assessment 1: Contemporary hazard assessment

Table 6.18 clearly demonstrates that the colours banned by the positive list were those judged by a government advisory committee at the time to be harmful or possibly harmful. Table 6.19 shows that of 99 coal tar colours assessed by the Pharmacology Panel of the Food Standards Committee in 1955, all 51 (100%) that were known or suspected to have harmful effects were banned by the 1957 regulations. Half (51%) of the colours suspected of being harmless, but for which there was conflicting or insufficient information, were also removed. The introduction of the positive list can therefore be considered by this assessment to have had a very beneficial effect on health, reducing the proportion of recognised or suspected hazards by 100%. This represents a drop of colours suspected of being hazardous at the time from over half (52%) of all coal tar colours in use, to none.

TABLE 6.18: EFFECT OF 1957 REGULATIONS ON HEALTH: UK ADVISORY COMMITTEE'S ASSESSMENT OF THE SAFETY OF COAL TAR COLOURS USED IMMEDIATELY BEFORE AND AFTER THE INTRODUCTION OF THE PERMITTED LIST

Compiled from table I.1 and table E.1

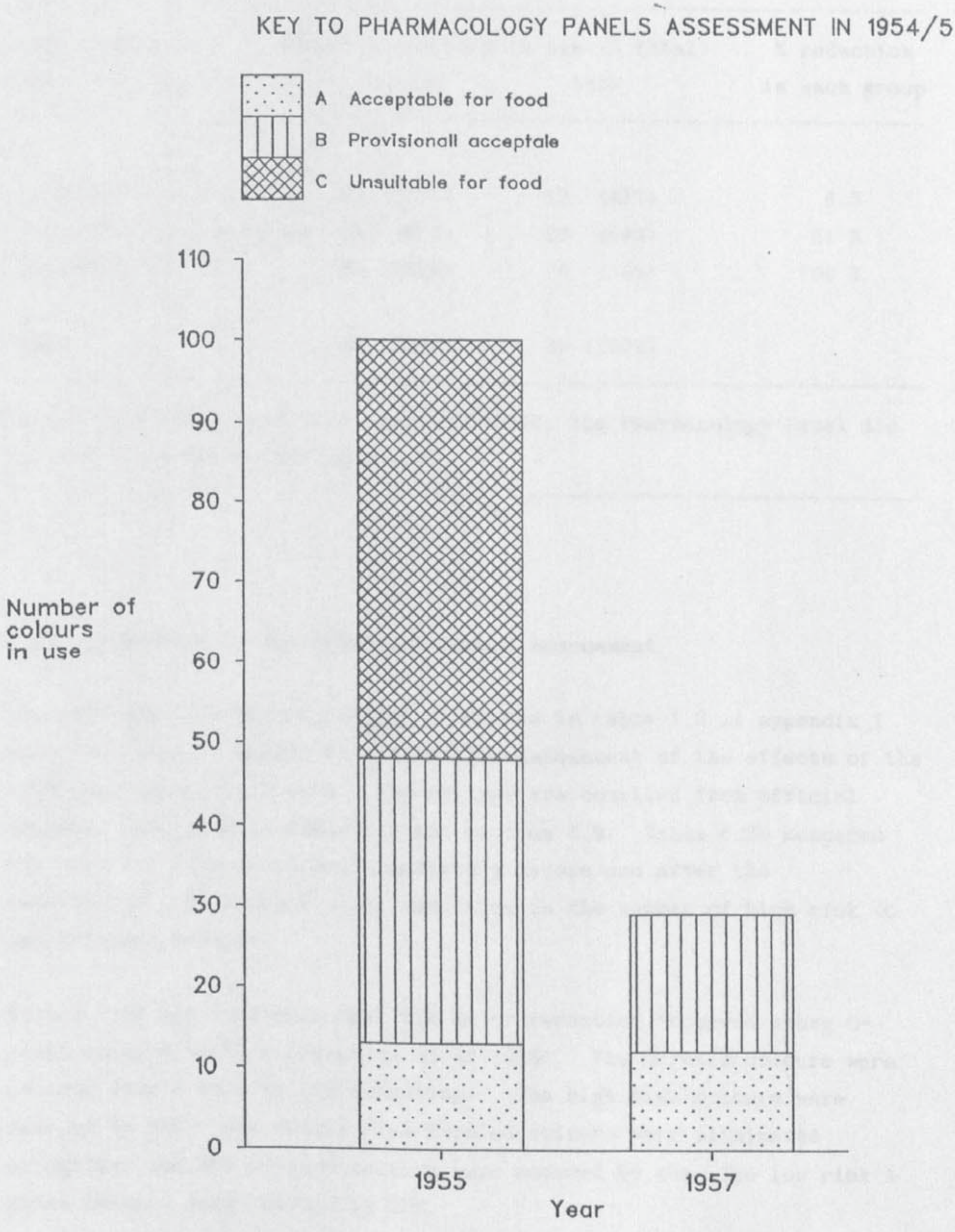


TABLE 6.19 : PROPORTION OF HAZARDOUS COAL TAR COLOURS IN USE BEFORE AND AFTER THE 1957 REGULATIONS - USING THE PHARMACOLOGY PANEL'S OWN ASSESSMENT OF 1954-5

Compiled from table I.1 and E.1

Contemporary hazard rating	Number of colours in use (% total) 1954/5	1957	% reduction in each group
Acceptable for food	13 (13%)	12 (41%)	8 %
Provisionally acceptable	35 (35%)	17 (59%)	51 %
Unsuitable for food	51 (52%)	0 (0%)	100 %
Total	99 (100%)	29 (100%)	

Note: This assessment excludes Violet BNP; the Pharmacology Panel did not publish a hazard rating for it.

6.37 Assessment 2: Retrospective hazard assessment

The retrospective hazard ratings presented in table I.3 in appendix I have been used to create an alternative assessment of the effects of the 1957 regulations on health. The ratings are compiled from official sources, described in table I.3 and section 6.9. Table 6.20 compares the coal tar colours in use immediately before and after the regulations. It shows a clear reduction in the number of high risk (C and D-rated) colours.

Tables 6.20 and 6.21 show that the major reduction occurred among C-rated colours, with a reduction of 47 (91%). The D-rated colours were reduced from 7 to 2 (a 71% reduction). The high risk colours were reduced by 89%. The medium risk B-rated colours were eliminated altogether and the E-rated colours were reduced by 48%. The low risk A rated colours were reduced by 20%.

TABLE 6.20: EFFECT OF 1957 REGULATIONS ON HEALTH: RETROSPECTIVE ASSESSMENT OF THE SAFETY OF COAL TAR COLOURS USED BEFORE AND AFTER THE INTRODUCTION OF THE PERMITTED LIST

Compiled from tables D.1, E.I and I.3

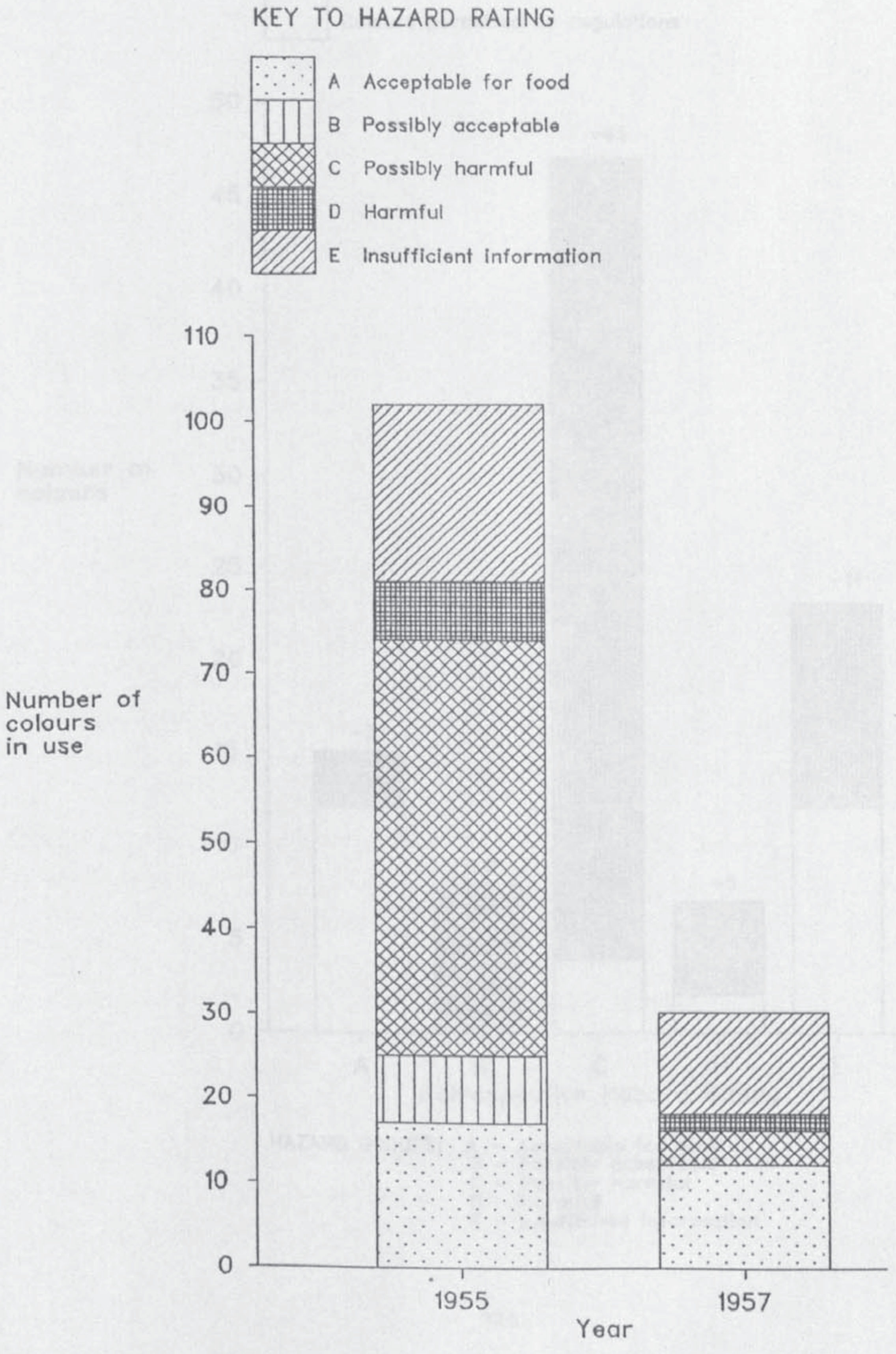


TABLE 6.21 : NUMBER OF COAL TAR COLOURS REMOVED BY THE 1957 REGULATIONS

Compiled from table D.1, table I.3 and table E.1

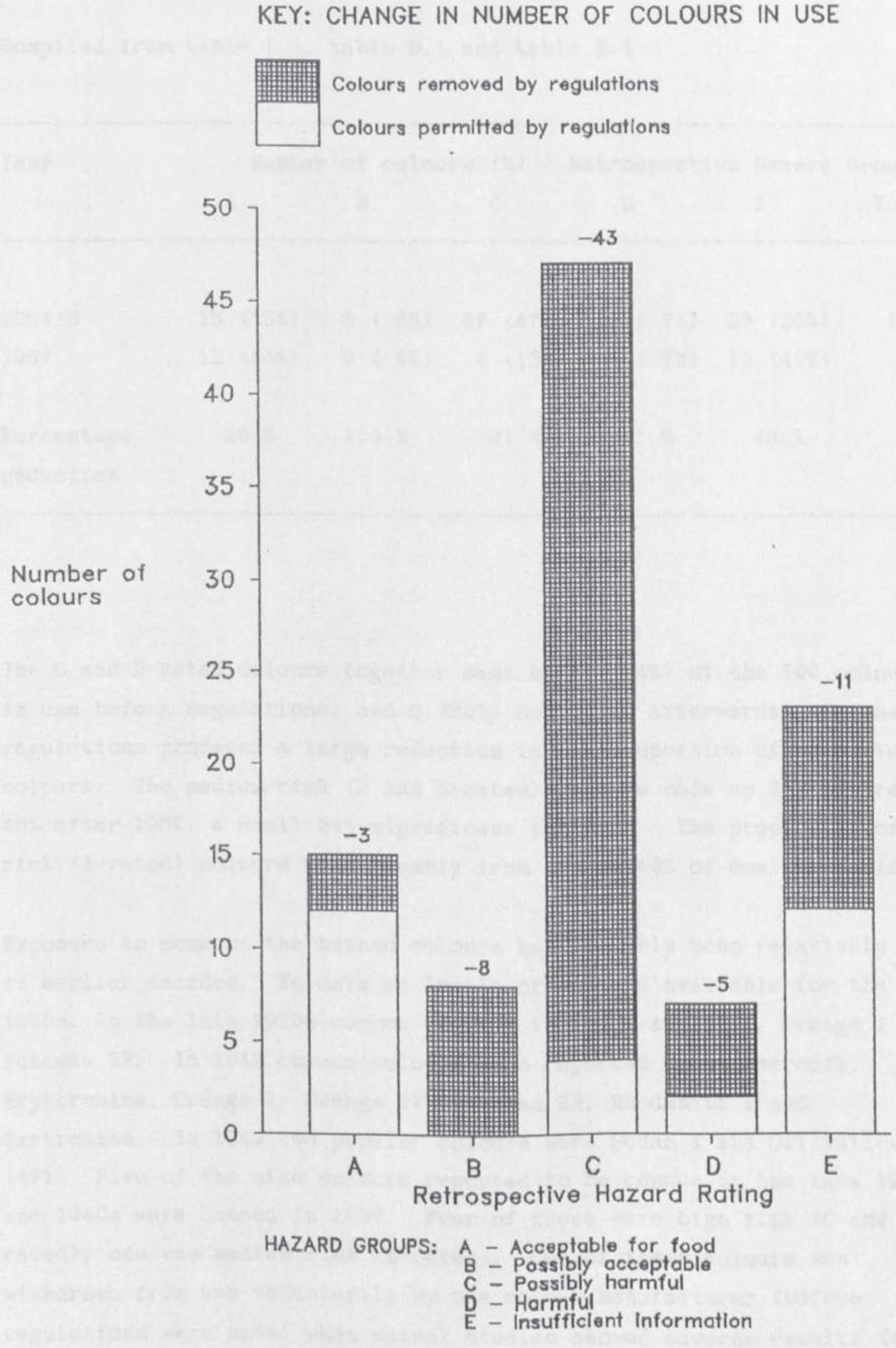


TABLE 6.22 : PROPORTION OF COAL TAR COLOURS IN USE IMMEDIATELY BEFORE AND AFTER THE 1957 REGULATIONS, DIVIDED BY RETRODSPECTIVE HAZARD RATING

Compiled from table I.3, table D.1 and table E.1

Year	Number of colours (%) / Retrospective Hazard Group					
	A	B	C	D	E	Total
1954/5	15 (15%)	8 (8%)	47 (47%)	7 (7%)	23 (23%)	100
1957	12 (40%)	0 (0%)	4 (13%)	2 (7%)	12 (40%)	30
Percentage reduction	20 %	100 %	91 %	71 %	48 %	

The C and D-rated colours together made up 54 (54%) of the 100 colours in use before regulations, and 6 (20%) out of 30 afterwards. So the regulations produced a large reduction in the proportion of high risk colours. The medium risk (B and E-rated) colours made up 31% before and 40% after 1957; a small but significant increase. The proportion of low risk (A-rated) colours rose greatly from 15% to 40% of coal tar colours.

Exposure to some of the banned colours had probably been relatively high in earlier decades. No data on levels of use are available for the 1950s. In the late 1930s common colours included Amaranth, Orange I and Ponceau 2R. In 1942 common colours were reported to be Amaranth, Erythrosine, Orange I, Orange II, Ponceau 2R, Rhodamine B and Tartrazine. In 1949 two popular colours were Sudan I and Oil yellow HA (47). Five of the nine colours reported to be common in the late 1930s and 1940s were banned in 1957. Four of these were high risk (C and D-rated); one was medium risk (E-rated). One of these colours was withdrawn from use voluntarily by one colour manufacturer (before regulations were made) when animal studies showed adverse results (48).

Assessment 2 shows that the effects of the positive list were very beneficial. They were not as beneficial as the contemporary hazard assessment suggested (assessment 1). The Pharmacology Panel's policy was to remove obvious high risk colours. But this left an enormous group (40% of the total) of medium risk 'unknowns'. This was an unsatisfactory state, although a great improvement on the unregulated situation. One of the prime limitations to the Pharmacology Panel's assessment was that they took lack of toxicological information as an indication of lack of hazard, for some colours. This point is examined later in chapter 7.

6.38 Assessment 3: Trade action

Table 6.23 examines the trends in hazard levels before regulation. The proportion of D-rated colours fluctuated, but moved down from 24% in 1926 to 7% in 1954/5. The proportion of C-rated colours also fluctuated, and moved upwards a moderate amount from 34% to 47%. The high risk colours were reduced slightly from 59% to 54%. The medium risk (B and E-rated) colours doubled from 14% to 31%. The proportion of low risk (A-rated) colours was reduced by about the same amount, from 28% to 15%, although there was some fluctuation. So trade control in the period before regulation produced a reduction in D-rated and low risk colours and a rise in medium risk colours.

There are few reports of the popular colours in the 1930s and 1940s. The reports indicate that at least ten colours (listed in assessment 2) were common in these periods. Butter yellow, once popular, was voluntarily phased out by some manufacturers in the late 1930s after animal tests indicated a risk of cancer. Although a call for a prohibition on it in 1942 possibly indicated a degree of concern that not all manufacturers had ceased to use it. Sudan I was withdrawn from sale by one colour manufacturer after being informed of the results of tests on animals (50).

Despite early adverse reports on two colours, Rhodamine B and Orange II, they remained common in the 1940s and were still used in 1954. They were banned by the positive list of 1957.

TABLE 6.23 : COAL TAR COLOURS: TRENDS IN THE PROPORTIONS OF HAZARD GROUPS, 1926 - 1955

Compiled from table I.6 in appendix I.

KEY:

A Acceptable for food

B Possibly acceptable

C Possibly harmful

D Harmful

E Insufficient information

Year	Number of Colours (%) / Retrospective Hazard Group					
	A	B	C	D	E	Total
1926	8 (28%)	2 (7%)	10 (34%)	7 (24%)	2 (7%)	29
1928	10 (21%)	0 (0%)	18 (37%)	9 (19%)	11 (23%)	48
1935/6	8 (28%)	0 (0%)	10 (34%)	6 (21%)	5 (17%)	29
1942	3 (38%)	0 (0%)	3 (38%)	0 (0%)	2 (25%)	8+
1954/5	15 (15%)	8 (8%)	47 (47%)	7 (7%)	23 (23%)	100

The same information is rearranged into low, medium and high risk groups, below:

Year	Number of colours (%) / Risk Group			
	Low risk (A)	Medium risk (B + E)	High risk (C + D)	Total
1926	8 (28%)	4 (14%)	17 (59%)	29
1928	10 (21%)	11 (23%)	27 (56%)	48
1935/6	8 (28%)	5 (17%)	16 (55%)	29
1942	3 (38%)	2 (25%)	3 (38%)	8+
1954/5	15 (15%)	31 (31%)	54 (54%)	100

This implies that although some manufacturers voluntarily stopped producing or using certain hazardous colours they were not all prepared to stop using colours that were very well suited to their technical needs.

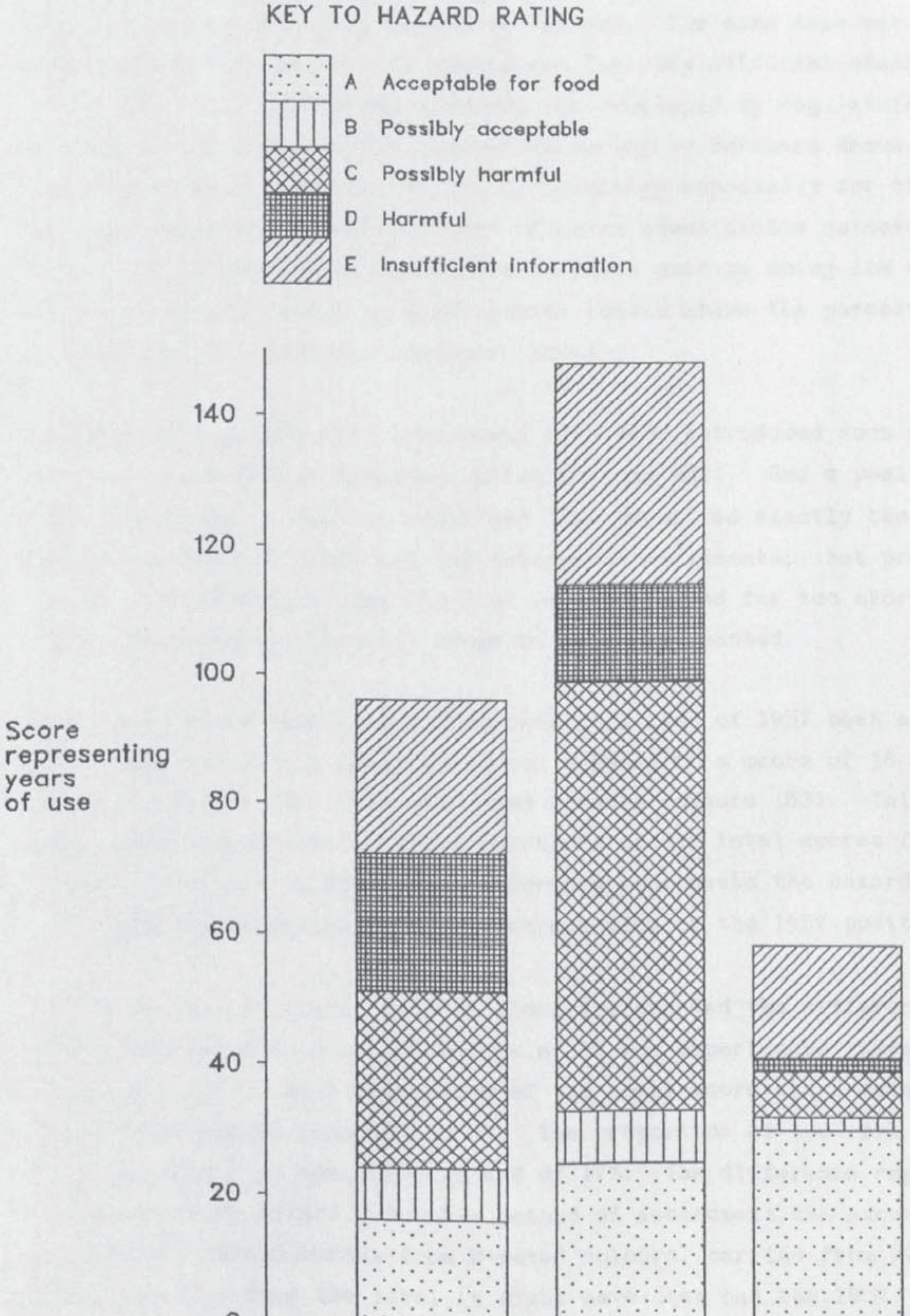
6.39 Assessment 4: Comparison of periods of regulation and trade control

A measurement can be made of the health burden from coal tar colours in the periods before and after the 1957 regulations. In this case the period of 1925-1956 is compared with 1957-1987. Table 6.24 presents the hazard burden measured as the relative number of years of reported use. To compensate for the different number of years in each period colours have been assigned a score for the proportion of reports of use in each period. The scores and method are given in section 6.8 and appendix K.

The hazard burden score for 1925-56 takes into account the changes that occurred in the use of C and D-rated colours in that period. These changes were made by the trade, not by regulation. The score therefore represents to some extent the activity of trade in either reducing or increasing the use of hazardous colours. Table 6.24 shows the hazard score of an earlier period that was predominantly under trade control. The effect of trade activity in reducing hazard can be measured by comparing changes between the two periods in columns 1 & 2. It shows that the proportion of D-rated colours decreased from 22% to 10%, while C-rated colours increased from 28% to 45%. C and D-rated colours together increased from 50% to 55% during the periods of trade control. This compares with a decrease in C and D colours from 55% to 15% as a result of the period of regulatory control. This suggests that, although the voluntary action of manufacturers was responsible for a large reduction in the proportion of D-rated colours, there was a large increase in the proportion of C-rated colours. The period of regulation can be seen to have been much more effective in reducing hazards from coal tar colours.

TABLE 6.24 : HAZARD BURDEN FROM COAL TAR COLOURS: SCORES FOR THREE PERIODS BETWEEN 1901 AND 1987

Compiled from table 6.57



6.40 Assessment 5: Effects of delay

A number of other countries introduced positive lists for coal tar colours at the end of the nineteenth century (see discussion in chapters 3 and 5). Most suffered from the problem of failing to identify properly the colours they sought to control. The same name was sometimes used by several manufacturers for very different chemicals (51). The first systematic approach was developed by regulators in 1906 to 1909 in the USA after an exhaustive survey by Bernhard Hesse, a consultant employed by the Bureau of Chemistry especially for the task. The USA introduced a positive list of seven identifiable colours in 1909. The UK government could have followed suit by doing its own survey if it had chosen to place public health above the perceived interests of the food and chemical industry.

An identifiable permitted list could have been introduced soon after 1901 when some Public Analysts called for one (52). Had a positive list been introduced in 1901 it would not have permitted exactly the same colours as the 1957 list and its subsequent amendments; but probably one of similar length. The USA list was considered far too short to offer manufacturers the full range of hues they wanted.

Table 6.25 shows that if the long permitted list of 1957 been adopted in 1901, then the public would have been exposed to a score of 18 hazard-years instead of 129, from the C and D-rated colours (53). This represents a reduction in the proportions of the total scores from 53% to 15% of colours in use. The difference represents the hazard that could have been removed by early introduction of the 1957 positive list.

If the scores of D-rated colours alone are counted the difference is still considerable: a hazard burden of 36 was experienced instead of a possible 4 (54). As a proportion of the total score the D-rated colours would have dropped from 15% to 3%. The proportion of low risk (A-rated) colours would have been 52% instead of 17%. The difference represents the preventable hazard. By this method of assessment the excess or preventable hazard burden from D-rated colours, carried from 1901 - 1956, was five-fold the level it might have been had the 1957 regulations been introduced in 1901 (55). The excess burden from all high risk (C and D-rated) colours was three-fold.

TABLE 6.25 : HAZARD SCORES OF 1901-1956 AND SCORES OF PERMITTED LIST FOR SAME PERIOD

Compiled from table 6.57

	Score for retrospective hazard groups					
	A	B	C	D	E	Total
Score for 1901-1956	41 (17%)	16 (6%)	93 (38%)	36 (15%)	58 (24%)	244
Score of permitted list for 1901-1956	60 (52%)	4 (3%)	14 (12%)	4 (3%)	34 (29%)	116

If the short USA positive list had been introduced in 1909 the benefits would have been less than might hae been expected. Table 6.26 compares the hazard score experienced between 1901 and 1956 and the scores of the USA list for the same period.

If the USA list had been adopted the high risk (C and D-rated) colours would have increased slightly from 53% to 57% of the total. The meduim risk (B and E-rated) colours would have been reduced from 30% to zero. The low risk (A-rated) colours would have doubled from 17% to 43%. It was unfortunate that Hesse's survey resulted in a high proportion of colours that turned out to be C-rated. This demonstrates the problem of inadequate toxicological information, described in chapters 3 and 7.

Nevertheless, it is likely that the short USA list brought a reduction in hazards because it had the effect of restricting coal tar colours to fewer foods. In the early 1900s the USA's permitted colours had not been adapted to suit a wide range of foods. Consequently they were technically inappropriate for certain applications.

TABLE 6.26 : HAZARD SCORES OF 1901-1956 COMPARED TO SCORES OF EARLY U.S.A. POSITIVE LIST

Compiled from table 6.57

Period	Score for retrospective hazard groups (%)					
	A	B	C	D	E	Total
Hazard score for 1901-1956	41 (17%)	16 (6%)	93 (38%)	36 (15%)	58 (24%)	244
Hazard score for USA list	12 (43%)	0 (0%)	12 (43%)	4 (14%)	0 (0%)	28

Note: The USA list included Amaranth, Erythrosine, Indigo carmine, Light green SF, Naphthol yellow S, Orange I and Ponceau 3R.

6.41 Summary of Effects of Permitted List on Coal Tar colours

The five assessments presented above all indicate that the positive list had a large effect in reducing hazards. Assessment 1 shows a drop in high risk colours based on the contemporary state of knowledge, from 52% to zero, an enormous reduction. Assessment 2 shows a reduction in colours, assessed retrospectively to be high risk, from 54% to 20%. This provides a more objective assessment of the benefits of the positive list.

Between 1901 and 1956 manufacturers had withdrawn voluntarily a number of colours on suspicion of harm or for technical improvements, and had replaced them with colours that were sometimes safer, sometimes not. The activities of manufacturers were primarily responsible for a drop in D-rated colours between 1925 and 1956. But the reduction in overall hazard levels was much greater during the period of the permitted list

(1957-1987). So the positive list system was considerably more successful in reducing the levels of hazard than voluntary trade action.

6.42 EFFECTS ON MINERAL COLOURS

The positive list of colours of 1957 made no significant difference to the few metallic and mineral colours. By 1957 the use of most mineral colours in food had become commercially insignificant.

6.43 Assessment 1: Colours affected

Table 6.27 shows the number of mineral colours in use immediately before and after the regulations. There was no change in the overall number of colours. All the colours reported still to be used in 1954/5 were presumed reasonably safe and placed on the permitted list. So there was no change in the proportion of colours in each hazard group when analysed by the contemporary hazard assessment of the Pharmacology Panel (listed in table I.1 in appendix I). When the hazard is judged retrospectively, there was also no change in the hazard ratings between the two periods, as table 6.28 demonstrates. There were no high risk colours. The proportion of medium risk (E-rated) colours remained at 29%. The proportion of low risk (A-rated) colours remained at 71%.

6.44 Assessment 2: Trends before regulation

Unfortunately no data are available to show the colours in use between 1924 and 1954. The same number of mineral colours were apparently in use in 1921-24 and 1954, although there was a considerable change in the actual colours in use.

Table 6.29 shows the change in the proportion of hazard groups before regulation. The high risk (D-rated) colours fell from 16% in 1924 to zero in 1954. (This was due to the ban on copper sulphate in 1925, mentioned above.) The proportion of medium risk (E-rated) colours rose from 16% to 29%. The proportion of low risk (A-rated) colours rose from 67% to 71%. So slight improvements were made by voluntary trade action.

TABLE 6.27: EFFECT OF THE 1957 REGULATIONS ON MINERAL AND METALLIC COLOURS: NUMBER OF COLOURS REPORTED IN USE BEFORE AND AFTER REGULATIONS

This histogram divides the colours by hazard rating and shows the numbers reported to be in use in 1954 compared with the number permitted in 1957

Compiled from table D.3 and table I.4

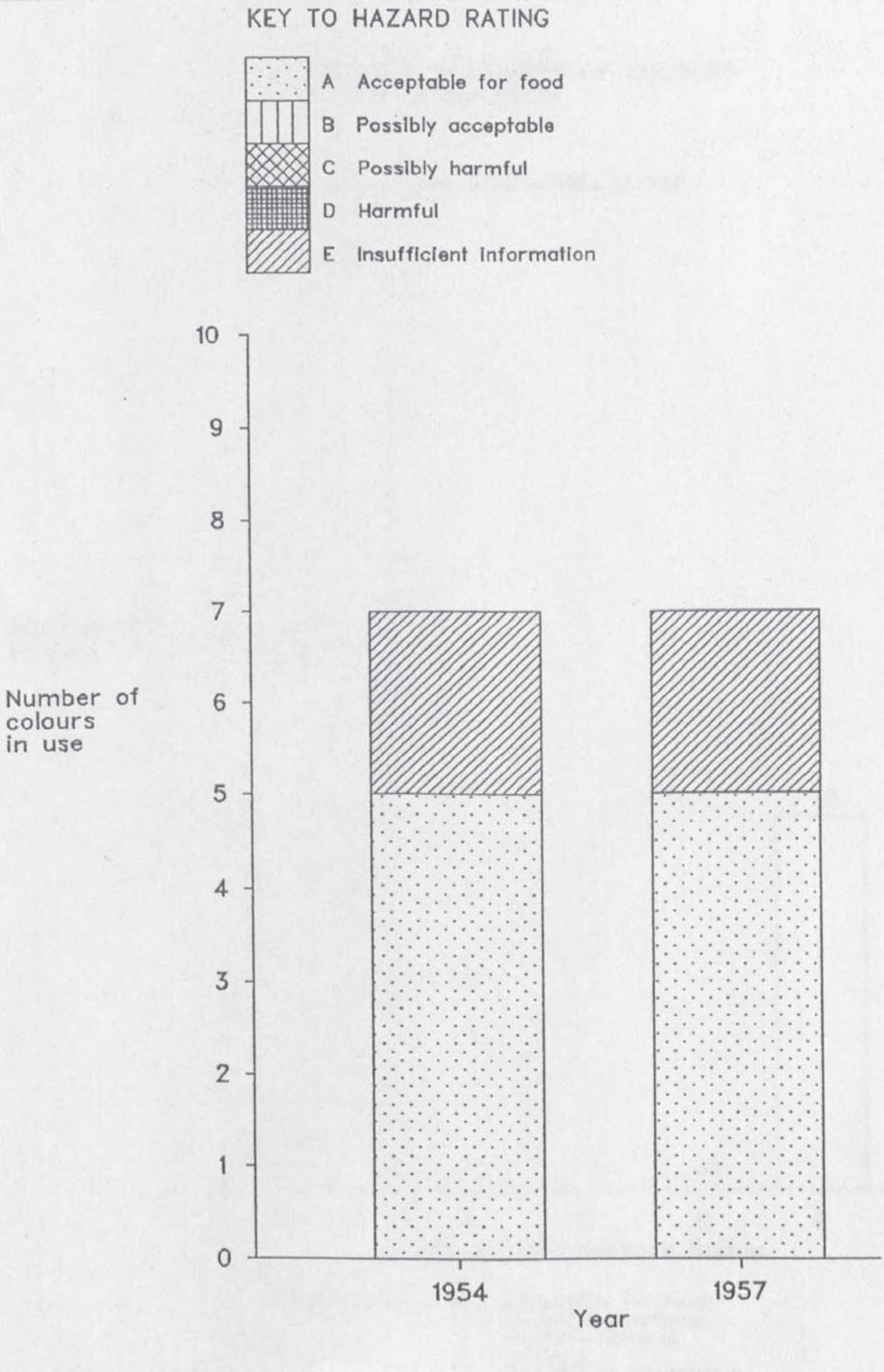


TABLE 6.28 : EFFECT OF 1957 REGULATIONS ON MINERAL AND METALLIC COLOURS: NUMBER OF COLOURS REMOVED BY THE PERMITTED LIST

This histogram divides the mineral and metallic colours by hazard rating (A-E). The shaded areas show the number of colours removed by the permitted list of 1957

Compiled from tables D.3, E.2 and I.4

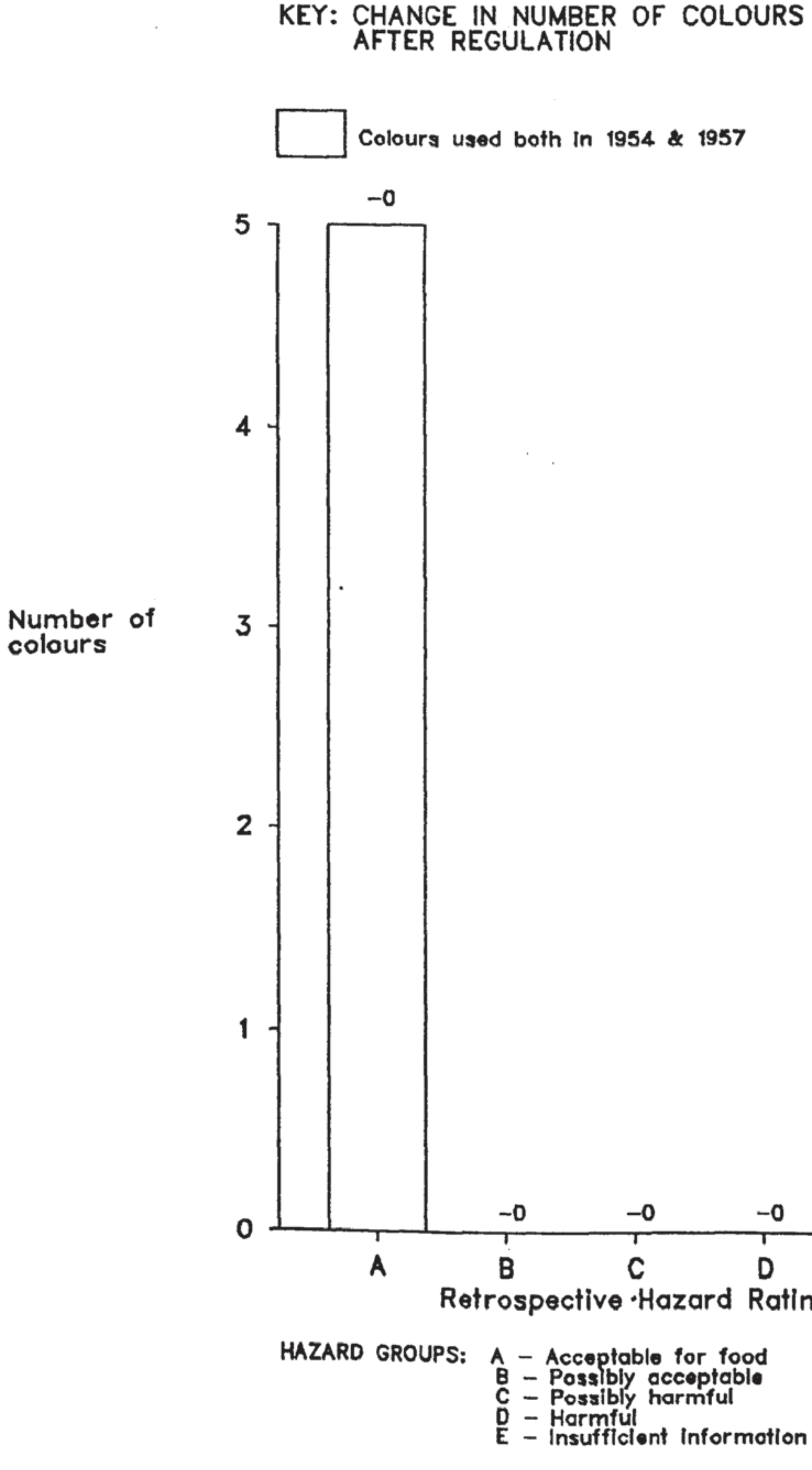


TABLE 6.29 : MINERAL COLOURS: TRENDS IN THE PROPORTIONS OF HAZARD GROUPS, 1924 - 1954

Compiled from table I.7 in appendix I

KEY:
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Year	Number of Colours (%) / Retrospective Hazard Group					
	A	B	C	D	E	Total
1924	4 (67%)	0 (0%)	0 (0%)	1 (16%)	1 (16%)	6
1954	5 (71%)	0 (0%)	0 (0%)	0 (0%)	2 (29%)	7

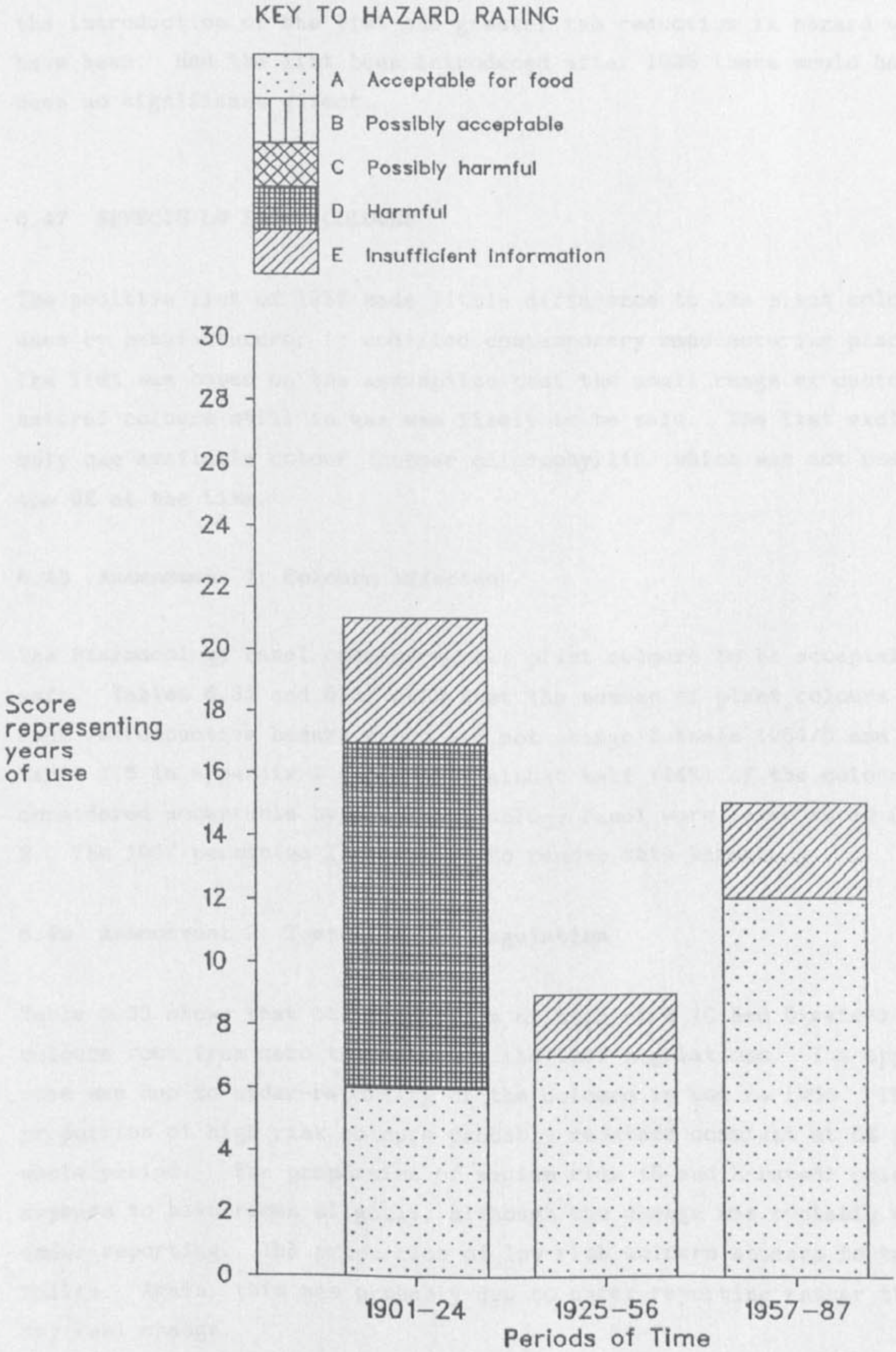
6.45 Assessment 3: Effects of delay

Table 6.30 shows that had the positive list been introduced in 1901 the public would have been exposed to a score of zero D-rated colours instead of 11. There were no C-rated colours for either period. As a proportion of the colours in use the scores of the high risk (D-rated) colours dropped from 52% to 0%.

By this method of assessment the excess or preventable hazard from high risk (D-rated) colours carried from 1901 was 52-fold the level it might have been had regulations been introduced earlier. However, as the graph in table 6.30 shows, this 52-fold hazard burden was only carried for the period 1901-1924; mostly in the early part of that period (see discussion in section 6.25). Commercial need for mineral colours reached its lowest point in the period of 1925-1956. If a positive list had been introduced for mineral colours in 1925 it would have had little effect except banning copper sulphate. If introduced before that time it would have had a significant effect.

TABLE 6.30 : HAZARD BURDEN FROM MINERAL COLOURS: SCORES FOR THREE PERIODS BETWEEN 1901 AND 1987

Compiled from table 6.60



6.46 Effects of positive list on mineral colours

The positive list in 1957 had no effect on hazard levels from mineral colours. Had it been introduced at any point before 1925 there would have been a significant reduction in the burden of hazard. The earlier the introduction of the list the greater the reduction in hazard would have been. Had the list been introduced after 1925 there would have been no significant effect.

6.47 EFFECTS ON PLANT COLOURS

The positive list of 1957 made little difference to the plant colours used by manufacturers; it codified comtemporary manufacturing practice. The list was based on the assumption that the small range of customary natural colours still in use was likely to be safe. The list excluded only one available colour (copper chlorophyllin) which was not used in the UK at the time.

6.48 Assessment 1: Colours affected

The Pharmacology Panel considered all plant colours to be acceptably safe. Tables 6.31 and 6.32 show that the number of plant colours in each retrospective hazard group did not change between 1954/5 and 1957. Table I.5 in appendix I shows that almost half (44%) of the colours considered acceptable by the Pharmacology Panel were later rated C and E. The 1957 permitted list failed to remove this hazard.

6.49 Assessment 2: Trends before regulation

Table 6.33 shows that the proportion of high risk (C and D-rated) colours rose from zero to 6% before the 1957 regulations. The apparent rise was due to under-reporting of the colours in use in 1936. The proportion of high risk colours probably remained constant at 6% for the whole period. The proportion of medium risk (B and E-rated) colours appears to have risen slightly, although the change was probably due to under-reporting. The proportion of low risk colours appears to have fallen. Again, this was probably due to under-reporting rather than to any real change.

TABLE 6.31: EFFECT OF 1957 REGULATIONS ON PLANT AND ANIMAL COLOURS: NUMBER OF COLOURS IN USE BEFORE AND AFTER REGULATIONS

Histogram comparing the number of colours of each hazard rating in use before the 1957 regulations and permitted after 1957

Compiled from tables D.4, E.3 and I.5

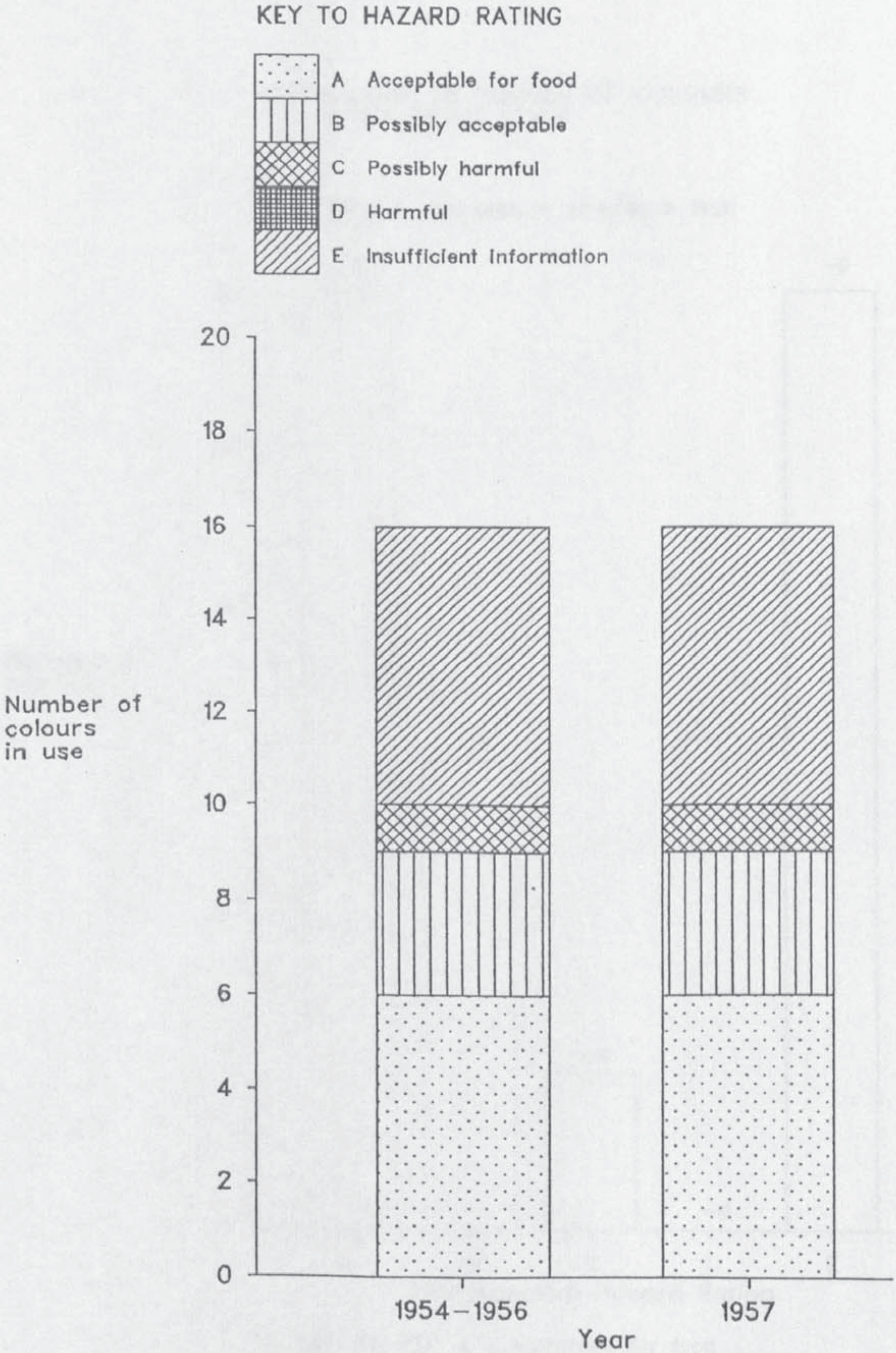


TABLE 6.32: EFFECT OF 1957 REGULATIONS ON PLANT AND ANIMAL COLOURS: NUMBER OF COLOURS REMOVED BY THE PERMITTED LIST

This histogram divides the colours by hazard rating and shows the change in number caused by the 1957 regulations

Compiled from tables D.4, E.3 and I.5

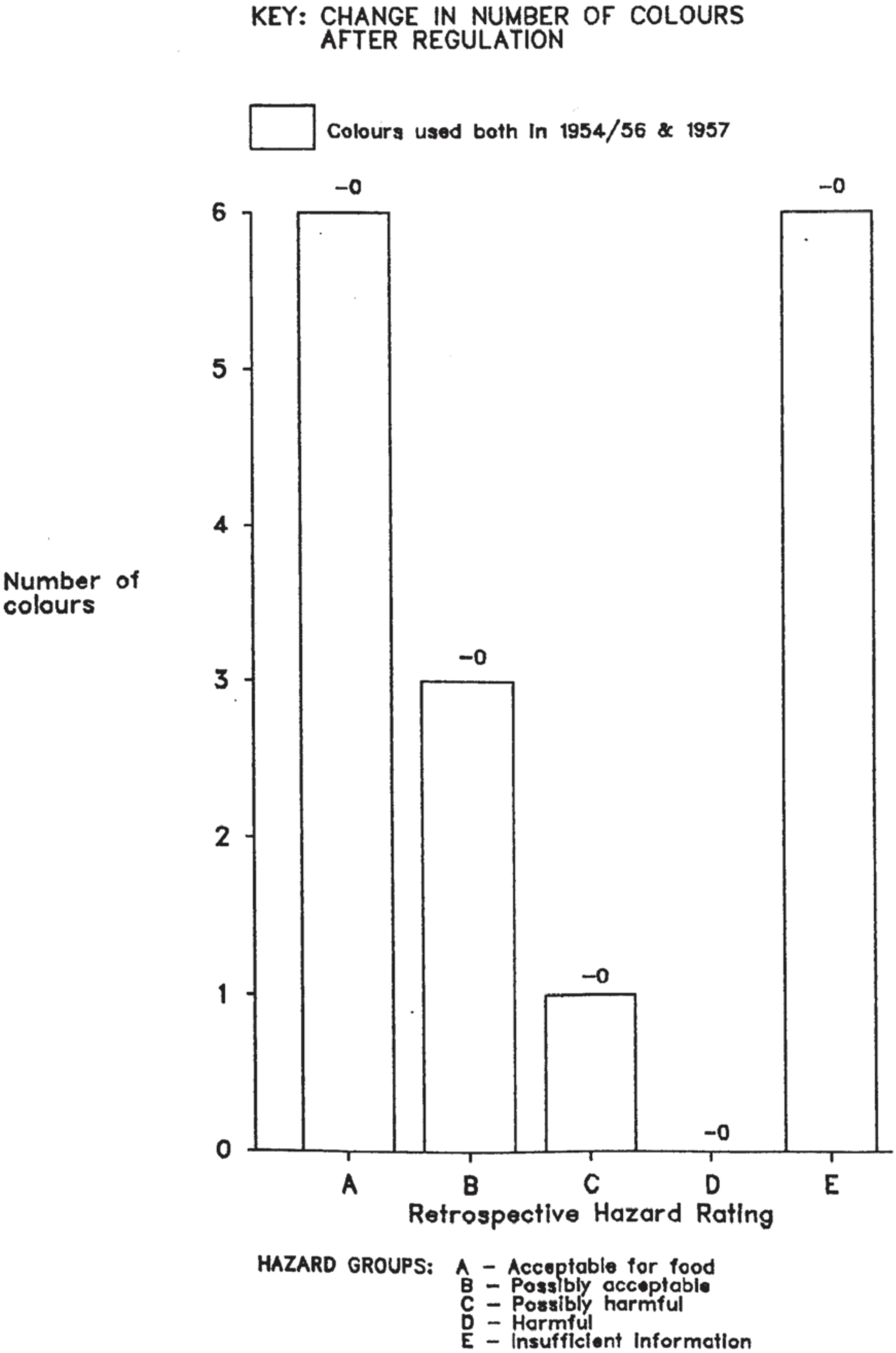


TABLE 6.33 : PLANT COLOURS: TRENDS IN THE PROPORTIONS OF HAZARD GROUPS, 1936 - 1954

Compiled from table I.8 in appendix I

KEY:
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Year	Number of Colours (%) / Retrospective Hazard Group					
	A	B	C	D	E	Total
1936	3 (50%)	1 (17%)	0 (0%)	0 (0%)	2 (33%)	6+
1954	6 (38%)	3 (19%)	1 (6%)	0 (0%)	6 (37%)	16

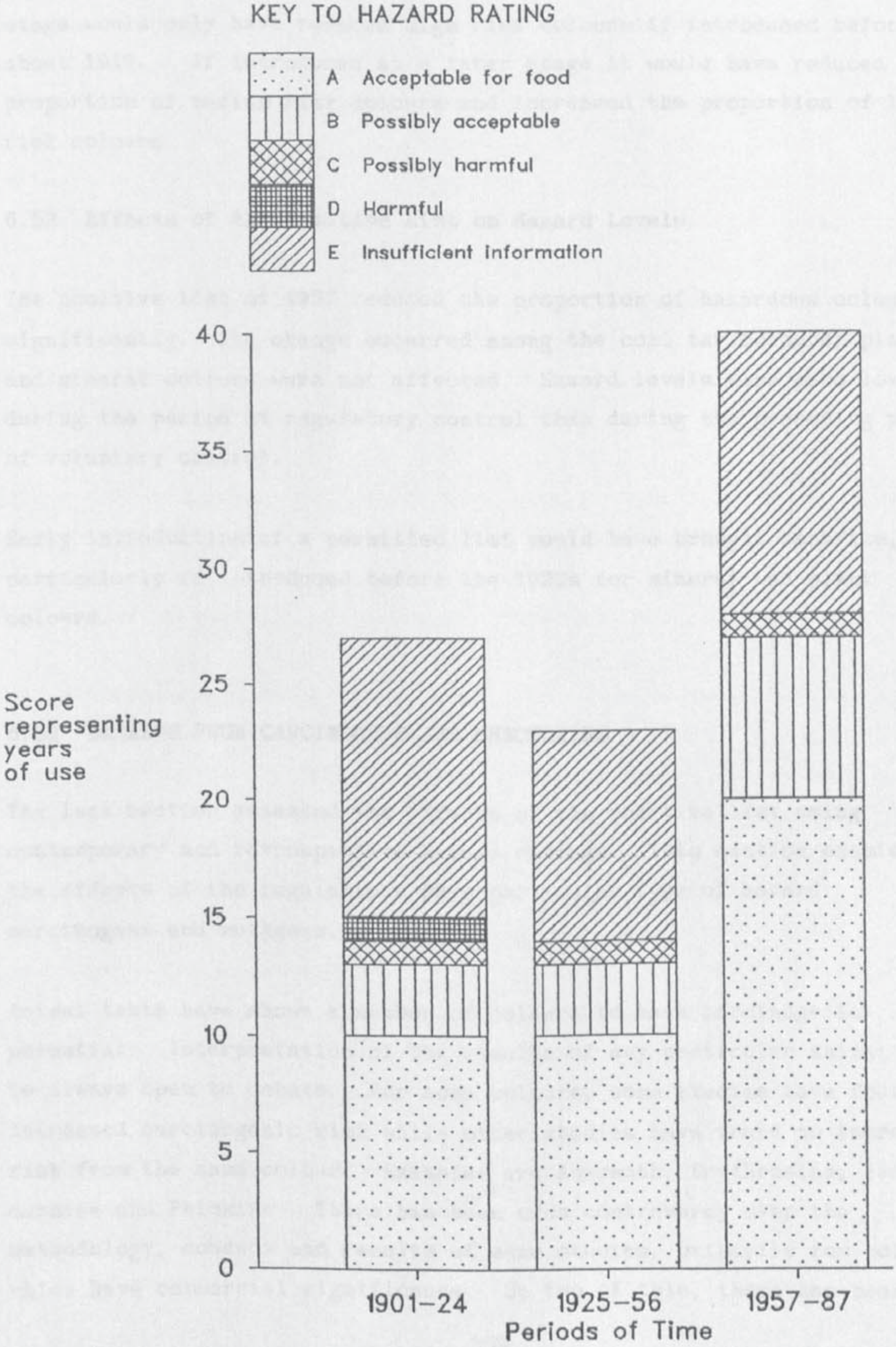
6.50 Assessment 3: Preventable hazard burden

Table 6.34 shows that had the positive list been introduced in 1901 instead of 1957 the public would have been exposed to a score of 2 high risk (C and D-rated) colours instead of 3; a proportion of 2% instead of 6%. This indicates that the preventable hazard burden from D-rated colours was three-fold the level it might have been had the positive list been introduced in 1901.

Table 6.34 shows that the hazard burden was concentrated in the period 1901-1924, and was higher in this period than the average figures suggest. Section 6.29 has already demonstrated that the single D-rated colour (Gamboge) responsible for the excess hazard burden, was used only occsionally by 1919. The positive list would have had a significant effect on high risk colours only if introduced before 1919. It would have been beneficial at a later time in slightly reducing the proportion of medium risk colours.

TABLE 6.34 : HAZARD BURDEN FROM PLANT COLOURS: SCORES FOR THREE PERIODS BETWEEN 1901 AND 1987

Compiled from table 6.62



6.51 Effects of positive list on plant colours

The 1957 permitted list did not have an effect on the level of hazard created by plant colours. The introduction of the list at an earlier stage would only have reduced high risk colours if introduced before about 1919. If introduced at a later stage it would have reduced the proportion of medium risk colours and increased the proportion of low risk colours

6.52 Effects of the Positive List on Hazard Levels

The positive list of 1957 reduced the proportion of hazardous colours significantly. The change occurred among the coal tar colours; plant and mineral colours were not affected. Hazard levels were much lower during the period of regulatory control than during the preceding period of voluntary control.

Early introduction of a permitted list would have brought benefits, particularly if introduced before the 1920s for mineral and plant colours.

6.53 HAZARDS FROM CARCINOGENS AND GENOTOXINS

The last section assessed the effects of the positive list using contemporary and retrospective hazard ratings. This section examines the effects of the regulations on a particular type of hazard: carcinogens and mutagens.

Animal tests have shown a number of colours to have carcinogenic potential. Interpretation of the results of any particular animal test is always open to debate. For some colours, some studies have found an increased carcinogenic risk while other studies have found no increased risk from the same colour. Examples are Amaranth, Erythrosine, Indigo carmine and Phloxine. There has been much controversy over the methodology, conduct and results of some studies, primarily for colours which have commercial significance. On top of this, there has been a debate about the extrapolation of the results of animal experiments to humans. This is discussed in section 6.54 below.

The lists in tables 6.35 and 6.36 summarise data about the carcinogenic and genotoxic potential of many current and former food colours.

The negative list of 1925 had no effect on the suspected carcinogens listed in table 6.35. The positive list of 1957 did have an effect, as table 6.37 (below) shows. The coal tar animal carcinogens (listed in table 6.35) were reduced from 9 in 1954/5 to 3 in 1957. The equivocal laboratory carcinogens (those which were only genotoxic or which gave -/+ results) were reduced from 16 to 11. It would not be meaningful to analyse these numbers in terms of the proportion of colours in use because the list in table 6.35 is not exhaustive. Information about the carcinogenicity of many colours used in 1954 is non-existent.

The number of animal carcinogens among the mineral colours remained at one in 1954/5 and 1957. There were no equivocal mineral carcinogens. There were no animal carcinogens identified among the plant colours. The number of equivocal plant carcinogens remained unchanged at eight.

The carcinogenic colours pose a hazard not just to consumers but also to people exposed occupationally in the food and chemical industries. All the colours listed in table 6.35 may be hazardous when breathed in or swallowed in workplaces. Occupational exposure to these colours is usually much higher than for consumers, although the exposure may be for just a few years rather than for a lifetime (56). Table 6.36 lists some more colours that present hazards to workers but probably not to consumers. The list includes colours found to cause tumours after being injected under the skin of animals. People routinely exposed via the skin (particularly via damaged skin) may be at risk. The effect of the 1957 positive list was to remove 9 of the 12 colours in use in 1954/5.

So the positve list can be considered to have had benefits in removing a number of possibly carcinogenic coal tar colours. The effect on the overall proportion of suspected carcinogens cannot be calculated.

TABLE 6.35 : COAL TAR COLOURS LINKED WITH CARCINOGENICITY AND GENOTOXICITY IN LABORATORY TESTS

KEY:

+	Studies indicate carcinogenic or genotoxic potential
-	Studies indicate no significant effect
-/+	Conflicting data
a	Weak effect
b	1 report only
c	Chemical reduction required for positive result
d	Effect thought to be due to contaminant

Note: Positive results of tumours at sites of repeated subcutaneous injection have not been included

Colour	Carcinogenic	Genotoxic	Reference
COAL TAR COLOURS			
Acid green GG	+		1
Acid violet 6B	+	+	1,3
Amaranth	-/+	-/+	1,2,3
Aminoazobenzene	+	+	4
Aminoazotoluene	+	+	4
Auramine	+		5
Brilliant blue FCF	-	-/+	2,3,4
Brown FK	-	+	3
Butter yellow	+		1
Chrysoidine	+	-/+	1,7
Erythrosine	-/	-/+	2,3,6
Fast green FCF	-	-/+	3,2
Indigo carmine	-/+	-/+	2,3
Malachite green	+	+	1
Metanil yellow		-/+	2
Methyl violet		-/+	3
Oil orange TX	+		1
Oil yellow AB	-/+	-	3
Orange G	-	-/+	2,3
Orange RN	-/+	-	3,8
Phloxine	-/+	+	2,3
Ponceau 2R	+	+c	3
Ponceau 3R	+	+c	3
Ponceau 4R	-	+	2,3
Red 2G	-?	+	3
Red 10B	-	-/+	3
Sudan I	-/+		1
Sudan II	+	-/+	1,7
Sunset yellow	-	-/+	2,3
Tartrazine	-	-/+	2,3
Violet BNP	+		3

Colour	Carcinogenic	Genotoxic	Reference
MINERAL COLOURS			
Carbon black	+		4
PLANT AND ANIMAL COLOURS			
Annatto	-	-/+a	2,3
Beet red	-	-/+b	2,3
Caramel	-	+	2,3
Carotene-β		-/+a	2,3
Cochineal (carminic acid)	-	-/+b	2,3
Curcumin	-?	-/+	1,2,3
Synthetic indigo		+	3
Quercitron		-/+d	1

Compiled from:

1 G Vettorazzi Handbook of International Food Regulatory Toxicology MTP Press, Lancaster 1981.

2 Robert Combes and RB Haveland-Smith 'A review of the genotoxicity of food, drug and cosmetic colours and other azo, triphenylmethane and xanthene dyes' Mutation Research 1982, vol 98 p101-248; M Ishidate et al 'Primary mutagenicity screening of food additives currently used in Japan' Food and Chemical Toxicology 1984, vol 22, p623-36.

3 R Combes 'Brown FK and the colouring of smoked fish', unpublished submission to the Food Advisory Committee, July 1986.

4 IARC Monographs on the Evalustion of the Carcinogenic Risk of Chemicals to Man WHO, Lyon 1973, vol 3, p22; 1975, vol 8; 1978, vol 16; vol 33.

5 ASTMS Policy Document The Prevention of Occupational Cancer ASTMS, London 1980.

6 CEC Reports of the SCF Brussels 1983, 14th series.

7 ILO Encyclopaedia of Occupational Health and Safety Geneva 1983.

8 J J-P Drake 'Food colours - harmless aesthetics or epicurean luxuries?' Toxicology 1975 vol 5 p24.

TABLE 6.36 : OCCUPATIONAL CARCINOGENIC HAZARDS FROM COAL TAR COLOURS

This table lists the colours that have caused an increased incidence of tumours in animal tests at high levels or as a result of subcutaneous injections. These types of exposure indicate a possible hazard to people exposed occupationally to food colours.

KEY:
h At high levels
s Via subcutaneous injections

Colours	Occupational carcinogenic hazard	Reference
Blue VRS	+ s	1
Brilliant blue FCF	+ s	2
Carmoisine	+ s	2
Erythrosine	+ h	3
Fast green FCF	+ s	1
Light green SF	+ s	1
Magenta	+ s	1
Nigrosine	+ s	1
Oil yellow OB	+ s	1
Orange I	+ s	1
Rhodamine B	+ s	1
Rhodamine 6G	+ s	2
Sudan I	+ s	1
Sudan IV	+ s	1

Compiled from:

1 G Vettorazzi Handbook of International Food Regulatory Toxicology MTP Press, Lancaster 1981.

2 IARC Monographs on the Evalustion of the Carcinogenic Risk of Chemicals to Man WHO, Lyon 1973, vol 3, p22; 1975, vol 8; 1978, vol 16; vol 33.

3 Food Advisory Committee Final Report on the Review of the Colouring Matter in Food Regulations MAFF, HMSO 1987.

TABLE 6.37 : EFFECTS OF POSITIVE LIST ON SUSPECTED CARCINOGENS

Compiled from tables D.1 and D.2 in appendix D and table 6.35

KEY:

+ Animal carcinogen

-/+ Equivocal results in laboratory tests

Class of colour	Number of colours in use / Year: + carcinogens		-/+ carcinogens and genotoxins	
	1954/5	1957	1954/5	1957
Coal tar	9	3	16	11
Mineral	1	1	0	0
Plant	0	0	8	8

6.54 Relevance of Animal Studies

In 1954 the Pharmacology Panel took the view that

> Until the contrary can be proved, suspicion must fall on any colour proposed for use in foods which is capable of producing neoplastic reactions in animals (57).

But this policy has long been challenged. It has been claimed that no food colour has ever caused cancer in humans. In 1954 the Food Standards Committee reported that one of the main objections to the introduction of a permitted list was that,

> Although certain 'coal-tar' colours have been shown to have adverse effects on the health of experimental animals it does not follow that human beings would be similarly affected (58).

In 1975 a textbook reviewing the toxicology of azo colours stated:

> Thus far there is no known case of cancer in man that can be traced to exposure to such dyes (59).

J Drake of BIBRA warned in the same year that

> It must be borne in mind that, with the exception of a few special cases of hypersensitivity...no direct evidence has emerged to incriminate any synthetic food dye among the factors responsible for serious illness in man (60).

Magnus Pyke, in a standard textbook on food science and technology said:

> While some diazo compounds have been reported to be carcinogenic when tested on experimental animals, the ones included in various 'permitted' lists have never been shown to be in any way toxic (61).

Dr J Coon, a toxicologist associated with the National Academy of Sciences' Food Protection Committee (a committee supported strongly by grants from the food and chemical industries (62) took issue with a claim that the US Delaney clause, which required any additive causing cancer in animal tests to be banned, had saved much ill-health. He pointed out that, fourteen years after the introduction of the clause,

> There is yet no evidence to support this claim (63),

and as far as human risk was concerned,

> No harmful chronic effects, no cancer, and no fetal abnormalities or genetic defects have ever been demonstrated in man to be attributable to the use of food additives (64).

In 1981 Frank Fairweather, director of the DHSS Toxicology Unit, discussed the history of coal tar dyes and the fact that industry had phased out the use of any where animal results indicated a possible carcinogenic risk to humans. While acknowledging the effects of animal studies he also undermined their significance by stating that:

> There have been no documented cases of food additives causing cancer in man (65).

6.55 Coal tar dyes and human cancer

There have been reports of cancer arising from occupational exposure to some coal tar colours. These sorts of colours were used in early periods and were usually voluntarily withdrawn from use. In 1934 W C Hueper reported on aniline cancer:

> Ten years ago the condition was almost unknown in England but with the development of the dye industry here a number of cases have been reported and nearly 40 deaths have been recorded. The carcinogenetic substances are aromatic bases which circulate in the blood after contact with aniline, benzidine, alpha- and beta-naphthylamine and their derivatives (66).

By 1937 the occurrence of bladder cancer among workers in the aniline dye industry had become an accepted fact in medical circles (67). A number of dyes and intermediates have been associated with occupational cancer since that time. Auramine has been recognised by IARC to present a human carcinogenic risk - from the dye itself and the aromatic amines used in its production (68). Workers manufacturing Magenta face an increased risk of bladder cancer, which may be due to an intermediate or an impurity (69). But until recently no human evidence has been available of cancer arising from the consumption of dyes.

6.56 Case Study : Chrysoidine

One dye, Chrysoidine, used in food between 1876 and 1957, has recently been linked with an excess incidence of cancer among anglers. A study of 240 men with urothelial cancer found smoking and coarse fishing to be significantly associated with the disease. Length of exposure to the Chrysoidine dye used to stain maggot bait was the most important predictor of risk; 5% of the cases of urothelial cancer were attributed to the dye. Exposure to the dye was via the fingers and mouth.

The study has been criticised by the DHSS's committee on carcinogenicity on the grounds that:

a) The study failed to differentiate between the effects of smoking and exposure to Chrysoidine. The degree of tobacco smoking was not quantified. Some patients may have been heavy smokers.

b) The study did not involve a full occupational history of the control group.

Nevertheless, Graham Sole, one of the authors of the study pointed out that the bladder tumours were very unusual. They usually arise in old age (over 60 year olds), but the tumours in anglers occurred in comparatively young people in their mid-thirties, who had been using dyes since their teens (70).

Chrysoidine was tested for carcinogenicity in 1938 by M Maruya and no tumours were found in a study lasting up to one year (71). In 1954 Z Albert found liver tumours in 72% (75 out of 104) mice fed Chrysoidine, compared to 1% (1/89) and 2% (2/117) tumours in the control groups (72). These studies were later evaluted by IARC, and Chrysoidine was judged to be carcinogenic in mice by the oral route; they found that no studies on human exposure were available, though significant quantities of the colour were produced for textiles etc. (73). JECFA pronounced Chrysoidine to be harmful and unsuitable for food in 1965 (74).

The first laboratory preparation of Chrysoidine was in 1875. The first report of large-scale production was in 1914 in the USA; by 1921 115,000kg/year were manufactured there (75). In 1972 production was about 203,000 kg in the USA (76). In 1974 IARC estimated that 12 manufacturers in Western Europe were producing a few hundred thousand kg per annum (77).

Chrysoidine has been used for textiles, leather, inks etc. as well as for food and fishing maggots. The use of Chrysoidine in food in the UK was reported in 1887, 1895, 1924, 1926 and 1928 (78). In 1913 significant quantities (over 16,000 lb) Chrysoidine were imported into the UK for all purposes (79). In 1922/3 one of the major firms manufacturing coal tar colours reported that the annual sales of Chrysoidine, to the food industry, were 100-500 lb. This was a fraction of the total quantity sold (80). Two trade associations put forward Chrysoidine for inclusion in the permitted list in 1954 (81). In the mid 1950s it was approved for food in Switzerland, Italy, Poland, Rumania and Egypt (82).

Chrysoidine is closely related to other dyes that have given adverse results in laboratory tests: Brown FK (which is mutagenic), Aminoazotoluene (an animal carcinogen) and 2,4-diaminotoluene (an animal carcinogen). 2,4-diaminotoluene is also suspected of causing bladder cancer in humans (83).

Substances that are animal carcinogens are not necessarily carcinogenic in humans. But animal studies are certainly not irrelevant as claimed. In the case of Chrysoidine animal studies could have provided a warning of the possible risk to humans. For other colours it has not been possible to measure the carcinogenic risk to humans; in most cases separate population groups who have been exposed by the oral route do not exist, and we are forced to rely on laboratory studies.

The above discussion indicates that, in contrast to claims, laboratory tests can provide useful, though imperfect, warnings of carcinogenic risk. The WHO's International Agency for Research on Cancer takes the view that

> It is reasonable for practical purposes to regard chemicals for which there is sufficient evidence of carcinogenicity in animals as if they presented a carcinogenic risk to humans (84).

The same view has been taken by specialists in cancer policy, such as Umberto Saffiotti of the US National Cancer Institute and Samuel Epstein of Case Western Reserve University.

Several trade unions have adopted this policy. The General, Municipal and Boilermakers' Union (GMBATU) has listed some practical reasons why evidence of cancer in animals should be taken seriously:

> Many substances are only 'suspect' carcinogens because they have not been used long enough for cancer to develop in workers (ie 5-50 years), or the workers' health has not been studied properly, and the only cancer evidence comes from animals or other experimental evidence. The GMB policy...is not to wait for dead workers to prove there is a cancer hazard, and to give workers, not chemicals, the benefit of any doubt (85).

These arguments apply to consumers as well. In the case of consumers there is an extra problem in detecting hazards because a) small quantities are eaten over a lifetime, and b) there are no obvious control groups.

6.57 INTOLERANT REACTIONS TO COLOURS

Consumption of some colours, especially coal tar colours, has been found to provoke hypersensitive reactions, such as asthma, chronic urticaria, rhinitis, hyperactivity, migraine and oral aphthous ulcers. Many of them cause dermatitis in contact with the skin, when handled in chemical or food factories or used in cosmetics and medical creams. Doses triggering intolerant reactions can be very low.

Table L.1 in appendix L lists some of the colours that have been observed to provoke (or sometimes aggravate) intolerant reactions, such as asthma and urticaria.

6.58 Prevalence of intolerant reactions

Reactions occur only in people who have become sensitized. This is believed to be a small proportion of people. The actual number is not known; estimates vary widely. The prevalence of reactions has been measured for only a few colours, as tables 6.38 and 6.39 below show. Most of these studies were conducted in Scandinavian countries, where the use of colours has always been lower than in the UK, because of tradition and regulatory policy. Since exposure in the UK is higher and hypersensitivity probably starts in response to some form of toxic overload, one would expect a higher proportion of consumers in the UK to have passed the point of toxic overload. The compilation of studies in table 6.38 indicates that a possible 0.01% - 0.15% of the population on the continent may react adversely to Tartrazine alone, from oral exposure. If all types of reactions are included the range becomes 0.10% - 0.15% (on the continent). The prevalence will change according to time and place. For example, in the UK it will probably be higher than on the continent, and it will have risen since the 1950s when exposure to coal tar colours was lower because processed foods made up a smaller proportion of the diet.

TABLE 6.38 : ESTIMATES OF PREVALENCE OF INTOLERANT REACTIONS TO COLOURS

KEY:

a Excluding population under 16 years of age

Colour	Type of reaction	Proportion of Population	Country	Ref.
Tartrazine	Asthma	0.06%	Sweden	1
Tartrazine	Asthma & urticaria	0.03%	Scandinavia	2
Tartrazine	Asthma, urticaria, etc	0.15%	France	4
Tartrazine	Eczema & urticaria	0.03%	France	3
Tartrazine	Hyperactivity	0.01%	Sweden	1
Tartrazine	Asthma, urticaria & rhinitis	0.10% a	Denmark	5
Range of estimates		0.01-0.15%		
Average		0.06%		

Compiled from:

1 L Juhlin 'Incidence of intolerance to food additives' International Journal of dermatology 1980, vol 19, p550.

2 S Slorach et al 'Forslag till fortatt avveckling av anvandning av fargamene i livsmedel' Report for the Swedish National Food Administration september 1976.

3 DA Moneret-Vautrin et al 'Allergie et intolerance a la tartrazine, colorant alimentaire et medicamentaux: a propos de deux observations' Medecine et Nutrition 1980, vol 16, p171.

4 A Pellegrin 'Deux observations nouvelles d'allergie a la tartrazine' Ann. Med. Interne 1979, vol 130, p211-214.

5 E Poulsen 'Danish report on allergy and intolerance to food ingredients and food additives' Toxicology Forum, Aspen, Colorado, 1980.

TABLE 6.39 : PERCENTAGE OF PATIENTS WITH CHRONIC URTICARIA REACTING TO FOOD COLOURS

Results of tests on patients with chronic urticaria, mainly in Scandinavian countries, 1975-1980

Source: Lennart Juhlin 'Incidence of intolerance to food additives' International Journal of Dermatology 1980, vol 19, p549

KEY:

a Mixed azo dyes, including tartrazine

Canthax Canthaxanthin (a xanthophyll)

No. urticaria patients	Percentage reacting to: tartrazine	other azo dyes	annatto	carotene & canthax.	Year
40	8				1968
52	36	20			1973
100	21	12-15			1975
23	30				1975
38	8				1976
108	13				1977
30	23				1978
65	5	5	8		1978
61	11	9-17	26		1978
24	46				1979
86	23				1979
81	21				1980
330		18 a	10	10-14	1980
Range of values	5-46%	5-20%	8-26%	10-14%	
Average	20%	14%	15%	12%	

Table 6.39 reviews studies of the prevalence of urticarial reactions to different groups of colours. The average of a series of studies indicates that a greater proportion of atopic patients may react to Tartrazine (20%) than to other azo dyes (14%). This may be due to the ubiquity of Tartrazine, or it may be due to its chemical properties. The proportion of atopics reacting to the plant colour Annatto was 15%; as high, on average, as the proportion reacting to azo dyes. The percentage reacting to the plant colours Carotene and Canthaxanthin was 12% on average. This indicates that the range of prevalence given in table 6.38 should be multiplied by a factor of the order of 2.05. This gives a prevalence of 0.21% - 0.31% for a wide range (but not exhaustive list) of colours. This is equivalent to adverse reactions in about 21 to 31 people in 10,000, by oral exposure alone.

6.59 Effects of regulations on allergens

The negative list of 1925 had no effect on any of the coal tar colours or plant colours linked with intolerant reactions. One mineral colour (Copper sulphate), reported to be a rare sensitizer via the skin, was removed by the negative list. This would have been of benefit to people canning peas and making pickles. The benefit may have been short-lived because the colour may have been replaced by a coal tar colour causing a similar form of ill-health.

Table 6.40 shows that the positive list of 1957 reduced the number of coal tar colour linked with intolerant reactions in consumers from 14 in 1954/5 to 11 in 1957. Those causing problems in the occupational sphere fell from 16 to 3. The number of mineral and plant colours linked with intolerant reactions remained unchanged.

6.60 International comparison of policy

In 1976 the Norwegian government acknowledged the problem of intolerant reactions to certain colours. They estimated that perhaps 0.03 - 0.15% of the population might be affected. They considered this to be a significant proportion and banned all the coal tar colours in 1978. The Swedish government took a different approach to the same problem. They decided to ban a number of the coal tar colours (all those of the azo

TABLE 6.40 : EFFECTS OF POSITIVE LIST ON COLOURS LINKED WITH INTOLERANT REACTIONS

Compiled from table L.1 in appendix L

Class of colour	Number of colours / Year: Oral sensitizers 1954/5	Oral sensitizers 1957	Skin sensitizers 1954/5	Skin sensitizers 1957
Coal tar	14	11	16	3
Mineral	0	0	2	2
Plant	2	2	4	4

class) and to restrict the rest to very few foods. Since 1980 coal tar colours have been restricted mainly to spirits, cocktail cherries and caviar in Sweden. The UK government rejected the Scandinavian approach and has continued to permit a relatively long list of colours in a very wide range of foods. The government has recently started to adopt a policy of requiring colours to be labelled on foods so that allergy sufferers can protect themselves. The problems with this approach are discussed in chapters 5 and 7.

EFFECTS OF CHANGES TO THE PERMITTED LIST, 1957-1987

6.61 Coal Tar Colours

Table E.1 in appendix E shows the changes made to the permitted list after 1957. The number of coal tar colours was gradually reduced from 30 in 1957 to 18 in 1957. Most of the changes occurred as a result of pressures to harmonise with the other EEC member states, but some were made because of adverse reports about safety.

6.62 Assessment 1: Change in level of hazard, 1957-87

Table 6.41 compares the level of hazard in 1957 and 1987. The number of colours in hazard groups C, D and E went down between 1957 and 1987. The number in groups A and B went up slightly. The number of high risk (C and D rated) colours dropped as a proportion of colours from 20% to 6%. The number of D-rated colours was reduced from 7% to 0%. The proportion of medium risk (B and E-rated) colours went down from 40% to 12%. The proportion of low risk (A-rated) colours doubled from 40% to 82%. This indicates that the total change made to the permitted list between 1957 and 1987 was very beneficial.

TABLE 6.41 : RETROSPECTIVE HAZARD RATING OF COAL TAR COLOURS, 1957 AND 1987

Compiled from table I.3 and table E.1 in appendices I and E

	Number of colours (%) / Retrospective hazard rating					
Year	A	B	C	D	E	Total
1957	12 (40%)	0 (0%)	4 (13%)	2 (7%)	12 (40%)	30
1987	15 (82%)	1 (6%)	1 (6%)	0 (0%)	1 (6%)	18

6.63 Assessment 2: Banned colours

Since 1957 most coal tar colours clearly demonstrated to be harmful at low levels in animal tests or for which there has been a substantial lack of safety data have eventually been removed from the permitted list. Table 6.42 lists the 20 coal tar colours banned after 1957 by amendmants to the positive list, and gives their retrospective hazard rating. 7 (35%) were finally rated C or D (high risk); 13 (65%) were rated E (medium risk). So the changes can all be considered beneficial to health.

TABLE 6.42 : COAL TAR COLOURS BANNED AFTER 1957

Compiled from table I.3 and table E.1 in appendices I and E

Colour	Retrospective hazard rating
Blue VRS	C
Orange RN	C
Indanthrene blue	C
Naphthol yellow S	C
Ponceau 2R	C
Ponceau 3R	D
Ponceau SX	D
Black 7984	E
Chocolate brown FB	E
Fast red E	E
Acid yellow G	E
Oil yellow GG	E
Oil yellow XP	E
Orange G	E
Red 6B	E
Red 10B	E
Red FB	E
Violet BNP	E
Yellow RFS	E
Yellow RY	E

Note:
Two further colours have been recommended by the FAC to be prohibited in 1987 or 1988. They are:

Yellow 2G - because of lack of safety data (E)
Methyl violet - because of possible toxicity (C)

At least two colours were removed from the permitted list because of concerns about safety. Orange RN was banned because of an animal study showing carcinogenicity. Ponceau 2R was banned because of liver nodules (thought to be a pre-cancerous condition) in test animals (86). Orange RN was banned on the basis of one adverse study. There were alternative colours on the list at the time. As the positive list became shorter the food industry became much more defensive and regulators became much more cautious about banning colours. The required lavel of evidence of harm rose substantially, and no colour would be banned today on the basis of a few adverse studies, as table 6.35 illustrates. The majority of colours were removed from the permitted list as a result of pressure to harmonise with the EEC list. The three colours banned from January 1977, for example, were removed because of pressure from the EEC rather than because of UK concern about hazards (87).

6.64 Assessment 3: Added colours

The coal tar colours introduced onto the UK permitted list after 1957 are shown in table 6.43. Most of the new colours were introduced under pressure to harmonise with the EEC list of permitted colours. It could be said that poor regulatory judgements were made in the case of the four colours added to the list and later banned. In 1955 the Pharmacology Panel placed Methy violet among the 'C' colours - indicating that it was known or suspected to be harmful. Methyl violet was introduced as a harmonisation measure. The other added coal tar colours have recently been given full toxicological clearance by COT, and their introduction can therefore be justified retrospectively as being consistent with stated regulatory policy.

It is important to note the enormous pressure from manufacturers to obtain continued regulatory clearance for colours on the positive list. The retrospective hazard rating of 'A' for the coal tar colours remaining in 1987 could cynically be described as having more to do with the amount of industry pressure and expenditure (backed up by partisan toxicological assessments in some cases) than with the safety of the colours concerned (88).

TABLE 6.43 : RETROSPECTIVE HAZARD RATING OF COAL TAR COLOURS ADDED TO THE POSITIVE LIST AFTER 1957

Compiled from table I.3 and table E.1 in appendices I and E

KEY:

* Colour due to be banned late 1987

Colour	Retrospective hazard rating
COLOURS ADDED	
Brilliant blue FCF	A
Patent blue V	A
Quinoline yellow	A
Lithol rubine	B
COLOURS ADDED AND LATER BANNED	
Indanthrene blue	C
Methyl violet *	C
Black 7984	E
Acid yellow G	E

6.65 Mineral Colours

Assessment 1: Changes in hazard levels, 1957-87

Table E.2 in appendix E shows the development of the positive list of mineral colours from 1957 to 1987. Table 6.44 compares the number of colours in each hazard group in 1957 and 1987. There were no C, D, or B-rated colours. The proportion of medium risk (E-rated) colours went down from 29% to zero. The proportion of low risk (A-rated) colours went up from 71% to 100%. The changes can be considered beneficial. However, as with the coal tar colours the remaining A-rated colours are not free from risk.

TABLE 6.44 : RETROSPECTIVE HAZARD RATING OF MINERAL COLOURS IN 1957 AND 1987

Compiled from table I.4 and table E.2 in appendices I and E

Year	Number of colours (%) / Retrospective hazard rating					
	A	B	C	D	E	Total
1957	5 (71%)	0 (0%)	0 (0%)	0 (0%)	2 (29%)	7
1987	8 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	8

6.66 Assessment 2: Colours added and banned

There were more changes to the permitted list than table 6.44 suggests. Table 6.45 lists the mineral colours added and banned, and gives their retrospective hazard rating. The banned colours were mostly rated E. Carbon black should more realistically be rated C. It has been linked with occupational cancer and is an animal carcinogen. Carbon black was dropped from use to some extent because of safety concerns. The three colours were banned in the UK in order to harmonise with the EEC in 1973 and 1978.

Changes to the permitted list of mineral colours potentially affected health positively by removing one possibly harmful colour.

6.67 Plant Colours

Changes to the permitted list of plant colours were potentially beneficial because they resulted in the removal of one C-rated colour and four out of five E-rated colours. Table E.3 in appendix E shows the changes to the list of plant colours between 1957 and 1987.

TABLE 6.45: RETROSPECTIVE HAZARD RATINGS OF MINERAL COLOURS ADDED TO OR REMOVED FROM THE POSITIVE LIST AFTER 1957

Compiled from table 6.3 and table 3.13

Colour	Retrospective hazard rating
COLOURS ADDED	
Gold	A
COLOURS BANNED	
Bole armenian	A [E]
Carbon black	E [C]
Ultramaine	E

6.68 Assessment 1: Change in Hazard Levels, 1957-87

Table 6.46 gives the retrospective hazard rating of plant colours in use in 1957 and 1987. There were no D-rated colours. The number of A and B colours increased. The number of C and E colours decreased. The proportion of high risk (C and D-rated) colours dropped from 6% in 1957 to zero in 1987. The proportion of medium risk (B and E-rated) colours dropped from 57% to 41%. The proportion of low risk (A-rated) colours rose from 38% to 59%. The changes can therefore be considered beneficial.

6.69 Assessment 2: Colours Added and banned

There were more changes to the permitted list of plant colours than table 6.46 suggests. Table 6.47 lists the colours introduced or banned after 1957 and gives their retrospective hazard ratings. The banned colours were mainly rated E. There was one C-rated colour (Quercitron).

TABLE 6.46 : RETROSPECTIVE HAZARD RATING OF PLANT COLOURS PERMITTED IN 1957 AND 1987

Compiled from table I.5 and table E.3 in appendices I and E

Year	Number of colours (%) / Retrospective hazard rating					
	A	B	C	D	E	Total
1957	6 (38%)	3 (19%)	1 (6%)	0 (0%)	6 (38%)	16
1987	10 (59%)	4 (23%)	0 (0%)	0 (0%)	3 (18%)	17

These plant colours were removed in order to harmonise with the EEC. The UK industry probably no longer required them anyway.

Three out of four of the colours added to the list after 1957 were later rated A. One (Canthaxanthin) was later rated C. A recent FAC report has recommended that it be removed from the positive list (89). So the addition of Canthaxanthin can be considered, retrospectively, to have been undesirable.

6.70 Evaluation of Changes to Positive List

The changes made to the positive list after 1957 were beneficial for all three groups of colours. The proportion of high risk colours was reduced from 20% to 6% for coal tar colours and from 6% to zero for plant colours. The proportion of medium risk colours was reduced from 40% to 12% for coal tar colours; from 29% to zero for mineral colours; and from 57% to 41% for plant colours. The proportion of low risk colours increased in all cases: from 40% to 82% for coal tar colours; from 71% to 100% for mineral colours; and from 38% to 59% for plant colours.

TABLE 6.47 : RETROSPECTIVE HAZARD RATING OF PLANT COLOURS ADDED OR BANNED AFTER 1957

Compiled from table I.5 and table E.3 in appendices I and E

Colour	Retrospective hazard rating
COLOURS ADDED	
β-apo carotenals	A
Copper chlorophyllins	A
Riboflavin-5'-phosphate	A
Canthaxanthin	C
COLOURS BANNED	
Indigo	A [E]
Quercitron	C
Alkannet	E
Fustics	E
Orchil	E
Persian berry	E

6.71 COMPARISON OF REGULATORY AND VOLUNTARY PERIODS

Tables 6.48, 6.49 and 6.50 show the burden of hazard from the three groups of colours in five periods from 1850 to 1987. For coal tar colours the greatest reduction in levels of high risk (C and D-rated) colours occurred between the periods 1925-56 and 1957-87, when the positive list was introduced. Table 6.49 shows that, for mineral colours, the greatest reduction in high risk colours occurred between 1850-75 and 1876-1900, when manufacturers voluntarily removed many harmful colours, with added pressures from adverse publicity and the Food Acts (see chapter 3).

TABLE 6.48 : HAZARD BURDEN FROM COAL TAR COLOURS, FOR FIVE PERIODS BETWEEN 1850 AND 1987

Compiled from table 6.57

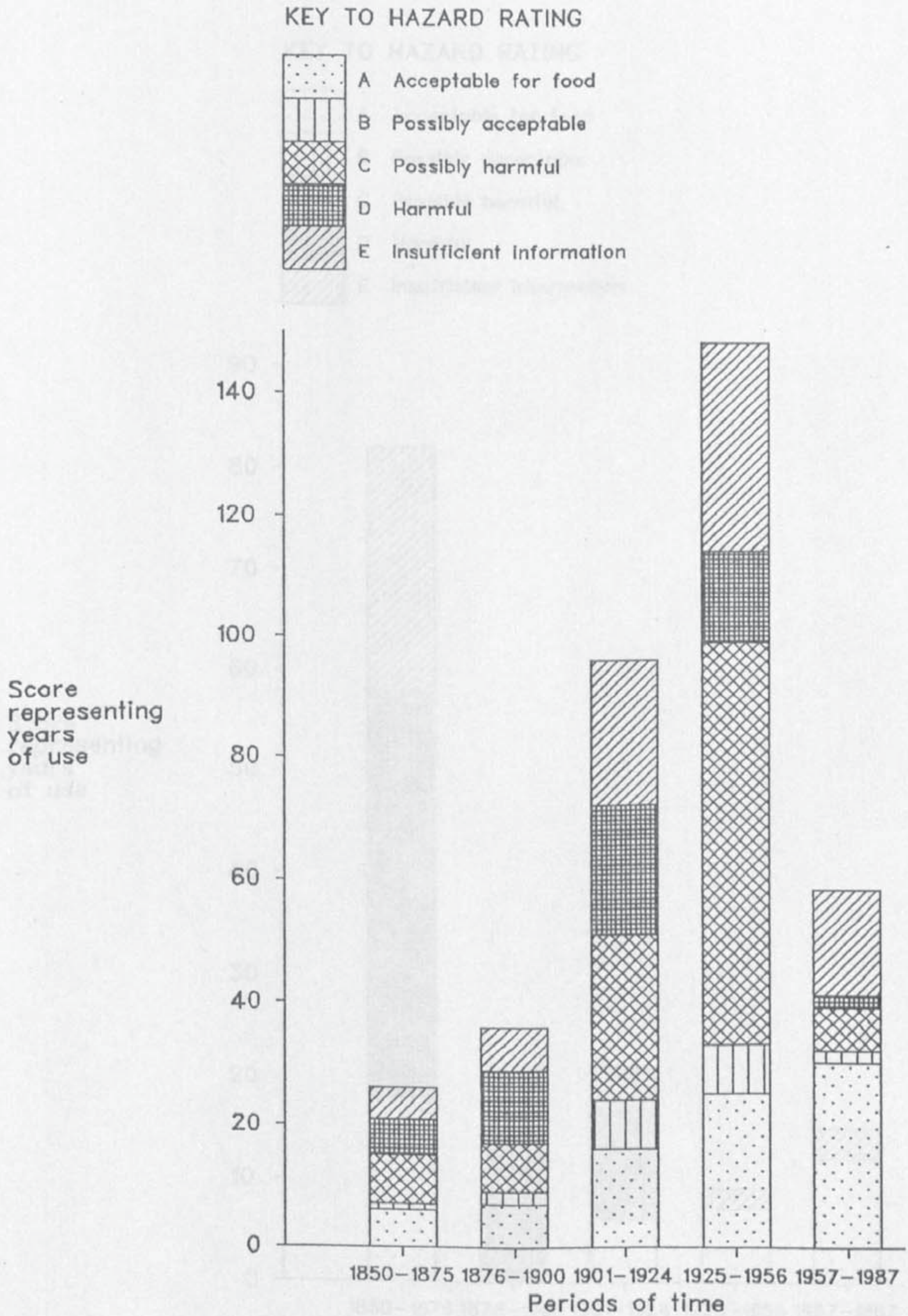


TABLE 6.49 : HAZARD BURDEN FROM MINERAL AND METALLIC COLOURS, FOR FIVE PERIODS BETWEEN 1850 AND 1987

Compiled from table 6.60

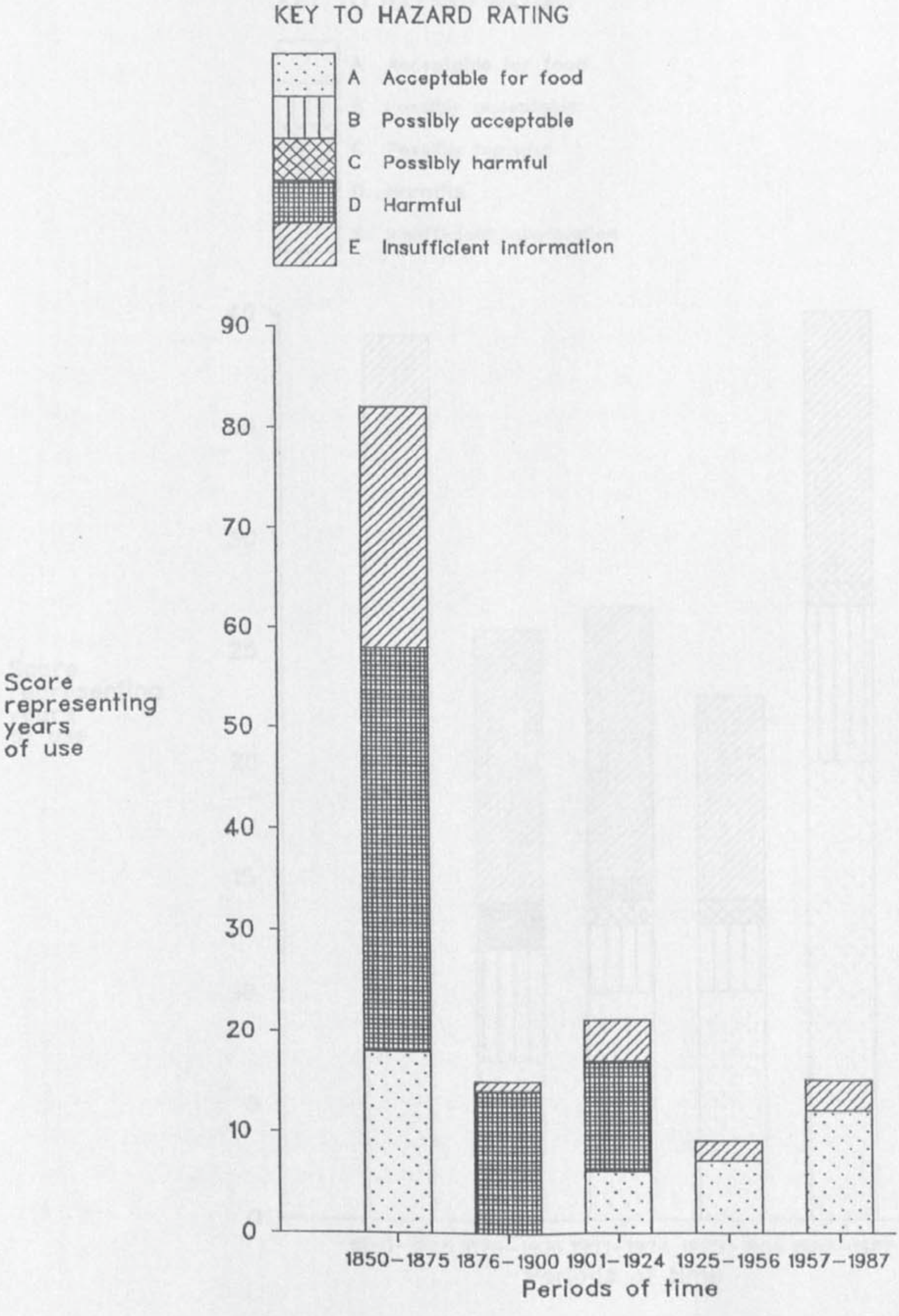
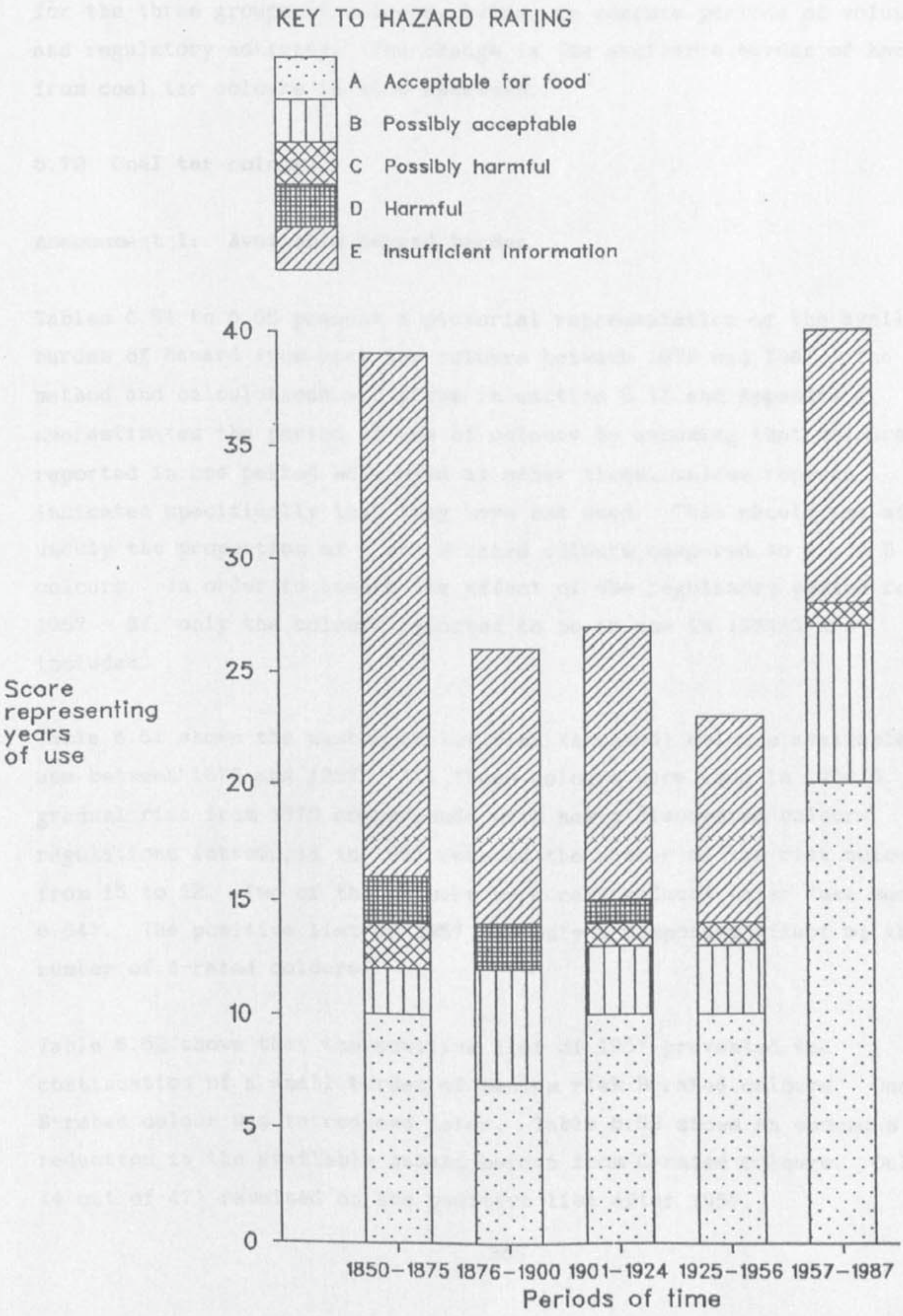


TABLE 6.50 : HAZARD BURDEN FROM PLANT AND ANIMAL COLOURS, FOR FIVE PERIODS BETWEEN 1850 AND 1987

Compiled from table 6.62



For plant colours (table 6.50) the greatest reduction in high risk occurred during periods of predominantly voluntary action from 1850-75 and 1876-1900.

The changes that occurred between the five periods are examined in turn for the three groups of colours, below, to compare periods of voluntary and regulatory activity. The change in the available burden of hazard from coal tar colours is also assessed.

6.72 Coal tar colours

Assessment 1: Available hazard burden

Tables 6.51 to 6.55 present a pictorial representation of the available burden of hazard from coal tar colours between 1870 and 1987. The method and calculations are given in section 6.11 and Appendix J. It overestimates the period of use of colours by assuming that colours reported in one period were used at other times, unless reports indicated specifically that they were not used. This should not affect unduly the proportion of C and D-rated colours compared to A and B colours. In order to assess the effect of the regulatory period from 1957 - 87, only the colours reported to be in use in 1954/5 are included.

Table 6.51 shows the number of low risk (A-rated) colours available for use between 1870 and 1987. All these colours were used in 1954/5. The gradual rise from 1870 corresponds with newly discovered colours. the regulations introduced in 1957 reduced the number of low risk colours from 15 to 12. Two of the colours were reintroduced later (see section 6.64). The positive list of 1957 had only a temporary effect on the number of A-rated colours.

Table 6.52 shows that the positive list of 1957 prevented the continuation of a small burden of medium risk B-rated colours. One new B-rated colour was introduced later. Table 6.53 shows an enormous reduction in the available hazard burden from C-rated colours. Only 9% (4 out of 47) remained on the positive list after 1957.

TABLE 6.51 : A-RATED COAL TAR COLOURS USED IN 1954/5: HAZARD BURDEN FROM 1870 - 1987

KEY:

X   Number of colours available for use

0   Colour introduced after 1954

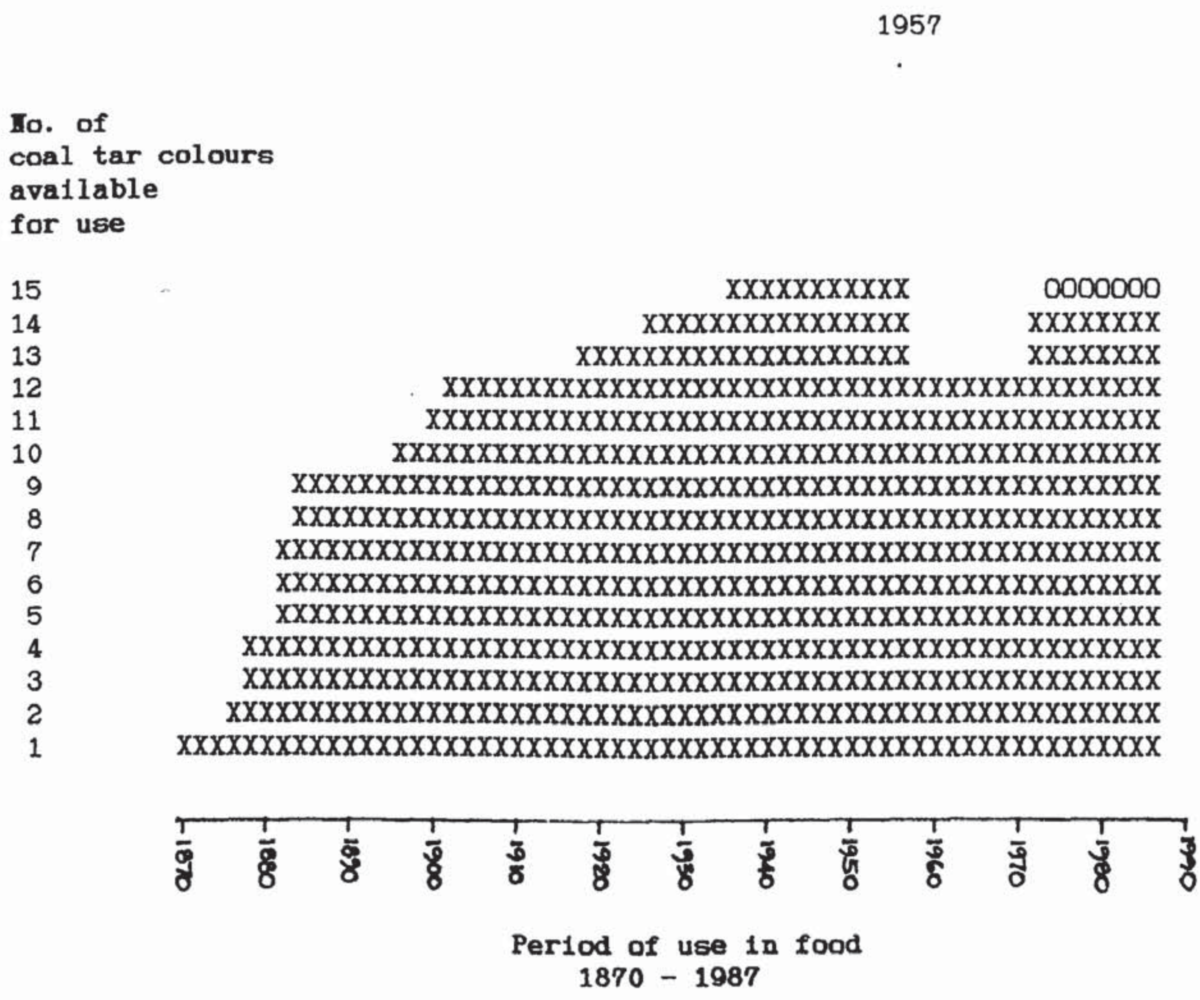


TABLE 6.52 : B-RATED COAL TAR COLOURS USED IN 1954/5: HAZARD BURDEN FROM 1870 - 1987

KEY:
X Number of colours available for use
0 Colour introduced after 1954

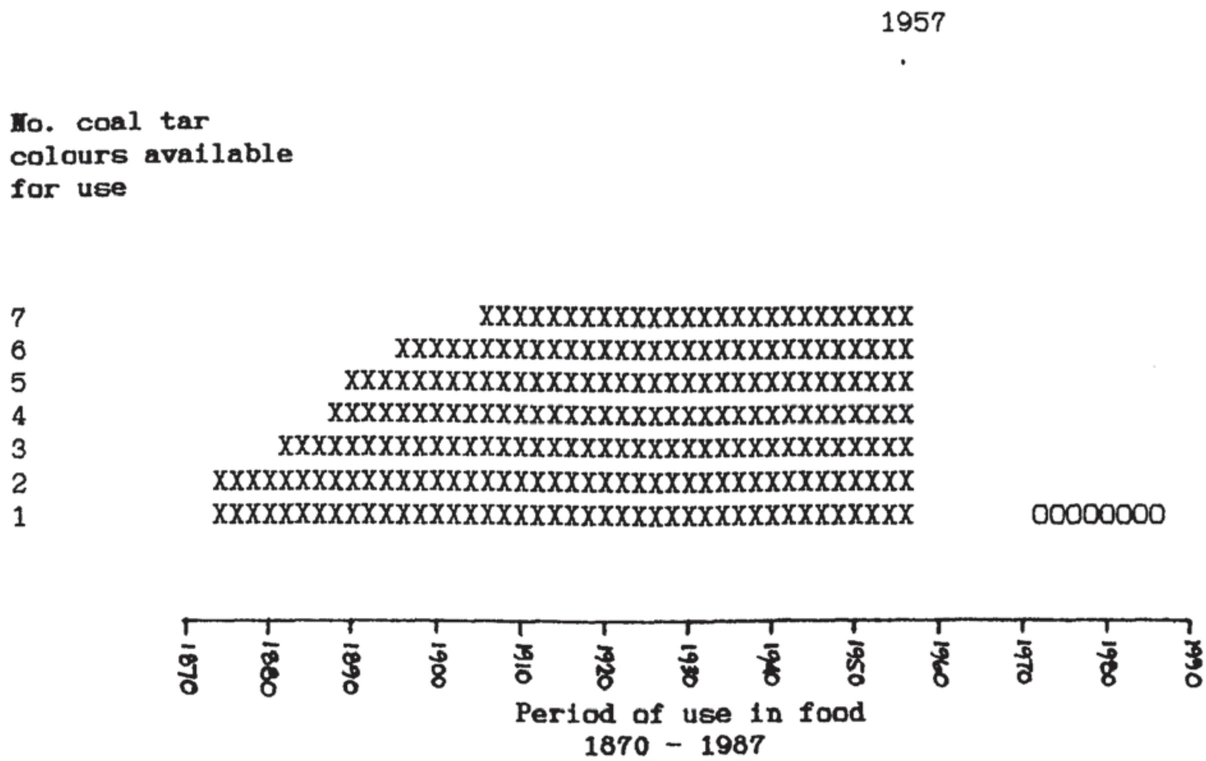


TABLE 6.53 : C-RATED COAL TAR COLOURS USED IN 1954/5: HAZARD BURDEN FROM 1870 - 1987

KEY:

X Number of colours available for use

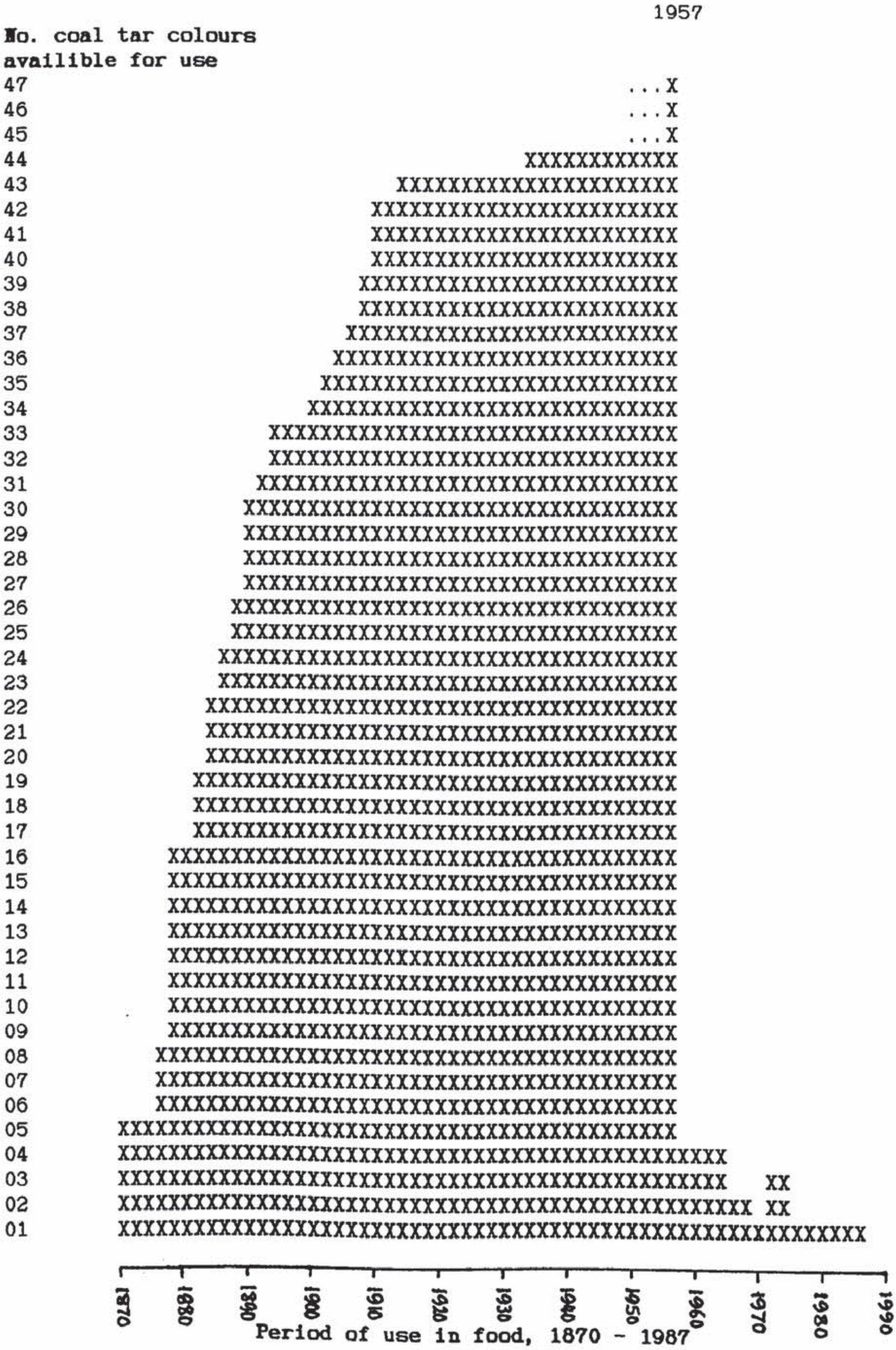


TABLE 6.54 : D-RATED COAL TAR COLOURS USED IN 1954/5: HAZARD BURDEN FROM 1870 - 1987

KEY:
X   Number of colours available for use

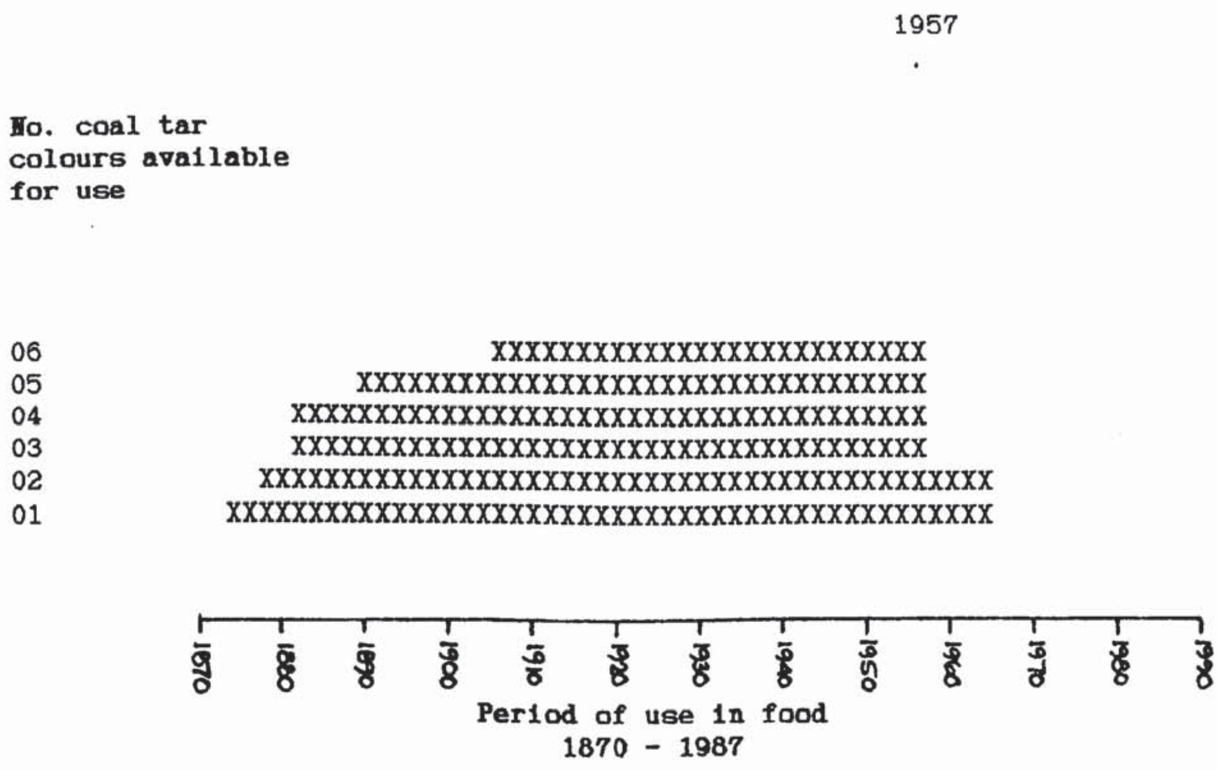


TABLE 6.55 : E-RATED COAL TAR COLOURS USED IN 1954/5: HAZARD BURDEN FROM 1870 - 1987

KEY:
X   Number of colours available for use

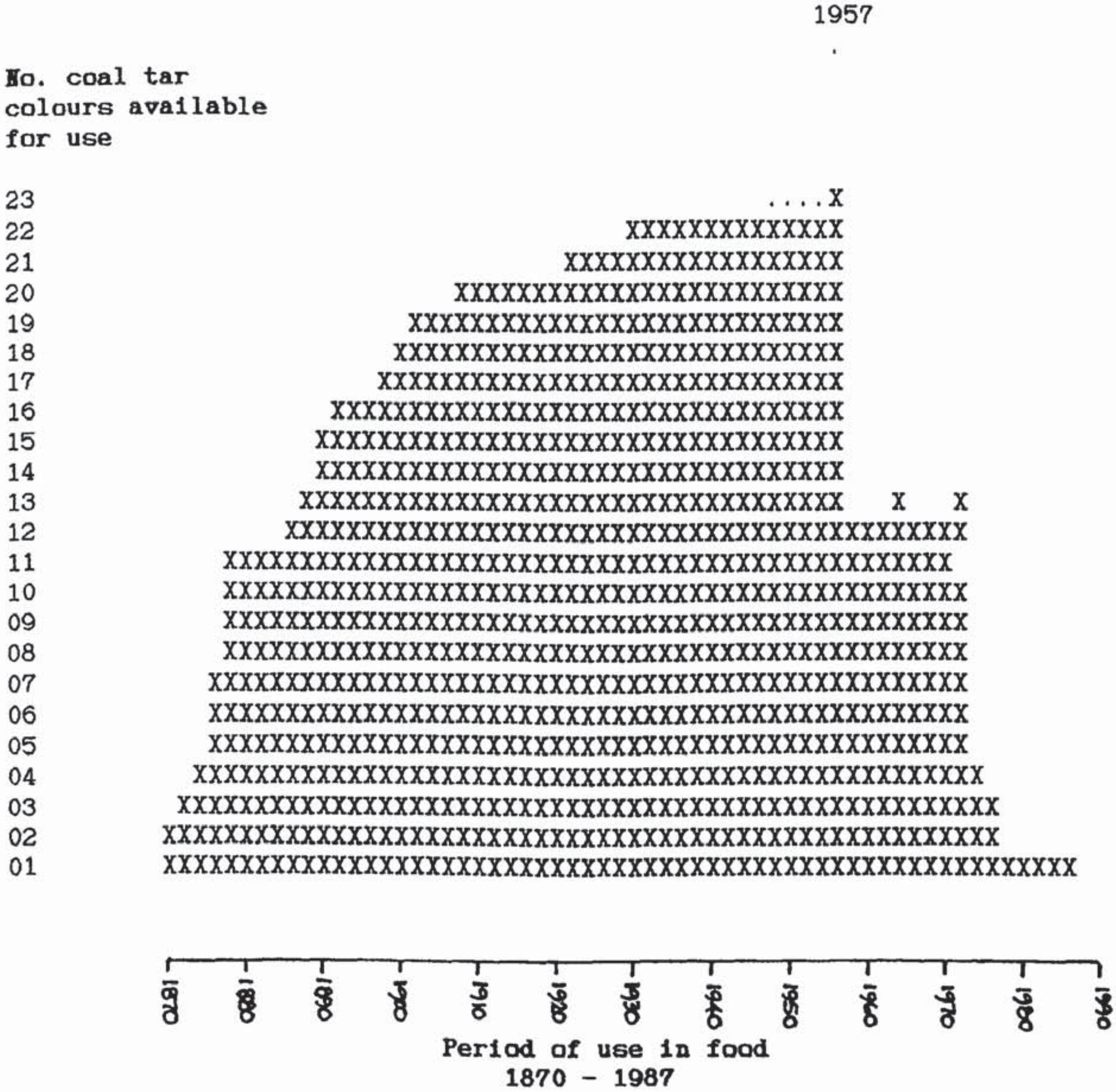


Table 6.54 shows that the positive list removed the burden of 4 out of 6 harmful D-rated colours. The remaining two were removed soon after by an amendment to the positive list. Table 6.55 shows that the positive list removed about 50% of the E-rated colours in 1957. Most of the others were removed by later amendments. This can be considered beneficial to health since there were likely to be some harmful colours among these 'unknowns'.

The data presented in tables 6.51 to 6.55 have been used to calculate numerical representations of the burden of hazard available from coal tar colours from 1870 to 1987. Table 6.56 below gives the hazard burden from coal tar colours in the period of 1870-1957. 89% of the hazard burden from high risk (C and D-rated) colours was discontinued on introduction of a period of regulation in 1957.

TABLE 6.56 : HAZARD BURDEN FROM COAL TAR COLOURS IN 1870-1956 AND 1957-1987, BEFORE AND AFTER PERIOD OF REGULATION

Compiled from tables J.3 and J.4.

Hazard group	Hazard burden 1870-1957 from colours removed in 1957	Hazard burden 1870-1957 from colours remaining in 1957	Total hazard burden
A	163 (19%)	685	848
B	492 (100%)	0	492
C	2676 (90%)	287	2963
D	344 (81%)	80	424
E	760 (56%)	604	1364
Total	4435 (73%)	1656	6091

6.73 Assessment 2: Hazard burden scores

Table 6.57 shows that the proportion of D-rated colours remained well above 20% foe the first three periods. In the period of 1925-56, a period predominantly of trade control, the proportion of D-rated colours came down to 10%. In the period of regulatory control (1957-87) it dropped futher to 3%. The high risk (C and D-rated) colours remained constant around 53% for the first four periods of predominantly voluntary control. The proportion dropped dramatically to 15% on entering the period of regulatory control (1957-87). Table 6.58 shows that the greatest change in the proportion of high risk colours occurred in the period of regulatory control.

The medium risk (B and E-rated) colours rose slightly from around 24% in the first two periods to 33% in the early 1900s. It then fell slightly to 28% in 1925-56. The start of the period of regulatory control increased to 32% the proportion of medium risk colours. Table 6.58 shows that the largest reduction in the proportion of medium risk colours occurred during a period of trade control.

The low risk (A-rated) colours dropped slightly from 23% to 17% in the first four periods of trade control. On introduction of the period of regulation ther was an enormous increase from 17% to 52%. Table 6.58 shows that the greatest change occurred at this point. Table 6.59 presents graphically the changes introduced by the period of regulation.

6.74 Mineral colours

Table 6.60 shows that the proportional score of D-rated mineral colours rose to 93% in 1876-1900 and dropped to 52% in the following period. In the fourth period of predominantly trade control the proportion droppd 100% to zero. The largest change in high risk colours occurred before regulations were made, in a period under trade control. However, chapter 3 has shown that many of the haardous mineral colours were removed from food because of the Food Acts.

TABLE 6.57 : COAL TAR COLOURS: SCORES REPRESENTING NUMBER OF YEARS OF USE IN FIVE PERIODS FROM 1850 TO 1987, DIVIDED BY HAZARD GROUP

Compiled from table K.1 in appendix K
KEY:
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

	Score (& percentage) / Retrospective hazard group					
Period	A	B	C	D	E	Total
1850-1875	6 (23%)	1 (4%)	8 (31%)	6 (23%)	5 (19%)	26
1876-1900	7 (19%)	2 (6%)	8 (22%)	12 (33%)	7 (19%)	36
1901-1924	16 (17%)	8 (8%)	27 (28%)	21 (22%)	24 (25%)	96
1925-1956	25 (17%)	8 (5%)	66 (45%)	15 (10%)	34 (23%)	148
1957-1987	30 (52%)	2 (3%)	7 (12%)	2 (3%)	17 (29%)	58

The same information is re-arranged below into low, medium and high risk groups:

Period	Score (& percentage) / Risk group			
	Low	Medium	High	Total
1850-1875	6 (23%)	6 (23%)	14 (54%)	26
1876-1900	7 (19%)	9 (25%)	20 (55%)	36
1901-1924	16 (17%)	32 (33%)	48 (50%)	96
1925-1956	25 (17%)	42 (28%)	81 (55%)	148
1957-1987	30 (52%)	19 (32%)	9 (15%)	58

TABLE 6.58 : COAL TAR COLOURS: CHANGE IN HAZARD BURDEN BETWEEN FIVE PERIODS FROM 1850 TO 1987

Compiled from table 6.57

KEY:
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Periods of time:
1 1850-1875
2 1876-1900
3 1901-1924
4 1925-1956
5 1957-1987

Change between periods	Change in proportion of hazard score Low	Medium	High
1 to 2	- 4	+ 2	+ 1
2 to 3	- 2	+ 8	- 5
3 to 4	0	- 5	+ 5
4 to 5	+ 35	+ 4	- 40

The score of medium risk (B and E-rated) mineral colours dropped between the first and second periods, then remained around 21% in the two periods of trade control in the twentieth century. There was a negligible drop to 20% on the introduction of the regulatory period.

The low risk (A-rated) colours fell from 22% in the first period to zero in the second. In the two periods of trade control of this century the proportion of low risk colours rose from 29% to 78%, an enormous increase. The period of regulatory control produced a further increase, to 80%.

TABLE 6.59 : CHANGE IN HAZARD BURDEN FROM COAL TAR COLOURS BETWEEN PERIODS 1926-1956 AND 1957-1987

Compiled from table 6.57

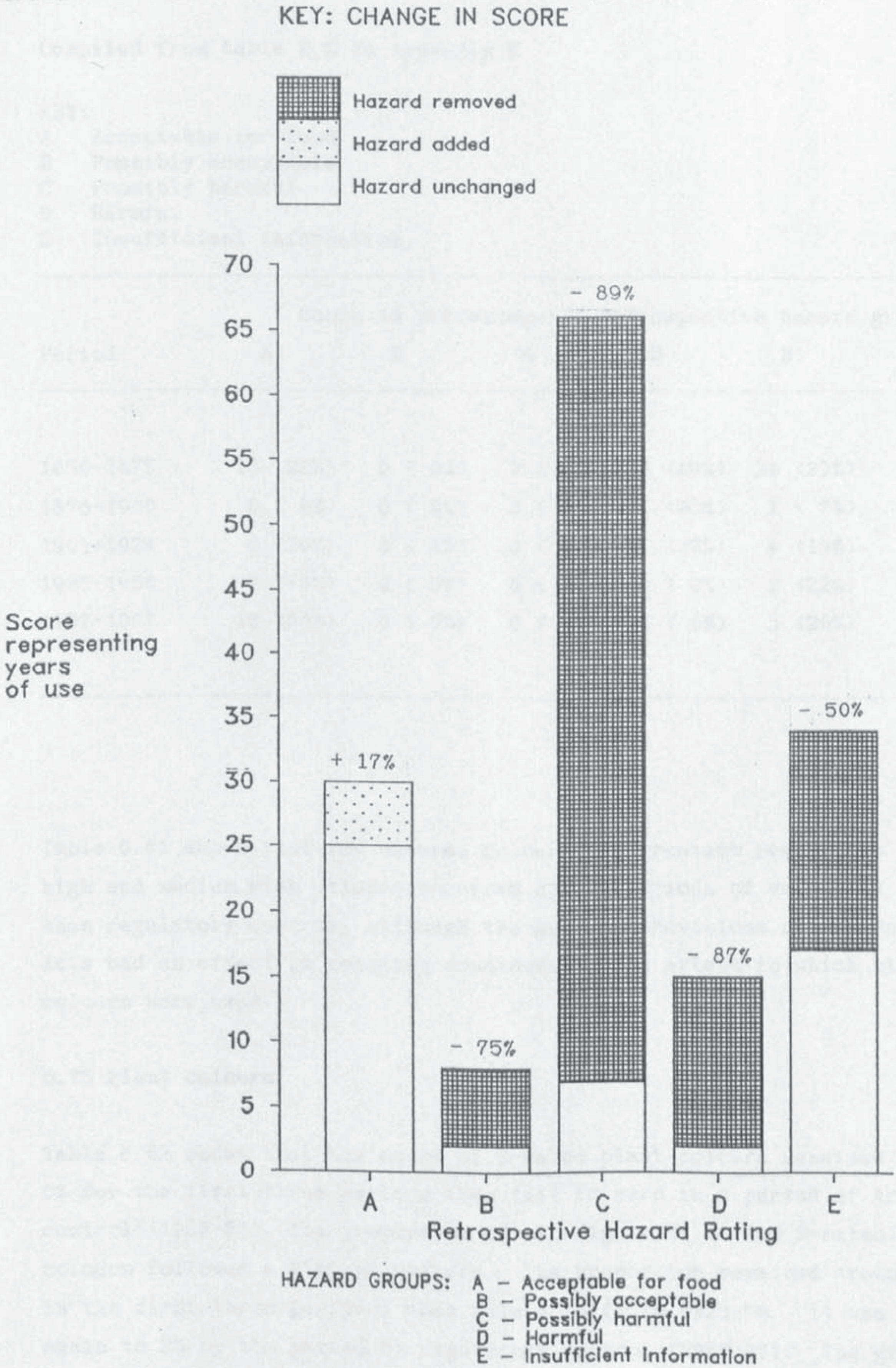


TABLE 6.60 : MINERAL COLOURS: SCORES REPRESENTING NUMBER OF YEARS OF USE IN FIVE PERIODS FROM 1850 TO 1987, DIVIDED BY HAZARD GROUP

Compiled from table K.2 in appendix K

KEY:
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

	Score (& percentage) / Retrospective hazard group					
Period	A	B	C	D	E	Total
1850-1875	18 (22%)	0 (0%)	0 (0%)	40 (49%)	24 (29%)	82
1876-1900	0 (0%)	0 (0%)	0 (0%)	14 (93%)	1 (7%)	15
1901-1924	6 (29%)	0 (0%)	0 (0%)	11 (52%)	4 (19%)	21
1925-1956	7 (78%)	0 (0%)	0 (0%)	0 (0%)	2 (22%)	9
1957-1987	12 (80%)	0 (0%)	0 (0%)	0 (0%)	3 (20%)	15

Table 6.61 shows that for mineral colours the greatest reductions in high and medium risk colours occurred during periods of voluntary rather than regulatory control, although the general provisions of the Food Acts had an effect in reducing considerably the extent to which mineral colours were used.

6.75 Plant colours

Table 6.62 shows that the score of D-rated plant colours remained around 6% for the first three periods then fell to zero in a period of trade control (1925-56). The proportion of all high risk (C and D-rated) colours followed a similar pattern. The proportion remained around 9% in the first three periods, then halved to 4% in 1925-56. It was halved again to 2% by the period of regulatory control (1957-87). The greatest

TABLE 6.61 : MINERAL COLOURS: CHANGE IN HAZARD BURDEN BETWEEN FIVE PERIODS FROM 1850 TO 1987

Compiled from table 6.60

KEY:
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Periods of time:
1 1850-1875
2 1876-1900
3 1901-1924
4 1925-1956
5 1957-1987

Between	Change in proportion of hazard score		
periods	Low	Medium	High
1 to 2	- 22	- 22	+ 44
2 to 3	+ 29	+ 12	- 41
3 to 4	+ 49	+ 3	- 52
4 to 5	+ 2	- 2	0

percentage change in high risk plant colours occurred in a period of trade control, as table 6.63 shows.

The proportion of medium risk plant colours was about 64% in the first two periods. It dropped to around 53% in the following two periods of trade control. The proportion fell slightly to 48% on introduction of the period of regulation. Table 6.63 shows that the greatest change in the proportion of medium risk plant colours was on the introduction of the period of 1867-1900, a period of trade control.

TABLE 6.62 : PLANT COLOURS: SCORES REPRESENTING NUMBER OF YEARS OF USE IN FIVE PERIODS FROM 1850 TO 1987, DIVIDED BY HAZARD GROUP

Compiled from table K.3 in appendix K

KEY:
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Period	Score (& percentage) / Retrospective hazard group A	B	C	D	E	Total
1850-1875	10 (26%)	2 (5%)	2 (5%)	2 (5%)	23 (59%)	39
1876-1900	7 (27%)	5 (19%)	0 (0%)	2 (8%)	12 (46%)	26
1901-1924	10 (37%)	3 (11%)	1 (4%)	1 (4%)	12 (44%)	27
1925-1956	10 (43%)	3 (13%)	1 (4%)	0 (0%)	9 (39%)	23
1957-1987	20 (50%)	7 (18%)	1 (2%)	0 (0%)	12 (30%)	40

The same information is re-arranged below into low, medium and high risk groups:

Period	Score (& percentage) / Risk group Low	Medium	High	Total
1850-1875	10 (26%)	25 (64%)	4 (10%)	39
1876-1900	7 (27%)	17 (65%)	2 (8%)	26
1901-1924	10 (37%)	15 (55%)	2 (8%)	27
1925-1956	10 (43%)	12 (52%)	1 (4%)	23
1957-1987	20 (50%)	19 (48%)	1 (2%)	40

The proportion of low risk plant colours remained around 26% in the first two periods. It then rose to 37% and 43% during the periods of trade control in the twentieth century. There was a further increase to 50% from the period of regulatory control.

TABLE 6.63 : PLANT COLOURS: CHANGE IN HAZARD BURDEN BETWEEN FIVE PERIODS FROM 1850 TO 1987

Compiled from table 6.62

KEY:
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Periods of time:
1 1850-1875
2 1876-1900
3 1901-1924
4 1925-1956
5 1957-1987

Change between periods	Change in proportion of hazard score Low	Medium	High
1 to 2	+ 1	+ 1	- 2
2 to 3	+ 10	- 10	0
3 to 4	+ 6	- 3	- 4
4 to 5	+ 7	- 4	- 2

6.76 EVALUATING FOOD COLOURS

Alan Irwin has made the following comment about the problem of controlling technological risks:

> The approach taken by the Council for Science and Society is that a hazard is not an objective phenomenon but rather an 'intellectual construct'. Different people within different social settings will perceive a hazard in individual ways - the numerical severity of a risk is just one dimension of the product or process in question which cannot be separated out from the overall social context. Seen in this light, the potential for risk is simply one aspect of a given technology: we do not judge the risk alone, but rather the whole 'package' of cost and benefit of which it is a part. It follows that any 'rational' attempt to abstract a statistical risk out from its technological and social setting will prove a sterile exercise. Moreover, as McGinty and Atherley point out, it is also likely to be undemocratic: the only people in a position to judge whether a specific risk is acceptable are those who will be directly affected by any consequent death or injury. This represents a powerful argument for public participation in matters of technological risk (90).

Colours are not evaluated solely on the basis of safety. Their benefits as well as their risks have traditionally been evaluated by advisory committees. Governments have developed procedures for assessing the need for and safety of colours. 'Need' has already been discussed in chapter 5. Safety evaluation procedures are discussed below. The extent to which people affected by the technology are involved in decisions is also examined.

The safety assessments of colours are inadequate in many respects, and undermine the ability of regulatiions to protect health. For example, the battery of tests required for colours is not entirely appropriate for determining their safety for humans. Moreover, there are a number of gaps in the testing programme. The following sections outline a number of problems with current safety testing procedures:

a) Extrapolation from animals to humans
b) Lack of research on plant colours
c) Cocktail effects
d) Important human data ignored
e) Restricted control of testing
f) Poor laboratory practice
g) Administrative expediency and industry pressure

h) Calculating safe doses

These problems are described below.

6.77 **a) Extrapolation from animals to humans**

There are a number of significant practical problems in interpreting the results of animal tests. One problem is the difficulty of predicting long term consequences by using tests of relatively short duration (91). Assumptions have to be made about how the lifetimes of test species (usually rats and mice) relate to lifespans of humans. This is problematic; but a more fundamental difficulty lies in the fact that some hazards cannot be detected when colours are tested on laboratory animals. For example,

> None of the animal models exhibit the range of disease entities that characterises ageing man (92).

So animal tests may fail to show up some types of disease that would affect the elderly.

It is difficult to extrapolate information gained about the health effects of colours in certain species (eg. rats) to another (humans). There are differences in the biochemistry and genetics of species that mean they can be affected differently by a substance (93). Large mammals, such as dogs, pigs or monkeys, provide much better models of humans than small mammals such as rats and mice. For example, when bladder cancers were found in an unexpectedly high number of dye workers some coal tar dyes were tested in rats and mice. Not many tumours were found in the rodents. But when the dyes were tested in dogs the results were much more useful as indicators because the dogs produced tumours as the dye workers had done. These tests were very expensive because they lasted about seven years. So although the dog is acknowledged to be the best model for testing chemicals suspected of causing bladder cancer, they are used rarely (94). In order to gain statistical confidence in test results (ie. for comparative tests between two groups of animals to be statistically meaningful) large numbers of test animals are required. In order to save housing space and feeding costs small mammals are used, despite the fact that they are less appropriate models in certain instances.

So the standard set of animal tests (called the protocol) currently required by regulators cannot provide full information about the effects of any colour on human health. It can indicate many acute effects but it cannot indicate all the possible chronic effects of small doses eaten over a number of years. Moreover, even the relatively large number of animals used are not large enough to predict acute effects that may occur in a minority of people (or test animals) such as hypersensitive reactions.

In the 1930s and 1940s toxicological assessments were easier in one respect because the tests were screening a wide range of colours for more obvious and acute forms of toxicity, such as overt liver damage. Today toxicology is being required to do a much more sophisticated job of screening the remaining colours for low level chronic toxicity. As well as reducing its effectiveness this change makes the results much more open to controversy.

It has been argued that laboratory tests now offer no better a prediction of safety than tossing a coin. This has been used as an argument to undermine the significance of tests that have shown adverse results. But in fact the point applies to a sub-group of laboratory studies: mainly some of the short-term tests for carcinogenicity developed in the 1970s. In a study on the reliability of some short term tests like the Ames test, they were found to give an 'all clear' result for three potent animal carcinogens (95). This was because short-term tests for genotoxicity can only indicate certain types of carcinogens (those involving gene damage).

The required battery of tests on food colours could be made much more appropriate to human experience. A number of improved testing systems have been developed. Human cells grown in culture, for example, provide alternative models. Models of the digestive system have been developed now that the significance of gut flora in breaking down additives has been realised. Single radial immunodiffusion assays have been developed for testing the potency of certain vaccines. The Lancet reported that these new tests had proved more precise and reproducible, and were probably as reliable as the challenge assay in mice (96). Tests like these could be amended and developed for colours. Some tests that are already available are much more appropriate for the required protocol for colours than those that are currently required by regulators.

6.78 b) Lack of research on plant colours

The coal tar colours remaining on the permitted list have had large numbers of tests conducted on them. In contrast, the plant colours have received very little attention.

Table E.3 in appendix E shows the development of the permitted list of plant colours after 1957. Negligible changes were made to the regulations despite very significant changes in technology (see chapter 4). Primarily, the regulations were not designed to cope with nor amended to cover the massive period of innovation in plant-based colours of the 1960s. The current UK permitted list (and that of most countries) is out-dated in reflecting the colour technology of the mid 1950s.

The plant-based colours have long been considered by regulators as toxicologically unproblematic, with the exception of gamboge. Hassall, for example, regarded vegetable colours as 'of course harmless' (97). This remained the attitude of many regulators and scientists until the 1970s. In 1978 (or earlier) JECFA adopted the view that naturalness *per se* does not assure safety, and that natural food colours should be classified in three groups and examined:

a) 'Natural' colours from a recognised foodstuff, chemically unmodified, used in the foodstuff from which it was extracted at levels normally found. These were considered, like a food, not to require safety testing.

b) Colours as in (a), used at higher levels or in other foods. These might require safety testing like any artificial colour.

c) Chemically modified colours from a food source or isolated from a non-food source or 'nature-identical' synthetic colours which may contain impurities. These would require testing (98).

The new questioning of plant colours started officially in the UK in the 1979 FACC report. Nevertheless in 1987, three (18%) plant colours rated E remained on the permitted list compared to one (6%) and zero (0%) for coal tar and mineral colours. There are also considerable differences in the proportions of low risk colours in the three groups. 59% of plant colours are currently rated A compared to 82% of coal tar colours and 100% of mineral colours (99).

This reflects a continuing difference in attitude to the level of toxicological information required for plant colours. In 1987 FAC recommended that much more attention be paid to the safety of plant colours. It re-classified in group E five plant products (solvent-extracted annatto, capsanthin (capsorubin), citranaxanthin, crocin and santalin). Interestingly FAC's solution for three of the E-rated colours is not to ban them until they have been cleared but to remove them from the scope of the colour regulations. They are all spices or extracts of spices and can be considered to give colour as a secondary function, so a loophole in the law will permit them to be used as colours still, although they are relatively untested. This will contravene recommendation (b) of JECFA, given above.

There is little justification for not testing all colours systematically and thoroughly. Among the natural/plant colours there are substances known to be harmful. Annatto, for example, can cause intolerant reactions. In one test it caused problems to more people than the coal tar colour Tartarazine (100). Curcumin, an extract of turmeric, has caused mutagenic effects in some tests (101).

The situation of toxicological testing lagging a long way behind developments in technology is a long-standing problem. Fred Steward identified the same difficulty in the 1950s.

> The problem highlighted by [the] initial introduction of a permitted list for food colours was that of undertaking assessment and control in a situation where the pace of technological change had so clearly outstripped that of the scientific investigation of its potential harm (102).

It is remarkable that this problem has persisted for so many years without being resolved adequately by regulators.

It has been argued that there are simply not enough toxicologists available to do all the testing required. This point is entirely true. However the conclusion often drawn from this fact by regulators and industry is that the suspect substances will just have to go on being used until toxicologists get around to testing them. This is an inadequate response for those who would wish to give public health a higher priority. It would be more appropriate to stop using substances that are not strictly needed, until they have been checked for safety, as the positive list approach is supposed to do in theory.

6.79 c) Cocktail effects

Another major gap in the testing procedure is that colours are not tested in combination. Safety tests are very rarely carried out on more than one additive at a time. Yet in real life they are eaten or handled in a variety of combinations with all sorts of interactions occurring.

A single meal may contain an elaborate cocktail of 12 to 60 different additives. Food workers may be exposed to mixtures of 4 to 50 additives at any one time (103). The cocktails of additives may react with each other and with foods to produce new chemical substances. These new products should be tested for safety, but they are not. In a rare test carried out on combinations of additives (including the colour Amaranth) and low fibre food it was found that the rats developed 'unthrifty' fur, alopecia and extensive diarrhoea, and there was a marked retardation in weight increase. This synergistic effect was not found when the animals received only one of the additives (104). It would be very time-consuming and costly to test all possible combinations of additives. It would be more logical to reduce considerably the number and levels of additives in use. In a recent publication of the European Commission, a public health specialist argued as follows:

> It is not scaremongering to say that the possibility cannot be ruled out of two substances, both harmless by themselves, interacting to yield a product which is toxic. Even apart from any toxic potential, the obvious limits of our knowledge therefore militate in favour of a reduction in the numbers of permitted substances; there are many doctors who would like [permitted] lists [of additives] to be as short as possible (105).

6.80 d) Important human data ignored

Government authorities responsible for food safety tend to overlook the daily risks to food workers from colours. When evaluating the safety of colours the safety for consumers is the angle that is examined, so colours are tested mainly by ingestion, rather than by inhalation or skin contact. Occasionally skin tests are now performed on humans to test for acute hypersensitive or irritant reactions. Where information has been gathered about workplace exposure it may be examined by the advisory committee COT, but such information tends to focus on acute effects only. It is only since the advent of European Directives and of the Health and Safety at Work Act (1974) that workers have received any attention from MAFF (106). The evaluation of food colours before that time did not involve worker exposure (except in much earlier periods, such as the 1920s).

Worker exposure is still not systematicaly monitored for long-term health effects once a colour has been approved. When it comes to weighing up the risks and benefits the long-term risks to workers are not necessarily known and so cannot be a part of the risk/benefit equation. Moreover, some government officers do not consider food workers to be significantly exposed to additives, certainly not by the oral route. This was underlined recently by a Principal Medical Officer responsible for additive safety assessments in the DHSS, who said,

> There aren't any workers who are particularly heavily exposed to additives... They don't have a particularly high intake of additives (107).

Yet it has been demonstrated that occupational exposure to colours can be enormous, by all routes, including the oral route (108). When challenged about the lack of research in occupational hazards, the Ministry of Agriculture points out that it interprets its remit to assess the 'safety-in-use' of colours as 'safety-when-eaten'. It leaves occupational protection to the Health and Safety Executive (HSE).

The HSE tends to assume additives present little hazard. A recent HSE review of health and safety in the food industry acknowledged that additives were assessed for people eating rather than working with them, but stated reassuringly that

> The nature and amount of additives which may be used are strictly controlled by law (109).

But the controls apply only to consumption. Thus they overlook the fact that occupational exposure occurs at far higher levels and via more routes than consumer exposure. Along with academic occupational hygienists they tend to assume additives are safe because they have been approved for use in food. For example, a major reference book on occupational hazards, edited by N I Sax, assumes a number of additives can be assigned a low toxicity rating because they are additives. For sodium gluconate, for example, Sax comments on the toxicity rating: 'No data. Probably low', because it is '... a sequestrant food additive' (110). Yet chemicals capable of acting as sequestrants are known to present risks to human health (111).

So both the government authorities that might be expected to take responsibility for assessing the hazards to food workers exposed to colours have not researched the problem.

It might be expected that government committees responsible for consumer safety might monitor the exposure and health of food workers, since it may provide an early warning of possible hazards to consumers. Some toxicologists have indicated that they are interested in monitoring workers - for the benefit of consumers (112). It is undesirable to use food workers as guinea pigs for the benefit of consumers. Preventive independent research is needed for both groups. But the fact that no monitoring of food workers is done by the committees that have responsibility for consumer safety is surprising. Given the difficulties toxicologists have in extrapolating the information gained from animal tests to human experience, the failure to monitor worker exposure can only be taken as another indicator of the relatively low proirity given by government bodies to researching potentially fruitful avenues of consumer safety.

6.81 e) Restricted control of testing

In the UK the standard set of tests for a colour (outlined in chapter 3) is performed in one of three places: in the laboratories of the company that wants to market the colour; in the laboratories of BIBRA or another research association; or in a contract laboratory. So safety testing is performed by a narrow range of institutions. The design of the tests is under the control of the company paying for it. Comparatively little research on colours has been done in academic institutions. There is little opportunity and no resources for consumers and other interested parties to have safety tests performed independently according to their preferred criteria. FAC invites evidence on colours from all interested parties. But in practice this invitation cannot be taken up by consumer groups because they do not have the resources or organisation for independent testing and evaluation. Toxicological tests can cost anything between £20,000 and £1,000,000. Though the Consumers' Association, for example, had for a long time a seat on FAC the CA did not research food safety itself and was therefore not able to make a truly independent input on questions of safety.

6.82 f) Poor laboratory practice

There have been problems with unsound and fraudulent practices in some testing laboratories. One example of bad practice was for animals that were likely to die over the weekend to be thrown away on Friday night because they would be too far decomposed by Monday for an autopsy. This meant the results from some affected animal were completely lost - significantly affecting the results of some tests (113). Occasionally laboratories have used too few animals in experiments and have fabricated data - because it saved money.

A glaring example of these practices was uncovered in America. A major testing company, Industrial Bio-Test, was recently closed down because of flawed and fabricated data. An independent pathologist, Adrian Gross, found that some animals that had died during testing were not examined for cause of death and were replaced with fresh animals, so it was not established whether the chemical being tested was the cause of death. Furthermore, the animal cages were not always secure so test animals escaped and wild rodents entered the cages, again affecting the results of tests (114).

As a result of bad practices the American Food and Drugs Administration issued a code of Good Laboratory Practice and set up an inspection force. Recently the DHSS has set up a small inspectorate to encourage laboratories to comply with the Good Laboratory Practice Code in the UK.

Where tests have been improperly conducted the results can be misleading and will tend to underestimate any hazards rather than overestimate them. Industrial Bio-Test was 'the cadillac of the testing industry' and performed one third of the world's safety testing, on which government regulators of many countries based their safety evaluations (115). For all the substances tested by Industrial Bio-Test and any other laboratory where good laboratory practice was not enforced, the results are unreliable. Furthermore, the financial pressures on laboratories to cut corners (by not making cages sufficiently secure, for example) still exist.

6.83 g) Administrative expediency and industry pressure

The lack of systematic human monitoring and the inadequacies of the standard tests (for example, the fact that colours are tested singly rather than in real-life mixtures) suggests that the assessment system has not been designed to provide the best available information about the safety of colours to humans. If this were the case the protocol would have been designed rather differently.

Thirty years ago J M Barnes and F A Denz made some fundamental criticisms of safety testing methods that are still valid today. They concluded that the system of tests that had been developed were conducted

> As measures of administrative expediency (116).

More recently, Professor David Conning, the director of the British Nutrition Foundation (an industry-funded information centre), formerly the director of BIBRA (the main testing house for coal tar colours) has criticised current safety testing methods for colours and other additives. He has pointed out that

> The development of toxicology over the last three decades has been largely at the behest of regulatory demands. As a conseqence, toxicology has developed as a technology concerned with demonstrating 'safety' rather than as a science seeking to explain the mechanisms whereby chemicals affect biological systems... It has been easier and cheaper to provide the regulatory system with the data it needs, rather than to argue the scientific point (117).

Many of the limitations of toxicology stem from the fact that its development as a science has been shaped by the needs of industry and regulators. So necessary areas of theory and method have not been developed. Government has failed to put resources into developing a good scientific basis for toxicology. In contrast, the government in the USA has put significant resources into developing toxicological methodology, because environmental safety was a greater political issue.

David Conning has also indicated some of the inadequacies brought about by pressure from industry:

> Another confounding factor has been the commercial pressure to achieve clearance of compounds through the regulatory obstacles by the easiest route and never mind the future consequences (118).

6.84 h) Calculating safe doses

The aim of safety testing is to establish the level at which a colour can be safely consumed. It is acknowledged that no colour or additive can be entirely safe.

> Any substance may have effects on the body if sufficient of it is administered. The quantity of the substance ingested and absorbed is all important (119).

That is, it is the dose that makes the poison. It is considered that for any colour it is possible to define a dose that is likely to have no effect on the health of the majority of consumers. 'Safe' levels of consumption for colours are usually calculated by dividing the lowest dose that produces no effect in animal tests by a safety factor of 100. There is no scientific reason why the figure 100 is used. It was decided as a convenient regulatory cut-off point. Sometimes, however, this figure is not used rigidly. Subjective judgements are made about the types of changes that are 'significant'. In certain cases the lowest no effect level has been ignored and a smaller safety factor has been used.

The dose/effect relationship is a fundamental principle of colour safety evaluation; but it has several limitations, described below.

Firstly, the dose/effect relationship does not hold true for all health effects. Hypersensitive reactions and the formation of cancer are related to dose in a very complex way; extremely small levels of exposure may trigger enormous ill-effects. So it is extremely difficult to calculate a safe level of exposure for colours linked with these reactions (120). Nevertheless, advisory committees attempt to estimate safe levels of exposure for such additves (121). For example, for an additive like Tartrazine (a yellow coal tar dye) that causes hypersensitive reactions, a safe dose does not exist for a minority of people. In them, tiny quantities of the colour can trigger dermatitis or asthma, and can even produce the danger of suffocation (122).

Secondly, calculations of safe dose do not take sufficient account of peoples' diets and nutritional status. Assumptions are made by the advisory committees about the quantity of each food that an individual may eat. In practice individuals eat much higher levels of some foods (such as the ones they enjoy or the ones they can afford) than others. Some young children, for example, eat a high proportion of highly processed foods, snacks and sweets, and are likely to regularly exceed the 'safe' dose for certain colours as a result.

Nutritional status (ie. the presence of adequate levels of vitamins and other essential nutrients in the diet) is now recognised as essential in determining the extent to which an individual can resist or cope with potentially harmful chemicals. Vitamin and iron deficiency is still a problem for a minority in the UK. People suffering nutrient deficiency are likely to be eating a high proportion of refined and colour-laden food, and are at risk of exceeding the safe doses. For one colour, the advisory committee has already acknowledged that the majority of the population may exceed the 'safe' dose (123).

Thirdly, 'safe' dose calculations do not take sufficient account of individual differences. Colours are tested on groups of homogeneous animals. The results are then use to assess a 'safe' level of exposure for a very wide range of humans with genetic differences. Furthermore, some people are much more vulnerable to potentially harmful colours - the elderly, children, people who have a particular genetic make-up or who are already ill.

Fourthly, calculations of 'safe' dose are made for consumers; these calculations do not protect food workers.

6.85 Coping with Inadequate Toxicological Information

In the early 1900s when the Americans were interested in introducing a permitted list of coal tar colours there was a dearth of toxicity data. The government commissioned a massive review of safety studies. The seven colours recommended as a result of this review (listed in table

6.26) later turned out to be comparatively poor choices. 3 of the 7 were assessed in the 1950s and 1960s to be possibly harmful (C-rated) and 1 of the 7 to be harmful (D-rated). The remaining 3 were A-rated.

In the 1920s and in earlier periods it was thought that chemical class was a reliable indicator of hazard. In 1925, for example, four of the five banned coal tar colours came from the nitro class. It is interesting to examine whether chemical class would have made a reliable basis for regulatory decision-making and compilation of a positive list in the 1920s.

Table 6.64 divides, by chemical class, the coal tar colours rated D and C, and gives information about their dates of introduction and removal from food. It shows no predominant pattern of introduction or removal of colours among the classes, except for the nitro group. (The removal of the nitro colours is discussed in section 6.19)

Table 6.65 analyses, by chemical class, the number of colours in each hazard group (A - E). No strong patterns of hazard emerge for any of the classes containing significant numbers of colours, except for the nitro group. There may be some significant grouping in the azoic and azine classes but the numbers are too low for judgement. D-rated colours are found in only 5 classes, but C-rated colours are found in almost all. A-rated colours are concentrated in 6 classes but in all cases except Quinoline there are C or D colours as well, Quinoline is the only class containing A-rated colours alone. This may or may not indicate that Quinoline colours are safer: the number is far too low to be significant

This assessment suggests that these definitions of chemical class are not very useful predictors of hazard for coal tar colours. Sometimes small alterations in chemical structure can change the hazard potential considerably. For example, 4-dimethylaminoazobenzene (Butter yellow) is a potent animal carcinogen but the 4-diethyl derivative is not. So it is not surprising that these broad chemical classes are too crude a mechanism. Nevertheless, some other elements of chemical structure are now recognised as useful indicators in the assessment of a new additive (such as certain side groups or breakdown products).

TABLE 6.64: C AND D-RATED COAL TAR COLOURS DIVIDED BY CHEMICAL CLASS, WITH APPROXIMATE DATES OF INTRODUCTION AND REMOVAL, 1870 - 1987

Compiled from table J.1 in appendix J

KEY:

d   Harmful colour (retrospective hazard rating)
c   Possibly harmful colour (retrospective hazard rating)
X   Approximate period of use in food (not necessarily continuous use)
CI Colour Index number (1975)

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Chemical class                             Period of use in food
Hazard rating
Colour Index No.
Name of colour           1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970
-------------------------+----+----+----+----+----+----+----+----+----+----+-----

Nitroso dyes       CI 10000-10299
c10020 Naphtol green B          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Nitro dyes         CI 10300-10999
d10305 Picric acid       XXXXXXXXXXXXXXXXXXXXXXXXXXX
d10310 Victoria yellow   XXXXXXXXXXXXXXXXXXXXXXXXXXXX
d10315 Manchester yellow XXXXXXXXXXXXXXXXXXXXXXXXXXXX
d10360 Aurantia            XXXXXXXXXXXXXXXXXXXXXXXX
c10316 Napthol yellow S       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Monoazo dyes       CI 11000-19999
d11020 Butter yellow         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
d11270 Chrysoidine          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
d11390 Oil yellow OB                       XXXXXXXXXXXXXXXXXXXXXXXXXX
d12055 Sudan I                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
d14700 Ponceau SX                                                  XXXXX
d16155 Ponceau 3R             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c11660 Hansa yellow 5G                       XXXXXXXXXXXXXXXXXXXXXXXX
c11680 Hansa yellow G                        XXXXXXXXXXXXXXXXXXXXXXXX
c11710 Hansa yellow 10G                       XXXXXXXXXXXXXXXXXXXXXXX
c11860 Oil yellow HA                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c12100 Oil orange TX         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c12140 Sudan II                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c14600 Orange I              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c15970 Orange RN              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c16150 Ponceau 2R             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c16180 Acid bordeau B         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c16250 Ponceau cryst. 6R        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Disazo dyes        CI 20000-29999
c21000 Bismarck brown G  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c21010 Bismark brown          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c21110 Permanent orange G                     XXXXXXXXXXXXXXXXXXXXXXX
c21670 Coomassie navy blue            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c22120 Congo red                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c22580?Direct black               ?XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c22610 Direct blue 2B               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c23500 Benzopurpurine 4B         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c26105 Sudan IV                                                  ...X
c27290 Brilliant croceine       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Polyazo            CI 35000-36999
c35445 Black 5410                                               ....X

Azoic              CI 37000-39999
c37130 Fast scarlet salt R                    XXXXXXXXXXXXXXXXXXXXXXX
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------------------------------------------------------------------------------------
Chemical class                             Period of use in food
Hazard rating
Colour Index No.
Name of colour           1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980
-------------------------+----+----+----+----+----+----+----+----+----+----+----+

c37275 Fast red salt AL                        XXXXXXXXXXXXXXXXXXXXXX
c37530 Naphthol AS-OL                               XXXXXXXXXXXXXXXXX

Diphenylmethane    CI 41000-41999
d41000 Auramine                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Triarylmethane     CI 42000-44999
d44040 Victoria blue R
d44045 Victoria blue B
d42085 Acid green GG            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
d42510 Magenta           XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c42000 Malachite green       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c42036 Turquoise blue G             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c42045 Blue VRS                           XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c42095 Light green SF         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c42535 Methyl violet     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX       XXXXXXXX
c42640 Acid violet 6B              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c43800 Aurine            XXXXXXXXXXXXXXXXXXXXXXXXX

Xanthene           CI 45000-45999
c45160 Rhodamine 6G                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c45170 Rhodamine B              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Azine              CI 50000-50999
c50400 Induline spirit   XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c50405 Induline          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c50420 Nigrosine         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Thiazine           CI 52000-52999
c52015 Methylene blue        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Anthraquinone      CI 58000-72999
c69800 Idanthrene blue                   XXXXXXXXXXXXXXXXXXXXXXXXXXXX       XX

Indigoid           CI 73000-73999
c73360 Helindone pink                       XXXXXXXXXXXXXXXXXXXXXXXXX

Phthalocyanine     CI 74000-74999
c74260 Phthalocyanine green                               XXXXXXXXXXX

No CI number
d      Oil yellow AB                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c      Baking brown               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c      Benzyl bordeau B          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c      Chlorazol sky blue           XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c      Croceine scarlet 5R    XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c      Fast yellow R          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c      Helio red                               XXXXXXXXXXXXXXXXXXXXXXXXXX
c      Heliotrope        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c      Methyl orange         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c      Oil red 2R                     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c      Orange R              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
c      Safranine        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
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TABLE 6.65 : COAL TAR COLOURS DIVIDED BY CHEMICAL CLASS AND BY RETROSPECTIVE HAZARD RATING

Compiled from table 7.1 and I.3

KEY to hazard rating:
A Acceptable for food
B Possibly acceptable; insufficient information
C Possibly harmful; insufficient information
D Harmful
E Insufficient information

Chemical constitution	Number (percentage) of each hazard ratinhg					
	A	B	C	D	E	Total
Nitroso	0	0	1 (100)	0	0	1
Nitro	0	0	1 (20)	4 (80)	0	5
Monoazo	9 (20)	2 (4)	11 (24)	6 (13)	18 (39)	46
Disazo	2 (12)	0	10 (59)	0	5 (29)	17
Polyazo	0	0	1 (100)	0	0	1
Azoic	0	0	3 (100)	0	0	3
Diphenylmethane	0	0	0	1 (100)	0	1
Triarylmethane	4 (16)	3 (12)	7 (28)	4 (16)	7 (28)	25
Xanthene	1 (13)	4 (50)	2 (25)	0	1 (13)	8
Acridine	0	0	0	0	1 (100)	1
Quinoline	1 (100)	0	0	0	0	1
Azine	0	0	3 (75)	0	1 (25)	4
Thiazine	0	0	1 (100)	0	0	1
Anthraquinone	0	0	1 (100)	0	0	1
Indigoid	1 (50)	0	1 (50)	0	0	2
Phthalocyanine	0	0	1 (100)	0	0	1
Unidentifiable	1 (4)	1 (4)	13 (57)	1 (4)	7 (30)	23
Total	19	10	56	16	40	141

By 1955 the amount of toxicological information about colours had increased enormously, but was still insufficient for making clearly beneficial decisions. Available information allowed the Pharmacology Panel to pinpoint and exclude from the permitted list some obviously hazardous colours, but they also permitted some colours that were shown later to be hazardous. Given the inadequate state of toxicological knowledge at the time, the selection of colours on the list of 1957 could only have been improved upon slightly, since the committee was determined to allow continued extensive use of colours.

Substantial improvements could not have been made without a large programme of research. Halving the list would merely have doubled exposure to the remaining colours, some of which were in the high risk category. A significant improvement in hazard levels would only have been guaranteed by a total ban on coal tar colours or restricting them to fewer foods. A total ban had been suggested by Peacock, in the trade press in 1952 (124). (He had examined the toxicology of a coal tar colour.) Politically his suggestion was totally untenable. The suggestion was considered 'unrealistic' by the advisory committee, because of the relatively poor technical qualities of the alternatives (125).

It has been suggested that the level of hazard might have been lower if the 1955 committee had adopted a more cautious approach, such as permitting only the colours they rated 'A' (126). Table 6.66 examines the level of hazard that would have been experienced had the committee restricted the positive list to the colours it rated A (acceptably safe) rather than being persuaded by trade pressures and a poorly defined concept of 'trade requirements' to accept colours for which the evidence was scanty or conflicting. Of the 17 colours considered 'provisionally acceptable' for food by the Pharmacology Panel in 1954, 6 (35%) were later judged to be low risk (A-rated); 9 (53%) to be medium risk (E-rated) and 2 (12%) to be high risk (C and D-rated).

Table 6.66 shows that the inclusion of only the 'acceptable' ('A'-rated) colours on the 1957 list would have reduced the **number** of high risk colours (rated C and D by later assessments) by 50%. It would have reduced the number of A-rated colours also by 50%, and E-rated colours by 66%. But, interestingly, the high risk (C and D-rated) colours as a proportion of all colours would have risen slightly from 20% to 23%.

TABLE 6.66 : RETROSPECTIVE HAZARD RATINGS OF COAL TAR COLOURS RATED 'A' AND 'B' BY THE PHARMACOLOGY PANEL IN 1954/5

Compiled from tables I.1 and I.3 in appendix I

	Number of colours (%) / retrospective hazard rating					
	A	B	C	D	E	Total
Colours accepted onto 1957 list (rated 'A' and 'B')	12 (40%)	0 (0%)	4 (13%)	2 (7%)	12 (40%)	30
Colours rated 'A' in 1954/5	6 (46%)	0 (0%)	2 (15%)	1 (8%)	4 (31%)	13
Colours rated 'B' in 1954/5	6 (35%)	0 (0%)	1 (6%)	1 (6%)	9 (53%)	17

The medium risk (E-rated) colours would have been reduced from 40% to 31%. The low risk (A-rated) colours would have been raised slightly to 46% of colours instead of 40%. The overall benefits of the change in risk levels would probably have been small.

This demonstrates the difficulty of making beneficial regulatory decisions on the basis of inadequate scientific information. This point was highlighted in chapter 6 when I examined the number of colours once rated A which were added to the positive list after 1957, only to be withdrawn later. It shows that the safest policy is to constantly review and minimise the use of colours in the face of toxicological uncertainties. This can be done by several means: not just by a relatively short permitted list of colours considered safest, but more importantly, by restricting the use of colours to a limited range of foods, so that the total exposure to colours is reduced.

Required improvements for toxicity assessments today include the following:

a) Substantial (ie. government) funding of basic research in toxicology.
b) An improved set of priorities for test protocols so that they are set up to be as realistic as possible (including synergistic effects, for example). The protection of human health should be put at top priority.
c) Assessments should be put in the hands of more independent groups - especially those likely to be affected by colours. This point is discussed below.
d) Assessments should include occupational as well as consumer hazards.
e) Plant colours should be thoroughly tested if they are to continue to be used.
f) Detailed data on consumption should be collected regularly. Information should include for each colour the quantity used and eaten, and the range of foods in which it is used.

In 1954 the Food Standards Committee acknowledged that they were

> Unable to recommend any colour unreservedly as safe (127).

Even today, after much more toxicological research and many bans, no permitted colour is entirely without risks. After an extensive and rare review of the genotoxicity of a number of colours in 1982, Robert Combes and R Haveland-Smith (from Portsmouth Polytechnic) concluded:

> More than half of the listed and delisted food dyes reviewed have exhibited activity in at least 1 short-term assay. It is of some significance that several of these are currently permitted...in certain countries. Although hazard evaluation is difficult, it is noticed that certain food colours may be active in vitro at levels comparable to those ingested daily. Caramel is an example of a genotoxic dye which may be taken up in considerable quantities. Members of all three main synthetic dye classes are genotoxic (128).

Commenting on the problem of technological risks, Alan Irwin has pointed out that:

> Certainly, no conclusion can ever be reached about 'acceptable' levels of risk until the technological choices have been considered and the crucial effects of political

power in structuring debate have been fully taken into account (129).

Some of the alternatives to colours are considered in chapter 5. It is impossible to make food completely safe. Even some natural foods are toxic. But there is no justification for adding to the burden of hazards without good reason. As a precautionary measure, it would be sensible to prohibit colours from food where they are not strictly needed. This would save scarce resources for testing the colours and other substances that really are essential, so the best alternatives could be identified.

6.86 SUMMARY

Coal tar colours were the most significant group of colours throughout the twentieth century, largely replacing both plant and mineral colours. Regulations had most effect on the coal tar colours.

The 1925 regulations actively banned three high risk colours. But the benefits were short-lived because at least two of the banned colours were rapidly replaced by equally hazardous ones. This demonstrates one of the fundamental problems with the negative list approach. Significant reductions in hazard levels would have been achieved by the very early introduction of a negative list for high risk mineral and plant colours. This might also have restricted colours to fewer foods because technically viable alternatives were not yet available for many foods.

The 1957 regulations were much more effective than the 1925 regulations. Although they had no effect on the plant and mineral colours they had a great impact on the coal tar colours which were predominant at the time. Exposure to mineral colours had become negligible. Exposure was small but significant for a few plant colours. The 1957 regulations reduced the proportion of high risk coal tar colours from 54% to 20% and raised the proportion of low risk colours from 15% to 40%. The number of suspected carcinogens and allergens was reduced. This is likely to have brought benefits for food and chemical workers as well as consumers.

Amendments to the positive list between 1957 and 1978 made further improvements. A number of colours were banned on grounds of safety, particularly in the earlier years. The proportion of high risk colours was reduced from 20% to 6% for coal tar colours and from 6% to zero for plant colours. The proportion of high risk mineral colours remained unchanged overall (at zero). The proportion of low risk colours increased for all three groups. Low risk colours rose from 40% to 82% for coal tar colours; from 71% to 100% for mineral colours; and from 38% to 59% for plant colours.

Periods of trade control in the nineteenth century slowly brought significant reductions in the proportion of high risk mineral and plant colours. This was possible only because viable technical alternatives became available. One high risk mineral colour, copper, was not removed voluntarily. It is likely that a coal tar replacement was either not available or was more expensive.

When the possible hazards from coal tar colours became more obvious in the twentieth century, particularly in the 1930s and 1940s, traders reduced the proportion of high risk colours, but doubled the proportion of medium risk colours and almost halved the proportion of low risk colours. So the overall benefits were probably negligible. The introduction of the positive list forced the proportion of low risk colours to be more than doubled, Improvements to the risk levels after 1957 were made by amendments to the regulations. These improvements would have been increasingly difficult (if not almost impossible) to achieve voluntarily because each ban reduced the range of available colours further. From the 1970s manufacturers have fought particularly hard to prevent the removal of any colour that was still useful, even when laboratory studies indicated a possible hazard. This is discussed in chapter 5.

A summary of the effects of the negative and positive lists is given in table 6.67 below.

TABLE 6.67 : SUMMARY OF EFFECTS OF NEGATIVE AND POSITIVE LIST ON HEALTH

Colour group	Commercial importance of group	Effect of negative list	Effect of positive list
Coal tar colours	High	Short-lived	Large
Mineral colours	Low (High for copper)	Short-lived	Negligible
Plant colours	Low	Negligible	Negligible

NOTES AND REFERENCES TO CHAPTER 6

1 See section 6.22.

2 'Colours in Food' Nature 1942 vol 149, No 3785, p538.

3 H F Steward 'Adversary and advisory processes in the assessment and control of food additives' unpublished PhD thesis, University of Manchester, Manchester 1978, p252.

4 J Walford Developments in Food Colours - 1 Applied Science, London 1980, p20.

5 H F Steward op cit p249; Nature op cit p538.

6 J Walford op cit p20.

7 W Jago and W Jago The Technology of Breadmaking Simpkin, Marshall, Hamilton, Kent, London 1911; A Hausner The Manufacture of Preserved Foods and Sweetmeats Scott, Greenwood, London 1912; James Grant Confectioners' Raw Materials Edward Arnold, London 1921.

8 For example, Food Manufacture June 1935 and June 1936.

9 Robert Wells The Bread and Biscuit Baker's Assistant Crosby, Lockwood, London 1902.

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13 H F Steward op cit p96-7.

14 Ministry of Food, Food Standards Committee Report on Colouring Matters HMSO, London 1954.

15 H Drake-Law 'Colours in foodstuffs' Journal of the Society of Chemical Industry 1926, vol XLV, p428-434 (p4 of reprint).

16 They probably worked for colour manufacturing firms. ibid.

17 ibid

18 ibid p20 of reprint.

19 ibid p21 of reprint.

20 ibid p18 of reprint.

21 ibid p19 of reprint.

22 ibid p13, 22 of reprint.

23 *ibid* p4 of reprint.

24 J J-P Drake, BIBRA 'Food colours - harmless aesthetics or epicurian luxuries?' *Toxicology* 1975 vol 5 p9.

25 H F Steward *op cit* p101.

26 Ministry of Food, Food Standards Committee *op cit*; Ministry of Agriculture, Fisheries and Food, Food Standards Committee *Supplementary Report on Colouring Matters* HMSO, London 1955.

27 J Drake *op cit* p14

28 For a full discussion of the problems of toxicological testing and evaluation see M Miller *Danger - Additves at Work* London Food Commission, London 1985.

29 M Miller *Danger - Additives at Work* London Food Commission, London 1985.

30 See section 6.54.

31 See Chapter 4 and H Drake-Law 'Colours in foodstuffs' *Journal of the Society of the Chemical Industry* 1926 vol XLV No 49 p428.

32 SI 1925 No 775; see table 3.5.

33 H Kenwood *Public Health Laboratory Work (Chemistry)* HK Lewis, London 1920.

34 The Governments of Australia, Canada and the US, the National Confectioners' Association of the UK, and Kenwood of the Public Health Laboratory.

35 Martindale & Westcott *The Extra Pharmacopaeia* Lewis, London 1925 18th edition, vol II, p484-7.

36 Compiled from column 4 of table I.3 in appendix I and table D.1 in appendix D.

37 H Drake-Law *op cit* reprint p8.

38 *ibid*

39 W Jago *op cit* p891-2.

40 H Kenwood *op cit* p382.

41 A Hassall 1861 *op cit* p489.

42 A Wynter Blythe *Foods: Composition and Analysis* Charles Griffin, London 1888 p81.

43 In 1852 the *Lancet* published a report of the Analytical Sanitary Commission on coppered pickles. Later, the Food Acts probably had an effect.

44 In 1895 the Select Committee reported its use in tinned vegetables; see table 3.10.

45 Evidence presented to the Ministry of Health *Final Report of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food* HMSO, London 1924 (MH56/15 p30).

46 He considered several others to be harmful because of the contaminants and adulterants they sometimes contained.

47 *Nature* 1942 *op cit*; H F Steward *op cit* p252.

48 H F Steward *op cit* p252.

49 *Nature* 1942 *op cit*.

50 H F Steward *op cit* p252.

51 This caused problems not only for regulators but also for the trade, particularly dyers. The need for systematic classification and identification led to the Shultz and Julius's books, Arthur Green's translation and expansion of the scheme, and eventually the development of the *Colour Index*. See, for example, B C Burdett 'The Colour Index: the past, present and future of colorant classification' *Journal of Society of Dyers and Colourists* 1982 vol 98 p114-120 and the discussion of the problem by Bernhard Hesse *ibid*. Appendix G lists the trade colour manuals produced between 1844 and 1924.

52 Committee on Food Preservatives *Report of the Departmental Committee* HMSO, London 1901, pxxi.

53 This has been calculated from table 6.29. The score of C and D-rated colours in the periods 1901-24 and 1925-56 is 27 + 66 + 21 + 15 = 129. The score of C and D-rated colours in the period 1957-87 is 7 + 2 = 9. If the score of the period 1957-87 had been experienced in place of the 2 other periods this would give a score of 2 x 8 = 16.

54 The score of D-rated colours in the two earlier periods is 21 + 15 = 36. The score in the later period is 2, which is doubled to 4. This figure is the difference in the proportion of D-rated colours of the totals in the two periods.

55 2 (29%) of the 7 colours judged in 1957 to be acceptable by the Pharmacology Panel were later given an E-rating.

56 For a full discussion of the problems of workplace exposure to colours and other additives see M Miller *op cit*.

57 Ministry of Food, Food Standards Committee *Report on Colouring Matters* HMSO, London 1954, p17, paragraph 17.

58 *ibid* p7.

59 Casarett and Doull *Toxicology* Macmillan, London 1975, p343.

60 J Drake *op cit* p9, 13.

61 M Pyke *Food Science and Technology* John Murry, London 1981, 4th ed, p227.

62 S Epstein 'The Delaney Amendment' *Preventive Medicine* 1973, vol 2 p145.

63 J Coon 'The Delaney clause' Preventive Medicine 1973, vol 2, p150.

64 ibid p154.

65 F Fairweather 'Food additives and cancer' Proceedings of the Nutrition Society 1981, vol 40, p21, 29.

66 W Hueper Journal of Industrial Hygiene and Toxicology 1934, vol 16, p255. In speaking about the development of the dye industry in the UK he was referring to growth resulting from the massive government promotion and protection scheme for the industry following the shock of finding during the 1914-18 war that the UK was reliant on other countries, particularly Germany, for its dyes.

67 I Berenblum and G M Bonser Journal of Industrial Hygiene and Toxicology 1937, vol 19, p86.

68 International Labour Organisation Encyclopaedia of Occupational Health and Safety Geneva 1983, p371.

69 G Vettorazzi, JECFA Handbook of International Food Regulatory Toxicology MTP Press, Lancaster 1981, vol 2, p49, note 441.

70 Personal communication.

71 M Maruya 'On the renal changes of albino rats induced by the oral administration of 14 azo-compounds and 5 aromatic amino-compounds' Tr. Japanese Pathology Society 1938, vol 28, p541-547.

72 Z Albert 'Effect of prolonged feeding with chrysoidin on the formation of adenoma and cancer of the liver in mice' Archives of Immunol. Ter. Dosw. 1956, vol 4, p189-242. The first tumours occurred after 10 - 11 months.

73 International Agency for Research on Cancer (IARC) Monographs WHO, Geneva 1974, vol 8, p94.

74 WHO/FAO 'Specifications for the identity and purity of food additives...' WHO Technical Report Series, Geneva 1965, No 309, p22.

75 US Tariff Commission Census of Dyes and Other Synthetic Organic Chemicals, 1921 Tariff Information series No 26, US Government Printing Office, Washington DC 1922, p63.

76 US Tariff Commission Synthetic Organic Chemicals, US Production and Sales, 1972 Tariff Commission Publication No 681, US Government Printing Office, Washington DC 1974, p60.

77 IARC op cit p92.

78 Table D.1; H Drake-Law 'Colours in foodstuffs' Journal of the Society of the Chemical Industry 1926, vol XLV, No 49, p428-434.

79 Total imports amounted to 40,071,368 lb. Board of Trade, Commissioner for Dyes Statistics of the Synthetic Dyestuffs Imported into the United Kingdom, During the Year 1913 HMSO, London 1918.

80 Evidence from Williams of Hounslow to the Departmental Committee 1924. See table C.2 in appendix C.

81 Food Standards Committee 1954 op cit p23. The FSC identified the colour as Colour Index (1924) 20 or 21.

82 Deutsche Forschungsgemeinschaft Toxikologische Daten von Farbstoffen und ibre Zulassung fur Lebensmittel in Verschiedenen Landern Steiner Verlag, Wiesbaden, 1955, Mitt, 6, part 1.

83 IARC Monographs WHO, Geneva 1982, vol 27, p307-18.

84 IARC Chemicals, Industrial Processes and Industries associated with Cancer in Humans IARC Supplement No 4, WHO, Geneva 1982, p7.

85 GMBATU Hazards in the Health Service Surrey 1985, p21.

86 J Drake op cit p22 & 26-27.

87 M Polunin The Right Way to Eat J M Dent, London 1978, p88.

88 For a discussion of these problems see M Miller op cit.

89 People who take Canthaxanthin capsules to produce a false sun-tan may be at risk from damage to the retina. FAC's position on this colour is very unusual. Traditionally, the advisory committees have taken the view that the extra hazard created by additives can be justified where it is negligible compared to the amount ingested from other sources, such as pollutants (eg. nitrates). There has been pressure on civil servants from coal tar manufacturers and possibly some sectors of the food industry to emphasise the toxicology of some natural colours and deflect some of the recent criticism of coal tar colours. This might partly explain the departure from traditional policy.

90 Alan Irwin Risk and the Control of Technology: Public Policies for Road Traffic Safety in Britain and the United States Manchester University Press, Manchester 1985, p23.

91 David Conning 'Toxicological methodology' unpublished submission to the Food Safety Research Committee, 1985, p1. For other information about the limitations of toxicological tests see B H MacGibbon, DHSS 'Control of food additives and contaminants in the United Kingdom' in G G Gibson and R Walker Food Toxicology: Real or Imaginary Problems? Taylor and Francis, London 1985, p41-51; DHSS Guidelines for the Testing of Chemicals for Toxicity HMSO, London 1982; DHSS Guidelines for the Testing of Chemicals for Carcinogenicity HMSO, London 1982; International Programme on Chemical Safety and the Joint Expert Committee on Food Additives Principles for the Safety Assessment of Food Additives and Contaminants in Food Environmental Health Criteria 70, WHO, Geneva 1987.

92 D Conning ibid p1.

93 B H MacGibbon op cit p45; DHSS op cit p6.

94 Interview with Dr S D Gangolli, Director of Research, BIBRA, September 1985.

95 Raymond Tennant, National Toxicology Program, USA, October 1987.

96 Lancet 19 October 1985.

97 Arthur Hassall Adulterations Detected Longman, Green, Longman and Roberts, London 1861, p491.

98 WHO/FAO Evaluation of Certain Food Additives Geneva 1978, 21st report, FAO Food and Nutrition Series, No 8, WHO Technical Report Series, No 617, p7.

99 See tables 6.41, 6.44 and 6.46 in chapter 6.

100 Commission of European Communities Reports of the Scientific Committee for Food Brussels 1982, 12th series, EUR 7823, p8.

101 G Vettorazzi, JECFA Handbook of International Food Regulatory Toxicology MTP, Lancaster 1981, p77.

102 H F Steward Adversary and Advisory Processes in the Assessment and Control of Food Additives unpublished PhD thesis, University of Manchester, Manchester July 1978, p261.

103 For example a common meal eaten by children: fish fingers, peas and oven chips with tomato sauce, followed by yoghurt and washed down with orange squash, may contain over 30 additives. Single food items can contain large numbers of additives, for example, one brand of dessert mix contains over 30 different additives. Depending on the sector they work in, food workers may be exposed to a small or wide varity of additives.

104 Benjamin H Hasoff 'Synergistic toxicity of food additives in rats fed a diet low in dietary fiber' Journal of Food Science 1976 vol 41, p949-951.

105 Commission of the European Communities Food Additves and the Consumer Brussels 1980, p6.

106 J Philip, MAFF 'Evaluation of the safety of foods' Proceedings of the Nutrition Society 1981 vol 40, p52.

107 J Steadman, DHSS 'Food additives and cancer' Symposium on Cancer and the Diet, Royal Society of Health, London 1985.

108 M Miller Danger: Additives at Work London Food Commission, London 1985.

109 Health and Safety Executive Food and Packaging: Health and Safety, 1977 to 1982 HMSO, London 1984, p7.

110 N I Sax Dangerous Properties of Industrial Materials Van Nostrand Reinhold, New York 1975, 5th edition, p982.

111 NIOSH Occupational Diseases US Department of Health and Human Sciences, Cincinnati, p24.

112 D Conning 'New approaches to toxicity testing' in G G Gibson and R Walker op cit p13.

113 S D Gangolli op cit.

114 World in Action 'Tried Untested' 17 december 1984.

115 _ibid_

116 J M Barnes and F A Denz 'Experimental methods used in determining chronic toxicity: a critical review' _Pharmacological Review_ 1954 vol 6, p232.

117 D Conning _op cit_ p11.

118 _ibid_

119 Alastair Frazer 'Some problems of the evaluation of safety-in-use of a food additive' in British Nutrition Foundation _Why Additives? the Safety of Foods_ Forbes, London 1977, p ix.

120 ASTMS policy document _The Prevention of Occupational Cancer_ London 1980; U Saffiotti 'Comments on the scientific basis of the delaney clause' _Preventive Medicine_ 1973, vol 2, p128-129.

121 A Frazer _op cit_ p ix-xvi; report of Committee on Toxicity in MAFF, Food Advisory Committee _Final Review of the Colouring Matter in Food Regulations 1973_ HMSO, London 1987.

122 Commission of European Communities 1982 _op cit_; M Miller 1985 _op cit_ p80.

123 The colour is Caramel (a poorly defined range of treated carbohydrates).

124 P R Peacock 'Colouring matter in foods' _Chemistry and Industry_ 15 March 1952, p238-241, cited in H F Steward _op cit_.

125 MAFF, Food Standards Committee _Supplementary Report on Colouring Matters_ HMSO, London 1955, paragraph 8.

126 H F Steward _op cit_ p257-258.

127 Ministry of Food, Food Standards Committee _Report on Colouring Matters_ HMSO, London 1954.

128 R D Combes and R B Haveland-Smith 'A review of the genotoxicity of food, drugs and cosmetic colours and other azo, triphenylmethane and xanthene dyes' _Mutation Research_ 1982 vol 98, p204.

129 A Irwin _op cit_ p260.

CHAPTER 7

CONCLUSIONS

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7.1 DISCUSSION OF METHOD

Possible methods for assessing the effects of regulations were identified in existing studies. The diversiy of existing methods was described in section 2.17. Most were car studies which were based on models that undermined the ability to draw conclusions from the results. For example, Peltzman's study of car safety developed a complex model based on some questionable assumptions (1). It lacked known significant variables (such as car size) and included correlated variables. He used highly aggregated, insensitive data. He failed to examine sufficient alternative explanations for his results. However he did examine trends before regulations and introduced the useful idea of extrapolating them, so actual changes could be compared with expected ones. The need to disaggregate data was underlined by a study of smoke pollution whcih masked regional variations in pollution levels (and regulations) by analysing national data (2).

A small number of studies (notably those of Leon Robertson and Fred Steward (3)) used methods that avoided complex constructed models (with their accompanying risk of large distortions) and explored the effects of other important factors. These are discussed below.

7.2 a) Assessing Health Effects

Leon Robertson classed car deaths by age of vehicle and plotted this over time (4). This simple method achieved the necessary separation of vehicles into pre- and post- regulatory design, allowing a straight comparison. He also examined effects of potentially important factors such as driver age and mileage. This study demonstrated the possibility of devising a simple and direct way of measuring changes and showed the necessity of choosing data that could be divided into pre- and post- regulatory groups.

Studies of the health effects of motor vehicle regulations used accident, injury and death figures. Such data were not available for colours (except for a few deaths in the 1800s). When chemicals are consumed at low doses by large sections of the population it is almost impossible to detect deaths and chronic ill-health.

For drugs it would be difficult to compile ill-health data. Fred Steward looked at the rate of withdrawal of drugs (sometimes for safety reasons) and at assessments of therapeutic significance to guage overall health gains/losses (5).

None of these measures could be applied to colours. Instead, for colours, a scheme was produced for measuring changes in hazard levels (described in section 6.9). Measuring hazard levels is not the same as measuring ill-health, but for many chronic hazards it represents the only way of assessing effects. It would have been valuable to incorporate information on the actual quantities of each colour consumed in the hazards rating scheme, but surprisingly this kind of data has not been monitored by regulators. Thousands of toxicity tests on colours have been conducted. Some colours have been relatively well studied while for others data is sparse or absent. It was inappropriate to construct a hazard rating scheme based on such studies because of many gaps and problems of evaluation. A more promising avenue was provided by using official assessments of safety.

Official assessments used diverse rating schemes, from 'acceptable/unacceptable' to six-category ratings. Official scales had to be converted into a universal rating system (section 6.9 and tables I.3, I.4 and I.5). The universal system was constructed after most of the official sources had been identified, so it was possible to construct a system that minimised the problem of translation. The limitations of the scheme have been described in section 6.9. The most significant problems were gaps in toxicity information and correct identification of colours. Identification was helped by the construction of a directory. Early assessments were included as a measure of official perception of hazards rather than as measures of actual hazards. But in a few cases they provided the only assesment. In the series of measurements in chapter 6, both comtemporary and retrospective hazard assessments were used.

If there had been more time it might have been possible to fill some of the gaps by including official reports from other Western countries (eg. Germany). This would be an interesting area for further work. Although the international nature of toxicology since the 1950s might possibly mean the extra data would have little effect on the main results, unless by chance the colours rated 'toxicity unknown' all happened to be high risk or low risk colours. The study assumed they consisted of an even spread of high, medium and low risk colours.

Exactly the same method could be applied usefully to the other groups of additives for which official hazard assesments are available (such as preservatives). The hazard rating method could be applied to other areas of technology such as the hundreds of chemicals assessed for carcinogenicity by the International Agency for Research on Cancer. The method is probably most appropriate to chronic hazards, such as occupational carcinogens, environmental pollution, nuclear hazards, food contaminants, and various substances or procedures causing chronic injury.

For technologies posing acute hazards it is preferable to use actual accident or ill-health data rather than the indirect measure provided by the hazard rating scheme. Such areas would include accidents involving electrical equipment or other machinery, explosions and acutely toxic chemicals. On occasion this point applies to chronic hazards too, where they cause uniquely identifiable diseases; examples include thalidomide, naphthylamine and diethylstilbestrol. Nevertheless, the hazard rating scheme could provide an additional indicator of the effects of regulations.

For some acute hazards, such as intolerant reactions, ill-health data may not be available. The scheme could be useful here, although the method would need to be supplemented by other measures for this difficult area. The examination of exposure and prevalence rates would need to be developed, for example.

The idea of measuring health 'foregone' because of the introduction of regulations was raised by Peltzman's cost-benefit analysis. It probably contributed to the idea of measuring a contrasting concept: hazard burdens - the hazard experienced in different time periods and as a result of the delay in introducing regulations. If there had been more time it would have been useful to compare the hazard burden in a range of Western countries, and changes in the hazard burden between periods. Hazard burden measurements could be applied to any type of technology for which a hazard rating scheme could be devised, as long as infomation on length of use of the technology was also available.

There are several areas of research into colour regulations that could be usefully pursued, such as the effects of purity standards on health, and the health effects of the change from coal tar to natural colours (particularly since naturals are less well studied and are used in higher concentrations).

7.3 b) Assessing Effects on Innovation

There were several existing studies of the effects on innovation. Peltzman's study suffered from aggregated data and a misleading cost-benefit analysis (6). Fred Steward's study on drug innovation provided an elegant method that was applied to colours (7). He collated information on patents and dates of introduction onto the market. He plotted trends over time and looked at the changes in the context of international and industrial policies.

There were few figures available to indicate the dates at which colours were first marketed for food. Discovery or patent dates (compiled from the Colour Index) were used to assess the changes that occurred in innovation. The fact that a gap of time usually exists between discovery date and patent date would have introduced discrepancies, since the basis of measurement was not uniform. But this problem would not have affected the conclusion that the major period of innovation for coal tar colours was over well before regulations were introduced - it would merely shift slightly the actual dates of the peaks.

It was not useful to collate discovery dates for plant and mineral colours becuase most were developed in ancient times. The Colour Index did not provide sufficient details of the new plant colours. Nevertheless, detailed studies of patents would be a fruitful area of further research.

This method of assessing the effects of innovation can be applied to any area of technology where sufficient information on discovery dates, patents or dates of introduction are available. It would be interesting, for example, to aassess the effects of British Standards for various consumer goods, to compare voluntary Standards with those incorporated into regulations.

Some areas of innovation studies that would benefit from further research include: the effect of 1925 and 1957 regulations on patents for natural colours; effect of 1925 regulation on research for a replacement for copper and two coal tar colours; more detail of the effect of 1957 regulations on patents for coal tar applications; actual number of marketed new colours compared with expected number (about .02-.03%); R&D expenditure compared with number of patents in dye industry and food colours, over time; effect of regulation as a possible barrier to innovation in smaller companies; effect of purity standards on innovation; patent data on mineral colours and biotechnology - potential growth areas of the future.

7.4 c) Assessing Effects on Choice and Quality

There were no known studies that attempted to measure the effects of regulations on choice and quality.

Effects on the range of hues were measured by counting the number available in different periods. They were easy to quantify compared to effects on food quality or choice of products. The assessment of choice and quality suffered from a lack of data. For example, data on the range of coloured and uncoloured food was uncovered for only two years (years which were far removed from the date of most regulations). And the two sets of data were not directly comparable. Nevertheless, the method could be applied to produce a useful assessment of the contemporary choice of food and any other regulated products. It was necessary to concentrate on case studies, such as the effect of colours on the cost of peas. This provided information that could not necessarily be generalised to other foods. The cses studies needed to be supplemented by other assessments ideally. Given more time it would be possible to scour trade literature and records to provide much more detailed case studies in some areas.

7.5 Identification of Main Activities

The methods used in this thesis can be divided into four main areas of research. Their chief features and pitfalls are outlined below, as a brief guide to studying the effects of regulations. This scheme of research could be applied to any area of technology or regulation.

i) Identification of technology and periods of use/exposure

Lists of colours reported to be used in food from the 1800s to 1987 were compiled. One major problem was the under-reporting of colours. This was due to the lack of time or interest on the part of most public analysts, and the fact that trade literature tended to focus on certain groups. Only one government report succeeded in compiling an exhaustive list. Compiling lists of which and when colours were used was time-consuming but essential for all the following assessments.

Many dyes had several names, making identification difficult. Some colours were impossible to identify and had to be omitted from the assessments, reducing their accuracy. The Colour Index and other trade books (listed in appendix G) were used to construct a directory of common names, chemical class, hue, CI number and discovery date. Some colours had several popular names, and it was essential to identify the CI number, then to cross-check the numbers to eliminate repeats.

It was also necessary to divide colours into the three main types of technology (coal tar, mineral and plant) because they were at different stages of developement and affected differently by innovation. They had also traditionally been treated differently by regulators.

ii) Historical comparisons

Assessments of both health, innovation and choice relied on historical comparisons. Analysis of studies of vehicles and drugs had shown that the effects of regulations could not be properly measured by comparing changes immediatedly before and after the introduction of regulations. It was essential to measure underlying trends. For example, in the innovation assessment there was a long-term decline in coal tar colour discoveries that would not have been picked up by studying the few years around 1925 or 1957. It was also essential to avoid aggregating data in ways that would mask the effects of regulations (or other significant factors). Producing a series of measures of the same effect (especially for health effects) was found to be useful, because each measure gave only part of the picture.

iii) International comparisons

Fred Steward used international comparisons to examine the rate of innovation in two different environments. Lack of time prevented comparison of colour innovation in the US and UK. It would be fruitful to look at this and to compare the rate of colour innovation with the length of the positive list of a range of countries. It would be interesting to compare hazard levels too, to help separate the effects of the social, political and economic environment from regulations, for example, for workplace accidents. Although, as Fred Steward has pointed out, there are spill-over effects from one country's regulations to another.

Some studies of car design, seat belts and motorcycle helmets made use of international data and geographical boundaries in another way: to provide comparisons of regulated and unregulated areas. Time prevented full use of the available international data on colours permitted in different countries. For this study the data were used in a new way: as a source of feasible permitted lists to measure what might have been introduced in the UK had there been the political will. This idea could be extended to other technologies, such as nitrate pollution and pesticides.

iv) Alternative explanations for changes

Fred Steward's study examined a range of possible explanations for the changes he detected (eg. R&D policy). Too many studies of car safety (especially early ones) failed to do this, except for the effects of the oil crisis. When studying colour innovation, background trends in the dye industry were examined and found to be as significant as changes in regulations. When studying hazard levels, ways were developed for assessing manufacturers' voluntary withdrawals of hazardous colours, and these turned out to have had more impact than legal changes in early periods. Lack of data made this assessment very difficult. Ideally it required the dates at which individual hazardous dyes were withdrawn from food. But it is doubtful that the records of colours supplied to thousands of food companies in the 1920s and 1950s still exist. Instead, available bits of information about the actual use of a few key colours (eg. copper) were compiled from trade literature.

Studying the effects of regulations has important implications for government policy on technological hazards. It is to be hoped that the methods that have been identified and developed in this study will contribute to further studies. So little work has yet been done to assess the effects of regulations that there is enormous scope for further research. Yet it is sorely needed to improve the quality of government decision-making and public protection.

7.6 APPLICATION OF APPROACH TO OTHER AREAS OF TECHNOLOGY

Can the conclusions drawn about food colour regulations be applied to other areas of technology, such as other chemicals, transport, electrical goods, new industrial processes? To answer this one needs first to define the type of regulation and type of technology.

A list of the technological hazards subject to regulatory control is given in Appendix M. The effects of regulation have been studied in few cases, leaving a very large area of potential research. Areas where effects have been studied (to varying degrees) include cars, motorbikes, smoke pollution and pharmaceutical products.

One might expect the findings on colours to be most applicable to similar technologies. Food colours are chemicals, used in the domestic sphere, consumed by most of the population, in relatively small quantities over long periods. Similar technologies include other groups of additives, drinking water (consumed in much larger quantities), pharmaceutical products (sometimes consumed only for short periods, and by identifiable groups), and some household chemicals (which are not usually consumed (except detergent) except via fumes). But points made about the positive and negative list could apply equally to these areas as to technologies that are not ingested or used solely in the domestic sphere, such as electrical equipment or motor vehicles.

The type of regulation is probably more important in most cases than the nature of the technology being controlled. An exception is the stage of development of the technology (and its alternatives) when the regulations are introduced. This affects changes in innovation. For example, coal tar colours were at a relatively late stage of development when a permitted list was introduced. The technology had been developed to suit the needs of another (the textile) industry. Natural colours had been developed for textiles then dropped in favour of superior dyes. But for food they were under-developed: there was plenty of scope for more applications and sources to be developed. Regulations could therefore be expected to have a different impact on the innovation of coal tar colours compared to natural colours. The state of technology could also be expected to have an impact on health; when colours are banned, for example, the technical properties and cost of the alternatives will determine the change in hazard levels.

Apart from identifying the state of development of technology, general conclusions about the effects of regulations are best made in the context of the type of regulation.

7.7 Generalising About the Effects of Regulations

A few academic studies have claimed that regulations that are supposed to protect health actually have an adverse effect on health and innovation (sections 2.3 and 2.4). My research on colours casts doubts on such sweeping assumptions, although a lot more research remains to be done before general conclusions can be made.

a) Effects of negative lists/one-off bans

The evaluation of the effects of the negative list of colours concurs with Auliciems and Burton's conclusion that local authority bans on domestic fires had no significant effect on pollution levels (8). Scarrow, however, concluded the opposite: that the bans had been effective in lowering hazards (9). The different results can be accounted for not only by the method of analysis but also by taking account of the system of grants given for cleaner heating systems, which are a form of regulation (classified as facilitating regulations in section 2.13) very different to negative lists. This area needs further research before general conclusions can be drawn about the health effects of negative lists and one-off bans.

Other negative lists that could be researched include bans on certain workplace chemicals, pesticides, the EEC Directive on drinking water and meat hormones, bans on lead in paints, controls on contaminants and materials for food packaging and utensils, negative list of flavours, bans on various industrial processes.

It is possible that some of these regulations will have had positive benefits, such as regulations on flavours, drinking water and lead. But this depends on the extent to which the hazardous substances were still used when regulations were introduced.

b) Effects of positive list/pre-use approval

The health effects of the positive list for colours were similar to the effects examined by Steward for pharmaceutical products (section 2.15). At this stage one might pose the general hypothesis that positive lists have beneficial effects on health where screening is reasonably reliable in detecting hazards. Other positive lists that could be assessed include additives such as preservatives, antioxidants, emulsifiers and stabilisers and the future EEC Directive on food packaging contaminants.

The effects of colour regulations on innovation were similar to the effects on pharmaceuticals studied by Steward. Whether innovation was promoted in new areas seemed to depend on the state of technological development, research polices and perceived market opportunities. While companies concentrated on well-explored areas, like anti-infective drugs or coal tar colours, they could not realistically expect a high rate of innovation. In the case of colours other more fruitful areas of research (natural colours) were taken up; but areas ripe for drug research (such as drugs for minority diseases or diseases prevalent in poorer parts of the world) were ignored because they were not economically attractive.

Would it have mattered if regulations had produced a significant overall reduction in colour innovation (or other area of technological innovation) ? It is generally assumed that innovation is a 'good thing' for economic, and therefore social, progress. But this assumption ignores the possible costs of ill-health. If there are limits on innovation in order to protect public health this may be a strong benefit.

Steward pointed out that the drop in the overall number of medical products did not represent a great medical loss as far as consumers were concerned. The decline in rate of new chemical entities could have represented a more serious loss, except that NCEs may not necessarily be medically beneficial or may have unacceptable ill-effects.

c) Effects of technical and procedural controls

The restriction of colours to certain foods introduced benefits in terms of health and food quality. Assessments of technical and procedural controls on motor vehicles show they probably also had health benefits (10). However, one would expect some types of vehicle control to have different effects to others. For example, it has been pointed out that regulations that prescribe a certain design of technology may restrict innovation more than regulations which require a technology to perform in a particular way. This argument has some merit but remains to be tested properly.

Most of the regulated technologies listed in Appendix M have some technical or procedural controls which remain to be assessed. For example, aircraft can only be flown by trained and licensed personnel; prams have to have brakes; moving parts of machinery have to be guarded. There are only three types of such controls on colours (section 2.13), but there are many more for other areas of technology, especially transport, occupational hazards and nuclear installations. Further work needs to be done to classify these regulations before assessments of their effects can be made.

d) Effects of information requirements and facilitating regulations

There are few if any studies of the effects of the remaining group of regulations covering information requirements and facilitating schemes. The effects of information deserve particular attention because of the increased reliance of UK and EEC policy on information as a means of protecting the public interest. There have been no facilitating regulations for food colours. Local authorities attempted to reduce domestic smoke pollution by introducing grants for cleaner heating systems. This was probably a very productive approach (11). For colours an equivalent facilitating regulation would require government-sponsored research to develop safer alternatives. Steward's study on drugs recognised this and recommended some state funding and control of innovation to ensure that health needs were met (12).

7.8 SUMMARY OF EFFECTS OF COLOUR REGULATIONS

The study suggests that some types of colour regulations have had more effect than others. For example, banning a whole class of hazardous chemicals appeared to have more effect on health or innovation than labelling requirements. The following sections summarise the effects of colour regulations according to type of control (as defined in section 2.13). Short summaries are also presented in tables 7.1 and 7.2 below.

7.9 a) Regulations Prohibiting Use of Technology

i) Negative list: The negative list of 1925 had a negligible effect on health, innovation and choice/quality. An exception was the ban on copper in tinned peas which had a beneficial effect on health, a temporary effect on choice and possibly a positive effect on innovation (by promoting research into an alternative).

If the list had banned many more colours or had been introduced 75 years earlier it would probably have had a beneficial effect on health. It might then have had some effect on innovation, choice and quality, but this would require further investigation.

ii) Positive list: The positive list of 1957 greatly reduced the proportion of high risk colours and can therefore be assumed to have benefitted health substantially. The benefits of the positive list were restricted by a generous interpretation of the 'need' for colours in a wide range of foods, and by a lack of toxicological information. Nevertheless, amendments removing further colours from the positive list were very beneficial in reducing the hazard burden.

Innovation overall was not slowed down although the number of marketable new coal tar colours for food was possibly slightly lower than expected. Applications research for permitted coal tar colours probably increased. Food regulations did not provide a barrier to the search for dyes for non-food purposes, traditionally the major role of dye research. Regulations greatly promoted innovation among natural colours, both in sources and applications. The effects on consumer choice and food quality were probably negligible.

TABLE 7.1 : SUMMARY OF EFFECTS OF NEGATIVE AND POSITIVE LISTS ON HEALTH, INNOVATION AND CHOICE

	Tyoe of regulation	
Effect on -	Negative list of 1925	Positive list of 1957
Health hazard	Negligible effect overall. For Cu: short-lived effect. Purer colours produced.	Coal tar: dramatic benefit. Naturals: negligible effect
Innovation		Rise in food colour patents compared to dye industry.
a) colour sources	Not known. Probably negligible.	Coal tar: innovation already low. Negligible or slight effect. Naturals: innovation already ceased. Dramatic rise.
b) colour applications	Not known. Replacement for Cu? Improved purity.	Promoted among permitted coal tars and especially naturals. Stopped research on banned colours.
Choice		
a) range hues	Small reduction in range. Negligible effect on food, except green/tinned peas.	Dramatic reduction in range Negligible effect on food, except yellow/margarine.
b) food quality	Negligible effect.	Negligible effect.

If a short permitted list had been introduced in 1957 when toxicological knowledge was rather sparse, gains in health would probably have been no greater than the longer list. But the ability of the positive list system to guarantee health benefits increases in proportion to advances in toxicological knowledge. A short list might have affected innovation adversely, although this is doubtful unless very short. The ability of manufacturers to find their way around regulations or to find solutions to technical difficulties should not be underestimated.

iii) Negative versus positive list

The degree of health benefit from prohibitions depended on: the extent of use or exposure to the technology, the hazardousness of items chosen for the list (eg. criteria for screening, adequacy of safety data), the state of the technology and its alternatives, and underlying policies of manufacturers. Positive and negative lists generally had greater health benefits than the voluntary action of manufacturers - although this depended on the cost and hazardousness of alternative technologies. A positive list offered greater health benefits than a negative list because it provided pre-exposure screening - although this can be undermined by inadequate toxicological data. In theory, a very short positive list could have lead to a greater consumption (higher proportion) of high risk colours than a very long negative list. But this would have been very unlikely in practice.

The degree to which prohibitions affected innovation was dependent on the length of lists, technical properties and applications of chosen items, stage of development of the technology and its alternatives, and R&D effort and policy. Prohibitions stunted some areas of research and promoted others. Negative and positive lists have prevented certain pre-existing colours from being used in food. While a negative list allows all new developments to be used, a positive list screens possible additions. While it has been suggested that the latter would have a much more restrictive effect on new products, this did not happen in the case of colours, because prohibitions on some areas actually inspired research in other areas. Although the negative list offered greater freedom to innovate, that freedom in itself did not necessarily bring about innovation.

Prohibitions limited some areas of choice (positive lists more so than negative lists) but this was not significant for the range of hues. There was little difference in the effect of the negative and positive lists on choice and quality. But choice might have been greatly restricted if the negative list had been very long or the positive list very short (affecting the range of hues), or if colours for which there were no alternatives had been banned. (Although in two cases where such colours were banned, alternatives were quickly developed.)

7.10 b) Technical and Procedural Controls on Use

i) Composition standards for foods (such as milk, fresh meat and jam) reduced exposure to colours via staple foods or foods subject to debasement. They therefore had benefits for health. They possibly made some areas of applications research redundant, because colours were no longer permitted or needed in certain foods. They had no effect on the overall range of hues available, but among regulated foods they removed the choice of buying coloured products. However, composition standards protected some aspects of food quality.

If more compositional standards had been introduced these effects would have been intensified.

ii) Restrictions on the use of certain colours (such as methyl violet and lithol rubine) had benefits on hazard levels, because they reduced exposure to colours which were relatively hazardous. They had no effect on the overall range of hues available. They probably had a negligible effect on choice and quality.

If more colours had been restricted to certain purposes there would have been signigficant health benefits, but also possible adverse effects on innovation and choice depending on extent of restrictions.

iii) Purity regulations introduced in the 1960s probably forced some manufacturers to improve purity, and so reduced hazards (see discussion in chapter 3). The other effects of purity regulations have not been assessed.

If the purity standards had been introduced earlier or had been more stringent they would have reduced hazards.

TABLE 7.2 : SUMMARY OF EFFECTS OF RESTRICTED USES, DECLARATIONS AND PURITY STANDARDS

Effect on -	Type of regulation Composition standards & restricted uses	Declaration of names on labels	Purity standards
Health hazard	Benefit: reduced consumption of colours.	Benefit: allowed identification for allergies. Voluntary elimination of some uses.	Probable benefit.
Innovation	Possibly restricted applications research.	Promoted research into naturals - sources and applications.	Not known.
Choice			
a) range hues	No effect on overall range. Removed choice for regulated foods.	Voluntary removal of colours from some products, increasing choice.	Not known - probably no effect.
b) food quality	Protected food quality.	Probably helped protect quality.	Not known - probably no effect.

c) Provision of Information

Regulations requiring the declaration of named colours (introduced between 1984 and 1986) have benefitted health in two ways. People with allergies have been able to identify and avoid problem colours. Some manufacturers have been encouraged, by public concern about long lists of E numbers, to review the need for colours and eliminate them from some products. Recently, public concern about 'artificial' colours has promoted research into any colours that can be labelled 'natural', so the labelling regulation can be considered to have had a spin-off effect in promoting innovation.

The possible effects if declarations had been required prior to the 1970s have not been assessed.

7.11 POLICY OPTIONS FOR COLOUR REGULATIONS

This section examines some of the current policy options for regulations controlling colours.

a) Removing Regulations

It would be possible, though undesirable, to remove regulations on colours and revert to voluntary controls. In the last century it was only possible for manufacturers to make large reductions in the proportion of hazardous colours voluntarily because equal or superior technical and economic alternatives existed. Cynics might claim that manufacturers only made such large reductions in the use of hazardous mineral colours because coal tar colours were cheaper. But this is not completely true. Evidence presented to the Select Committees in the 1800s shows that some manufacturers were genuinely concerned about public health and were prepared to make changes even if it cost more. But good intentions were not sufficient to change the practices of all manufacturers. The economic pressure on most of them meant that they were forced to use whatever was most economical. Only the cost of lost business resulting from public outcry and from prosecutions under the Food Acts forced some manufacturers to change the colours they used.

On safety grounds, few people would now challenge the need for regulations specifying acceptable colours. There are in fact advantages of this system for manufacturers because they are no longer liable to prosecution while they use only the approved colours.

7.12 b) Changing to a Negative List

Changing to a negative list would offer less protection for health than current controls. Even a long negative list would permit many more colours. It would provide no mechanism for pre-marketing screening.

The freedom to innovate would theoretically be increased, but in practice ther would be little stimulation for innovation since a very wide range of hues and applications would be available. The choice of hues would be increased, but it is debatable whether this would be noticed by the public.

Few people would seriously suggest removing the positive list now and replacing it with a negative list - although some have attacked the positive list approach (see chapter 6).

7.13 c) Amending the Positive List

The options consist of expanding, maintaining or reducing the length of the positive list.

i) Adding colours

The number of colours added to the list after 1957 only to be removed later suggests it is unwise to add new colours without a very thorough examination of their possible effects (see section 6.64 in chapter 6). Examining proposed colours by the current battery of tests would not safeguard health. A new scheme of tests would need to be developed. It is likely that it would be prohibitively expensive. Unfortunately, it was recommended in 1987 by the FAC that a new colour, Allura red, could be added to the positive list. This colour has caused much controversy in the USA. It would be undesirable to add it to the list because it has not been examined thoroughly.

Adding colours might inspire some research into new applications. It would increase the range of hues slightly. It would have a negligible effect on quality.

ii) Maintaining current list

The second option is to keep the list at its current length and composition. This has not been proposed. But it is probably a safer option than adding to the list. The pattern of innovation already identified would probably continue.

iii) Removing colours

The third option is to reduce the positive list. The government announced after FAC's recent review, that it would ban Yellow 2G and restrict the use of Methyl violet. Neither colour is used significantly in the UK. The benefit of the prohibition will be negligible, but it is still worth making the change so that the colours cannot be used legally at all. Yellow 2G was recently given a hazard rating of E and Methyl violet was rated C.

A government that was interested in giving a higher priority to public health might consider banning all the coal tar colours, as the Norwegian government has done. It might go further and ban the plant and mineral colours linked with intolerant reactions or toxicological controversies. This scenario is rather unlikely, however. It would meet with considerable opposition from industry and possibly even oppostion from a minority of consumer organisations. A more realistic option for the UK would be to ban the eight most controversial colours, and to restrict the rest to fewer foods.

As in the 1950s, restricting coal tar colours would probably provoke more research into natural colours and new applications for remaining colours. Research would also move into other areas such as biotechnology, to produce fruit and vegetables that are highly coloured, so by-passing the need to add colours at a later stage.

7.14 d) Improving Labelling

It would be beneficial if full labelling were to be introduced for colours and ingredients. It is unfortunate at the moment that the public is legally required to be given more information about the composition of a pair of socks than a packet of food. Socks and many other garments have to declare the percentage of their ingredients (eg. 20% cotton; 80% nylon). The European Parliament recommended in March 1987 that a similar regulation should be introduced for food (so the percentage of ingredients of foods over 3% would all be declared). This would be of benefit in allowing interested consumers to compare the quality of products, and to see whether colourants have been used to mask the low levels of particular ingredients. However, the European Commission and UK government are not in favour of this sort of revealing labelling. The majority of consumer organisations take the view that the public should have a legal right to be told what is put into products.

Improved labelling would help allergy sufferers and would not restrict choice. It would probably provoke innovation in areas where full declarations have not previously been required, such as colourings in alcoholic drinks and the use of colours in animal feed.

7.15 e) Extending Standards

Even if improved labelling were to be introduced it would probably not be sufficient on its own to protect the public interest: it throws all the onus of protecting themselves back onto the public. While a policy of labelling rather than legal standards seems to offer consumers the benefits of infinite choice, it is clear from the discussion in chapter 5 that under certain circumstances, where there is a risk to health or people are liable to be defrauded, there are benefits to be gained from reducing choice in some areas. Considerable improvements could be made to the quality of food by introducing optimum standards and definitions of the characterising ingredients. Public health could also be protected by prohibiting colourants from certain foods, particularly staple foods. This policy might in fact offer more protection to health and quality than reducing the size of the positive list much more.

Extending standards might affect innovation adversely by making certain areas of research redundant. But it would promote research in other areas to allow manufacturers to accomodate the new regulations.

7.16 f) Introducing Quantity Restrictions

No restrictions on the quantity of colouring that may be added to food have yet been made in the UK. It has always been claimed that colours are self-limiting, that is, that manufacturers will not put higher quantities into food than is strictly necessary. However cases of excessive amounts of colouring being added to food have been reported (13). A survey of colour usage conducted by MAFF in 1980 demonstrated that different manufacturers were using high and low levels of colour in very similar products (14). This suggests limits could be introduced in practice to reduce the unnecessary quantities of added colour. The FAC in 1987 proposed quantitative regulations on colours: a general limit of 50 mg/kg for all colours except caramel (2000mg/kg), and special limits for some foods. If these recommendations are made into regulations then they will reduce the levels of colour added to a small proportion of products, and so reduce consumption slightly.

FAC chose levels which would have a minimal effect on the vast majority of manufacturers (15). Had the levels been set lower, then regulations could reduce the levels of colour very significantly. This would reduce overall consumption of colour, and hence risk. It would not offer much protection to people suffering hypersensitive reactions since these are often triggered by very low levels. If the overall amount of provoking substance is reduced it follows that the overload point of fewer people will be reached. So it might prevent some people becomimg hypersensitive.

Imposing quantity restrictions might increase research to develop colours with more intense colouring effects at low levels of use.

7.17 g) Reliance on Labelling

Current government policy is to remove statutory standards where possible and to replace them with labelling requirements alone. It is worth examining some of the implications of this policy.

From the late 1800s various groups, including some traders, have recommended that labelling of ingredients should be compulsory on foods in order to protect the public. At the 1895 Select Committee inquiry, for example, a grocer representing the London Chamber of Commerce felt that labelling of ingredients would combat fraud (16). The 1924 advisory committee recommended a declaration of the use of colours on labels (if a permitted list were not introduced) (17). These recommendations were mot taken up.

The declaration of 'added colour' was eventually introduced for some foods in the 1950s. The identification of individual colours was not introduced until the early 1980s, when the EEC's E number system was implemented. This required the generic group 'colour' to be declared, followed by the name or E code number of the colour. The latter regulation has had a significant impact on public opinion. People assumed that the newly informative packets contained new ingredients, and became concerned about the widespread use of colours and other additives. These recent labelling regulations have been useful in allowing people with motivation, time, appropriate knowledge, access and money to avoid particular colours of concern.

Current government policy is to place increasing emphasis on the labelling of colours and foods to allow consumers to protect their own interests. The government currently acknowledges some of the problems associated with colours, such as intolerant reactions. But their policy is not to ban or restrict any of the colours in the way some Scandinavian countries have done. They feel that the declaration of colours on food labels will give sufficient protection. On the issue of food quality this is also the government view. In 1985, George Jupe, Head of Food Standards at MAFF, made the following statement about policy:

> I want to make it clear ... that generally speaking British Ministers are not in favour of anything more than the absolute minimum of controls on the composition of food. Their general policy is that people should be left free to produce or to buy whatever they want, provided that everybody knows what it is. That brings me to labelling... (18).

The provision of more and better information on food packs is important and necessary. However, it is unwise to rely primarily on labelling as a means of public protection. Labelling fails to offer sufficient protection in two respects:

i) There are loopholes in the labelling laws.

ii) There are fundamental limitations to the policy of labelling.

These issues are examined in turn.

7.18 i) Labelling loopholes

There are a number of major loopholes in the labelling laws, so colours are not always declared. Some loopholes are listed below:

* Ingredients of beer, wine and spirits do not have to be declared. Tartrazine and similar coal tar colours are used in some types of lager and cider; caramel is used is some beer and spirits; coal tar colours are used in liqueurs and campari. There is no practical reason why the ingredients of alcoholic drinks should not be labelled like other packaged foods. In bars the ingredients of draft beers could be displayed on the compulsory sign that currently declares the prices.

* Small individually-wrapped sweets contain many colours. They are exempt from labelling because of their small size (less than $10dm^2$ surface area). But ingredients could be displayed on a sign near or in front of the sweets (as is currently required for unwrapped meat products).

* Some unwrapped foods are exempt from labelling. For example, bread and cakes from bakery shops (and bakeries in supermarkets) often contain colourings: caramel in bread and coal tar dyes in cakes. Environmental Health Officers in Preston surveyed the use of colourants in unpackaged smoked fish in 1987. They found that only two of the 68 samples carried a declaration of the added colour (19).

* Colours used in fast foods and take-aways are not labelled. A recent survey by Environmental Health Officers in Dudley found tartrazine in the majority of fish batter and chips from chip shops. Colours in take-away foods like McDonalds are not declared, even though the products are as standardised as packaged food.

* Colourants in food served in restaurants and canteens is not declared on the menu or on wall charts. A new labelling directive from the EEC has proposed that it should be.

* Colourants mixed with other additives or food ingredients by an earlier manufacturer do not have to be declared if they have no intended function in the finished product. Generally these carry-over colours are present at low levels. But even low levels of certain substances can trigger intolerant reactions, so they should be declared.

* Egg yolks and the flesh of farmed trout and salmon are often coloured by adding colours to the animals' feed. The Food Advisory Committee recommended in 1987 that this one loophole in the labelling law should be closed and products containing added colour by this means should be labelled as such.

It is surprising for the UK government to have a policy of relying heavily on labelling as a means for protecting the public, and yet to continue to permit so many loopholes in the labelling law.

7.19 ii) Fundamental limitations to labelling

A food policy relying on labelling does appear to offer considerable advantages: unlimited choice; well-informed consumers making decisions and shaping the food market to meet their needs. Unfortunately, the policy does not work this way in practice. Labelling can only be effective where the public have the education, willingness, time and money to read and act on information on food packs. The following two examples highlight the problems.

Firstly, on the issue of intolerant reactions to colourants, labelling does not protect certain groups of the population: those whose eyesight is poor; children who are too young to read; those who do not realise that their allergies are caused by colourants. Furthermore, labelling does not protect people exposed occupationally to colours. A recent survey conducted by the London Food Commission and the GMBATU found that a number of respondents reported reactions such as asthma attacks, breathing difficulties and skin rashes from common colours. The sufferers were not free to avoid these colours except by leaving their jobs or, preferably, by getting the colours removed from the products they worked with. Although improved labelling would be useful, labelling alone is not a solution to the problem of intolerant reactions. Policies that would give much greater protection to public health would be to ban or restrict the allergy-inducing colours, as the Norwegian and Swedish governments have done.

Secondly, on the issue of food quality, there has been a change in the law recently to implement a policy of 'informative labelling' in place of quality standards for many meat products. This has already been described in chapters 1 and 5. Table 5.18 shows the effects of relying on labelling alone: the quantity of meat in products fell, by an average of 33%. This has implications for safety as well as quality because debasement of foods means greater use of colours.

The government's emphasis on labelling has been adopted recently by the European Commission, despite heavy criticism from Members of the European Parliament. This discussion suggests that the current direction of the UK and EEC food policies could produce a reduction in public protection and that there is urgent need for a reappraisal of policy.

The lack of research into the effects of regulations of all kinds is undesirable. Such work would be valuable for informing current policy debates, which are largely based at present on myth rather than sound information or empirical studies. This study on food colours demonstrated that regulations can be assessed, and that their effects should not be taken for granted. It showed that it is possible to devise schemes for measuring factors which at first sight might seem difficult to measure.

The study showed a general benefit from regulations in this area, with little evidence of damage to choice and innovation. But it also illustrated the necessity for separating out different kinds of regulations, rather than treating them as a homogeneous group.

It would be productive to continue to examine regulations controlling other types of technology, so controls can be developed to protect more effectively the public's interests in the areas of risk and need.

NOTES AND REFERENCES FOR CHAPTER 7

1 Sam Peltzman Journal of Political Economy 1975 vol 83 p677-725.

2 Auliciems and Burton Atmospheric Environment 1973 vol 7 p1063-1070.

3 Leon Robertson Accident Analysis and Prevention 1977 vol 9 p151-156; H F Steward in D Black and G P Thomas (ed) Providing for the Health Services 1978 p132-153; F Steward Nature 1980 vol 284 p118.

4 L Robertson ibid.

5 H F Steward op cit.

6 Sam Peltzman Regulation of Pharmaceutical Innovation American Enterprise Institute 1974.

7 H F Steward op cit.

8 Auliciems and Burton op cit.

9 Scarrow British Journal of Political Science 1972 vol 2 p261-282.

10 L Robertson op cit; G GrimeThe Protection Afforded by Seatbelts Transport and Road Research Laboratory, Crawthorne, 1979, SR 449; P M Hurst Accident Analysis and Prevention 1979 vol 11 p27; Leonard Evans Human Factors 1982 vol 24 p41-48; John Graham Policy Sciences 1984 vol 17 p141-151.

11 Scarrow op cit.

12 H F Steward op cit.

13 M Miller Danger: Additives at Work London Food Commission, London 1985.

14 MAFF, Working Party on Food Colours Survey of Colour Usage 19th report of the Steering Group on Food Surveillance, HMSO, London 1987.

15 This is demonstrated by the low number of products affected by the cut-off levels chosen by FAC in tables 2 and 3 in MAFF, Food Advisory Committee Final Review of the Colouring Matter in Food Regulations 1973 HMSO, London 1987 p89-98. The few that would be affected significantly include the manufacturers of cola drinks, snack foods, seasonings, gravy and pizza.

16 J Rogers' evidence to the 1895 Select Committee on Food Products Adulteration Parliamentary Papers HMSO, London 1895, vol X.

17 Ministry of Health Final Report of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food HMSO, London 1924, p54.

18 G Jupe 'Food policy issues and government regulations' Conference of Food Policy Issues and The Food Industries, University of Reading, Reading, September 1985, p5-6.

19 Preston Newspaper 20 March 1987.

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APPENDICES

APPENDIX A

TABLE A.1 : REPORTS OF THE FOOD STANDARDS COMMITTEE (FSC)

Source: M Miller Danger: Additives at Work London Food Commission, London 1985, p161-162.

Report No	Subject	Date of publication
1.	Soya in Sausage	1942
1.	Soya in Sausage (supplementary)	1942
2.	Coffee Essences	1942
3.	Self Raising Flour	1942
4.	Soft Drinks	1943
5.	Baking Powder and Golden Raising Powder	1943
6.	Mustard	1943
7A.	Shredded Suet	1943
8.	Vinegar	1943
9.	Dripping and Tallow	1943
10.	Coffee Essences	1944
11.	Custard Powder	1945
12.	Salad Cream and Mayonnaise	1945
13.	Self Raising Flour (addendum to Supplementary Report FS/PB/9)	1945
14.	Flourine	1946
15.	Tomato Ketchup	1948
16.	Curry Powder	1948
17.	Processed Cheese	1949
18.	Iodised Salt	1950
19.	Not allocated	-
20.	Edible Gelatine	1950
21.	Fish Paste	1950
22.	Ice Cream	Not published
23.	Cream	1950
24.	Ice Cream (supplementary)	Not published
25.	Fish Cakes	1951
26.	Coffee Mixtures	1951
27.	Soft Drinks	Not published
28.	Edible Gelatine (supplementary)	Not published
29.	Synthetic Cream	1951
30.	Artificial Cream	1951
31.	Fish Cakes (supplementary)	Not published
32.	Saccharin and other sweetening tablets	1952
33.	Shredded Suet and Block Suet	1952
34.	Coffee Mixtures (supplementary)	Not published
35.	Jams and Marmalades	1952
36.	Vitaminisation of Margarine	1954
37.	Sausages	1956
38.	Processed Cheese and Cheese	1956
39.	Ice Cream Standards	1957
40.	Soft Drinks	1959

Report No	Subject	Date of publication
41.	Starch Syrup in Table Jellies	Not published
42.	Milk Bread	1959
43.	Bread and Flour	1960
44.	Hard, Soft and Cream Cheeses	1962
45.	Dried Milk	1962
46.	Canned Meat	1962
47.	Meat Pies	1963
48.	Food Labelling	1964
49.	Fish and Meat Pastes	1965
50.	Claims and Misleading Descriptions	1966
51.	Cream	1967
52.	Canned and Powdered Soups	1968
53.	Jams and Other Preserves	1969
54.	Condensed Milk	1969
55.	Pre 1955 Compositional Orders (Baking Powder and Golden Raising Powder, Edible Gelatine, Mustard, Curry Powder, Tomato Ketchup, Fish Cakes and Suet)	1970
56.	Offals in Meat Products	1972
57.	Date Marking of Food (Interim) No longer available	1971
58.	Vinegars	1972
59.	Date Marking of Food	1972
60.	Condensed Milk (supplementary)	1973
61.	Bread and Flour (Second Report)	1974
62.	Novel Protein Foods	1975
63.	Soft Drinks - Part I Fruit Juices and Nectars	1975
64.	Yogurt	1975
65.	Soft Drinks - Part II	1976
66.	Report on the EEC Draft Directive on Fruit Jams, Jellies and Marmalades and Chesnut and Puree	1976
67.	The Change from Calorie to Joule in Food Energy Declarations	1976
68.	Beer	1977
69A	The Use of Fructose in Foods Specially Prepared for Diabetics	1977
69B	Exemptions from Ingredient Listing and Generic Terms (forms an Appendix to FSC/REP/69 - Second Report on Labelling of Food)	1977
69.	Second Report on Labelling of Food	1979
70.	Water in Food	1978
71.	Second Report on Claims and Misleading Descriptions	1980
72.	Meat Products	1980
73.	Infant Formulae (Artificial Feeds for the Young Infant)	1981
74.	Margarine and Other Table Spreads	1981
75.	Cheese	1982
76.	Cream	1982
77.	Mince	1983

TABLE A.2 : REPORTS OF THE FOOD ADDITIVES AND CONTAMINANTS COMMITTEE (FACC) AND FOOD ADVISORY COMMITTEE (FAC)

Source: M Miller <u>Danger: Additives at Work</u> London Food Commission, London 1985, p160.

Report No	Subject	Date of publication
1.	Antioxidants (Supplementary)	1965
2.	Solvents	1966
3.	Cyclamates	1966
4.	Antioxidants (2nd Supplementary)	1966
5.	Aldrin and Dieldrin	1967
6.	Cyclamates (Supplementary)	1967
7.	Further classes of additives	1968
8.	Azodicarbonamide	1968
9.	Emulsifiers and stabilisers	1970
10.	Packaging	1970
11.	Antioxidants (3rd Supplementary)	1971
12.	- not allocated -	
13.	Additives in Bread and Flour (FSC/REP/61, 1974 - Appendix 4)	1971
14.	Preservatives	1972
15.	Liquid freezants	1972
16.	Emulsifiers and stabilisers (Supplementary)	1972
17.	Solvents	1974
18.	Antioxidants	1974
19.	Liquid Freezants (Supplementary)	1974
20.	Mineral Hydrocarbons	1975
21.	Lead	1975
22.	Flavourings	1976
23.	Representation for the use of sulphur dioxide as an alternative to permitted colouring matter in canned garden peas	1977
24.	Sorbic acid	1977
25.	Solvents	1978
26.	Beer	1978
27.	Nitrites and Nitrates in Cured Meats and Cheese	1978
28.	Flavour Modifiers	1978
29.	Colouring Matter (Interim Report)	1979
30.	Asbestos	1979
31.	Modified Starches	1980
32.	Bulking aids	1980
33.	Infant formulae (FSC/REP/73, 1981 - Appendix 3)	1981
34.	Sweeteners	1982
35.	Enzymes	1982
36.	Cheese (FSC/REP/75, 1982 - Appendix III)	1982
37.	Cream (FSC/REP/76, 1982 - Appendix II)	1982
38.	Metals in Canned Foods	1983
39.	Arsenic	1984

TABLE A.3 : REGULATIONS ON ADDITIVES AND FOOD COMPOSITION, 1944-1984

Some minor regulations that made very small changes have been omitted

Year/No	Name of regulation or order
1944/	Labelling of Food (No 2) Order
1945/0627	Dried Egg (Control of Use) Order
1945/0911	Fruit Pulp Order
1946/0010	Milk (Special Designations) Regs
1946/0945	Soft Drinks Order
1946/2169	Labelling of Food Order
1947/0612	Ice Cream (Heat Treatment) Regs
1947/1134	Fluorine in Food Order
1948/	Public Health (Preservatives etc. in Food) Regs
1949/0614	Mineral Oil in Food Order
1949/1817	Food Standards (Tomato Ketchup) Order
1949/	Milk (Special Designa'n) (Pasteurised & Sterilised Milk) Regs
1953/0246	Offals in Meat Products Order
1953/1311	Artificial Sweeteners in Food Order
1953/	Food Standards (Preserves) Order
1953	Labelling of Food Order
1956/1167	Food Standards (Tomato Ketchup) Order
1957/1066	Colouring Matter in Food Regs
1958/1454	Antioxidant in Food Regs
1959/0277	Milk and Dairies (General) Regs
1959/0734	Ice Cream (Heat Treatment etc) Regs
1959/0831	Arsenic in Food Regs
1959/1838	Slaughterhouse Licences (Forms & Records) Regs
1959/2106	Fluorine in Food Regs

Year/No	Name of regulation or order
1960/1268	Meat (Staining & Sterilisation) Regs
1960/1542	Milk (Special designation) Regs
1960/1601	Food Hygiene (General) Regs
1960/1602	Food Hygiene (Docks, Carriers etc) Regs
1960/2331	Skimmed Milk with Non-Milk Fat Regs
1961/1931	Lead in Food Regs
1962/0720	Emulsifiers & Stabilisers in Food Regs
1962/1532	Preservatives in Food Regs
1963/1229	Meat Inspection Regs
1963/1435	Bread & Flour Regs
1963/1503	Liquid Egg (Pasteurisation) Regs
1964/0019	Meat (Treatment) regs
1964/0760	Soft Drinks Regs
1964/1289	Mineral Hydrocarbons in Food Regs
1966/0791	Food Hygiene (Markers, Stalls & Delivery Vehicles) Regs
1966/1073	Mineral Hydrocarbons in Food Regs
1966/	Antioxidants in Food Regs
1967/0385	Food (Control of Irradiation) Regs
1967/1119	Artificial Sweeteners in Food Regs
1967/1582	Solvents in Food Regs
1967/1939	Solvents in Food (Amendment) Regs
1967	Labelling of Food Regs
1968/0097	Imported Food Regs
1969/1817	Artificial Sweeteners in Food Regs
1969/1818	Soft Drinks (Amendment) Regs
1970/0400	Labelling of Food Regs

Year/No	Name of regulation or order
1970/	Food Hygiene (General) Regs
1970	Cream Regs
1972/0205	Food (Control of Irradiation) (Amendment) Regs
1972/1391	Bread & Flour (Amendment) Regs
1973/1064	Milk & Dairies (Semi-skimmed & Skimmed Milk)(Heat Treatment & Labelling) Regs
1973/1340	Colouring Matter in Food Regs
1974/1119	Preservatives in Food Regs
1974/1120	Antioxidants in Food Regs
1974/1121	Miscellaneous Additives in Food
1975/1349	Medicines (Feeding Stuffs Additives) Order
1975/1488	Colouring Matter in Food (Amendment) Regs
1975/	Preservatives in Food Regs
1975/	Emulsifiers & Stabilisers in Food Regs
1976/0509	Specified Sugar Products Regs
1976/1209	Poultry Meat (Hygiene) Regs
1976/2086	Colouring Matter in Food (Amendment) Regs
1977/0691	Erucic Acid in Food Regs
1977/	Milk (Special Designation) Regs
1978/0105	Antioxidants in Food Regs
1978/1787	Colouring Matter in Food (Amendment) Regs
1978/1927	Materials & Articles in Contact with Food Regs
1979/0415	International Carriage of Perishable Foodstuffs Regs
1979/0752	Preservatives in Food Regs
1979/1254	Lead in Food Regs
1979/1426	Imported Food (Amendment) Regs
1980/0036	Chloroform in Food Regs

Year/No	Name of regulation or order
1980/0931	Preservatives in Food (Amendment) Regs
1980/1831	Antioxidants in Food (Amendment) Regs
1980/1832	Solvents in Food (Amendment) Regs
1980/1833	Emulsifiers & Stabilisers in Food Regs
1980/1834	Miscellaneous Additives in Food Regs
1980/1838	Materials & Articles in Contact with Food (Amendment) Regs
1980/1849	Food Labelling Regs
1981/1063	Jam & Similar Products Regs
1982/0014	Miscellaneous Additives in Food (Amendment) Regs
1982/0015	Preservatives in Food (Amendment) Regs
1982/0016	Emulsifiers & Stabilisers in Food (Amendment) Regs
1982/0017	Cocoa & Chocolate Products (Amendment) Regs
1982/1018	Meat (Sterilisation & Staining) Regs
1982/1066	Condensed Milk & Dried Milk (Amendment) Regs
1982/1311	Fruit Juices & Fruit Nectars (Amendment) Regs
1982/1703	Milk & Dairies (Revision of Penalties) Regs
1982/1727	Food (Revision of Penalties) Regs
1983/1211	Sweeteners in Food Regs
1983/1508	Milk-based Drinks (Hygiene & Heat Treatment) Regs
1983/1509	Milk & Dairies (Heat Treatment of Cream) Regs
1983/1810	Emulsifiers and Stabilisers in Food (Amendment) Regs
1984/0649	Cheese (Amendment) Regs
1984/1304	Bread & Flour Regs

TABLE A.4 : REPORTS AND REGULATIONS ON ADDITIVES, SHOWING THE ACTIVITY ON COLOURS COMPARED TO OTHER GROUPS OF ADDITIVES, 1953-1987

Compiled from tables A.1, A.2 and A.3

Additive group	Date & No of FSC or FACC report	Regulation	Amendment
Antioxidants	1953/1		
	1954/2	1958/1454	
	1963/2		
	1965/1		
	1966/4	1966/	
	1971/11	1974/1120	
	1974/18	1978/0105	1980/1831
Bulking aids	1980/32		
Colours	1954/3		
	1955/4	1957/1066	
	1960/8		
	1964/4	1966/1203	1970/1102
		1973/1340	1975/1488
			1976/2086
			1978/1787
	1979/29		
	1987/		
Emulsifiers and stabilisers	1956/5	1962/0720	
	1970/9		
	1972/16	1975/	
		1980/1833	1982/0016
			1983/1810
Enzymes	1982/35		
Flavours (& chloroform)	1965/5		
	1976/22		
	1978/28		
	1980/36	1980/0036	
Freezants	1972/15		
	1974/19		

Additive group	Date & No of FSC or FACC report	Regulation	Amendment
Mineral oils		1949/0614	
	1962/1	1964/1289	
		1966/1073	
	1975/20		
Miscellaneous groups	1968/7	1974/1121	
	1976/25	1980/1834	1982/0014
Modified atarch	1980/31		
Preservatives	1959/6		
	1960/7	1962/1532	
	1972/14	1974/1119	1975/
	1977/23		
	1977/24		
	1978/27	1979/0752	1980/0931
			1982/0015
Solvents	1965/2	1967/1582	1967/1939
	1974/17		
	1978/25		1980/1832
Sweeteners	1952/32	1953/1311	
	1953/32a		
	1966/3	1967/1119	
	1967/6	1969/1817	
	1982/34		1983/1211
Additives in beer	1978/26		
Additives in bread & flour	1968/8		
	1971/13		
Additives in baby food	1981/33		
Additives in cheese	1982/36		
Additives in cream	1982/37		

TABLE A.5 : CODES OF PRACTICE ON FOOD STANDARDS, 1948 - 1969

Source: MAFF 1970

KEY:

FMF Food Manufacturers Federation

LAJAC Local Authorities Joint Advisory Committee of Food Standards Codes

Year	Subject	Comment
MINISTRY OF FOOD CODES		
1948	Cocoa and drinking chocolate	-
1948	Spa waters	Revised 1951
1948	Macaroni and similar products	Adopted with amendment by FMF in 1963
1948	Herbs and mixtures of herbs	-
1948	Brandy	Now LAJAC Code No 2
1948/9	Wines and spirits	-
1948/9	Vitamin and mineral contents (suggested code of practice in framing labels and advertisements)	-
1949	Fish and fish products	Superseded by Regulations SI 1950 No 589 and SI 1968 No 430
1949	Canned soups	Amended by circular MF3/54 Adopted by FMF in 1965
1949	Soft drinks	Revised 1951. Superseded by SI 1964 No 760 Regulations SI 1969 No 1818
1949	Speciality flours	Superseded by Regulations 1946 No 157, 1963 No 1435
1949	Tea and coffee	Coffee part superseded by Regulations SI 1967 No 1865
1949	Salt	-
1949	Shredded suet	Superseded by Regulations SI 1952 No 2203
1949	Vinegars - solution of acetic acid	Cancelled by MF15/50
1949	Malted milk	-

Year	Subject	Comment
1949	Biscuits	Under consideration by LAJAC
1949	Bread	Superseded by Regulations 1963 No 1435
1950	Fish pastes and fish spreads	Superseded by Regulations SI 1968 No 430
1950	Horseradish sauce	Still in operation
1951	Essences and flavourings	Superseded by Regulations
1951	Meat pastes and spreads	Superseded by Regulations SI 1968 No 430
1951	Use of the word "butter" in description of chocolate	MF 21/51 Superseded by Regulations
	Flour mixtures	Cancelled
	Labelling of medicated foods and drinks	Superseded by Regulations SI 1970 No 400
MISCELLANEOUS CODES		
	Chocolate couverture	
	Cider and perry	
	Pasta Products	
	Butter in flour confectionery	
	Biscuits	
	Canned fruit and vegetables	
LOCAL AUTHORITIES JOINT ADVISORY COMMITTEE OF FOOD STANDARDS CODES		
1963	Use of the word "chocolate" in flour confectionery	-
1963	Labelling of brandy (labelling of brandy, correction)	-
1963	Norwegian crab products	-
1965	Canned fruit and vegetables	-
1965	Canned beans in tomato sauce	-
1969	Marzipan, almond paste and almond icing	-

APPENDIX B

TABLE B.1 : DIRECTORY OF COAL TAR COLOURS

The directory includes:
Alternative names
Hue
Colour Index Numbers from 1924 and 1975
EEC E Number (former and current)
USA FDA Number

Name	Hue	1924 CI No	1975 CI No	E No	USA Code
Acid bordeau B (Fast red B, Bordeaux B, 2B, G, R)	Red	88	16180		
Acid fuchsine - see Acid magenta					
Acid green GG (Guinea green B, CI Food green 1)	Green	666	42085		FDC Gre 1
Acid magenta II (Acid fuchsine, Acid rubin?, CI Acid violet 19)	Red	? 692	42685		
Acid violet 6B (Benzyl violet 4B, Acid violet 5B) (Violet 6B, CI Food violet 2)	Violet	697	42640		FDC Vio 1
Acid violet 4BN	Violet	695	42615		
Acid violet S4B - see Acid violet 6B or Violet 5BN					
Acid yellow G (CI Food yellow 2, Fast yellow SX) (Fast yellow AB, Solid yellow)	Yellow	16	13015		
Acilan brilliant blue FFR - see brilliant blue FFR					
Acilan fast green 10G	Green		42170		
Alkali blue	Blue	704	42765 or 42750		
Allura red (CI Food red 17)	Red		16035	129	FDC Red 40
Amaranth (one type of Azorubine S, Fast red D) (Naphthylamine red, Naphthol reds, Bordeaux S) (CI Food red 9)	Red	184	16185	123	FDC Red 2
Amidoazotoluol (Aminoazotoluene, Fast azo garnet base) (Fast azo oil yellow, Fast spirit yellow) (Called Butter yellow by one US manufacturer)	Yellow	17	11160		

Name	Hue	1924 CI No	1975 CI No	E No	USA Code
Aminoazobenzene (Aniline yellow, Fast spirit yellow)	Yellow	15	11000		
Aniline blue - see Gentian violet 6B					
Aniline orange - see Victoria yellow or Orange RN					
Aniline purple - see Mauveine					
Archil substitute	Brown		13365?		
Auramine (Fat yellow A, Canary yellow) (Auramine 0, 00, II, Primrose yellow)	Yellow	655	41000		
Aurantia (Imperial yellow)	Yellow	12	10360		
Aurine (Rosolic acid, Coralline)	Yellow	724	43800		
Azoblue (CI Direct violet 28)	Violet	463	23685		
Azorubine - see Amaranth and Carmoisine					
Baking brown	Brown	612			
Baking brown AW	Brown				
Bengal red - see Rose bengale					
Benzopurpurine 4B	Red	448	23500		
Benzyl bordeau B	Red	85			
Benzyl violet 4B - see Acid violet 6B					
Benzyl violet 5BN - see Violet 5BN					
Bismark brown (Bismarck brown R, Manchester brown EE, an aniline brown)	Brown	332	21010		
Bismarck brown G (Golden brown Y, manchester brown, Leather brown)	Brown	331	21000		
Black 5410	Black		35445		
Black 7984 (CI Food black 2)	Black		27755	152	
Black PN (Brilliant black BN, Black 1743)	Black		28440	151	

Name	Hue	1924 CI No	1975 CI No	E No	USA Code
(Naphthol black B, CI Food black 1)					
Blue VRS	Blue	672	42045		
(Xylene blue VS, CI Food blue 3)					
Bordeaux B - see Acid bordeaux B					
Bordeaux extra	Red		22500		
Brilliant black BN - see Black PN					
Brilliant blue FCF	Blue	671	42090	133	FDC Blu 1
(- Na & NH_4 salts; Erioglaucine)					
(CI Food blue 2, Patent blue AE)					
Brilliant blue FFR	Blue		42735		
Brilliant croceine	Red	252	27290		
Brilliant green cryst. Y	Green	662	42040		
(Brilliant green, Ethyl green)					
(Emerald green crystals, CI Basic green 1)					
Brilliant indocyanin 6B			42660		
(Supranocyanin)					
Brilliant yellow	Yellow	364			
(Paper yellow 3G)					
Brown FK	Brown		-	154	
(Brown 1545, CI Food brown 1)					
Butter yellow	Yellow	19	11020		
(Oil yellow D, an aniline yellow)					
CI Food black 1 - see Black PN					
CI Food black 2 - see Black 7984					
CI Food blue 1 - see Indigo carmine					
CI Food blue 2 - see Brilliant blue FCF					
CI Food blue 3 - see Blue VRS					
(discont. by 1971)					
CI Food blue 4 - see Idanthrene blue					
CI Food blue 5 - see Patent blue V					
CI Food brown 1 - see Brown FK					

Name	Hue	1924 CI No	1975 CI No	E No	USA Code

CI Food brown 2 - see Chocolate brown FB

CI Food brown 3 - see Chocolate brown HT

CI Food green 1 - see Guinea green B
(discont. by 1971)

CI Food green 2 - see Light green SF yellowish
(discont. by 1971)

CI Food green 3 - see Fast green FCF

CI Food green 4 - see Green S

CI Food orange 1 - see Crocein orange

CI Food orange 2 - see Orange GGN

CI Food orange 3 - see Oil yellow GG

CI Food orange 4 - see Orange G

CI Food orange 5 - see β-carotene

CI Food orange 6 - see β-apo-8'-carotenoate

CI Food orange 8 - see Canthaxanthin

CI Food red 1 - see Ponceau SX

CI Food red 2 - see Scarlet GN

CI Food red 3 -see Carmoisine

CI Food red 4 - see Fast red E
(discont. by 1971)

CI Food red 5 - see Ponceau 2R

CI Food red 6 - see Ponceau 3R
(discont. by 1971)

CI Food red 7 - see Ponceau 4R

CI Food red 8 - see Ponceau 6R

CI Food red 9 - see Amaranth

CI Food red 10 - see Red 2G

CI Food red 11 - see Red 6B

Name	Hue	1924 CI No	1975 CI No	E No	USA Code

CI Food red 12 - see Red 10B

CI Food red 13 - see Red FB

CI Food red 14 - see Erythrosine

CI Food red 15 - see Rhodamine B
(discont. by 1971)

CI Food red 16 - see Sudan red G
(discont. by 1971)

CI Food red 17 - see Allura red

CI Food violet 1 - see Violet 5BN
(discont. by 1971)

CI Food violet 2 - see Acid violet 6B

CI Food violet 3 - see Violet BNP

CI Food Yellow 1 - see Naphthol yellow S
(discont. by 1971)

CI Food Yellow 2 - see Acid yellow G

CI Food Yellow 3 - see Sunset yellow FCF

CI Food Yellow 4 - see Tartrazine

CI Food Yellow 5 - see Yellow 2G

CI Food Yellow 6 - see Yellow RFS
(discont. by 1971)

CI Food Yellow 7 - see Yellow 27175N
(discont. by 1971)

CI Food Yellow 8 - see Chrysoine

CI Food Yellow 9 - see Yellow RY
(discont. by 1971)

CI Food Yellow 10
(discont. by 1971)

CI Food Yellow 11
(discont. by 1971)

CI Food Yellow 12 - see Oil yellow XP

Name	Hue	1924 CI No	1975 CI No	E No	USA Code
CI Food Yellow 13 - see Quinoline yellow					
Carmoisine (Azorubine S, LZ; Fast red C) (CI Food red 3)	Red	179	14720	122	
Chlorazol sky blue	Blue	518			
Chocolate brown FB (Brown 11660, CI Food brown 2)	Brown		-		
Chocolate brown HT (Brown 1538, CI Food brown 3) (Brown RS)	Brown		20285	155	
Chrome violet - see Mauveine					
Chrysamine R (direct yellow 3R)	Brown	480			
Chrysaniline - see Phosphine					
Chrysoidine	Orange	20 or 21	11270 ?		
Chrysoine (Resourcine, Resorcinol yellow) (CI Food yellow 8, Tropaeolin O & R)	Yellow	148	14270	103	
Chrysoine SGX			14275		
Citron orange	Orange		13090		
Citronine A - see Naphthol yellow S					
Citrus red 2 (Solvent red 80)			12156		
Cochineal red A - see Ponceau 4R					
Congo red	Red	370	22120		
Coomassie navy blue	Blue	289	21670		
Coralline - see Aurine					
Coupier's blue - see Induline spirit soluble					
Crispin black G (CI Acid black 73)	Black				
Croceine scarlet 5R	Red	280			

Name	Hue	1924 CI No	1975 CI No	E No	USA Code
Crystal roseine - see Magenta					
Cyanol	Blue	715	43535		
Diamond yellow	Yellow	213 or 218			
Direct black	Black	581 ?	22580 ?		
Direct blue 2B (CI Direct blue 6)	Blue	406	22610		
Double brilliant scarlet (3R, S)	Red	194	14730		
Eosine	Red	768	45380		D&C 22 & 23
Eosine scarlet	Red	771	45400		
Erioglaucine - see Brilliant blue FCF					
Erythrosine (CI Food red 14, Erythrosine B) (Eosin J, Iodeosin B, Eosin bluish)	Red	773	45430	127	FDC Red 3
Fast green FCF (CI Food green 3)	Green		42053		FDC Gre 3
Fast red A - see Rocceline					
Fast red E (CI Food red 4)	Red	182	16045		
Fast red salt AL	Red		37275		
Fast scarlet salt R	Red		37130		
Fast yellow AB - see Acid yellow G					
Fast yellow R	Yellow	18			
Fat yellow GS (a Sudan yellow, Fat yellow 3G?, Sudan yellow 3G?)	Yellow		12700 ?		
Fluorescin (CI Acid yellow 73)	Yellow		45350		D&C Yell 8
Fuchsin - see Magenta					
Fuchsin acid - see Acid magenta					

Name	Hue	1924 CI No	1975 CI No	E No	USA Code
Gentian blue 6B	Blue	689	42775		
(Spirit blue 2B, B, R; an aniline blue)					
(CI Solvent blue 3, Lyon's blue)					
Gentian violet	Violet	680			
(mixture based on methyl violet)					
Green S	Green	737	44090	142	
(Acid brilliant green, Wool green)					
(CI Food green 4)					
Golden brown Y - see Bismarck brown G					
Guinea green - see Acid green G					
Hansa yellow 5G	Yellow		11660		
(Lithol fast yellow 5G, Monolite yellow 5G)					
Hansa yellow 10G	Yellow		11710		
Hansa yellow G	Yellow		11680		
Helindone pink	Red	1211	73360		
Helio red	Red	69			
Heliotrope - several colours					
Hoffman's violet R	Violet	679	42530		
Idanthrene blue	Blue	1106	69800	130	
(Idanthrone, CI Food blue 4, Anthragen blue)					
(Anthraquinone blue, Solanthrene blue RS)					
Indian red	Red	1027			
(a sulphonated azo red)					
Indigo carmine	Blue	1180	73015	132	FDC Blu 2
(Indigotine, CI Food blue 1)					
Induline	Blue	861	50405		
(Fast blue R, 3R; Indulin R,B)					
(Induline water soluble, Croupier's blue)					
Induline spirit soluble	Blue	860	50400		
(Fast blue R, B; Indulin 3B, 6B)					
Light brown - see Resorcine brown					
Light blue - see Gentian blue 6B					

Name	Hue	1924 CI No	1975 CI No	E No	USA Code
Light green SF (Light green SF yellowish, CI Food green 2)	Green	670	42095		FDC Gre 2
Lithol rubine BK (Pigment rubine)	Red		15850	180	
lyon's blue - see Gentian blue 6B					
Magenta (Fuchsine, Aniline red) (Crystal roseine)	Violet	677	42510		
Malachite green	Green	657	42000		
Manchester yellow (Martius yellow, Naphthol yellow) (Naphthalene yellow)	Yellow	9	10315		
Mandarin orange - see Orange II					
Martius yellow - see Manchester yellow					
Mauveine (Chrome violet, Mauve, Aniline purple)	Violet	846 ?	50245		
Metanil yellow (type of Tropaeolin G)	Yellow	138 ?	13065		
Methyl orange (Orange III, Helianthin, Tropaeolin D) (Dimethylanilin orange)	Orange				
Methyl violet (Methyl violet 2B, paris violet) (Methylaniline violet)	Violet	680	42535		
Methylene blue	Blue		52015		
Naphthol black B - see Naphthol blue black or Black PN					
Naphthol blue black			20470		
Naphthol green B	Green		10020		
Naphthol orange - see Orange I					
Naphthol yellow - see Manchester yellow					
Naphthol yellow S (Na salt and K salt) (Citronin A, Brilliant yellow) (CI Food yellow 1, Acid yellow S)	Yellow	10	10316		FDC Yel 1 FDC Yel 2

Name	Hue	1924 CI No	1975 CI No	E No	USA Code
Naphthylamine - see Manchester yellow					
New coccine - see Ponceau 4R					
Nigrosine (Coupir's black, water soluble nigrosine)	Black	865	50420		
Nigrosine spirit (Oil black, Spirit black, Spirit nigrosine) (Nigrosine spirit soluble)	Black	864	50415		
Oil black - see Nigrosine spirit soluble					
Oil orange E - see Sudan I					
Oil orange SS - see Oil orange TX					
Oil orange TX (Oil orange SS)	Orange		12100		FDC Ora 2
Oil orange XO - see Sudan II					
Oil orange XX - see Sudan II					
Oil red 2R	Red	82			
Oil yellow 3G (Ceres Gelb GRN)			21230		
Oil yellow AB (Yellow AB)	Yellow	22	11380		FDC Yel 3
Oil yellow D - see Butter yellow					
Oil yellow GG (Sudan G, CI Food orange 3) (Sudan yellow AR, Oil orange GG)	Orange	23	11920		
Oil yellow HA	Yellow		11860		
Oil yellow OB (Yellow OB)	Yellow	61	11390		FDC Yel 4
Oil yellow XP (Oil yellow SEG, CI Food yellow 12)	Yellow		12740		
Orange I (Tropaeoline 000, I. G, Naphthol orange)	Orange	150	14600		FDC Ora 1
Orange II (Mandarin orange, Tropaolin 000, β-naphthol orange)	Orange	151	15510		

Name	Hue	1924 CI No	1975 CI No	E No	USA Code
Orange IV (Tropaeolin OO, an aniline yellow)	Yellow	143			
Orange B (Acid orange 137)	Orange		19235		
Orange G (CI Food orange 4)	Orange	27	16230		D&C Ora 3
Orange GGN (Orange GGP, CI Food orange 2)	Orange		15980	111	
Orange R (Ponceau 2G, CI Acid orange 8)	Red	161	15575		
Orange RN (Crocein orange, CI Food orange 1) (Aniline orange J, Ponceau 4GBL)	Orange	26	15970		
Orange yellow 5					
Paris violet - see Methyl violet					
Patent blue A	Blue	714			
Patent blue V (CI Food blue 5, CI Acid blue 5, Sulphan blue)	Blue		42051	131	
Permanent orange G	Orange		21110		
Phloxine	Red	774	45405		
Phosphine (Chrysaniline, Xanthin)	Yellow		46045		
Phtalocyanin blue (Heliogen blue G)	Blue		74100 74140 74160		
Phthalocyanine green	Green		74260		
Picric acid (Carbazotic acid)	Yellow	7	10305		
Ponceau cryst. 6R	Red	89	16250		
Ponceau 2R (Ponceau MX, Xylidine scarlet) (Scarlet RF,R; CI Food red 5))	Red	79	16150		
Ponceau 3R (CI Food red 6, Ponceau N3R)	Red	80	16155		FDC Red 1

Name	Hue	1924 CI No	1975 CI No	E No	USA Code
Ponceau 4R (Cochineal red A, New coccine) (CI Food red 7, Scarlet 4R, Brilliant scarlet)	Red	185	16255	124	
Ponceau 6R (Scarlet 6R, CI Food red 8)	Red	186	16290	126	
Ponceau MX - see Ponceau 2R					
Ponceau SX	Red		14700		FDC Red 4
Quinoline yellow (CI Food yellow 13, chinolin yellow)	Yellow	801	47005	104	DC Yel 10
Red 4B - see Benzopurpurin 4B					
Red 6B (CI Food red 11)	Red	57	18055		
Red 10B (CI Food red 12)	Red	30	17200		
Red FB (CI Food red 13)	Red	225	14780		
Red 2G (CI Food red 10)	Red	31	18050	128	
Resorcine brown (Light brown)	Brown	234	20170		
Resorcine yellow - see Chrysoine					
Rhodamine B (Rhodamine O, Safraniline)	Red	749	45170		
Rhodamine 6G	Red	752	45160		
Rhodamine G	Red	750	45150		
Rocceline (Fast red, Fast red A)	Red		15620		
Rose aniline - see safranine					
Rose bengal	Red	777	45440		
Rose pink - see Safranine					
Safranine (Saffranine, Aniline rose, Safranine T, Vermilion?)	Red	841	50240		

Name	Hue	1924 CI No	1975 CI No	E No	USA Code
Scarlet GN (CI Food red 2)	Red		14815	125	
Solanthrene blue RS - see Idanthrene blue					
Soluble blue [a]	Blue		42780		
Soluble blue [b] (Water blue)	Blue	707	42755		
Spirit black - see Nigrosine spirit					
Spirit nigrosine - see Nigrosine spirit					
Sudan I (Oil orange E, a fat yellow) (Fat orange E)	Orange	24	112055		
Sudan II	Orange	73	12140		
Sudan III	Red	248	26100		
Sudan IV (Sudan red BB, Scarlet red)	Red	258	26105		
Sudan blue II (CI Solvent blue 35)	Blue				
Sudan G - see Oil yellow GG					
Sudan orange - see Oil yellow GG					
Sudan red G (Ceres rot G, CI Food red 16)	Red	113	12150		
Sudan R	Orange ?		12155 ?		
Sulfon red B	Red				
Sunset yellow FCF (CI Food yellow 3)	Yellow		15985	110	FDC Yel 6
Tartrazine (an acid yellow, CI Food yellow 4)	Yellow	640	19140	102	FDC Yel 5
Thiazine brwon R			20220		
Tropaeolin D - see Methyl orange					
Tropaeolin G - see Metanil yellow and ?					

Name	Hue	1924 CI No	1975 CI No	E No	USA Code
Tropaeolin O, R - see Chrysoine					
Tropaeolin OO - see Orange IV					
Tropaeolin OOO - see Orange I and Orange II					
Turquoise blue G	Blue	661	42036		
Vermilion - See Safranine. Also a mineral colour					
Victoria blue B	Blue		44045		
Victoria blue R	Blue		44040		
Victoria yellow (Saffron substitute, Dinitrocresol) (Golden yellow, Aniline orange, English yellow)	Yellow	8	10310		
Violamine R			45190		
Violet 5BN (Benzyl violet 5BN, CI Food violet 17)	Violet	698	42650		
Violet 6B - see Acid violet 6B					
Violet BNP (CI Food violet 3)	Violet		42580		
Water blue - see Soluble blue [b]					
Wool black	Black	279	26435		
Wool green S - see Green S					
Xylene blue VS - see Blue VRS					
Xylene red B (Rhodamine acid brilliant B)	Red	748	45100		
Yellow 2G (Dispersed yellow 1639, CI Food yellow 5) (Hexacol yellow 2G)	Yellow	639	18965		
Yellow OB - see Oil yellow OB					
Yellow RFS (CI Food yellow 6)	Yellow		13011		
Yellow RY (CI Food yellow 9)	Yellow		20281		

TABLE B.2 : DIRECTORY OF MINERAL AND METALLIC COLOURS

Name	Hue	1924 CI No	1975 CI No	E No	USA FDA
Aluminium	Metallic	1316	77000	173	
Antwerp blue (a preparation/modification of (Prussian blue with chalk, CI Pigment blue 27)	Blue	1288	77510 77520		
Armenian bole - see Bole armenian					
Artificial ultramarine (German ultramarine, (similar to natural ultramarine)	Blue				
Berlin blue - see Prussian blue					
Bichromate of potash - see Chromate of potash					
Blue verditer (sesquicarbonate of copper) (Basic cupric carbonate, CI Pigment blue 30)	Blue	1283	77420		
Bole armenian (an iron oxide, Armenian earth) (Red ferruginous earth, prepared ferric oxide) (CI Pigment red 102)	Red				
Brick dust	Brown				
Brunswick green deep (Oxychloride of copper) (CI Pigment green 15)	Green	1295			
Brunswick green middle (oxychloride of copper) (CI Pigment green 15)	Green	1295			
Brunswick green pale (oxychloride of copper) (CI Pigment green 15)	Green	1295			
Burnt umber - see Umber					
Calcium sulphate			77231		
Carbon black (CI Pigment black 7, Channel black)	Black	1308	77266		
Carbonate of lime	White				

Name	Hue	1924 CI No	1975 CI No	E No	USA FDA
Carbonate of magnesia	White				
Chalk (Calcium carbonate, CI Pigment white 18)	White	1261	77220	170	
Channel black - see Carbon black					
China clay	White				
Chromates of potash (Potassium chromate compounds)	Yellow				
Chrome deep (Bright or canary chrome, a lead chromate) (CI Pigment yellow 34)	Yellow	1270?			
Chrome lemon (a lead chromate) (CI Pigment yellow 14 and CI Pigment green 15)	Yellow	1270?	77600		
Chrome orange (a lead chromate) (CI Pigment orange 21)	Yellow	1270?	77601		
Cinnabar (Vermilion, HgS, Bisulphuret of mercury) (CI Pigment red 106)	Red	1280	77766		
Cobalt blue (Cobalt, CI Pigment blue 28) (Smalt, CI Pigment blue 32)	Blue	1287	77346 77365		
Copper bronze (alloy of copper and zinc)	Metallic		77400		
Emerald green - see Scheele's green					
False brunswick green deep (mixture of chromates of lead and indigo or possibly Prussian blue)	Green				
False brunswick green middle (mixture of chromates of lead and indigo or possibly Prussian blue)	Green				
False brunswick green pale (mixture of chromates of lead and indigo or possibly Prussian blue)	Green				
False verditer (Subsulphate of copper and chalk)	Green				

Name	Hue	1924 CI No	1975 CI No	E No	USA FDA
French chalk - see Talc					
Fuchsine (Acetate of copper)	Green				
Fuller's earth	Brown				
Gold	Metallic		77480	175	
Gold bronze (alloy of copper and zinc)	Metallic				
Graphite - see Plumbago					
Green earth - see Terre verte					
Gypsum - see Plaster of Paris					
Indian red (mainly ferrric silicate)	Red	1027 or 1276	77538		
Iodide of lead	Yellow				
Iodide of mercury	Red				
Iron oxides:					
Ferrous oxide FeO			77489		
Ferric oxide FeO_3 (Venetian red, Umber, Red ochre, Iron ore)	Red		77491	172	
Hydrated ferric oxide	Brown/yellow		77492	172	
Ferroso-ferric oxide (Yellow ochre, Sienna)	Brown		77499	172	
Bole armenian (Aluminium silicate coloured by ferric oxide)			77015		
Ferric silicate			77538		
CI Pigment red 101			77491		
King's yellow - see Orpiment					
Litharge - see Red lead					
Massicot (Protoxide of lead, CI Pigment yellow 46)	Yellow		77577		

Name	Hue	1924 CI No	1975 CI No	E No	USA FDA
Mineral green - see Verditer					
Mountain blue - see Blue verditer					
Naples yellow (Sulphuret of antimony, CI Pigment yellow 41)	Yellow	1295			
Orpiment (As_2S_3, a lemon yellow mineral) (CI Pigment yellow 39, Realgar, King's yellow)	Yellow	1273	77086		
Plaster of Paris (Hydrated sulphate of lime (Mineral white, Gypsum)	White	1257			
Plumbago (Black lead, Graphite) (CI Pigment black 10)	Black	1307	77265		
Potash	White				
Prussian blue (Ferrocyanide of iron) (CI Pigment blue 27)	Blue	1288	77510 77520		
Realgar - see Orpiment					
Red lead (Minimum; red oxide of lead; Pb_3O_4) (artificial, synthsised by Egyptians) (CI Pigment red 105, Litharge)	Red	1278	77578		
Red ochre (Red ferruginous earth, anhydrous ferric oxide) (mainly ferric oxide, CI Pigment red 101 & 102)	Red	1276 ?	77491		
Red orpiment - see Orpiment					
Salt	White				
Scheele's green (Copper arsenite, Emerald green) (CI Pigment green 22)	Green	1295	77412		
Schweinfurt's green (Cupric acetoarsenic, CI Pigment green 21)	Green	1295	77410		
Sienna (Brown ferruginous earths) (CI Pigment yellow 43)	Brown	1267	77492		

Name	Hue	1924 CI No	1975 CI No	E No	USA FDA
Silver	Metallic		77820	174	
Silver bronze (alloy of copper and zinc)	Metallic				
Smalt - see Cobalt					
Sulphate of copper (Blue vitriol)	Green				
Sulphate of iron					
Talc (China clay, French chalk, Soapstone) (Hydrated aluminium silicate, CI Pigment white 19)	White	1265	77019 77004	553b	
Terra alba (Sulphate of lime, CI Pigmant white 25)	White		77231		
Terre verte (K/Al/Fe/Mg silicate; derived from glauconite) (Green earth, CI Pigment green 23)	Green	1296	77009		
Tin	Metallic	1266? or 1273?			
Titanium dioxide	White	1264	77891	171	
Ultramarine (double silicate of alumina & soda with sulphuret of sodium) (NaCa aluminium silicate)	Blue	1290	77007		
Umber (Brown ferruginous earths, iron oxides) (Burnt umber, CI Pigment brown 7)	Brown	1305	77491	181	
Vandyke brown (Brown ferruginous earths) (CI Pigment brown 9)	Brown	1303 1306	77430		
Venetian red (Red ferruginous earth) (CI Pigment red 101, an iron oxide)	Red	1276			
Verdigris (diacetate of copper) (CI Pigment green 20)	Green	1294	77408		
Verditer (Carbonate of copper) (CI Pigment green 22)	Green		77412		

Name	Hue	1924 CI No	1975 CI No	E No	USA FDA
Vermilion - see Cinnabar					
White lead (Carbonate of lead, CI Pigment white 1) (artificial, synthesised by Egyptians)	White	1260	77597		
Yellow ochre (ferruginous earth, an iron oxide) (CI Pigment yellow 43)	Yellow	1267	77492		
Yellow orpiment - see Orpiment					
Zinc white (CI Pigment white 7)	White		77975		

TABLE B.3 : DIRECTORY OF PLANT AND ANIMAL BASED COLOURS

Name	Hue	1924 CI No	1975 CI No	E No	USA FDA
PLANT PROCUCTS					
Alkannet (Alkannin, Orcanette) (from roots of *Alkanna tinctoria* (CI Natural red 20)	Red	1240	75520 75530		
Annatto (from seed pods of *Bixa orellana*) (Bixin, Norbixin, Rocou) (CI Natural orange 4)	Orange		75120	160b	
Anthocyanins (Grape skin extract)				163	
Apricot fruit	Orange				
β-apo-8'-carotenal (- C30, CI Natural orange 7) (CI Food oragnge 6)	Orange		40820	160e	
β-apo-8'-carotenic acid ethyl ester (- C30, CI Natural orange 8) (CI Food orange 7)	Orange		40825	160f	
Beetroot (Beet red, Betanin)	Red		-	162	
Bilberries	Red				
Brazil wood (Redwood, Lignum fernambucci) (Braselin, from *Caesalpinia brasiliensis*) (CI Natural red 24)	Red		75280		
Brazil wood lake	Red				
Buckthorn - see Persian berry					
Camwood - see Sandalwood					
Canthaxanthin (a xanthophyll) (CI Food orange 8)	Orange		40850	161g	
Capsanthin (& Capsorubin) (colouring principles of paprika)			-	160c	

Name	Hue	1924 CI No	1975 CI No	E No	USA FDA
Caramel (Burnt sugar or black jack) (CI Natural brown 10)	Brown		-	150	
Carbon black (Carbon medicinalis, Vegetable carbon, Charcoal) (CI Pigment black 8)			-	153	
Carotene, β (Carrot and veg. extract, natural carotenoids) (CI Natural yellow 26)	Yellow		75130	160a	
Carotene, β synthetic (CI Food orange 5)			40800	160a	
Carotene, γ & α	Orange		40800	160a	
Carthamus (Carthamin is pure colouring principle of Safflower)			75140		
Catechu (mainly tannin - tree extract) (CI Natural brown 3)	Brown		75250 75260		
Cayenne	Orange				
Chlorophyll, α & β (from plants or synthetic) (CI Natural green 3)	Green		75810	140	
Chrysophanic acid (Rhubarb extract, CI Natural yellow 23)	Yellow		75400		
Copper chlorophylls	Green		75810	141	
Copper chlorophyllins and Copper complexes of chlorophyll	Green		75810?	141	
Crocein (Saffron extract or substitute) (Colouring principle of saffron, Crocetin)	Yellow		75100?		
Cryptoxanthin (a Xanthophyll)				161c	
Curcumin (Colouring principle of turmeric) (CI Natural yellow 3)	Yellow		75300	100	N Yel 3
Cyanidin (an anthocyanin)			-	163	

Name	Hue	1924 CI No	1975 CI No	E No	USA FDA
Delphinidin (an anthocyanin)			–	163	
Elderberry juice	Red				
Flavine (from Quercitron bark) (CI Natural yellow 10)	Yellow		75670		
Flavoxanthin (a xanthophyll)		1249a ?		161a	
French berries - see Persian berry					
Fustic wood (Yellow wood, Lignum citrinium) (CI Natural yellow 11 & 8) (Maclurin, Morin, Osage orange)	Yellow		75240 75660		
Fustic wood lake	Yellow				
Gamboge (dried sap of *Garcinia* tree) (CI Natural yellow 24)	Yellow				
Grape skin extract (an anthocyanin, enocyanine)	Red				
Indigo (CI Natural blue 1, Indigotine) (CI Vat blue 1, synthetic indigo)	Blue	 1247 1177	 75780 73000		
Kermes (Lac dye, similar to Cochineal)	Red?	1239			
Liquorice	Black				
Litmus (chalk & gypsum plus colour from lichens)	Blue & red				
Logwood (from *Haemotoxylon campechianum* tree) (CI Natural black 1, Haematoxylin)	Red/black	1253?	75290		
Logwood lakes	Black		75291		
Lutein (a xanthophyll)				161b	
Lycopene	Yellow		75125	160d	
Maclurin - see Fustic					

Name	Hue	1924 CI No	1975 CI No	E No	USA FDA
Madder root	Brown/Purple/Red				
(artificial or roots of *Rubia tinctorum*)					
(Alizarin)			75330		
(Purpuroxanthin)			75340		
(Rubiadin)			75350		
(Munjistin)			75370		
(Purpurin)			75410		
(Pseudopurpurin)			75420		
Madder lake			75330		
(CI Natural red 9)			75420		
Madder purple - Purpurin					
Malvinidin					
(an anthocyanin)					
Marigold			75125		
(CI Natural yellow 27)			75135		
(Extract is a mixture of Violoxanthin, Rubixanthin and Lycopene)					
Mangold	Brown				
Morin - see Fustic					
Norbixin					
(Annatto extract)					
Orellin	Orange		75120		
(Orellana earth)					
(component of CI Natural orange 4)					
Orchil	Red	1242		121	
(Orcein, from *Roccella* lichens)					
(CI Natural red 28)					
(Orchil contains Orcein, Orcin and Litmus)					
Osage orange - see Morin					
Paprika					
(Colouring principles - see Capsanthin)					
Paprika oleoresin - see Capsanthin or Capsorubin					
Peonidin					
(an anthocyanin)					
Petunidin					
(an anthocyanin)					

Name	Hue	1924 CI No	1975 CI No	E No	USA FDA
Persian berry	Yellow	1234	75640		
(CI Natural yellow 13)					
(from *Rhamnus* berries, Buckthorn)					
(French berry)					
(Rhamnazin)			75700		
(Morindon)			75430		
(Kaempferol)			75650		
(Quercetin)			75670		
(Rhamnetin)			75690		
(Rhamnetin 3)			75695		
Persian berry lake	Yellow		75440		
(CI Natural yellow 14)					
Purpurin - see Madder					
Quercitron	Yellow		75670		
(CI Natural yellow 10)					
(Quercetin, Quercitin)			75670		
(Quercitrin)			75720		
Quercitron bark lake	Yellow				
(CI Natural yellow 9)					
Redwood - see Brazilwood					
Riboflavin				101	
(Lactoflavin)					
Rhodoxanthin				161f	
(a xanthophyll)					
Rubixanthin			75135	161d	
(a xanthophyll, CI Natural yellow 27)					
Safflower	Red/Yellow		75140		
(from *Carthamus tinctorius* flowers)					
(CI Natural red 26 & yellow 5)					
(Carthamin, Carthamic acid)					
Saffron	Yellow		75100		
(from styles & stigmas of *Crocus sativus*)					
(CI Natural yellow 6 & 19, Crocin, Crcetin)					
Sandalwood	Red				
(CI Natural red 22)					
(Sanderswood, Dexoysantalin)			77510		
(Sandalwood, Santalin)			75540		
(Camwood, Isosantalin)			75550		
(Camwood, Deoxyisosantalin)			75560		

Name	Hue	1924 CI No	1975 CI No	E No	USA FDA
Sap green (juice of *Rhamnus catharticus* berries) (CI Natural green 2, type of Persian berry)	Green				
Shikonin (Optical antipode of Alkannin, Tokyo violet) (from root of *lithospermum*)			75535		
Synthetic indigo - see Indigo					
Terre Japonica - see Catechu					
Treacle	Brown				
Turmeric (rhizomes of *Curcuma longa*) (CI Natural yellow 3, Curcumin)	Yellow		75300		
Turmeric oleoresin	Yellow				
Turnip	Yellow				
Violaxanthin (a xanthophyll)				161c	
Woad (from *Isatis tinctoria*)	Blue				
Yellow wood - see Fustic					
ANIMAL PRODUCTS					
Baked horse's liver	Brown				
Burnt blood	Brown				
Cochineal (from female insect *Coccus cacti*) (CI Natural red 4, Carmine, Carminic acid)	Red		75470	120	
Cochineal lakes	Red				

APPENDIX C

TABLE C.1 : FOOD COLOURS MENTIONED IN THE REPORT OF THE COMMITTEE ON FOOD PRESERVATIVES, 1901

Source: Committee on Food Preservatives Report of the Departmental Committee Appointed to Enquire into the Use of Preservatives and Colouring Matters in the Preservation and Colouring of Food HMSO, London 1901, Cmnd 833, p369, 370, 371, 372, 385, etc.

Name	Hue	Foods used in
COAL TAR COLOURS		
Acid yellow	Yellow	Sugar crystals -sometimes mixed with Bismarck brown.
Auramine	Yellow	Fruit, jellies, jams, confectionery
Aurantia (Imperial yellow)	Yellow	Confectionery
Benzopurpurin		Jam.
Bismarck brown G	Brown	Mixed with an azo red & used to imitate smoke colour of ham.
Butter yellow	Yellow	Dairy produce and margarine. Coal tar yellow most frequently used in dairy produce.
Chocolate brown (unspec) (an aniline colour)	Reddish brown	Confectionery.
Citron orange	Orange	Temperance beverages, confectionery, fruit, jellies, jams.
Congo red	Red	Sausages, skin of poloneys, ham, chicken products, tongue, potted and prepared meats.
Crocein orange	Orange	Fruit, jellies, jams.
Eosin	Red	Sweetmeats, meat products.
Theodine (a type of eosine)	Red	potted and prepared meats.
Eosine scarlet	Red	Sweetmeats, meat foods.
Magenta (Fuchsin)	Red	Fruit, jellies, jams, sausages, skin only of poloneys, confectionery.

Name	Hue	Foods used in
Manchester yellow	Yellow	Macaroni
Metanil yellow (a yellow Tropaeolin)	Yellow	Coming into frequent use for dairy produce eg. cream; sweetmeats.
+ another yellow Tropaeolin		ditto
Methyl orange		low quality butter and margarine
Ponceau red (unspec)	Red	Temperance beverages.
Ponceau red (Biebrich or crocein scarlet)	Red	Confectionery
Rhodamine (unspec) (French cream pink)	Red	Confectionery
Rhodamine and similar	Red	Confectionery

UNIDENTIFIED COAL TAR COLOURS

Name	Hue	Foods used in
Concentrated pink (hydrochlorate of rosaniline) = Fuchsin or similar	Red	Confectionery
coal tar yellow in alkaline solution		Butter
'Jetoline' black (prob. di amine black)	Black	Confectionery
Lemon yellow	Yellow	Confectionery
Heliotrope (Hoffmans violet R, hydrochlorate of tri ethyl rosaniline)	Violet	Confectionery
Lavender (mix of Hoffmans violet)	Violet	Confectionery
Damson blue (also mix of Hoffmans violet)	Violet	Confectionery
Tuscan		Confectionery
Orange		Confectionery
Salmon pink		Confectionery
red diazos	Red	Table jellies.
Rhodites (hydrochlorate of phthalein of diethylmeta amidophenol)	Red	Confectionery

Name	Hue	Foods used in
Cherry red (sodium salt of tetra iod fluorescein)	Red	Confectionery
Saffron yellow (Prob the Na salt of amido azo benzene sulphonic acid)	Yellow	Confectionery
yellow diazos	Yellow	Table jellies.
yellow & brown aniline dyes		Sugars.
a red aniline		Meat foods

Because of the almost unlimited range of colour and the very small quantities required, coal tar colours were 'coming into inceasing favour to replace the red, yellow, orange, green, blue, and violet colours required for jams, temperance drinks, sweets, and confectionery'.

PLANT PRODUCTS

Annatto	Yellow	Dairy produce eg cream, butter, milk, cheese. Most commonly used colour for dairy produce. Gradually being superseded by coal tar yellows.
Apricot	Yellow	Confectionery
Caramel	Brown	Frequently used in temperance drinks, wines, spirits eg. whisky, etc. Sugar, acetic acid vinegar. 'Acknowledged to be harmless'.
Carrot juice	Yellow	Dairy produce. Rare useage.
Grape juice	Red	Wine
Logwood	Red	Sausages, potted meats, anchovy & bloater pastes, sweets, etc. Occasional use, being superseded by red coal tar colours.
Rose pink	Red	Fruit, jellies, jams, sausages, confectionery.
Saffron	Yellow	Dairy produce. Gradually being superseded by coal tar yellows. Confectionery
Turmeric	Yellow	Dairy produce. Gradually being superseded by coal tar yellows. Piccalilli, mustard.

and 'others'

Name	Hue	Foods used in
ANIMAL PRODUCTS		
Cochineal	Red	Confectionery, fruit jellies, jams and cordials. Used occasionally.
MINERAL AND METALLIC PRODUCTS		
Camwood	Red	Sausages, potted meats, anchovy & bloater pastes, sweets, etc. Occasional use, being superseded by red coal tar colours.
Chromate of lead		Sugar, oranges, lemons
Copper sulphate	Green	Preserved green vegetables eg. beans, peas. 'Extensively used' (in c. 35% sampled preserved vegetables).
Graphite	Black	Peppercorn surfaces.
Iron oxides (eg. Armenian bole)	Red/brown	Sausages, potted meats, anchovy & bloater pastes, other preserved meats, tinned lobster, sweets, etc. Red iron oxides used in cocoa Occasional use, being superseded by red coal tar colours.
Prussian blue	Blue	Confectionery
Saltpetre	Red	Bacon, ham, German sausage
Sulphur	Bleach	Dried fruit eg. raisins, apricots, plums, champignons.
Sulphuric acid	Intensify	Red pickled cabbage.
n chloride	Brown	Imported West Indian so-called Demerara sugar. Practice about to be discontinued, apparently.
Vermilion	Red	confectionery

TABLE C.2 : LIST OF FOOD COLOURS SUPPLIED BY WILLIAMS OF HOUNSLOW IN 1922/23

Source: Ministry of Health Final Report of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food HMSO, London 1924.

List relates to sales in the period 1 July 1922 - 30 June 1923. It was not claimed by the source to be an exhaustive or complete list.

KEY to sales figures:

i 0 - 100 lb pa
ii 100 - 500
iii 500 - 1000
iv 1000 - 2000
v 2000 - 5000
vi 5000 +

Name	Colour	Sales
COAL TAR COLOURS		
Acid blues - sundry (eg Cyanole, Patent blue V, Soluble blue Xylene blue VS, Erioglaucine)	blue	ii
Acid greens - sundry (eg. Acid green GG, Light green SF yellowish, Wool green S)	green	ii
Acid violets - sundry (eg Benzyl violet 5BN)	purple	ii
Acid green GG	green	
Acid magenta	red	ii
Acid yellow FWA	yellow	vi
Amaranth (Azorubine S)	red	vi
Auramine	yellow	iii
Benzopurpurine 4B	red	ii
Bismarck brown	brown	v
Bismarck brown G (Golden brown)	brown	vi
Blue VRS (Xylene blue VS)	blue	
Brilliant blue (Erioglaucine)	blue	
Butter yellow (Oil yellow D)	yellow	nil
Carmoisine	red	v
Chrysoidine	yellow	ii
Chrysoine (Resorcine yellow)	yellow	ii
Congo red	red	iv
Cyanol	blue	
Erythrosine	red	ii
Green S (Wool green S)	green	
Induline	black	

Name	Colour	Sales
Light green SF yellowish	green	
Magenta	red	ii
Malachite green	green	5 lbs.
Metanil yellow (Tropaeoline G)	yellow	v
Methylene blue	blue	nil
Methyl violet	purple	i
Naphthol yellow S	yellow	i
Nigrosine	black	vi
Orange I	orange	nil
Orange II (Mandarin orange)	orange	v
Patent blue V	blue	
Phloxine	red	
Ponceau 2R	red	v
Ponceau 4R (New coccine)	red	ii
Quinoline yellow	yellow	iii
Resorcine brown	brown	i
Rhodamine B	red	iv
Rocceline (Fast red)	red	i
Rose bengal	red	
Saffranine	red	i
Soluble blue	blue	
Sudan I (a fat yellow)	yellow	) vi
Sudan G (a fat yellow) & other fat yellows	yellow	)
Sulfon red B	red	iii
Tartrazine	yellow	vi
Violet 5BN	purple	

TABLE C.3 : FOOD COLOURS USED IN 1923 OR 1924 FOR CONFECTIONARY

Source: Unpublished evidence presented by Dr MacFadden to the Ministry of Health Final Report of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food HMSO, London 1924 [Public Records Office: MH56/16]. Dr MacFadden's information came from Williams of Hounslow (colour manufacturers), Clarke Nickolls and Coombs (wholesale confectioney manufacturers), Langdales (vegetable colour and essence merchants) and Mr Matthison (Secretary of the Confectioners Vegetable Colour and Fruit Essences Co. and Director of Clarke Nickolls and Coombs).

Name	Hue
COAL TAR COLOURS	
Acid violet S4B	blue
Acid yellow G	Yellow
Amaranth	Red
Auramine	Yellow
Bordeaux B	Red
Carmoisine	Red
Chrysoidine	Yellow
Eosin	Red
Erythrosine	Red
Fat orange R	Orange
Fat yellow GS	Yellow
Induline	Blue
Magenta	Red
Malachite green	Green
Naphthol yellow	Yellow
Naphthol yellow S	Yellow
Nigrosine	Black
Orange II	Orange
Phloxine	Red
Phosphine	Yellow
Ponceau 2R	Red
Ponceau 3R	Red
Quinoline yellow	Yellow
Rhodamine B	Red
Rhodamine G	Red
Tartrazine	Yellow
ANIMAL PRODUCTS	
Cochineal	Red

Name	Hue
PLANT PRODUCTS	
Annatto	
Charcoal black	
Chlorophyll extract	
Indigo	
Persian berry	
Persian berry lake	Yellow
Synthetic indigo	
MINERAL PRODUCTS	
Iron oxides	Orange Brown Red
Sienna	
Tin salts	

TABLE C.4 : FOOD COLOURS LISTED IN 1924 COLOUR INDEX

Source: F M Rowe (ed) Colour Index Society of Dyers and Colourists, Bradford, Yorks, 1924, p336. Compiled in 1922-3.

1924 CI No	Name	Colour
88	Acid bordeaux	Red
16	Acid yellow G	Yellow
17	Amidoazotoluol	Yellow
15	Aminoazobenzene	Yellow
331	Bismarck brown G	Brown
19	Butter yellow	Yellow
179	Carmoisine	Red
773	Erythrosine	Red
1180	Indigo carmine	Blue
670	Light green SF yellowish	Green
677	Magenta	Red
10	Naphthol yellow	Yellow
22	Oil yellow AB	Yellow
61	Oil yellow OB	Yellow
150	Orange 1	Yellow
79	Ponceau 2R	Red
80	Ponceau 3R	Red
640	Tartrazine	Yellow

No plant or mineral products were listed.

TABLE C.5 : FOOD COLOURS LISTED IN 1928 COLOUR INDEX

Source: F M Rowe (ed) Supplement to the Colour Index Society of Dyers and Colourists, Bradford, 1928, p24.

1924 CI No	Name	Hue
COAL TAR COLOURS		
88	Acid bordeaux	Red
666	Acid green G	Green
16	Acid yellow G	Yellow
184	Amaranth	Red
17	Amidoazotoluol	Yellow
15	Aminoazobenzene	Yellow
331	Bismarck brown G	Brown
19	Butter yellow	Yellow
179	Carmoisine	Red
194	Double brilliant scarlet	Red
773	Erythrosine	Red
1180	Indigo carmine	Blue
670	Light green SF yellowish	Green
677	Magenta	Red
10	Naphthol yellow	Yellow
865	Nigrosine	Blue & black
22	Oil yellow AB	Yellow
61	Oil yellow OB	Yellow
150	Orange 1	Yellow
79	Ponceau 2R	Red
80	Ponceau 3R	Red
185	Ponceau 4R	Red
752	Rhodamine 6G	Red
640	Tartrazine	Yellow
PLANT COLOURS		
1241	Annatto	Yellow

TABLE C.6 : LIST OF COLOURS OFFERED FOR SALE BY WILLIAMS OF HOUNSLOW IN 1928

Source: Advertisement in F M Rowe (ed) Supplemnt to the Colour Index Society of Dyers and Colourists, Bradford 1928. The advert reads: Dyes and srtains for all purposes... all colours for [a wide range of purposes including] ...confectionery (Guaranteed in addordance with all existing Regulations).

Colour
COAL TAR COLOURS
Acid yellow G
Azo rubine
Bismarck brown
Bordeaux extra
Carmoisine
Chrysoidine
Congo red
Croceine orange
Croceine scarlet MOO
Direct black
Direct blue
Fast red
Golden brown
Induline
Naphthol green B
Nigrosine
Oil black
Orange I
Orange II
Orange G
Orange R
Ponceau 2R
Ponceau 4R
Resorcine brown
Resorcine yellow
Soudan I
Soudan II
Soudan III
Soudan IV
Soudan G
Soudan R
Spirit black
Tartrazol yellow
and the bases of all colours

TABLE C.7 : FOOD COLOURS LISTED IN THE FOOD STANDARDS COMMITTEE REPORTS OF 1954 AND 1955

Source: Ministry of Food, Food Standards Committee Report on Colouring Matters HMSO, London 1954; Ministry of Agriculture, Fisheries and Food, Food Standards Committee Supplementary Report on Colouring Matters HMSO, London 1955.

1924 CI No	Colour	Hue
COAL TAR COLOURS		
88	Acid bordeau B	Red
692	Acid magenta II	Red
16	Acid yellow G	Yellow
697	Acid violet 6B	Violet
695	Acid violet 4BN	Violet
704	Alkali blue	Blue
184	Amaranth	Red
655	Auramine	Yellow
612	Baking brown	Brown
-	Baking brown AW	Brown
448	Benzopurpurin 4B	Red
85	Benzyl bordeau B	Red
331	Bismarck brown	Brown
332	Bismarck brwon G	Brown
-	Black 5410	Black
672	Blue VRS	Blue
-	Brilliant black BN	Black
671	Brilliant blue FCF NH_4 salt	Blue
-	Brilliant blue FCF Na salt	Blue
252	Brilliant croceine	Red
662	Brilliant green cryst. Y	Green
-	Brown FK	Brown
179	Carmoisine	Red
518	Chlorazol sky blue	Blue
-	Chocolate brown	Brown
20/21	Chrysoidine	Orange
370	Congo red	Red
289	Coomassie navy blue	Blue
-	Crispin black G	Black
280	Croceine scarlet 5R	Red
-	Direct black	Black
406	Direct blue 2B	Blue
768	Eosine	Red
771	Eosine scarlet	Red
773	Erythrosine	Red
-	Fast green FCF	Green
182	Fast red E	Red
18	Fast yellow R	Yellow

1924 CI No	Colour	Hue
737	Green S	Green
666	Guinea green B	Green
-	Hansa yellow 5G	Yellow
-	Hansa yellow 10G	Yellow
-	Hansa yellow G	Yellow
1211	Helindone pink	Red
69	Helio red	Red
1106	Idanthrene blue	Blue
1180	Indigo carmine	Blue
861	Induline	Blue
860	Induline spirit soluble	Blue
234	Light brown	Brown
670	Light green SF	Green
657	Malachite green	Green
138	Metanil yellow	Yellow
680	Methyl violet	Violet
-	Naphthol AS-OG + Fast red salt AL	Red
-	Naphthol AS-OL + Fast scarlet salt R	Red
10	Napthol yellow S	Yellow
865	Nigrosine	Black
-	Oil orange TX	Orange
73	Oil orange XX	Orange
82	Oil red 2R	Red
22	Oil yellow AB	Yellow
23	Oil yellow GG	Yellow
-	Oil yellow HA	Yellow
61	Oil yellow OB	Yellow
-	Oil yellow SEG	Yellow
150	Orange 1	Orange
151	Orange II	Orange
27	Orange G	Orange
26	Orange RN	Orange
714	Patent blue A	Blue
-	Permanent orange G	Orange
774	Phloxine	Red
-	Phthalocyanine green	Green
89	Ponceau cryst. 6R	Red
79	Ponceau MX	Red
80	Ponceau 3R	Red
185	Ponceau 4R	Red
-	Ponceau SX	Red
801	Quinoline yellow	Yellow
57	Red 6B	Red
30	Red 10B	Red
225	Red FB	Red
31	Red 2G	Red
749	Rhodamine B	Red
752	Rhodamine 6G	Red

1924 CI No	Colour	Hue
750	Rhodamine G	Red
777	Rose bengal	Red
258	Sudan IV	Red
113	Sudan red G	Red
-	Sunset yellow FCF	Yellow
640	Tartrazine	Yellow
661	Turquoise blue G	Blue
698	Violet 5BN	Violet
707	Water blue	Blue
748	Xylene red B	Red
639	Yellow 2G	Yellow
-	Yellow RFS	Yellow
-	Yellow RY	Yellow

PLANT COLOURS

Alkannet
Annatto
Caramel
Carotene
Chlorophyll
Chlorophyll Cu compounds
Cochineal lakes
Flavine
Indigo
Maclurin
Morin
Orchil
Osage orange
Persian berry
Persian berry lakes
Quercetin
Quercitrin
Rhamnazin
Rhamnetin
Safflower
Saffron
Sandalwood
Turmeric
Extracts of food plants

ANIMAL COLOURS

Cochineal

1924 CI No	Colour	

MINERAL/METALLIC COLOURS

	Aluminium	external use only
	Carbon black	
	Iron oxide (Bole)	
	Silver	external use only
	Titanium dioxide	
	Ultramarine	

APPENDIX D

TABLE D.1 : COAL TAR COLOURS USED IN FOOD IN THE U.K. BETWEEN 1887 AND 1954

Compiled from:

(1) Alexander Wynter Blyth Foods: their Composition and Analysis Charles Griffin, London 1888 p80-95

(2) Aniline dyes assumed to be used, on the basis of a comment (see chapter 3) made to the Select Committee on Food Products Adulteration Report from the Select Committee on Food Products Adulteration HMSO, London 1895, p113, and the list of aniline dyes in Arthur Green Systematic Survey of the Organic Colouring Matters Macmillan, London 1894

(3) Committee on Food Preservatives Report of the Departmental Committee appointed to Inquire into the use of Preservatives and Colouring Matters... HMSO, London 1901

(4) Henry Kenwood Public Health Laboratory work (Chemistry) HK Lewis. London 1920, p382-4; James Grant Confectioner's Raw Materials Edward Arnold, London 1921, p117-125; Geoffrey Martin Animal and Vegetable Oils, Fats and Waxes Appleton, New York 1920 (English) p167-9.

(5) Ministry of Health Final Report of the Departmental Committee on the Use of Preservatives and Colouring Matters in Food HMSO, London 1924 (see table C.2; letter from the Herring board to Amanda Cornford about Brown FK.

(6) H Drake-Law 'Colours in foodstuffs' Journal of the Society of Chemical Industry 1926 vol XLV, No 49, p428-434.

(7) List of colours offered for sale by Williams of Hounslow in an advertisement and colours for food use in FM Rowe (ed) Colour Index Society of Dyers and Colourists, Bradford 1928, p24 and adverts (see tables C.5 and C.6).

(8) Harold Silman 'Food colours' Food Manufacture June 1936 p202-206; AG Kay 'Colours for foodstuffs' Food Manufacture June 1935.

(9) 'Colours in Food' Nature 1942 vol 149 p537-8: it lists the seven most common dyes of approximately 25 claimed to be in use. Not a precise report.

(10) Ministry of Food, Food Standards Committee Report on Colouring Matters HMSO, London 1954, p22-24; Ministry of Agriculture, Fisheries and Food, Food Standards Committee Supplementary Report on Colouring Matters HMSO, London 1955, p12-13.

KEY:

/ Reported to be used in food
X Reported as not used in food in UK or banned by 1925 regulations
* Used in UK after 1957
a Occasionally used
b Commonly used
c Rarely made from 1884, according to Arthur Green, ref (2)

Colour	Date of reported use in food 1887 (1)	1895 (2)	1901 (3)	1919 (4)	1924 (5)	1926 (6)	1928 (7)	1935 (8)	1942 (9)	1954 (10)
Acid bordeau B					/		/	/		/
Acid green GG					/	/	/	/		/
Acid magenta II					/					/
Acid violet 6B					/					/
Acid violet 4BN										/
Acid yellow G			/	/	/		/	/		/
Alkali blue										/
Allura red										
Amaranth				/	/	/	/	/	/	/
Amidoazotoluene						/	/		X?	
Aminoazobenzene	/	/		/		/	/			
Aniline greens	/	X?c								
Auramine			/		/	/				/
Aurantia			/							X
Aurine	/				X					X
Baking brown										/
Baking brown AW										/
Benzopurpurine 4B			/		/	/		/		/
Benzyl bordeau B										/
Bismark brown			/	/	/		/	/		/
Bismarck brown G	/		/		/		/	/		/
Black 5410										/
Black 7984										
Blue VRS					/					/
Bordeaux extra							/			

Colour	Date of reported use in food 1887 (1)	1895 (2)	1901 (3)	1919 (4)	1924 (5)	1926 (6)	1928 (7)	1935 (8)	1942 (9)	1954 (10)
Brilliant black BN										/
Brilliant blue FCF						/				/
Brilliant croceine										/
Brilliant green cryst.										/
Brown FK					/		/			/
Butter yellow		/	/	/	/		/		X?	
Carmoisine					/	/	/	/		/
Chlorazol sky blue										/
Chocolate brown FB				/	) one					/
					) or					
Chocolate brown HT				/	) both?					/
Chrysoidine	/	/			/		/	/		/
Chrysoine					/		/			
Citron orange			/							
Congo red			/		/	/	/			/
Coomassie navy blue										/
Crispin black G										/
Croceine scarlet 5R						/	/			/
Cyanol					/					
Diamond yellow					/					
Direct black							/			/
Direct blue 2B							/			/
Double brilliant scarlet										/
Eosine			/	/	/					/
Eosine scarlet			/	/						/
Erythrosine					/	/	/	/	/	/

Colour	Date of reported use in food									
	1887 (1)	1895 (2)	1901 (3)	1919 (4)	1924 (5)	1926 (6)	1928 (7)	1935 (8)	1942 (9)	1954 (10)
Fast green FCF										/
Fast red E							/			/
Fast red salt AL										/
Fast scarlet salt R										/
Fast yellow R										/
Fat yellow GS					/					
Gentian blue 6B	/	/		/						
Gentian violet				/						
Green S					/					/
Hansa yellow 5G										/
Hansa yellow 10G										/
Hansa yellow G										/
Helindone pink										/
Helio red										/
Hofman's violet	/		/							
Idanthrene blue										/
Indigo carmine	/					/	/	/		/
Induline	/	/		/	/		/			/
Induline spirit soluble										/
Light green SF					/	/	/			/
Lithol rubine BK										
Magenta	/	/	/	/b	/	/	/			
Malachite green				/	/	/				/
Manchester yellow	/	/	/	/	/		X			X
Mauveine	/	/		/						

Colour	Date of reported use in food									
	1887 (1)	1895 (2)	1901 (3)	1919 (4)	1924 (5)	1926 (6)	1928 (7)	1935 (8)	1942 (9)	1954 (10)
Metanil yellow			/	/	/					/
Methylene blue				/	/					
Methyl orange			/							
Methyl violet	/			/	/					/
Naphthol AS-OG										/
Naphtol green B				/			/			
Napthol yellow S					/	/	/	/		/
Nigrosine					/		/	/		/
Nigrosine spirit							/			
Oil orange TX										/
Oil red 2R										/
Oil yellow AB						/	/	/	X?	/
Oil yellow GG	/	/		/	/					/
Oil yellow HA										/
Oil yellow OB				/		/	/	/	X?	/
Oil yellow XP										/
Orange I					/	/	/	/	/	/
Orange II					/	/	/	/	/	/
Orange IV	/	/			/					
Orange G	/	/				/	/	/		/
Orange R							/			
Orange RN	/	/	/	/			/			/
Patent blue A								/		/
Patent blue V					/					
Permanent orange G										/

Colour	Date of reported use in food 1887 (1)	 1895 (2)	 1901 (3)	 1919 (4)	 1924 (5)	 1926 (6)	 1928 (7)	 1935 (8)	 1942 (9)	 1954 (10)
Phloxine				/	/					/
Phosphine					/					
Phthalocyanine green										/
Picric acid	/			/a	X					X
Ponceau cryst. 6R						/		/		/
Ponceau 2R			?		/	/	/	/	/	/
Ponceau 3R			?		/	/	/	/		/
Ponceau 4R			?		/	/	/	/		/
Ponceau 6R										
Ponceau SX										/
Quinoline yellow					/					/
Red 6B										/
Red 10B										/
Red FB										/
Red 2G								/		/
Resorcine brown					/		/			/
Rhodamine B			?		/	/		/	/	/
Rhodamine 6G			?				/			/
Rhodamine G			?		/	/				/
Rocceline					/					
Rose bengal					/					/
Safranine	/	/	/	/	/	/				
Scarlet GN										
Soluble blue [a]					/					
Soluble blue [b]					/					/

Colour	Date of reported use in food 1887 (1)	1895 (2)	1901 (3)	1919 (4)	1924 (5)	1926 (6)	1928 (7)	1935 (8)	1942 (9)	1954 (10)
Sudan I	/	/		/	/	/	/	/		
Sudan II							/			/
Sudan III							/			
Sudan IV							/			/
Sudan blue II							/			
Sudan red G			/				/			/
Sudan R							/			
Sulfon red B					/					
Sunset yellow FCF								/		/
Tartrazine					/	/	/	/	/	/
Turquoise blue G										/
Victoria blue B										
Victoria blue R										
Victoria yellow	/	/		/						X
Violamine R										
Violet 5BN					/					/
Violet BNP										
Xylene red B										/
Yellow 2G										/
Yellow RFS								/		/
Yellow RY										/

TABLE D.2 : COAL TAR COLOURS PERMITTED IN THE U.K. BETWEEN 1957 AND 1987

Compiled from: Government reports of 1954-55; and colour regulations from 1957-1978
(the minor changes made in regulations in 1970 & 1975 have been omitted)

KEY
/ permitted in food in UK
X prohibited from food in UK
a for surface colouring only
b prohibited in 1970
c prohibited in 1975

Name	1954	1957	1966	1973	1976	1978
Acid bordeau B	/	X	X	X	X	X
Acid green GG	/	X	X	X	X	X
Acid magenta II	/	X	X	X	X	X
Acid violet 6B	/	X	X	X	X	X
Acid violet 4BN	/	X	X	X	X	X
Acid violet S4B		X	X	X	X	X
Acid yellow G	/	X	X	X	X	X
Acilan fast green 10G		X	X	X	X	X
Alkali blue	/	X	X	X	X	X
Allura red		X	X	X	X	X
Amaranth	/	/	/	/	/	/
Amidoazotoluol		X	X	X	X	X
Aminoazobenzene		X	X	X	X	X
Auramine	/	X	X	X	X	X
Aurantia		X	X	X	X	X
Aurine	X	X	X	X	X	X
Baking brown	/	X	X	X	X	X
Baking brown AW	/	X	X	X	X	X
Benzopurpurine 4B	/	X	X	X	X	X

Name	1954	1957	1966	1973	1976	1978
Benzyl bordeau B	/	X	X	X	X	X
Bismark brown		X	X	X	X	X
Bismarck brown G		X	X	X	X	X
Black 5410	/	X	X	X	X	X
Black 7984		X	/	/	X	X
Blue VRS	/	/	X	X	X	X
Bordeaux extra		X	X	X	X	X
Brilliant black BN	/	/	/	/	/	/
Brilliant blue FCF	/	X	X	/	/	/
*Brilliant blue FCF Na salt		X	X	X	X	X
*Brilliant blue FFR		X	X	X	X	X
Brilliant croceine	/	X	X	X	X	X
Brilliant green cryst. Y	/	X	X	X	X	X
Brilliant indocyanin 6B		X	X	X	X	X
Brown FK	/	/	/	/	/	/
Butter yellow		X	X	X	X	X
Carmoisine	/	/	/	/	/	/
Chlorazol sky blue	/	X	X	X	X	X
Chocolate brown FB	one?{/ or {	/	/	/	/	X
Chocolate brown HT	both{/	/	/	/	/	/
Chrysoidine	/	X	X	X	X	X
Chrysoine		X	X	X	X	X
Citron orange		X	X	X	X	X
Citrus red 2		X	X	X	X	X
Congo red	/	X	X	X	X	X
Coomassie navy blue	/	X	X	X	X	X

Name	1954	1957	1966	1973	1976	1978
Crispin black G	/	X	X	X	X	X
Croceine scarlet 5R	/	X	X	X	X	X
Cyanol		X	X	X	X	X
Direct black	/	X	X	X	X	X
Direct blue 2B	/	X	X	X	X	X
Double brilliant scarlet		X	X	X	X	X
Eosine	/	X	X	X	X	X
Eosine scarlet	/	X	X	X	X	X
Erythrosine	/	/	/	/	/	/
Fast green FCF	/	X	X	X	X	X
Fast red E	/	/	/	X	X	X
Fast red salt AL	/	X	X	X	X	X
Fast scarlet salt R	/	X	X	X	X	X
Fast yellow AB		X	X	/	X	X
Fast yellow R	/	X	X	X	X	X
Fat yellow GS		X	X	X	X	X
Fuchsin acid		X	X	X	X	X
Green S	/	/	/	/	/	/
Hansa yellow 5G	/	X	X	X	X	X
Hansa yellow 10G	/	X	X	X	X	X
Hansa yellow G	/	X	X	X	X	X
Helindone pink	/	X	X	X	X	X
Helio red	/	X	X	X	X	X
Heliotrope		X	X	X	X	X
Indanthrene blue	/	X	X	/	X	X
Indian red		X	X	X	X	X

Name	1954	1957	1966	1973	1976	1978
Indigo carmine	/	/	/	/	/	/
Induline	/	X	X	X	X	X
Induline spirit soluble	/	X	X	X	X	X
Light brown	/	X	X	X	X	X
Light green SF	/	X	X	X	X	X
Lithol rubine BK		X	X	/ a	/ a	/ a
Magenta		X	X	X	X	X
Malachite green	/	X	X	X	X	X
Manchester yellow		X	X	X	X	X
Metanil yellow	/	X	X	X	X	X
Methylene blue		X	X	X	X	X
Methyl orange		X	X	X	X	X
Methyl violet	/	X	X	/ a	/ a	/ a
Naphthol AS-OG	/	X	X	X	X	X
Naphtol green B		X	X	X	X	X
Naphthol AS-OL	/	X	X	X	X	X
Napthol yellow S	/	/	X	X	X	X
Nigrosine	/	X	X	X	X	X
Oil black		X	X	X	X	X
Oil orange TX	/	X	X	X	X	X
Oil orange XX	/	X	X	X	X	X
Oil red 2R	/	X	X	X	X	X
Oil yellow 3G		X	X	X	X	X
Oil yellow AB	/	X	X	X	X	X
Oil yellow GG	/	/	/	X	X	X
Oil yellow HA	/	X	X	X	X	X

Name	1954	1957	1966	1973	1976	1978
Oil yellow OB	/	X	X	X	X	X
Oil yellow XP	/	/	/	X	X	X
Orange I	/	X	X	X	X	X
Orange II	/	X	X	X	X	X
Orange B		X	X	X	X	X
Orange G	/	/	/	/	/	X
Orange GGN		X	X	X	X	X
Orange R		X	X	X	X	X
Orange RN	/	/	/	/	X c	X
Orange yellow 5		X	X	X	X	X
Patent blue A (=?V)	/	X	X	X	X	X
Patent blue V		X	X	/	/	/
Permanent orange G	/	X	X	X	X	X
Phloxine	/	X	X	X	X	X
Phosphine		X	X	X	X	X
Phtalocyanin blue		X	X	X	X	X
Phthalocyanine green	/	X	X	X	X	X
Picric acid	X	X	X	X	X	X
Ponceau cryst. 6R	/	X	X	X	X	X
Ponceau 2R	/	/	/	X b	X	X
Ponceau 3R	/	/	X	X	X	X
Ponceau 4R	/	/	/	/	/	/
Ponceau 6R		X	X	X	X	X
Ponceau SX	/	/	X	X	X	X
Prussian blue		X	X	X	X	X
Quinoline yellow	/	X	X	/	/	/

Name	1954	1957	1966	1973	1976	1978
Red 6B	/	/	/	X	X	X
Red 10B	/	/	/	X	X	X
Red FB	/	/	/	X	X	X
Red 2G	/	/	/	/	/	/
Resorcine brown		X	X	X	X	X
Rhodamine B	/	X	X	X	X	X
Rhodamine 6G	/	X	X	X	X	X
Rhodamine G	/	X	X	X	X	X
Rocceline		X	X	X	X	X
Rose bengal	/	X	X	X	X	X
Rose pink		X	X	X	X	X
Saffranine		X	X	X	X	X
Scarlet GN		X	X	X	X	X
Soluble blue [a]		X	X	X	X	X
Soluble blue [b]		X	X	X	X	X
Spirit black		X	X	X	X	X
Sudan I		X	X	X	X	X
Sudan II		X	X	X	X	X
Sudan III		X	X	X	X	X
Sudan IV	/	X	X	X	X	X
Sudan blue II		X	X	X	X	X
Sudan red G	/	X	X	X	X	X
Sudan R		X	X	X	X	X
Sulfon red B		X	X	X	X	X
Sunset yellow FCF	/	/	/	/	/	/
Tartrazine	/	/	/	/	/	/

Name	1954	1957	1966	1973	1976	1978
Turquoise blue G	/	X	X	X	X	X
Ultramarine blue		X	X	X	X	X
Vermilion		X	X	X	X	X
Victoria blue B		X	X	X	X	X
Victoria blue R		X	X	X	X	X
Victoria yellow		X	X	X	X	X
Violamine R		X	X	X	X	X
Violet 5BN	/	X	X	X	X	X
Violet BNP		/	/	X	X	X
Water blue	/	X	X	X	X	X
Xylene red B	/	X	X	X	X	X
Yellow 2G	/	/	/	/	/	/
Yellow RFS	/	/	X	X	X	X
Yellow RY	/	/	X	X	X	X

TABLE D.3 : MINERAL AND METALLIC COLOURS USED IN FOOD IN THE U.K. BETWEEN 1850 AND 1954

Compiled from:

(1) Arthur Hassall Adulterations Detected - or Plain Instructions for the Discovery of Frauds in Food and Medicine Longman, Green, Longman and Roberts, London 1861, 2nd edition, p11-17, 20-21, 490-98, etc.

(2) Arthur Hassall Food: Its Adulterations, and the Methods for their Detection Longmans, Green and Co, London 1876.

(3) A Wynter Blythe Foods: Their composition and Analysis charles Griffin, London 1888 p81.

(4) Committee on Food Preservatives Report of the Departmental Committee Appointed to Inquire into the Use of Preservatives and Colouring Matters... HMSO, London 1901 (see table C.1 in appendix C).

(5) A Hausner The Manufacture of Preserved Foods and Sweetmeats Scott, Greenwood, London 1912, p179-83.

(6) Henry R Kenwood Public Health Laboratory Work (Chemistry) HK Lewis, London 1920, 7th ed. p382-4.

(7) Reports of the Public Analysts 1921-1922.

(8) Evidence presented by Dr MacFadden to the Departmental Committee on the use of colours and preservatives, 1923 or 1924.

(9) Food Standards Committee Supplementary Report on Colouring Matters Ministry of Food, HMSO, London 1955, p4.

KEY:
/ Reported to be used in food
X Reported as not used
a For surface use only
b Rarely used
c Commonly used

Colour	Date of reported use in food								
	1850s (1)	early 1870s (2)	1887 (3)	1901 (4)	1911 (5)	1920 (6)	1921-1922 (7)	1924 (8)	1954 (9)
Aluminium									/a
Blue verditer	/	/			/				
Bole armenian	/	/		/					/
Brick dust	/								

Colour	Date of reported use in food 1850s (1)	early 1870s (2)	1887 (3)	1901 (4)	1911 (5)	1920 (6)	1921-1922 (7)	1924 (8)	1954 (9)
Brunswick greens	/	/							
Deep	/	/							
Middle	/	/							
Pale	/	/							
Carbon black									/
Chalk	/	/			/				
Chromates of potash	/	/							
Chrome yellows			/b	/	/				
Chrome deep	/	/							
Chrome lemon	/	/							
Chrome orange	/	/							
Cinnabar	/	/	/b	/	/				
Cobalt blue	/	/			/				
Copper bronze	/	/							
Copper sulphate	/	/	/b	/c		/	/	/	
False brunswick greens	/	/							
Deep	/	/							
Middle	/	/							
Pale	/	/							
False verditer	/	/							
Fuchsine	/	/							
Fuller's earth	/								
Gold									
Gold bronze	/	/							
Indian red	/	/							
Iodide of lead	/	/							
Iodide of mercury	/	/							

Colour	Date of reported use in food 1850s (1)	 early 1870s (2)	 1887 (3)	 1901 (4)	 1911 (5)	 1920 (6)	 1921-1922 (7)	 1924 (8)	 1954 (9)
Iron oxides:	/	/		/					/
Red								/	
Brown				/				/	
Orange								/	
Red ochre	/	/			/				
Sienna	/	/						/	
Umber	/	/							
Vandyke brown	/	/							
Venetian red	/	/							
Yellow ochre	/	/			/				
Massicot	/	/							
Naples yellow	/	/							
Orpiment	/	/							
King's yellow	/	/							
Realgar	/	/							
Plaster of Paris	/	/							
Plumbago	/	/		/					
Potash	/	/							
Prussian blue	/	/		/	/				
Antwerp blue	/	/							
Red lead	/	/	/b		/				
Scheele's green	/	/	/b		/				
Silver									/a
Silver bronze	/	/							
Sulphate of iron	/	/							
Talc	/	/							
China clay	/	/							
French chalk	/	/							
Terra alba	/	/							
Tin		/b						/	
Titanium dioxide									/

Colour	Date of reported use in food 1850s (1)	early 1870s (2)	1887 (3)	1901 (4)	1911 (5)	1920 (6)	1921-1922 (7)	1924 (8)	1954 (9)
Ultramarine	/	/					/		/
Artificial ultramarin	/	/							
Verdigris	/	/	/b						
Verditer	/	/	/b		/				
White lead	/	/			/				
Zinc white					/				

TABLE D.4 : PLANT AND ANIMAL BASED COLOURS AS USED IN FOOD IN THE U.K. BETWEEN 1850 AND 1956

Compiled from:

(1) Arthur Hassall Adulterations Detected - or Plain Instructions for the Discovery of Frauds in Food and Medicine Longman, Green, Longman and Roberts, London 1861, 2nd edition, p11-17, 20-21, 490-98, etc.

(2) Arthur Hassall Food: Its Adulterations, and the Methods for their Detection Longmans, Green and Co, London 1876; John Slater The Manual of Colours and Dye Wares Lockwood, London 1870.

(3) Alexander Wynter Blyth Foods: their Composition and Analysis Charles Griffin, London 1888, 3rd ed. p80-95.

(4) Robert Wells The Bread and Biscuit Baker's and Sugar Boiler's Assistant Crosby Lockwood, London 1902; Alfred Wilcox Easy Household Tests for Food Adulteration Iliffe, London c1900.

(5) A Hausner The Manufacture of Preserved Foods and Sweetmeats Scott, Greenwood, London, 1912 p180-3.

(6) Henry R Kenwood Public Health Laboratory Work (Chemistry) HK Lewis, London 1920, 7th ed. p382-4; James Grant Confectioners' Raw Materials Edward Arnold, London 1921, p117-125.

(7) Unpublished evidence presented by Dr MacFadden and others to the Departmental Committee on the use of colours and preservatives, 1923 or 1924 (see table C.3 in appendix C).

(8) Harold Silman 'Food colours' Food Manufacture June 1936, p206.

(9) Food Standards Committee Report on Colouring Matters Ministry of Food, HMSO, London 1954.

(10) W J Bush & Co Skuse's Complete Confectioner Bush & Co, London 1957, 13th ed. p34-6.

KEY

/ Reported to be used in food
X Reported as not used in food
* Used in UK after 1957
a Occasionally used
b Very extensively used
c Commonly used
d Extracts

Colour	Date of Reported use in Food 1850s (1)	early 1870s (2)	1887 (3)	1901 (4)	1919 (5)	1911 (6)	1923 (7)	1936 (8)	1954 (9)	1956 (10)
ANIMAL PRODUCTS										
Baked horse's liver		/	/							
Burnt blood	/	/								
Cochineal/Carmine	/	/	/	/	/	/c	/	/	/	/
Kermes			/		/	/				
Cochineal lakes	/	/							/	
PLANT PRODUCTS										
Alkannet			/			/			/	
Annatto	/	/	/	/		/b		/	/	/
Bixin			/							
Orellin			/			/				
Anthocyanins						/				
Fruit extracts						/				
Grape skin				/		/				
Beetroot red	/	/			/	/				
Brazil wood	/	/	/		/d					
Braselin			/		/					
Brazil wood lake	/	/								
Caramel (Burnt sugar type)	/	/	/	/	/	/		/	/	/
Carotene/carrot	/	/		/		/			/	
Catechu	/	/								
Charcoal							/			
Chlorophyll from plants			/			/	/	/	/	/
Copper chlorophylls										/
Fustic			/							
Morin			/						/	
Osage orange									/	
Maclurin									/	
Fustic lake			/							

Colour	Date of Reported use in Food									
	1850s	early 1870s	1887	1901	1919	1911	1923	1936	1954	1956
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Gamboge	/	/	/	/		/a				
Indigo	/	/	/	/		/c	/		/	/
Natural extract						/	/			
Synthetic						/	/			
Liquorice	/	/								
Logwood	/	/	/	/	/d	/c				
Haematein			/							
Haemotoxylin			/							
Rose pink	/	/		/		/				
Lycopene										
Madder	/	/				/				
Alizarine			/							
Purpurine	/	/	/							
Mallow flowers		/								
Marigold					/	/				
Orchil						/			/	
Litmus	/	/	/		/	/				
Orcein										
Paprika										
Persian berry	/	/					/		/	
Rhamnazin									/	
Rhamnetin									/	
Sap green	/									
Persian b'y lake	/	/					/		/	
Poppy						/				
Quercitron	/	/			/d					
Quercetin									/	
Quercitrin									/	
Quercitron lake	/	/								
Flavine									/	
Riboflavin										
Safflower			/		/	/			/	
Carthamine			/			/				

Colour	Date of Reported use in Food									
	1850s	early 1870s	1887	1901	1919	1911	1923	1936	1954	1956
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Saffron	/	/		/	/	/		/	/	/
Crocein						/				
Chinese yellow	/	/								
Sandalwood			/						/	
Santalin			/							
Camwood				/						
Turmeric	/	/	/	/	/	/		/	/	
Curcumin			/		/	/				/
Xanthophylls			/							
Extracts of edible plants						/	/		/	/
Red berries					/					
Apricot				/						
Bilberries	/	/				/				
Blackberry		/								
Chrysophanic acid				/			/			
Elderberry	/	/								
Mangold	/	/								
Mulberry		/								
Radish skin		/								
Red cabbage		/								
Spinach juice					/	/				
Turnip	/	/								
Dutch pink	/	/								

APPENDIX E

TABLE E.1 : DEVELOPMENT OF THE POSITIVE LIST OF COAL TAR COLOURS, 1957-1987

Compiled from:

(1) Colouring Matter in Food Regulations 1957, SI 1957 No 1066.

(2) Colouring Matter in Food Regulations 1966, SI 1966 No 1203.

(3) Colouring Matter in Food (Amendment) Regulations 1970, SI 1970 No. 1102

(4) Colouring Matter in Food Regulations 1973, SI 1973 No 1340.

(5) Colouring Matter in Food (Amendment) Regulations 1975, SI 1975 No. 1488.

(6) Colouring Matter in Food (Amendment) Regulations 1976, SI 1976 No 2086.

(7) Colouring Matter in Food (Amendment) Regulations 1978, SI 1978 No 1787.

(8) Recommendations of the Food Advisory committee Final Report on the Review of the Colouring Matter in Food Regulations 1973 MAFF, HMSO 1987.

KEY
/ Permitted in food in UK
X Prohibited from food in UK
a For surface colouring only

Colour	Date of Regulation 1957 (1)	1966 (2)	1970 (3)	1973 (4)	1975 (5)	1976 (6)	1978 (7)	1988 (8)
Acid yellow GG	X	X	X	/	/	X	X	X
Allura red	X	X	X	X	X	X	X	/
Amaranth	/	/	/	/	/	/	/	/
Black 7984	X	/	/	/	/	X	X	X
Blue VRS	/	X	X	X	X	X	X	X
Brilliant black BN	/	/	/	/	/	/	/	/
Brilliant blue FCF	X	X	X	/	/	/	/	/
Brown FK	/	/	/	/	/	/	/	/
Carmoisine	/	/	/	/	/	/	/	/

Colour	Date of Regulation 1957 (1)	1966 (2)	1970 (3)	1973 (4)	1975 (5)	1976 (6)	1978 (7)	1988 (8)
Chocolate brown FB	/	/	/	/	/	/	X	X
Chocolate brown HT	/	/	/	/	/	/	/	/
Erythrosine	/	/	/	/	/	/	/	/
Fast red E	/	/	/	X	X	X	X	X
Green S	/	/	/	/	/	/	/	/
Indanthrene blue	X	X	X	/	/	X	X	X
Indigo carmine	/	/	/	/	/	/	/	/
Lithol rubine BK	X	X	X	/ a	/ a	/ a	/ a	/ a
Methyl violet	X	X	X	/ a	/ a	/ a	/ a	/ a
Napthol yellow S	/	X	X	X	X	X	X	X
Oil yellow GG	/	/	/	X	X	X	X	X
Oil yellow XP	/	/	/	X	X	X	X	X
Orange G	/	/	/	/	/	/	X	X
Orange RN	/	/	/	/	X	X	X	X
Patent blue V	X	X	X	/	/	/	/	/
Ponceau 2R	/	/	X	X	X	X	X	X
Ponceau 3R	/	X	X	X	X	X	X	X
Ponceau 4R	/	/	/	/	/	/	/	/
Ponceau SX	/	X	X	X	X	X	X	X
Quinoline yellow	X	X	X	/	/	/	/	/
Red 6B	/	/	/	X	X	X	X	X
Red 10B	/	/	/	X	X	X	X	X
Red FB	/	/	/	X	X	X	X	X
Red 2G	/	/	/	/	/	/	/	/
Sunset yellow FCF	/	/	/	/	/	/	/	/
Tartrazine	/	/	/	/	/	/	/	/

Colour	Date of Regulation 1957 (1)	1966 (2)	1970 (3)	1973 (4)	1975 (5)	1976 (6)	1978 (7)	1988 (8)
Violet BNP	/	/	/	X	X	X	X	X
Yellow 2G	/	/	/	/	/	/	/	X
Yellow RFS	/	X	X	X	X	X	X	X
Yellow RY	/	X	X	X	X	X	X	X
Total Number permitted	30	25	24	24	23	20	18	18

TABLE E.2 : DEVELOPMENT OF THE POSITIVE LIST OF MINERAL AND METALLIC COLOURS, 1957 - 1987

Compiled from:

(1) Colouring Matter in Food Regulations 1957, SI 1957 No 1066.

(2) Colouring Matter in Food Regulations 1966, SI 1966 No 1203.

(3) Colouring Matter in Food Regulations 1973, SI 1973 No 1340.

(4) Colouring Matter in Food (Amendment) Regulations 1976, SI 1976 No 2086.

(5) Colouring Matter in Food (Amendment) Regulations 1978, SI 1978 No 1787.

(6) Recommendations of the Food Advisory committee Final Report on the Review of the Colouring Matter in Food Regulations 1973 MAFF, HMSO 1987.

KEY:
/ Permitted in food
X Prohibited from food
a For external colouring of dragees and the decoration of sugar-coated flour confectionery only
b For colouring hard cheese rind only

Colour	Date of Regulation 1957 (1)	1966 (2)	1973 (3)	1976 (4)	1978 (5)	1988? (6)
Aluminium	/ a	/ a	/ a	/ a	/ a	/ a
Bole Armenian	/	/	X	X	X	X
Iron oxides & hydroxides:	/	/				
77489			/	/	/	/
77491			/	/	/	/
77492			/	/	/	/
77499			/	/	/	/
Carbon black	/	/	/	/	X	X
Gold	X	/ a	/ a	/ a	/ a	/ a
Silver	/ a	/ a	/ a	/ a	/ a	/ a
Titanium dioxide	/	/	/	/	/	/
Ultramarine	/	/	X	X	X	X
Total	7	8	9	9	8	8

TABLE E.3 : DEVELOPMENT OF THE POSITIVE LIST OF PLANT AND ANIMAL COLOURS, 1957 - 1987

Compiled from:

(1) Colouring Matter in Food Regulations 1957, SI 1957 No 1066.

(2) Colouring Matter in Food Regulations 1966, SI 1966 No 1203.

(3) Colouring Matter in Food Regulations 1973, SI 1973 No 1340.

(4) Colouring Matter in Food (Amendment) Regulations 1976, SI 1976 No 2086.

(5) Colouring Matter in Food (Amendment) Regulations 1978, SI 1978 No 1787.

(6) Recommendations of the Food Advisory Committee Final Report on the Review of the Colouring Matter in Food Regulations 1973 MAFF, HMSO 1987

KEY
/ Permitted in food
X Not permitted in food
a To be removed from the scope of the Colour Regulations
b Proposed by European Commission to be banned
c These may have been allowed before 1973

Colour	Date of Regulation 1957 (1)	1966 (2)	1973 (3)	1976 (4)	1978 (5)	1988? (6)
ANIMAL PRODUCTS						
Cochineal extract	/	/	/	/	/	/
PLANT PRODUCTS						
*Alkannet	/	/	X	X	X	X
*Annatto	/	/	/	/	/	
water extracted annatto						/
solvent extracted						X
Bixin			/	/	/	
Norbixin			/	/	/	

Colour	Date of Regulation 1957 (1)	1966 (2)	1973 (3)	1976 (4)	1978 (5)	1988? (6)
Anthocyanins						
Anthocyanin glycosides			/	/	/	
Cyanidin			/	/	/	
Delphinidin			/	/	/	
Malvidin			/	/	/	
Pelargonium			/	/	/	
Peonidin from fruits and edible plant parts			/	/	/	
Beetroot red			/	/	/	/
Caramel	/	/				
Heated sugars			/	/	/	/
Acid treated			/	/	/	/
Ammonia or hydroxides			/	/	/	/
Carbonate, phosphate sulphates or sulphites c			/	/	/	/
*Carotene	/	/				
Carotene, α			/	/	/	/
Carotene, β			/	/	/	/
Carotene, γ			/	/	/	/
β-apo-carotenal	X	/	/	/	/	/
β-apo-carotenoic acid ethyo ester	X	/	/	/	/	/
Charcoal	/	/	/	/	/	/
*Chlorophyll	/	/				
Chlorophyll a			/	/	/	/
Chlorophyll b			/	/	/	/
Copper chlorophyll & chlorophyllins	X	X	/	/	/	/

Colour	Date of Regulation 1957 (1)	1966 (2)	1973 (3)	1976 (4)	1978 (5)	1988? (6)
*Fustics	/	/	X	X	X	X
*Indigo	/	/	X	X	X	X
Lycopene			/	/	/	/ b
*Orchil/Litmus	/	/	/	X	X	X
Paprika			/	/	/	/ a
Capsanthin (& Capsorubin)			/	/	/	X
*Persian berry	/	/	X	X	X	X
*Quercitron extracts	/	/	X	X	X	X
Riboflavin			/	/	/	/
Riboflavin-5'-phosphate	X	X	X	X	/	/
*Safflower	/	/	X	X	X	X
*Saffron	/	/	/	/	/	/ a
Crocein			/	/	/	X
*Sandalwood	/	/	/	/	/	/ a
Santalin			/	/	/	X
*Turmeric	/	/	/	/	/	/ a
Curcumin			/	/	/	/
Xanthophylls						
Canthaxanthin	X	/	/	/	/	X
Cryptoxanthin			/	/	/	/
Flavoxanthin			/	/	/	/
Lutein			/	/	/	/
Rhodoxanthin			/	/	/	/
Rubixanthin			/	/	/	/
Violoxanthin			/	/	/	/
Total Number of Groups	16	17	18	17	18	18

Colour	Date of Regulation					
	1957 (1)	1966 (2)	1973 (3)	1976 (4)	1978 (5)	1988? (6)
MISCELLANEOUS EXTRA COMMENTS						
*Any colouring matter from edible fruit or vegetables	/		X	X	X	X
Synthetic pure colouring principle of any natural permitted colour			/	/	/	/
Pure colouring principles of any colours marked * whether extracted or synthesised	/	/	X	X		
Lakes :						
Al salts	/	/	/	/	/	
Ca salts	/	/	/	/	/	
Na salts	X	X	/	/	/	

TABLE E.4 : COLOURS PERMITTED BY 1957 REGULATIONS

Source: The Colouring Matter in Food Regulations 1957 (ST 1957 No 1066) (into operation 1957)

1924 CI No	Name	Hue
COAL TAR COLOURS		
184	Amaranth	Red
-	Black PN	Black
672	Blue VRS	Blue
-	Brown FK	Brown
179	Carmoisine	Red
-	Chocolate brown FB	Brown
-	Chocolate brown HT	Brown
773	Erythrosine BS	Red
182	Fast red E	Red
737	Green S	Green
1180	Indigo carmine	Blue
10	Naphthol yellow S	Yellow
23	Oil yellow GG	Yellow
-	Oil yellow XP	Yellow
27	Orange G	Orange
26	Orange RN	Orange
79	Ponceau MX	Red
80	Ponceau 3R	Red
185	Ponceau 4R	Red
-	Ponceau SX	Red
57	Red 6B	Red
30	Red 10B	Red
225	Red FB	Red
31	Red 2G	Red
-	Sunset yellow FCF	Yellow
640	Tartrazine	Yellow
-	Violet BNP	Violet
639	Yellow 2G	Yellow
-	Yellow RFS	Yellow
-	Yellow RY	Yellow

1924 CI No	Name	Hue
VEGETABLE COLOURS - extracted or synthetic		
	Alkannet	
	Annatto	
	Caramel	
	Carotene	
	Chlorophyll	
	Flavine	
	Indigo	
	Orchil	
	Osage orange	
	Persian berry	
	Safflower	
	Saffron	
	Sandalwood	
	Turmeric	
Any colouring natural to edible fruits or vegetables		
ANIMAL COLOURS		
	Cochineal	Red
METALLIC/MINERAL COLOURS		
Aluminium		for surface colouring only
Iron oxide (bole)		
Silver		for surface colouring only
Titanium dioxide		
Ultramarine		

TABLE E.5 : COLOURS PERMITTED BY 1966 REGULATIONS

Source: The Colouring Matter in Food Regulations 1966, SI 1966 No 1203. Regulations came into force in June 1967

1924 CI No	Name	Hue
	COAL TAR COLOURS	
	Amaranth	Red
	Black 7984	Black
	Brilliant black PN	Black
	Brown FK	Brown
	Carmoisine	Red
	Chocolate brown FB	Brown
	Chocolate brown HT	Brown
	Erythrosine BS	Red
	Fast red E	Red
	Green S	Green
	Indigo carmine	Blue
	Oil yellow GG	Yellow
	Oil yellow XP	Yellow
	Orange G	Orange
	Orange RN	Orange
	Ponceau 4R	Red
	Ponceau MX	Red
	Red 6B	Red
	Red 10B	Red
	Red 2G	Red
	Red FB	Red
	Sunset yellow FCF	Yellow
	Tartrazine	Yellow
	Violet BNP	Violet
	Yellow 2G	Yellow
	PLANT PRODUCTS	
	Alkannet	Red
	Annatto	Orange
	Carotene	Orange
	Chlorophyll	Green
	Flavine	Yellow

1924 CI No	Name	Hue
	Indigo	Blue
	Orchil	Red
	Osage orange	Yellow
	Persian berry	Yellow
	Safflower	Red
	Saffron	Yellow
	Sandalwood	Red
	Turmeric	Yellow
	Pure colouring principles of all above colours	
	β-apo-8'-caretenal	Orange
	B-apo-8'-carotenoic acid ethyl ester	Orange
	Caramel	Brown
	Canthaxanthin	Orange
	Charcoal	Black
	Any colouring natural to edible fruits or vegetables	
	ANIMAL PRODUCTS	
	Cochineal extract	Red
	MINERAL PRODUCTS	
	Aluminium (surface only)	Metallic
	Carbon black	Black
	Gold (surface only)	Metallic
	Iron oxides X 3 (Bole)	
	Silver (surface only)	Metallic
	Titanium dioxide	White
	Ultramarine	Blue
	Aluminium lakes of any permitted water-soluble colours	
	Calcium lakes of any permitted water-soluble colours	

TABLE E.6 : COLOURS PERMITTED BY 1973 REGULATIONS

Source: <u>The Colouring Matter in Food Regulations</u>1973 (SI 1973 No 1340)

KEY:
a For surface colouring only

1924 CI No	Name	
	COAL TAR COLOURS	
-	Acid yellow G	
184	Amaranth	
-	Black 7984	
-	Black PN	
	Brilliant blue FCF	
-	Brown FK	
179	Carmoisine	
-	Chocolate brown FB	
-	Chocolate brown HT	
773	Erythrosine BS	
737	Green S	
-	Indanthrene blue	
1180	Indigo carmine	
	Lithol rubine	for surface colouring only
	Methyl violet	for surface colouring only
27	Orange G	
26	Orange RN	
-	Patent blue V	
185	Ponceau 4R	
-	Quinoline yellow	
31	Red 2G	
-	Sunset yellow FCF	
640	Tartrazine	
639	Yellow 2G	
	VEGETABLE COLOURS - extracted or synthetic	
	Annatto	
	Anthocyanins	
	Beetrood red	
	Caramels	
	Carotene	
	β-apo carotenal	
	β-apo carotenic acid	
	Charcoal	

1924 CI No	Name	
	Chlorophyll	
	Copper chlorophylls	
	Lycopene	
	Orchil	
	Saffron	
	Sandalwood	
	Turmeric	
	Xanthophylls	

Synthetic pure colouring principle of any natural permitted colour

ANIMAL COLOURS

Cochineal

MINERAL AND METALLIC COLOURS

Aluminium	for surface colouring only
Gold	for surface colouring only
Iron oxide (bole)	
Silver	for surface colouring only
Titanium dioxide	

APPENDIX F

TABLE F.1 : DISCOVERY DATES OF COAL TAR COLOURS USED IN FOOD

Compiled from table J.1

Period	Colour	Date of First Synthesis	Colour Index Number
1740-1744	Indigo carmine	1740	73015
1770-1774	Picric acid	1771	10305
1830-1834	Aurine	1834	43800
1855-1859	Magenta (fuchsine)	1856	42510
	Manchester yellow	1856	10315
	Soluble blue [a]	1858	42780
	Mauveine	1856	50245
	Safranine	1859	50240
1860-1864	Bismarck brown G	1863	21000
	Methyl violet	1861	42535
	Soluble blue [b]	1862	42755
	Alkali blue	1862	
	Aminoazobenzene	1861	
	Aniline greens	1862	
	Gentian blue 6B	1861	
	Hofman's violet	1863	
	Induline spirit soluble	1863	
	Phosphine	1862	
1865-1869	Victoria yellow	1869	10310
	Induline	1867	50405
	Nigrosine	1867	50420
	Nigrosine spirit	1867	
1875-1879	Acid magenta	1877	42685
	Amaranth	1878	16185
	Butter yellow	1876	11020
	Chrysoidine	1875	11270
	Chrysoine	1875	14270
	Erythrosine	1876	45430
	Metanil yellow	1879	13065
	Phloxine	1875	45405
	Ponceau 2R	1878	16150
	Roccelline	1877	15620
	Acid yellow	1877	13015
	Ponceau 3R	1878	16155
	Orange G	1878	16230
	Ponceau 4R	1878	16255
	Naphthol yellow S	1879	10316
	Fast red E	1878	16045
	Acid bordeaux	1878	16180
	Bismarck brown	1878	21010
	Light green SF yellowish	1879	42095
	Malachite green	1877	42000
	Methylene blue	1876	52015
	Oil yellow GG	1875	11920

Period	Colour	Date of First Synthesis	Colour Index Number
	Orange I	1876	14600
	Orange II	1876	15510
	Orange IV	1876	
1875-1879	Aminoazotoluene	1877	
	Brilliant green crystal	1879	
	Croceine scarlet 5R	1879	
	Eosine scarlet	1875	
	Fast yellow R	1878	
	Methyl orange	1876	
	Oil orange TX	1878	
	Orange RN	1878	
	Sudan III	1879	
	Yellow RFS	1878	
1880-1884	Auramine	1883	41000
	Benzopurpurine	1884	23500
	Carmoisine	1883	14720
	Congo red	1884	22120
	Green S	1883	44090
	Quinoline yellow	1882	47005
	Rose bengal	1882	45440
	Tartrazine	1884	19140
	Acid green	1883	42085
	Double brilliant scarlet 3R	1882	14730
	Resorcine brown	1881	20170
	Benzyl bordeau B	1885	
	Bordeaux extra	1883	
	Brilliant croceine	1882	
	Citron orange	1880	
	Naphthol green B	1883	
	Ponceau crystal 6R	1883	
	Sudan I	1883	
	Sudan II	1883	
1885-1889	Acid violet 6B	1889	42640
	Rhodamine B	1887	45170
	Patent blue V	1888	42051
	Baking brown	1887	
	Brilliant black PN	1885	
	Diamond yellow	1889	
	Direct black	1889?	
	Fat yellow GS	1887?	
	Orange R	1887	
	Patent blue A	1888	
1890-1894	Rhodamine 6G	1892	45160
	Red 10B	1890	17200
	Red FB	1893	14780
	Violet BNP	1891	42580
	Cyanol	1891	43535
	Violet 5BN	1890	42650
	Chrolazol sky blue	1891	

Period	Colour	Date of First Synthesis	Colour Index Number
	Direct blue 2B	1890	
	Oil red 2R	1894	
	Oil yellow AB	1890	
	Oil yellow HA	1890	
	Rhodamine G	1891	
	Turquoise blue G	1891	
1895-1899	Brilliant blue	1896	42090
	Acid violet 4BN	1896	
	Coomassie navy blue	1895	
	Sudan red G	1899	
1900-1904	Red 2G	1902	18050
	Idanthrane	1901	69800
	Red 6B	1902	18055
	Blue VRS	1902	42045
	Lithol rubine	1903	15850
1905-1909	Yellow 2G	1908	18965
	Hansa yellow 5G	1909	
	Hansa yellow G	1909	
	Helindone pink	1907	
	Helio red	1905	
	Xylene red B	1906	
1910-1914	Fast red salt AL	1914	
	Fast scarlet salt R	1911	
	Hansa yellow 10G	1911	
	Permanent orange G	1910	
1920-1924	Naphthol AS-OL	1922	
	Oil yellow XP	1923	
1925-1929	Fast green FCF	1927	
1930-1934	Naphthol AS-OG	1930?	
	Yellow RY	1931	
1935-1939	Sunset yellow	1937	15985
	Phthalocyanine green	1935	
	Sudan R	1937	
1950-1954	Ponceau SX	1954	

TABLE F.2 : DATES OF INTRODUCTION AND REMOVAL OF COAL TAR COLOURS 1870 - 1987, ARRANGED IN ALPHABETICAL ORDER

Compiled from tables J.1, D.1 and D.2

KEY:
X Possible period of use in food

```
Colour                  Possible Period of Use in Food
                        1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980

Acid bordeau B               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Acid green GG                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Acid magenta II             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Acid violet 6B                    XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Acid violet 4BN                       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Acid yellow G               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX        XX
Alkali blue             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Allura red
Amaranth                     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Aminoazotoluene             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX..
Aminoazobenzene         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Aniline greens          XXXXXXX
Auramine                       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Aurantia                  XXXXXXXXXXXXXXXXXXXXXXXX
Aurine                  XXXXXXXXXXXXXXXXXXXXXXXXXX
Baking brown                     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Baking brown AV                                               .....X
Benzopurpurine 4B               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Benzyl bordeau B                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Bismark brown                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Bismarck brown G        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Black 5410                                                    .....X
Black 7984                                                              XXXXX
Blue VRS                                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Bordeaux extra                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Brilliant black BN              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Brilliant blue FCF                    XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX        XXXXXXXX
Brilliant croceine             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Brilliant green cryst.            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Brown FK                                     ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Butter yellow               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Carmoisine                     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Chlorazol sky blue                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Chocolate brown FB                  ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Chocolate brown HT                  ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Chrysoidine                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Chrysoine                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Citron orange                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Congo red                       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Coomassie navy blue                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Crispin black G                                                 ...X
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Colour	Possible Period of Use in Food											
	1870	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980
Croceine scarlet 5R		X	X	X	X	X	X	X	X	X		
Cyanol			X	X	X	X	X	X	X	X		
Diamond yellow			X	X	X	X	X	X	X	X		
Direct black			?X	X	X	X	X	X	X	X		
Direct blue 2B			X	X	X	X	X	X	X	X		
Double brilliant scarlet		X	X	X	X	X	X	X	X	X		
Eosine	X	X	X	X	X	X	X	X	X	X		
Eosine scarlet		X	X	X	X	X	X	X	X	X		
Erythrosine		X	X	X	X	X	X	X	X	X	X	X
Fast green FCF							X	X	X	X		
Fast red E		X	X	X	X	X	X	X	X	X	X	X
Fast red salt AL					X	X	X	X	X	X		
Fast scarlet salt R					X	X	X	X	X	X		
Fast yellow R		X	X	X	X	X	X	X	X	X		
Fat yellow GS		?	X	X	X	X	X	X	X	X		
Gentian blue 6B	X	X	X	X	X	X	X	X	X	X		
Gentian violet					...	X						
Green S		X	X	X	X	X	X	X	X	X	X	X
Hansa yellow 5G					X	X	X	X	X	X		
Hansa yellow 10G					X	X	X	X	X	X		
Hansa yellow G					X	X	X	X	X	X		
Helindone pink					X	X	X	X	X	X		
Helio red					X	X	X	X	X	X		
Hofman's violet	X	X	X	X	X	X	X	X	X	X		
Idanthrene blue				X	X	X	X	X	X	X		XX
Indigo carmine	X	X	X	X	X	X	X	X	X	X	X	X
Induline	X	X	X	X	X	X	X	X	X	X		
Induline spirit	X	X	X	X	X	X	X	X	X	X		
Light green SF		X	X	X	X	X	X	X	X	X		
Lithol rubine BK									?...	X		XXXXXXX
Magenta	X	X	X	X	X	X	X	X	X	X		
Malachite green		X	X	X	X	X	X	X	X	X		
Manchester yellow	X	X	X	X	X	X						
Mauveine	X	X	X	X	X	X	X	X	X	X		
Metanil yellow		X	X	X	X	X	X	X	X	X		
Methylene blue		X	X	X	X	X	X	X	X	X		
Methyl orange		X	X	X	X	X	X	X	X	X		
Methyl violet	X	X	X	X	X	X	X	X	X	X		XXXXXXX
Naphthol AS-OG							?...	X	X	X		
Naphtol green B			X	X	X	X	X	X	X	X		
Naphthol AS-OL						X	X	X	X	X		
Napthol yellow S		X	X	X	X	X	X	X	X	X	X	
Nigrosine	X	X	X	X	X	X	X	X	X	X		
Nigrosine spirit	X	X	X	X	X	X	X	X	X	X		
Oil orange TX		X	X	X	X	X	X	X	X	X		
Oil red 2R				X	X	X	X	X	X	X		
Oil yellow AB			X	X	X	X	X	X	X	X		
Oil yellow GG		X	X	X	X	X	X	X	X	X	X	X
Oil yellow HA			X	X	X	X	X	X	X	X		
Oil yellow OB					X	X	X	X	X	X		

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------------------------------------------------------------------------------
                              Possible Period of Use in Food
Colour            1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980
------------------------------------------------------------------------------

Oil yellow XP                               XXXXXXXXXXXXXXXXXXXXXXXXXX
Orange I             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Orange II            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Orange IV           XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Orange G              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Orange R                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Orange RN             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Patent blue A              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Patent blue V              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX        XXXXXXX
Permanent orange G                    XXXXXXXXXXXXXXXXXXXXXXXX
Phloxine            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Phosphine         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Phthalocyanine green                              XXXXXXXXXXXX
Picric acid       XXXXXXXXXXXXXXXXXXXXXXXXXX
Ponceau cryst. 6R       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Ponceau 2R            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Ponceau 3R            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Ponceau 4R            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Ponceau SX                                                  XXXXXX
Quinoline yellow        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX       XXXXXXXX
Red 6B                            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Red 10B                     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Red FB                       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Red 2G                            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Resorcine brown        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Rhodamine B               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Rhodamine 6G                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Rhodamine G                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Rocceline            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Rose bengal             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Safranine         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Soluble blue [a]  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Soluble blue [b]  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Sudan I                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Sudan II                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Sudan III             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Sudan IV                                                  ...X
Sudan blue II                                             ...X
Sudan red G                     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Sudan R                                            XXXXXXXXXXX
Sulfon red B                                              ...X
Sunset yellow FCF                                  XXXXXXXXXXXXXXXXXXXXXXXXXX
Tartrazine               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Turquoise blue G            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Victoria yellow  XXXXXXXXXXXXXXXXXXXXXXXXXXXX
Violet 5BN                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Violet BNP                                              ? ...XXXXXXXXX
Xylene red B                        XXXXXXXXXXXXXXXXXXXXXXXXXX
Yellow 2G                            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Yellow RFS            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Yellow RY                                       XXXXXXXXXXXXXXXXXX
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APPENDIX G

TABLE G.1 : DEVELOPMENT OF EARLY COLOUR & DYE MANUALS

1844	E A Parnell (ed) Applied Chemistry in Manufacturers, Arts and Domestic Economy vol I
1849	E A Parnell (ed) Dyeing and Calico Printing - reprinted from 1844
1855	H C Baird The Dyer and Colour Maker's Companion H C Baird & Co, Philadelphia
1859	Clinton E Gilroy A Practical Treatise on Dyeing and Calico-Printing Including the Latest Inventions and Improvements Harper, New York
1870	John Wm Slater The Manual of Colours and Dye Wares Lockwood & Co, London
1876	Dyer and Colour Makers' Companion H C Baird & Co, Philadelphia, New edition
1882	J W Slater The Manual of Colours and Dye Wares Lockwood & Co, London, 2nd enlarged edition
1882	G H Hurst Dictionary of Coal Tar Colours
1885	W R Richardson 'Classification of coal-tar colours, giving their commercial names, chemical nomenclature and chemical formulae' Journal of Society of Dyers and Colourists Vol I (suggested scheme for classifying colours)
1886	R Benedikt & E Knecht The Chemistry of Coal-Tar Colours; a translation of R Benedikt Die Kunstlichen Farbestoffe (Theefarben) [Synthetic Dyes (Coal-Tar Dyes)] Germany, 1883
1888	G Schultz & P Julius Tabellarische Ubersicht der Kunstlichen Organischen Farbestoffe [Tabular survey of synthetic organic colouring matters] Germany
1889	R Benedikt & E Knecht The Chemistry of Coal-Tar Colours, 2nd enlarged ed.
1894	Arthur G Green Systematic Survey of the Organic Colouring Matters English translation of Schultz & Julius, with additions for UK and US industries.
1896	G H Hurst Dictionary of Coal Tar Colours, 2nd enlarged ed.
1896	A Seyewetz & P Sisley La Chimie Des Matieres Colorantes Artificielles [The Chemistry of the Synthetic Colouring Matters] France

1901 C Rawson, Wm Gardner & W F Laycock A Dictionary of Dyes, Mordants & Other Compounds Used in Dyeing & Calico Printing

1904 Arthur G Green Systematic Survey of the Organic Colouring Matters, 2nd enlarged ed.

1905 Reprint of C Rawson, Wm Gardner & W F Laycock A Dictionary of Dyes, Mordants & Other Compounds Used in Dyeing & Calico Printing (1901)

1915 Arthur G Green The analysis of dyestuffs and their identification in dyed and coloured materials, leather pigments, foodstuffs etc. Griffin's Technological Handbooks, London

1918 Reprint of C Rawson, Wm Gardner & W F Laycock A Dictionary of Dyes, Mordants & Other Compounds Used in Dyeing & Calico Printing (1901)

1922-1924 F M Rowe Colour Index Soc. Dyers & Colourists, Bradford

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APPENDIX H

TABLE H.1 : FOODS CONTAINING COLOURS IN THE 1850s

Compiled from: Arthur Hassall Adulterations Detected - or Plain Instructions for the Discovery of Frauds in Food and Medicine Longman, Green, Longman and Roberts, London 1861, 2nd edition, p11-17, 20-21, 490-498.

Name	Hue	In Hassall's view: Should permit (+) Should prohibit (-) Injurious (*)	Foods found in
PLANT PRODUCTS			
Annatto	Yellow		Cheese
Beetroot juice	Red		
Bilberries	Red		
Brazil wood	Red	+	
Brazil wood lake	Red	+	
Caramel (Burnt sugar or black jack)	Brown		
Carmine	Red	+	
Carmine lake	Red	+	
Carrot	Yellow		
Catechu (mainly tannin)	Brown		
Cayenne	Orange	*	Gin, rum, ginger, mustard
Elderberry juice	Red		
French berries	Yellow	+	
French berry lake (Yellow lake)	Yellow	+	
Fustic wood	Yellow	+	
Fustic wood lake	Yellow	+	
Gamboge	Yellow	-/*	Sugar confectionary

Name	Hue	In Hassall's view: Should permit (+) Should prohibit (-) Injurious (*)	Foods found in
Indigo	Blue	+/-/*	Sugar confectionary
Logwood	Red	+	
Liquorice	Black		
Litmus	Blue	+/-	
Madder root	Brown		
Madder purple	Purple	+	
Mangold	Brown		
Persian berries	Yellow	+	
Persian berry lake	Yellow	+	
Quercitron bark	Yellow	+	
Quercitron bark lake	Yellow	+	
Saffron	Yellow	+	
Sap green (juice of Rhamnus catharticus berries)	Green	+/-	
Treacle	Brown		
Turmeric	Yellow	+	
Turnip	Yellow		
ANIMAL PRODUCTS			
Baked horse's liver	Brown		
Burnt blood	Brown		
Cochineal	Red	+	
Cochineal lakes	Red	+	
MIXTURES & UNKNOWNS			
Chinese yellow	Yellow		

Name	Hue	In Hassall's view: Should permit (+) Should prohibit (-) Injurious (*)	Foods found in
Dutch pink (a vegetable dye plus chalk or carbonate of lime)	Yellow		
Pink madder lake	Red	+	
Rose pink (Logwood plus carbonate of lime)	Red		
MINERAL/METALLIC PRODUCTS			
Alkali	Yellow		
Alum	White	*	Bread & flour
Antwerp blue (a preparation/modification of Prussian blue with chalk)	Blue	-/*	Sugar confectionary
Artificial ultramarine (German ultramarine, similar to natural ultramarine)	Blue	*	Sugar confectionary
Bichromate of potash	Yellow		
Blue verditer (sesquicarbonate of copper)	Blue	-	
Bole armenian (Red ferruginous earth)	Red	-/*	Red sauces (eg. shrimp, lobster, anchovy & tomato), potted meats & fish, cocoa, chicory, anchovies, annatto, cheese, tea, snuff, etc
Brick dust	Brown		
Brunswick green deep (oxychloride of copper)	Green	-/*	Sugar confectionary
Brunswick green middle (oxychloride of copper)	Green	-/*	Sugar confectionary
Brunswick green pale (oxychloride of copper)	Green	-/*	Sugar confectionary
Burnt umber	Brown		
Carbonate of lime	White		

Name	Hue	In Hassall's view: Should permit (+) Should prohibit (-) Injurious (*)	Foods found in
Carbonate of magnesia	White		
Chalk	White		
China clay	White		
Chromates of potash	Yellow	*	Tea, snuff
Chrome deep (Bright or canary chrome, a lead chromate)	Yellow	-	Custard powders, sugar confectionary, tea, snuff
Chrome lemon (a lead chromate)	Yellow	-	Custard powders, sugar confectionary, tea, snuff
Chrome orange (a lead chromate)	Yellow	-	Custard powders, sugar confectionary, tea, snuff
Cobalt	Blue	-	
Copper bronze (alloy of copper and zinc)	Metallic	-/*	Sugar confectionary
Emerald green (Scheele's green or arsenite of copper)	Green	-/*	Coloured sugar confectionary
False brunswick green deep (mixture of chromates of lead and indigo or possibly Prussian blue)	Green	-/*	Sugar confectionary
False brunswick green middle (mixture of chromates of lead and indigo or possibly Prussian blue)	Green	-/*	Sugar confectionary
False brunswick green pale (mixture of chromates of lead and indigo or possibly Prussian blue)	Green	-/*	Sugar confectionary
False verditer (Subsulphate of copper and chalk)	Green	-	
French chalk (Soapstone, a species of talc)	White		
Fuchsine (Acetate of copper)	Green		

Name	Hue	In Hassall's view: Should permit (+) Should prohibit (-) Injurious (*)	Foods found in
Fuller's earth	Brown		
Gold bronze (alloy of copper and zinc)	Metallic	-	
Gypsum			
Indian red	Red		
Iodide of lead	Yellow	-	
Iodide of mercury	Red	-	
King's yellow (Sulphuret of arsenicum with lime & sulphur)	Yellow	-	
Massicot (Protoxide of lead)	Yellow	-	
Mineral green (Green verditer or subcarbonate of copper)	Green	-	
Naples yellow (Sulphuret of antimony)	Yellow	-	
Plaster of Paris (hydrated sulphate of lime or mineral white)	White	*	Sugar confectionary, bread, flour
Plumbago (Black lead or graphite)	Black	*	Certain black & Lie teas
Potash	White		
Prussian blue (Ferrocyanide of iron)	Blue	-/*	Sugar confectionary
Red lead (Minimum or red oxide of lead)	Red	-/*	Curry powder, cayenne
Red ochre (Red ferruginous earth)	Red	-/*	Red sauces (eg. shrimp, lobster, anchovy & tomato), potted meats & fish, cocoa, chicory, anchovies, annatto, cheese, tea, snuff, etc
Red orpiment (Realgar or bisulphuret of arsenic)	Red	-	

Name	Hue	In Hassall's view: Should permit (+) Should prohibit (-) Injurious (*)	Foods found in
Salt	White		
Sienna (Brown ferruginous earths)	Brown	-/*	Red sauces (eg. shrimp, lobster, anchovy & tomato), potted meats & fish, cocoa, chicory, anchovies, annatto, cheese, tea, snuff, etc
Silver bronze (alloy of copper and zinc)	Metallic	-	
Smalt (a glass of cobalt)	Blue	-	
Sulphate of copper (Blue vitriol)	Green	*	Pickles, bottled fruits & vegetables, preserves, dried & crystallised fruits, annatto; bread - rarely
Sulphate of iron		*	Re-dried tea, beer
Terra alba (Sulphate of lime)	White		
Ultramarine (double silicate of alumina & soda with sulphuret of sodium)	Blue	-/*	Sugar confectionary
Umber (Brown ferruginous earths)	Brown	-/*	Red sauces (eg. shrimp, lobster, anchovy & tomato), potted meats & fish, cocoa, chicory, anchovies, annatto, cheese, tea, snuff, etc
Vandyke brown (Brown ferruginous earths)	Brown	-/*	Red sauces (eg. shrimp, lobster, anchovy & tomato), potted meats & fish, cocoa, chicory, anchovies, annatto, cheese, tea, snuff, etc
Venetian red (Red ferruginous earth)	Red	-/*	Red sauces (eg. shrimp, lobster, anchovy & tomato), potted meats & fish, cocoa, chicory, anchovies, annatto, cheese, tea, snuff, etc

Name	Hue	In Hassall's view: Should permit (+) Should prohibit (-) Injurious (*)	Foods found in
Verdigris (diacetate of copper)	Green	-/*	Pickles, bottled fruits & vegetables, preserves, dried & crystallised fruits
Verditer (Carbonate of copper)	Green	*	Coloured sugar confectionary, tea
Vermilion (Cinnabar or bisulphuret of mercury)	Red	-/*	Sugar confectionary, cayenne
White lead (Carbonate of lead)	White	-/*	Sugar confectionary
Yellow ochre (ferruginous earth)	Yellow	-/*	Red sauces (eg. shrimp, lobster, anchovy & tomato), potted meats & fish, cocoa, chicory, anchovies, annatto, cheese, tea, snuff, etc
Yellow orpiment (Sulphuret of arsenicum)	Yellow	-/*	Sugar confectionary

TABLE H.2 : RANGE OF FOODS CONTAINING COAL TAR COLOURS 1901 AND 1983

Compiled from: Committee on Food Preservatives Report of the Departmental Committee appointed to Inquire into the Use of Preservatives and Colouring Matters HMSO, London 1901; MAFF Survey of Colour Usage in Food Nineteenth report of the Steering Group on Food Surveillance, The Working Party on Food Colours, Food Surveillance Paper No 19, London, HMSO 1987.

Food	Year 1901	Year 1983
Beer		
Baked goods (including mixes)		Ponceau 4R Sunset yellow Tartrazine
Biscuits (including fillings)	-	Amaranth Carmoisine Choc brown HT Erythrosine Green S Indigo carmine Ponceau 4R Sunset yellow Tartrazine
Bread		
Breakfast cereals	-	Amaranth Black PN Ponceau 4R Sunset yellow Tartrazine
Butter	Butter yellow Metanil yellow Methyl orange	
Preserved cherries		Carmoisine Erythrosine Green S Sunset yellow Tartrazine

Food	Year 1901	1983
Preserved fruit	Auramine	Amaranth
	Citron orange	Black PN
	Crocein orange	Brill. blue
	Magenta	Carmoisine
	Rose pink	Erythrosine
		Green S
		Indigo carmine
		Ponceau 4R
		Sunset yellow
		Tartrazine
Canned vegetables		Brill. blue
		Green S
		Patent blue V
		Sunset yellow
		Tartrazine
Cheese (including spread)	Butter yellow	Lithol rubine*
	Metanil yellow	Ponceau 4R
		Tartrazine
Chocolate confectionery	Auramine	Amaranth
	Aurantia	Black PN
	Chocolate brown	Brill. blue
	Citron orange	Carmoisine
	Eosin	Choc brown HT
	Eosine scarlet	Erythrosine
	Magenta	Green S
	Metanil yellow	Indigo carmine
	Ponceau red b	Ponceau 4R
	Prussian blue	Red 2G
	Rhodamine a	Sunset yellow
	Rhodamine b	Tartrazine
	Rose pink	
	Vermilion	
	Concentrated pink	
	Jetoline	
	Lemon yellow	
	Heliotrope	
	Lavender	
	Damson blue	
	Tuscan	
	Orange	
	Salmon pink	
	Rhodites	
	Cherry red	
	Saffron yellow	

Food	Year 1901	Year 1983
Christmas pudding		
Cider		Amaranth Black PN Carmoisine Green S Indigo carmine Ponceau 4R Sunset yellow Tartrazine
Dessert mixes		Amaranth Black PN Brown FK Carmoisine Choc brown HT Erythrosine Green S Indigo carmine Ponceau 4R Sunset yellow Tartrazine Yellow 2G
Edible ices		Amaranth Black PN Brill. blue Brown FK Carmoisine Choc brown HT Erythrosine Green S Indigo carmine Patent blue V Ponceau 4R Quinol. yellow Sunset yellow Tartrazine
Fats and oils (including margarine)	Butter yellow Methyl orange	
Filled pancakes		

Food	Year 1901	1983
Fish products		Brown FK Ponceau 4R Sunset yellow Tartrazine
Fish spreads		Choc brown HT Erythrosine Red 2G Sunset yellow Tartrazine
Flour confectionery Cakes and pastries (including fillings)		Amaranth Black PN Brill. blue Carmoisine Choc brown HT Erythrosine Green S Indigo carmine Patent blue V Ponceau 4R Red 2G Sunset yellow Tartrazine
Home baking ingredients		Carmoisine Tartrazine
Infant foods		
Instant lemon tea		Amaranth Indigo carmine Tartrazine
Jellies	Auramine Citron orange Crocein orange Magenta Rose pink red diazos	Amaranth Brill. blue Carmoisine Erythrosine Green S Indigo carmine Ponceau 4R Sunset yellow Tartrazine

Food	Year 1901	1983
Meal substitutes (liquids)		Amaranth Carmoisine Choc brown HT Erythrosine Green S Indigo carmine Ponceau 4R Sunset yellow Tartrazine
Meat products (including coatings, sauces, pasta etc. where part of dish)	Bismarck brown G Congo red Eosin Theodine Eosine scarlet Magenta Rose pink	Amaranth Black PN Brown FK Carmoisine Erythrosine Green S Ponceau 4R Red 2G Sunset yellow Tartrazine
Sausages	Congo red Eosin Eosine scarlet Magenta Rose pink	Amaranth Black PN Brown FK Carmoisine Choc brown HT Erythrosine Ponceau 4R Red 2G Sunset yellow Tartrazine
Meat spreads	Congo red Eosin Theodine Eosine scarlet	
Milk products		Amaranth Black PN Brill. blue Carmoisine Choc brown HT Erythrosine Green S Indigo carmine Ponceau 4R Sunset yellow Tartrazine

Food	Year 1901	1983
Non-dairy creamers		Amaranth Green S Sunset yellow Tartrazine
Pasta products	Manchester yellow	
Pickles & relishes		Amaranth Black PN Brill. blue Green S Quinol. yellow Sunset yellow Tartrazine
Prepared vegetables		Carmoisine Erythrosine Ponceau 4R Sunset yellow Tartrazine
Preserves (all jams etc)	Auramine Benzopurpurin Citron orange Crocein orange Magenta Rose pink	Amaranth Black PN Carmoisine Choc brown HT Erythrosine Green S Indigo carmine Ponceau 4R Red 2G Sunset yellow Tartrazine
Sauces & dressings		Amaranth Black PN Brill. blue Brown FK Choc brown HT Green S Indigo carmine Ponceau 4R Sunset yellow Tartrazine
Seasonings		Carmoisine Indigo carmine Tartrazine

Food	Year 1901	1983
Snack foods (instant) (including crisps)		Brill. blue Brown FK Carmoisine Erythrosine Green S Indigo carmine Ponceau 4R Red 2G Sunset yellow Tartrazine Yellow 2G
Soft drinks	Citron orange Ponceau red a	Amaranth Black PN Brill. blue Brown FK Carmoisine Choc brown HT Green S Indigo carmine Patent blue V Ponceau 4R Quinol. yellow Red 2G Sunset yellow Tartrazine Yellow 2G
Soups		Amaranth Black PN Brill. blue Brown FK Carmoisine Choc brown HT Erythrosine Green S Indigo carmine Ponceau 4R Sunset yellow Tartrazine
Sugar confectionery	Auramine Aurantia Chocolate brown Citron orange Eosin Eosine scarlet	Amaranth Black PN Brill. blue Brown FK Carmoisine Choc brown HT

Food	Year 1901	1983
Sugar confectionery (cont.)	Magenta Metanil yellow Ponceau red b Prussian blue Rhodamine a Rhodamine b Rose pink Vermilion Concentrated pink Jetoline Lemon yellow Heliotrope Lavender Damson blue Tuscan Orange Salmon pink Rhodites Cherry red Saffron yellow	Erythrosine Green S Indigo carmine Patent blue V Ponceau 4R Quinol. yellow Red 2G Sunset yellow Tartrazine Yellow 2G
Vegetable protein		Erythrosine Red 2G
Vinegar		
Wines & spirits		Amaranth Black PN Brill. blue Carmoisine Green S Ponceau 4R Sunset yellow Tartrazine
Milk	Butter yellow Metanil yellow	
Cream	Butter yellow Metanil yellow	
Sugar	Acid yellow	

APPENDIX I

TABLE I.1 : SAFETY RATINGS FOR COLOURS, ASSIGNED BY THE PHARMACOLOGY PANEL IN 1954/5

Source: Food Standards Committee <u>Report on Colouring Matters</u> Ministry of Food, HMSO, London, 1954; Food Standards Committee <u>Supplementary Report on Colouring Matters</u> Ministry of Agriculture, Fisheries and Food, HMSO, London, 1955.

KEY:
- A Acceptable for food
- B Provisionally acceptable
- C Unsuitable for food
- / Considered to be unproblematic for health
- X Considered unsuitable for food
- * Recommended for permitted list
- > Recommended for permitted list but not put on it
- # Not recommended for permitted list but put on it

Name	Hue	Chemical type	Safety rating
COAL TAR COLOURS			
Acid bordeau B	Red	Azo	C
Acid green GG	Green	Triphenylmethane	C
Acid magenta II	Red	Triphenylmethane	A
Acid yellow G	Yellow	Azo	B
Acid violet 4BN	Violet	Triphenylmethane	B
Acid violet 6B	Violet	Triphenylmethane	B * >
Alkali blue	Blue	Triphenylmethane	C
Amaranth	Red	Azo	A *
Auramine	Yellow	Diphenylmethane	B
Baking brown	Brown	Polyazo	C
Baking brown AW	Brown	Polyazo	B * >
Benzopurpurin 4B	Red	Disazo	C
Benzyl bordeau B	Red	Azo	C
Bismark brown	Brown	Disazo	C
Bismark brown G	Brown	Disazo	C
Black 5410	Black	Polyazo	C
Blue VRS	Blue	Triphenylmethane	A *
Brilliant black BN	Black	Disazo	B *
Brilliant blue FCF	Blue	Triphenylmethane	C
Brilliant croceine	Red	Disazo	C
Brilliant green cryst. Y	Green	Triphenylmethane	B
Brown FK	Brown	Azo	B *
Carmoisine	Red	Azo	A *
Chlorazol sky blue	Blue	Disazo	C
Chocolate brown FB	Brown	Disazo	B *
Chocolate brown HT	Brown	Disazo	B *
Chrysoidine	Orange	Azo	C
Congo red	Red	Disazo	C
Coomassie navy blue	Blue	Disazo	C
Crispin black G	Black	Triazo	C
Croceine scarlet 5R	Red	Disazo	C
Direct black	Black	Disazo	C

Name	Hue	Chemical type	Safety rating
Direct blue 2B	Blue	Disazo	C
Eosine	Red	Xanthene	B
Eosine scarlet	Red	Xanthene	B
Erythrosine	Red	Xanthene	B *
Fast green FCF	Green	Triphenylmethane	C
Fast red E	Red	Azo	A #
Fast yellow R	Yellow	Azo	B
Green S	Green	Triphenylmethane	B *
Hansa yellow 5G	Yellow	Azo	C
Hansa yellow 10G	Yellow	Azo	C
Hansa yellow G	Yellow	Azo	C
Helindone pink	Red	Indigoid	C
Helio red	Red	Azo	C
Indanthrene blue	Blue	Anthraquinone	B
Indigo carmine	Blue	Indigoid	A *
Induline	Blue	Azine	C
Induline spirit soluble	Blue	Azine	C
Light green SF	Green	Triphenylmethane	C
Malachite green	Green	Triphenylmethane	C
Metanil yellow	Yellow	Azo	C
Methyl violet	Violet	Triphenylmethane	C
Naphthol AS-OG + Fast red salt AL	Red	Azo	C
Naphthol AS-OL + Fast scarlet salt R	Red	Azo	C
Napthol yellow S	Yellow	Nitro	A *
Nigrosine	Black	Azine	C
Oil orange TX	Orange	Azo	C
Oil red 2R	Red	Azo	C
Oil yellow AB	Yellow	Azo	C
Oil yellow GG	Yellow	Azo	B *
Oil yellow HA	Yellow	Azo	C
Oil yellow OB	Yellow	Azo	C
Oil yellow XP/SEG	Yellow	Pyrazolone	B *
Orange 1	Orange	Azo	C
Orange II	Orange	Azo	C
Orange G	Orange	Azo	B *
Orange RN	Orange	Azo	B *
Patent blue A	Blue	Triphenylmethane	C
Permanent orange G	Orange	Pyrazolone	C
Phloxine	Red	Azo	B
Phthalocyanine green	Green	Phthalocyanine	C
Ponceau cryst. 6R	Red	Azo	C
Ponceau MX	Red	Azo	B *
Ponceau 3R	Red	Azo	B *
Ponceau 4R	Red	Azo	A *
Ponceau SX	Red	Azo	A *
Quinoline yellow	Yellow	Quinoline	B
Red 6B	Red	Azo	A *
Red 10B	Red	Azo	B *
Red FB	Red	Azo	A *
Red 2G	Red	Azo	B *
Resorcine brown	Brown	Disazo	C

Name	Hue	Chemical type	Safety rating
Rhodamine B	Red	Xanthene	B * >
Rhodamine 6G	Red	Xanthene	B * >
Rhodamine G	Red	Xanthene	B
Rose bengal	Red	Xanthene	B
Soluble blue [b]	Blue	Triphenylmethane	C
Sudan II	Orange	Azo	C
Sudan IV	Red	Disazo	C
Sudan red G	Red	Azo	C
Sunset yellow FCF	Orange	Azo	A *
Tartrazine	Yellow	Pyrazolone	A *
Turquoise blue G	Blue	Triphenylmethane	C
Violet 5BN	Violet	Triphenylmethane	B * >
Violet BNP	Violet	Triphenylmethane	#
Xylene red B	Red	Xanthene	B
Yellow 2G	Yellow	Pyrazolone	B *
Yellow RFS	Yellow	Azo	B *
Yellow RY	Yellow	Azo	B *
PLANT BASED PRODUCTS			
Alkannet	Red		/ *
Annatto	Orange		/ *
Caramel	Brown	Heated sugar	/ *
Carbon black	Black	Pure carbon	/ *
Carotene	Yellow		/ *
Chlorophyll	Green		/ *
Copper chlorophyllin	Green		X
Flavine	Yellow		/ *
Indigo	Blue		/ *
Orchil	Red		/ *
Osage orange	Yellow		/ *
Persian berry	Yellow		/ *
Safflower	Red		/ *
Saffron	Yellow		/ *
Sandalwood	Red		/ *
Turmeric	Yellow		/ *
Other extracts of food plants and pure colouring principles eg. Morin			/ *
ANIMAL PRODUCTS			
Cochineal	Red		/ *
MINERAL COLOURS			
Aluminium	Metallic		*
Iron oxide (Bole)	Various		/ *
Silver	Metallic		*
Titanium dioxide	White		*
Ultramarine	Blue		*

TABLE I.2 : 'ACCEPTABLE DAILY INTAKE' FIGURES FOR COAL TAR COLOURS, WHO/FAO JECFA ASSESSMENTS, 1964 - 1985

Compiled from:
JECFA Specifications for the Identity and Purity of Food Additives and their Toxicological Evaluation FAO Nutrition Meetings Report series No 38, 1965; JECFA Toxicological Evaluation of some Food colours WHO Food Additives Series, No 6 and No 8, 1975; JECFA Evaluation of Certain Food Additives 21st report WHO Technical Report Series no 617, 1978; FAO/WHO Food Additives Data System FAO Food and Nutrition Papers 30/Rev1 and 30/REv1/Add1, FAO Rome 1985.

KEY:

JECFA	Joint Expert Committee on Food Additives, of WHO and FAO
N	No ADI allocated - because of lack of information
C	Colour 'Not to be used' because safety not established or lack of information or possible harmful effects
D	Colour 'Not to be used' because harmful
T	Temporary ADI; normally set for a specified time while awaiting more data
F	Full ADI; evaluation complete
ADI	Acceptable daily intake over a lifetime (mg/kg bodyweight/day)

Colour	Date of JECFA decision									
	1964 -66	1969	1972	1974 -75	1977 -78	1979	1980	1981 -82	1983 -84	1985
Acid bordeau B										
Acid green GG	D									
Acid magenta II	N									
Acid violet 6B					C					
Acid violet 4BN										
Acid violet S4B										
Acid yellow G					N					
Alkali blue										
Allura red				N	N	7F	7T	7F		
Amaranth	1.5F		.75T	.75T	.75T			.75T	.5F	
Amidoazotoluol										
Aminoazobenzene										
Auramine	D									

Colour	Date of JECFA decision 1964-66	1969	1972	1974-75	1977-78	1979	1980	1981-82	1983-84	1985
Aurantia										
Aurine										
Baking brown										
Baking brown AW										
Benzopurpurine 4B										
Benzyl bordeau B										
Bismark brown										
Bismarck brown G										
Black 5410										
Black 7984					N					
Blue VRS										
Bordeaux extra										
Brilliant black		N		2.5T	2.5T			1F		
Brilliant blue	N	12.5F								
Brilliant croceine										
Brilliant green cryst.		Y								
Brown FK	N				N					
Butter yellow	D									
Carmoisine				.5T	1.25T				4F	
Chlorazol sky blue										
Chocolate brown FB					N					
Chocolate brown HT					.25T	.25T	.25F	2.5T	1.5F	
Chrysoidine	D									
Chrysoine					N					
Citron orange										

Colour	Date of JECFA decision 1964 -66	1969	1972	1974 -75	1977 -78	1979	1980	1981 -82	1983 -84	1985
Citrus red 2			C							
Congo red										
Coomassie navy blue										
Crispin black G										
Croceine scarlet 5R										
Cyanol										
Direct black										
Direct blue 2B										
Double brilliant scarlet										
Eosine										
Eosine scarlet										
Erythrosine		1.25T			2.5F				1.25T	
Fast green FCF		12.5F						12.5T		12.5T
Fast red E					N					
Fast red salt AL										
Fast scarlet salt R										
Fast yellow R										
Fat yellow GS										
Green S		5T		C						
Hansa yellow 5G										
Hansa yellow 10G										
Hansa yellow G										
Helindone pink										
Helio red										
Heliotrope										

Colour	1964 -66	1969	1972	1974 -75	1977 -78	1979	1980	1981 -82	1983 -84	1985
	----------- Date of JECFA decision --------------									
Idanthrene blue	N	1T		N						
Indian red										
Indigo carmine		2.5T		5F						
Induline										
Induline spirit soluble										
Light green SF	C									
Lithol rubine BK					N			N		
Magenta	D									
Malachite green	C									
Manchester yellow										
Metanil yellow										
Methylene blue										
Methyl orange										
Methyl violet										
Naphthol AS-OG										
Naphtol green B										
Naphthol AS-OL										
Napthol yellow S										
Nigrosine	C									
Nigrosine spirit										
Oil orange TX										
Oil red 2R										
Oil yellow 3G										
Oil yellow AB	D									
Oil yellow GG										

Colour	Date of JECFA decision 1964 -66	1969	1972	1974 -75	1977 -78	1979	1980	1981 -82	1983 -84	1985
Oil yellow HA										
Oil yellow OB	D									
Oil yellow XP										
Orange I					N					
Orange II										
Orange G										
Orange R										
Orange RN				N	N					
Patent blue A										
Patent blue V		1T		C				N		
Permanent orange G										
Phloxine										
Phosphine										
Phthalocyanine green										
Picric acid										
Ponceau cryst. 6R										
Ponceau 2R	C									
Ponceau 3R	D									
Ponceau 4R		.75T		.125T	.125T			.125T	4F	
Ponceau 6R										
Ponceau SX	D				N		N			
Prussian blue										
Quinoline yellow	N	.1T		.5T	.5T			.5T	10F	
Red 6B										
Red 10B										

Colour	Date of JECFA decision 1964 -66	1969	1972	1974 -75	1977 -78	1979	1980	1981 -82	1983 -84	1985
Red FB										
Red 2G					.006T	.006T		.1F		
Resorcine brown										
Rhodamine B	C									
Rhodamine 6G										
Rhodamine G										
Rocceline										
Rose bengal										
Rose pink										
Saffranine										
Scarlet GN										
Soluble blue [a]										
Soluble blue [b]										
Sudan I	D									
Sudan II										
Sudan III										
Sudan IV	C									
Sudan blue II										
Sudan red G										
Sudan R										
Sulfon red B										
Sunset yellow	5F							2.5F		
Tartrazine	7.5F									
Turquoise blue G										
Vermilion										

Colour	Date of JECFA decision 1964-66	1969	1972	1974-75	1977-78	1979	1980	1981-82	1983-84	1985
Victoria blue B										
Victoria blue R										
Victoria yellow										
Violet 5BN										
Violet BNP										
Xylene red B										
Yellow 2G				N	.025T	N				
Yellow RFS										
Yellow RY										

TABLE I.3 : OFFICIAL HAZARD ASSESSMENTS OF COAL TAR COLOURS USED IN FOOD

Compiled from:

(1) Paris Ordinance 1890, reported in W Jago & W Jago The Technology of Breadmaking Simpkin, Marshall, Hamilton, Kent, London 1911, p891-2. The Paris list was interpreted as follows:
'Permitted' - A
'Prohibited' - D

(2) Bernhard Hesse Coal-tar Colors used in Food Products US Bureau of Chemistry Bulletin No 147, Government Printing Office, Washington 1912. Hesse's assessments were interpreted as follows:
'Favourable' - A
'Unfavourable' - D
'Possibly harmful' - C

(3) Henry Kenwood Public Health Laboratory Work (Chemistry) HK Lewis, London 1920, p382-4. Kenwood's assessments were interpreted as follows:
'Harmless' - A
'Harmful' - D

(4) WH Martindale and WW Westcott The Extra Pharmocopaeia HK Lewis London 1925, vol II, p485-7. Martindale's assessments were interpreted as follows:
'Considered harmless' - A
'Poisonous' - D

(5) Food Standards Committee Supplementary Report on Colouring Matters MAFF, HMSO, London 1955. The Pharmacology Panel's assessments were interpreted as follows:
'A' - A
'B' - B
'C' - C (in this instance it actually means C, D or E)

(6) Food Standards Committee Report on Colourihng Matters MAFF, HMSO, London 1964. The Pharmacology Panel's assessments were interpreted as follows:
'A' - A
'B' - B
'C' - C
'D' - D
'E' - E
'F' - F

(7) Gaston Vettorazzi, WHO Handbook of International Food Regulatory Toxicology MTP Press, Lancaster 1981. JECFA's assessments were interpreted as follows:
'A'; 'full ADI' - A
'B'; 'C.I'; 'temporary ADI' - B
'C.III'; 'possibly harmful' - C
'E'; 'harmful' - D
'C.II'; 'D'; 'insufficient data' - E

(8) Food Advisory Committee Final Review of the Colouring Matter in Food Regulations 1973 MAFF, HMSO, London 1987.

KEY:
A Acceptable for food use
B Possibly acceptable; insufficient information
C Possibly harmful; insufficient information
D Harmful
E Insufficient information

Colour	Hazard assessments								
	1890 (1)	1912 (2)	1920 (3)	1925 (4)	1955 (5)	1964 (6)	1981 (7)	1987 (8)	Hazard rating
Acid bordeau B	A	A		A	C				C
Acid green GG		A			C		D		D
Acid magenta II	A	A		A	A		E		E
Acid violet 6B		A			B	D	C		C
Acid violet 4BN					B				B
Acid yellow G	A	C		A	B		E		E
Alkali blue		A			C		E		E
Allura red							B	B	B
Amaranth		A		A	A	A	B	A	A
Amidoazotoluene				A					A
Aminoazobenzene				A					A
Auramine		D			B		D		D
Aurantia	D	D							D
Aurine		C							C
Baking brown					C				C
Baking brown AW					B				B
Benzopurpurine 4B		D			C				C
Benzyl bordeau B					C				C
Bismark brown		D	D	D	C				C
Bismarck brown G		C		A	C				C
Black 5410					C				C
Black 7984						B	E		E

Colour	Hazard assessments 1890 (1)	1912 (2)	1920 (3)	1925 (4)	1955 (5)	1964 (6)	1981 (7)	1987 (8)	Hazard rating
Blue VRS					A	D	C		C
Bordeaux extra	A								A
Brilliant black BN		C			B	B	B	A	A
Brilliant blue FCF					C	D	A	A	A
Brilliant blue FCF Na salt					C				C
Brilliant croceine					C				C
Brilliant green crystal		C?			B				B
Brown FK					B	E	C	A	A
Butter yellow		C		A			D		D
Carmoisine		A		A	A	B	B	A	A
Chlorazol sky blue					C				C
Chocolate brown FB					B	E	E		E
Chocolate brown HT					B	E	B	A	A
Chrysoidine		C			C		D		D
Chrysoine	D	C				C	E		E
Citron orange									
Citrus red 2							C		C
Congo red		A		A	C		C		C
Coomassie navy blue					C				C
Crispin black G					C				C
Croceine scarlet 5R					C				C
Cyanol									
Direct black					C				C
Direct blue 2B					C				C
Double brilliant scarlet									

Colour	Hazard assessments 1890 (1)	1912 (2)	1920 (3)	1925 (4)	1955 (5)	1964 (6)	1981 (7)	1987 (8)	Hazard rating
Eosine	A	A		A	B		E		E
Eosine scarlet					B				B
Erythrosine	A	A		A	B	B	A	A	A
Fast green FCF					C		A		A
Fast red E		A		A	A	B	E		E
Fast red salt AL					C				C
Fast scarlet salt R					C				C
Fast yellow R		C			B	C			C
Fat yellow GS									
Gentian blue	A		A						A
Gentian violet			D						D
Green S					B	A	C	A	A
Hansa yellow 5G					C				C
Hansa yellow 10G					C				C
Hansa yellow G					C				C
Helindone pink					C				C
Helio red					C				C
Hofman's violet		C							C
Idanthrene blue					B	C	C		C
Indigo carmine		A		A	A	B	A	A	A
Induline		C	A	A	C				C
Induline spirit	A	A			C				C
Light green SF		A		A	C		C		C
Lithol rubine BK							E	B	B
Magenta	D	C	A	A			D		D

Colour	Hazard assessments								
	1890 (1)	1912 (2)	1920 (3)	1925 (4)	1955 (5)	1964 (6)	1981 (7)	1987 (8)	Hazard rating
Malachite green	A	C		A	C		C		C
Manchester yellow	D	D	D	D					D
Mauveine		A	A	A					A
Metanil yellow	D	C	D	D	C		E		E
Methylene blue	D	C	D	D					D
Methyl orange	D	C							C
Methyl violet	A	C	A	A	C		E	C	C
Naphtol green B		C	D	D					D
Naphthol yellow S	D	A		A	A	D	C		C
Nigrosine		A			C		C		C
Nigrosine spirit									
Oil orange TX					C				C
Oil red 2R					C				C
Oil yellow AB				A	C		D		D
Oil yellow GG					B	E	E		E
Oil yellow HA					C				C
Oil yellow OB				A	C		D		D
Oil yellow XP					B	E			E
Orange I	D	A		A	C		C		C
Orange II	D	C			C		E		E
Orange G		C			B	E	E		E
Orange GGN						C	E		E
Orange R		C							C
Orange RN		C	A	A	B	E	C		C
Patent blue A									

Colour	Hazard assessments 1890 (1)	1912 (2)	1920 (3)	1925 (4)	1955 (5)	1964 (6)	1981 (7)	1987 (8)	Hazard rating
Patent blue V					C	E	C	A	A
Permanent orange G					C				C
Phloxine	A	A		A	B				B
Phosphine									
Phthalocyanine green					C				C
Picric acid	D	D	D						D
Ponceau crystal	A				C				C
Ponceau 2R	A	C		A	B	B	C		C
Ponceau 3R	A			A	B	D	D		D
Ponceau 4R	A	C		A	A	B	B	A	A
Ponceau 6R	A					C	C		C
Ponceau SX	A				A	C	D		D
Quinoline yellow		D			B	E	B	A	A
Red 6B					A	E			E
Red 10B					B	E	C	E	E
Red FB					A	E			E
Red 2G					B	E	B	A	A
Resorcine brown					C		E		E
Rhodamine B		C			B	D	C		C
Rhodamine 6G					B	D	C		C
Rhodamine G		D			B				B
Rocceline		A							A
Rose bengal	A	A		A	B				B
Safranine		C	B						B
Scarlet GN						C	E		E

Colour	Hazard assessments 1890 (1)	1912 (2)	1920 (3)	1925 (4)	1955 (5)	1964 (6)	1981 (7)	1987 (8)	Hazard rating
Soluble blue [a]									
Soluble blue [b]		C			C		E		E
Sudan I		C					D		D
Sudan II					C				C
Sudan III							E		E
Sudan IV					C		C		C
Sudan blue II									
Sudan red G					C		E		E
Sudan R									
Sulfon red B									
Sunset yellow FCF					A	B	A	A	A
Tartrazine		D		A	A	B	A	A	A
Turquoise blue G					C				C
Victoria blue B		D							D
Victoria blue R		D?							D?
Victoria yellow	D	D	D	D					D
Violamine R							C		C
Violet 5BN					B	E	E		E
Violet BNP						E			E
Xylene red B					B				B
Yellow 2G					B	E	B	E	E
Yellow RFS					B	E			E
Yellow RY					B	E			E

TABLE I.4 : OFFICIAL HAZARD ASSESSMENTS OF MINERAL AND METALLIC COLOURS USED IN FOOD

Compiled from:

(1) Prof AS Taylor's evidence to the Select Committee on Food Adulteration 1955 Parliamentary Papers 1856 vol VIII p2 - this is not an official assessment, but had substantial status

(2) Paris Ordinance [positive list] of 1890, reported in William Jago and William Jago The Technology of Breadmaking Simpkin, Marshall, Hamilton, Kent, London 1911, p891-2

(3) Henry Kenwood Public Health Laboratory Work (Chemistry) HK Lewis, London 1920, p382-4

(4) JECFA 8th report, WHO Technical Report Series 309, Geneva 1965 p21-3

(5) Gaston Vettorazzi (ed), WHO Handbook of International Food Regulatory Toxicology MTP Press, Lancaster 1981.

(6) Food Advisory Committee Final Report on the Review of the Colouring Matter in Food Regualtions 1973 MAFF, HMSO, London 1987

See references to table I.3 for information about conversions to hazard ratings

KEY:
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Colour	Hazard assessments 1855 (1)	1890 (2)	1920 (3)	1965 (4)	1981 (5)	1987 (6)	Hazard rating
Aluminium				E	A	A	A
Blue verditer		D					D
Brick dust							
Brunswick greens		D					D
deep							
middle							
pale							
Carbon black				E	E		E
Chromates of potash							

Colour	Hazard assessments						
	1855 (1)	1890 (2)	1920 (3)	1965 (4)	1981 (5)	1987 (6)	Hazard rating
Chrome yellows	D	D					D
deep							
lemon							
orange							
Cinnabar	D	D					D
Cobalt blue							
Copper bronze		D					D
Copper sulphate		D	D				D
False brunswick greens		D					D
deep							
middle							
pale							
False verditer		D					D
Fuchsine		D					D
Fuller's earth							
Gold				E	A	A	A
Gold bronze		D					D
Indian red							
Iodide of lead		D					D
Iodide of mercury							
Iron oxides and hydroxides				E	B	A	A
Bole armenian							–
Red ochre							A
Sienna							A
Umber							A
Vandyke brown							
Venetian red							A
Yellow ochre							A
Massicot	D	D					D
Naples yellow							
Orpiment	D	D					D

Colour	Hazard assessments 1855 (1)	1890 (2)	1920 (3)	1965 (4)	1981 (5)	1987 (6)	Hazard rating
Plaster of Paris							
Plumbago		D					D
Potash							
Prussian blue	A						A
Red lead	D	D					D
Scheele's green	D	D					D
Silver				E		A	A
Silver bronze		D					D
Sulphate of iron							
Talc							
Terra alba							
Tin							
Titanium dioxide				B	A	A	A
Ultramarines	A			E	E		E
Verdigris		D					D
Verditer		D					D
White lead		D					D
Zinc white							

TABLE I.5 : OFFICIAL HAZARD ASSESSMENTS OF PLANT AND ANIMAL COLOURS USED IN FOOD

Compiled from:

(1) Henry Kenwood Public Health Laboratory Work (Chemistry) HK Lewis, London 1920, p382-5

(2) Martindale & Westcott Extra Pharmacopaeia Lewis. London 1925, p487

(3) JECFA 8th report, WHO Technical Report Series 309, Geneva 1965, p21-3

(4) Gaston Vettorazzi (ed) Handbook of International Regulatory Toxicology MTP Press, Lancaster 1981, vol 2

(5) Food Advisory Committee Final Report on the Review of the Colouring Matter in Food Regulations 1973 MAFF, HMSO, London 1987

See references to table I.3 for information about conversions to hazard ratings

KEY
A Acceptable for food use
B Possibly acceptable; insufficient information
C Possibly harmful; insufficient information
D Harmful
E Insufficient infornation

Colour	Hazard assessments 1920 (1)	1925 (2)	1965 (3)	1980 (4)	1987 (5)	Hazard rating
ANIMAL PRODUCTS						
Cochineal	A		E	E	A	A
Carminic acid			E			E
PLANT PROCUCTS						
Alkannet			E	E		E
Annatto	A	A	E	B	A	A
Bixin			E		A	A
Norbixin			E		A	A
Anthocyanins			E	E	A	A
β-apo-8'-carotenal			B	A	A	A
β-apo-8'-carotenic acid ethyl ester			B	A	A	A

Colour	Hazard assessments 1920 (1)	1925 (2)	1965 (3)	1980 (4)	1987 (5)	Hazard rating
Beetroot red	A		E	B	A	A
Betanin			E			E
Brazil wood			E			E
Caramel	A		E	A	B	B
Burnt sugar	A		E	A		A
Ammonia				B	B	B
Ammonia/sulphite				B	B	B
Carotene, β						
Natural				E	A	A
Synthetic			B	A	A	A
Carotene, γ & α				E	A	A
Charcoal			E	E	A	A
Chlorophyll	A		E	A	A	A
Copper complexes of chlorophyll			E	A	A	A
Fustic			E			E
Gamboge	D					D
Indigo	A					A
Liquorice			E			E
Logwood	A	A	E			E
Lycopene			E	E	B	B
Madder extracts	A	A	E			E
Orchil			E	E		E
Litmus	A					A
Orcein			E			E
Paprika						
Capsanthin			E	E	E	E
Capsorubin			E		E	E
Persian berry extracts			E	E		E
Quercitron extracts			E	C		C
Riboflavin			E	A	A	A
Riboflavin-5'-phosphate					A	A

Colour	Hazard assessments 1920 (1)	1925 (2)	1965 (3)	1980 (4)	1987 (5)	Hazard rating
Safflower extracts	A		E	B		B
Saffron extracts	A	A	E	E	E	E
Crocein			E	E	E	E
Crocetin			E			E
Sandalwood extracts			E		E	E
Santalin					E	E
Turmeric extracts	A	A	E	B	E	E
Curcumin			E	B	B	B
Xanthophylls			E	E	B	B
Canthaxanthin			B	A	C	C
Cryptoxanthin				E	B	B
Flavoxanthin				E	B	B
Lutein				E	B	B
Rhodoxanthin				E	B	B
Rubixanthin				E	B	B
Violaxanthin				E	B	B
Extracts of edible plants	A	A	A	A	A	A
Chrysophanic acid	A	A				A

TABLE I.6 : NUMBER OF COAL TAR COLOURS IN USE AT VARIOUS TIMES FROM 1850 TO 1987, DIVIDED BY HAZARD GROUP

Compiled from tables D.1 and I.3

KEY to retrospective hazard group:

A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Year	No Colours / Retrospective Hazard Group					
	A	B	C	D	E	Total
1887	-	-	6	6	-	21
1895	-	-	2	6	-	15+
1901	-	-	9	5	-	23
1919	4	3	5	10	4	26
1924	11	4	16	9	17	57
1926	8	2	10	7	2	29
1928	10	0	18	9	11	48
1936	8	0	10	6	5	29
1942	3	0	3	0	2	8+
1954/5	15	8	47	7	23	100
1957	12	0	4	2	12	30
1973	-	-	3	0	-	24
1978	15	1	1	0	1	18
1987	15	1	1	0	1	18

TABLE I.7 : NUMBER OF MINERAL COLOURS IN USE AT VARIOUS TIMES FROM 1850 TO 1987, DIVIDED BY HAZARD GROUP

Compiled from tables D.3 and I.4

KEY to Retrospective hazard group:

A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Year	No Colours / Retrospective Hazard Group					
	A	B	C	D	E	Total
1850s	10	0	0	20	12	42
early 1870s	10	0	0	20	11	41
1887	0	0	0	7	1	8+
1901	4	0	0	4	0	8+
1911	4	0	0	7	2	13
1919	0	0	0	1	0	1+
192102	0	0	0	1	1	2+
1924	4	0	0	1	1	6
1954	5	0	0	0	2	7
1957	5	0	0	0	2	7
1973	8	0	0	0	1	9
1978	8	0	0	0	0	8
1987	8	0	0	0	0	8

TABLE I.8 : NUMBER OF PLANT & ANIMAL COLOURS IN USE AT VARIOUS TIMES FROM 1850 TO 1987, DIVIDED BY HAZARD GROUP

Compiled from tables D.4 and I.5

KEY to retrospective hazard group:

A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Year	No Colours / Retrospective Hazard Group					
	A	B	C	D	E	Total
1850s	5	2	1	1	10	19
early 1870s	5	2	1	1	11	20
1887	4	4	0	1	7	16
1901	5	1	0	1	3	10
1911	2	3	1	0	5	11
1919	7	3	0	1	7	18
1924	4	0	0	0	1	5
1936	3	1	0	0	2	6+
1954	6	3	1	0	6	16
1956	4	2	0	0	1	7+
1957	6	3	1	0	6	16
1973	9	4	0	0	4	17
1978	10	4	0	0	3	17
1987	10	4	0	0	3	17

Note: Edible plants and foods have been omitted.

APPENDIX J

TABLE J.1 : NUMBER OF YEARS FOR WHICH INDIVIDUAL COAL TAR COLOURS WERE AVAILABLE FOR USE IN FOOD

Source of information:

(1) This figure is the date of discovery given by the Colour Index 1924, 1928, 1956, 1963, 1971, 1975, 1982, and Hesse 1912. Where there was a discrepancy between Colour Index and Hesse, I used the CI date.

(2) This is primarily based on the date of discovery, except where more precise information about the date of first use in food is available. I have assumed that the first commercial use of a dye was one year after the date of discovery, if later than 1870. Where the discovery date was before 1870, I have assumed the colour was not used until 1870 to allow for the fact that early colours offered few technical advantages over existing colours. Hassall reported that coal tar colours were introduced into food before 1876 (and after 1861). 'a' indicates that the date of introduction was assumed to be 1870.

(3) This figure is the year the colour was banned or was reported as no longer used in food. The source of the information was table D.1 and D.2.

(4) Calculated by subtracting column 2 from column 3.

Colour	Year first synthesised (1)	Possible first use in food (2)	Year use in food stopped (3)	Number of years available (4)
Acid bordeau B	1878	1879	1957	78
Acid green GG	1883	1884	1957	73
Acid magenta II	1877	1878	1957	79
Acid violet 6B	1889	1890	1957	67
Acid violet 4BN	1896	1897	1957	60
Acid yellow G	1877	1878 1973	1957) 1975)	81
Alkali blue	1862	a 1870	1957	87
Allura red	1970	-	-	0
Amaranth	1878	1879	current	108
Aminoazotoluene	1877	1878	1935	57
Aminoazobenzene	1861	a 1870	1957	87
Aniline greens	1862	a 1870	1894?	24

Colour	Year first synthesised (1)	Possible first use in food (2)	Year use in food stopped (3)	Number of years available (4)
Auramine	1883	1884	1957	73
Aurantia	1873	1874	1920?	46?
Aurine	1834	a 1870	1920?	50?
Baking brown	1887	1888	1957	69
Baking brown AW			1957	
Benzopurpurine 4B	1884	1885	1957	72
Benzyl bordeau B	1885	1886	1957	71
Bismark brown	1878	1879	1957	78
Bismarck brown G	1863	a 1870	1957	87
Black 5410			1957	
Black 7984		1966	1976	10
Blue VRS	1902	1903	1966	63
Bordeaux extra	1883	1884	1957	73
Brilliant black BN	1885	1886	current	101
Brilliant blue FCF	1896	1897 1973	1957) current)	74
Brilliant croceine	1882	1883	1957	74
Brilliant green cryst.	1879	1880	1957	77
Brown FK		1920?	current	67
Butter yellow	1876	1877	1937?	60?
Carmoisine	1883	1884	current	103
Chlorazol sky blue	1891	1892	1957	65
Chocolate brown FB			1978	
Chocolate brown HT			current	
Chrysoidine	1875	1876	1957	81
Chrysoine	1875	1876	1957	81

Colour	Year first synthesised (1)	Possible first use in food (2)	Year use in food stopped (3)	Number of years available (4)
Citron orange	1880	1881	1957	76
Congo red	1884	1885	1957	72
Coomassie navy blue	1895	1896	1957	61
Crispin black G			1957	
Croceine scarlet 5R	1879	1880	1957	77
Cyanol	1891	1892	1957	65
Diamond yellow	1889	1890	1957	67
Direct black	1889 ?	1890 ?	1957	67?
Direct blue 2B	1890	1891	1957	66
Double brilliant scarlet	1882	1883	1957	74
Eosine	1871	1872	1957	85
Eosine scarlet	1875	1876	1957	81
Erythrosine	1876	1877	current	110
Fast green FCF	1927	1928	1957	29
Fast red E	1878	1879	1973	94
Fast red salt AL	1914	1915	1957	42
Fast scarlet salt R	1911	1912	1957	45
Fast yellow R	1878	1879	1957	78
Fat yellow GS	1887 ?	1888 ?	1957	69 ?
Gentian blue 6B	1861	a 1870	1957	87
Gentian violet			1920	
Green S	1883	1884	current	103
Hansa yellow 5G	1909	1910	1957	47
Hansa yellow 10G	1911	1912	1957	45
Hansa yellow G	1909	1910	1957	47

Colour	Year first synthesised (1)	Possible first use in food (2)	Year use in food stopped (3)	Number of years available (4)
Helindone pink	1907	1908	1957	49
Helio red	1905	1906	1957	51
Hofman's violet	1863	a 1870	1957	87
Idanthrene blue	1901	1902 1973	1957) 1975)	57
Indigo carmine	1740	a 1870	current	117
Induline	1867	a 1870	1957	87
Induline spirit soluble	1863	a 1870	1957	87
Light green SF	1879	1880	1957	77
Lithol rubine BK	1903	 1973	1957) current)	14?
Magenta	1856	a 1870	1957	87
Malachite green	1877	1878	1957	79
Manchester yellow	1856	a 1870	1925	55
Mauveine	1856	a 1870	1957	87
Metanil yellow	1879	1880	1957	77
Methylene blue	1876	1877	1957	80
Methyl orange	1876	1877	1957	80
Methyl violet	1861	a 1870 1973	1957) 1987)	101
Naphthol AS-OG	1930?	1931?	1957	26?
Naphtol green B	1883	1884	1957	73
Naphthol AS-OL	1922	1923	1957	34
Napthol yellow S	1879	1880	1966	86
Nigrosine	1867	a 1870	1957	87
Nigrosine spirit	1867	a 1870	1957	87
Oil orange TX	1878	1879	1957	78

Colour	Year first synthesised (1)	Possible first use in food (2)	Year use in food stopped (3)	Number of years available (4)
Oil red 2R	1894	1895	1957	62
Oil yellow AB	1890	1891	1957	66
Oil yellow GG	1875	1876	1973	97
Oil yellow HA	1890	1891	1957	66
Oil yellow OB	1905	1906	1957	51
Oil yellow XP	1923	1924	1973	49
Orange I	1876	1877	1957	80
Orange II	1876	1877	1957	80
Orange IV	1876	1877	1957	80
Orange G	1878	1879	1978	99
Orange R	1887	1888	1957	69
Orange RN	1878	1879	1975	96
Patent blue A	1888	1889	1957	68
Patent blue V	1888	1889 1973	1957) current)	82
Permanent orange G	1910	1911	1957	46
Phloxine	1875	1876	1957	81
Phosphine	1862	a 1870	1957	87
Phthalocyanine green	1935	1936	1957	21
Picric acid	1771	a 1870	1923?	53
Ponceau cryst. 6R	1883	1884	1957	73
Ponceau 2R	1878	1879	1970	91
Ponceau 3R	1878	1879	1966	87
Ponceau 4R	1878	1879	current	108
Ponceau SX	1954	1955	1966	11
Quinoline yellow	1882	1883 1973	1957) current)	88

Colour	Year first synthesised (1)	Possible first use in food (2)	Year use in food stopped (3)	Number of years available (4)
Red 6B	1902	1903	1973	70
Red 10B	1890	1891	1973	82
Red FB	1893	1894	1973	79
Red 2G	1902	1903	current	84
Resorcine brown	1881	1882	1957	75
Rhodamine B	1887	1888	1957	69
Rhodamine 6G	1892	1893	1957	64
Rhodamine G	1891	1892	1957	65
Rocceline	1877	1878	1957	79
Rose bengal	1882	1883	1957	74
Saffranine	1859	a 1870	1957	87
Soluble blue [a]	1858	a 1870	1957	87
Soluble blue [b]	1862	a 1870	1957	87
Sudan I	1883	1884	1957	73
Sudan II	1883	1884	1957	73
Sudan III	1879	1880	1957	77
Sudan IV			1957	
Sudan blue II			1957	
Sudan red G	1899	1900	1957	57
Sudan R	1937	1938	1957	19
Sulfon red B			1957	
Sunset yellow FCF	1937	1938	current	49
Tartrazine	1884	1885	current	102
Turquoise blue G	1891	1892	1957	65
Victoria blue B	1883	- ?		

Colour	Year first synthesised (1)	Possible first use in food (2)	Year use in food stopped (3)	Number of years available (4)
Victoria blue R	1892	- ?		
Victoria yellow	1869	a 1870	1925	55
Violet 5BN	1890	1891	1957	66
Violet BNP	1891	1957 ?	1973	16
Xylene red B	1906	1907	1957	50
Yellow 2G	1908	1909	current	78
Yellow RFS	1878	1879	1966	87
Yellow RY	1931	1932	1966	34

TABLE J.2 : COAL TAR COLOURS USED IN 1954/5 DIVIDED BY RETROSPECTIVE HAZARD RATING, SHOWING PERIODS OF AVAILABILITY, 1870 - 1987

Compiled from table J.1

KEY:
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

```
                                Period of use in food
Colour            1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980
```

Colours with retrospective hazard rating A

```
Patent blue V                                                           XXXXXXX
Fast green FCF                                  XXXXXXXXXXXXXXXX
Brilliant blue FCF              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX       XXXXXXXX
Quinoline yellow         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX       XXXXXXXX
Sunset yellow FCF                                    XXXXXXXXXXXXXXXXXXXXXXXXXX
Brown FK                                ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Red 2G                              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Chocolate brown HT            ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Brilliant black BN        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Tartrazine                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Green S                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Carmoisine               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Ponceau 4R             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Amaranth               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Erythrosine           XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Indigo carmine    XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

Colours with retrospective hazard rating B

```
Lithol rubine BK                                                       XXXXXXXX
Baking brown AW                                           .....X
Xylene red B                          XXXXXXXXXXXXXXXXXXXXXXXXXX
Acid violet 4BN                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Rhodamine G                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Brilliant green cryst.      XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Rose bengal              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Phloxine             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Eosine scarlet       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

```
                                     Period of use in food
Colour                1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980
```

Colours with retrospective hazard rating C

```
Blue VRS                               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Napthol yellow S           XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Ponceau 2R                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Orange RN                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Idanthrene blue                       XXXXXXXXXXXXXXXXXXXXXXXXXXXXX       XX
Methyl violet         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX       XXXXXXX
Crispin black G                                                ...X
Sudan IV                                                       ...X
Black 5410                                                   .....X
Phthalocyanine green                                   XXXXXXXXXXXX
Fast red salt AL                             XXXXXXXXXXXXXXXXXXXXXX
Fast scarlet salt R                        XXXXXXXXXXXXXXXXXXXXXXXX
Permanent orange G                         XXXXXXXXXXXXXXXXXXXXXXXX
Hansa yellow 10G                           XXXXXXXXXXXXXXXXXXXXXXXX
Hansa yellow 5G                           XXXXXXXXXXXXXXXXXXXXXXXXX
Hansa yellow G                            XXXXXXXXXXXXXXXXXXXXXXXXX
Helindone pink                           XXXXXXXXXXXXXXXXXXXXXXXXXX
Helio red                               XXXXXXXXXXXXXXXXXXXXXXXXXXX
Oil red 2R                         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Coomassie navy blue                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Rhodamine 6G                      XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Direct blue 2B                   XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Oil yellow HA                    XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Turquoise blue G                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Chlorazol sky blue               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Acid violet 6B                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Direct black                   ?XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Rhodamine B                    XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Baking brown                   XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Benzopurpurine 4B             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Congo red                     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Benzyl bordeau B              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Sudan II                     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Brilliant croceine           XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Ponceau cryst. 6R            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Acid bordeau B             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Oil orange TX             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Light green SF             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Bismark brown              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Croceine scarlet 5R        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Fast yellow R              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Malachite green           XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Orange I                  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Bismarck brown G      XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Induline spirit       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Induline              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Nigrosine             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

```
                                Period of use in food
Colour           1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980
```

Colours with retrospective hazard rating D

```
Ponceau SX                                                   XXXXXX
Ponceau 3R             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Oil yellow OB                       XXXXXXXXXXXXXXXXXXXXXXXXXXX
Oil yellow AB                XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Auramine                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Acid green GG            XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Chrysoidine          XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

Colours with retrospective hazard rating E

```
Violet BNP                                                 ? ...XXXXXXXXX
Yellow RY                                        XXXXXXXXXXXXXXXXXX
Yellow RFS                 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Fast red E             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Oil yellow GG        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Oil yellow XP                                XXXXXXXXXXXXXXXXXXXXXXXXXX
Red 6B                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Red FB                        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Red 10B                      XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Chocolate brown FB            ....XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Orange G               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Yellow 2G                             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Acid yellow G         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX       XX
Sudan red G                      XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Violet 5BN                   XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Resorcine brown         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Metanil yellow         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Orange II             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Acid magenta II       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Eosine             XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Soluble blue [b]  XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Alkali blue       XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Patent blue A               XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
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TABLE J.3 : HAZARD BURDEN OF COAL TAR COLOURS REMOVED BY THE PERMITTED LIST OF 1957, 1870 - 1957

This list only contains colours used in 1954/5 and banned by the 1957 list

Compiled from table I.3 and J.1

KEY:
A Acceptable for food use
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Name of colour banned by 1957 list	No. years colour in use till 1957	Retrospective hazard rating
Acid bordeau B	78	C
Acid green GG	73	D
Acid magenta II	79	E
Acid violet 6B	67	C
Acid violet 4BN	60	B
Acid yellow G	79	E
Alkali blue	87	E
Auramine	73	D
Baking brown	69	C
Baking brown AW	4+	B
Benzopurpurine 4B	72	C
Benzyl bordeau B	71	C
Bismark brown	78	C
Bismarck brown G	87	C
Black 5410	4+	C
Brilliant blue FCF	60	A
Brilliant croceine	74	C

Name of colour banned by 1957 list	No. years colour in use till 1957	Retrospective hazard rating
Brilliant green crystal	77	B
Chlorazol sky blue	65	C
Chrysoidine	81	D
Congo red	72	C
Coomassie navy blue	61	C
Crispin black G		C
Croceine scarlet 5R	77	C
Direct black	67?	C
Direct blue 2B	66	C
Eosine	85	E
Eosine scarlet	81	B
Fast green FCF	29	A
Fast red salt AL	42	C
Fast scarlet salt R	45	C
Fast yellow R	78	C
Hansa yellow 5G	47	C
Hansa yellow 10G	45	C
Hansa yellow G	47	C
Helindone pink	49	C
Helio red	51	C
Idanthrene blue	55	C
Induline	87	C
Induline spirit soluble	87	C
Light green SF	77	C
Malachite green	79	C

Name of colour banned by 1957 list	No. years colour in use till 1957	Retrospective hazard rating
Metanil yellow	77	E
Methyl violet	87	C
Nigrosine	87	C
Oil orange TX	78	C
Oil red 2R	62	C
Oil yellow AB	66	D
Oil yellow HA	66	C
Oil yellow OB	51	D
Orange I	80	C
Orange II	80	E
Patent blue A	68	
Permanent orange G	46	C
Phloxine	81	B
Phthalocyanine green	21	C
Ponceau cryst. 6R	73	C
Quinoline yellow	74	A
Resorcine brown	75	E
Rhodamine B	69	C
Rhodamine 6G	64	C
Rhodamine G	65	B
Rose bengal	74	B
Soluble blue [b]	87	E
Sudan II	73	C
Sudan IV		C
Sudan red G	57	E

Name of colour banned by 1957 list	No. years colour in use till 1957	Retrospective hazard rating
Turquoise blue G	65	C
Violet 5BN	66	B
Xylene red B	50	B

TABLE J.4 : HAZARD BURDEN OF COAL TAR COLOURS REMAINING IN 1957 AFTER THE PERMITTED LIST WAS ESTABLISHED, 1870 - 1957

Compiled from tables I.3 and J.1

KEY:
A Acceptable for food use
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Colour remaining after 1957	No years colour in use to 1957	Retrospective hazard rating
Amaranth	78	A
Blue VRS	54	C
Brilliant black BN	71	A
Brown FK		A
Carmoisine	73	A
Chocolate brown FB		E
Chocolate brown HT		A
Erythrosine	80	A
Fast red E	78	E
Green S	73	A
Indigo carmine	87	A
Napthol yellow S	77	C
Oil yellow GG	81	E
Oil yellow XP	33	E
Orange G	78	E
Orange RN	78	C
Ponceau 2R/MX	78	C
Ponceau 3R	78	D

Colour remaining after 1957	No years colour in use to 1957	Retrospective hazard rating
Ponceau 4R	78	A
Ponceau SX	2	D
Red 6B	54	E
Red 10B	66	E
Red FB	63	E
Red 2G	54	A
Sunset yellow FCF	19	A
Tartrazine	72	A
Violet BNP	0 ?	E
Yellow 2G	48	E
Yellow RFS	78	E
Yellow RY	25	E

TABLE J.5 : HAZARD BURDEN OF COLOURS ON THE PERMITTED LIST, 1957- 1987

Compiled from tables I.3 and J.1

KEY
A Acceptable for food use
B Possibly acceptable; insufficient information
C Possibly harmful; insufficient information
D Harmful
E Insufficient information

Colour on permitted list 1957 - 1987	No. years on permitted list 1957 - 1987	Retrospective hazard rating
Acid yellow G	2	E
Allura red	0	B
Amaranth	30	A
Black 7984	10	E
Blue VRS	9	C
Brilliant black BN	30	A
Brilliant blue FCF	14	A
Brown FK	30	A
Carmoisine	30	A
Chocolate brown FB	21	E
Chocolate brown HT	30	A
Erythrosine	30	A
Fast red E	16	E
Green S	30	A
Indanthrene blue	2	C
Indigo carmine	30	A
Lithol rubine BK	14	B
Methyl violet	14	C
Napthol yellow S	9	C

Colour on permitted list 1957 - 1987	No. years on permitted list 1957 - 1987	Retrospective hazard rating
Oil yellow GG	16	E
Oil yellow XP	16	E
Orange G	21	E
Orange RN	18	C
Patent blue V	14	A
Ponceau 2R	13	C
Ponceau 3R	9	D
Ponceau 4R	30	A
Ponceau SX	9	D
Quinoline yellow	14	A
Red 6B	16	E
Red 10B	16	E
Red FB	16	E
Red 2G	30	A
Sunset yellow FCF	30	A
Tartrazine	30	A
Violet BNP	16	E
Yellow 2G	30	E
Yellow RFS	9	E
Yellow RY	9	E

APPENDIX K

TABLE K.1 : COAL TAR COLOURS: SCORE REPRESENTING NUMBER OF YEARS IN USE IN FOOD IN FIVE PERIODS BETWEEN 1850 AND 1987

This table gives a score to each colour (0, 1 or 2) to represent the number of years for which it was in use.

Compiled from tables D.1 and D.2

KEY:

0 No record of use in this period

1 Use in food reported, by 50% or less of records for that period in tables D.1 and D.2

2 Use in food reported, by more than 50% of records for that period in tables D.1 and D.2

For 1850-1875, where there were no records, colours were given '1' if first synthesised between 1860 and 1870 and '2' if synthesised before 1860. Data from 1926 and 1935/6 were omitted.

Colour	Score for number of years in use in each period 1850-1875	1876-1900	1901-1924	1925-1956	1957-1987
Acid bordeau B	0	0	1	2	0
Acid green GG	0	0	1	2	0
Acid magenta II	0	0	1	1	0
Acid violet 6B	0	0	1	1	0
Acid violet 4BN	0	0	0	1	0
Acid yellow G	0	0	2	2	1
Alkali blue	1	0	0	1	0
Allura red					
Amaranth	0	0	2	2	2
Amidoazotoluene	0	0	0	1	0
Aminoazobenzene	1	2	1	1	0
Aniline greens	1	1	0	0	0
Auramine	0	0	2	1	0

Colour	Score for number of years in use in each period 1850-1875	1876-1900	1901-1924	1925-1956	1957-1987
Aurantia	0	0	1	0	0
Aurine	2	1	0	0	0
Baking brown	0	0	0	1	0
Baking brown AW	0?	0	0	1	0
Benzopurpurine 4B	0	0	2	1	0
Benzyl bordeau B	0	0	0	1	0
Bismark brown	0	0	2	1	0
Bismarck brown G	1	1	2	1	0
Black 5410	0?	0	0	1	0
Black 7984	0	0	0	0	1
Blue VRS	0	0	1	1	1
Bordeaux extra	0	0	0	1	0
Brilliant black BN	0	0	0	1	2
Brilliant blue FCF	0	0	1	1	2
Brilliant croceine	0	0	0	1	0
Brilliant green crystal	0	0	0	1	0
Brown FK	0?	0	1	2	2
Butter yellow	0	1	2	1	0
Carmoisine	0	0	1	2	2
Chlorazol sky blue	0	0	0	1	0
Chocolate brown FB	0?	0	1	1	2
Chocolate brown HT	0?	0	1	1	2
Chrysoidine	0	2	1	2	0
Chrysoine	0	0	1	1	0
Citron orange	0	0	1	0	0

Colour	Score for number of years in use in each period 1850-1875	1876-1900	1901-1924	1925-1956	1957-1987
Congo red	0	0	2	2	0
Coomassie navy blue	0	0	0	1	0
Crispin black G	0?	0	0	1	0
Croceine scarlet 5R	0	0	0	2	0
Cyanol	0	0	1	0	0
Diamond yellow	0	0	1	0	0
Direct black	0?	0	0	2	0
Direct blue 2B	0	0	0	2	0
Double brilliant scarlet	0	0	0	1	0
Eosine	0	0	2	1	0
Eosine scarlet	0	0	2	1	0
Erythrosine	0	0	1	2	2
Fast green FCF	0	0	0	1	0
Fast red E	0	0	0	2	1
Fast red salt AL	0	0	0	1	0
Fast scarlet salt R	0	0	0	1	0
Fast yellow R	0	0	0	1	0
Fat yellow GS	0?	0	1	0	0
Gentian blue 6B	1	2	1	0	0
Gentian violet	0?	0	1	0	0
Green S	0	0	1	1	2
Hansa yellow 5G	0	0	0	1	0
Hansa yellow 10G	0	0	0	1	0
Hansa yellow G	0	0	0	1	0
Helindone pink	0	0	0	1	0

Colour	Score for number of years in use in each period 1850-1875	1876-1900	1901-1924	1925-1956	1957-1987
Helio red	0	0	0	1	0
Hofman's violet	1	1	1	0	0
Idanthrene blue	0	0	0	1	1
Indigo carmine	2	1	0	2	2
Induline	1	2	2	2	0
Induline spirit soluble	1	0	0	1	0
Light green SF	0	0	1	2	0
Lithol rubine BK	0	0	0	0	2
Magenta	2	2	2	1	0
Malachite green	0	0	2	1	0
Manchester yellow	2	2	2	0	0
Mauveine	2	2	1	0	0
Metanil yellow	0	0	2	1	0
Methylene blue	0	0	2	0	0
Methyl orange	0	0	1	0	0
Methyl violet	1	1	2	1	2
Naphthol AS-OG	0?	0	0	1	0
Naphtol green B	0	0	1	1	0
Naphthol AS-OL	0	0	0	1	0
Napthol yellow S	0	0	1	2	1
Nigrosine	1	0	1	2	0
Nigrosine spirit	1	0	0	1	0
Oil orange TX	0	0	0	1	0
Oil red 2R	0	0	0	1	0
Oil yellow AB	0	0	0	2	0

Colour	Score for number of years in use in each period				
	1850-1875	1876-1900	1901-1924	1925-1956	1957-1987
Oil yellow GG	0	2	2	1	1
Oil yellow HA	0	0	0	1	0
Oil yellow OB	0	0	1	2	0
Oil yellow XP	0	0	0	1	1
Orange I	0	0	1	2	0
Orange II	0	0	1	2	0
Orange IV	0	2	1	0	0
Orange G	0	2	0	2	2
Orange R	0	0	0	1	0
Orange RN	0	2	2	2	1
Patent blue A	0	0	0	1	0
Patent blue V	0	0	1	0	2
Permanent orange G	0	0	0	1	0
Phloxine	0	0	2	1	0
Phosphine	0	0	1	0	0
Phthalocyanine green	0	0	0	1	0
Picric acid	1	1	1	0	0
Ponceau cryst. 6R	0	0	0	1	0
Ponceau 2R	0	0	1	2	1
Ponceau 3R	0	0	1	2	1
Ponceau 4R	0	0	1	2	2
Ponceau SX	0	0	0	0	1
Quinoline yellow	0	0	1	1	2
Red 6B	0	0	0	1	1
Red 10B	0	0	0	1	1

Colour	Score for number of years in use in each period 1850-1875	1876-1900	1901-1924	1925-1956	1957-1987
Red FB	0	0	0	1	1
Red 2G	0	0	0	1	2
Resorcine brown	0	0	1	2	0
Rhodamine B	0	0	1	2	0
Rhodamine 6G	0	0	0	2	0
Rhodamine G	0	0	1	1	0
Rocceline	0	0	1	0	0
Rose bengal	0	0	1	1	0
Safranine	1	2	2	0	0
Soluble blue [a]	1	0	1	0	0
Soluble blue [b]	1	0	1	1	0
Sudan I	0	2	2	1	0
Sudan II	0	0	0	2	0
Sudan III	0	0	0	1	0
Sudan IV	0?	0	0	2	0
Sudan blue II	0?	0	0	1	0
Sudan red G	0	0	1	2	0
Sudan R	0?	0	0	1	0
Sulfon red B	0?	0	1	0	0
Sunset yellow FCF	0	0	0	1	2
Tartrazine	0	0	1	2	2
Turquoise blue G	0	0	0	1	0
Victoria yellow	1	2	1	0	0
Violet 5BN	0	0	1	1	0
Violet BNP	0	0	0	0	1

Colour	Score for number of years in use in each period 1850-1875	1876-1900	1901-1924	1925-1956	1957-1987
Xylene red B	0	0	0	1	0
Yellow 2G	0	0	0	1	2
Yellow RFS	0	0	0	1	1
Yellow RY	0	0	0	1	1

TABLE K.2 : MINERAL AND METALLIC COLOURS: SCORES REPRESENTING NUMBER OF YEARS IN USE IN FOOD, FOR FIVE PERIODS BEWEEN 1850 AND 1987

This table gives a score to each colour (0, 1 or 2) to represent the number of years for which it was in use

Compiled from tables D.3 and E.2

KEY

0 No record of use in food in this period

1 Use in food reported, by 50% or less of records for the period in tables D.3 and E.2

2 Use in food reported, by more than 50% of records for the period in tables D.3 and E.2

Colour	Score for number of years in use in each period: 1850-1875	1876-1900	1901-1924	1925-1956	1957-1987
Aluminium	0	0	0	1	2
Blue verditer	2	0	1	0	0
Bole armenian	2	0	1	1	1
Brick dust	1	0	0	0	0
Brunswick greens	2	0	0	0	0
Carbon black	0	0	0	1	2
Chromates of potash	2	0	0	0	0
Chrome yellows	2	2	1	0	0
Cinnabar	2	2	1	0	0
Cobalt blue	2	0	1	0	0
Copper bronze	2	0	0	0	0
Copper sulphate	2	2	2	0	0
False brunswick greens	2	0	0	0	0
False verditer	2	0	1	0	0

Colour	Score for number of years in use in each period: 1850-1875	1876-1900	1901-1924	1925-1956	1957-1987
Fuchsine	2	0	1	0	0
Fuller's earth	1	0	0	0	0
Gold	0	0	0	0	2
Gold bronze	2	0	0	0	0
Indian red	2	0	0	0	0
Iodide of lead	2	0	0	0	0
Iodide of mercury	2	0	0	0	0
Iron oxides	2	0	2	2	2
Massicot	2	0	0	0	0
Naples yellow	2	0	0	0	0
Orpiment	2	0	0	0	0
Plaster of Paris	2	0	0	0	0
Plumbago	2	0	0	0	0
Potash	2	0	0	0	0
Prussian blue	2	0	0	1	0
Red lead	2	2	1	0	0
Red ochre	2	0	1	0	0
Scheele's green	2	2	1	0	0
Sienna	2	0	1	0	0
Silver	0	0	0	1	2
Silver bronze	2	0	0	0	0
Sulphate of iron	2	0	0	0	0
Talc	2	0	0	0	0
Terra alba	2	0	0	0	0

Colour	Score for number of years in use in each period: 1850-1875	1876-1900	1901-1924	1925-1956	1957-1987
Tin	0	1	1	0	0
Titanium dioxide	0	0	0	1	2
Ultramarine	2	0	1	1	1
Umber	2	0	0	0	1
Vandyke brown	2	0	0	0	0
Venetian red	2	0	0	0	0
Verdigris	2	2	0	0	0
Verditer	2	2	1	0	0
White lead	2	0	1	0	0
Yellow ochre	2	0	1	0	0
Zinc white	0	0	1	0	0

TABLE K.3 : PLANT AND ANIMAL BASED COLOURS: SCORE REPRESENTING NUMBER OF YEARS IN USE IN FIVE PERIODS BETWEEN 1850 AND 1957

This table gives a score to each colour (0, 1 or 2) to represent the number of years for which it was in use

Compiled from tables D.4 and E.3

KEY:

0 No record of use in food in this period

1 Use in food reported, by 50% or less of records for the period in tables D.4 and E.3

2 Use in food reported, by more than 50% of records for the period in tables D.4 and E.3

Colour	Score for number of years in use in each period: 1850-1875	1876-1900	1901-1924	1925-1956	1957-1987
ANIMAL PRODUCTS					
Baked horse's liver	2	0	0	0	0
Burnt blood	2	0	0	0	0
Cochineal	2	2	2	2	2
PLANT PRODUCTS					
Alkannet	0	1	1	1	1
Annatto	2	2	1	2	2
Anthocyanins	0	0	1	0	2
Beetroot red	2	0	1	0	2
Brazil wood	2	2	1	0	0
Caramel	2	2	2	2	2
Carotene β/carrot	2	0	1	1	2
Catechu	2	0	0	0	0
Charcoal	0	0	1	0	2
Chlorophyll	0	1	1	2	2

Colour	Score for number of years in use in each period: 1850-1875	1876-1900	1901-1924	1925-1956	1957-1987
Copper chlorophylls	0	0	0	1	2
Fustics	0	1	0	1	1
Gamboge	2	2	1	0	0
Indigo	2	2	2	2	1
Liquorice extract	2	0	0	0	0
Logwood	2	2	2	0	0
Lycopene	0	0	0	0	2
Madder	2	1	1	0	0
Mallow flowers	1	0	0	0	0
Marigold	0	0	1	0	0
Orchil	2	2	1	1	1
Paprika extracts	0	0	0	0	2
Persian berry	2	0	1	1	1
Quercitron	2	0	1	1	1
Riboflavin	0	0	0	0	2
Riboflavin-5'-phosphate	0	0	0	0	1
Safflower extract	0	2	1	1	1
Saffron extracts	2	0	2	2	2
Sandalwood extract	0	1	0	1	2
Turmeric extract	2	2	2	2	2
Xanthophylls	0	1	0	0	2

TABLE K.4 : COAL TAR COLOURS: PERCENTAGE CHANGE IN HAZARD BURDEN SCORES BETWEEN FIVE PERIODS FROM 1850 TO 1987

Compiled from table K.1

KEY:
Retrospective Hazard Groups
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Periods of time:
1 1850-1875
2 1876-1900
3 1901-1924
4 1925-1956
5 1957-1987

Hazard Group	Change (& % Change) Between Periods: 1 to 2	2 to 3	3 to 4	4 to 5
A	+1 (+17%)	+9 (+129%)	+9 (+56%)	+5 (+20%)
B	+1 (+100%)	+6 (+300%)	+0 (+0%)	-6 (-75%)
C	+0 (+0%)	+19 (+238%)	+39 (+144%)	-59 (-89%)
D	+6 (+100%)	+9 (+75%)	-6 (-29%)	-13 (-87%)
E	+2 (+40%)	+19 (+271%)	+7 (+27%)	-17 (-52%)

TABLE K.5 : MINERAL COLOURS: PERCENTAGE CHANGE IN HAZARD BURDEN SCORES BETWEEN FIVE PERIODS FROM 1850 TO 1987

Compiled from table K.2

KEY:
Retrospective Hazard Groups
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Periods of time:
1 1850-1875
2 1876-1900
3 1901-1924
4 1925-1956
5 1957-1987

Hazard Group	Change (& % Change) Between Periods: 1 to 2	2 to 3	3 to 4	4 to 5
A	-18 (-100%)	+6 (+600%)	+1 (+17%)	+5 (+71%)
B	+0	+0	+0	+0
C	+0	+0	+0	+0
D	-26 (-65%)	-3 (-21%)	+0	+0
E	-23 (-96%)	+3 (+300%)	-2 (-50%)	+1 (+50%)

TABLE K.6 : PLANT & ANIMAL COLOURS: PERCENTAGE CHANGE IN HAZARD BURDEN SCORES BETWEEN FIVE PERIODS FROM 1850 TO 1987

Compiled from table K.3

KEY:
Retrospective Hazard Groups
A Acceptable for food
B Possibly acceptable
C Possibly harmful
D Harmful
E Insufficient information

Periods of time:
1 1850-1875
2 1876-1900
3 1901-1924
4 1925-1956
5 1957-1987

Hazard Group	Change (& % Change) Between Periods: 1 to 2	2 to 3	3 to 4	4 to 5
A	-3 (-30%)	+3 (+43%)	+0	+10 (+100%)
B	+3 (+150%)	-2 (-40%)	+0	+4 (+133%)
C	-2 (-100%)	+1 (+100%)	+0	+0
D	+0	-1 (-50%)	-1 (-100%)	+0
E	-11 (-48%)	+0	-3 (-25%)	+3 (+33%)

APPENDIX L

TABLE L.1 : COLOURS LINKED WITH INTOLERANT REACTIONS

Compiled from:

1 Alexander A Fisher Contact Dermatitis Lea & Febiger, Philadelphia, 1973 p358-421

2 Commission of the European communities Reports of the Scientific Committee for Food twelfth series, 1982, EUR 7823 p7-8

3 British Dietetic Association and Leatherhead Food Research Association's food intolerance databank, established in 1987

4 Martindale Extra Pharmacopaeia London 1938, 21st ed, vol II p722

5 J Pront Proceedings of the Royal Society of Social Medicine 1973, 66, p261

6 E Cronin Journal of the Society of Cosmetic Chemistry 1967, 18, p681

7 Gaston Vettorazzi (ed) Handbook of International Food Regulatory Toxicology MTP, Lancaster, 1981 vol II p24

8 ibid p54

9 ibid p62

10 A Wright et al 'food allergy or intolerance in severe recurrent aphthous ulceration of the mouth' British Medical Journal 1986, vol 292, p1237

11 J Egger et al 'Is migraine food allergy?' Lancet 15 Oct 1983, p865

12 K Fujimoto et al 'Occupational pigmented contact dermatitis from azo dyes' Contact Dermatitis 1985, vol 12 p17

KEY:
\+ Intolerant reactions have been reported
r Reported to be very rare

Colour	Route of exposure Oral	Skin	Reference
COAL TAR COLOURS			
Acid magenta		+	1
Amaranth	+	+	1,2
Aminoazobenzene		+	1
Aminoazotoluene		+	1
Azo dyes	+	+	1,2
Bismarck brown		+	1
Brilliant black PN	+		3

Colour	Route of exposure Oral	Skin	Reference
Brilliant blue	+		2
Brilliant green crystal		+	1
Brown FK	+		3
Butter yellow		+	7
Carmoisine	+		3
Chocolate brown HT	+		3
Chrysoidine		+	1
Eosin		+	1,6
Erythrosine	+	+	1,2
Fast green FCF	+		2
Gentian violet		+	1
Lithol rubine	+	+ ?	3,12
Malachite green		+	1
Methylene blue		+	1
Methyl orange		+	1
Nigrosine		+	1
Nigrosine spirit		+	1
Orange G		+	5
Oil orange TX		+	12
Oil yellow AB		+	8
Oil yellow OB		+	4
Picric acid		+	1
Ponceau 4R	+		2,3,10
Ponceau 6R	+		9
Quinoline yellow	+		2
Red 2G	+		3
Resorcine		+	2
Rhodamine		+	2
Rose bengal		+	2
Sudan I		+	12
Sunset yellow	+		2,10
Tartrazine	+		2,10,11
Yellow 2G	+		3
Yellow OB		+	4
MINERAL COLOURS			
Carbon		+	1
Cinnabar		+	1
Copper sulphate		+ r	1
Gold		+	1
Iron oxide		+	1
Red lead		+	1
Plaster of Paris		+	1
Plumbago		+	1
Sienna		+	1
Talc		+	1

Colour	Route of exposure Oral	Skin	Reference
PLANT AND ANIMAL COLOURS			
Annatto	+		2
Caramel	+ ?		
Carmine		+	1
Carotenes (vitamin A)		+	1
Chlorophyll		+	1
Chlorophyllins		+	1
Indigo		+	1
Logwood		+	1

APPENDIX M

TABLE M.1 : TECHNOLOGICAL HAZARDS SUBJECT TO SOME FORM OF REGULATORY CONTROL

Compiled from Statutory Instruments introduced in England and Wales from 1945 - 1986

Environmental sphere:

- industrial effluent
- agricultural effluent
- shipping effluent/ dumping
- radioactive installations and material
- poisonous waste
- domestic refuse/litter
- domestic smoke
- noise

Consumer/domestic sphere:

- drinking water
- food/additives/contaminants
- drugs
- household chemicals eg. detergents, aerosols, bleach
- machines/equipment eg. electrical goods, heaters, prams
- materials/fabrics/furnishings/utensils/packaging/paint
- toys
- tobacco
- firearms
- gas/electric supply

Transport:

- airplanes
- motor vehicles/motorbikes
- trains
- ships/ferries/hovercraft
- fuel
- movement of unsafe goods

Workplace:

- chemicals/hazardous substances
- machinery/equipment
- processes/procedures
