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Food Standards, Today and Tomorrow

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An address delivered at the Annual General Meeting of the Association of Public Analysts on 10*th May*, 1968.

The presentation of a paper on Food Standards to the Association of Public Analysts is a formidable task and one which I approach with considerable diffidence. Each member is concerned daily with the problems occasioned by the enforcement of current food legislation so that he has, at first hand, a knowledge and critical view concerning this legislation which it is not possible for me to attain. I propose, therefore, to look at some general points which affect the approach to food standards in this country and which also influence the means by which the provisions of new standards are devised. The views I shall be expressing are entirely personal, although I have been influenced, consciously and unconsciously, by discussions during the last few years with members of the Food Standards Committee, Public Analysts, manufacturers, and the officials of the Ministry of Agriculture, Fisheries and Food.

The most important single problem of the future will be the way in which the Codex Alimentarius standards are integrated into the system of national standards in this and other countries. It will be appropriate to return to this point in the concluding section of this paper.

THE BRITISH SYSTEM

The characteristic British talent for allowing change to occur by piecemeal growth, as the result of a series of compromises, is nowhere more evident than in food legislation and in the set of Regulations which has derived from the Food and Drugs Acts. Side by side with such wide-ranging provisions as Sections 1 and 2 of the Act of 1955, the Act itself makes detailed provisions in Sections 47 and 48 for reconstituted and imitation cream. Such provisions for other foods of much greater importance to the community, would be contained in Regulations made under the Act. The dairy industry occupies a unique position in the Act in that so many detailed provisions concerned with it and its products are found there rather than in Regulations. It is doubtful if this selective treatment of dairies and dairy products is justified today and it may well prove, from time to time, a serious obstacle to technical development.

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The provision in Section 32 (1) of the Act concerning the addition of water to milk, reasonable though it is in relation to past practices, has made difficult the assessment of the merits of the steam injection method for the ultra-heat treatment of milk. In this process, extremely rapid heating of the milk is achieved by the condensation of steam in the milk. After a brief holding time of a second or two, exposure of the hot milk to reduced pressure causes rapid evaporation which is used to cool the milk very quickly. An amount of water is lost which is almost the same as the amount previously added during the heating period. The use of this process to prepare U.H.T. milk for sale is clearly an offence despite the absence, at least in respect of the addition of water, of any detriment to the consumer. Had the provisions of Section 32 been included in Regulations rather than in the Act, it would have been more readily possible to change them to allow for new developments while retaining adequate powers to prevent dilution with water.

Further examples could be given where provisions included in the Act are often less general and less important than those in some of the major Regulations made under the Act. No doubt many of the detailed provisions in the Act had their origin in earlier Acts which did not provide the present powers for making regulations.

The early knowledge of the health hazards of milk consumption, and of the essential part which milk can play in infant feeding, explains how the various special provisions for milk came to be included in the early Acts. The dairy industry was also the first major section of the food industry to make appreciable use of chemists and other scientists, so that the work of the Public Analyst was reinforced by the actions of the dairy chemist and bacteriologist, who had responsibility for the quality of the milk supplied by the farms to the dairy.

Almost more anomalous than the various provisions of the Act is the selection of commodities for which Regulations including compositional standards at present exist. These range from The Bread and Flour Regulations 1963 (which are concerned with major components of the national diet of great nutritional importance), to the Food Standards (Edible Gelatine) Order, 1951. In the last few years, the investigations of the Food Additives and Contaminants Committee, and the Regulations which have followed their reports, have been based on a deliberate sub-division of additives into various categories (colours, preservatives, emulsifiers, antioxidants, flavours, and so on), each group being considered in turn. Similarly, the Food Standards Committee has carried out a comprehensive review of Labelling, and of Claims and Misleading Descriptions. The majority of the recommendations of the two resulting reports have either already been adopted or modified in Regulations, or are under consideration as draft Regulations. No such pattern is yet discernible in the array of compositional standards.

There is much to be said for a system, which may perhaps be exemplified by the Canadian Food and Drugs Act and the Regulations made under the Act, where a short and relatively simple Act is supported by a comprehensive set of Regulations. The procedure for amendment can be made reas simple so that all provisions for the major foods can be revised in the lig technological advance. There may well be advantage to the consumer, often also to the manufacturer, in controlling certain essential factors in min commodities even where these commodities are of little or no nutritiona significance. This is the present practice in Canada. But there can be no defence of the British system, whereby one minor commodity has acquired a compositional standard for some reason which is almost certainly no longer of significance, while hundreds of others of equal or greater importance as foods are subject only to the general provisions of the Act.

But it may be that the pace of development of the internationally-agreed standards of the Codex Alimentarius will exert a predominant influence before this area of food law in Britain has created sufficient difficulties to occasion pressure for change to a more rational system.

FOOD STANDARDS AND THE MANUFACTURER

The nineteenth-century horror, on the part of manufacturers, at the thought of government interference with their freedom to produce any saleable item of food has been dispelled. The experience of the two world wars and the mutual aid and continuous discussion between government and industry which modern economic and trading conditions now impose has brought this about. In some instances a number of manufacturers, anxious to protect a product and its public image from debasement and also their own output from competition with cheaper but inferior commodities, have taken the initiative in pressing for a compositional standard. To achieve this they have given extensive aid in providing information on which to base a standard which will be sufficiently rigorous to protect them as well as the consumer.

The problems of analytical enforcement, especially for the composite preserved foods which are a major growth point today, are such that it is essential that the majority of standards are regarded as reasonable by the reputable manufacturer. The most powerful factor ensuring compliance with regulations is the reluctance of almost all manufacturers today to act in open contravention of the law.

A second aspect of growing importance is that, for many foods, production is now concentrated almost entirely in the hands of a few large companies and at factories serving a national market. These companies do not fear the effect of competition from sub-standard products. They regard themselves, with their market research and consumer surveys, as better able to say what the general public wants than the various bodies which have been set up to represent and express the consumer viewpoint. They may, therefore, oppose an attempt to improve a product by changes of regulation as an interference with their own highly developed procedure for taking account of the attitude of the consumer. They would even argue that the imposition of an "improvement" would be to the detriment of the consumer's real wishes and needs. Such views are by no means universal but there is a marked growth of opinion reflecting a sophisticated form of the nineteenth-century resistance to governmental interference.

As a consequence of this, there has been some change from the situation in the early days of the Food Standards Committee. There is now a greater tendency for manufacturers to challenge the need for more extended regulations —whether compositional or labelling. This attitude may, however, have resulted partly from a situation where, as in the last few years, the range and the power of Regulations have been greatly extended, causing additional and often complex work for managements. I am sure that if, in the interests of rationalisation, it was proposed to withdraw a number of the Regulations, the many advantages of the existence of standards to the reputable manufacturer would rapidly give rise to pressure from him to maintain many of the Regulations in operation.

FOOD STANDARDS AND THE CONSUMER

Nutrition

The Food Standards Committee has always had at its disposal advice concerning the nutritional significance of the commodities with which it is concerned. This advice has been available from distinguished nutritionists who have served on it as members, from the staff of the Ministry of Health and of the Ministry of Agriculture, Fisheries and Food, or from specially appointed advisers or panels (*e.g.* the Joint Nutrition Panel on Bread and Flour). By similar means, the Committee is made aware of the nutritional significance of the measures which it may propose. The departments, in drawing up the Regulations, are again able to take further advice, in the light of comments on the Committee's reports. The discussions of the Committee of the Ministry of Health concerned with the Medical Aspects of Food Policy provide guidance on some nutritional questions.

There is little doubt that in reviewing major commodities, such as bread and flour, the nutritional implications must be a major factor influencing the Committee's view. At the other end of the scale there are many minor commodities, for which there may be some good reason to think Regulations are necessary, but which are of negligible nutritional importance to any sector of the population. Between these two extremes there is a wide range of foods, both raw and processed, which individually make a small, but none-the-less significant contribution to human nutrition. Of particular significance today is the increasing impact which processed and "convenience" foods are making on the diet of the population as a whole. These foods are playing, and will play, an even greater part in the nutrition of certain specialised groups, for example, those living in furnished rooms and small flats. The use of these foods in catering is also rapidly expanding, so affecting those entirely fed in institutions or using commercial catering extensively. Almost all processes of food preparation and food preservation bring about reductions in essential nutrients although this may, in some instances, be no more than occurs in domestic cooking. The processed foods are sold and judged by the consumer on the basis of their appetising taste, texture and appearance and only rarely is their relation to nutrition regarded as important. There is clearly an area of potential danger here, which, although covered in principle by the general provisions of the Food and Drug Act, would be very difficult to control on this basis. It may well be that some new means of control will be needed, in the interests of consumers, both to limit nutrient loss and damage and also to make known to the consumer the change produced by processing.

The complexity of the subject of the nutritional status of particular processed foods is, however, such as to deter action until the need for it becomes urgent. The natural variation in nutrient levels in raw foods and the losses they undergo, without any processing, before sale or before use in a food factory, create an initial problem. It is important, however, for the public to be able to assess the effect of different processing methods on the various nutrients especially when alternative processing methods exist. This information might influence their choice between, for instance, the frozen, dried or canned products or indeed might suggest the advantage of a frozen vegetable over the raw equivalent where the latter suffers loss before reaching the consumer. Consumer education in both nutrition and the effects of processing on food would minimise the possible dangers, but would at the same time create a demand for more information on labels.

There is, perhaps, some hesitancy at present in stressing nutritional considerations, except where, as with baby foods, it is clear that a captive and vulnerable group of consumers is at risk. Even current nutritional teaching often reaches the consumer in forms greatly exaggerating the importance of, for instance, high protein foods in the normal diet, or giving undue prominence to some particular vitamin for which almost any reasonable diet provides an adequate supply. The general sufficiency of the diet of this country, since the second world war, is not in doubt. I only wish to stress that some of the conditions which have ensured this (namely, a wide range of foods consumed by almost all sections, with processed foods forming only a minor part) are changing rapidly.

The Consumer's Viewpoint

It is not usually difficult to obtain the generally agreed view of a particular sector of the food industry concerning proposals for Regulations. Occasionally there are sharp differences of opinion in industry but, since individual firms can always comment on proposals, reports or draft regulations, there is no problem in the method of communication. Adequate machinery also exists to enable the various local authority organisations or port authorities to present a unified viewpoint and the Association of Public Analysts has always been of great service to the Committee both in presenting general arguments based on what is considered to be the interests of the consumer and in providing help with particular points of detail or analytical figures.

It is when the attitude of the bulk of the consuming population, if it could be known, would be a significant factor in reaching a decision that the greatest difficulty is experienced. The Committee is aided by the views of those of its own members who are connected with women's organisations, but it rarely happens that the particular issues under consideration have been discussed in any formal way within these organisations.

There is some danger of accepting a totally wrong emphasis, if views put forward by the various consumer groups are regarded as fully representative. Inevitably, those with the time and interest to take an active part in consumer organisations will tend to be drawn from the middle class, especially from those with an academic or professional background. There may even be an abnormally high proportion of those participating who have firmly held rather extreme views on particular matters. Areas such as London and the southern towns may tend to play a disproportionate part in these organisations nationally as compared with either the industrial north and midlands or the working rural population.

It is clear that authentically representative views of the consumer can only be obtained by questioning carefully a properly constituted sample of the whole population. As is well known, the design of questions to obtain authentic, unprompted answers, is difficult and may require skilled interviewing as well as the use of questionnaires. Some individual firms and certain national organisations have aided the Food Standards Committee by making their own consumer survey results available. Useful though these are, it is only when the approach being made and the questions asked in the survey seek enlightenment on precisely the same points as those that the Committee requires that the results can be freely accepted as serving the required purpose.

The high cost of properly conducted surveys makes it unlikely that the Committee will be able to look for assistance from special surveys in the near future.

It might be argued that it is unnecessary to give weight to the uninformed views of the bulk of the population on matters which have complex technical aspects. But the aim of everyone concerned, whether manufacturer, Public Analyst, nutritionist or central or local government official, is to ensure that the various foods which are produced shall be eaten, and that from them adequate nutrition can be secured. The consumer, by the exercise of choice as a result of his various preferences, is the key factor. His view, however uninformed, is decisive.

The Education of Consumers

On occasion, manufacturers will be heard to complain that particular Regulations are needlessly complex. Certainly the courts, from time to time, have the problem of deciding the exact meaning of a section of an Act or Regulation. The majority of consumers are very poorly placed to understand what is done on their behalf. At present virtually no steps are taken to educate the public to derive the maximum benefit from the many provisions in the various

Acts and Regulations connected with food which have been designed to protect them.

If industry is criticised for not always wishing to describe its products accurately or adequately, the government is surely even more at fault for failing to make known to the public, in a form which can be understood, the measures which it has taken. The Food Standards Committee has, in recent years, attempted to make its reports more informative by the inclusion of brief accounts of manufacturing procedure, of production and consumption and of technical changes in progress or impending. But it would be idle to think that the reports will reach more than a minute audience. Most reports and new Regulations fail to attract any attention in the national press and, indeed, only some "newsworthy" provision would be picked out if a report is mentioned.

Probably the largest single source of information on food, which reaches a wide sector of the general population, is the women's magazine. The combination of informative and easily-available official leaflets, and appropriate news items in these magazines, would do much to inform the housewife. The meaning of the labels she sees, the minimum standards to which foods must comply and the names corresponding to particular standards would all need explanation. Many manufacturers would respond to an informed population by providing further useful information concerning their products—as indeed some already do. It is likely that more knowledgeable housewives and other consumers would make increasing enquiries of the Public Analyst as well as supplying him with a larger number of samples thought to be of doubtful quality. This would often allow him to serve the public in an educational rôle for which he is very well fitted.

The Large User

When foods are sold from one manufacturer to another it is reasonable to expect specifications to be drawn up and samples analysed to ensure compliance with these specifications. So there is little need in most instances, for Regulations to include foods or food components which are involved in these transactions between manufacturers. An important exception is the provision in Regulation 24 of the Bread and Flour Regulations (1963) and in Schedule 1 of the Regulations to ensure a minimum content of certain nutrients in flour. This Regulation applies whether the flour is to be used for domestic or manufacturing purposes. The form of these regulations was primarily dictated by technical considerations, *e.g.*, by the problem of ensuring even dispersion of small quantities of added nutrients, and, as such, is exceptional.

Relatively large-scale sales also take place from manufacturer to caterer. Unlike most manufacturers, caterers are not usually equipped to test the products they receive other than by inspection and, in many instances, they do not have the knowledge to set suitable specifications. It is therefore reasonable to expect foods which are sold to caterers for service to customers without further compounding, except perhaps with water and seasonings, to comply with compositional standards. As more and more foods are supplied in ready to use forms to the caterer, so the application of Regulations to catering supplies becomes more important, not primarily in the interests of the caterer but to benefit the ultimate consumer. Added protection is also needed for the institutional caterer and those for whom he provides meals, for it is often here that inferior bulk supplies are encountered. Often the budgets for institutional catering allow little margin, so creating conditions where inferior products are accepted in return for a lower price.

THE MODE OF OPERATION OF THE FOOD STANDARDS COMMITTEE

Although the Food Standards Committee has experts in certain fields among its members, it is not an expert committee. Its duty in advising Ministers is primarily to evaluate and compare all the evidence it receives and to find common ground where different and conflicting views arise. The members with industrial experience are able to interpret the impact which proposals may have on the productive operation. Not always is it of advantage for them to have had direct experience of making a product which is under discussion, for then the difficulties tend to loom large while the advantages of the proposals being considered may not seem so apparent. I have already emphasised sufficiently the difficulties for those on the Committee whose background enables them to advise on the interests of the consumer. There remains a third group of members selected for their scientific knowledge, comprising by custom a member of the staff of the Government Chemist, a Public Analyst and a nutritionist. I would at this stage wish to pay tribute to the work on the committee of Mr. R. W. Sutton, both during the latter part of his active career as Public Analyst in Derby and after his retirement. He was a member of the inter-departmental committee which preceded the formation in 1947 of the Food Standards Committee and he has served continuously on the Committee from then until the spring of this year. He had completed nearly one hundred and fifty attendances and always contributed with characteristic thoroughness and tact to the discussions. He will be greatly missed by his colleagues on the Committee.

As you will know, the Committee considers matters referred to it by the four Ministers to whom it reports and does not have power to initiate discussion of further unrelated matters. It operates with the assumption that, in the long term, the interests of consumer and of manufacturer are not basically in conflict. Where there is an apparent conflict, the discussions of the Committee, often enlightened by further enquiries, are usually able to resolve the conflict or at least to reach a workable compromise solution. Where expert advice is needed many courses of action are open to the Committee. For the more important commodities, an assessor or assessors may be invited to assist the Committee. The assessor needs both expert knowledge and an independent outlook so that it is appropriate that he should normally be drawn either from the universities, the research institutes or the research associations. The staffs of the ministries also give technical advice and, where appropriate, the Food

Additives and Contaminants Committee and the Committee on Medical and Nutritional Aspects of Food Policy may be consulted on particular points. Special panels may be set up to review a specialist aspect and various expert bodies, including the Association of Public Analysts are approached for information and advice. I have already referred to examples in the field of nutrition.

Perhaps the most important factor influencing the Committee's procedure is the way in which general submissions on matters referred to the Committee are obtained. The initial reference to the Committee by Ministers will have appended to it such information as is available to the Secretariat, with some guidance on the aspects which appear to the Secretariat to be of importance. Any representations which have been received previously by one or other of the Ministries are also included. After preliminary consideration, the Committee will invite comment and proposals, either from the appropriate organisations, alone, or, in addition, by a general invitation for submissions through a press release. It is usual to ask the various organisations a number of specific questions on matters which the Committee already feels to be relevant. But these questions too frequently channel the resulting submissions into narrow replies to the points raised. Organisations often either fail to consider the general implications or do not communicate their views to the Committee.

The Committee only exceptionally chooses to supplement written submissions by oral evidence. This procedure is especially appropriate, however, in relation to manufacturing interests, partly because the particular processes employed industrially may not be familiar to any committee member, and partly to allow manufacturers to present their view with greater freedom than perhaps they would think appropriate in a written submission. The independence of the Committee allows the Ministers to authorise the printing of the Committee's reports without any commitment concerning implementing the recommendations. In many instances draft regulations which closely follow the lines of the report are prepared and then lead to Regulations with little change from the draft. But cogent criticism of a report of the Committee from a responsible source may influence materially the draft proposals for Regulations and these in turn may be further modified in the final Regulations.

In the same sense that specific questions in a request for comment can inhibit a general expression of opinion, so criticism of Reports or Draft Regulations tend too often to refer only to those sections which are regarded as needing modification, and do not indicate overall approval.

The procedures of the Committee are not static but are modified as the members and function of the Committee change and as it meets changing circumstances in industry and elsewhere.

ENFORCEMENT

I have already suggested that the deliberate evasion of compositional standards by reputable manufacturers is rarely encountered today. A standard, therefore, exerts an influence to the benefit of the consumer by its very existence, irrespective of the method of enforcement. While this justifies the retention of some standards which are either unenforceable because of lack of an analytical procedure, or could be readily evaded because, for example, additions could be made which would mislead the analyst, the ideal must still be a set of Regulations for which the techniques of enforcement are clear-cut and simple.

The normal decision not to specify particular methods of measurement or analysis is wise, since it allows the use of new and more reliable methods as soon as they become available. The immense strides which have been made over the last twenty years in analytical techniques, separation procedures and the application of physical methods to analysis, now permit accurate determinations of components of complex mixtures which were previously impossible. No doubt many further advances will be made in this field, simplifying the resolution of analytical problems. These will, however, demand a degree of instrumentation which will strain the resources of many laboratories.

Whatever progress is made, however, two problems will remain—the natural variation in raw biological materials, fruit, meat, etc., and sampling problems, such as uneven distribution between containers. The latter can be said to be a manufacturers' problem but it is right to recognise the difficulties it can create. It may lead to pressure from manufacturers to set an absurdly low standard for some particular component, solely to ensure that no product contains less than this limit, although the average content in the product may be many times greater. The problem of variability of natural raw materials does not readily lend itself to solution except by the analytical examination of a range of the raw materials each year in order to establish norms of the appropriate analytical parameters. Perhaps more readily-exercised powers of inspection of records and of processes would provide the least onerous way of providing effective enforcement for some of the commodities affected by these uncertainties.

It is unfortunate that powers do not appear to exist to allow the Ministries to negotiate Codes of Practice, in connection with the composition and related matters, for foods which are either of too little importance to justify Regulations or too complex to permit them to be readily compiled. The divided responsibility whereby the manufacturers negotiate with the Local Authorities Joint Advisory Committee on Food Standards on Codes of Practice, and with the Ministry of Agriculture, Fisheries and Food on regulations, can be confusing. It may, on occasion, lead to a very protracted procedure, when there is doubt whether a Regulation or a Code of Practice is the appropriate means of control.

INTERNATIONAL ASPECTS

The steady progress which is being made in the various committees of the Codex Alimentarius Commission makes it certain that the national acceptance of Codex Standards and the enactment of regulations to give effect to them will occur in the fairly near future. The fruitful collaboration between ministry officials and industry in formulating the British attitude to the various proposals will make it easier to reach agreement as to the appropriate mode of acceptance for each standard. The Commission owes much to the work of the various British delegations and this has been recognised by the election of Mr. J. H. V. Davies as Chairman of the Commission.

Some Codex Standards will follow sufficiently closely the pattern of British regulations to leave only quantitative comparisons to be made. The latitude in the Codex procedure which allows the adoption of a standard with the retention of more stringent provisions will then be of value. For others, the approach may differ from that previously adopted in this country, and here greater difficulty in changing may be experienced. There will also be a large number of Codex Standards for commodities not covered by regulations at present, for instance canned fruit and vegetables. Indeed, where a Codex Standard is likely to be accepted by the Commission in the next few years and no British regulations exist, it will be wise to await the Codex Standard before considering what action to take.

It may be that the machinery for adoption of the actual or modified Codex Standards will need a form of consideration and consultation. The first stage of this may still be carried out most readily by the Food Standards Committee or the Food Additives and Contaminants Committee.

CONCLUSION

Although I have dealt with rather general considerations in this paper, the various points have relevance to the whole procedure for the formulation of regulations and the enforcement of their provisions. Future changes will continue to need the critical consideration and advice of the Association of Public Analysts to ensure their adequacy and effectiveness.

DISCUSSION

E. C. Wood: 1. Would it be accurate to say that the defect in many regulations was a result of the definitions? For example "Bread" is defined as "the substance commonly known as bread"; this might include certain current dietary formulations and "substitute" loaves. Likewise, "fibre" is insufficiently defined, the strengths of acid and alkali digestion liquors being omitted.

2. If too much reliance were placed on the consumer's viewpoint, would not standards tend to level off at a "lowest common denominator"?

Professor Ward: I agree there may be some inconsistencies regarding definitions, especially in the older regulations. A quinquennial review of the Bread and Flour Regulations is the next major field for consideration by the Committee, and there will be an opportunity to look at the examples quoted by Dr. Wood.

The Food Standards Committee needs to know the viewpoint of the consumer, when advising on Regulations but I did not intend to imply that the Committee would wish always to enact what the consumer is currently thinking. The manufacturers often feel they are in the best position to inform the Committee what the consumer is thinking!

E. H. W. J. Burden: Can Professor Ward envisage, in the near future, a committee operating in the field of food additives on the same lines as the Dunlop Committee? At least one large private concern operates its own private organisation to protect itself from the use of additives which may possibly be toxic, and it might be useful if an official committee operated on the same lines.

Professor Ward: This is the province of the Food Additives and Contaminants Committee. The trend is such that the time may come when all additives which may be used in food must be selected from "permitted lists". A new additive will not normally be accepted if supported only by evidence of safety from foreign sources, although such evidence is taken into account. Clearly, in the future, the operation of the corresponding Codex Committee may have an influence, since the present national differences are a serious obstacle to trade.

J. H. Hamence: The Food Additives Committee is very active and has prevented the use in this country of one or two internationally-accepted substances. The aim is to set up a barrier against all but the most extensively investigated chemicals. Evidence of the necessity for an additive must be produced to justify its acceptance.

E. G. Whittle: Is there a risk of this country accepting, through the Codex Alimentarius, standards adapted to levels which are acceptable in under-developed countries?

Professor Ward: This need not happen in practice. The less developed countries can accept a higher standard and then bring it into operation gradually, over a period of years. Alternatively, if a Codex standard appears inadequate in some respect in relation to British practice, it can be adopted, but selected more stringent conditions also applied.

J. H. Barker: In view of the prevalance of symptomless iron-deficiency anaemia in women, and the fact that these people do not always come before a doctor for treatment, it is desirable that food composition should be such that these cases do not arise. Has the Food Standards Committee any power in this matter in regard to the proposed revision of the Bread and Flour Regulations?

Professor Ward: The Committee will give due consideration to the role of added iron, and will consider this question in the forthcoming review in the light of nutritional progress since the last review.

J. Markland: What is the policy regarding standards which are analytically "unenforceable"?

Professor Ward: It is clearly preferable that standards shall be enforceable by analytical methods, but they have value even in the absence of such methods since most manufacturers aim to conform to standards as a matter of principle. The use of inspection is also a valuable supplementary means of assisting enforcement.

G. B. Thackray: Has the Committee considered creation of standards based on parameters such as figures for N, P and K in jam and fruit drinks?

Professor Ward: This is a difficult problem. The question has been discussed by the Committee, but such standards can readily be falsified and also have an element of artificiality in relation to manufacture. The method is used in the American legislation for jelly products but is not considered an attractive proposition by our own departments. It would seem better to have the analyst free to measure whatever parameters he thinks appropriate by methods of his selection.

W. B. Chapman: Professor Ward mentioned the considerable rate of advance of analytical techniques. Could I ask that such progress is taken into consideration in any proposals of the Food Standards Committee, so that comparatively temporary difficulties of analysis do not prevent otherwise desirable systems of legislation being introduced?

Professor Ward: This is certainly the position. The Committee has members who are well able to advise on analytical trends. In the recent past the two members especially concerned have been Dr. Egan and Mr. Sutton but the advice of bodies such as the Association of Public Analysts is also sought.

J. H. Hamence: How far does the principle that a food should be enjoyed enter into the decisions of the Committee? Are nutritional aspects considered?

Professor Ward: Both these factors are constantly borne in mind. The Committee includes one nutritionist as a member and can also seek advice from the Ministry of Health.

P. P. Donovan: What is the relationship of the Public Analyst to the Codex Alimentarius Committee dealing with methods of sampling and analysis? These methods refer to analysis of foods, food additives, preservatives, colours etc. They came within the province of the Public Analyst who could advise on precise analytical methods for international acceptance.

Professor Ward: The International Committee is composed of Government representatives, but they are advised by experts. The latter include both manufacturers and Public Analysts. I do not know the formal machinery for consultation on analytical matters.

E. C. Wood: Is a standard considered satisfactory if it is "unenforceable"? What can you say on this subject in regard to Vitamin D specifications or the control of carcinogenic substances in the paraffin wax in chewing gums?

Professor Ward: My earlier answer deals with the general point. Despite the severe difficulties of estimating Vitamin D, especially in some foods, manufacturers have generally complied with the various provisions of using added Vitamin D, if necessary with an allowance for processing loss. I have no comment on the second example.

R. Sinar: What are Professor Ward's views regarding disclaimers on labels?

Professor Ward: I personally do not favour them.

A. J. Harrison: Why does the period of grace before the introduction of new legislation grow longer? Why does the period when both old and new Regulations may be complied with, frequently precede the date of final effect of the new legislation, instead of implementing the new legislation immediately and allowing to follow a specific period when both sets of regulations may be complied with?

Professor Ward: This is a matter for the Ministry not for the Committee. The final suggestion has features to commend it.

G. B. Thackray: Is there any objection to bringing regulations into effect immediately and allowing a "period of grace"? This procedure was applied to antioxidants.

Professor Ward: The answer to the previous question applies.

W. B. Chapman: Is it true to say that after publication of the report of the Food Standards Committee, there is no opportunity for the Committee to comment on proposed regulations? I feel that in many cases, valuable reports of the Food Standards Committee are very considerably altered under Trade pressure without the possibility of the opposing arguments being fully considered by the Ministry.

Professor Ward: Unless a specific point is referred back to the Committee, it has no further contact with proposals based on its reports once these reports have been sent for publication. Economic factors not considered by the Committee can clearly cause divergence between the recommendations of a report and the draft Regulations.

B. Hulme: In so far as Food Standards are concerned, who are "the Ministry", *i.e.* to whom does Professor Ward hand over the Food Standards proposals for framing into Regulations? How many people are concerned? Is Professor Ward confident of their qualifications and competence, and does the Food Standards Committee have direct contact with the framers of this legislation?

Professor Ward: This can be answered in part by consulting the establishments of the Ministries (see Whittaker). Four Ministries are concerned:—

The Secretary of State for Scotland.
The Department for Northern Ireland
The Ministry of Health.
The Ministry of Agriculture, Fisheries and Food.

The primary work is done by the Food Standards Division of the Ministry of Agriculture, Fisheries and Food.

Both the Committee's Reports and the subsequent draft Regulations are widely circulated for comment and other interested parties take part. Since enforcement falls to some 300 local authorities, the greatest care has to be taken in framing Regulations since defects in drafting cannot be subsequently corrected by administrative action.

One serious difficulty is that representations concerning both the Committee's reports and draft Orders usually only state points of disagreement or criticism. It is essential that agreement is also indicated where appropriate, to avoid an impression that a section is not in favour when, in fact there are only one or two vocal dissenters. The Association of Public Analysts has a special responsibility in this connection.

A Test for Traces of Ethanol in Distillates

by D. B. LISLE

*(Laboratory of the Government Chemist, Cornwall House, Stamford Street, London, S.E.*1)

The test depends on the formation of acetaldehyde which is distilled into a solution of 2,4-dinitrophenylhydrazine. The hydrazone formed is identified by thin layer chromatography.

Small amounts of ethanol may be involved in the manufacture of many foodstuffs (for example, as a solvent for added flavour) and remain in the finished goods. The ethanol is normally determined by the addition of water to the prepared sample, distillation of the aqueous ethanol and, if necessary, removal of any oily material from the distillate by the method of Thorpe and Holmes[1]. The relative density of the purified distillate is measured and the ethanol content established by reference to alcoholometric tables.[2] The presence of ethanol must also be established. With commodities such as liqueur chocolates, the refractive index of the distillate provides an adequate check but this is not possible with the small amounts of ethanol being considered. For many years, until gas-chromatographic methods became available, the purely qualitative test of Thresh[3] was applied. In this test, ethanol in the distillate is oxidised to acetaldehyde, which is distilled into a strong solution of sodium hydroxide. A brown resin of characteristic odour is formed. The test is very straightforward but has two defects—resin is not always produced in visible amounts, and differences in the ability of operators to detect the odour appear to be enormous. Since a gas chromatograph is not always available, there is a need for a more efficient method of identification.

Smaller amounts of ethanol can be detected if the 2,4-dinitrophenylhydrazone derivative is formed instead of the resin. A precipitate is always visible if the relative density of the distillate is perceptibly less than 1.00000. The derivative may be extracted and chromatographed to demonstrate that ethanol was present in the sample and that other alcohols or ketones were not.

Apparatus

1. 100-ml conical flask, fitted with a rubber stopper, through which passes a glass tube so bent that vapour from the flask can be taken to the bottom of a 150 × 20-mm test tube with a glass stopper.
2. Thin layer chromatography apparatus. The Kodak 'Chromatogram' using 100 × 40-mm sheets.
3. Silica gel sheets activated at 110°C (100 × 40 mm).
4. Pumice powder boiling aid.

Reagents

1. *Potassium dichromate:* 10 per cent. w/v in 10 per cent. v/v sulphuric acid.
2. 2,4-*dinitrophenylhydrazine:* saturated solution in 2 N hydrochloric acid.
3. *Reference solution:* Acetaldehyde-2,4-dinitrophenylhydrazone solution in ether (preserve in the dark).
4. *Chromatographic solvent:* Carbon tetrachloride/diethyl ether (4 : 1).
5. *Diethyl ether:* A.R. quality.

Method

Filter about 5 ml of 2,4-dinitrophenylhydrazine solution into a test tube cooled in a beaker of water. Into the 100-ml flask introduce up to 20 ml of sample distillate, add 10 ml of dichromate reagent and a little pumice powder. Stopper the flask and arrange the glass tube so that the distillate passes into the cooled reagent. Distil about 5 ml as rapidly as possible. If a precipitate appears, indicating the presence of an alcohol or ketone, shake the contents of the tube with about 5 ml of ether. Place spots of about 0·5-microlitre portions of the ether extract and of reference solution on to a silica gel sheet and develop the chromatogram until the solvent has risen 50 to 80 mm. The yellow spots are very easily seen as dark spots against a light background if viewed in ultra-violet light (354 mμ) or when the developed chromatogram is immersed in a dilute solution of sodium hydroxide.

A precipitate of the derivative is produced if the alcoholic strength of the distillate is 0·01° proof (0·006 per cent. v/v) or greater.

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The Accurate Determination of Total Volatile Nitrogen in Meat and Fish

by D. PEARSON and M. MUSLEMUDDIN

(National College of Food Technology (University of Reading), Weybridge, Surrey)

The total volatile nitrogen (TVN) in flesh increases progressively as spoilage advances. The TVN figure has therefore been recommended as a suitable index for assessing the degree of freshness. Different results are obtained however according to the procedure employed. Using atmospheric distillation additional ammonia is continually formed from breakdown of protein. Results obtained by distillation at 50°C under reduced pressure were found to be identical with those obtained by established methods. A technique involving a 25-minute distillation period is recommended, and readily available apparatus can be used.

Part II of this paper will deal with the application of the vacuum technique to white demersal fish in which trimethylamine is produced during spoilage in addition to ammonia. Part III will extend the method to elasmobranchs in which the TVN includes further quantities of ammonia derived from urea.

PART I: TECHNIQUES AND APPLICATION TO BEEF AND SALMON.

Since the amount of volatile bases present in flesh increases during spoilage their determination represents a useful method for following the course of the deterioration of meat[1,2,3,4] and fish[5,6]. In meat and most types of salmon, volatile amines are present in insignificant amounts and the volatile nitrogen (TVN) is almost entirely present as ammonia[7]. For the determination of TVN in routine work it is preferable to apply macro-distillation directly to the minced sample rather than to prepare a deproteinated extract. Richardson and Scherubel[8] distilled the ammoniacal nitrogen from meat in the presence of magnesium oxide. On adding more water and repeating the distillation, more volatile base came over, due, presumably, to the effect of heat on the protein. By standardising the procedure, however, consistent results could be obtained and the results could be interpreted on a comparative basis. The effect of side reactions can be reduced by shortening the distillation time[8,9].

Various workers have reported that the volatile bases in fish (containing volatile amines in addition to ammonia) can be more accurately determined by carrying out the distillation under reduced pressure[10]. Thus, Reay[11] stated, "For the removal of volatile bases from extracts of tissues, the best method was found to be distillation of the extracts in the presence of borate in steam at 45° to 50°C, at a pressure of about 20 mm of Hg". Hjorth-Hansen and Bakken[12], however, using the intact fish sample, reported that borax did not appear to give satisfactory results within a reasonable period. Tomiyama and Harada[13] using a trichloracetic acid extract and potassium carbonate as the base, demonstrated that secondary decomposition does not occur under vacuum conditions at temperatures up to 75°C. Their method resulted in removal of volatile bases in 10 minutes at 70°C from whale meat, mackerel and 'kama-boko'.

Subsequently Tomiyama, da Costa and Stern[14] described a modified procedure for the vacuum distillation of both the volatile bases and the volatile acids on a common extract.

For routine work, the Authors considered that it would be useful to distil the intact sample at 50°C in an apparatus constructed with readily-obtainable glassware fitted with ground glass joints.

Experimental

1. SAMPLING Successively mince and mix the edible portion.

2. TOTAL VOLATILE NITROGEN

Method (a): Macro distillation at atmospheric pressure. Determine the TVN by the modified Lucke and Geidel technique[15].

Method (b): Conway micro-diffusion technique. Determine the TVN by diffusion overnight in a Conway unit from a trichloracetic acid extract[16]. Determine moisture (by drying at 100°C) and fat (by extraction of the dried material with light petroleum ether) and recalculate the Conway TVN figure as mg of nitrogen per 100 g so that the results can be compared with those obtained using Methods (a) and (c).

Method (c): Vacuum distillation.

Apparatus

The vacuum distillation apparatus used is shown in Fig. 1. The essential features are the 500-ml distillation flask (A), a Liebig condenser of effective length 40 cm (B), a 500-ml, round-bottomed receiving flask (C) and connections (i) to the manometer and (ii) to vacuum via a 100-ml Buchner flask (D).

Procedure

Weigh 5 g of homogenised sample on to a filter paper and transfer to the distillation flask (A). Add 1 g of magnesium oxide together with 150 ml of tap water and a few drops of octyl alcohol to act as anti-foaming agent. Heat the flask (A) by immersion in a water bath maintained at 50°C. Carry out the distillation under reduced pressure (10–15 mm of Hg) for 25 min. (see below) with the end of the delivery tube dipping below 20 ml of 2 per cent. boric acid solution containing screened methyl red indicator in the receiving flask (C).

For the preparation of the TVN time distillation curves (Fig. 2), stop the distillation momentarily by releasing the vacuum through the air-leak (E) and then opening stopcock (F). Replace the receiving flask with a second flask and continue the distillation after re-closing taps.

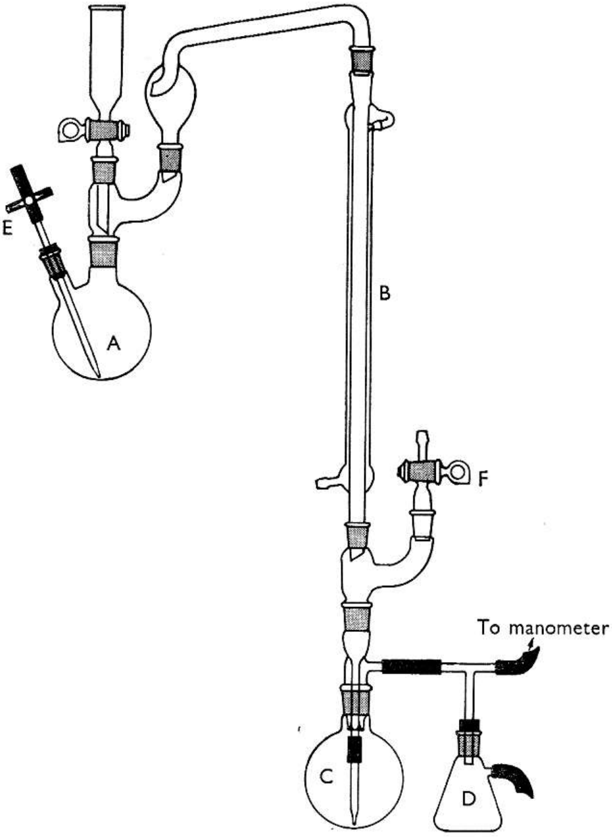

Fig. 1. Apparatus for vacuum distillation of volatile nitrogen compounds in meat and fish (Method c).

The two flasks are then used alternately. Take the time of distillation from the moment the first drop of distillate leaves the end of the condenser. Titrate the volatile bases with 0·05 N HCl using a semi-micro burette. Multiply the titration (less blank) by 14 in order to express the result as mg of nitrogen per 100 g of sample.

Results and Discussion

The vacuum distillation technique was applied to the following:

(*a*) samples of flesh,

(*b*) solutions containing ammonia,

(*c*) samples of flesh + added ammonia and volatile amines.

In each instance no further volatile base came over at 50°C after approximately 20 minutes distillation under reduced pressure. Also, the recovery of ammonia from solution during this time (Fig. 2) and recovery of amounts added to flesh was 99·0 per cent. or greater in all instances. Consequently the time of distillation was standardised at 25 minutes for all subsequent work.

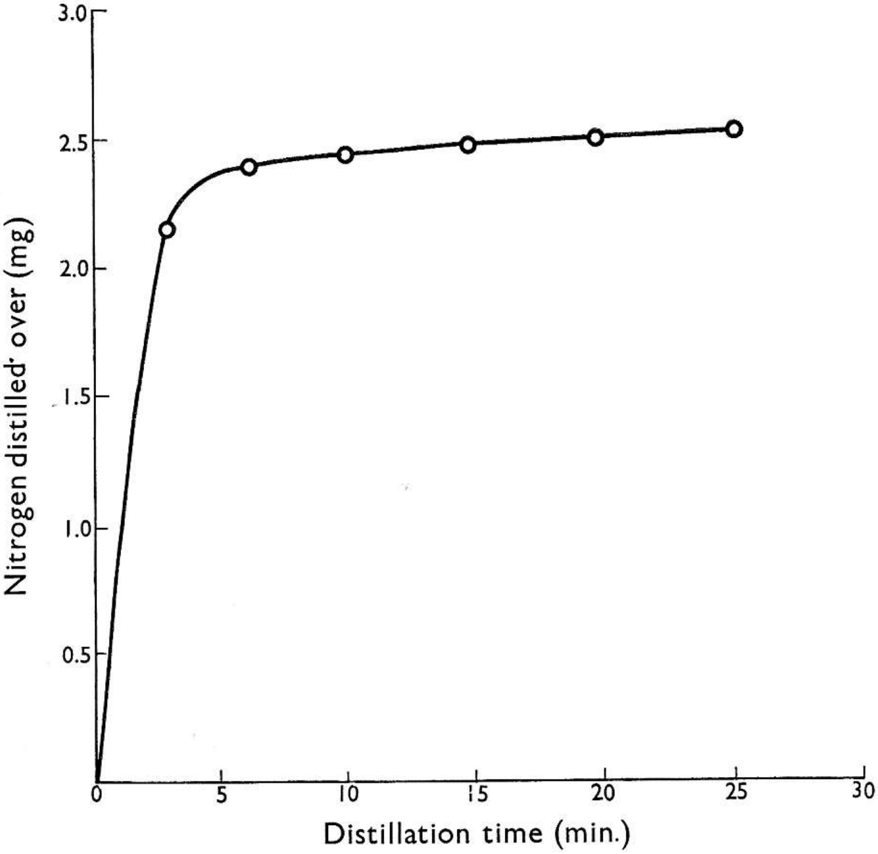

Fig. 2. Rate of release of ammonia from NH_3 solution during vacuum distillation.

The Lucke and Geidel (a), Conway diffusion (b) and vacuum distillation (c) techniques were applied to fresh and spoiled samples of beef and salmon, in which the volatile base produced consists almost entirely of ammonia. The corresponding distillation time curves for Methods (a) and (c) are shown in Figures 3 and 4. In each instance it is apparent that in the Lucke and Geidel method there is a perpetual loss of TVN from the sample, but with the vacuum technique a constant value is obtained after the distillation has proceeded for about 20 minutes. The degree of breakdown after the original TVN has come over can be assessed by measuring the slopes of the curves at various stages of freshness. From Table I, the slope for the vacuum method after 20 minutes shows values ranging from 0·02 to 0·05 mg of nitrogen per 100 g per min., which corresponds with lines almost parallel to the axis. With the application of the

Lucke and Geidel method, however, to beef and salmon protein, decomposition was still occurring after 20 mins, as shown by the range of slopes from 0·31–0·39 mg of nitrogen per 100 g per min.

The three methods for determining TVN were each applied to samples of beef and salmon (Table II). If it is assumed there is minimal breakdown during micro-diffusion by the "cold" Conway technique (b), comparison of the ratios

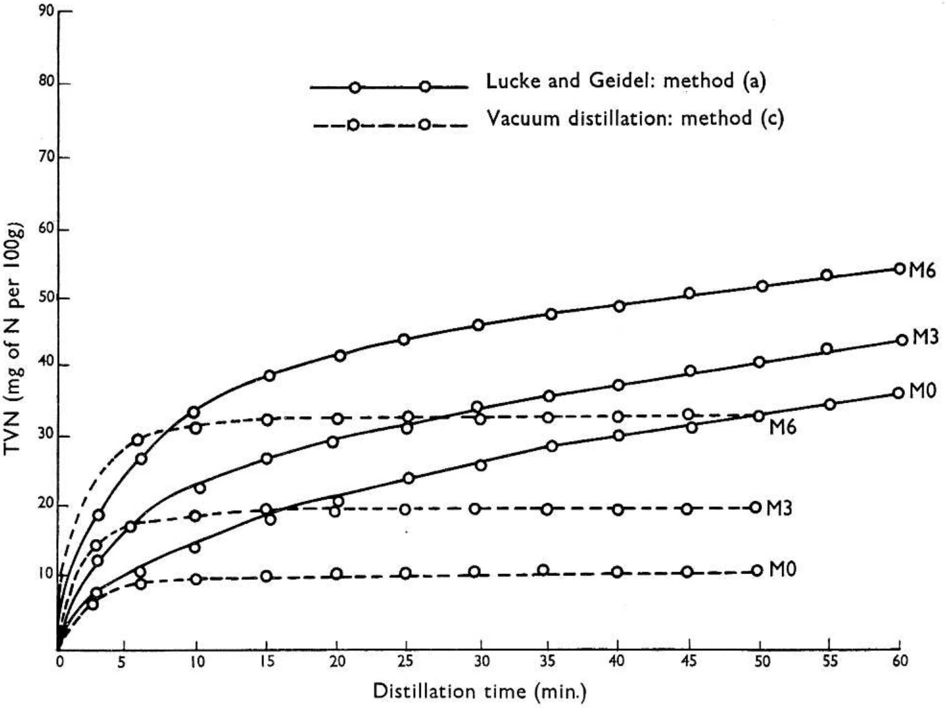

Fig. 3. Comparison of recoveries of TVN from beef by Lucke and Geidel and by vacuum distillation methods.

MO immediately after purchase.
M3, M6 after storage at 2°C for 3 or 6 days.

TABLE I

COMPARATIVE RECOVERY RATES OF TVN USING LUCKE/GEIDEL AND VACUUM DISTILLATION METHODS

Method	Type of flesh	Slope of distillation curves (figs. 3, 4) Fresh sample	Storage at 2°C for 3 days	Storage at 2°C for 6 days	Mean values
		mg of nitrogen per 100 *g per minute*			
Lucke and Geidel Method (a)	Beef	0·38	0·35	0·31	0·34
	Salmon	0·39	0·38	0·36	0·38
Vacuum distillation Method (c)	Beef	0·02	0·03	0·03	0·03
	Salmon	0·03	0·05	0·04	0·04

Time of distillation—20 minutes.

TABLE II

COMPARATIVE RECOVERIES OF TVN USING LUCKE/GEIDEL AND VACUUM DISTILLATION METHODS

Sample	Duration of storage after purchase *days*	Total volatile nitrogen Lucke and Geidel method (a) A	Conway method (b) B	Vacuum distillation method (c) C	Ratio A/B	Ratio C/B	Mean of A/B	Mean of C/B
		mg of N per 100 *g per min*						
Beef	0	22·4	10·1	10·1	2·22	1·00	1·72	1·00
	3	30·3	18·8	19·1	1·61	1·02		
	6	42·4	32·1	31·8	1·32	0·99		
Salmon	0	32·9	16·5	17·7	1·99	1·07	1·68	1·02
	3	38·9	23·9	24·1	1·63	1·01		
	6	47·3	33·5	33·0	1·41	0·99		

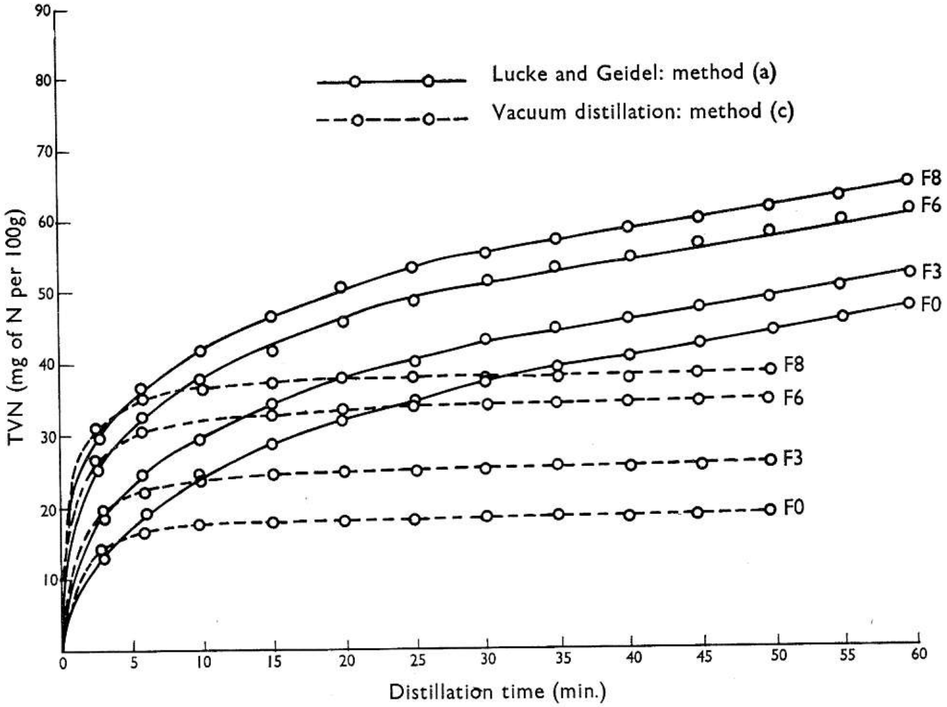

Fig. 4. Comparison of recoveries of TVN from salmon by Lucke and Geidel and by vacuum distillation methods.
FO immediately after purchase.
F3, F6, F8 after storage at 2°C for 3, 6 or 8 days.

A/B and C/B indicates the relative degree of breakdown in the Lucke and Geidel (A) and vacuum distillation (C) methods respectively. The mean ratios of C/B of 1·00 and 1·02 indicate good agreement between the vacuum and Conway methods. If the Conway method is taken as the reference procedure, therefore, the vacuum method is seen to give almost identical results. By comparison the

Lucke and Geidel method showed mean ratios of 1·72 and 1·68 due to protein breakdown during atmospheric distillation. Raising the temperature of the vacuum distillation from 50° to 70°C caused a little more volatile base to come over such that results higher than those indicated by the Conway technique were obtained. This suggests that protein decomposition may occur at 70°C.

The vacuum distillation method gave consistent results in duplicate and replicate determinations (coefficients of variation below 1 per cent.). The proposed technique therefore has been shown to give accurate results for the estimation of the volatile nitrogen in beef and salmon. The apparatus used is relatively simple and composed of readily-available pieces of equipment. Also, by using the minced intact sample, instead of an extract, results can be obtained within one hour of sampling.

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The Differentiation of Blue Colouring Matters in Food and Drugs with Particular Reference to Blue VRS and Patent Blue V

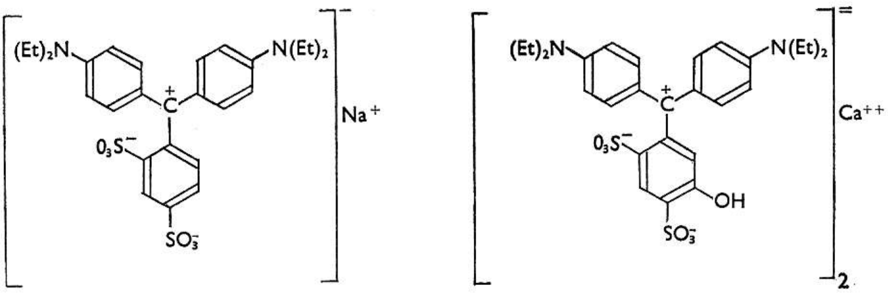
by W. B. CHAPMAN and D. OAKLAND

(*Scientific Branch, Greater London Council*)

Thin layer chromatography and paper electrophoresis have been used to differentiate some permitted and non-permitted blue colouring matters in food and drugs. The systems developed enable Blue VRS, Brilliant Blue FCF, Green S and Patent Blue V to be clearly distinguished.

Prior to June 1967, both Green S and Blue VRS were permitted food colours in Great Britain but the latter has now been removed from the permitted list by the Colouring Matter in Food Regulations 1966 (S.I. No. 1203, 1966)[1]. Patent Blue V has never been legally accepted as a food colour in Great Britain but is allowed in European Economic Community Countries, and, as a result, imported foods, particularly of French origin, have been found to contain this colour. A number of drugs in capsule and tablet form have, in the past, contained Blue VRS and for obvious reasons it is undesirable that this colour be used in such products.

It has, therefore, been necessary to differentiate clearly between Blue VRS, Patent Blue V and Green S in order to take any action in respect of such samples and the methods given below have been successfully used in this laboratory since 1964[2,3]. The methods are primarily designed to resolve the above trio of blue colours, but in addition, Water Blue 707 (which was being sold by retail as a food colour even as late as 1963), Brilliant Blue FCF (FD and C Blue No. 1) and a number of other blue colours have also been included in the scheme of identification.



BLUE VRS

(C.I.1956 : No. 42045)

PATENT BLUE V

(C.I.1956 : No. 42051)

Fig. 1. Configuration of Blue Colouring Matters.

Hitherto, paper chromatographic methods have been widely used for the identification of colouring matters in foodstuffs, particularly those of the A.P.A.[4], involving seven systems, supported by the work of Pearson and Chaudhri[5], Pearson[6], and Pearson and Walker[7]. However, difficulty has been experienced in the differentiation of Patent Blue V and Blue VRS by the use of these techniques. These two colours are very closely related, the only basic difference in the chemical structure being the presence of the hydroxyl group in the Patent Blue V. This similarity is reflected in the physical characteristics of the two dyes when subjected to 12 paper chromatographic systems, under comparable conditions as recorded in Table I.

TABLE I

R_f VALUES (× 100) OF PATENT BLUE V AND BLUE VRS FOR 12 PAPER CHROMATOGRAPHIC SYSTEMS

Paper system (*See below**)	Patent Blue V	Blue VRS
1	97	91
2	100	100
3	100	100
4	87	84
5	75	73
6	68	81
7	62	66
8	95	98
9	75	78
10	75	72
11	90	86
12	98	98

* The solvent systems referred to in this table are those employed by the Association of Public Analysts (Reference 4) and by Pearson and Chaudhri (Reference 5).

Therefore, in order to differentiate clearly between these dyes, methods other than these paper chromatographic systems are essential and it was found that Thin Layer Chromatography[8] and Paper Electrophoresis[9] were useful in this respect. Positive identification of 14 blue colours (permitted and non-permitted) has been achieved by these methods.

THIN LAYER CHROMATOGRAPHY

From the numerous systems tried, the two found to be most useful are given below:—

System 1

1. *Support phase:* Kieselgel G (Merck).
2. *Solvent phase: iso*-Propanol (A.R.)/ammonia solution (S.G. 0·880) (4:1 v/v). This solvent should be freshly prepared.

Method

Using 30 g of Kieselgel G and 60 g of water, prepare layers of Kieselgel G 250 μ thick on 20 × 20-cm glass plates using a suitable applicator. Allow the plates to dry at room temperature overnight, and then heat them at 105°C for 2 hours; store in a desiccator over silica gel.

Pipette 5-microlitre aliquots of an aqueous solution of the colouring matter (approximately 0·1 per cent.) on to the thin-layer plate, at least ¾ inch from the side edge and not less than 1 inch from the bottom of the plate. Heat the plate in an oven at 105°C for one hour and allow to cool in a desiccator for 10 minutes. Place the plate in a chromatographic tank containing the freshly prepared solvent phase and allow the plate to develop at room temperature for a distance of about 15 cm (approximately 2 hours).

System 2

1. *Support phase:* Cellulose CC41 (Whatman).
2. *Solvent phase: iso*-Butanol (A.R.)/water/ethanol/ammonia solution (S.G. 0·880) (25 : 25 : 50 : 2).

Method

Prepare thin layers of Cellulose CC41 in a similar manner to Kieselgel G plates (30 g Cellulose CC41 + 60 g water). Allow the plates to dry overnight and store in a desiccator over silica gel.

Apply the colouring matter as described under System 1 and heat the plate in an oven at 105°C for 10 minutes. Place the cooled plate in a chromatographic tank containing the freshly-prepared solvent phase and allow the chromatogram to develop at room temperature for a distance of about 15 cm (approximately 1–1½ hours).

PAPER ELECTROPHORESIS

Two systems of paper electrophoresis, at different pH values, have been used.

Apparatus

The Shandon Universal Electrophoresis apparatus (after Kohn), Mark II, with the Vokan constant voltage/constant current power supply.

Reagents

1. *System A:* 0·1 N Ammonia solution.
2. *System B:* 0·25 M Borax solution (pH 9·2 Buffer).

Pipette 5 microlitres of an aqueous solution of the colouring matter, at a suitable concentration, on to a 25 × 10-cm Whatman 3 MM paper and allow it to dry. Saturate the paper with the appropriate electrolyte, place in the apparatus and subject it to a constant current of 6 milliamperes for a period of about 2 hours.

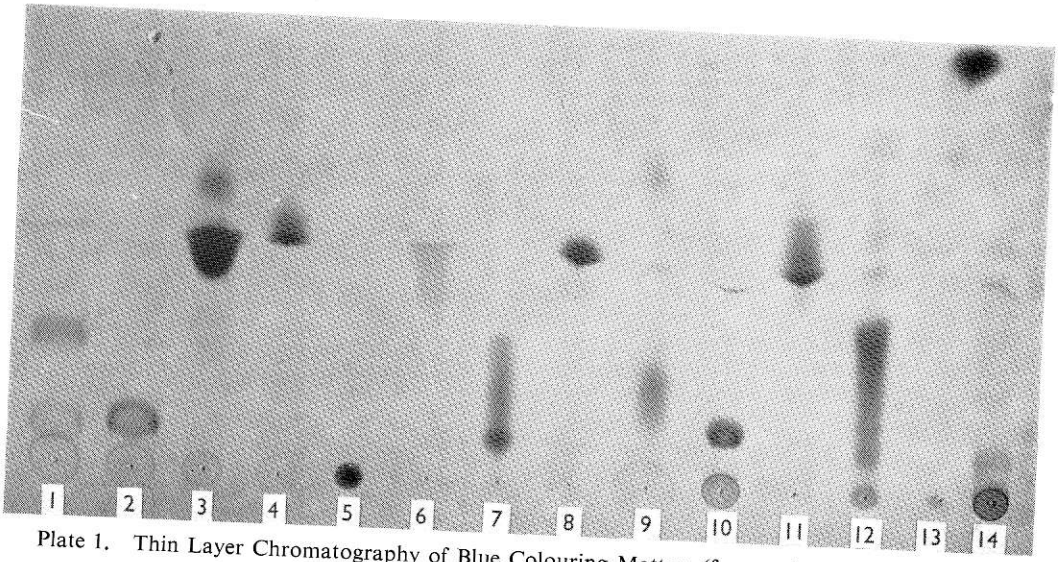


Plate 1. Thin Layer Chromatography of Blue Colouring Matters (for numbering, see Table II) (System 1)

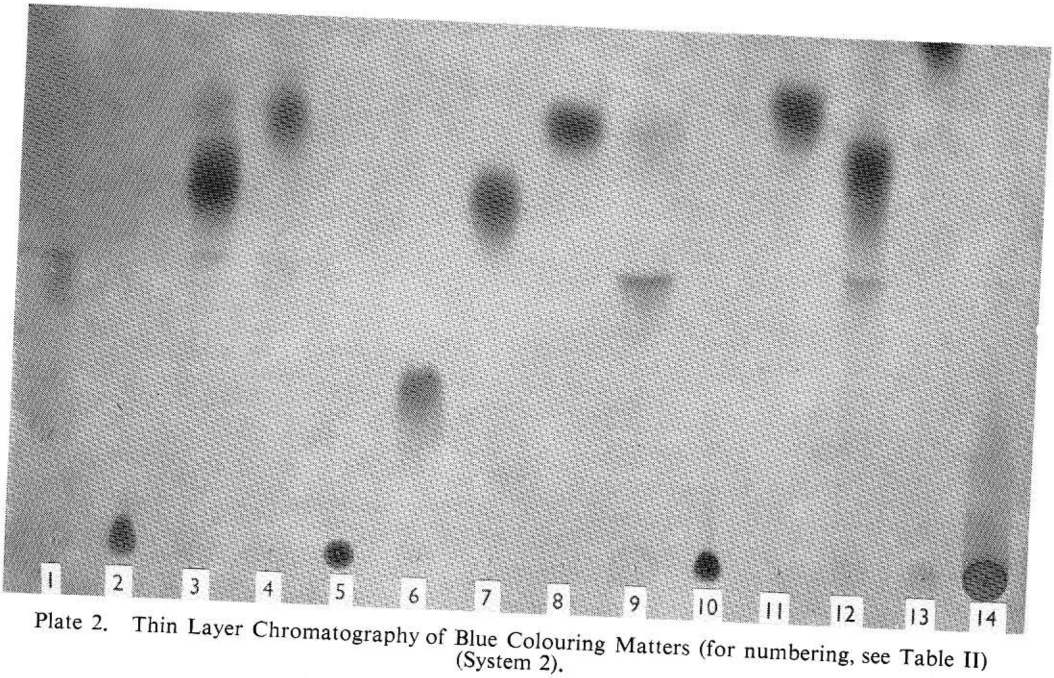


Plate 2. Thin Layer Chromatography of Blue Colouring Matters (for numbering, see Table II) (System 2).

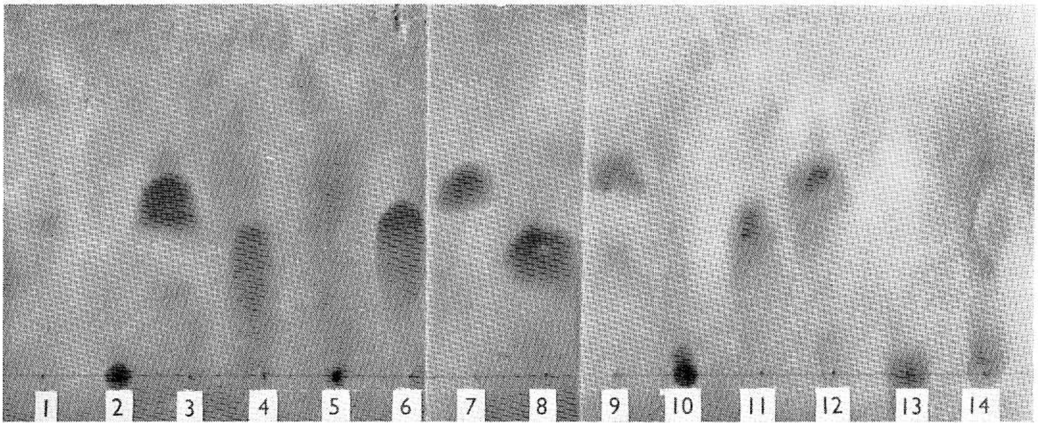


Plate 3. Paper Electrophoresis of Blue Colouring Matters (for numbering, see Table II) (Solvent A)

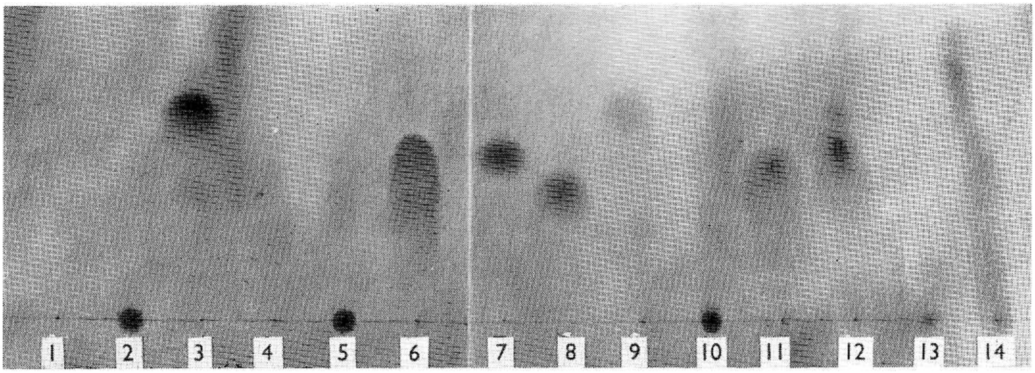


Plate 4. Paper Electrophoresis of Blue Colouring Matters (for numbering, see Table II) (Solvent B.)

DISCUSSION OF RESULTS

Thin Layer Chromatography

Plates 1 and 2 illustrate the separation achieved by the use of thin layer chromatographic Systems 1 and 2 respectively, the numbers on the plates correspond to those listed in Table II.

The R_f values recorded in Table II indicate the relative positions of the different colours and act as a useful guide for comparison purposes when using these two systems.

TABLE II

R_f VALUES ($\times$ 100) OF THE MAJOR SPOTS OF 14 BLUE FOOD COLOURS USING TLC

	Food colour	System 1 100 R_f		System 2 100 R_f	
1	Water Blue 707	29		50	(tail to 29)
2	Chlorazol Sky Blue	12		0	(streak to 5)
3	Brilliant Blue FCF	48	(tail to 40)	69	
4	Violet BNP	51	(streak to 57)	76	
5	Indanthrene Blue	0		0	
6	Indigo Carmine	50	(tail to 46)	32	(tail to 17)
7	Patent Blue V	8	(streak to 31)	65	(slight tail to 55)
8	Blue VRS	49		80	
9	Green S	24	(tail to 11)	51	(slight tail to 45)
10	Direct Blue 2B	12		0	(streak to 3)
11	Patent Blue	48	(streak to 60)	83	(slight tail to 76)
12	Patent Blue A	34	(tail to 6)	77	(tail to 62)
13	Turquoise Blue G8	94		99	(slight tail to 95)
14	Induline (Water)	2		0	(streak to 29).

System 1.

A pronounced difference in behaviour of Patent Blue V and Blue VRS is apparent in this system. The former produces a very characteristic, compact, blue spot with an upward tail leading from it. This tail is hardly visible during the actual development of the chromatogram but appears much stronger when the solvent is removed on drying. In contrast, Blue VRS gives one compact spot (very occasionally two spots very close together), whereas Green S gives a rather diffuse band without a definite compact spot within it. It should be noted that small traces of impurities have been observed in Green S, one of which has a similar R_f value to that of Blue VRS, but the proportion of this colour is very small. It is, therefore, a source of difficulty only if a mixture of Green S and Blue VRS is present in which the proportion of the latter is very low.

System 2

In this system, Patent Blue V comes midway between Blue VRS and Green S all of which form fairly compact spots. The trace impurity developing to a distance similar to that of Blue VRS is again apparent with Green S in this system.

From these two systems, it can be seen that these three colours can be differentiated from all the other 14 colours mentioned in the list. In this differentiation, not only is the position of the spot important but also its shape and hue. For example, whilst in System 2 Patent Blue V (Number 7 in the list) may well be considered to be fairly similar to Brilliant Blue FCF (No. 3), System 1 clearly differentiates between these two colours. Similarly Blue VRS (No. 8) is fairly similar in System 2 to Patent Blue (No. 11) but in System 1 the greater length of the tail of the spot of Patent Blue can differentiate these two.

Even when other colours are present which may theoretically interfere with the movement of the blue colours, (for example, Tartrazine, which occurs in System 1 just above the compact lower spot of Patent Blue V), no interference has in fact been observed and Patent Blue V is found to exhibit its characteristic compact spot and tail irrespective of any Tartrazine or other colours present in the sample.

Paper Electrophoresis

Plates 3 and 4 indicate that, although not as precisely as the thin layer chromatographic procedures, paper electrophoresis will confirm the differentiation between Patent Blue V, Blue VRS and Green S. For instance, Patent Blue V has a similar mobility to Green S in System A and both are greater than that of Blue VRS. But in System B, the order of increasing mobility is Blue VRS, Patent Blue V and Green S. The numbers on each plate refer to those given in Table 2.

Other methods of differentiating these very similar food colours (*e.g.* infrared spectroscopy)[10] have not been employed because the Authors consider the thin layer chromatographic and paper electrophoresis systems give adequate differentiation and enable comparatively large numbers of samples to be run rapidly on a routine basis.

The Authors thank Dr. B. R. Brown, Scientific Adviser, for permission to publish this paper.

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The Calculation of the Lean Meat Content of Pork Sausages

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The Stubbs and More calculation gives the total meat content of pork sausage based on the sum of the defatted meat and the extracted fat. To calculate the "lean meat content" as the lean meat free of visible fat, as defined in The Sausage and Other Meat Product Regulations 1967, it is necessary to allow for the intramuscular fat and the nitrogen present in the outside fat. New formulae are presented for assessing the proportions of lean and fatty tissue present in pork sausage. The lean meat figure obtained does not differ markedly from the defatted meat figure calculated by the Stubbs and More method. Checking sausage samples for compliance with the new Regulations would appear to require agreement on limiting or average figures for the composition of lean meat and outside fat.

Introduction

The calculation method of Stubbs and More[1] with the modified nitrogen factors of the Analytical Methods Committee of the Society for Analytical Chemistry[2,3] gives a reasonably accurate assessment of the total meat (TM) present in pork sausages. The Sausage and Other Meat Product Regulations, 1967 (S.I. 1967 No. 862)[4], which are due to come into operation on 31st May, 1969, prescribe, in addition to a minimum total meat requirement of 65 per cent., that pork sausage should have a lean meat content of not less than 32·5 per cent. For the latter requirement "lean meat content" means ". . . lean meat free of visible fat . . .", which is best considered as lean muscle with the outside fat completely cut away from it. In practice a mixture of various cuts each containing varying proportions of lean and fatty tissue is used by manufacturers.

In the Stubbs and More calculation[1], the total meat content is assessed from the summation of the defatted meat and the extracted fat. The defatted meat is calculated from the total meat nitrogen, a part of which is derived from the fatty tissue present. The outside fat from pork consists only of about 9/10ths "pure" fat. Apart from the effect of the added fat, calculation of the true lean meat must also take into account the presence of the intramuscular ("non-visible") fat.

Composition of lean and fatty pork

The composition of different cuts of pork depends on the proportion of fat present. The fat : protein ratio, for instance, may vary from 0·13 : 1 up to 100 : 1 or even higher. The SAC committee[2] found that the nitrogen in the fat-free meat (N/FF) ranged from about 2·8 to 4·2, but the Society recommended the use of an average factor of 3·45 for assessing the lean meat content of pork products. Most of the values used were derived from cuts which usually contain a reasonable proportion of lean meat, but one sample described as "Fat" in the SAC report gave an average N/FF factor of less than 3·2. Also, the six pork fats examined by Jackson and Jones[5], and containing 90–93 per cent. of fat, appear to correspond to an average N/FF factor of about 3·1. Since the factor of 3·45 for "average" lean has official recognition, it was considered desirable to apply it to both lean and fat tissue in this paper.

The amount of fat within the lean meat may vary from one to 18 per cent.[6] Thus to calculate the *true* lean meat content, an allowance of 10 per cent. of fat in the "lean" could be reasonable.

TABLE I

COMPOSITION OF THEORETICAL SAMPLES OF LEAN PORK AND PORK FATS

Sample	Fat *per cent.*	Total nitrogen *per cent.*	Nitrogen in fat-free meat *per cent.*
LM_0	0	3·45	3·45
LM_5	5	3·28	3·45
LM_{10}	10	3·11	3·45
LM_{18}	18	2·83	3·45
LM_{20}	20	2·76	3·45
F_{90}	90	0·345	3·45
F_{95}	95	0·1725	3·45

LM_x = "lean" meat containing x per cent. of fat.
F_y = "fat" material containing y per cent. of fat.

Table I gives the nitrogen and fat contents of theoretical samples of (a) lean tissue, with fat contents from 0–20 per cent., and (b) fatty tissue containing 90 and 95 per cent. of fat. Table II shows the amounts of fat, nitrogen and equivalent of defatted meat which would be introduced by the incorporation of 30, 32·5 or 35 per cent. of the theoretical samples. Table III shows the results of mixing together the various lean meats with pork fat containing 90 per cent. of fat. Samples 5, 6, 7 and 8 represent the minimal amounts which can be legally used in a sausage. By applying the Stubbs and More calculation, and assuming that the added fat matter contains 90 per cent. of fat, it is seen that the lean meat used should not contain more than about 10 per cent. of intramuscular fat. Samples 1, 2, 3 and 4 would contain less than the statutory minimum of lean meat but the introduction of lean meat containing less than 5 per cent. of fat would result in over 32 per cent. of defatted meat being present in the examples quoted.

Calculation of lean meat with no visible fat in pork sausages

The following abbreviations are used in the subsequent calculations

C = percentage of dry carbohydrate + cellulose (by difference)
N_T = percentage of total nitrogen in sausage sample (by analysis).
F_{Ext} = percentage of total extracted fat in sausage sample (by analysis)
F_A = percentage of added fatty tissue (calculated)
DM = percentage of defatted meat (from Stubbs and More)
LM = percentage of added lean meat (calculated)
TM = percentage of total meat (from Stubbs and More)
= DM + F_{Ext}
TM_A = percentage of total added meat = LM + F_A

TABLE II
CALCULATED NITROGEN AND FAT CONTENTS OF THEORETICAL SAMPLES OF "MEAT" AND "FAT"

Sample	30 per cent. theoretical meat				32·5 per cent. theoretical meat				35 per cent. theoretical meat			
	Calculated nitrogen *per cent.*	Calculated defatted meat *per cent.*	Calculated fat *per cent.*	Total meat *per cent.*	Calculated nitrogen *per cent.*	Calculated defatted meat *per cent.*	Calculated fat *per cent.*	Total meat *per cent.*	Calculated nitrogen *per cent.*	Calculated defatted meat *per cent.*	Calculated fat *per cent.*	Total meat *per cent.*
LM_0	1·025	30·0	0	30·0	1·121	32·5	0	32·5	1·208	35·0	0	35·0
LM_5	0·985	28·5	1·5	30·0	1·067	30·9	1·6	32·5	1·148	33·3	1·7	35·0
LM_{10}	0·933	27·0	3·0	30·0	1·011	29·3	3·2	32·5	1·088	31·55	3·45	35·0
LM_{18}	0·849	24·6	5·4	30·0	0·920	26·6	5·9	32·5	0·990	28·7	6·3	35·0
LM_{20}	0·828	24·0	6·0	30·0	0·896	26·0	6·5	32·5	0·966	28·0	7·0	35·0
F_{90}	0·1035	3·0	27·0	30·0	0·1121	3·3	29·2	32·5	0·1208	3·5	31·5	35·0
F_{95}	0·0518	1·5	28·5	30·0	0·0561	1·6	30·9	32·5	0·0604	1·75	33·25	35·0

LM_x = "Lean" meat containing x per cent. of fat. F_y = Fat material containing y per cent. of fat.

TABLE IV
COMPARATIVE PROBABLE COMPOSITION OF TWO THEORETICAL SAMPLES OF PORK SAUSAGE MEAT

	Ingredients	Nitrogen *per cent.*	Fat *per cent.*		*per cent.*
Sample A	32·5 per cent. of LM_{10}	1·011	3·25	DM	32·6
	32·5 per cent. of F_{90}	0·1121	29·25	F_{Ext}	32·5
	5 per cent. dry carbohydrate	0·10		TM	65·1
		N_T = 1·2231	F_{Ext} = 32·5	LM	32·6
				F_A	32·5
				TM_A	65·1
				LM-DM	0·0
Sample B	32·5 per cent. of LM_{18}	0·920	5·9	DM	28·3 ✓
	32·5 per cent. of F_{95}	0·056	30·9	F_{Ext}	36·8 ✓
	5 per cent. dry carbohydrate	0·10		TM	65·1
		N_T = 1·076	F_{Ext} = 36·8	LM	27·2 — from eq 1 p.132
				F_A	37·9
				TM_A	65·1
				LM-DM	−1·1

1·123/0·45

For explanation of abbreviations see page 130.

TABLE III

CALCULATED COMPOSITION OF VARIOUS THEORETICAL MEAT AND FAT MIXTURES

Sample No.	Mixture of meats	Calculated defatted meat *per cent.*	Calculated fat *per cent.*	Total meat *per cent.*
1	30% LM_0 + 35% F_{90}	33·5	31·5	65·0
2	30% LM_5 + 35% F_{90}	32·0	33·0	65·0
3	30% LM_{10} + 35% F_{90}	30·5	34·5	65·0
4	30% LM_{20} + 35% F_{90}	27·5	37·5	65·0
5	32·5% LM_0 + 32·5% F_{90}	35·8	29·2	65·0
6	32·5% LM_5 + 32·5% F_{90}	34·2	30·8	65·0
7	32·5% LM_{10} + 32·5% F_{90}	32·6	32·4	65·0
8	32·5% LM_{20} + 32·5% F_{90}	29·3	35·7	65·0

LM_x = "Lean" meat containing *x* per cent. of fat.
F_y = "Fat" material containing *y* per cent. of fat.

Assuming that the "allowable" limit of fat in the added lean meat (LM) is 10 per cent. and 90 per cent. of fat is a reasonable average fat content for outside fatty material, then

$$\text{Fat due to added fat in sausage sample } (\textit{per cent.}) = \left(F_{Ext} - \frac{10(LM)}{100}\right)$$

where F_{Ext} = total extracted fat determined by analysis (*per cent.*)

If the figure of 3·45 per cent. recognised by the SAC is adopted for the N/FF factor for fatty pork, then

Nitrogen (*per cent.*) in the added fat containing 90 per cent. of fat = 0·345. Therefore, nitrogen in the sausage

$$\text{derived from added fat} = \left(F_{Ext} - \frac{(LM)}{10}\right) \times \frac{0{\cdot}345}{90}$$

Re-arrangement of the Stubbs and More equation for pork sausage gives:

defatted lean meat (*per cent.*)

$$= \frac{N_T - \left[\left(F_{Ext} - \frac{(LM)}{10}\right) \times \frac{0{\cdot}345}{90}\right] - 0{\cdot}02C}{3{\cdot}45} \times 100$$

where N_T = total nitrogen in pork sausage sample (*per cent.*)
and C = dry carbohydrate + cellulose (*per cent.*)

If it is assumed that the added lean pork meat contains 10 per cent. of fat,

Lean meat (*per cent.*) = LM =

$$\frac{N_T - \left[\left(F_{Ext} - \frac{(LM)}{10}\right) \times \frac{0{\cdot}345}{90}\right] - 0{\cdot}02C}{3{\cdot}45} \times 100 \times \frac{100}{90}$$

This reduces to:

$$LM\ (\textit{per cent.}) = \frac{112{\cdot}5\ N_T - 0{\cdot}4312\ F_{Ext} - 2{\cdot}25\ C}{3{\cdot}45} \quad .. \quad (1)$$

Since fat from outside fat (*per cent.*) $= \left(\mathrm{F}_{Ext} - \frac{10(\mathrm{LM})}{100}\right)$,

and since the outside fat is assumed to contain 90 per cent. of fat:

Added fatty tissue (*per cent.*) $= \mathrm{F}_A = \left(\mathrm{F}_{Ext} - \frac{10(\mathrm{LM})}{100}\right) \times \frac{100}{90}$

Hence:

$$\mathrm{F}_A = \frac{100\ \mathrm{F}_{Ext} - 10(\mathrm{LM})}{90} \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Total added meat (*per cent.*) $= \mathrm{TM}_A = \mathrm{LM} + \mathrm{F}_A$ .. .. .. (3)

From the Stubbs and More equation,

Defatted meat (*per cent.*) $= \mathrm{DM} = \frac{\mathrm{N}_T - 0{\cdot}02\ \mathrm{C}}{3{\cdot}45} \times 100$

$$\therefore\ \mathrm{DM} = \frac{100\ \mathrm{N}_T - 2\ \mathrm{C}}{3{\cdot}45} \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

Total meat (*per cent.*) $= \mathrm{TM} = \mathrm{DM} + \mathrm{F}_{Ext}$ .. .. .. (5)

From (1) and (4),

$$\mathrm{LM} - \mathrm{DM} = \frac{12{\cdot}5\ \mathrm{N}_T - 0{\cdot}4312\ \mathrm{F}_{Ext} - 0{\cdot}25\ \mathrm{C}}{3{\cdot}45} \quad \ldots \quad \ldots \quad (6)$$

LM − DM can be negative in samples with relatively high fat contents.

Beef Sausages

For beef the SAC[7] factor for the mean N/FF is 3·55. If similar assumptions are then made for the fat in the outside fat (90 per cent.) and 10 per cent. of fat is "allowed" in lean beef, the calculated lean meat content of beef sausages can be obtained from the following modified form of equation (1):—

$$\text{Lean meat } (\textit{per cent.}) = \frac{112{\cdot}5\ \mathrm{N}_T - 0{\cdot}4437\ \mathrm{F}_{Ext} - 2{\cdot}25\ \mathrm{C}}{3{\cdot}55}$$

Results and Discussion

Pork sausage 'A' (Table IV) is assumed to be made up from the minimal permitted amounts of lean meat (with no visible fat) and added fat. Both also contain the exact amounts of fat which are used in computing equations (1), (2) and (3). As would be expected for 'A', DM = LM and $\mathrm{F}_{Ext} = \mathrm{F}_A$.

Sample 'B' however, although made up from the same weights of "lean" and "fat" differs considerably on analysis as the lean meat and added fat used contain the maximum "allowable" and maximum possible amounts of fat, i.e. 18 and 95 per cent. respectively. In practice the analyst would not know the composition of ingredients in samples examined. In this instance, by assuming the fat in lean tissue is 10 per cent. and fat in the added fatty matter is 90 per cent., the lean meat content (LM) is seen to be 27·2 per cent. compared with 28·3 per cent. of defatted meat (DM) as derived from the Stubbs and More calculation. For Sample 'B' (LM $-$ DM) $= -1{\cdot}1$ which is quite small and, as would be expected, equals ($F_A - F_{Ext}$). Similarly $TM = TM_A$.

Although the Stubbs and More method combines the protein in the fat with the defatted meat, and the extracted fat includes the intramuscular fat, there appears to be an accidental compensating effect such that the calculated defatted meat does not differ to any extent from the added "lean" meat and F_{Ext} is equally close to F_A. In order to calculate the lean meat content "free of visible fat" for the purpose of checking compliance with the new regulations, it would now appear to be necessary to have, in addition to the factors for nitrogen in fat-free lean meat published by the SAC,

(a) an accepted maximum fat content for lean meat;

(b) an accepted average or limiting fat content for added "fat."

References

1. Stubbs, G., and More, A., *Analyst*, 1919, **44**, 125.
2. Society for Analytical Chemistry, *Analyst*, 1961, **86**, 557.
3. Society for Analytical Chemistry, *Analyst*, 1965, **90**, 579.
4. "Sausage and Other Meat Product Regulations, 1967", S.I. 1967, No. 862, H.M.S.O., London.
5. Jackson, F. W., and Jones, O., *Analyst*, 1932, **57**, 562.
6. Food Standards Committee, "Report on Sausages", 1956, H.M.S.O., London, p. 8 (para 31).
7. Society for Analytical Chemistry, *Analyst*, 1963, **88**, 422.

Book Review

THE MERCK INDEX. MERCK AND CO., INC. (Publ.) pp. 1713 + xii. Rahway, N. J., U.S.A.: Merck and Co., Inc. 8th Edition, 1968. Price £7 7s.

This book is indeed all that it claims to be, an encyclopedia of chemicals and drugs. The major section of the book consists of 1133 pages containing nearly 10,000 chemical and drug monographs, over 4,500 structural formulae and some 42,000 proprietary names and synonyms. Where possible, each monograph provides the following information: proprietary names and synonyms, chemical formula and constitution, natural sources and/or commercial preparations, references to scientific literature or patents describing the substance and its preparation, physical and chemical properties, main derivatives, commercial or medicinal use, dosage and toxicity. From "Abbott 29119" to "Zytron" this Index is one of the most comprehensive collections of chemicals and drugs to be found in one volume. The descriptions for each monograph are brief but concise. In this 8th Edition, some deletion of the numerous chemical derivatives and their melting points (previously published in the 7th Edition, 1960) has been made to make way for the future trend of modern chemistry. A quote from the Editor's Preface, reflects the increasing rôle played by modern instrumental techniques:—

> "Nowadays, in a modern laboratory, the melting point tends to be measured after the infra-red and nuclear magnetic resonance spectra, and soon mass spectra will be commonplace. In future editions of this book, the full impact of the new laboratory techniques will probably induce radical changes in the presentation of the subject matter."

The second section of the book consists of a collection of named reactions, covering some 95 pages. Each entry bears the name of the chemist, references to literature, formula, etc. The following 168 pages contain many useful Miscellaneous Tables, including radioisotopes (with special reference to those used in medicinal therapy and diagnosis), first aid in poisoning, prescription notations, Latin terms in medicine, weights and measures and a formula index.

The remaining thumb-indexed section, the Cross Index, incorporates the most valuable section of the book, and indeed, on every page of the main section, readers are advised to consult the Cross Index first.

The Index lists trade names, common names, chemical synonyms and many other alternatives to the entries in the main section.

Although published in America by Merck & Co. Inc. the book is not a catalogue of Merck products, but a very comprehensive collection of chemicals and drugs collected from worldwide literature. Although it has a bias to the medicinal element, it is essentially a collection of organic and inorganic chemicals with particular reference to their properties and medicinal use.

The contents are clearly printed on good quality paper, with excellent drawings of chemical structures but the binding of the book is rather flimsy and I doubt if it will stand up to the enormous amount of handling which it will inevitably receive in those laboratories purchasing this excellent work.

MISS A. COOK.

THE LABORATORY HANDBOOK OF METHODS OF FOOD ANALYSIS. By R. LEES. Pp. 181 + xii. London: Leonard Hill Books Ltd., 1968. Price 63s.

This book is an attempt to provide a practical working text for the laboratory bench operator in the food industry and, as the author says in his introduction, no attempt has been made to enlarge on the theory on which the methods are based. As it stands, although it contains much useful information, the realisation falls short of the concept and the book might have been far more useful had greater care been taken in the preparation and proof reading.

The arrangement is unusual in that the methods are completely divorced from products, the three sections being entitled, respectively, Notes on General Laboratory Methods Used in Food Analysis, Index to Methods of Analysis for Named Foodstuffs and Methods of Analysis. Section I deals in a rather perfunctory manner with some of the common laboratory methods and techniques, while the quaintly-named Section II is, as its name implies, merely an index to the third section. The list of foods is arranged (more or less) alphabetically in one column and two further columns give respectively a list of applicable determinations and a reference to the detailed methods of analysis, which are to be found in Section III.

It is disconcerting enough to find Dried Milk, Evaporated Milk and Sweetened, Condensed Milk listed under "D", "E" and "S" respectively, but, at least, one would expect consistency; Dried Cloves, Dried Onions and Dried Thyme, however, are to be found under the initial letter of the foodstuffs. Crude Sugar is listed at "C" and Sugar, Refined at "S"; if there is some objection to indexing them both under the main heading of "Sugar" then calling them Raw and Refined Sugar would, nevertheless, bring them under the same letter of the alphabet. The situation is not improved by the absence of cross-referencing.

Section III contains all the actual methods and comprises nearly two-thirds of the book. The methods are well set out in numbered stages and are easy to follow but there are some curious omissions and not a few errors. A method for the determination of cyclamates is included but there is no reference at all to saccharin. Under "Soft Drinks", in Section II, no less than nineteen separate determinations are listed (including acid-insoluble ash and volatile oil) but the determination of saccharin, for which there is a legal requirement, is apparently considered superfluous. Phosphorus and potassium are not among the determinations mentioned above, nor do they appear among the fourteen listed analyses for "Jam", although, in each case, they might be expected to supply some information about the fruit content of the sample. In fact, no method for the determination of potassium is given.

Lead and arsenic are the only trace metals for which methods are quoted and there is no mention of the official dithizone method for the former. Lead is not among the determinations recommended for "Curry Powder" although there is a special legal limit for lead in this material. Under "Gelatin", no methods are given for copper and zinc, although the Food Standards (Edible Gelatine) Order, 1951, specifies limits for both. Methods for the determination of sulphur dioxide and benzoic acid are included, but for other preservatives only a qualitative TLC method is given.

If these omissions detract from the usefulness of the book, the large number of errors, many of which could have been avoided by more careful proof-reading, make it a dangerous weapon in the hands of the inexperienced. It is not claimed that the following list is exhaustive, but it is representative:—

Page 127: *Iodine Value.* The reader is instructed to weigh 10 g of oil for this determination.

Page 163: *Saponification Value.* The instruction is to use 0·1 N alcoholic potash and hydrochloric acid, an unusual and non-standard procedure, but the calculation assumes the use of the more usual 0·5 N reagents.

Page 82: *Added Water.* (Listed alphabetically under "A"). The formula for calculating this from the freezing point depression of milk is wrong by a factor of a hundred and the operator is invited to "tape the thermometer until the reading remains stationary"!

Page 113: *Esters.* No instructions are given for the simultaneous titration of the alcoholic potash, without addition of sample and the calculation assumes the use of exactly 0·5 N potash solution.

Page 119: *Free Fatty Acids.* Titration with 0·01 N sodium hydroxide solution is directed, but the expression given for the calculation of acid value is based on the use of the more usual 0·1 N reagent.

Page 143: *Peroxide Value.* (9) 0·02 N is printed for 0·002 N.

The errors begin, in fact, on page 6, where the wrong page number is quoted in reference to Fig. 1(b) and, a few lines lower, "laborious" appears instead of the adverb; "optical" for "optically" on page 25, P,O_8 for P_2O_5 on page 85 and "filtrate" for "filter paper" on page 125, Method I 1(g). Method I 2 omits to state the strength of the resorcinol solution to be used and Method M 5 (5) refers to "unsaponifiable matter", although no attempt is made to confirm that the oil is, in fact, unsaponifiable.

In addition to these errors, the reader is constantly confronted by the author's ambivalent attitude to the spelling of "desiccator" and other orthographic monstrosities such as "pumace" and "pyridene" are irritating.

There is no doubt that these faults tend to colour one's assessment of the book as a whole. It contains much information, although some of it is open to question (*i.e.* the statement on p. 15 that "although selenium and mercury salts have been suggested as suitable catalysts for the macro determination of nitrogen, copper sulphate is still the most reliable material to use"). Selenium and mercury have not only been suggested but have been in use for more than 25 years and the work of Osborn and Krasnitz, Milbauer, Middleton and Stuckey, to name a few, have shown that mercury is superior to copper for most purposes and its use is now standard in such works as the British Pharmacopoeia and the Fertilisers and Feeding Stuffs Regulations. Again, in method N 2, which deals with the determination of nitrogen Mr. Lees does not mention any period of boiling after the solution has cleared, although most authorities specify 1–2 hours.

The weaknesses of the book can be classed under two main headings. In the first place the divorcement of the actual manipulative methods from the products being analysed tends to create confusion and makes it impossible to use the methods in part three except in conjunction with the index in part two. Although methods are headed "Phosphate" or "Added Water" or "Iodine" they are not, in fact, universally applicable and do not encourage the student to select a suitable method for a product not in the index. It seems to me that the more holistic approach of the British Pharmacopeia would be a better model. Secondly the failure to advance reasons why certain operations are performed, the paucity of definitions and the failure to give any indications of the kind of results to be expected in normal samples makes the presentation rather mechanistic. To borrow a word from the computer age, chemists should not only be given instruction, they should be "programmed": otherwise they are liable to come up with answers that are not meaningful.

Perhaps in a second edition of this book the author might consider a happier compromise between the practical and the theoretical approaches along the lines indicated.

S. J. BUSH.