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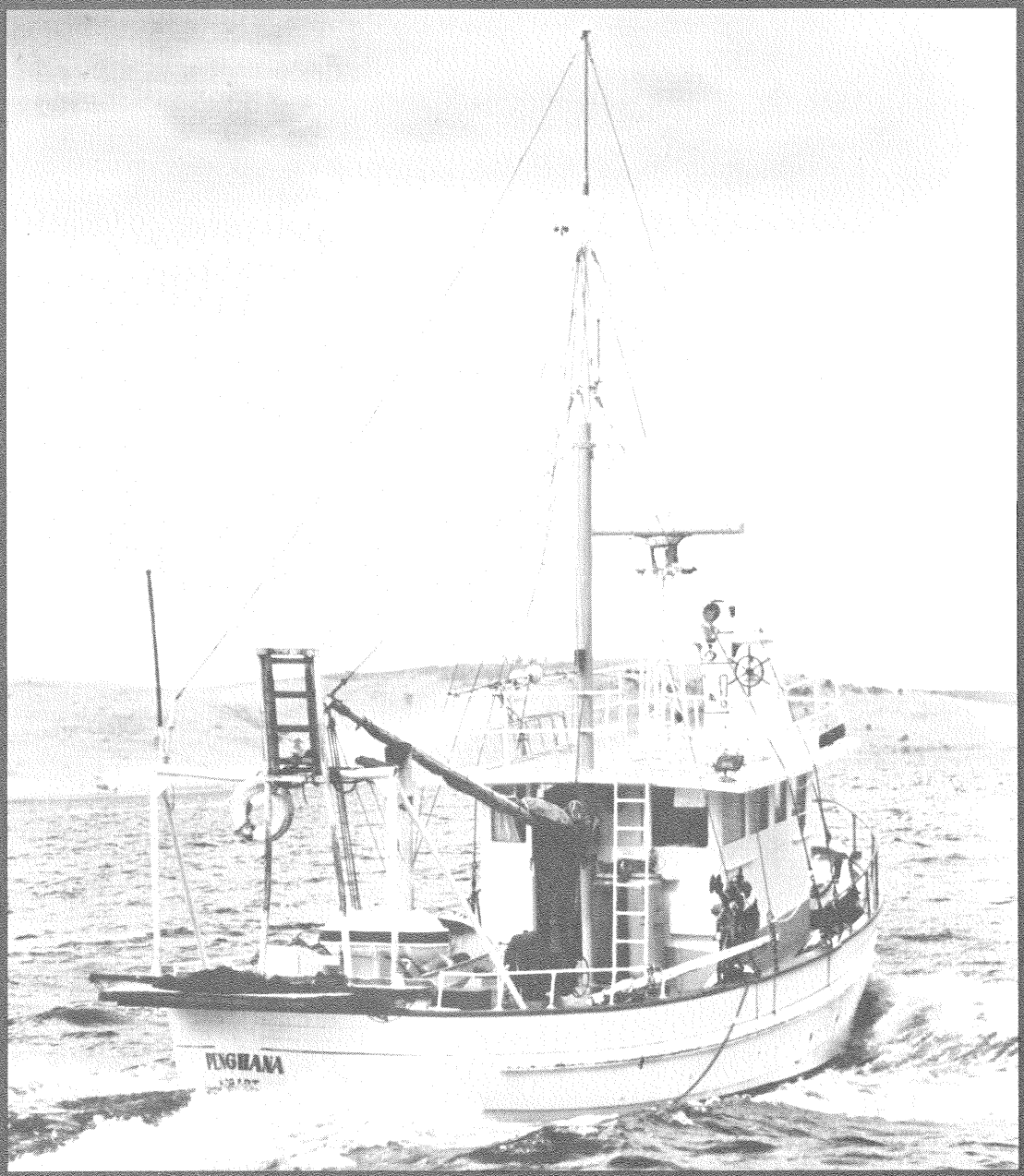

The assessment of food additives in Australia

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Australia has escaped much of the acrimonious debate which has come to surround the use of food additives in some countries. This is not to say that the system in force to scrutinize the use of food additives in this country has universal approval. From time to time food manufacturers claim, perhaps not publicly, that health authorities are being obstructive and petty in not allowing the use of a particular additive or in refusing to widen the list of foods in which a permitted additive may be used. On the other hand, consumers or consumer groups have, on occasions, maintained that the Government, through its officers, has continued to permit the use of additives believed to be harmful or superfluous. For support, these groups have tended to rely on the popular press which in turn has relied on piecemeal information from overseas or on the opinions of single scientists. The fact that all too frequently these scientists took their training in disciplines unrelated to toxicology or food science has passed without comment.

With this background in mind, it is useful to consider the scope of the evidence on which regulatory decisions are based and the mechanisms by which the evidence is secured and evaluated.

Food additives and the law in Australia

In Australia the use of food additives, including consequent labelling requirements, is governed in each State by a separate Pure Foods Act or its equivalent. For many years the Australian and State Governments have cooperated in health matters through the National Health and Medical Research Council (NHMRC). The NHMRC relies on its Food Science and Technology Subcommittee (FST) which reports to the Food Standards Committee (FSC) for an evaluation of potential new additives and also for a continuing review of the justification for currently permitted additives.

Through the States, Australia has adopted the system of prohibition as the basic element of its food law. According to this system everything that is not expressly authorized is prohibited. The system of prohibition involves the preparation of positive lists of food additives in order that authorized food additives may be legally added to specified foods. This is indeed the case in Australia at the present time for all additives except flavouring substances. Whenever an additive is specifically permitted, the regulation governing its addition to a given foodstuff will specify a maximum permitted concentration.

Bottomley (1967) has given a concise account of the machinery involved in food additive legislation in Australia and it is recommended as an introduction to this subject.

Principles governing the use of food additives

Australia was represented at the first meeting of the Joint FAO/WHO Expert Committee on Food Additives held in Rome in 1956, and has maintained representation at subsequent meetings. Authorities in Australia are guided by the recommendations of this Committee but they must also take into account patterns of food production and usage which may be peculiar to this country.

At the first meeting in 1956 the Committee elaborated a number of principles to be observed in evaluating a substance proposed for use as a food additive (FAO/WHO 1957). An earlier conference of the Joint FAO/WHO Expert Committee on Nutrition, which had recommended that the Expert Committee on Food Additives be established, had defined food additives as non-nutritive substances which are added intentionally to food, generally in small quantities, to improve its appearance, flavour, texture, or storage properties (FAO/WHO 1955).

The principles set down at the first meeting of the Expert Committee on Food Additives are as follows.

A. Technical purposes for which food additives are used:

- Maintenance of the nutritional quality of a food.
- Enhancement of keeping quality or stability with reduction in food wastage. Anti-oxidants and anti-microbial agents including curing salts are the most important additives in this category.
- Making food attractive to the consumer. Flavourings and colourings are the obvious examples of additives used to attract consumers, although emulsifiers and stabilizing agents may also have this effect. The use of food additives for this purpose is being questioned more critically than before by consumer groups and legislators. The Committee drew attention to the fact that the use of these additives should not lead to deception and that adequate labelling of food packages is important.

B. Situations in which food additives should not be used:

- To disguise the use of faulty processing and handling techniques.
- To deceive the consumer.
- When the result is a substantial reduction of the nutritive value of a food.
- When the desired effect can be obtained by good manufacturing practices which are economically feasible.

C. The safety in use of a food additive must be established, recognizing that it is impossible to establish absolute proof of non-toxicity under all conditions.

Another factor in addition to the main guidelines laid down by this Committee was:

D. The overall advantages to be gained by permitting a food additive: when a new food additive is proposed for use, clear evidence must be available to show that benefits to the consumer will ensue. In comparison with additives or processes already in use, it should be more effective in producing an acceptable product, or should confer on that product acceptable qualities not produced by other additives, or should be cheaper and thus tend to reduce the price of the food to the consumer. The potential health hazard should be no greater and preferably lower than that of comparable approved additives.

This is one way of expressing the risk/benefit concept which is seen by industry representatives as a critical point in their approach to legislation concerning food additives. The last sentence in paragraph D is also of special importance. There is no scientific justification for the belief, firmly held by many consumer groups, that a shorter permitted list of additives is necessarily a safer list (Anon. 1966). Alternative permitted additives which perform the same function in a foodstuff can be used to reduce the daily intake of any one additive.

Assessment of a food additive

The principles set out above can be summarized briefly.

- A technological need must be established for the use of an additive.
- The safety in use of the additive must be established.

Protection of the nutritive value of a foodstuff is inherent in the second principle.

It is towards these principles that the NHMRC, through its FST Subcommittee and FSC, addresses itself and it is to these principles it expects a petitioner for a food additive to address himself (Bottomley 1967).

On the basis of an applicant's submission and their personal knowledge of the area under discussion, members of the FST Subcommittee of the NHMRC make a judgment on whether a sufficiently strong case has been made for the use of an additive. In a similar manner the food industry is called upon when appropriate to justify the continuing use of an additive or the continuing usage level of certain additives. This situation arises when investigation of the need for, and effects of, a particular additive reveals new facts that may cast doubt on an earlier decision. Likewise the industry may petition on the basis of new evidence for the extension of the use of a permitted additive; for the use of an additive previously removed from the permitted list; or one which has previously been rejected outright.

What this means in practice is that members of the FST Subcommittee have to sift through (i) information supplied in support of a food additive petition, (ii) the reports of the Joint FAO/WHO Expert Committees on Food Additives, (iii) the scientific literature on relevant areas of research, particularly that published since the latest Joint Expert Committee meeting,

and in many instances (iv) the results of their own scientific or technological investigations.

An essential role of the experts on the FST Subcommittee is to identify and discard poor data and unsound judgments (Vettorazzi 1975). This is of particular importance in relation to toxicological information and requires time-consuming study and not infrequently, a request for further information.

Establishing a technological need

When considering a food additive application, it is usual for the FST Subcommittee to address itself to this question first. To establish a technological need, a petitioner has to demonstrate that a satisfactory product is not being or cannot be presented to the consumer by the use of alternative technology. Alternative technology encompasses the use of new or more modern equipment, greater quality control at the point of manufacture, or in some circumstances, the use of already approved additives.

An application which came before the then Food Additives Subcommittee (now the Food Science and Technology Subcommittee) some years ago illustrates these points. A manufacturer was experiencing serious loss of some lines of canned soft drink because of yeast spoilage. The yeast causing the spoilage was always of the same type and was found to be resistant to the permitted preservatives, benzoic and sorbic acids, at their maximum permitted concentrations of 400 mg/kg. The yeast was sensitive to sulphur dioxide, also a permitted preservative in soft drink, but sulphur dioxide could not be used in the canned product because of problems with corrosion. No spoilage was being experienced in similar bottled products where sulphur dioxide was the preservative of choice. Diethylpyrocarbonate was also an effective preservative but it had recently been removed from the permitted listings.

The manufacturer sought approval in his application for the use of 700 mg/kg of sorbic acid or 800 mg/kg of benzoic acid or a mixture of benzoic and sorbic acids. In his application the manufacturer furnished evidence that these levels of preservative would inhibit a low initial population of the troublesome yeast.

He also produced information which established that an initial population of one or two cells per can was sufficient to initiate spoilage under appropriate storage conditions and that with accepted good manufacturing practice he could not ensure that the product would be free of a small number of viable cells at the time of canning.

It was recognition of this fact which had originally led to the permitted use of antimicrobial preservatives in bottled and canned soft drinks. Having set out a justification for the use of an increased level of additive(s) in accordance with the requirements of the NHMRC, the applicant then proceeded to the question of the possible use of alternative technology. Sulphur dioxide and diethylpyrocarbonate were not appropriate for the reasons given above. In-can pasteurization, however, did offer a means of overcoming the problem without recourse to food additives.

The applicant submitted that products which had undergone an in-can pasteurization would be competitively disadvantaged because of quality considerations and further, that if the range of products in question justified in-can pasteurization, then all soft drinks could equally well be pasteurized after canning and the use of preservatives eliminated from the whole range of carbonated beverages.

It is not known what the Food Additives Subcommittee thought of this last argument but they were not satisfied that a technological need had been established for an increase in the level of preservative in order to cope with the resistant yeast. It was known that the petitioner had produced the product in question by using the pasteurization facilities of another company and no evidence was produced to indicate that a product so processed had met with consumer resistance. It was also known that at least one other Australian company producing the same range of products was operating successfully by means of in-can pasteurization. The possibility of installing improved filling equipment to facilitate cleaning operations and thereby minimize cross-contamination also did not seem to have been fully explored in the submission.

Although the submission was ultimately unsuccessful, it was soundly constructed. It attempted to answer specifically the clauses relating to technological need which appear in the format for the application for the use of a food additive. It did not resort to

general statements and it did not rely on references to the literature or to overseas practices as a justification for the position adopted. While reference to such material may be most useful to all parties, an applicant should use it to complement the assessment of his own problem and references should not be used to replace such an assessment.

With some groups of food additives such as anti-microbial preservatives and anti-oxidants, the issues involved in establishing a technological need are fairly well defined. Their use can prevent waste of food. Other permitted additives including emulsifiers, which are widely used in baked goods, ice cream, margarine and confectionery, and thickening agents, which are incorporated in many frozen desserts and dessert mixes, have contributed significantly to the wide range of foods now available that require little or no preparation in the home, i.e. true convenience foods.

Assessment of the technological need for these additives is based on the assumption that there is a need for the multiplicity of prepared foods available today. Without these additives many convenience food products could not be offered for sale in their present form. Most would never have appeared on the market. Unless society rejects the aim of reducing the preparation of food at home to a minimum—and there is now a whole generation with no real appreciation of any other concept—it seems likely that technological need for these additives will continue to be assessed in this light. When this is done the issues involved in establishing a technological need are again reasonably well defined. The onus rests with the applicant to establish that a satisfactory product cannot be placed on the market by alternative technology or the use of other permitted additives.

Colours and flavours

With two more major groups of food additives, colours and flavours, the issues to be resolved are no better defined. It is true to say that these groups have not been, and probably cannot be, assessed in the same manner as most other food additives. This is because there can be no strict technological justification made for these additives. The justification for their use is sociological, a term used to embrace the economic pressures of the market place as well as the response of individuals to foods made available to them.

This does not mean that to obtain permission to use a prescribed colouring in a food a manufacturer has to demonstrate only the safety in use of that colouring. The Joint Expert Committee on Food Additives clearly regarded the use of additives to make sound food more attractive to the consumer as legitimate. However, in describing situations in which the use of food additives was not justified, they set down three constraints which impinge on the use of food colouring (as outlined above).

The most important of these—and the one about which the others revolve—is that food additives may not be used to deceive the consumer. When one studies the list of foods to which prescribed colouring may be added (NHMRC 1975) it is clear that the majority of the foods listed are such that a serious question of deception does not arise e.g. with confectionery, cordials, dessert and, custard mixes, flavoured milk, ice cream and soft drinks. This position is reinforced by the requirements about labelling which make it mandatory for a manufacturer to include the statement 'Artificially coloured' on the label of foods to which colour has been added.

At present there are some exceptions to this requirement, e.g. cheese (all classes), alcoholic beverages, cake, pastry and biscuits, and it will be interesting to see what attitude is adopted towards these foods in the proposed legislation for labelling the ingredients of packaged foods. The important point is that such labelling cannot excuse the use of colours to give a false impression of the quality of the raw materials used in a process, or to give a false impression of changes undergone by a raw material during processing.

If the addition of colour to foods presents certain problems to the FSC and FST Sub-committee within their terms of reference, the addition of flavours presents far greater ones. Until recently there has not been, in this country or elsewhere, a truly comprehensive approach to legislation concerning flavouring (Edwards 1973). Thus while food colours are in an ambiguous position with regard to technological or sociological need, the toxicological status of permitted colourings is comparable to that of other food additives. Added flavours occupy a similar position to colours with regard to need, while knowledge of their toxicity, in the terms required for other additives, is small

indeed. There is no positive list of flavours that may be added to food, although in New South Wales there is, for example, a short negative list made up of safrole and its derivatives (N.S.W. Pure Food Act No. 31, 1908 and Regulations Thereunder, Revised Issue 1975) and a blanket clause prohibiting the addition to an article of food of 'any harmful substance'.

Current thinking in Australia on this problem is aligned with the position adopted by the Council of Europe which represents some 18 European countries. As part of its program in public health, the Council has drawn up a document which attempts to rationalize the toxicological status of flavouring materials, either natural or artificial. Some have been granted acceptable status largely on the basis of long usage, while for a small proportion sufficient toxicological information is available to set an acceptable daily intake in the usual manner. Others are listed as provisionally acceptable pending further toxicological testing which will be expensive and time consuming. In fact, the effort required to establish the safety in use of this group may be such that it is not considered worth while for some of the chemicals as listed. Some 240 substances are in this provisionally accepted group. A third list comprises known flavouring substances that are not allowed because of their toxicity.

The listings by the Council of Europe have not been met with unqualified acceptance by the food and flavour industry in member countries, nor by the Joint Expert Committee on Food Additives. A similar attitude is likely in this country and it is too early yet to say whether the Council's proposals are workable or whether greater flexibility or greater constraints may be necessary. The Council of Europe also recommended that any substance not included in its listings, but which manufacturers may wish to use in the future, would be subject to the same sort of appraisal by the Joint Expert Committee on Food Additives as are other proposed new additives.

An important point in connection with a permitted list of food flavourings is the question of enforcement. Analysis of flavours extracted from food is a complex process and some arbitrary decisions would have to be made by government analysts about what proportion of their available facilities is taken up with monitoring flavourings in foods.

Establishing the safety in use of a food additive

There are two stages in the toxicological evaluation of a substance proposed for use as a food additive. The first is the collection of relevant data derived from experimental tests on laboratory animals and, when possible, from observations on man. The NHMRC requires an applicant to produce this data and to show that the testing has been carried out according to the general terms of reference given in FAO Nutrition Meetings Report Series, No. 17 (FAO/WHO 1958). The second stage is the interpretation and assessment of the data in order to arrive at a decision about the acceptability or otherwise of the substance as a food additive. This assessment is carried out by the toxicologists on the FST. It should be stressed again that an important part of their task is to identify and discard poor data, i.e. data derived from poorly constructed experiments and judgments based on such experiments.

The general procedure adopted both by the Joint Expert Committee on Food Additives and the FST Subcommittee is to establish an acceptable daily intake (ADI) for each food additive. The concept of an ADI is based on the fact that all chemicals are toxic but their toxicities vary markedly in the amount that is required to produce ill effects (Vettorazzi 1975). The ADI expressed in mg/kg body weight is defined as the amount of a chemical that might be ingested daily, even over a lifetime, without appreciable risk to the consumer, in the light of information available at the time of evaluation. 'Without appreciable risk' is taken to mean the practical certainty that injury will not result after a lifetime exposure (Vettorazzi 1975).

For an ADI to be set for a food additive the toxicological data supplied must be sufficient to identify a 'no-effect' level in animal studies. The 'no-effect' level is the daily dose up to which there is no indication of toxic effects in the test animal. When the toxicological data are derived from experiments on animals, which is usual, their extrapolation to man involves the application of a safety factor to the highest 'no-effect' level obtained in animal studies. The safety factor is required for a number of reasons, both biological and statistical, and a factor of 100 has been widely accepted, but this is by no means inflexible.

It can be seen that the toxicological basis for estimating an ADI is not absolute or unequivocal but is subject to informed decisions based on experimental data. When an ADI has been set for a given food additive, it is necessary to maintain a continuing surveillance of the use pattern of foods to which the substance may be legally added. This is necessary to ensure that the ADI is not likely to be exceeded by the population in general.

Since food suppliers and food use patterns change and since toxicological investigations of new and existing additives are proceeding all the time, often employing new techniques, the public and manufacturers must expect changes from time to time in legislation on food additives.

There is no uniform regimen for toxicological testing but the main tests can be summarized as follows.

Short-term tests

The short-term toxicity of a compound is usually determined by carrying out three types of animal tests.

- Determination of the LD_{50}
- Determination of the maximum tolerated dose
- A 90-day feeding test.

The LD_{50} is the dose after which 50% of the test animals die and gives some indication of the relative toxicity of diverse compounds. The route of administration of the compound is important and must be stated. The maximum tolerated dose is the maximum daily dose following which most of the animals survive for a period of 21 days. The aim of this test is to indicate the organ or organs on which the test material produces toxic effects. This enables special attention to be given to these organs during the 90-day feeding study. For this investigation several levels of treatment are chosen based on the available data. During the 90-day exposure to the compound being tested, the animals, usually rats, are observed for any sign of physical or behavioural abnormality and their food consumption and body weight are measured regularly. At the end of the 90 days the animals are killed and samples of tissues and fluids are examined to detect any abnormalities.

The result of this test may indicate a 'no-effect' level from which an acceptable daily intake in man can be calculated.

Long-term tests

The principal aim of these tests is to detect any carcinogenic potential of the compound, but they also supplement short-term tests. Rats and mice are animals commonly used and the tests extend over several generations. The most important investigation carried out is the search for tumours at the end of the test. Testing for teratogenicity of food additives has become a standard procedure with selected animal species and a growing number of additives or potential additives are being subjected to mutagenicity testing. However, tests currently available are of limited value for this purpose and provide results which are at best difficult to interpret. A discussion of some of the procedures and problems involved in the assessment of toxicity of food additives can be found in a paper by Carpanini and Crampton (1972).

Risk/benefit concept

As indicated above, manufacturers see the risk/benefit analysis of the use of a food additive as the critical point in their approach to food additive legislation. It is not a new concept and has been inherent in all discussion on food additives based on the principles laid down in 1956 by the Joint Expert Committee on Food Additives. Food manufacturers are restating it emphatically in an attempt to redress the imbalance which has often occurred in media reports on the use of food additives.

Lloyd and Drake (1975) point out that the use of chemical preservatives, and by extension other additives, must reflect not only the outcome of scientific evaluation, but also a complex interaction of technological, economic and sociological factors. These considerations have established that it is society which ultimately defines 'safety' and 'benefit' in food terms. On the other hand, the analysis of 'risk' or 'hazard' must continue to remain unequivocally within the scientific process.

While this broad view of society's responsibilities is the ideal towards which we progress, decisions on benefit and risk largely rest in practice with the same people who are called upon to deliberate about food additives in Australia and elsewhere.

In cases where an additive helps to prevent wastage of food, e.g. sodium nitrite, sulphur dioxide or butylated hydroxy anisole, a relatively higher toxicity might be tolerated

than in a case where the additive merely facilitates the preparation of agreeable convenience foods. The benefits obtained by the use of additives near the top of the accompanying table are arguably much greater than those obtained from additives near the bottom of the table. The risk that on occasions the ADI may be exceeded is considered outweighed by the benefits that the widespread use of these additives bestow. Sulphur dioxide is of some concern in this regard (Anon. 1966) but no satisfactory alternative has been found for many of its uses. It is conceivable, however, that as a result of ongoing research the risk/benefit relationship of sulphur dioxide in foods may be reappraised and greater restrictions on its use as a food additive imposed.

A striking current example of risk/benefit analysis is the use of nitrite in cured meats. The ADI for nitrite in the table refers to the toxicity of nitrite *per se* and use levels present no hazard from direct nitrite intake. However, under certain conditions reaction can occur between nitrites and some amines naturally present in foods to form a group of chemical compounds, nitrosamines. Some of these nitrosamines are known carcinogens and have been demonstrated to occur rarely in foods at the μg/kg level (Anon. 1972).

Some common food additives and their ADI figures (FAO/WHO 1974)

Name	Function in food	Acceptable daily intake (mg/kg body weight)
Sodium nitrite	Anti-microbial preservative colour-fixing agent	0–0·2
Butylated hydroxy anisole	Anti-oxidant	0–0·5
Sulphur dioxide	Anti-microbial preservative anti-oxidant	0–0·7
Benzoic acid	Anti-microbial	0–5
Calcium cyclamate	Non-nutritive sweetener	0–10
Saccharin	Non-nutritive sweetener	0–15
Sorbic acid	Anti-microbial	0–25
Polyglycerol esters of fatty acids	Emulsifying agents	0–25
Tribasic calcium phosphate	Anti-caking agents	0–30
Guar gum	Gelling agent	No limit
Pectin (non-amidated)	Gelling agent	No limit

Nitrites are used in cured meats for two reasons: to develop the characteristic pink coloration by combination with meat pigments and to inhibit the outgrowth of spores of *Clostridium botulinum* which may survive the heating process. No substitute has yet been found effective in fulfilling either function.

While many nitrosamines are recognized as chemical carcinogens when administered to laboratory animals, dosages in experiments establishing this effect have been vastly in excess of those likely to arise from normal foods (Lloyd and Drake 1975). It is usually concluded (Magee 1971) that the possible hazard to man of exposure to very low concentrations of nitrosamines cannot be assessed in the absence of reliable data on dose–response relations at comparable levels. Such data are now being actively sought.

Concern about carcinogens must be balanced against the need for effective control of botulism and many of the experiments performed to establish the minimum nitrite concentration required to inhibit outgrowth of *Cl. botulinum* spores, are also difficult to relate to commercial conditions. It has been argued throughout the world, however, that whereas the effects of toxins formed in meat products by *Cl. botulinum* present an identifiable immediate hazard to consumers, no unusual incidence of cancer has been linked with a high consumption of cured meats in the long period during which nitrites have been added to human food. Any risk/benefit analysis of the use of nitrite clearly favours its continued use at this stage, but many countries including Australia have taken steps to tighten their regulations regarding the amount of nitrite that may be added to foods.

It is interesting to speculate on what action might have been adopted had the benefits from nitrite been less substantial. For instance, if nitrite had served as a colour-fixing agent only, or had controlled the growth of food spoilage bacteria only as distinct from toxigenic clostridia, would a different risk/benefit balance apply. Diethylpyrocarbonate, an anti-microbial preservative formerly permitted in fruit juices, wines and some other beverages, was removed from the approved food additives

listings of the NHMRC when it was found that under certain conditions the known carcinogen urethane could be formed in trace quantities in the beverages. The benefits conferred by diethylpyrocarbonate were slight compared with those afforded by nitrite, however, and alternative, though expensive, technology was available to manufacturers using this additive.

Summary

The appraisal of the use of food additives involves judgments in which scientific evidence plays a major, but not the sole, part. It involves the judgment of qualified experts with due recognition of the limitations of the evidence before them. Any potential risk posed by the approval of an additive must be sufficiently remote to be socially acceptable and must be out-balanced by the benefits which will ensue from the use of that additive.

Food manufacturers in Australia, when applying to use a food additive, are provided with a set format by the NHMRC. It is the responsibility of the applicant to answer the questions asked as fully and as accurately as possible, supported where appropriate by data collected by the applicant and relevant reference material.

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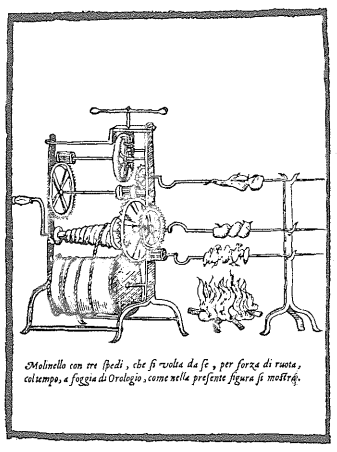

Molinello con tre ſpedi, che ſi rivolta da ſe, per forza di ruota, columpo, a foggia di Orologio, come nella preſente figura ſi moſtra.

Cholesterol and fatty acids in Australian seafoods

By Judith A. Pearson

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Overseas reports have indicated that figures previously quoted for the cholesterol content of some seafoods were too high, because the analytical methods used to obtain the data do not differentiate between cholesterol and the other sterols present. This article describes methods for determining total sterols, cholesterol, fat content and fatty acid composition of seafoods, and presents data for a wide variety of Australian seafoods commercially available.

Medical practitioners and dietitians, when giving patients advice about diets for reducing the level of serum cholesterol, have often suggested that the consumption of certain seafoods should be limited on account of their high cholesterol content.

However, reports from the U.S.A. (Kritchevsky *et al.* 1967, Feeley *et al.* 1972), New Zealand (Coster *et al.* 1975), and Britain (Schulze and Truswell 1976) indicate that the figures previously quoted for the cholesterol content of many seafoods are too high. Now that gas–liquid chromatography (g.l.c.) is used in conjunction with the other methods for determining sterols, the amount of cholesterol present in the sterols of such foods may be more accurately measured.

The samples analysed in this work are examples of the wide variety of fresh and processed fish products available to the Australian consumer. The analytical method used was devised to give a relatively rapid estimation of total sterol and cholesterol in each sample, and to indicate the amount of fat and of individual fatty acids present.

Experimental procedure

Molluscs, fin fish, crustaceans and some canned and bottled seafoods were purchased from the Sydney Fish Market or from local shops. The surface of some samples was dried on paper tissues to remove excess moisture before subsampling. With canned fish the oil or water was removed in the same way so that only the flesh and absorbed oil were sampled for analysis.

Lipid was extracted by the method of Bligh and Dyer (1959) from accurately weighed samples of approximately 10 g of the edible portion. Chloroform extracts were dried over sodium sulphate and aliquots were used to determine fat content. The extracted lipid was separated into sterol esters, triacylglycerols and sterols by chromatography in a Florisil column (Carroll 1961) and the fractions were weighed. These data were needed to determine the weight of individual fatty acids present as described later.

Most samples contained negligible amounts of sterol esters but shellfish, e.g. oysters and scallops, contained small amounts. To reduce the time taken for each analysis the lipids were transesterified before separation on Florisil, the sterols from the sterol ester fraction being released and thus estimated with the non-esterified sterols. For trans-esterification of the total lipid an aliquot of the chloroform extract containing *c.* 100 mg of lipid was treated by the method of Glass and Christopherson (1969) as modified by Hood *et al.* (1972). The resultant mixture of methyl esters was then dissolved in hexane and transferred to a column containing Florisil (12 g, 7% w/w hydrated). A fraction containing only the methyl esters of the fatty acids was obtained by eluting with 5% ether in hexane (100 ml), and a fraction containing sterols was then eluted with 25% ether in hexane (100 ml). Both fractions were subjected to g.l.c. and the fatty acid composition, cholesterol content, total sterol content and sterol composition were determined. The sterols were analysed by g.l.c. with a Packard Gas Chromatograph (Model 7508) fitted with a flame ionization detector (FID) and a 180 by 0·3-cm ID coiled glass column containing 3% SE 30 on Gas Chrom Q

operated at 250°C. The methyl esters of the fatty acids were analysed on a 200 by 0·2-cm ID glass U-tube column of SP2340 on 100/120 Chromosorb W-AW at 170°C in a Packard Gas Chromatograph (Model 7301). The weight of cholesterol in the original sample was determined by adding an exact quantity of carbon disulphide (chosen to minimize response of the FID to the solvent) to the sterol fraction and injecting a known volume of this solution onto the column at the start of the g.l.c. analysis. The area of the resulting cholesterol peak was measured and compared with a calibration graph prepared from a series of chromatograms of cholesterol standards run under identical g.l.c. conditions. The amounts of cholesterol and total sterol present were then calculated as mg/100 g wet weight of the sample of seafood.

The amounts of the individual fatty acid methyl esters present were expressed as a percentage of the total fatty acid methyl esters. The weights of the fatty acids in the samples were calculated and expressed as mg/100 g wet weight of edible portion by the following procedure which is similar to that suggested by Exler *et al.* (1975).

Table 1. Fat, cholesterol and total sterol content of seafood

Type of seafood		No. of samples	Fat (g/100 g wet wt.)	Cholesterol (mg/100 g wet wt.)	Total sterol (mg/100 g wet wt.)
Crustaceans					
Prawns	School	3	1·4	203	210
	King	5	1·5	169	181
	Royal red	1	1·5	192	206
	Banana	1	1·3	175	186
Lobster	Sydney rock	2	1·2	79	84
	Tropical	1	1·0	58	59
	West Aust.	1	1·0	52	52
	Sand lobster (Balmain Bug)	3	1·1	95	103
Crab	Shop, cooked	1	0·8	105	133
	Blue swimmer	2	0·8	54	58
	Mangrove mud	2	0·7	40	43
Molluscs					
Oysters	Sydney rock	8	2·3	38	117
	Bottled	1	2·6	72	225
Mussels	Fresh	4	2·1	45	112
	Bottled	1	2·7	62	154
Scallops		4	1·5	29	111
Cockles		1	1·3	59	163
Abalone		2	0·9	105	114
Salt-water fish					
Cod		1	1·1	42	49
Flathead		1	1·6	58	61
Bream		1	4·0	139	150
Silver Dory		1	0·9	30	34
Processed fish					
Herrings in tomato sauce		1	6·4	88	90
Herrings (canned in water)		1	12·5	138	149
Pickled herrings		1	6·4	132	146
Tuna (in oil)		1	7·1	92	113
Sprats (in oil)		1	9·9	251	287
Oysters (in oil)		1	7·7	38	127
Clams (in water)		1	3·5	79	193
Smoked salmon (in oil)		1	4·5	26	40
Snow crab (in water)		1	2·2	192	214
Sardines (in oil)		2	12·5	145	150

Sterols, triacylglycerols and sterol esters were obtained as weighed fractions from a number of samples, including all the processed fish. It was assumed that the lipid remaining after subtracting the known amounts of sterols and triacylglycerols was phospholipid. From these data a factor was derived which was used to convert the figures for individual fatty acids from '% of total fatty acids' to 'mg fatty acid/100 g wet weight of seafood', values more suitable for use in food composition tables. The calculations were based on the following four relationships.

$$\blacktriangleright PL = 100 - (TAG + ST)$$

$$\blacktriangleright F = \frac{TAG}{100} \times 0{\cdot}956 + \frac{PL}{100} \times 0{\cdot}72$$

▶mg individual fatty acid/100 g extracted lipid $= F \times FA \times 1000$

▶mg individual fatty acid/100 g seafood

$$= F \times FA \times \frac{TL}{100} \times 1000$$

where PL is the percentage of phospholipid, TAG is the percentage of triacylglycerol,

Table 2. Fatty acid composition of seafood

Type of seafood		No. of samples	Fat (% wet wt.)	% total fatty acids		
				Saturated	Mono-unsat.	Poly-unsat.
Crustaceans						
Prawns	School	3	1·4	47·7	25·7	26·6
	King	3	1·5	43·2	28·3	28·5
	Royal red	1	1·5	34·1	36·8	29·1
	Banana	1	1·3	45·4	31·0	23·6
Lobster	Sydney rock	2	1·2	33·3	31·6	35·1
	Tropical	2	1·0	34·9	27·7	37·4
	West Aust.	1	1·0	43·2	28·2	28·5
	Sand lobster (Balmain Bug)	2	1·1	35·3	29·6	35·1
Crab	Shop, cooked	2	0·8	23·3	23·6	53·1
	Blue swimmer	2	0·8	31·8	34·9	33·3
	Mangrove mud	2	0·7	32·5	33·0	34·5
Molluscs						
Oysters	Sydney rock	4	2·3	53·9	17·1	29·0
	Bottled	1	2·6	52·6	18·5	28·9
Mussels	Fresh	4	2·1	40·8	24·8	34·4
	Bottled	1	2·7	39·2	21·5	39·1
Scallops		2	1·5	37·8	19·0	43·2
Cockles		1	1·3	44·2	24·6	31·2
Abalone		1	1·0	39·1	34·4	26·5
Salt-water fish						
Cod		1	1·1	32·0	23·4	44·6
Flathead		1	1·6	45·7	24·5	29·8
Bream		1	4·0	37·3	43·2	19·5
Silver Dory		1	0·9	35·7	30·8	33·5
Processed fish						
Herrings in tomato sauce		1	6·4	44·6	25·0	30·4
Herrings (canned in water)		1	12·5	36·4	50·1	13·5
Pickled herrings		1	6·4	37·3	52·3	10·4
Salted herrings		1	6·1	32·0	62·3	5·7
Tuna (in oil)		1	7·1	17·9	20·7	61·4
Sprats (in oil)		1	9·9	33·7	40·6	25·7
Oysters (in oil)		1	7·7	45·2	23·9	31·0
Clams (in water)		1	3·5	39·4	25·0	35·6
Smoked salmon (in oil)		1	4·5	22·0	30·5	47·5
Snow crab (in water)		1	2·2	39·1	31·4	29·6
Sardines (in oil)		1	14·4	40·0	43·3	16·7

ST is the percentage of sterols, F is a conversion factor, FA is fatty acid as a percentage of total fatty acids, and TL is the weight (g) of fat extracted from 100 g seafood. The use of the values 0·956 and 0·72 is based on the assumption that triacylglycerols contain on average 95·6% by weight of fatty acids and phospholipids contain 72%.

Results

Table 1 gives the amount of fat, cholesterol and total sterol in a variety of fresh and processed seafoods. Prawns have the highest level of cholesterol of the fresh seafoods analysed, with 169–203 mg cholesterol per 100 g sample, (compare egg yolk which contains about 1000 mg cholesterol per 100 g), varying a little with

Table 3. Cholesterol and fatty acid content of seafood (mg/100 g wet weight) (continued on next page)

Type of seafood	No. of Samples	Sample type	Cholesterol mg/100g	14:0	16:0	18:0	Total[B] sat.
Crustaceans							
Prawns							
Banana	1	Frozen	175	53	195	87	358
Royal red	1	Frozen	192	21	232	49	324
Western king	1	Frozen	168	40	213	103	387
King	2	Fresh	164	37	215	101	381
School	3	Fresh	204	57	273	73	427
Lobster							
Sydney rock	2	Fresh	79	56	139	36	255
Tropical	2	Frozen	58	41	137	69	227
West Aust.	1	Frozen	52	95	122	52	285
Sand (Balmain Bug)	2	Fresh	81	24	99	48	187
Crab							
Blue swimmer	2	Fresh	54	10	106	42	167
Mangrove mud	2	Fresh	40	13	93	30	144
Crab meat	2	Frozen	105	42	98	82	225
Molluscs							
Oysters	4	Fresh	41	187	873	188	1294
	1	Bottled (water)	42	75	587	127	827
Mussels	4	Fresh	48	145	526	61	755
Scallops	2	Frozen	33	81	346	66	516
Cockles	1	Fresh	59	39	155	123	336
Abalone	1	Fresh	105	24	258	22	313
Salt-water fish							
Cod	1	Fresh	42	8	167	52	235
Flathead	1	Fresh	58	86	400	67	561
Bream	1	Fresh	139	233	884	146	1284
Silver Dory	1	Fresh	30	18	172	35	238
Processed fish							
Herring	1	Pickled	132	613	1195	62	1917
Herring	1	Canned (water)	138	1167	1918	80	3210
Herring	1	Salted	ND[A]	490	1030	45	1595
Herring	1	Canned (tomato sauce)	88	229	2118	367	2806
Tuna	1	Canned (oil)	92	70	858	205	1145
Sprats	1	Canned (oil)	251	472	2299	140	2939
Oysters	1	Canned (oil)	38	450	1632	131	2248
Clam	1	Canned (water)	79	69	577	178	874
Salmon	1	Canned (oil)	26	108	640	108	856
Snow crab	1	Canned (water)	192	105	300	110	544
Sardines	1	Canned (oil)	145	1304	3733	258	5361

[A] ND, not determined.

species. This level reflects a higher level of fat than in lobster and crab as well as a greater proportion of sterols in the fat. Cholesterol is the main component of crustacean sterols. The sterol content of most of the molluscs examined is quite high, but cholesterol is only one of a number of sterols present. The other sterols include the so-called plant sterols (e.g. sitosterols, brassicasterol and stigmasterol) which are not contraindicated in the dietary treatment of elevated serum cholesterol. In this study the sterols were 'identified' by measuring g.l.c. retention times. An unequivocal identification of each sterol from each seafood would require the use of g.l.c. in combination with mass spectrometry, but this degree of certainty was beyond the scope of the survey. Kritchevsky *et al.* (1967) have indicated that certain seafoods may contain

Type of seafood	16:1	18:1	20:1	22:1	Total[B] mono-unsat.	18:2	18:3	20:4	20:5	22:5	22:6	Total[B] poly-unsat.
Crustaceans												
Prawns												
Banana	78	139	2	–	244	7	2	46	75	–	52	186
Royal red	71	237	11	–	350	6	1	37	132	–	96	276
Western king	73	107	9	–	212	8	3	53	110	4	76	270
King	76	140	8	–	250	13	2	32	143	–	60	251
School	74	135	2	–	230	27	4	46	110	–	50	238
Lobster												
Sydney rock	53	158	6	–	242	5	2	75	109	2	77	269
Tropical	47	110	5	–	180	16	5	127	74	–	17	243
West Aust.	34	120	6	–	186	6	2	103	55	3	11	188
Sand (Balmain Bug)	37	108	2	–	157	5	1	19	81	1	59	186
Crab												
Blue swimmer	30	141	2	–	183	14	2	17	73	–	68	175
Mangrove mud	37	92	–	–	146	20	5	35	66	–	25	153
Crab meat	38	186	–	2	228	1	–	22	378	2	111	513
Molluscs												
Oysters	116	120	68	64	410	38	83	30	206	–	208	696
	83	104	46	36	290	16	35	14	203	–	124	454
Mussels	236	71	74	56	458	16	10	59	404	–	129	637
Scallops	93	109	49	2	260	16	20	17	252	–	236	590
Cockles	15	29	34	97	187	12	14	25	46	–	132	237
Abalone	28	145	38	57	275	9	9	41	71	77	–	212
Salt-water fish												
Cod	17	96	3	2	172	6	1	53	50	12	167	328
Flathead	64	211	10	9	300	6	1	12	68	14	261	366
Bream	299	1124	38	21	1486	56	24	14	265	10	247	672
Silver Dory	27	112	44	19	205	12	–	8	22	–	180	223
Processed fish												
Herring	294	963	536	860	2689	62	21	10	134	–	273	536
Herring	592	972	1025	1768	4419	115	44	9	424	–	469	1185
Herring	185	920	660	1295	3105	65	25	–	65	–	60	285
Herring	332	448	275	466	1570	85	–	42	388	–	1341	1912
Tuna	37	1273	6	–	1322	3366	198	12	102	–	237	3921
Sprats	358	3129	18	–	3549	1477	219	9	192	–	297	2246
Oysters	450	556	141	71	1187	51	40	25	909	–	323	1540
Clam	144	219	129	38	555	16	21	70	228	34	367	788
Salmon	72	1052	52	44	1184	1708	136	–	24	–	–	1844
Snow crab	131	288	–	–	436	11	2	87	169	5	130	411
Sardines	1098	2738	749	1201	5812	116	52	–	633	–	736	2245

[B]Total for each group includes all minor fatty acids not listed.

small amounts of atherogenic sterols (i.e. those implicated in the onset of atherosclerosis) other than cholesterol, e.g. dehydrocholesterol.

The results of the fatty acid determinations are presented in Table 2. Oysters and prawns have the highest levels of saturated fatty acids while fatty fish, e.g. herring, contain greater proportions of monounsaturated fatty acids and small proportions of polyunsaturated fatty acids.

Table 3 lists the cholesterol, major fatty acids and combined saturated, monounsaturated and polyunsaturated fatty acids (including all the minor fatty acids) content of the seafoods analysed in mg/100 g wet weight. The usual shorthand notation for fatty acids is used, the number before the colon showing the number of carbon atoms, and that after the colon the number of double bonds.

Discussion

It is not possible to provide precise figures for the amount of cholesterol present in seafoods. The level varies with location of growing area, season, reproductive status at the time of harvest and sampling errors of various kinds. However, the data presented here may be used as a guide by those wishing to include seafoods in low cholesterol diets. All the prawn varieties contained more than 160 mg of cholesterol per 100 g wet weight, the only other seafoods exceeding this level being the canned sprats and the canned snow crab. Sydney rock oysters, however, contained only about 38 mg of cholesterol per 100 g wet weight, although their total sterol content was 117 mg per 100 g.

The fatty acid composition of fish will also show considerable variation with diet and physiological state. Most of the local crustaceans, molluscs and fin fish examined in this study contained low levels of fat; herrings, and fish canned in vegetable oil, contain relatively high levels of fat (up to 14%). All samples contain high levels of long-chain polyunsaturated fatty acids, but with the exception of some of the crustaceans (school prawns, mud crabs and tropical lobster) they contained less than 2% linoleic acid (C18: 2), in contrast to other foods in which linoleic acid is the major essential fatty acid. Tuna and salmon canned in vegetable oil had a high content of linoleic acid, 53% and 43% respectively of the total fatty acids or 3·4 and 1·7 g/100 g of the original sample, derived mainly from the absorbed oil. Herrings and sardines are high-fat fish and differ from other fish in this study in that the fat contained a higher proportion of monounsaturated fatty acids including high levels of C22: 1 acids, 13% of which is erucic acid (Ackman and Castell 1966).

Although tables of fatty acid composition indicate the degree of saturation of the fat in a seafood, the dietitian is more concerned with the total intake of cholesterol or saturated fatty acids or polyunsaturated fatty acids, and this can be ascertained from Tables 2 and 3. Apart from herrings and fish canned in oil, the amount of fat in the seafoods listed is less than 5% on a wet weight basis and compares very favourably with most animal meats which contain about 20% fat. Most animal meats contain cholesterol at levels of 60–120 mg/100 g fresh weight, and obviously some of the seafoods, e.g. oysters and scallops, compare very favourably. However, at 200 mg/100 g of edible portion the cholesterol level of prawns is nearly twice as much as that of animal meats. With those seafoods containing other sterols as well as cholesterol, a question to be considered is which of those sterols may be involved in the onset of atherosclerosis, and which are generally considered non-atherogenic. To answer this question each sterol present must be identified and its atherogenic potential determined. While the overseas studies have provided some data on the individual sterols in seafoods, the role of such sterols in the dietary manipulation of hypercholesterolaemia requires more investigation.

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The hazard to man from aflatoxin

L. Stoloff and L. Friedman of the US Food and Drug administration in Washington, D.C. in a paper entitled 'Information bearing on the evaluation of the hazard to man from aflatoxin ingestion' (*PAG Bulletin*, 1976, VI, No. 2, 21–32) have surveyed published information to answer nine important questions on aflatoxin carcinogenesis. The questions and summaries of the answers are reproduced here with the kind permission of the authors and publisher of *PAG Bulletin.*

Question 1 Does the Fisher rat strain have unusual sensitivity to aflatoxin carcinogenesis?

Summation: Compared with USC and Wistar rat strains, the Fisher rat strain is highly sensitive to aflatoxin carcinogenesis.

Question 2 Is aflatoxin carcinogenic to resistant animals at any level?

Summation: Liver tumours can be induced in mice by a dose in the ppm range (level translated to feed) by the i.p. route at a very early stage of life. A tumourigenic response was induced in a subhuman primate by the equivalent of 0·2 ppm aflatoxin B_1 in the feed. The type of tumour produced in the subject animal at this dose was not typical of liver tumours associated with aflatoxin carcinogenesis in the rat; in addition, the administration of the toxin included the intramuscular route.

Question 3 Is the liver the only target organ for aflatoxin carcinogenesis?

Summation: The possibility of aflatoxin induced tumours of the kidney, colon, lung and lacrimal gland has been demonstrated. The case for lung tumours is weak, being based on a strain of mice subject to a high incidence of spontaneous lung tumours and on either a simultaneous challenge with urethan or massive i.p. administration in DMSO. Dose levels required to induce tumours of the other organs were, in most cases, in the ppm range. Opinion differed between pathologists who examined the renal tumours concerning the state of malignancy. Variable species susceptibility to each type of tumour is suggested by the experimental results, but the data are insufficient for even a tentative conclusion.

Question 4 Is there an increased risk during the prepartum or preweaning periods?

Summation: The limited information with one species (hamster) showed that a relatively high single dose caused terata. No delivered terata were seen in a study with rats dosed over the entire vulnerable period, but this last study did show some danger of oncogenesis from exposure through the placenta or milk from these high levels.

Question 5 Is aflatoxin *per se* the carcinogen?

Summation: There is good inferential evidence that a liver metabolite(s) of aflatoxin B_1 is the active carcinogen in the rat.

Question 6 Are there any differences in the metabolism of aflatoxin by livers of animals resistant and susceptible to aflatoxin carcinogenesis and how do these differences relate to man?

Summation: *In vitro* experiments, although in some cases producing contradictory results, show major differences in rate of aflatoxin metabolism and the pattern of metabolic products formed by liver

preparations of the various species studied. The aflatoxin metabolism pattern of human liver is generally different from that of the rat but resembles that of monkeys. In this last regard refer to the response to Question 2.

Question 7 Is there any epidemiological evidence relating to the susceptibility of man to aflatoxin carcinogenesis?

Summation: All five studies of aflatoxin ingestion in areas having local populations with relatively high rates of liver cancer show a positive correlation, but provide no basis for a conclusion that aflatoxin is a causative factor. On the assumption that aflatoxin is a causative factor, the data provide a conservative estimate that in a population exposed to an average 0·12 ppb aflatoxin B_1 in its food, the risk of liver cancer is statistically very low.

Question 8 Are there any other known causes of liver cancer that could affect the epidemiological findings?

Summation: The populations included in the epidemiological studies could have been exposed to hepatocarcinogens other than aflatoxins, particularly pyrrolizidine alkaloids and selenium compounds, and to alcohol. None of the studies report an attempt to check for possible etiological factors other than aflatoxins, except for one study (Purchase and Goncalves 1971) in which the foodstuffs were analysed for sterigmatocystin with negative results.

Question 9 Does the picture of liver, kidney or colon cancer in the United States indicate any relation to aflatoxin exposure?

Summation: The data show a negative correlation between the expected exposure to aflatoxin and the incidence of liver, colon, or kidney cancer in the United States, but other etiological considerations cannot be completely eliminated as factors complicating the determination of a relationship.

A new system for branding meat

All Australian meat for export must be labelled and this is usually done by stamping the meat with solvent-based, water-soluble inks. Inks used at present are slow drying and smudge easily, and it is difficult to obtain legible impressions on surfaces which are irregular, fatty or wet. If the 'Australian approved' brand on export meat is illegible, overseas buyers may exclude the meat from their market. A new method of labelling has been developed at the CSIRO Meat Research Laboratory at Cannon Hill to overcome these problems.

The brand is printed in reverse on the underside of a flexible gelatine film 0·1-mm thick with an edible, waterproof ink which consists of a dispersion of pigment of a food grade in hardened vegetable oil. The presence of the gelatine over the brand prevents subsequent smudging. The film carrying the brand is applied directly to the surface of freshly slaughtered carcasses or to chilled meat cuts which are to be frozen or vacuum-packed.

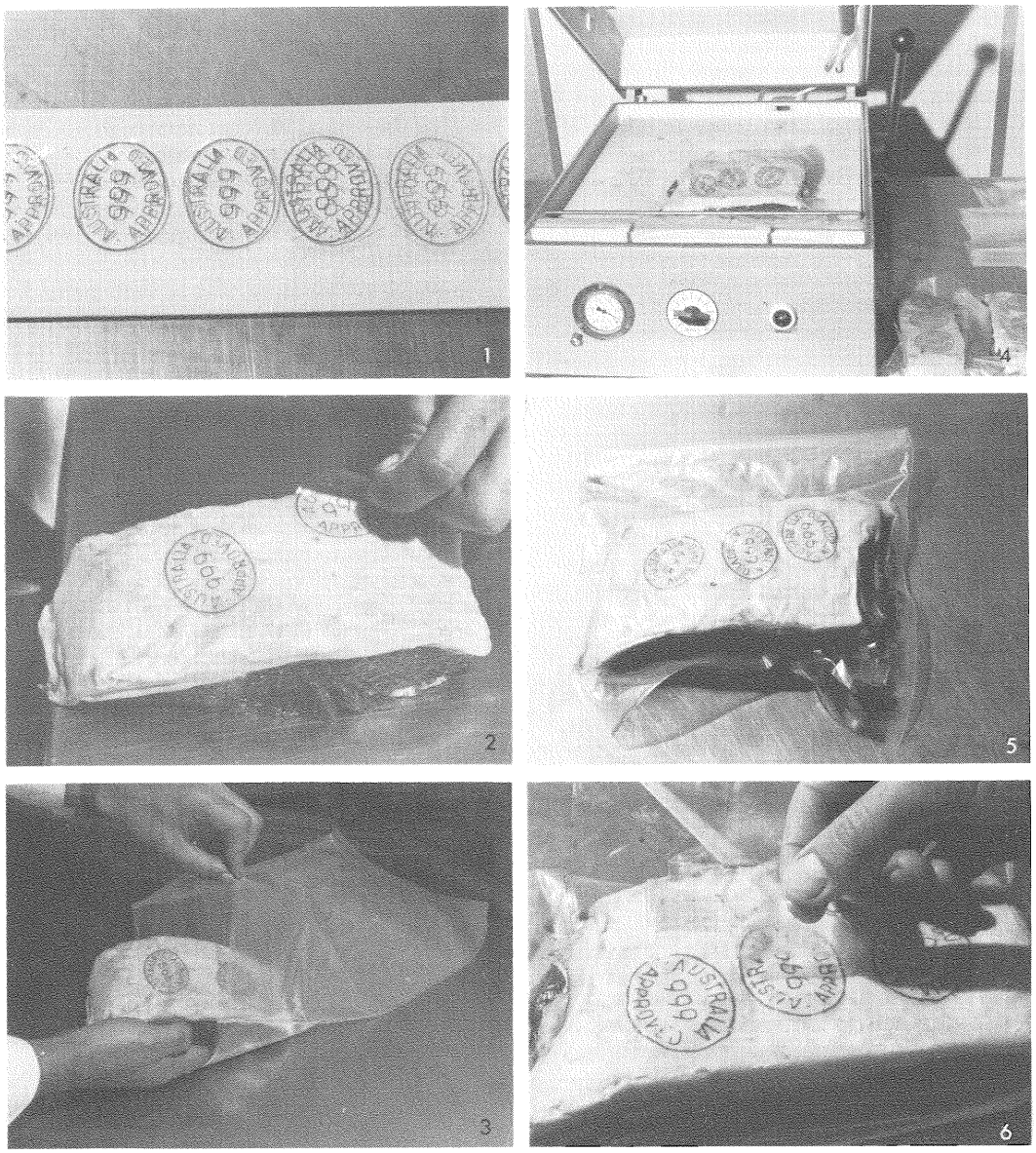
When applied to warm, wet carcasses the label hydrates, becomes tacky at the meat interface and releases the print from the gelatine film. In the chiller, the label dehydrates and adheres firmly to the carcass. Should the transfer be removed, the print remains on the carcass, thus ensuring that each brand has a once only use.

When applied to vacuum-packed meat, the gelatine film hydrates, releasing the print onto the surface of the fat. The swollen gelatine then protects the brand against abrasion. A similar situation occurs when frozen, branded meat is thawed.

The gelatine film branding system proved successful in two trial shipments of meat; one of chilled meat to Japan, the other of frozen meat to the United States. The branding system is now being patented in major meat exporting countries as well as in Australia. Conditional approval to use the new type of brand has been granted by Japan and the U.S.A. The system now has the prospect of worldwide use for the labelling of export and domestic meats.

More information on the new branding process is available from the Industry Section of MRL.

R. G. HAMILTON



1, The gelatine transfers; 2, applying the transfers; 3, placing the meat in bags; 4, evacuating and sealing the bags; 5, bag ready for packing; and 6, the label can't be removed because the print transfers to the meat.

News from the Division

Retirements

Wally Szulmayer

Mrs Wally Szulmayer retired on 16 July 1976 after 17 years in the Division of Food Research. She was Polish-born and studied at the University of Heidelberg in Germany. Wally migrated to Australia in 1950 and worked for nearly three years for the Sydney County Council. In 1954 she joined the CSIRO Division of Physics but resigned in 1957 for personal reasons.

In 1959 she rejoined CSIRO as an Experimental Officer in the Physics Section of the Division of Food Research. Working mainly independently, she developed instruments for measuring relative humidity in confined spaces and particularly on the high humidity range. She also developed methods and equipment for the measurement of colour in fresh and processed foods.

In 1969 her growing interest in the use of solar energy prompted Wally to transfer to the Food Technology Section where she studied physical aspects of sun-drying, particularly of grapes and tree fruits. She was an inveterate traveller and attended a number of international conferences on the use of solar energy and presented papers that aroused interest in many countries.

Wally pursued any idea that she considered worth while with commendable skill based on her sound physical knowledge and applied great enthusiasm and determination to any project she undertook.

Since retiring from CSIRO, Wally continues to follow her interest in solar energy at the Physics Department of the University of New South Wales.

D. McB.

John Conochie

Mr John Conochie graduated B.Sc. (Agric) in 1938 and then worked with Professor Underwood at the University of Western Australia on problems in animal nutrition. He joined the Dairy Research Section of CSIRO in 1942 and undertook work on oxidation problems in butter and butter products. Mr Conochie was responsible for bringing about the export of cheese, in the rindless form, to Britain, and also worked on and discovered the reasons for seaminess in Cheddar cheese. He has contributed greatly to developments in the packaging and transport of cheese and other dairy products. Mr Conochie was awarded the Australian Society of Dairy Technology Silver Medal in 1966 and was recently awarded a Life Membership of the Society in recognition of his services to the Society and the Dairy Industry. His retirement in August 1976 marked the end of 34 years' service to CSIRO and in particular to the Dairy Research Laboratory at Highett, Vic.

B. McK.

Joseph Czulak

Dr Joseph Czulak retired in July 1976. After taking his B.Sc.(Agric.) degree and Diploma in Bacteriology at Reading (U.K.), he joined the Dairy Research Section of CSIRO in 1951, in which he worked for 25 years. Dr Czulak's initial work was concerned with bacteriophage problems and the establishment of a collection of phage unrelated cheese starter cultures. He organized a country-wide supply of freeze-dried cultures to cheese factories and in 1953 began investigations into the possibility of mechanizing the manufacture of Cheddar cheese. As a result of these investigations, the first Bell-Siro Cheesemaker 3 machine went into production as well as the first continuous curd fusing or cheddaring machine, known as the Bell-Siro 2. In recognition of his work, Dr Czulak was awarded both the Silver and the Gold Medals of the Australian Society of Dairy Technology. For many years he headed the cheese group at the Dairy Research Laboratory, providing invaluable service to the dairy industry as a whole. In 1973, Dr Czulak received an honorary degree of Doctor of Science from the Sardar Patel University in recognition of his work on the manufacture of cheese from buffalo's milk and services to the dairying industry.

B. McK.

Jack Lawrence

Mr Jack Lawrence retired in July 1976 after 31 years' service with CSIRO. He joined the Organization as an assistant

Research Officer with the Dairy Research Section at Fishermen's Bend, Melbourne. Mr Lawrence played an important role as a research chemist, assisting particularly in the development of analytical techniques and standard methods for the analysis of dairy products.

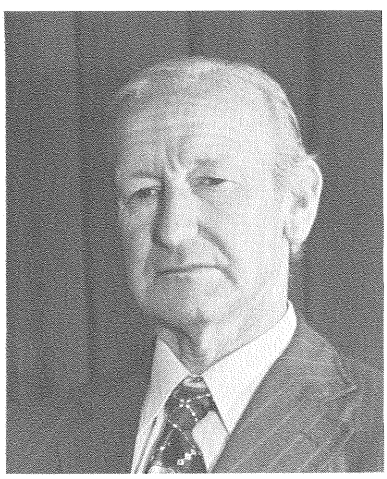
B. McK.

Brian McKeon

Members of the staff of DRL recently farewelled Brian McKeon who had retired from CSIRO in December.

After graduating in agricultural science from the University of Melbourne in 1936, Brian spent the next 27 years with the Victorian Department of Agriculture, working initially in the field of agronomic research and extension and later occupying senior scientific administrative positions in the Department's central administration, acting for some years as personal assistant to the Director of Agriculture.

In 1959 he was awarded an International Zeider Fellowship by the US State Department and spent some months studying agricultural research and extension in the US and in the UK. In 1964 Brian joined the Secretariat of CSIRO and while at Head Office became well known to most of the agricultural and biologically oriented Divisions in CSIRO. In 1971 he was appointed Industry Liaison Officer of the Dairy Research Laboratory where his long associations with the dairying industry proved of great value. For some 10 years Mr McKeon was Chairman of the Committee of Management of the Australian Journal of Experimental Agriculture and Animal Husbandry and for three years edited the Australian Journal of Dairy Technology. He is a past President of the Victorian branch of the Australian Institute of Agricultural Science.



Brian plans a busy retirement; he will still maintain his connections with both the Dairy Research Laboratory and the industry as an Associate Editor of the Australian Journal of Dairy Technology and as Secretary of the Australian Dairy Products Standards Organization. In addition, he will be undertaking a post-graduate project in agricultural history.

H.D.

Appointments

Dr R. E. Paull has joined the Plant Physiology Unit of FRL for three years as a Research Scientist. Dr Paull graduated B.Sc.Agr. from the University of Sydney in 1966 and was awarded his doctorate by the University of California in 1974. He subsequently became a lecturer in the Department of Botany at the Berkeley campus.

Dr Paull is studying the effects of temperature, particularly in the chilling range, on plants and their fruits. These investigations should lead to plant-breeding programs of practical significance in Australia and may also improve low temperature storage of fruits and vegetables in this country.

Dr Helen Hudson was appointed as an Experimental Officer in FRL's Microbiology Section in January 1977. She is engaged in biochemical and biophysical studies of the development of bacterial spores and their heat resistance. Dr Hudson obtained a 1st Class Honours B.Sc. in Microbiology from the University of Sydney in 1972 and Stanford University conferred a Ph.D. degree on her in 1976.

Mr D. T. Kerr, Experimental Officer, was appointed to the Process Development Group, MRL, in December 1976 to investigate the practical implementation of new meat processing techniques. He was awarded a diploma in mechanical engineering from Caulfield Technical College in 1963, and has worked with M.W.M. Diesel (Far East) Pty Ltd, the Brisbane Gas Company, and the Victorian Gas and Fuel Corporation.

Dr R. Leppik, Experimental Officer, was appointed to the New Products Group at

MRL in June 1976 to take part in a new research program on the utilization of abattoir by-products. He was awarded a Ph.D. from A.N.U. in 1973, and worked in the Department of Biochemistry at the University of Queensland as a Research Officer until he joined MRL.

Mr P. Pisansarakit, a member of the CSIRO Division of Animal Production, is working with the research staff of the Muscle Growth and Development Section on the genetic determinants of muscle growth. He joined MRL in December 1976 and will remain for three years.

Resignations

Miss Josephine Bastian, who started work as Assistant Editor at the Division of Food Research in June 1972 to assist in the editing of scientific papers and reports, resigned recently.

She graduated from Sydney University in 1952 with first-class honours in English Literature and gained an M.A. from London University in 1958.

Subsequently she was a Teaching Fellow at the Department of English Literature, Sydney University, and Acting Principal of the Women's College at the same University.

Josephine also worked as a freelance journalist for some years.

Shortly after coming to the Division Josephine spent nearly three years editing and organizing the material for each issue of *Food Research Quarterly*. The up-dating of the format of the *Quarterly* in recent years has been due mainly to her initiative and enthusiasm.

Since September 1975 she has been fully occupied in writing the history of the Division, which will be published in two issues of the *Quarterly*.

Owing to family and other commitments Josephine has now decided to resign and we will sorely miss her perennially cheerful disposition, and her diplomatic and professional approach to editing.

Mr R. D. Radford resigned from his position as an Experimental Officer with the Process Investigation Section, MRL.

Mrs V. Miller, an Experimental Officer with the Biochemistry Section, MRL, has also resigned.

Visiting Scientist

Professor W. James Harper, Department of Food Science and Nutrition, Ohio State University, Columbus, Ohio, began a five months' period as a visiting scientist at the Dairy Research Laboratory last January. During his stay Professor Harper is studying possible uses of the lipids and lipoprotein complexes in whey protein concentrates.

Postdoctoral Fellowship

Mr E. J. McMurchie of PPU, on leave of absence from the Division to work in the Biochemistry Department at the University of Adelaide, has completed the research for his Ph.D. thesis there. He has been awarded a CSIRO Postdoctoral fellowship to continue his work on biological membranes for a year in Professor C. F. Fox's laboratory at the University of California, Los Angeles.

Survey of fresh fruit and vegetable distribution in S.E. Asia

In January and February 1977 a three-week course was conducted by officers of the Food Research Laboratory for technical personnel from the Philippines, Malaysia and Indonesia, who are to coordinate surveys of fresh fruit and vegetable distribution in their own countries.

The FRL course included lectures and practical work in temperature, relative humidity and air-speed measurement, survey planning and analysis, and taste testing; it was attended by Miss A. Dolendo of the Food Research and Processing Department of the Food Terminal, Manila, Philippines, Mr A. Kamari of the Agricultural Products Utilization Division of MARDI, Selangor, West Malaysia, and Mr K. Sitinjak of the Department of Agricultural Economics, University of North Sumatra, Indonesia. They will now train advanced-level agricultural science students in their own countries to be the actual survey workers.

Committees

Dr D. Graham, FRL, has been elected Chairman of the Fruit and Vegetable Postharvest Research Sub-Committee for the two year period 1976–78. (Mr G. Fisher, FRL, is Secretary of the Committee.)

Mr K. C. Richardson, FRL, has become a member of the Food Technology Advisory Committee, New South Wales Department of Technical and Further Education.

Mr P. W. Board, FRL, is CSIRO representative on the working party on reprocessing and recycling procedures in meat canneries, established by the Australian Bureau of Animal Health.

Awards

Mr P. B. H. O'Connell of PPU, FRL, received the degree of M.Sc. from Sydney University for his thesis 'Protein synthesis in ripening banana fruit'.

Mr G. L. Ford of FRL's Biochemistry Section qualified for the B.A. degree from Macquarie University (in Science).

International award

Dalgety Agri-Lines Pty Limited has been awarded the 'Prix de la Recherche' for its range of 'Altapol' cheeses, by the French organization APRIA (Association pour la Promotion Industrie Agriculture), the supreme organizing body for the 7th biennial SIAL (Salon International de l'Alimentation). The prize is given to a new product requiring intensive research and development in relation to marketing.

The SIAL competition, held at Porte de Versailles, is followed by an exhibition extending over five days with an anticipated attendance of 25 000–30 000 visitors.

Following an exchange of correspondence between the executives of APRIA and their qualifying jury, Altapol cheeses were granted entry to the international competition, 'Innovation IAA 76—New Products', in which over 50 countries participated in a number of different categories.

The CSIRO Divisions of Food Research and Animal Production collaborated with Dalgety Agri-Lines Pty Limited in the development of polyunsaturated ruminant products, following the granting of an exclusive licence to the Company by the Organization in 1972.

Three new journals in food science

The pressure of research work offered for publication in food science is such that it is considered to justify the appearance of three new journals. Officers of the Division of Food Research have been invited to join the Editorial Boards of each of these journals and would be pleased to advise authors contemplating the submission of papers. Details of the new journals are as follows.

Journal of Food Biochemistry, a quarterly in English, edited by Professor H. O. Hultin, Department of Food Science and Nutrition, University of Massachusetts, U.S.A., and published by Food & Nutrition, Press Inc., Editorial Office, 49 Harkness Road, Amherst, Mass. 01002, U.S.A. The price in the U.S., Canada and Mexico will be $45 (U.S.) for an institutional order and $25 (U.S.) for a personal one. The corresponding prices for Australia would be $55 and $35 for surface mail delivery and $62 and $42 for air mail. This journal is devoted to original research on the effects of handling, storage and processing on the biochemistry of food tissues and systems, with emphasis on applications of enzyme chemistry and technology, membrane biology and chemistry, cell biology, biophysics, genetic expression and phytopathology to post-harvest, post-mortem and processing problems. Dr W. B. McGlasson of FRL is a member of the Editorial Board of this journal.

Meat Science, a quarterly in English, edited by Professor R. A. Lawrie, University of Nottingham, England, and published by Applied Science Publishers Limited, Ripple Road, Barking, Essex. The overseas price for Volume 1 (1977) which will consist of four issues is £28 including surface mailing. The scope of this journal is stated to be the composition, nutritive value, wholesomeness and consumer acceptibility of meat and the control of these qualities through growth of the animal to slaughter and ultimate processing and marketing. Dr D. J. Walker, Officer-in-Charge of MRL, is a member of the Editorial Board of this journal.

Food Chemistry, a quarterly in English, edited by Dr G. G. Birch and Mr L. F. Green of the National College of Food Technology, University of Reading, England, also published by Applied Science Publishers Limited. The overseas price for Volume 1 (1976) which will consist of two issues is £8 including surface mailing. Subsequent volumes will consist of four issues. *Food Chemistry* will provide a vehicle for research papers and reviews concerned with the chemistry and biochemistry of foods and with sensory and nutritional properties of foods within a chemical or biochemical framework. Mr J. F. Kefford, Officer-in-Charge of FRL, has agreed to join the Editorial Board of this journal.

ASEAN/Australian economic cooperation

A steering committee has been set up to plan training courses in post-harvest handling of fruits and vegetables. Members of the committee are Dr D. Graham, FRL (Chairman), Mr E. G. Hall (Project Coordinator), Dr W. B. McGlasson, FRL, Dr T. H. Lee and Dr R. B. H. Wills, University of New South Wales, and Dr Alex

Buchanan (Kuala Lumpur) acting as Australian Liaison Officer to the program.

The steering committee is organizing an eight-week training course, June to August 1977, at the School of Food Technology, University of New South Wales. The course is intended for middle level management personnel from the five member countries of ASEAN (Singapore, Malaysia, Thailand, Philippines and Indonesia). Three people from each country are expected to attend the first course.

In addition, the steering committee is assisting in the establishment of a one-year training course for young graduates from each country and in the setting up of facilities for post-harvest research and training at the University of the Philippines, Los Banos (UPLB).

Proceedings published

Proceedings of the Cheese Starter Culture Workshop held at DRL in May 1976 have now been published and copies issued to participants.

A limited number of copies is available for purchase and enquiries should be made to Mr G. Amoore, Australian Dairy Corporation, 576 St. Kilda Road, Melbourne, 3004 (Tel.: 51 8724).

Selected publications of the Division

Reprints of most of the papers listed below can be supplied by the Librarian of the laboratory from which they were published.

From the Dairy Research Laboratory

Breheny, S.*, Kanasaki, M.*, Hillier, A. J., and Jago, G. R. (1975). Effect of temperature on the growth and acid production of lactic acid bacteria. 2. The uncoupling of acid production from growth. *Aust. J. Dairy Technol.* **30**, 145–8.

Conochie, J., and Birtwistle, R.* (1976). The effect of the stacking pattern during early storage on the rate of cooling and on the quality of rindless cheddar cheese packaged in fibreboard containers. Int. Inst. Refrig. Joint Meeting of Commissions C2, D1, D2, D3 & E1, Melbourne, 6–10 September 1976.

Hammond, L. A. (1976). Starters and selected microorganisms in cheesemaking. *Food Technol. Aust.* **28**, 11–13.

Horwood, J. F., Shanley, R. M., and Sutherland, B. J. (1974). Fatty acids in cheese-curd slurries. 19th Int. Dairy Congr., Section B.7, 489–90.

Hillier, A. J., Kanasaki, M.*, and Jago, G. R. (1975). Effect of temperature on the growth and acid production of lactic acid bacteria. 3. The influence of added growth supplement. *Aust. J. Dairy Technol.* **30**, 149–52.

Kanasaki, M.*, Breheny, S.*, Hillier, A. J., and Jago, G. R. (1975). Effect of temperature on the growth and acid production of lactic acid bacteria. 1. A rapid method for the estimation of bacterial populations in milk. *Aust. J. Dairy Technol.* **30**, 142–4.

Kieseker, F. G. (1976). Reconstitution and recombination of conserved products for extending milk supply for liquid consumption. Int. Dairy Congr., 19th, India, 1974, lecture C 2(b), 466–78.

Lees, G. J., and Jago, G. R. (1976). Acetaldehyde: an intermediate in the formation of ethanol from glucose by lactic acid bacteria. *J. Dairy Res.* **43**, 63–73.

Lees, G. J., and Jago, G. R. (1976). Formation of acetaldehyde from threonine by lactic acid bacteria. *J. Dairy Res.* **43**, 75–83.

Lloyd, G. T. (1975). The production of concentrated starters by batch culture. II. Studies on the optimum storage temperature. *Aust. J. Dairy Technol.* **30**, 107–8.

Lloyd, G. T. (1976). The production of frozen concentrated cheese starters. *Food Technol. Aust.* **28**, 15–16.

Muller, L. L. (1976). Utilisation of byproducts within the plant and economic disposal of dairy effluent. Int. Dairy Congr., 19th, India, 1974, lecture C 6, 522–33.

Sutherland, B. J. (1975). Rapidly ripened cheese-curd slurries in processed cheese manufacture. *Aust. J. Dairy Technol.* **30**, 138–42.

Zadow, J. G., and Chituta, F.* (1975). Age gelation of ultra-high-temperature milk. *Aust. J. Dairy Technol.* **30**, 104–6.

Zadow, J. G., and Kieseker, F. G. (1975). Manufacture of recombined whipping cream. *Aust. J. Dairy Technol.* **30**, 114–17.

From the Food Research Laboratory

Banks, H. J.*, Sharp, A. K., and Irving, A. R. (1975). Gas interchange in freight containers. Proc. 1st Int. Working Conf. Stored-Product Entomol. Savannah, Georgia, Oct. 7–11, 1974, 519–31.

Barnett, D. (1976). How much sulphur dioxide in the prawn dip? *Aust. Fisheries* **35**, 17–18.

Board, P. W., and Steele, R. J. (1975). Diagnosis of corrosion problems in tinplate food cans, CSIRO Aust. Div. Food Res. Tech. Pap. No. 14.

Brady, C. J., and O'Connell, P. B. H. (1976). On the significance of increased protein synthesis in ripening banana fruits. *Aust. J. Plant Physiol.* **3**, 301–10.

Davis, E. G., Rooney, M. L., and Larkins, P. L.* (1975). Permeability of polymer films to sulfur dioxide at low concentration. *J. Appl. Polym. Sci.* **19**, 1829–35.

Farooqi, W. A., and Hall, E. G. (1974). Some effects of ethoxyquin on pears during storage and ripening. *Nucleus* **11**, 15–17.

Irving, A. R., and Sharp, A. K. (1976). Measurement of air circulation in a refrigerated ISO container. Int. Inst. Refrig. Joint Meeting of Commissions C2, D1, D2, D3 & E1, Melbourne, 6–10 September 1976.

Irving, A. R., and Sharp, A. K. (1976). The temperature of frozen foods during local distribution in Australia: a survey. *Food Technol. Aust.* **28**, 288–94.

Irving, A. R., and Sharp, A. K. (1976). Use of dry ice for controlling the temperature of chilled foods in insulated containers. Int. Inst. Refrig. Joint Meeting of Commissions C2, D1, D2, D3 & E1, Melbourne, 6–10 September 1976.

McBean, D. McG. (1976). Drying and processing tree fruits, CSIRO Aust. Div. Food Res. Circ. No. 10.

Mellor, J. D. (1976). Thermophysical properties of foodstuffs. 1—Introductory review. *Extr. Bull. Int. Inst. Refrig.* **3**.

Murray, K. E., Bannister, P. A., and Buttery, R. G.* (1975). Geosmin: an important volatile constituent of beetroot (*Beta vulgaris*). *Chem. Ind.* No. 22, 973–4.

Rooney, M. L. (1976). Interesterification of starch with methyl palmitate. *Polymer* **17**, 555–8.

Ruello, J. H. (1976). How to handle and process the prawn catch. *Aust. Fisheries* **35**, 10–12.

Ruello, J. H. (1976). Prawns—fresh and frozen. *CSIRO Food Res. Q.* **36**, 13–7.

Ruello, J. H., and Beilby, V. G. (1976). Control of black spot in prawns: how fishermen and processors can use sulphite to control the development of black spot in raw prawns. *Aust. Fisheries* **35**(7), liftout.

Ruello, J. H., and McBride, R. L. (1976). The effect of sodium metabisulphite on the flavour of fried prawns. *Food Technol. Aust.* **28**, 131–3.

Scott, K. J.*, and Wills, R. B. H.* (1976). Core flush of apples. 1—Effect of absorption of carbon dioxide, ethylene and water from the storage atmosphere. *J. Hortic. Sci.* **51**, 55–8.

Scott, K. J.*, and Wills, R. B. H.* (1976). Core flush of apples. II—Effect of phorone and gibberellic acid. *J. Hortic. Sci.* **51**, 59–64.

Sharp, A. K., and Irving, A. R. (1976). The domestic storage of frozen foods: a survey of temperatures and storage times. *Food Technol. Aust.* **28**, 295–301.

Sharp, A. K., Irving, A. R., and Banks, H. J.* (1976). Leakage of air into insulated containers. Int. Inst. Refrig. Joint Meeting of Commissions C2, D1, D2, D3 & E1, Melbourne, 6–10 September, 1976.

Sidhu, G. S., Brown, M. A., and Johnson, A. R. (1976). Autoxidation in milk rich in linoleic acid. II—Modification of the initiation system and control of oxidation. *J. Dairy Res.* **43**, 239–50.

Wills, R. B. H.*, Bailey, W. McC., and Scott, K. J.* (1975). Possible involvement of α-farnesene in the development of chilling injury in bananas. *Plant Physiol.* **56**, 550–1.

From the Food Research Unit, Hobart

Thrower, S. J., and James, D. G. Utilization of the resources of the sea. *In* Resources of the Sea—a symposium arranged by the Royal Society of Tasmania, November 1974, 101–11.

From the Meat Research Laboratory

Bouton, P. E., Ford, A. L., Harris, P. V., and Ratcliff, D.* (1975). Objective-subjective assessment of meat tenderness. *J. Texture Stud.* **6**, 315–28.

Bouton, P. E., Harris, P. V., and Shorthose, W. R. (1975). Changes in shear parameters of meat associated with structural changes produced by aging, cooking and myofibrillar contraction. *J. Food Sci.* **40**, 1122–6.

Bouton, P. E., Harris, P. V., and Shorthose, W. R. (1975). Possible relationships between shear, tensile, and adhesion properties of meat and meat structure. *J. Texture Stud.* **6**, 397–414.

Bremner, H. A. (1976). Batch dry rendering: the influence of controlled processing conditions on the quality of meat meal prepared from sheep stomachs. *J. Sci. Food Agric.* **27**, 307–14.

Ford, A. L., Park, R. J., and Ratcliff, D.* (1976). Effect of a protected lipid supplement on flavor properties of beef. *J. Food Sci.* **41**, 94–6.

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Park, R. J., Ford, A. L., and Ratcliff, D.* (1975). Effect on meat flavour of period of feeding a protected lipid supplement to lambs. *J. Food Sci.* **40**, 1217–21.

Park, R. J., Ford, A. L., and Ratcliff, D.* (1976). The influence of two kinds of protected lipid supplement on the flavour of lamb. *J. Food Sci* **41**, 633–5.

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Shaw, F. D., Baxter, R. I.*, and Ramsay, W. R.* (1976). The contribution of horned cattle to carcase bruising. *Vet. Rec.* **98**, 255–7.

* Not a member of the Division.