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Vol. 38 No. 3 September 1978

Division of Food Research — Review of Research Programs

The Division of Food Research traces its origin to 1926, and in recent issues, **36**, 3 and 4, this Journal has reported its history during the first 50 years (the history will be completed in Vol. 37, No. 4). It is now one of the largest Divisions of CSIRO with a total staff of 322, including 148 professional staff, and an annual budget of $6·484 million. The Division consists of the Dairy Research Laboratory (DRL), Highett, Vic., the Meat Research Laboratory (MRL), Cannon Hill, Qld, the Food Research Laboratory (FRL), North Ryde, N.S.W., and the Tasmanian Food Research Unit which operates in Hobart as a branch laboratory of FRL.

Early in 1977, the Chief of the Division, M. V. Tracey, decided that the time was opportune for a major and thorough review of the Division's research programs. Five working parties were formed to undertake this review, each consisting of seven active scientists of diverse seniority, and each with members from DRL, MRL, and FRL. The basic task of the working parties was to determine, independently of any consideration of current programs, what future programs the Division should pursue to meet both national and international needs likely to arise in the next 20 years.

The widest possible range of data was supplied to the working parties in order to ensure a sound basis for their reports and recommendations. The major sources of data were Divisional staff, various segments of the food industry, other CSIRO Divisions, academic staff of universities, senior officials of various State and Federal Departments, and the major associations involved with food.

In their reports, the working parties indicated no major new research areas to which the Division should direct attention, suggesting that the previous research management of the Division had been essentially satisfactory. However, the reports did suggest that there was a need to reconsider the relative importance of existing programs. This need for changes in emphasis reflected changes in the awareness and demands of consumers, and current and anticipated changes in the general socio–economic environment. In addition, there was recognition of the need for more precise knowledge of the chemistry and physiology of raw and processed foods and of the relationship between diet and health. Another relevant factor was that advances in scientific instrumentation and techniques have extended the areas in which profitable research can be conducted.

The main areas in which increased research effort was recommended were nutritional quality of food, the influence of processing on the composition of food, structure and function of biomembranes, food safety, the bio-availability of food components and the way in which this might be influenced by individual components or by food additives. All working parties also advocated that the Division should strengthen its extension and liaison activities with the aim of achieving more effective relationships with industry, with other government bodies, with educational institutions, and with consumers.

Food Research Laboratory (Officer-in-Charge: Dr A. R. Johnson)

The outcome of the review at FRL is a reorganization in which the previous structure of 12 research sections mainly based on disciplines is replaced by 5 multidisciplinary groups, each headed by a Research Leader:

- Applied food science (Leader: P. W. Board)
- Food safety and nutritional quality (Leader: Dr W. G. Murrell)
- Food structure (Leader: J. Middlehurst)
- Plant physiology (Leader: Dr D. Graham)
- Sensory aspects and trace components of foods (Leader: Dr K. E. Murray).

In addition there will be a Liaison Group (Leader: J. F. Kefford), and in Hobart a

smaller research group concerned with seafoods (Leader: Dr June Olley).

Each research group will conduct mission-oriented sub-programs that are clearly related to food research, and that will embrace both applied and strategic research.

The Headquarters of the Division will remain at FRL and the Chief, M. V. Tracey, the Associate Chief, Dr J. H. B. Christian, and the Assistant Chief (External Relations), J. F. Kefford, are located there.

Dairy Research Laboratory (Officer-in-Charge: Dr B. S. Harrap)

In a less extensive reorganization at DRL four research groups have been formed:

- Chemistry and technology of cheese (Leader: Dr G. W. Jameson)
- Biochemistry and microbiology of cheese (Leader: Dr G. R. Jago)
- Components of milk as ingredients in foods (Leader: Dr R. E. Timms)
- Whey utilization and process inter-relationships (Leader: L. L. Muller).

Meat Research Laboratory (Officer-in-Charge: Dr D. J. Walker)

Since substantial changes in the meat research program were made before the review, the organization of MRL will remain unchanged with the following research sections:

- Biochemisty (Leader: Dr R. P. Newbold)
- Microbiology (Leader: Dr F. H. Grau)
- Muscle growth and development (Leader: Dr D. J. Morton)
- Meat science and technology (Leader: J. J. Macfarlane)
- Process development (Leader: Dr D. S. Macarthur)
- New products (Leader: Dr R. J. Park)
- Process investigations (Leader: L. S. Herbert)
- Industry section (Leader: Dr V. H. Powell).

Torry Research Station Jubilee Conference, 23–27 July 1979

In connection with the 50th Anniversary of the establishment of Torry Research Station, an International Conference on Fish Science and Technology will be held in Aberdeen, Scotland, from 23 to 27 July 1979.

The aims of the Conference will be two-fold: firstly to review the state of advancement in various areas of fish science and technology and, secondly, to provide a forum for the presentation of the latest findings in research and development.

The first aim will be achieved through 15 plenary lectures given by leading authorities. There will be two general lectures on the theme 'Response to change', four lectures on fish technology topics (Handling methods, Preservation methods, Utilization and new products, Quality improvement and maintenance) and nine lectures on Fish Science (Quality assessment, Proteins and structure, Lipids, Other organic components, Nutrition, Biological factors, Microbiology, Physical properties and processes, Engineering). The formal lectures will combine a retrospective account of developments over the past 50 years with appraisals of the current position and of probable future trends.

The second aim will be achieved by inviting scientists and technologists to read and discuss accounts of original work. About 35 papers will be presented and they will be selected on the basis of interest and topicality. All the lectures and papers will be published.

The Conference will last four days in two equal halves separated by one day devoted to visits. On this middle day, Torry Research Station will be open to visitors. Post-conference tours will be arranged to places of interest. A brochure giving fuller details and an application form will be available from Torry Research Station, P.O. Box 31, 135 Abbey Road, Aberdeen AB9 8DG, towards the end of 1978.

Practical aspects of microbiological testing

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End product testing is not an effective means of quality control in the food industry and the microbiologist's role extends to process design and surveillance. It is often impractical to sample and test enough units to ensure a high probability of detecting a faulty unit. Soundly based internal standards can usually be set to ensure an adequate shelf-life for a product. Lack of information on food poisoning organisms and the doubtful basis for indicator organism tests makes the setting of internal standards for organisms of public health significance more difficult.

Few foods in Australia are required to meet legally enforceable microbiological standards. They may more frequently have to conform to a specification set by a buyer but this applies in the main to food for manufacturing purposes rather than finished products.

The microbiological condition of much of the food on the Australian market is governed by the company's quality control staff who may or may not include specialist microbiologists. They must decide the maximum microbial population that can be tolerated in a particular food before off-flavour and shelf-life problems will be encountered, and what level, if any, of known pathogens or indicator organisms can be tolerated.

These decisions are not easy. Answers depend on the nature of the food, its performance record, the standard of the retail distribution system it will enter, and its end use. By one means or another, however, the company microbiologist sets an internal standard or series of standards which he may have to modify from time to time.

He is then confronted with still more difficult questions: How many samples must be examined to give him a reasonable chance of detecting a faulty unit? Where does he take these samples? What does he do when he finds a faulty unit?

* This paper was presented at the Annual Scientific Meeting of the Australian Society for Microbiology Inc. at Melbourne in May 1977.

How many samples?

The answer to this question will be influenced greatly by what is known of the microbiological history of the product concerned. Either it is known to have been produced from tested raw materials under sound quality control, or its manufacturing and/or storage history is unknown. The former situation is exemplified by microbiological surveillance in a well-run food plant, and the latter by the work of a regulatory agency examining local or imported food of unknown history.

The very large quantities in which foods are produced and distributed have tended to discourage microbiologists from applying orthodox statistical procedures to their sampling plans. For example, incubation of canned foods, sometimes followed by microscopic examination and pH determination, is commonly used to test the microbial stability of these packs. It is highly questionable whether incubation at appropriate temperatures of say 10 cans out of 5000 shows whether the batch has been processed correctly. In this case there is only a good chance (90% probability) of a defect being found when at least 20% of the batch has been underprocessed

(Anema 1975). Gross underprocessing of this order is now very rare.

In practice the level of sampling for incubation is much lower. A common procedure is to incubate one or two cans per stationary retort load, which is often about 5000 cans. When cans are processed in a continuous cooker, as in a hydrostatic cooker, one can may be taken for incubation every hour, or perhaps one can every 15 minutes. When it is realized that a number of Australian canneries process up to 10^6 cans per day the theoretical inadequacy of these sampling procedures as a means of quality control is evident.

On the other hand, sampling at higher rates would involve incubation and examination of hundreds of cans per day which is not a practical proposition for quality control laboratories performing a range of duties.

What to do when a failed unit is discovered

The microbiologist's problems really start when he discovers a failed unit, which in a canned food is fairly easy to define. Suppose out of 20 cans incubated from one day's production one unit failed. The microbiologist now has to decide how many of the cans from that day's production are represented by the failure. If the can was drawn from one retort load, and the company's coding system allows him to identify the cans in the warehouse from that retort load, then the load should be held and more extensive sampling carried out to determine if the whole load or 'lot' was faulty. The complete lot might in some instances be incubated to facilitate this decision.

With a continuous cooker or any other continuous process, the situation is not so easily resolved. How does the microbiologist define the particular 'lot of material' that is to be accepted or rejected. If a prior decision has not been made, and usually it has not, then in effect no sampling plan whatever is being used. Is all product packed within 15 min or 1 h of the faulty unit to be examined or discarded? This might be around 60 000 units. It is because such problems surround the discovery of a faulty canned product that the emphasis in quality control of canned foods is directed to process control, and in the better establishments to microbiological control of raw materials.

Special problems in continuous processes

The chicken processing industry presents the quality control microbiologist with problems statistically similar to those of the canning industry, but different microbiologically. In this industry we have a continuous processing line so the problem of defining a 'lot' remains. Processing rates are usually between 5000 and 8000 birds per hour in larger plants. Before the microbiologist can approach a statistician for advice, he has to produce a definition for his own use of a 'failed unit' and a 'lot'.

Since the chicken industry does not, in general, prepare food for government contracts or export there are no regulations that a microbiologist can use as a guide to sampling such as exist for the canning industry. In practice, the level of microbiological testing in the chicken industry is not high. When testing is carried out, it is usually on a once-a-day basis so that a picture of day-to-day variation may emerge, but variations that may arise from one process operation to another are not so apparent. The number of units (birds) taken on this once daily sampling for microbiological examination is usually 8–10. It might be assumed from this sampling procedure that the microbiological quality of chickens on the Australian market is either very good or very bad. In fact it is probably correct to say that it is somewhere in between.

With food products other than canned foods it is usually more constructive and informative to acknowledge three microbiological classes: acceptable, marginal and not acceptable; rather than to consider the product to be either acceptable or not acceptable. There is a significant amount of data which indicates that the total microbial count on chickens, when measured by a whole bird rinse procedure, is such that a satisfactory shelf-life is obtainable whether the birds enter the market chilled or frozen, provided they are handled correctly during distribution and home storage. From this point of view most birds entering the market would be acceptable (Edwards 1975).

Examination of the data available on the incidence of common food poisoning

bacteria in commercially produced chickens highlights the problems of the company microbiologist. With our present state of knowledge, the most we could say about the microbiological quality of most of these chickens is that it is marginal.

Figures available from N.S.W. processors indicate that over 50% of birds leaving processors are contaminated with relatively high numbers of *Staphylococcus aureus*, *Salmonella* and *Clostridium perfringens* (Edwards 1975). The prevalence of these potential pathogens must be a cause for concern. Obviously the consumer depends greatly on proper cooking of chickens to destroy contaminating pathogens.

It is at this point in a quality control program that the microbiologist working in industry needs assistance from his colleagues in regulatory laboratories and research institutes. He cannot define a failed unit, let alone a failed lot, because the information is not available. Millions of chickens are consumed annually in Australia but whether any or many of these are the cause of food-borne illness is unknown. Similarly, we have no idea how often illness is caused by other foods contaminated with pathogens transferred from chickens during preparation of food for consumption.

From another standpoint, it is possible to establish a picture of the load of pathogens on chickens leaving a given plant. If one makes some conservative assumptions about the fate of these pathogens during distribution and preparation of the chicken for eating, one could estimate how many might be ingested with an average serving. What would be the next step? Our knowledge of what constitutes an infective or toxigenic dose under these conditions is poor, so again there is no real basis to define a failed unit.

Still further questions then arise: how many defective units at most can one allow a lot to contain and still call it acceptable? How many defective units must be found in a lot for it to be 'unsatisfactory'? (Leussink 1975). Does 'unsatisfactory' mean unmarketable or can the lot be further processed? Until all these questions are answered, it is difficult to seek a statistician's assistance in developing a sampling plan.

In the absence of sufficient knowledge in a number of areas, only arbitrary answers can be given to the questions that have been posed.

Internal standards

As little is known of the significance of food poisoning organisms in or on foods and because tests for specific pathogens are usually complex, the emphasis in in-plant microbiological control is concentrated on standard plate counts, which provides a useful measure of the general cleanliness of operations and the potential shelf-life of the finished product. Tests for indicator organisms may be used to supplement information gained from standard plate counts. These counts may be performed not only on the finished product, but also on raw materials and products in process.

The setting of internal standards either for the end product, for some critical point in the processing line, or for raw materials, is usually based on quality control charts. These quality control charts should present a historical picture of the microbial population for a particular process operation or sampling point over a substantial period. With experience a microbiologist can correlate product performance with the quality control chart and usually he can correlate the effectiveness of plant sanitation with both. How successfully the latter can be done will depend on the degree of control exercised over the microbiological quality of raw materials used in manufacture. There can be good correlation when the raw materials are held until they receive a clearance from the laboratory, but in some instances, e.g. in the case of fresh meat, this is not possible.

Extensive surveys are required to establish the rapidity with which the microbiological picture may change. Taking and examining as many samples as possible over a shift or a day will show when and where is the best time to sample in order to detect significant changes. The rate of possible change in microbiological results is useful in determining what represents a 'lot' in either a continuous or batch production process. In collecting data on which to base sampling decisions, many simple tests are usually preferable to a few complex ones (Christian 1976).

The production of frozen precooked meals or portion packs illustrates some of the points raised so far. Most of such packs

on the retail market are usually not subject to extensive microbiological examination. The manufacturer relies on process control to produce a product of acceptable microbiological quality, and on adherence to storage and preparation instructions to ensure that it remains in that condition till consumed. A large number of hospitals and some other institutions now rely heavily on frozen precooked foods for their catering requirements. The same considerations apply whether it is a portion pack or a whole-meal system. The centralized kitchens are under the control of a supervisor who is technically qualified, and most have set up some microbiological specifications, usually a standard plate count, and counts of coliforms and possibly of *Escherichia coli*. Tests for the common food-borne pathogens *Salmonella*, *S. aureus* and *Cl. perfringens* are not included, probably because of their greater complexity.

With precooked foods filled from bulk batches into unit containers for freezing, the last containers to be filled from each batch are usually sampled. This represents about one sample per 500 units. It is sometimes appropriate, e.g. when there is a delay before filled containers enter the freezing tunnel, to sample also from the first container to be filled. Control over the temperature of the food and the time for which it stands before freezing, combined with careful control over raw materials, removes dependence on microbiological counts in the assessment of quality.

Personnel involved in these operations are aware of their responsibilities and take internal specifications seriously. Food lots have in fact been rejected when the standard plate count specification has been exceeded, although as experience has been gained with cook-freeze systems, more flexible plate count specifications have been set.

Significance of indicator organisms

It has already been pointed out that good process control and sanitation are the basis of quality control in the food industry. However, the food industry microbiologist is still faced with problems such as the detection of raw materials that have been handled unhygienically and may contain pathogens, perhaps of faecal origin. He must also test the end product to assess the effectiveness of the code of hygienic practice employed, and/or of the processing itself, in producing food of acceptable microbiological quality.

Direct testing for all the pathogens likely to be present in food is usually impossible in industrial situations. Even when such testing is possible the irregular distribution of pathogens in unhygienically handled food may make their detection unreliable. Consequently, a simple test applied to a large number of samples may be more effective than more exhaustive testing of a small number.

The first steps in overcoming problems of this nature were taken by public health microbiologists interested in the bacteriological quality of water supplies. They reasoned that in the absence of more easily detectable organisms found in large numbers in the gut of man and animals, pathogenic types would probably also be absent. Investigations of the microbial ecology of water have shown that counts of faecal indicator organisms, such as coliforms, faecal coliforms, and faecal streptococci, could be used to detect faecal contamination reliably enough for routine testing.

Similar procedures, particularly faecal coliform counts, are followed to evaluate the microbiological safety of shellfish. Because of their life-style, shellfish have a microflora closely related to that of the water from which they are harvested. Ecological studies and experience with certification programs in other countries have shown that if shellfish and the waters in which they grow have acceptable counts of faecal coliforms and a suitable history, there is a minimal chance of the shellfish containing bacterial pathogens of faecal origin. Counts regarded as acceptable are defined in legislation in many parts of the world, including Australia, and these standards serve as a guide to quality control microbiologists.

The usefulness of coliform counts and aerobic plate counts in monitoring production of frozen precooked meals has already been mentioned. Coliform counts are used in a similar fashion as an index of the efficiency of procedures used to minimize bacterial contamination during processing of milk and dairy products. Legal standards for coliforms and *E. coli* in dairy foods assist the quality control microbiologist to define a failed unit in these products.

Coliforms and the *Enterobacteriaceae* family as a whole are receiving increased attention

for monitoring plant hygiene during production of a range of foods processed in such a way that most of the *Enterobacteriaceae* present in the raw materials will be destroyed. In such foods, these organisms do not indicate an immediate health hazard but warn that the food has been treated in an unhygienic manner after processing, or that processing has been inadequate. They certainly do not indicate faecal contamination. When testing less rigorously processed foods, such as some types of dried vegetables, or where an indicator of recent faecal pollution is required, faecal coliform or *E. coli* counts are necessary.

When appropriate internal standards are set, all these tests can be very useful for assessing the day-to-day acceptability of relevant foods and for recognizing when the variation in the microflora becomes unacceptable.

Obviously, counts of indicator organisms should only be used where knowledge of the microbial ecology of the food allows realistic assessment of the results, as Drion and Mossel (1977) have demonstrated for dried foods processed for safety. This is true of the reasonably well defined systems used as examples. Unfortunately there has been a tendency to use indicators to imply a much more direct risk to public health than may be warranted in many situations. Although little is known of the significance of the pathogens regularly isolated from some foods, even less is known of the significance of the indicators.

Several recent studies have demonstrated a poor relationship between the presence of the indicator organisms and the more common food-borne pathogens such as salmonellae (Miskimin *et al.* 1976, Silliker and Gabis 1976). These studies on large numbers of samples of raw and ready-to-eat foods and dried foods show quite clearly that testing for indicators alone does not on the one hand guarantee freedom from pathogens, and may on the other hand result in rejection of food that does not contain pathogens. In addition, faecal indicator counts cannot provide an adequate index of contamination with disease agents that are not of faecal origin or that have properties markedly different from those of the indicators. For example, shellfish may contain *Vibrio parahaemolyticus*, a natural inhabitant of marine environments, and viruses of faecal origin that behave quite differently from bacteria.

Major difficulties therefore exist in determining how to sample in the plant and how to correlate any bacteriological findings with food safety.

Problems of methodology

Another inherent problem in assessing food products in the laboratory is the choice of microbiological methodology. While it is obvious that microorganisms will be unevenly distributed over some units, e.g. a chicken carcass or a beef carcass, it may not be so obvious that uneven distribution is also the rule in most solid processed foods such as dehydrated and frozen vegetables.

By taking a sufficient number of samples of the one product it may be possible to take account of this distribution. However, it is not always possible to account for the different results frequently obtained on the one sample in duplicate or replicate determinations.

Extensive work on dehydrated vegetables has shown that on any single standard plate count an allowance of at least -65% and $+150\%$ should be made; e.g. if a single count of 8×10^6 g^{-1} were obtained from a vegetable, the true population might be any number between about 3×10^6 and 2×10^7 g^{-1} (Risbeth 1947). This has serious implications when setting internal standards, to say nothing of externally imposed standards. Standard methods, though essential, are only part of the answer. The methods have to be improved and preferably reduced in cost.

The problem of variable results from the one sample is diminished in importance when three-class sampling plans are applied. These make use of two levels of sample counts, m and M. If the count on any sample exceeds M, the lot is rejected. Counts between m and M are undesirable, but are accepted if there are not too many of them. An example of a three-class plan might be $n = 5$, $c = 2$, $m = 10^4$ g^{-1}, $M = 10^6$ g^{-1}; where n is the number of samples examined and c the maximum number of samples that may lie between m and M. This concept is discussed in detail in ICMSF (1974).

Similar problems are encountered in detection of indicator organisms and pathogens. Selective media frequently pose problems of reproducibility and may not be sufficiently selective or may be too selective, i.e. they may give rise to false positives

and/or false negatives. Since the numbers involved are very much smaller than with standard plate counts, errors inherent in the methodology assume far greater proportions.

Attention has been drawn to the large number of approximations used in sampling in the food industry for microbiological analysis and the further approximations used in estimating microbial numbers and their significance. The use of statistically based sampling plans when logistically possible is highly desirable. Care must be taken, however, to guard against the possibility that legitimate statistical procedures may be used to give microbiological results and conclusions an unwarranted legitimacy.

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Cooling of vined peas in Australia

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Methods of handling vined peas from the field to the factory in the Australian pea industry are briefly reviewed. The effects of various conditions of handling, transporting and cooling vined peas on their subsequent physical and organoleptic properties are described.

Introduction

The quality of frozen peas, especially their flavour, is affected by the time and temperature at which the vined peas are held before processing. Talburt and Legault (1950) reported, for instance, that the maximum delay between vining and blanching, without detectable loss of quality, was 1 h at 23–27°C. When mobile viners were introduced into the Australian pea processing industry, processors realized that consequent changes in harvesting and

handling procedures could result in a reduction in the quality of the processed product.

Peas for processing used to be harvested by mowing the crop and threshing the peas at vining stations that were usually located near the processing plants; consequently there were only minimum delays between vining and processing, when the development of off-flavours is likely to be most rapid. Nowadays however, mobile viners operate where the peas are grown (Fig. 1) so even under the best conditions of transport there may be serious delays. The delay will depend on such factors as the number of viners working on the crop, the capacity of the bulk transport, the distance and road conditions between the field and the factory, the queueing conditions in the factory yard, and the capacity of the processing plant. Typical times taken to deliver peas to one major factory varied between 1 and 5 h and most loads took about 2 h. The time taken to process the load of peas varied from 20 to 60 min. The temperature of uncooled peas in trucks and bins measured at the factory varied between 25–29°C when ambient temperatures were 20–25°C. The increase in the temperature of the peas above ambient was caused by respiratory self-heating of the peas in bulk bins and this increase in temperature accelerated the development of off-flavours and other deteriorative processes. Haas (1956) reported that the temperature at the centre of a 40-kg bin of peas increased from 16°C to 29°C in 12 h, and Holdsworth (1969) found that the rate of production of metabolic heat by peas was five times greater at 15·5°C than at 0°C.

Owing to the temperature increases encountered in bulk handling, field cooling is now widely used to minimize quality deterioration in vined peas, especially when ambient temperatures are likely to be high and the delay times long. Cooling is carried out in several ways including immersing the peas in iced water, covering loads of peas with ice, or cascading chilled water through the bulk bins of peas.

Cooling peas with ice or by immersion in iced water may have undesirable effects. For instance, Tressler and Evers (1957) reported that the water from melting ice leached soluble constituents from peas and caused loss of flavour and Adam (1956) found that tenderometer values increased for peas stored in air while they decreased for peas stored in iced water.

The work reported in this paper was carried out to measure the efficiency of a commercial water cascade cooling operation

Fig. 1. Peas being harvested in northern Tasmania by a mobile viner.

and to determine the effect of different methods of cooling on the quality of frozen peas.

Materials and methods

The peas were harvested with mobile viners from commercial crops and were transported in bulk bins, usually of 1 tonne capacity.

The temperature of the peas was measured with thermocouples, the measuring junctions being placed at several defined points within the bin.

Replicate samples of peas were filled into mesh baskets of 3 kg capacity and the baskets were placed near the centre of the bin as the bin was being filled with peas. After treatment of the bin, the baskets were removed to give comparable samples of peas with a known history for further study.

Maturometer indexes (MI) were taken on cleaned samples of peas (Mitchell *et al.* 1961) and tenderometer readings were taken on replicate samples of peas.

The mean mass per pea was determined by weighing about 500 cleaned peas.

Peas for taste testing were washed, blanched for 90 s at 95°C, cooled, sealed in polyethylene bags containing about 1 kg of peas, frozen in dry ice and stored at −20°C for three months. The peas were prepared for tasting by heating in boiling water for 5 min. The samples were served hot to a panel of 20 tasters who assessed not more than four samples at a sitting and scored them for flavour acceptability on a nine-point hedonic scale (see Table 2). The samples from each treatment were assessed on two occasions.

Results and discussion

Efficiency of cascade cooling

The data in Table 1 show that the preliminary washing treatment with mains water brought the temperature of most of the peas to within about 1 deg. C of the mains water temperature. There were rapid decreases in temperature when chilled water at 2°C was applied at the rate of 320 l min^{-1}. After the cascade of cool water was stopped, the temperature at all points in the bin was less than 3·5°C and was not more than 5°C when the peas arrived at the processing plant after a four-hour journey.

Calculations showed that cooling to satisfactory holding temperatures would have been completed in considerably less than the 15 min used commercially. Shorter applications of cold water were therefore used and the equilibrium temperature of the peas was measured 5 min after cascade cooling ceased. The difference between the temperature of the peas and the cooling water was then plotted on a logarithmic scale against time to give the curve shown

Table 1. Temperatures (°C) in a 1-tonne bin of peas before and after cascade cooling

Stage of handling	Elapsed time h.min	Location of thermocouple					
		corner	opposite corner	centre bottom	centre middle	centre top	mean
Vining started	0·00	(Ambient temperature 28°C)					
Bin filled from viner	0·36	29·5	29·5	29·0	29·5	31·0	29·7
Before washing	1·41	30·5	30·5	30·0	30·5	31·7	30·6
After washing with water at 18°C	1·54	19·0	19·0	25·5	19·5	18·3	20·3
After cooling with water at 2°C for 1 min	1·55	4·0	3·3	4·5	3·3	14·0	9·7
After cooling with water at 2°C for 15 min and standing for 25 min	2·34	3·3	2·8	2·2	2·8	3·3	2·9
Before transport in tarpaulin-covered bin	3·01	4·5	2·8	2·2	3·3	5·0	3·6
At processing plant	7·16	4·5	5·0	4·5	5·0	4·0	4·6

in Fig. 2. The straight line portion of the curve for two sets of measurements was calculated by the method of least squares and the times taken to traverse one log cycle (f) were 2·8 and 3·2 min. The lag factors (j) for the curves were 2·15 and 1·8 and were calculated by taking the ratio of the value of the straight line at zero time to the experimental value at that time. Values of $f = 3$ min and $j = 2$ were used in subsequent calculations and were found to be applicable where the rate limiting process in cooling is conduction of heat from the centre of the pea to its surface, i.e. when there is sufficient flow of cooling water to remove the heat as it reaches the surface of the peas.

Figure 3 shows calculated cooling curves for peas having initial temperatures of 18° and 25°C when the cooling water is at 2°C. Since the temperature of peas after washing is unlikely to be above 25°C, cooling for 5 min should cool the peas sufficiently to minimize deterioration.

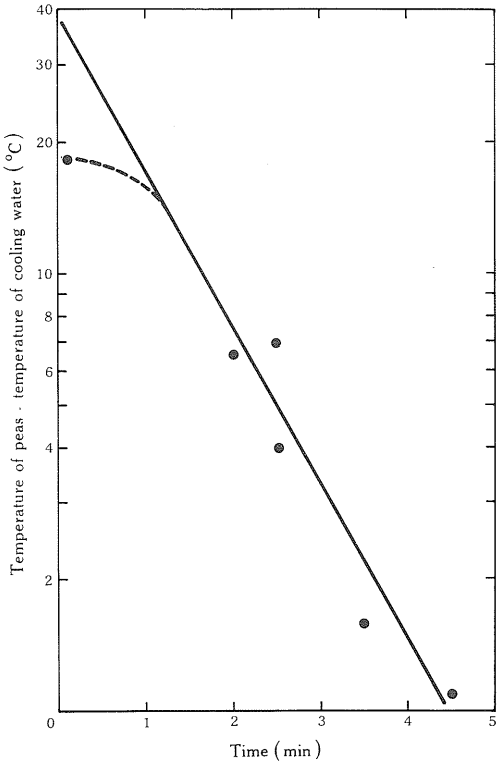

Fig. 2. The temperature difference between the peas and cooling water related to time during cascade cooling.

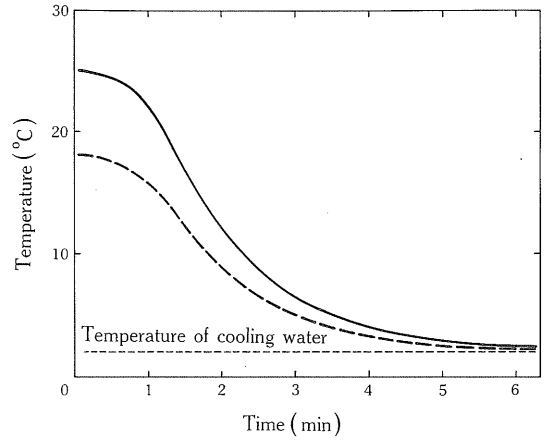

Fig. 3. Calculated cooling curves for peas with initial temperatures of 18° and 25°C during cascade cooling.

Effect of period of delay and temperature on flavour

The results of taste tests on peas that had been frozen after various periods of delay between vining and processing, with and without cascade cooling, are given in Table 2. There were important variations in the effect of cooling and delay on the scores for flavour in the five trials. For instance, uncooled peas held for 2 h in taste test 4 showed a significant deterioration in flavour whereas peas similarly treated in taste test 3 were not significantly different from the control sample. It appears that factors additional to time and temperature of holding influence the rate of deterioration of flavour. Talburt and Legault (1950) reported that bruising as well as delay influenced the rate of deterioration in flavour of peas during the holding period before blanching. Consequently, it is not possible to specify close limits for the conditions for holding peas between vining and processing. The data in Table 2, however, indicate that the flavour of the peas may be adversely affected if the delay before cooling exceeds 2 h. Cascade cooling extended the time before deterioration of flavour was detected to 5 h.

Physical changes in vined peas

The effects of conditions of holding vined peas before processing, on their temperature, and mean mass per pea, were determined with the results shown in Table 3. In general the data show that peas cooled by

Table 2. Mean scores from taste tests on frozen peas which were or were not cooled before processing

Taste test	Temperature of peas before freezing (°C)	Treatment	Delay (h)	Mean[B] score	SE of mean (df)
1	23	Not cooled	0·75	7·26a[A]	
	4·5	Cooled	8	7·00a	±0·34 (54)
	23	Not cooled	0·75	6·63a	
	26	Not cooled	8	5·63	
2	4·5	Cooled	8	5·89	
	26	Not cooled	8	4·74a	±0·29 (36)
	4·5	Cooled and stored at 4·5°C	24	4·84a	
3	17·2	Not cooled	0·5	6·32a	
	5	Cooled	2	6·42a	±0·32 (54)
	18·9	Not cooled	2	6·10a	
	8·3	Cooled	6	6·72a	
4	17·2	Not cooled	0·5	6·44	
	8·3	Cooled	6	5·61a	±0·29 (51)
	18·9	Not cooled	2	5·44a	
	20	Not cooled	6	3·77	
5	19·5	Not cooled	0·5	6·44	±0·28 (34)
	6·7	Cooled	5	5·58a	
	20	Not cooled	5	5·25a	

[A] Values within each taste test followed by letter 'a' cover samples that were not significantly different at $P = 0·05$
[B] Hedonic scale 1 to 9: dislike extremely to like extremely.

cascading water had lower MI values and the mean mass per pea was larger than for the initial samples. Storage without cooling tended to give increased values of MI and reduced the mean mass per pea. Lynch *et al.* (1959) reported similar trends and hence it is important to assess the maturity of the crop as soon as possible after vining and before cooling.

Table 3. Effect of holding conditions on the temperature, maturometer index (MI) and mean mass per pea of vined peas

Delay time and cooling	Ambient temperature (°C)	Temperature of peas (°C)	MI	Mean mass/pea (mg)
Initial	21·0	23·0	193	340
8 h not cooled		26·0	206	339
8 h cooled		4·5	217	369
Initial	16·0	17·2	260	387
2 h not cooled		18·9	251	385
2 h cooled		5·0	246	397
6 h not cooled		20·0	269	385
6 h cooled		8·3	241	386
Initial	18·3	19·5	266	443
5 h not cooled		20·0	294	446
5 h cooled		6·7	241	463

The effects on MI, tenderometer reading and the mean mass per pea of holding vined peas for 5 and 6 h uncooled, iced, and immersed in an ice-water mixture, were measured and the results are shown in Table 4. The MI again increased for peas held in air and decreased for peas that were stored iced or in ice-water mixture. The tenderometer values were larger for the samples of peas stored in air than for those stored iced or in ice-water mixture. The mean mass per pea tended to decrease for peas stored in air and increase for those stored iced and in ice-water mixture. These trends were similar to those shown by the data in Table 3.

Lynch *et al.* (1959) reported that a large number of peas stored in ice-water split during storage. In this investigation the same phenomenon was observed in samples that were stored iced and in ice-water mixture. Split peas would be lost during processing and cause increased sorting costs.

Table 4. Measurements on peas stored in air, ice, and ice-water mixture

Quantity	Initial value	Stored 6 h	
		dry	iced
Trial 1			
Maturometer index	156	162	138
Mean mass per pea (mg)	366	345	380
Trial 2			
Maturometer index	256	292	234
Mean mass per pea (mg)	544	527	592
Trial 3			
Maturometer index	325	346	280
Mean mass per pea (mg)	632	625	674

		Stored 5 h		
		dry	iced	ice-water
Trial 4				
Maturometer index	336	338	300	292
Mean mass per pea (mg)	537	523	576	603
Tenderometer reading	—	150	140	141

The peas stored in air for 5 or 6 h had an off-odour and would not have been suitable for processing but the peas stored iced or in ice-water mixture had no off-odour.

On the basis of these studies it is recommended that:

- processors should monitor the temperature and delay times of vined peas and take every practical step to avoid conditions that may result in reduced quality in the final product
- if the travelling time from field to factory is likely to be longer than 1 h, peas should be cooled as soon as possible after vining. Cooling is more important when ambient temperatures are high.
- peas should be transported in small loads from the viners to the cooling station to reduce delays in loading and in queueing at the cooling station. Such a practice may, however, introduce economic penalties
- before cascade cooling the peas should be washed with water at mains temperature to reduce contamination of the recirculated cooling water and to reduce the load on the refrigeration plant
- peas should be cooled by cascading an ample supply of chilled water for about 5 min followed by draining. If crushed ice only is used, the amount of ice should be kept to a minimum and water from the melted ice should be allowed to drain away
- the load should be covered with tarpaulins during transport from the cooling station to the factory in order to maintain low temperatures in the cooled bins.

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Cholesterol and fatty acids in Australian seafoods. II

By Judith A. Pearson

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In response to many enquiries, some further analyses of seafoods have been carried out. The tables of cholesterol and fatty acids presented in this issue of the *Food Research Quarterly* are intended to supplement the article published in Vol. 37 No. 2, June 1977. The seafoods analysed include a range of salt water fin-fish, canned red salmon and fresh squid. Further analyses of bottled oysters and mussels, fresh king prawns and canned herring are also given.

The seafoods were purchased in Sydney at a suburban fish shop and a city store in October and November 1977 and the cholesterol and sterol contents of the edible portion were determined by the method given in the previous article. In most cases only one sample was analysed and the results shown in the tables, as with the

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

Type of seafood	Sample type	No. of samples	Fat (g/100 g wet wt.)	Cholesterol mg/100 g wet wt.	Total sterol mg/100 g wet wt.
Crustaceans					
Prawns, King	Fresh	1	1·4	158	166
Molluscs					
Oysters	Bottled	2	2·6	57	156
Mussels	Bottled	2	2·6	77	192
Salt-water fish					
Bream	Fillets (fresh)	2	1·6	68	73
Barramundi	Fillets (fresh)	1	2·1	46	56
Flounder	Fillets (fresh)	1	0·7	33	35
Gemfish	Fillets (fresh)	1	6·4	44	45
Jewfish	Fillets (fresh)	1	1·3	49	60
John Dory	Fillets (fresh)	1	1·1	57	64
Kingfish	Fillets (fresh)	1	1·9	32	32
Leatherjacket	Fillets (fresh)	1	0·7	26	32
Mullet (small)	Fillets (fresh)	1	1·8	34	36
Redfish	Fillets (fresh)	1	1·8	29	31
Whiting	Fillets (fresh)	1	0·5	28	30
Processed fish					
Herrings	Canned (tomato sauce)	1	12·0	81	88
Herrings	Canned (oil)	1	8·4	52	65
Red salmon	Canned (water)	1	4·7	44	45
Other					
Squid	Fresh	1	1·4	189	197

Table 2. Cholesterol and fatty acid content of seafood (mg/100 g wet weight)

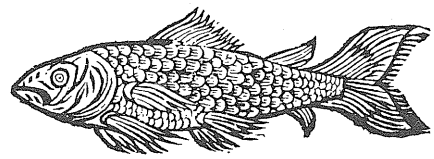
Type of seafood	Sample type	No. of samples	Cholesterol mg/100g	14:0	16:0	18:0	Total[A] sat.	16:1	18:1	20:1	22:1	Total[A] mono-unsat.	18:2	18:3	20:4	20:5	22:5	22:6	Total[A] poly-unsat.
Crustaceans																			
Prawns, King	Fresh	1	158	16	139	87	266	68	152	13	53	292	16	7	10	124	13	126	315
Molluscs																			
Oysters	Bottled	2	57	74	486	203	955	135	137	96	2	349	41	74	41	314	15	225	874
Mussels	Bottled	2	77	44	255	92	427	100	94	66	79	340	28	47	72	433	35	218	941
Salt-water fish																			
Bream	Fillets (fresh)	2	68	25	210	88	353	42	182	46	23	294	13	31	29	113	62	257	521
Barramundi	Fillets (fresh)	1	46	35	341	111	541	72	489	12	28	605	33	31	40	85	21	363	608
Flounder	Fillets (fresh)	1	33	26	69	37	137	43	105	37	23	209	3	12	23	60	19	58	184
Gemfish	Fillets (fresh)	1	44	58	1407	450	2067	339	1746	298	82	2464	76	99	162	204	93	397	1314
Jewfish	Fillets (fresh)	1	49	16	205	55	311	31	201	27	7	268	10	9	24	36	8	278	375
John Dory	Fillets (fresh)	1	57	9	173	65	283	19	101	4	3	127	7	4	31	43	21	298	411
Kingfish	Fillets (fresh)	1	32	43	352	128	557	81	388	38	32	541	18	30	33	63	43	337	559
Leatherjacket	Fillets (fresh)	1	26	4	100	30	148	9	53	10	5	78	3	5	29	30	7	182	264
Mullet (small)	Fillets (fresh)	3	34	185	384	169	816	370	319	67	67	902	88	21	29	301	140	362	969
Redfish	Fillets (fresh)	1	29	76	384	107	591	95	375	26	9	508	12	11	12	124	31	219	454
Whiting	Fillets (fresh)	1	28	5	80	28	120	23	46	3	3	77	6	3	33	38	11	66	165
Processed fish																			
Herrings	Canned (tomato sauce)	1	81	783	1935	273	3232	706	2060	791	1809	5371	137	262	330	592	68	962	2788
Herrings	Canned (oil)	1	52	77	1001	224	1457	224	1726	276	613	2839	2196	403	30	22	178	239	3190
Red salmon	Canned (water)	1	44	159	610	130	978	234	844	577	100	1760	50	84	401	284	71	426	1450
Other																			
Squid	Fresh	1	189	38	266	68	394	22	56	20	—	100	Trace	Trace	45	84	3	288	435

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

previous group, are only intended to provide a guide for consumers. Some minor changes in the method of fatty acid analysis eliminated a bias in favour of the saturated fatty acids, e.g. in prawns and mussels in the first article. Other differences such as high fat level in bream compared with the later samples, emphasize the possible variations due to season, diet and physiology.

Table 3. Fatty acid composition of seafood

Type of seafood	Sample type	No. of samples	Fat (g/100 g wet wt.)	% total fatty acids		
				Saturated	Mono unsat.	Poly-unsat.
Crustaceans						
Prawns, King	Fresh	1	1·4	30·5	33·4	36·1
Molluscs						
Oysters	Bottled	2	2·6	43·8	16·0	40·1
Mussels	Bottled	2	2·6	24·4	19·4	54·0
Salt-water fish						
Bream	Fillets (fresh)	2	1·6	30·3	25·2	44·9
Barramundi	Fillets (fresh)	1	2·1	30·8	34·4	34·6
Flounder	Fillets (fresh)	1	0·7	25·9	39·4	34·7
Gemfish	Fillets (fresh)	1	6·4	35·4	42·2	22·5
Jewfish	Fillets (fresh)	1	1·3	32·7	28·1	39·3
John Dory	Fillets (fresh)	1	1·1	34·4	15·4	50·1
Kingfish	Fillets (fresh)	1	1·9	33·6	32·6	33·7
Leatherjacket	Fillets (fresh)	1	0·7	30·2	15·9	53·9
Mullet (small)	Fillets (fresh)	3	3·0	35·9	32·3	31·9
Redfish	Fillets (fresh)	1	1·8	38·1	32·8	29·3
Whiting	Fillets (fresh)	1	0·5	33·2	21·4	45·7
Processed fish						
Herrings	Canned (tomato sauce)	1	12·0	28·4	47·2	24·5
Herrings	Canned (oil)	1	8·4	19·5	38·0	42·7
Red salmon	Canned (water)	1	4·7	23·4	42·1	34·7
Other						
Squid	Fresh	1	1·4	42·4	10·7	46·8



Liquid sampler suitable for use in the food industry

By D. E. Bailey

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Many foods, food components, or food wastes are processed in liquid form and are stored in vats, tanks or ponds and periodic sampling of these liquids may be necessary for quality control purposes. The sample collectors presently being used for liquids are usually expensive and sophisticated units that are difficult to maintain. With the inexpensive units that are available it is usually not possible to take samples from predetermined depths without contamination from other levels.

This article describes a device for the sampling of liquids at any predetermined depth without risk of contamination. It is simple, inexpensive and easily fabricated. It is also robust, has very few moving parts, and requires little maintenance. The sample is collected in a screw-top jar which can be removed and capped, making multiple sampling a simple task. It can be used for sampling liquids in tanks or vats, or in treatment ponds.

By choosing suitable materials for fabrication, the device can be used for extremely hot or cold fluids. The dimensions of the unit may be changed proportionally to adapt it for other purposes, e.g. a jar with a smaller neck could be used for sampling liquids of low viscosity with no solids present.

Description of the sampler

The sampler consists of a jar which screws into a collection unit, thus permitting the jar to remain sealed as it is submerged to a predetermined depth. It may then be opened and closed at this depth by means of a draw cord within a length of pipe (the handle) which has a male thread to fit the collection unit on one end, and a pull ring at the other.

The sampler is operated in the following way. The jar is screwed into the collection unit which is then attached to the handle. The sampler is then lowered vertically into the body of liquid to be sampled. When submerged to the required depth, which is marked on the handle, the draw cord is pulled upward, and the liquid enters the jar. The jar is opened when a plate that normally seals the jar by spring tension moves upwards in response to the pull on the cord. The cord is released, the plate drops down to seal the jar, and the sampler is withdrawn from the liquid. The jar containing the sample is then unscrewed from the collection unit and capped.

The collection unit has a transparent lid which allows observation of the sample

Liquid sampler

while it is still sealed. It was designed for use at depths of up to 5 m but it could be used at greater depths with additional weight. If a gauze or mesh screen is wrapped around the body of the collection unit, liquids may be sampled in the presence of coarse solids without fouling of the lid closure.

The handle may be extended to any required length by the addition of several similar stages that can be joined together. Three stages are required to submerge the sampler to a depth of 5 m.

The unit was originally designed for use in abattoirs, and has been successfully used for the sampling of abattoir effluent and tallow.

The construction of the device is described in CSIRO Meat Research Report No. 15/77, available from the Information Officer, CSIRO Meat Research Laboratory, P.O. Box 12, Cannon Hill, Queensland 4170.

Dietary fibre, serum cholesterol and heart disease

By David Oakenfull

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Hippocrates (*c.* 400 B.C.) recommended eating wholemeal bread 'for its salutary effects upon the bowels' (Graham 1837). We have recently begun to take this ancient advice seriously—at least at breakfast time—and a great deal has been said and written during the past two or three years about the benefits we should derive from increasing the amount of fibre in our diet. Lack of sufficient fibre has been held to be the cause (or a contributory cause) of a formidable list of diseases common in contemporary Western society, e.g. ischaemic heart disease, appendicitis, diverticular disease of the colon, gallstones, varicose veins, deep vein thrombosis, hiatus hernia, haemorrhoids, and tumours of the colon and rectum (Burkitt and Trowell 1975). I intend to concentrate particularly on heart disease since my own work on dietary fibre is related to this problem. Before discussing the evidence for a beneficial effect of a high fibre diet we should first of all be clear about the meaning of the term *dietary fibre*.

Dietary fibre is a convenient but not very satisfactory name for a chemically diverse range of plant substances. The best definition is probably a phenomenological one in terms of human physiology (Trowell 1972). Dietary fibre is simply that part of plant material taken in our diet which is resistant to digestion by the human gastrointestinal tract. Its main components are lignin, cellulose, hemicelluloses and pectins. The term *fibre* is thus used in a way very different from its usual sense of a thread-like substance, since dietary fibre may include materials as unthreadlike as gums, mucilages and water soluble pectins. For this reason Spiller (1977) has suggested *plantix* as a less confusing alternative but the term *dietary fibre* is probably too firmly entrenched to be displaced. It is also important to realize that *dietary fibre* represents a considerably greater proportion of the plant material than *crude fibre* of food composition tables (Cummings 1973).

Crude fibre is a nineteenth century term (Hennenberg and Stohmann 1860). It is what remains after the plant material has been treated successively with organic

solvents, dilute sulphuric acid and then sodium hydroxide. Some cellulose may survive this treatment but most of the residue is lignin. Crude fibre determinations usually amount to only about 25% of the dietary fibre content of a food (Cummings 1973).

Returning to the list of typically Western diseases, the evidence associating these diseases with a low fibre diet is primarily epidemiological. Burkitt and Trowell (1975) have claimed that the incidence of these diseases has increased dramatically in Western societies since about 1870 and that this coincides with a decline in the consumption of bread and potatoes. They also maintain that the incidence of these diseases is low in African countries compared with Europe or North America and that Africans consume considerably more fibre than is usual in Western societies.

This argument has two major weaknesses. Firstly, the fibre content of the British diet seems to have actually *increased* since the nineteenth century (Robertson 1972). Although the consumption of bread and potatoes has undoubtedly declined there has been an increase in the consumption of other vegetables and fruit. However, the possibility remains that, because fibre is such a diverse material, and because its primary source has changed from cereals to fruit and vegetables, the nature of the fibre consumed is more important than the quantity. It is also important to remember that the fibre consumed by native Africans is very different from that consumed by either contemporary or nineteenth century Britons. Secondly, the argument suffers from the obvious weakness of epidemiological associations in that a good correlation does not necessarily imply a causal relationship. (There is an excellent correlation, for example, between the number of school teachers in New South Wales and the consumption of alcohol!) Epidemiological associations are useful, though, in that they suggest hypotheses that can be experimentally tested.

Experimental evidence provides a link between a low fibre diet and coronary heart disease—that is if we accept that a high serum cholesterol level is a factor in causing heart disease (National Heart Foundation of Australia 1974). Serum cholesterol levels in man or experimental animals have been lowered by changing from a low fibre to a high fibre diet. (These experiments are summarized in Table 1.) It is clear, though, that the nature of the fibre is critical since the fibre associated with wheat bran has no effect on serum cholesterol levels in man (Truswell and Kay 1976).

I have recently carried out some experiments which may explain why the nature of the fibre is critical. An explanation for the

Table 1. Plants or plant products reported to reduce serum cholesterol levels

Plant material	Saponin content (% dry weight)	Experimental animal	Reference
Lucerne	2–3[A]	Rabbit	Horlick *et al.* 1967
Oats	0·015[B]	Chicken	Fisher *et al.* 1967
Rolled oats	0·015[B]	Man	de Goot *et al.* 1963
Chick peas	0·2–0·3[C]	Rat	Devi and Kurup 1970
Chick peas	0·2–0·3[C]	Man	Mathur *et al.* 1968
Textured soya bean protein	*c.* 2	Man	Sirtori *et al.* 1977
Mung beans	Contain saponins[D]	Man	Mathur *et al.* 1968
Green gram (*Phaseolus radiatus*)	Contains saponins[D]	Man	Mathew *et al.* 1968
Horse gram (*Dolichos biflorus*)	Not known to contain saponins	Man	Mathew *et al.* 1968
Red gram (*Cajanus cajan*)	Not known to contain saponins	Man	Mathew *et al.* 1968
Wheat straw	Nil	Rabbit	Moore 1967
Pectin	Nil	Man	Keys *et al.* 1961 Jenkins *et al.* 1975
Guar gum	Nil	Man	Jenkins *et al.* 1975

[A]Birk 1969; [B]Maizel, Bunkardt and Mitchell 1964; [C]Toya and Iseda 1964; [D]Basu and Rastogi 1967.

effect of fibre on serum cholesterol levels is that fibre adsorbs bile salts (Burkitt and Trowell 1975). Bile salts are biological detergents that solubilize and disperse dietary lipids (Heaton 1972). They are synthesized in the liver from cholesterol. (The structures of the two most common bile salts in man—glycocholate and glycochenodeoxycholate—are shown in Fig. 1 which also includes cholesterol for comparison.) The bile salts are largely recycled. They are stored in the gall bladder and pass into the duodenum in response to a meal. Most are eventually reabsorbed and returned to the liver through the portal vein. The bile salt pool in man is 2–4 g in size. It circulates twice with each meal but with a daily loss of 500–700 mg, or 15–20% of the total. If bile salts are adsorbed onto dietary fibre then a high fibre diet would divert bile salts from the cycle. The deficit would then be made good by increased catabolism of cholesterol in the liver. The effect of ingestion of cholestyramine provides convincing evidence that this is so. Cholestyramine is an anionic exchange resin which strongly adsorbs bile salts. It can lower the serum cholesterol level by up to 40% (Farah *et al.* 1977) and has become a standard treatment for hypercholesterolaemia. Experiments show that, contrary to previous belief, plant fibre alone does not adsorb bile salts to any significant extent. Adsorption seems to require the additional presence of saponins (Oakenfull and Fenwick 1978).

Saponins are widely distributed in the plant kingdom and have been identified in about 500 species (Bondi *et al.* 1973) but relatively few of these are food plants. The more common food plants are soya beans, chick peas, peanuts, spinach, and aubergines. Saponins are powerful surfactants in which a disaccharide and a steroid or triterpene are combined in one molecule (Fig. 2). Dietary saponins remain within the gastrointestinal tract and are not adsorbed into the blood stream (Birk 1969). Thus they could induce association between fibre and bile salts, particularly as they are known to interact strongly with bile salts and with sterols in general (Bondi *et al.* 1973).

The plant fibre preparations that I have investigated are listed in Table 2. Those that did adsorb bile salts were all derived from plants containing saponins. Briefly, the fibre was prepared by treating the finely chopped plant material with boiling water, then ethanol and finally acetone. Materials with a high protein content (such as soya

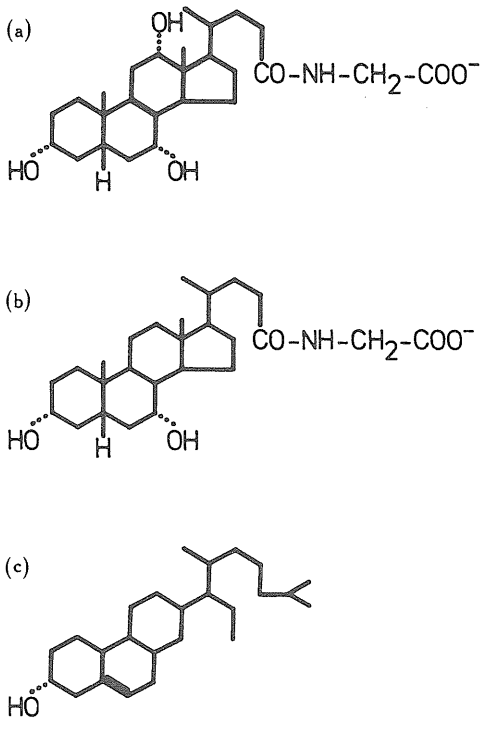

Fig. 1. The structures of (a) glycocholate, (b) glycochenodeoxycholate and (c) cholesterol, for comparison.

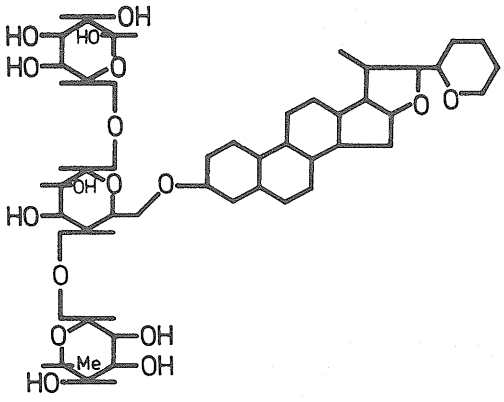

Fig. 2. A typical saponin showing the combination in one molecule of a disaccharide and a steroid or triterpene.

Table 2. Plant fibre preparations tested for their ability to adsorb bile salts (sodium cholate and sodium deoxycholate)

Non-adsorbing	Adsorbing
Lemon albedo	Soya beans
'Dry grain'[A]	Mung beans
Apple	Chick peas
Sawdust	Spinach
Wheat bran	Sunflower seeds
Rolled oats	
Lignin[B]	

[A]A residue from brewing; [B]Prepared from wheat bran by treatment with 72% (w/w) sulphuric acid.

beans) were also digested with pronase. Adsorption was measured by shaking a weighed quantity of the dry fibre preparation with a bile salt solution of known initial concentration. The mixture was filtered and the concentration change, if any, gave the amount of bile salt adsorbed.

The role of saponins in bile salt adsorption is also indicated by results of feeding trials. In Table 1, which lists those plant materials that have been shown to lower serum cholesterol levels in man or experimental animals, plants containing saponins make up more than half the total. Dietary saponins lower the liver cholesterol level, but not that in the serum of chickens (Newman *et al.* 1958) and it has been reported that an extract of horse-chestnuts (which are particularly rich in saponins) reduces the development of atherosclerosis in rabbits and rats (Mikhailova *et al.* 1965). Also, lucerne saponins prevent hypercholesterolaemia in monkeys (Malinkow *et al.* 1977). Possibly the most significant of the results listed in Table 1 is the effect of soya bean textured protein on serum cholesterol levels in man. Soya beans have the highest saponin content (*c.* 0·5% dry weight) of generally accepted foods and the saponins remain with the protein isolate (Smith and Circle 1972). In a group of twenty patients suffering from hypercholesterolaemia, a low lipid diet with soya bean protein lowered their mean serum cholesterol level by 21%, whereas an equivalent diet with animal protein had only a small effect (Sirtori *et al.* 1977). Thus dietary saponins may lower serum cholesterol levels and consequently the risk of heart disease, but this still needs to be tested in clinical trials.

The important point is that fibre is an exceedingly diverse material. If we are to benefit from increasing the fibre in our diet in terms of reducing the risk of heart disease, then clearly the choice of fibre is important. It is pointless for this purpose simply to increase consumption of wheat bran or straight cellulose which have no demonstrable effect on serum cholesterol levels (although they may have other benefits). The evidence suggests that the fibre should be from plants containing saponins; soya beans are probably the most commonly accepted foodstuff with a high saponin content.

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News from the Division

Retirement

Mr William A. Montgomery retired in April 1978 after 37 years' service in the Division. Following some experience in hospital laboratories he started work at the Homebush laboratory in 1941 as a laboratory assistant in the Canning Section which was at that time working mainly on Service rations and substitutes for tinplate containers. In 1942 Bill joined the RAAF, enlisting as aircrew but being re-mustered as a laboratory technician. He served for 18 months in New Guinea and also in Broome, W.A., and was discharged in 1946.

When he rejoined the Division he was assigned to the Fish Preservation Section. He resumed part-time studies at Sydney Technical College and completed the Science Diploma. Later he returned to the College as a part-time lecturer. In the laboratory Bill developed notable skills in a wide range of analytical techniques in connection with investigations on chemical methods of defining spoilage in fish, on denaturation of fish muscle proteins, and on post-mortem muscle properties in prawns and crayfish. A particular achievement was the establishment of a vivarium for maintaining crayfish alive for laboratory studies. In 1957 he was made an Experimental Officer.

In addition to his laboratory work, Bill cultivated a close technical liaison with the fishing industry and he became FRL's principal authority on fish storage and processing technology. In this capacity he completed his career as a valued member of the Liaison Section at FRL.

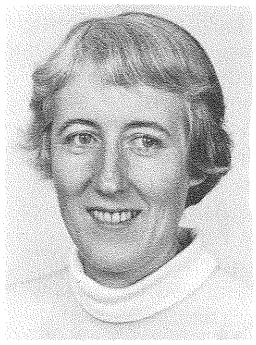
Resignation

Dr Elza A. Chapman (Mrs N. L. Wade) resigned from the Division on 3 March 1978 after almost 18 years' service. She joined CSIRO Coal Research Section in November 1956, immediately on leaving school and transferred to the P.P.U. at Sydney University in 1960.

She gained a B.Sc. degree at the University of N.S.W. by part-time study in 1966 with majors in Biochemistry and Microbiology. Technical support staff were in short supply in the early sixties and at one stage Elza was Technical Assistant to three Research Officers, Drs Giovanelli, ap Rees and Graham, in fortnightly instalments. This arrangement, although demanding, provided her with a very broad range of expertise, and she served virtually as laboratory manager for P.P.U.

Setting her sights on a higher degree Elza undertook an M.Sc. project in 1967 investigating regulation of the mitochondrial tricarboxylic acid cycle in plant cells. In 1969 she converted her M.Sc. course to the Ph.D. stream and was awarded that degree by Macquarie University in 1971. She continued her studies of mitochondria in plants and developed a collaborative project with the Royal Botanic Gardens, Sydney and Macquarie University on environmental effects on photosynthesis in arid regions. More recently she investigated the physiology of chilling injury in plants with Dr J. K. Raison.

Dr Chapman is a person with outstanding abilities who, having missed university training early in her career, managed by diligence and devotion to science to progress professionally to the status of Research Scientist and to make significant research contributions. Her marriage to Dr Neil Wade, of the N.S.W. Department of Agriculture, was an occasion for warmest congratulations from all their many friends and colleagues, and the birth of a daughter is the immediate cause of her retirement.



Dr E. Chapman

W. A. Montgomery

Visitors

Among the many visitors to FRL in recent months were:

The Hon. Julian Chan, Deputy Prime Minister and Minister for Primary Industry, Papua New Guinea; Dr Melicio Magno, Director-General of the Philippines National Science Development Board; His Excellency Mr Ahmadi, Minister of Agriculture, Iran; Mr J. H. Hulse, Program Director, Agriculture, Food and Nutrition Sciences, International Development Research Centre, Canada.

Visiting worker

Mr Jitendra Parekh from the National Dairy Research Institute (Karnal), India, spent two months at DRL to investigate alternative outlets for butterfat.

Symposium

A joint symposium was held at FRL on 15 May between members of the CSIRO Divisions of Human Nutrition and Food Research, on projects of mutual interest. Also present, by invitation, were Professor A. S. Truswell and Professor M. L. Wahlquist, Professors of Nutrition at Sydney and Deakin Universities respectively.

Work overseas

Dr W. B. McGlasson (FRL) spent a further two weeks at the University of the Philippines, Los Baños, to complete the setting up of equipment at the ASEAN Postharvest Laboratory and to conduct a training course for technicians from ASEAN countries.

Dr J. H. B. Christian chaired the first session of an International Meeting on Food Microbiology and Technology at

Parma, Italy, in April 1978. The Meeting was held to commemorate the introduction of the concept of water activity into microbiology by Dr W. J. Scott of this Division 25 years ago.

Dr B. S. Harrap (DRL) and Mr L. L. Muller (DRL) attended the International Dairy Congress and the Annual Sessions of the International Dairy Federation in Paris. Dr Harrap also attended the IDF Symposium on the Physics and Chemistry of Milk Proteins, at Ayr, Scotland, and visited research centres in Europe and Japan.

Mrs G. Urbach (DRL), whilst on a private visit overseas, returned to duty to visit a number of research centres in Scotland, England and Holland. She also attended the Second Weurman Flavour Research Symposium held at Norwich.

Dr B. A. Cornell attended a training course on the operation of the Bruker CSP100 NMR Spectrometer, at Karlsruhe, West Germany. Such an instrument is shortly to be installed at FRL.

Dr D. J. Casimir (FRL) made a private visit overseas in April/May to present a paper at a symposium in Berne, Switzerland, organized by the International Fruit Juice Producers' Scientific-Technical Commission. He also visited research centres in France, Sweden and Switzerland.

On a private journey in March/April Mr L. R. Fisher (FRL) visited the Physiology Department at the University of Cambridge, and the Physical Chemistry Department at the University of Bristol, and attended the Faraday Society Discussion on Colloid Stability held at Lunteren, The Netherlands.