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Meat Content and Fat

IN ORDER to control the quality and nutritive value of canned meat products, many countries have found it desirable to set up standards of composition. In Australia, for instance, several States have enacted regulations prescribing the meat content and fat content of canned meats (e.g. N.S.W. Pure Food Act 1908–1958*a*).

MEAT CONTENT

Canned meat products may consist substantially of meat, with the addition only of seasonings or curing ingredients, or they may be mixtures of meat with cereal fillers, pastry, vegetables, flavourings, and added water. The meat content of such packs may be approximately estimated by means of a procedure originally devised by Stubbs and More (1919) for the analysis of sausages. This method is based on the following principles:

- The meat is the main source of nitrogen in the pack.
- The nitrogen content of meat, on a fat-free basis, is sufficiently uniform to permit the conversion of nitrogen content to lean meat content by application of an average factor.
- An estimate is made of the amount of nitrogen contributed by the filler or other ingredients in the pack. Cereal fillers as prepared for addition to the pack are assumed to contain about 40 per cent. water, about 50 per cent. carbohydrate, and about 1 per cent. nitrogen.

Thus, after determination of the moisture, fat, ash, and nitrogen contents of the product, the following calculations are performed:

(1) Total N% × 6·25 = Protein%
(2) 100−(Water % + Fat % + Ash % + Protein%) = Carbohydrate%
(3) Carbohydrate% × 2/100 = Filler N%
(4) Total N% − Filler N% = Meat N%
(5) Meat N% × 100/F = Lean Meat%, where F is a factor (see below)
(6) Lean Meat% + Fat% = Total Meat%

For the factor F, representing the average nitrogen content of fat-free meat, Stubbs and More (1919) originally proposed the values 3·75 for beef and mutton, and 4·0 for pork. Subsequently, a committee of the Society of Public Analysts, in the light of additional data, recommended the values 3·4 for beef, 3·6 for pork, and 3·5 for mixed meats (Anon. 1952). More recently, Reith, Hofsteede, and Langbroek (1955) and Marshall (1955) have presented evidence indicating that 3·4 per cent. would be a fairer average nitrogen content for British and European pig meats.

In the experience of this laboratory, meat content calculated by the Stubbs and More method tends to be consistently higher than the nominal meat content; for instance it is common to find more than 100 per cent. meat in packs with a nominal meat content of 95 per cent.

The method as described applies most particularly to canned meat products containing cereal fillers as the only ingredients in addition to the meat. Even then assumptions are made about the composition of the filler. The presence of ingredients high in protein such as milk powder or soya flour will lead to erroneous results. On the other hand, no correction is made for nitrogen in the filler if it is potato starch (Anon. 1952).

* Earlier articles in this series appeared in *C.S.I.R.O. Food Preservation Quarterly*, Vol. 13 (1953), pp. 3–8, 21–31; Vol. 14 (1954), pp. 8–18, 26–31, 46–52, 74–6; Vol. 15 (1955), pp. 28–32, 52–7, 72–7; Vol. 16 (1956), pp. 7–10; Vol. 17 (1957), pp. 11–14, 30–5, 42–7; and Vol. 18 (1958), pp. 15–19, 25–29.

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Content of Canned Meats

When the nature of the filler is known, its composition should be determined and appropriate values inserted in the calculations. Thraves (1955) has discussed in some detail the corrections to be applied for nitrogen in fillers and other ingredients when determining meat content, with specific reference to canned beans with pork sausage and tomato sauce.

The carbohydrate content of canned meats, calculated by difference as indicated above, may be checked by a direct determination of starch. The difference between the two estimates should not exceed 2 per cent., otherwise the presence of ingredients such as milk powder or soya flour may be suspected.

A further check on the calculations may be made by estimating the added water content, thus:

(1) Carbohydrate% × 2 = Cereal Filler%

(2) 100−(Total Meat% + Cereal Filler% + Salt%) = Added Water%

(3) Added Water% + 40/100 Cereal Filler% + 75/100 Lean Meat% = Total Water%

The total water content calculated in this way should not differ by more than 2 per cent. from the moisture content of the product as determined by analysis.

A scheme for simplifying calculations of meat content by reference to appropriate tables, when large numbers of routine determinations are being made, has been presented by Goose (1956).

Australian regulations, e.g. N.S.W. Pure Food Act (1908–1958*a*) and Victorian Department of Health (1958) prescribe for the estimation of the meat content of canned meats a procedure which is similar to the Stubbs and More method but differs in the detail of calculation. The lean meat content is calculated by multiplying the percentage of meat protein by a factor which depends on the treatment of the meat before canning.* The factors prescribed, which were determined by the late E. J. O'Brien, of the N.S.W. Department of Health, from the results of a survey of commercial canned meats, are as follows:

Meat not cooked before canning: 4·8
Meat partly cooked before canning: 4·2
Meat cooked before canning: 3·5.

The Victorian regulations include two additional factors:

For sausage meat containing pork: 4·6
For meat pies: 5·1.

In order that the analyst may know which factor to apply, the canner is required to label or code the pack appropriately. Essentially this method determines the content of raw meat, partly-cooked meat, or cooked meat in the respective packs. For packs made from raw beef or mutton it will give substantially the same result as the Stubbs and More method, since

$$N \times 6{\cdot}25 \times 4{\cdot}8 = 30N,$$

while

$$N \times 100/3{\cdot}4 = 29{\cdot}4N.$$

For other types of packs, however, the value of the method depends upon the canner's description of the process. Partial cooking is a vague term which may describe shrinkage varying from 10 to 20 per cent., while complete cooking may cause shrinkage in the range 20 to 33 per cent. The shrinkage that occurs during the cooking of meats is mainly a loss of water with only small losses

* A similar method (N.S.W. Pure Food Act 1908–1958*b*) is prescribed for determining the fish content of canned fish packs, with two factors: 5·0 for raw fish, and 3·5 for precooked fish.

of solids and nitrogen. General experience suggests that the ultimate shrinkage is the same whether all the cooking takes place in the can or whether some cooking occurs before canning. For instance, Dahl (1956) found the drained weight of a canned meat pack to be substantially the same whether or not the meat was precooked. The Stubbs and More method will give an approximate estimate of the amount of raw meat represented by the contents of a can irrespective of any pretreatments that may have been imposed.

Reith and Hofsteede (1954) have claimed that the Stubbs and More method does not give a true estimate of the meat content of vienna sausages canned in brine, because the sausages absorb water and some nitrogen passes into the brine. However, the discrepancies they encountered would not occur if the complete contents of the can were analysed rather than the drained sausages.

A method for the estimation of meat content in soups depending on the determination of insoluble meat protein has been reported by Dannacher and Staub (1955).

ANALYTICAL PROCEDURES

Preparation of the Sample

In the examination of meat products, particular care is necessary to secure representative and uniform samples for analysis; otherwise, the analytical results, no matter how accurately determined, are worthless. The Association of Official Agricultural Chemists (A.O.A.C.) (1955*a*) recommends that canned meats should be sampled by passing the entire contents of the can through a mincer, preferably with $\frac{1}{8}$-in. plate, three times, mixing thoroughly after each mincing. Because moisture is readily lost during preparation of the sample, the analyst is warned to work rapidly, to prepare large rather than small samples, and to transfer the prepared sample immediately to a glass container with a tight closure.

Most canned meats are sufficiently soft to permit comminution in a high-speed blender as an alternative procedure. The sample should be blended for 3–4 min, the operation being stopped two or three times so that material on the sides of the bowl may be pushed down with a spatula. Prolonged blending should be avoided since it may overheat the sample. If necessary a measured quantity of water may be added to the sample in the blender to assist comminution to a homogeneous, semi-fluid medium. Allowance must then be made for the added water in subsequent calculations.

For some specific canned meats, sampling of portion of the contents rather than the entire contents of the can may be prescribed. For instance, the Royal Australian Chemical Institute (R.A.C.I.) (1952*c*) specifies that analyses on canned sausages shall be made on the scraped sausages, while the N.S.W. Pure Food Act (1908–1958*a*) specifies that, in canned meats or sausages with vegetables, pastry, or tomato sauce, the meat or sausages shall be separated from the remainder of the pack for analysis.

Moisture Content

Moisture determination in canned meats has been discussed in Part VII of this series (Kefford 1955). The A.O.A.C. (1955*b*) and R.A.C.I. (1952*b*) prescribe vacuum-oven drying at 95–100°C for 5 hr, or air-oven drying at 101°C for 16–18 hr, or air-oven drying at 125°C for 2–4 hr. After the last-named procedure the dried sample is not suitable for subsequent fat determination.

Because these oven-drying methods are too slow for factory control purposes there has been much interest in rapid methods. Perrin and Ferguson (1957) claim that moisture in meat products may be satisfactorily determined in 15 min by drying a 25 g sample in a large aluminium dish in a forced-circulation oven at 200°C. A rapid method based on azeotropic distillation with 2-octanol (capryl alcohol) was developed by Everson, Keyahian, and Doty (1955). Moisture is determined in 15 min, and the results differ from the A.O.A.C. (1955) air-oven method by not more than 3 per cent. A procedure which is claimed to determine the moisture content of meat products in 5–8 min with an accuracy of 1–2 per cent. is described by Karpati (1952). The sample is shaken with glycerol or 60 per cent. sugar solution for 5 min, then the refractive index of the resulting solution is measured, and from this the moisture content of the sample is calculated.

Ash Content

For the determination of ash in canned meats, the R.A.C.I. (1952*b*) recommends the

procedure of the A.O.A.C. (1955*d*), which involves carbonization of a 5–10 g sample in a platinum dish in a muffle furnace at 525°C and extraction of the charred mass with hot water. After filtration through an ashless paper, the paper and residue are ignited to a white ash, the filtrate is added and evaporated to dryness, and ignition is continued at 525°C to constant weight.

Nitrogen Content

Nitrogen in meat products is determined by the Kjeldahl procedure (e.g. A.O.A.C. 1955*e*; Benne, Van Hall, and Pearson 1956).

Starch Content

For the determination of starch in canned sausages the R.A.C.I. (1952*d*) prescribes the tentative procedure of the A.O.A.C. (1945), in which the starch, after separation and hydrolysis, is determined as reducing sugar by a modified Fehling method. This procedure, however, was not satisfactory and has been omitted from later editions of the A.O.A.C. methods. Blanchard (1958) reports on subsequent studies of methods for starch in meat products but considers that it is not yet possible to recommend a satisfactory method.

The Society of Public Analysts outlines a gravimetric procedure (Anon. 1952) in which the meat sample is digested with dilute alkali and the starch separated by filtration. The starch is dissolved in alkali, reprecipitated with acid, filtered, dried and weighed, then ashed and the weight of ash deducted.

FAT CONTENT

Three types of methods have been developed for the determination of fat in meat products: gravimetric extraction methods, volumetric digestion methods, and instrumental methods.

Gravimetric Methods

The A.O.A.C. (1955*c*) prescribes a method in which the sample is dried for 6 hr at 100–102°C, or 1·5 hr at 125°C. The dried solids are ground with sand or asbestos to aid extraction and are extracted with ether or petroleum ether in a Soxhlet or similar extractor for 4–16 hr. The solvent is evaporated and the extracted fat is dried and weighed. Benne, Van Hall, and Pearson (1956) vary this procedure by containing the sample in a Gooch crucible, extracting the dried solids with ether in a Bailey-Walker extraction flask, and determining the fat content by the loss in weight. Regulations in Victoria (Victorian Department of Health 1958) prescribe a method in which the wet sample is weighed and dried in a Soxhlet thimble, and then extracted with ether to constant weight.

In another method of this type, described by Grzhivo and Shornikova (1957), the sample is mixed with a dehydrating agent and ground with a fat solvent, then the solvent is evaporated and the fat weighed.

Bacon: For the determination of the fat content of canned bacon rashers, the R.A.C.I. (1952*a*) prescribes a specific procedure. The sample is prepared from six cans by unrolling the rashers, separating the "Cellophane" interlining, and scraping the fat carefully from the "Cellophane" and the can. The combined can contents are minced three times, quartered, and requartered. A 10-g sample is weighed in a tared aluminium dish with a tared filter paper and dried 1–2 hr at 98–100°C. The dried cake on the paper is transferred to a Soxhlet thimble and extracted with ether (dried over calcium oxide) for 8 hr. The extracted fat is dried and weighed and the weight of fat remaining in the aluminium dish is added.

Cream Soups: Determination of fat in cream soups by drying and extraction is unsatisfactory because of persistent retention of fat in the dried solids. The Food Manufacturers' Federation (1954) recommends a procedure involving digestion of the soup with hydrochloric acid and wet extraction of the digest with ether and petroleum ether. After evaporation of the solvent, the fat is dried, then redissolved, filtered, freed from solvent, and weighed.

Volumetric Methods

Fat determinations by gravimetric methods require 2–3 days for completion. There is need, therefore, for rapid methods for production control.

Volumetric methods for determining fat in meats are based on the Babcock procedure for analysis of dairy products. The wet sample, contained in a Babcock bottle of the type used for cheese analysis, is digested by heating with a suitable reagent to liberate the fat and, after centrifuging, the

length of the fat column is measured. A determination requires approximately 30 min.

A comprehensive review of methods of this type has been provided by Salwin, Bloch, and Mitchell (1955), who also tested a number of digesting reagents. While sulphuric acid alone was satisfactory for some canned meats, the best results were obtained with a mixture of equal parts of 60 per cent. perchloric acid and glacial acetic acid. This reagent digested cereals and seasonings completely and gave fat columns light in colour and free from curd and foam. Salwin, Bloch, and Mitchell (1955) compared their rapid volumetric method with the extraction method of the A.O.A.C. (1955) and found that less than 1 per cent. of the deviations exceeded 0·5 per cent. fat. Windham (1957) also tested the perchloric-acetic procedure and another modified Babcock method using sulphuric acid against the A.O.A.C. (1955) method. Both rapid methods showed reproducibility comparable with the official method and the fat percentages agreed satisfactorily, provided a correction factor of 0·95 was applied to results by the perchloric-acetic procedure, since the fat layer was found to contain approximately 5 per cent. acid. The perchloric-acetic method has been adopted as a "first action" procedure for the determination of fat in canned fish (A.O.A.C. 1959).

Pohja, Komulainen, and Niinivaara (1956) have successfully applied the Gerber method, which is the European equivalent of the Babcock method, to the determination of fat in meat products.

Instrumental Methods

An instrument for the rapid estimation of fat, known as the Steinlite Tester (Fred Stein Laboratories, Atchison, Kansas, U.S.A.), is based on the fact that the high-frequency impedance of a solution of fat in a suitable solvent varies with the fat content. In the analysis of meat products, the fat is extracted with *o*-dichlorobenzene in a high-speed blender. Windham (1957) tested the Steinlite method against the extraction method of the A.O.A.C. (1955*c*) and found comparable reproducibility and close agreement in fat contents.

Everson, Keyahian, and Doty (1955) demonstrated the possibility of making rapid concurrent determinations of moisture and fat. During azeotropic removal of water by distillation with a mixture of 2-octanol and 1-octanol, the fat in the sample is extracted by the solvent. The fat content of the solvent mixture is then determined by means of the Steinlite Tester.

Rendered Fat

In packs such as canned bacon rashers, an important quality factor, in addition to the total fat content, is the content of rendered fat, i.e. the fat which is rendered during the heat processing of the pack and is likely to be lost from the edible portion when the bacon is cooked. A high proportion of edible bacon and a low proportion of rendered fat is desirable. An empirical procedure for estimating rendered fat in canned bacon which originated with the British Ministry of Food is as follows:

Cover an unopened can of the pack with cold water in a suitable pan. Bring the water to the boil in about 15 min and hold the can totally immersed in the boiling water for 25 min. Open the can carefully and drain off the liquor. Weigh the solid portion of the pack while hot to obtain the yield of edible bacon. When the liquor is cold and the fat has set hard, puncture the surface and run off the gravy. Weigh the fat and gravy fractions separately and calculate the rendered fat content.

Critical comments on the procedures described in this article, and suggestions for modified or alternative methods found to be useful in practice, will be welcomed.

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Winter School for Factory Foremen

HAWKESBURY AGRICULTURAL COLLEGE, Richmond, N.S.W., in conjunction with the Food Technology Association of New South Wales, is conducting a Winter School for factory foremen on "The Principles of Food Preservation". The course, in which special reference will be made to canning, will be conducted at the College during the week commencing June 29, 1959.

Attendance will be limited to thirty, and accommodation will be available at the College.

Further information may be obtained from Mr. S. M. Adams, Secretary, Food Technology Association of New South Wales, 12 O'Connell Street, Sydney, N.S.W.

The Commonwealth Antioxidant Research Project

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IN AUSTRALIA during World War II there was a considerable amount of research conducted into production of dried compacted food. At the end of the war, research into this field virtually ceased. In 1948 the Australian Defence Food Research Programme was instituted as a result of a resolution by the Commonwealth Advisory Committee on Defence Science that all Governments in the British Commonwealth be urged to acknowledge the desirability of extended and continuous research in this field.

The Defence Department formulated the lines of research on which the present programme is based. In 1952 the Department of Commerce and Agriculture was given the responsibility for the research programme as the Department concerned with food production in war. After the Department was reorganized this function was maintained by the newly formed Department of Trade until March 1958, when responsibility was returned to the Department of Defence. As the service having the major interest, the Army has been the manager of the research programme, which is administered through the Army Food Science Establishment. The terms of reference cover a broad field of fundamental and technological research, and work is being done at present on operational ration packs, the compression of dehydrated vegetables and fruit, and the toxic hazards involved in the use of antioxidants. The Commonwealth Antioxidant Research Project is responsible for the last-named aspect of the programme.

* Published with the approval of the Director of Supply and Transport, Department of Army.

INITIATION OF PROJECT

An agreement was drawn up in 1953 between the Commonwealth, the Government of South Australia, and the University of Adelaide, that the Project be housed in the University's Medical School. Sir C. Stanton Hicks, then Professor of Human Physiology and Pharmacology at the University of Adelaide, who was closely connected with the Defence Food Research Programme, was the main sponsor of this site. Thus the project was, and still is, closely linked with the Department of Human Physiology of which the present head is Professor R. F. Whelan.

Research began in 1954 under the leadership of Dr. W. D. Brown, who resigned in 1956. The present staff consists of two Senior Research Officers, a part-time histologist, and a number of technical assistants. Two research laboratories, office space, and a small but well-equipped air-conditioned animal-house comprise the accommodation in this self-contained unit.

FIELD OF RESEARCH

The main objects of the Project are to investigate the toxic hazards associated with the use of antioxidants under wartime or emergency conditions. Antioxidants are substances which delay the onset of rancidity in foodstuffs and thus extend their storage life. In wartime, when increased storage life of foodstuffs is essential, it is envisaged that antioxidants will be used more freely than under normal commercial conditions. Consequently greater risks are attached to their use in wartime, and more rigorous investigations into the toxicity of these substances

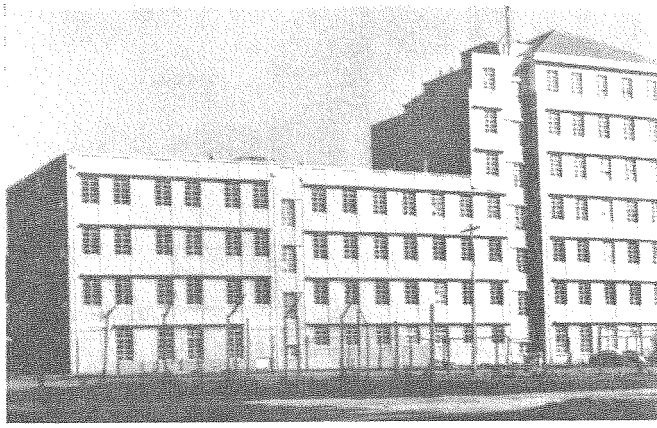
are required. It was decided that the investigations should take the form of a thorough examination of the chemistry and metabolism of the antioxidants, coupled with a reinvestigation of the chronic effects of antioxidants in experimental animals in the light of information gained from a knowledge of their metabolism.

The work to date has been concerned with three antioxidants, butylated hydroxy toluene (BHT), butylated hydroxy anisole (BHA), and propyl gallate (PG). So far most information has been obtained on the first of these.

EVALUATION OF TOXICITY

An attempt has been made to assess the value of conventional methods used in evaluation of the toxicity of a food additive—in particular, whether there is any justification for use of the normal testing dose (NTD) as a criterion for the safety of the food additive. The NTD is a dose level in the diet of an experimental animal 100 times the maximum normally expected to be present in human foods. If there are no deviations from normal cellular behaviour in animals whose diet contains the NTD of a substance, it is said to have fulfilled one of the major criteria of non-toxicity for humans. The difficulties involved in the transfer of results from one species to another has led to claims (Frazer 1952; Johnson 1959) that the NTD may not be an adequate safeguard for the health of the public. On the other hand, it should also be pointed out that some consider that the safety factor of 100 times the level in human foods is too high. In the case of the antioxidants, the NTD represents 0·1 per cent. of the diet of the experimental animals and this relatively high concentration of an abnormal constituent of the diet may produce pathological effects because it is outside the normal physiological range of ingestion of a material.

Some results obtained (Day *et al.* 1959) show a relationship between the level of dietary fat and the effect of BHT. For example, the increase in serum cholesterol levels produced by relatively large doses of BHT are enhanced by increasing the lard content of the diet. This may be merely a reflection of the greater ease of absorption into the tissues of this fat-soluble antioxidant



The Medical School, University of Adelaide, in which the Commonwealth Antioxidant Research Project is housed.

in the presence of increased fat, or it might possibly point to a biochemical interrelationship between the metabolism of BHT and fat. Further studies are being undertaken to elucidate the role of the level or type of dietary fat in the metabolism, and to assess the toxic hazards associated with antioxidants.

While performing their functions of inhibiting oxidative chain reactions, antioxidants are converted to a variety of oxidation products. A food treated with antioxidants may, after long storage at elevated temperatures, contain little of the original antioxidant, but considerable amounts of its oxidation products. This must be borne in mind when assessing the toxicity of these compounds. Chemical research on these oxidation products in fat is most difficult, but the oxidation of antioxidants in similar, but less complex chemical systems is being investigated.

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Skatole Taint in Beef

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INTRODUCTION

A condition involving an unusual taint in beef was brought to the attention of the Division of Food Preservation by a Sydney wholesale butcher. He reported that a large number of customers who purchased beef from three carcasses which had passed through his establishment complained that the meat had a bad odour, which was particularly noticeable during cooking.

When examined in the laboratory, steaks and other cuts from the three carcasses all showed a pronounced off-odour variously described by different observers as resembling naphthalene, α-naphthylamine, indole, or skatole. The odour was apparent in the surface and deep fatty tissues in all cuts, but could not be detected in the lean areas free from visible fat. On heating the fat and lean separately an overpowering faecal odour developed in the fat, whereas there was no detectable off-odour in the lean. There were no indications of microbial spoilage in any of the meat examined.

LABORATORY INVESTIGATIONS

A search of the literature failed to disclose any reference to tainting of meat by any of the suspected substances, but it was found that a so-called "weed taint" with an associated production of indole in the milk fat of cows had been investigated overseas and also by the C.S.I.R.O. Dairy Research Section in Australia.

Determinations by the method recommended by the Association of Official Agricultural Chemists (1955) showed the presence of indole in concentrations of about 10 p.p.m. in the fatty tissues and 1 p.p.m. in the lean. Attempts were then made to reproduce the typical taint by the addition of pure indole to melted and cooled beef fat. Although indole (in concentrations from 1 to 5 p.p.m.) could be smelt and tasted quite readily in aqueous solutions, it could barely be detected organoleptically in the cold fat at concentrations as high as 20 p.p.m.

The effect of cooking was to intensify the indole odour and flavour. Both could be detected readily in warm, lightly cooked lean beef to which 5 p.p.m. of indole had been added. In warm cooked beef fat it could be detected by odour at a level of 5 p.p.m. and by flavour at 10 p.p.m.

Since the intensity of odour and flavour in the naturally tainted beef was far stronger than comparable samples of fresh beef containing equal concentrations of indole it appeared that skatole (a methyl derivative of indole) might be involved. Accordingly, organoleptic tests were carried out with aqueous solutions of pure skatole and with beef to which skatole was added. These results showed that skatole could be detected by odour and by flavour at approximately one-tenth of the concentration of indole. For example, skatole was easily detected at a level of 5 p.p.m. in cold beef fat whereas indole could barely be detected at 20 p.p.m. The majority of observers also considered that the odour and flavour produced by skatole bore a closer resemblance to those found in the naturally tainted beef.

The presence of skatole in the fat was not clearly shown in ultraviolet absorption spectra but was readily demonstrated by the colour reagents developed by Myers (1950). A quantitative determination by the same methods showed that the affected fat contained 4 p.p.m. of indole and 18 p.p.m. of skatole. This concentration of skatole was sufficient to account for the pronounced "faecal" taint in the affected fat.

DISCUSSION

The above investigation of an "indole-like" taint in beef has shown the need to employ an analytical method capable of distinguishing between indole and skatole. The tests carried out showed that skatole produces

a much more intense odour and flavour than indole in similar concentrations in water and in fat. They also indicated that the concentration of skatole was appreciably greater than that of indole in the tainted beef fat.

Although it has not been possible to find the reason for the presence of concentrations of skatole and indole in beef body fats sufficient to produce this faecal taint, it is likely that the condition was brought about in the same way as the so-called indole type of "weed taint" in milk fats. It has been found in many parts of the world that this taint often appears in the milk of cows when certain weeds including *Lepidium* spp. (peppercress, hoary cress, etc.), *Thlaspi arvense* (French weed or penny cress), and *Ambrosia* sp. (one of the ragweeds) make up a large proportion of the diet.

Prior to the work of Conochie (1953), it was postulated that these weeds provided a special source of indole apart from the tryptophane present in the protein-containing foods consumed by the animals. Indole and skatole are known to be produced from tryptophane by a variety of bacteria inhabiting the intestinal tract. Several workers have claimed that additional indole was released by certain proteolytic enzymes from the weeds concerned, with the result that there was a large increase in indole production and in its absorption into the blood stream.

Conochie's investigations, in which goats were used as experimental animals, proved that *Lepidium* spp. from Australian sources did not contain indole, skatole, or precursors of these. He found no evidence for the presence of a plant tryptophanase, and he showed also that the proteins were normal in tryptophane content. He proved conclusively that the effect of ingestion of large quantities of these weeds is to interfere with the animal's excretion of indole and skatole, with the result that these substances accumulate to abnormally high levels in the blood and in the milk fats.

Blood indole and skatole levels in the *Lepidium*-fed animal are raised abnormally during the period when indole is being more slowly excreted. Indole and skatole are much more soluble in fat than in aqueous media. The occurrence of high concentrations in the blood at the time of fat formation in the mammary gland would therefore result in the building up in the milk fat of high concentrations which would be reduced only slowly.

A similar transfer of indole and skatole from the blood to body depot fats would account for their presence in the fats of the beef examined in this laboratory. These findings support statements given to Conochie by farmers who claimed that the meat of cattle and sheep fed on *Lepidium* spp. was tainted. Eggs from poultry were also said to be affected. The cattle concerned in this investigation were grazed in a southern area of Queensland known to be infested with *Lepidium* spp. which frequently cause butter taint. These species are widespread throughout Australia and could cause taint in the fats of animals and possibly poultry consuming sufficient quantities of them to upset the normal body mechanism for the detoxication and excretion of indole and skatole.

It has been reported that the milk from cows consuming large quantities of *Lepidium* spp. can be freed from "indole" taint within one or two days of exclusion of these weeds from the diet. The period required for the elimination of similar taints from beef body fats is not known, but is probably much longer because of the relatively poor blood supply to these tissues by comparison with the mammary gland, and also because the operation of milking removes from the body the secreted milk fats containing indole and skatole. In areas of Australia where *Lepidium* spp. form a large proportion of the natural herbage it is impracticable to prevent their consumption by livestock, except by resorting to hand feeding. Further investigation would be required before recommendations could be made to ensure that the fats of such livestock are free from indole and skatole taints at the time of slaughter.

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Waxing Citrus Fruits

By J. K. Long and D. Leggo*

New South Wales Department of Agriculture

IN REVIEWS of citrus handling practices under Australian conditions Hall (1938, 1947) discussed the waxing of oranges and mentioned early successful experiments with the hot fog method. The present paper discusses more fully the various methods of waxing and recommends methods for applying water-base wax emulsions as dips and foams. The recommendations are the outcome of investigations carried out at the Citrus Wastage Research Laboratory at Gosford, N.S.W., which is run on a co-operative basis by the C.S.I.R.O. Division of Food Preservation and Transport, and the N.S.W. Department of Agriculture.

The application of a thin film of wax to citrus fruits helps to maintain them in fresh condition by reducing water loss, and improves appearance by imparting an attractive lustre to the rind. Once picked from the tree citrus fruits lose water and become dull and wilted in appearance, especially under warm, dry conditions. These adverse changes, which may occur quickly, can prejudice sale of the fruit, but they can be effectively checked by waxing. Under commercial conditions efficient waxing by any one of the several methods available should reduce weight loss by at least 30 per cent. Under experimental conditions reductions as high as 50 per cent. have been achieved without harmful effect on the fruit.

Low melting point waxes, such as paraffin, give good control of wilting but poor lustre, and high melting point waxes such as the vegetable waxes carnauba and candelilla and some mineral waxes impart an attractive and permanent lustre but give poorer control of wilting. Only a very thin film of wax should be applied, since thicker films can cause the development of fermented and other off-flavours in the fruit.

It is important that the fruit be cleaned before waxing. Dust can be removed by running the fruit over a set of soft polishing brushes, but if sooty mould or sooty blotch is present the fruit should be washed as recommended by Long and Leggo (1958).

The following are the more important methods of waxing fruit:

Slab Waxing
Spray Waxing
  (*a*) Solvent Waxing
  (*b*) Hot Fog
Water-wax Emulsion
  (*a*) Dipping
  (*b*) Foam Waxing

In the slab method dry wax is applied to the fruit. In spray waxing, the wax is either molten or in a volatile solvent, and dries instantly on contact with the rind. Water-wax emulsions leave the fruit wet and it must be artificially dried before being packed. Except in the case of slab or hot fog waxing, brushing of the fruit *after* waxing is not necessary. Indeed brushing may, unless the wax film is completely dry, make smears or streaks on the surface.

SLAB WAXING

This method is most readily applied in small packing sheds where the fruit is not washed, but merely dry cleaned and polished by sets of revolving brushes before being size graded. The first brushes remove dust from the fruit. Next follow the brushes which apply the wax. Trays, each containing a shaped slab of wax, are fitted under three or four of the brushes, against which they are pressed by a spring-loaded mechanism. The brushes transfer wax to the fruit. Finally, a set of brushes helps to distribute and buff the wax film.

It is the simplest method of waxing, for which a comparatively soft (low melting point) paraffin wax is used. Although economical, slab waxing has two important disadvantages:

- It is difficult to cover the fruit completely. Consequently wilting is not controlled as it should be.

* This article is also being published in *Agric. Gaz. N.S.W.* **70** (in press).

- Because low melting point waxes are used, little permanent gloss is imparted to the fruit.

SPRAY WAXING

In this method, the wax is sprayed on the fruit immediately before grading and sizing. As in slab waxing it is essential that the fruit be *quite dry*. Various mixtures of high and low melting point waxes can be used to obtain the desired lustre and control of shrinkage. There are two methods of application, in both of which the fruit is carried through an enclosed chamber by roller conveyors which turn the fruit as the wax is applied.

Solvent Waxing

In solvent waxing, the fruit passing through the chamber receives a fine spray of wax dissolved in a highly volatile solvent. The solvent quickly volatilizes, the fumes are drawn off by an exhaust fan, and a film of wax remains on the fruit. This method is used in the "Flavorseal" process, which is stated to be covered by world patents held by the American company—Food Machinery and Chemical Corporation. The Corporation makes the equipment and wax available to packing houses on a lease and royalty basis. In Australia business is handled by Food Machinery (Australia) Limited.

Hot Fog

In the hot fog process, hot molten wax, without solvent, is sprayed on the fruit in a heated chamber in the form of a fine fog. The wax solidifies on the fruit rind. This method of application has had only limited use in Australia, but it has given very satisfactory results when properly used. For best results the applicator chamber must be heated correctly, the molten wax held at a suitable temperature, and the spray nozzles set at the correct angles, and at suitable distances from the fruit.

WATER-WAX EMULSION

Water-wax emulsions are the most convenient to use in existing wet processing plants. In these plants the fruit passes through a soak tank containing a detergent and/or a fungicidal solution, over a set of rotating, transverse, wet cleaning brushes, in some cases through a rinse tank, and then into a drying chamber through which a stream of hot air is blown.

Emulsion waxing is the method commonly used in Australia and has proved very satisfactory. A number of commercial formulations of water-wax emulsions are available. They are generally supplied in a concentrated form and can be freely mixed with water to any desired concentration. Most of the manufacturers recommend that the concentrated emulsions be mixed with an equal quantity of water, but the strength of the emulsions can be varied to suit requirements. A 1:1 dilution appears to be satisfactory for most of the concentrated emulsions at present available.

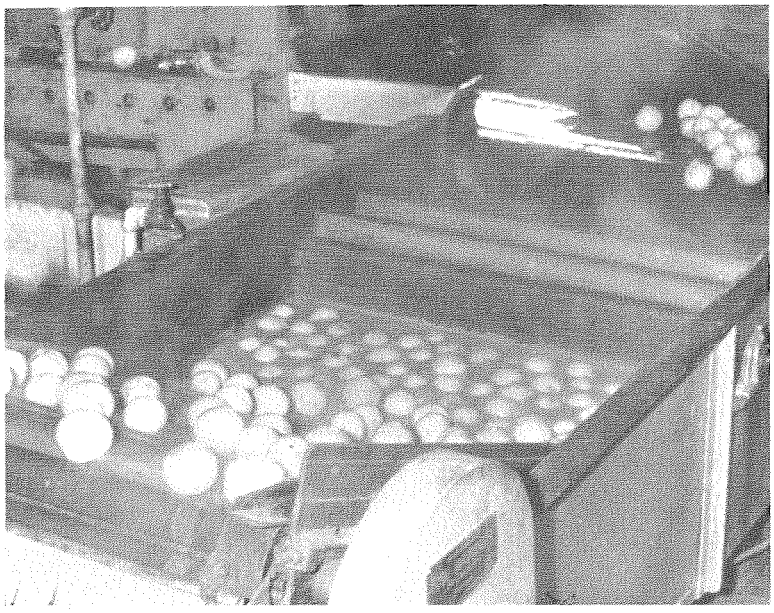
It is important, when using a water-wax emulsion, to dry the fruit thoroughly after waxing, otherwise the gloss and control of shrinkage may be disappointing.

Dipping

For the purpose of applying wax by dipping, a small waxing tank such as that illustrated on page 34 is fitted between the scrubbing brushes and the drier. A small tank is recommended because wax emulsions may "break" under certain conditions of use, and must then be discarded. Only sufficient emulsion is needed to wet the fruit. A plant capable of treating 100–150 bushels per hour should not require a waxing tank of more than 50 gallons capacity.

It is necessary to have a set of water-eliminating rollers between the cleaning brushes and the wax tank to remove surplus water from the fruit and avoid excessive dilution of the emulsion in the waxing tank. The water is swept from the rollers by rubber scrapers pressing against them from below. Excess emulsion is similarly removed from the fruit as it passes over rollers after being through the waxing tank. It may be recovered from the rollers and used again. Each set of rollers should consist of approximately six brass-covered transverse rollers of 4 in. diameter, with centres set at $4\frac{1}{2}$ in. The rollers revolve at 160–180 r.p.m.

Retention of Emulsion Strength.—The concentration of the emulsion will weaken gradually as water is carried into the tank by wet fruit. The volume of added water will be less than that of the emulsion removed on the fruit, therefore the level in the tank will fall and more emulsion must be added. In the course of "topping up" the concentration in the tank can be corrected by adding



Dip Waxing. *The oranges are passing through a tank of wax emulsion.*

concentrated emulsion. The strength to be used will vary with individual plants. Where a half-strength dilution is used for dipping, experience has shown that, in general, a mixture containing 75–100 per cent. of the concentrated emulsion should be added when topping. If the wax emulsion in the tank is too dilute, the initial gloss may be satisfactory for a few hours but it will soon disappear. Control of shrivelling will also be poor. It is therefore important to maintain the correct concentration. This can be simply and accurately determined by means of an hydrometer or a simple refractometer. The strength of the freshly made emulsion in the tank is first determined. It is again checked when topping becomes necessary. Enough full-strength emulsion (as supplied by the manufacturer) is then added to bring the emulsion in the tank back to its original strength.

Example.—Suppose a 50-gallon tank is initially filled with 25 gallons of water and 25 gallons of concentrated wax emulsion having a refractometer value of 16 per cent. The refractometer reading on the diluted emulsion would therefore be 8 per cent. After use, 40 gallons remain in the tank and the refractometer reading is (say) 6·5 per cent. Forty gallons reading 6·5 per cent. are equivalent to $32\frac{1}{2}$ gallons of half-strength (8 per cent.) emulsion + $7\frac{1}{2}$ gallons of water. Therefore $7\frac{1}{2}$ gallons of concentrated (16 per cent.) emulsion must be added to bring the diluted emulsion back to half strength. To make up the volume to 50 gallons a further $2\frac{1}{2}$ gallons is needed and this would be obtained by adding $1\frac{1}{4}$ gallons of concentrated emulsion and $1\frac{1}{4}$ gallons of water. Thus the total quantities required would be $8\frac{3}{4}$ gallons of concentrated emulsion and $1\frac{1}{4}$ gallons of water.

Heating the Emulsion.—The drying of the fruit will be hastened by heating the emulsion to about 100°F. The heating must be done carefully as temperatures above 115–120°F can cause complete "breaking" of some emulsions.

Prevention of Emulsion Break.—Most of the commercial emulsions available in New South Wales at the time of writing are moderately alkaline. Carbon dioxide from the air and from the fruit passing through the tank will slowly reduce the alkalinity, and a point may be reached at which some emulsions will break. The drop in alkalinity can be tested by removing a cupful of the emulsion each morning and adding to it several drops of 0·05 per cent. phenolphthalein indicator solution, which may be purchased from any pharmacist. If a persistent red colour appears the alkalinity is

satisfactory, but, if no colour develops, the alkalinity should be increased by adding either ammonia or a weak solution of sodium hydroxide (say 0·1 per cent.). A strong solution of sodium hydroxide should not be added as this may cause localized breaking in the emulsion. Re-testing with the indicator will determine whether the alkalinity has been raised sufficiently.

Cost of Treatment.—The cost of the emulsion needed to wax a bushel of fruit is influenced by a number of factors, including the size of the tank and the quantity of fruit processed. On the basis of the prevailing price (20*s.* per gallon) the cost would be 2*d.*–3*d.* per bushel.

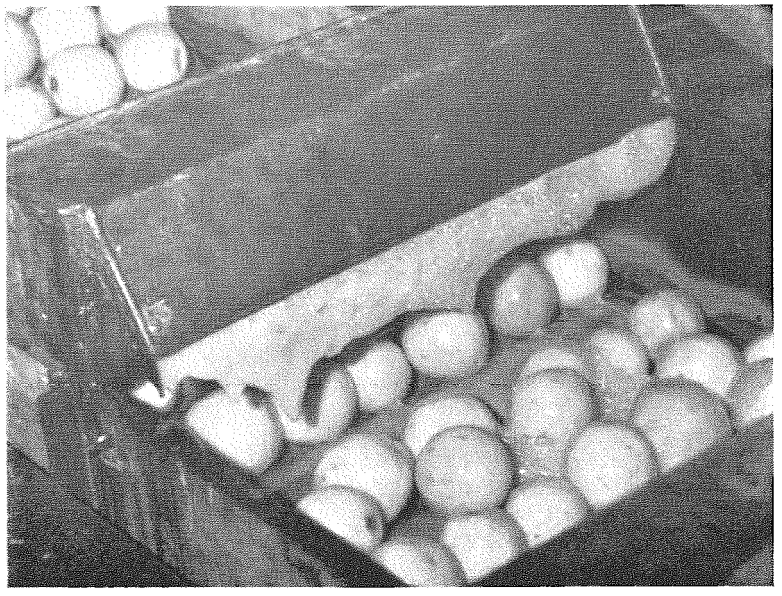
Foam Waxing

This method of applying wax emulsion to the fruit as a foam was suggested by Dr. W. Grierson of the Citrus Experiment Station, University of Florida. It has been further developed at the Gosford Laboratory and is being increasingly used in commercial packing houses. In foam waxing, a wax emulsion storage tank supplies a constant-level tank, which in turn feeds a foam-applicator tank. The latter is situated above a set of water-eliminating rollers which are between the scrubbing brushes and the drier. Compressed air, blown into the applicator tank, foams the wax emulsion which falls on to the fruit passing over rollers (see illustration below). The foam is spread by the spinning of the rollers and by the fruits pushing against each other. It is particularly important that the fruit be thoroughly dried. The method is simpler, more flexible, and cheaper than the dipping method of application. Its advantages are:

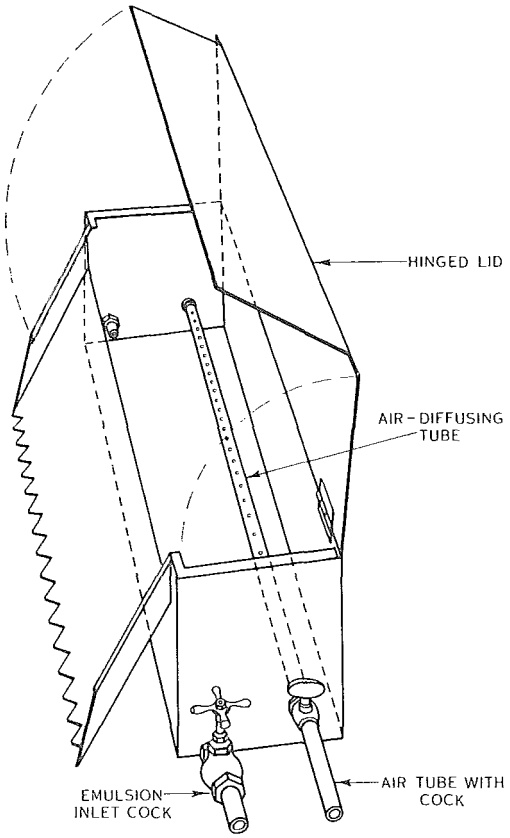
- It is simple to regulate the foam to vary the amount of wax applied to the fruit.
- The foam can be turned on and off, hence the fruit to be waxed may be selected. When wax is applied by dipping, on the other hand, *all* fruit passing through the tank is waxed.
- If the emulsion breaks, which is unlikely, but may occur in the foam applicator, no more than a gallon or two will be lost.
- Excess emulsion can be collected in a drip tray, and used again after its concentration has been adjusted.

Description of Equipment.—The main parts of the equipment have been briefly referred to on page 33, and they are described more fully below.

Spin Rollers.—In a foam waxing installation the set of transverse spin rollers usually consists of 12 brass-covered rollers of 4 in. diameter with centres set at 4½ in., the rollers revolving at 160–180 r.p.m. Each roller should have a rubber scraper bearing against



Foam Waxing. *The oranges are shown passing under a curtain of foamed wax emulsion.*



Foam applicator tank, used for foam waxing. In later designs of this equipment the air tube is placed nearer the center of the tank base.

it from below or, alternatively, a spring-loaded rubber squeegee roller can be set under each pair of brass rollers. The foam applicator is placed about 6 in. above the spin rollers and should deliver the foam *directly between* two rollers (about the fifth and sixth from the drying chamber end). All spin rollers preceding the foam applicator and the two directly beneath the applicator *must* be fitted with the rubber scrapers. Between the applicator and the drier, scrapers are needed only on alternate rollers. A drainage tray under these rollers will collect the surplus emulsion which can be strained, corrected for strength, and re-used. Another drainage tray placed under the first rollers will collect surplus water which would otherwise dilute the surplus emulsion excessively.

Foam Applicator.—The applicator is illustrated at left. It consists of a tank with a hinged lid, a toothed spillway at the top, and an air-diffusing tube running just above the base. A suitable tank can be made from 20-gauge galvanized flat iron, and a gasket may be required under the hinged lid. The length of the foam applicator will depend upon the method of fixing above the spin rollers. The length of the toothed spillway for the foam should be 1 in. less than the length of the spin rollers (i.e. $\frac{1}{2}$ in. in from each end). Apart from the air inlet control cock, two other cocks are suggested. One of these is for connection to the constant-level tank and the other for draining the emulsion from the tank. The air-diffusing tube, which should be 1–1$\frac{1}{2}$ in. above the base of the tank, could be made from copper tubing ($\frac{5}{16}$ in. outside diameter). Brass bushes should be placed between the copper tube and the galvanized iron tank to reduce electrolytic corrosion. Four $\frac{1}{16}$ in. diameter holes are spaced about the circumference of the air tube, at 1-in. intervals along its length. Should the air tube be longer than 24 in., the holes should be slightly further apart at the air-entry end, and closer together at the opposite end. The tube should be bound with two or three thicknesses of open-weave cloth (e.g. organdie) to break up the air stream from the $\frac{1}{16}$ in. holes. As the air-diffusing holes may become blocked with wax, the air tube should be so fitted that it is easily removed for cleaning. The solidified wax is most readily removed from the holes by steam pressure, but the tank must first be drained, as direct contact between steam and the emulsion will cause the latter to break.

Constant-level Tank.—This tank can be made from galvanized flat iron and needs to be large enough to contain a low-pressure ball-cock valve (i.e. about 6 in. by 18 in. by 8 in. high). The tank should have a cover to protect it from dust. A pipe from the base of this tank to the foam-applicator tank serves to maintain a constant level of emulsion in the latter. The best level seems to be about 1–1$\frac{1}{2}$ in. above the air-diffusing tube. In smaller installations, an additional compartment may be joined to the end of the foam-applicator tank and an upturned bottle containing emulsion may be used to

maintain the constant level, thus eliminating the constant-level tank.

Strength of Wax Emulsion.—Manufacturers of citrus water-wax emulsions suitable for use in a foam applicator will recommend the strength to be used. With currently available emulsions, dilution with an equal volume of water (i.e. 1 gallon of emulsion to 1 gallon of water) is usually satisfactory, although a slightly higher strength might be preferred. *Provided sufficient water has been removed from the fruit before it reaches the applicator*, 1 gallon of the emulsion collected from the drainage tray can usually be brought to correct strength by the addition of about $\frac{1}{2}$ gallon of the full-strength emulsion supplied by the manufacturers. The exact proportion to add will vary greatly and it is best determined by the method described under the dip method of application. If the emulsion is used at half strength, 1 gallon of the diluted emulsion should be adequate to treat 60 bushels of fruit, but if the surplus emulsion is used again this quantity can be doubled. In the latter case, with an emulsion initially costing 20*s.* per gallon, the cost of treating fruit should be about 1*d.* per bushel.

Ideally the amount of foam dropping from the applicator should be regulated to give a good coverage of the fruit and a minimum of run-off into the drip tray. Once the correct setting of the regulator has been found, any variation in the amount of wax applied to the fruit should be made only by altering the strength of the emulsion.

Compressed Air Requirements.—Compressed air is required at a pressure of only a few pounds per square inch. The volume needed is of the order of $\frac{1}{4}$ cubic foot per minute per 12-in. length of air tube. A control valve, capable of fine adjustment at low pressures, is necessary on the compressed air line.

Cost of Equipment.—The cost of the two tanks, including fittings, is about £20, and a suitable air compressor unit (new) should cost £60–£80.

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* Reprints are available from the Publications Section of the New South Wales Department of Agriculture.

NEWS FROM THE DIVISION OF FOOD PRESERVATION AND TRANSPORT

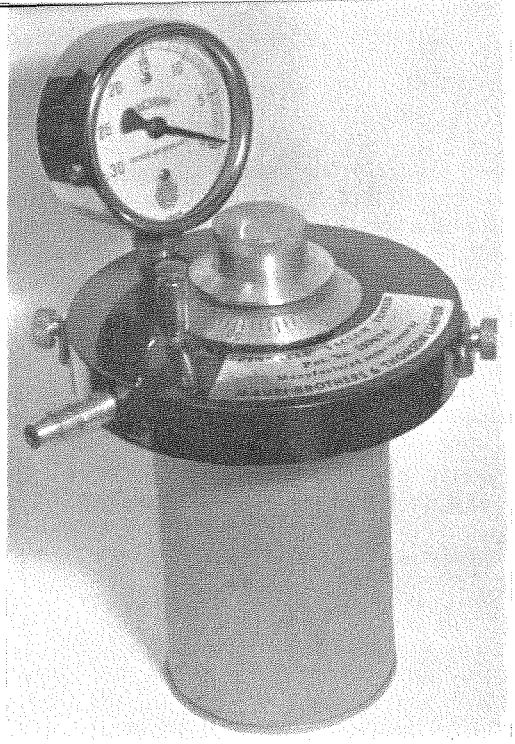
RECENT PATENTS

Officers of the Division have, within recent years, been responsible for two inventions for which C.S.I.R.O. has taken out patents. An instrument has been devised for testing vacuum in cans without puncturing them, and a process has been discovered which enhances the survival rates of microorganisms during storage in the dried state.

Vacuum Testing in Cans

When food is canned, air is removed from the can before the lid is seamed on, so that there is a partial vacuum within the closed can. Deterioration of the contents, defects in the can, or faulty closing techniques lead to loss of this vacuum. Consequently it is often useful to measure the vacuum in cans after a period of storage. Internal vacuum is generally measured by means of a puncture gauge, which destroys the can.

Instruments have been developed for measuring the vacuum in a can without opening it, and they may be used to follow loss of vacuum in a series of cans over a period of time, or to separate cans with low and high vacuum. These instruments depend on applying suction to one end of the can and measuring the vacuum required to make



Vacuum tester in position on can.

the end "flip" from a concave to a convex shape.

The difficulty of getting a gauge reading exactly when the can end flips is overcome in an instrument designed by two of the Division's research staff—Messrs. L. J. Lynch and R. S. Mitchell. The instrument is illustrated on this page. Suction is applied to the end of the can through a cap which is pressed against the end seam of the can. When the vacuum under the cap is just sufficient to balance the internal vacuum, the can end begins to move outwards and touches the stem of a valve similar to those used in car tyres. This allows air to enter from the atmosphere, so that the vacuum under the cap is held exactly at the value which balances the vacuum in the can. The reading on a gauge in the cap thus gives a direct indication of the internal vacuum.

The instrument was first developed for use in the laboratories of the Division, and is the subject of a paper by E. G. Davis and A. G. L. Elliott, which is reviewed on p. 40 of this issue. The vacuum tester may be used on canned products of all kinds. It is covered by Australian Patent No. 209,624, dated June 10, 1957, and arrangements have been made for it to be manufactured by Mauri Bros. & Thompson Ltd., Sydney.

Dried Storage of Microorganisms

When bacteria and yeasts are preserved by drying, some survive but many of the cells die. Dr. W. J. Scott found this was due to a reaction between carbonyl compounds, including reducing sugars, and the proteins of the cells. The addition of substances to prevent this reaction results in much higher rates of survival during storage in the dried state. The protective substances include non-reducing sugars and polyols, hexitols, free amino acids and reagents such as semi-carbazide, which react with carbonyl compounds in the dry or near-dry state.

The specification gives as examples of the use of this process the preservation of cheese starter, *Rhizobium* for inoculating clover seeds, bakers' yeast, and viruses.

This process is covered by Australian Patent No. 212, 235, dated January 17, 1958, and British Patent No. 799,644, dated August 13, 1958. Copies of the specifications may be bought from the Department of Patents, Canberra, A.C.T.

Patent Policy

It is the policy of C.S.I.R.O. to patent inventions arising from its research programmes whenever this step is considered to be in the public interest, and to file patent applications in Australia and overseas on suitable inventions.

C.S.I.R.O. will issue licences granting rights to the use of its patents. For Australian patents, as a general rule, the Organization charges nominal royalties only, but full commercial royalties are charged on exclusive licences. Full commercial royalties are usually charged for overseas patents.

PERSONAL

DR. R. P. NEWBOLD, formerly Research Biochemist at the Ruakura Animal Research Station, Hamilton, New Zealand, reached Australia with his wife and family on May 19, 1959, to take up a position as Principal Research Officer in the Sydney laboratories of the Division. Dr. Newbold has been invited to take charge of researches into the biochemistry of muscle.

DR. H. A. MCKENZIE, Principal Research Officer, who has been in charge of physicochemical investigations in the Division has resigned to accept appointment as a Senior Fellow in the Department of Physical Biochemistry at the Australian National University, Canberra. Dr. McKenzie joined the Division in 1944, and, in the course of his 15 years' service with the Organization, has published many papers in food chemistry, particularly in the fields of trace metal analysis, the applications of polarography, and the physical chemistry of proteins.

DR. THELMA REYNOLDS, Principal Research Officer in the Division's laboratories at Homebush, spent the months of April, May, and part of June visiting the United States and Europe. Dr. Reynolds held consultations with research workers in chemical laboratories in England and the United States, and in May delivered a paper to the 19th Annual Meeting of the Institute of Food Technologists at Philadelphia on recent Australian work on the chemistry of non-enzymic browning.

DR. K. S. ROWAN, Senior Research Officer in the Division's Plant Physiology Unit at the University of Melbourne, has accepted a research fellowship in biochemistry at the Department of Vegetable Crops in the University of California at Davis, U.S.A. The fellowship is tenable from June 1959 to November 1960. At Davis Dr. Rowan will join a research team engaged on investigations into the biochemistry of the ripening of fruit.

MR. J. J. MACFARLANE, Research Officer, returned to Australia on March 24, 1959, after spending nearly two years in the United Kingdom on a C.S.I.R.O. Studentship. Mr. Macfarlane spent some time at the Low Temperature Research Station, Cambridge, and the laboratories of the Atomic Energy Authority at Wantage, at both of which he studied the preservation of foodstuffs by ionizing radiations. In the course of his return he observed parallel work in progress at several laboratories in the United States of America. Mr. Macfarlane will be initiating research on ionizing radiations in the Division.

PUBLICATIONS BY STAFF

The Phytotoxic and Fungicidal Effects of Sodium *o*-Phenylphenate in Controlling Green Mould Wastage in Oranges. J. K. Long* and E. A. Roberts*. *Aust. J. Agric. Res.* **9**: 609–28 (1958).

Work at the Citrus Wastage Research Laboratory, Gosford, N.S.W., in collaboration with the Division of Food Preservation has shown that solutions of sodium *o*-phenylphenate control green mould wastage (due to the fungus *Penicillium digitatum*) more effectively than borax–boric acid, but can cause rind injury in oranges. Data are given on the effects of varying concentrations and pH levels of sodium *o*-phenylphenate solutions, duration of dip, rinsing, and the addition of hexamine. The degree of rind injury depends primarily upon the concentration of *o*-phenylphenol in the solution, which can be controlled by pH adjustment.

The Relationship of High-energy Phosphate Content, Protein Synthesis, and the Climacteric Rise in the Respiration of Ripening Avocado and Tomato Fruits. K. S. Rowan, H. K. Pratt,† and R. N. Robertson. *Aust. J. Biol. Sci.* **11**: 329–35 (1958).

Superficial Scald, a Functional Disorder of Stored Apples. I. The Role of Volatile Substances. F. E. Huelin and B. H. Kennett. *J. Sci. Fd. Agric.* **9**: 657–66 (1958).

Superficial scald, an external browning of apples which may develop after several months' cold storage, is thought to be due to the accumulation of volatile substances given off by the fruit, as it occurs less in ventilated stores. The effect of 19 volatile products on the development of scald was investigated. The evidence suggests that the causal substance is not a major component of the volatile substances found in the storage atmosphere.

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* N.S.W Department of Agriculture.

† Department of Vegetable Crops, University of California, Davis, U.S.A. Fulbright Act Research Scholar in Australia (1956).

Estimation of Vacuum in Unopened Containers. E. G. Davis and A. G. L. Elliott. *Food Tech., Champaign* **12**: 473–8 (1958).

An instrument for measuring flip vacuum, designed in the Division of Food Preservation, is described. Its performance was assessed on a series of test packs in 301×411 cans. When used in conjunction with a calibration curve, the internal vacuum could be estimated with a standard deviation of 1·3 in. mercury.

A Revised Table of the Ph function of Ball and Olson. E. W. Hicks. *Food Res.* **23**: 396–400 (1958).

This table permits greater accuracy in calculating the lethal value to microorganisms of the heating phase of canning processes than the graphical method recommended by Ball and Olson in their book "Sterilization in Food Technology".

A New Reaction of Aldoses with Primary Amines and its Significance for Non-enzymic Browning Reactions. E. F. L. J. Anet. *Chem. & Ind.* **1958**: 1438–9.

The Effect of Residual Water on the Survival of Dried Bacteria During Storage. W. J. Scott. *J. Gen. Microbiol.* **19**: 624–33 (1958).

The optimum water activity (a_w) for survival of dried bacteria was determined by storing the organisms in water-vapour equilibria with solutions of known a_w value. The optimum a_w differed according to the suspending fluid and the presence or absence of air in the storage atmosphere.

The Taxonomy of the Psychrophilic Meat-spoilage Bacteria: A Reassessment. A. D. Brown and J. F. Weidemann. *J. Appl. Bact.* **21**: 11–17.

The identity of bacteria associated with meat stored at low temperatures was re-examined by modern methods and according to criteria used in an up-to-date classification. Almost all gram-negative bacteria growing on beef were found to be pseudomonads. This corrects a statement from the Division of Food Preservation in 1939 that they were species of *Achromobacter*.

The Effect of Washing Treatments on the Composition of *Salmonella oranienburg*. J. H. B. Christian. *Aust. J. Biol. Sci.* **11**: 538–47 (1958).

Microorganisms for experimental purposes are frequently washed with water, buffers, or salt solutions to free them from traces of their previous environment. The effect of these treatments on the retention of sodium and potassium in the cells is discussed, and recommendations made for the choice of solutions for washing and suspending *S. oranienburg*.

Uridine Diphosphoglucose Pyrophosphorylase of Pea Seeds. Donella H. Turner and J. F. Turner. *Biochem. J.* **69**: 448–52 (1958).

Glycolysis by an Extract from Pea Seeds. M. D. Hatch and J. F. Turner. *Biochem. J.* **69**: 495–501 (1958).

These are two of a series of papers on the biochemistry of the life processes of peas, which may lead to a better understanding of their behaviour during handling and processing.

The Recording of D.C. Polarographic Waves and the Measurement of the Instantaneous Current at the End of the Life of the Mercury Drop. H. A. McKenzie and M. C. Taylor. *Aust. J. Chem.* **11**: 260–70 (1958).

Polarographic Current-Time Curves and the Ilkovic Equation. H. A. McKenzie. *Aust. J. Chem.* **11**: 271–84 (1958).

Polarographic Residual Current-Time Curves. H. A. McKenzie. *Aust. J. Chem.* **11**: 383–6 (1958).

Polarography has proved a useful analytical method in food investigations. Methods and theoretical considerations are discussed in these three papers.

Copies of papers mentioned above may be obtained from the Librarian, Division of Food Preservation and Transport, Private Bag, P.O., Homebush, N.S.W. (Telephone: UM 8431, UM 6782, UM 8938).