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The Citrus Industry of Israel

Promotion through Research and Coordination

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In this article the author reports his observations on the citrus industry in Israel which he visited recently as part of a tour of citrus research institutes and processing plants in several countries. It does not attempt a comprehensive description of citrus technology in Israel, presenting details of the plants only where they have novelty. Neither does it attempt a comprehensive review of recent Israeli research, since many scientists were understandably reluctant to discuss their unpublished results. What is attempted is an overall impression of the industry, not only the processing operations, and a demonstration that no other country devotes as large a proportion of its scientific effort to one food crop as Israel devotes to its varied and intensive research into citrus products. This country has earned the right to be proud of its citrus industry, established in near-desert areas by a people with a very limited agricultural heritage, and its present status is an excellent example of the benefits to be derived from efficient coordination of all branches of the industry and far-sighted investment in scientific and technological research.

The site of the Technion Institute on Mount Carmel overlooking Haifa Bay.

The citrus industry in Israel is highly organized and very progressively minded, and both these qualities have contributed to the increase in its production from 250,000 tons in 1947–48 to 1·5 million tons in 1970–71. There are now more than 125,000 acres under citrus cultivation in Israel, representing over 25% of irrigated land, and almost one-third of this acreage consists of young groves. The growing and marketing of citrus in Israel have been reviewed by Burke (1967) and a more recent assessment of the situation there, particularly its effect on world citrus exports, has been made by the U.S. Department of Agriculture (Anon. 1971) and by Johnson (1971).

Citrus is Israel's major food export and main source of external revenue, and the industry is geared entirely to the export market. Thus the only fresh citrus on public sale, amounting to a meagre 6% of the crop, is poor in quality, either 'backyard' fruit or export rejects from the 45 packing houses, while the 'citrus juices' available in hotels, restaurants, and shops are comminuted products containing only 10–30% juice. Although twice as much fruit is exported fresh (value $85 million) as is exported processed (value $25 million), the processing industry is highly developed, with one citrus cannery for every 100,000 people or every 1000 square miles (including disputed territories).

Since orchards in Israel are no more healthy or better cultivated than in Australia and the processing plants no more productive or better run, reasons must be found elsewhere for the sixfold growth of the citrus industry in Israel over the past 23 years while it has only doubled in Australia. Much of the success of the industry in Israel is the direct result of the dynamic, even aggressive, promotion of citrus products by the state regulatory authority, the Citrus Marketing Board, whose direction everyone accepts, growers and processors alike, for the national good. A further factor is the tightly meshed network connecting research and development in universities and industry, with advice and consultation available to industry through a number of agencies operating at different levels. This system is made even more effective by the smallness of the country and by the high level of scientific and technical skill evident throughout the industry.

Technion, Haifa

Most of the work on citrus technology in Israel is done in the Food Technology Department of the Technion Institute, at the time of this visit still within the city limits of Haifa but shortly to join the rest of the Institute on a new site half-way up Mount Carmel, at the top of which stands the recently established University of Haifa. This move solves the housing problems associated with the Department's wide range of pilot processing equipment and provides space for such approved but still to be purchased laboratory equipment as nuclear magnetic resonance facilities.

Under the direction of Professor Zeki Berk, the Technion Department has an applied bias, and most problems studied have direct practical significance. Although other foods are dealt with, citrus receives major attention. Recent projects associated with citrus processing include the viscous structure of concentrated orange juice and its behaviour under ultrasonics, the decomposition of naringin by microbial enzymes, the aroma of citrus products, the effect on canned grapefruit segments of various methods of sweetening and acidification, cloud retention in orange juice, and new methods for juice concentration.

The Department maintains excellent relations with industry; it will act as consultant and will undertake research work under contract. Individual members of the Department also provide private consulting services, and the University authorities accept this situation since it compensates the faculty for comparatively low salaries (by Western standards) and often leads to contracts for research work. Thus Professor Berk acts as private consultant, is on the board of the Center for Industrial Research (see below), and also advises the Industries Development Corporation (see below) and the recently established Advanced Technology Center for Science Based Industries. The ATC is a State-supported cooperative venture between the Municipality of Haifa and the Technion which will permit industrial firms, too small themselves to undertake research and development, to hire facilities and personnel to carry out such work on a short-term basis.

Center for Industrial Research, Haifa

Closely associated with the Technion's Food Technology Department is the State-financed Center for Industrial Research which, although located temporarily in the same building that housed Professor Berk's Department, will shortly move to a new building adjacent to the new Technion campus, thus permitting the continuance of the close cooperation between the two groups. With a staff of 21 increasing to 50 this year, the Center is somewhat similar to CSIRO though much smaller. It was set up to 'extend the frontiers of research' in Israel's four main manufacturing industries (food, plastics, petrochemicals, and minerals). The head of the Center, Dr Shorrm, encourages free movement between the research areas, perhaps with the idea of giving cohesion to a wide range of disciplines; thus, a petrochemist was working on fat hydrogenation, and a bacteriologist on the biodegradation of plastics.

The principal worker in the Center's food group is Dr Monshe Tishel, a graduate of the University of California at Davis. I was able to meet Tishel, only because my visit coincided with his two days' leave from the three-week army 'retraining' course which everyone under 50, including university professors, must do annually, with longer periods at regular intervals; all lectures missed by students under this system must be made up by the faculty.

The main interests of the group are the nature of the cloud in citrus juices and the role of pectin in its stabilization, the utilization of naringin as a bitter additive, and problems of bitterness in citrus juices. Particular attention has been given to the taste relations of limonin, its removal from model systems by atmospheric oxidation, and the de-bittering of grapefruit juice using an insoluble enzyme system incorporating naringinase free of pectolytic activity.

Food Industries Development Ltd, Haifa

Also at Haifa, serving yet another purpose in the complex pattern of research and industry in Israel, is the Food Industries Development Corporation, a branch of the Industries Development Corporation, a complex of consultant services which has similar branches dealing with other manufacturing areas; for instance, the IDC was recently called in to advise on the location, design, and construction of the Technion-sponsored Advanced Technology Center discussed above. The IDC was developed by its founder, Dr A. Hoffmann, a consulting engineer, from a one-man firm into its present position of international influence in only about 10 years.

The FID is only one part of this highly organized and efficient consulting firm, but it has access to the IDC staff of 200 engineers, architects, economists, scientists, and outside consultants like Professor Berk at the Technion. Thus, the FID is able to advise on the establishment of food processing plants, their feasibility, location, design, construction, layout, and equipping, making an extensive in-depth analysis of each project and producing a detailed report with recommendations. The principal FID food technologist until his recent resignation was Meir Hoffmann, well known to many in the citrus industry in Australia from his visit to this country in an advisory capacity about three years ago. As an example of FID activities, at the time of my visit, Hoffmann had recently returned from a term in Turkey advising on prune production and was due to leave for Venezuela to report on the establishment of a general fruit and vegetable cannery.

University of Tel Aviv

The depth of citrus research in Israel and its efficient coordination are indicated by the number of problems simultaneously receiving biochemical study in parallel with more applied investigation. The centre for biochemical research in citrus is in the Department of Biochemistry at the University of Tel Aviv, under Professor A. Lifshitz.

There is close contact between this laboratory and the workers at Haifa only 60 miles away, and when they both tackle, for example, the problem of cloud retention in juices there is not so much a duplication of research as an attack from two viewpoints, the biochemical and the technological. The ability of this small country to support such a healthy element of competition is evidence of Israel's enviable and probably unique research potential, especially since both Departments have excellent facilities and enjoy the stimulating atmosphere of new and expanding campuses.

The group at Tel Aviv is principally concerned with the nature of the cloud and pectin constituents of citrus juice and their interrelationships, and with the identification of the carbohydrates, amino acids, and oil constituents of citrus. Many of these projects are financed by U.S. Public Health grants, and most have practical significance in the fields of citrus processing and product authentication.

Volcani, Weizmann, and Braverman Institutes, Rehovot

While Haifa and Tel Aviv may be considered the centres for research in Israel on citrus technology and biochemistry, most of the work on citrus cultivation is carried out at Rehovot, a small town about 20 miles south of Tel Aviv and 40 miles west of Jerusalem. Here are located the agricultural faculties of the University of Jerusalem (earlier known as the Hebrew University) and the Federal and University Institute of Agricultural Research (formerly the Volcani Institute). This Institute, which functions as the research arm of the University, does not bear any obligatory teaching load and is financed partly by government funds and partly by grants from industry. It operates a large Division of Citriculture, while post-harvest physiology of citrus is studied by the Division of Fruit and Vegetable Storage; two other Australians (Cary 1970; Turpin 1971*a*, 1971*b*) have reported on recent contributions of these Divisions to our knowledge of citrus cultivation and storage.

The Division of Food Technology in the Institute is also an active centre for research on citrus products under Dr I. Ben-Gera, a Technion graduate with many years of experience in the U.S.A. Like Technion's Food Technology Department whose work it complements, this Division was housed in cramped and out-dated quarters at the time of my visit, but was to expand its faculties early in 1971 when the entire Institute moved into a new building about one mile from the Rehovot campus of the University of Jerusalem.

The Food Technology Division's citrus group is headed by Dr Solange Flavian and her associate, Aaron Levi, a Technion graduate who worked with Dr J. B. S. Braverman on 'exploded' comminuted orange, a product later superseded by simpler methods for comminution. For several years now, their main interest has been the problem of limonin bitterness in Shamouti orange juice, and their evidence for the presence of a limonin-degrading system in the albedo of this fruit has confirmed findings made in the CSIRO Division of Food Research with other oranges. However, the citrus industry in Israel is not greatly concerned about orange juice bitterness because the level of bitterness in recent years has not been high, and because comminuted products offer a means of utilizing bitter juice by blending it with non-bitter comminuted peel from other oranges.

On the opposite side of the road to the University is the Weizmann Institute, a large, privately endowed, and very well equipped centre for fundamental scientific research, standing in beautiful, park-like surroundings. In the Department of Organic Chemistry, Dr D. Lavie leads studies on natural product biogenesis and he has applied to model compounds related to limonin several chemical reactions similar to the biochemical processes by which simple triterpenoids are presumably converted to the complex limonin molecule in citrus fruits.

A few miles south-east of Rehovot is the Braverman Citrus Products Research Institute, financed on a voluntary basis by citrus processors to provide quality control reports on their products for export. The Institute will perform analyses before or after submission of products to the Citrus Marketing Board and will suggest to processors how rejected products may be improved to meet export specifications. In addition to this testing and trouble-shooting, the Institute develops and tests methods for analysis of citrus products and has amassed a vast amount of data on the quality of citrus juices, concentrates, and oils. Although well equipped as an analytical laboratory, the Institute was not financially well off, as demonstrated by its location in an old packing house ingeniously converted to accommodate the handful of staff. At the time of my visit the future of the Institute seemed in doubt since many processors had withdrawn financial support because they now had their own highly competent control laboratories, and the then Director, Dr H. B. Basker, has recently joined Dr Ben-Gera's group at Rehovot.

Yakhin, Jafora, and Pardess Plants

One of Israel's largest citrus processors, the Yakhin Canning Company, provides an excellent example of the research, development, and control laboratories which are such an admirable feature of the citrus industry in Israel. Moreover, the presence of three Ph.D. graduates on the staff of Yakhin's main laboratory, each supervising different areas of activity, testifies to the high academic standard of the scientific personnel employed by citrus processors in Israel.

This laboratory was located in the largest Yakhin plant, that at Petach-Tyfka 10 miles east of Tel Aviv. Although this plant had the appearance of an old citrus cannery repeatedly modified to accommodate changing technologies, about 20,000 tons of oranges were processed into juice and concentrate annually. A more modern plant at Ashdod, 20 miles south-west of Rehovot, catered for the expanding world trade in grapefruit products, 80% of which is handled by Israel from a crop of over 300,000 tons. Juice, concentrate, and segments are processed at Ashdod, with an impressive, large-scale, fully manual line for canned segments.

Also at Petach-Tyfka was a large plant for pectin recovery, which is usually not considered economic where oranges are the main citrus processed. Although handling citrus wastes from Yakhin's three locations (a third cannery in southern Israel processes both orange and grapefruit products), this plant was operating at a low profit margin, largely brought about by the world-wide surplus of pectin.

Another impressive control laboratory was attached to the Jafora cannery, situated just outside Rehovot. This plant, one of the oldest in Israel, provided most of the illustrations for an early classic treatise on citrus products (Braverman 1949) but the manager, Dr I. Stern, a respected pioneer of the citrus industry in Israel, was planning an extensive rebuilding and relocation programme to be undertaken at the end of 1970. Jafora was one of the first plants to undertake the recovery of hesperidin, the so-called vitamin P, also being recovered at Petach-Tyfka, but the rejection by the U.S. authorities of claims made for the physiological activity of this 'bioflavonoid' has made it doubtful whether this untidy chemical process will continue to be

Can-filling section of the grapefruit segment line at the Yakhin factory.

a worth-while operation for citrus processors.

Also in the Rehovot district is the 10-year-old plant of the Pardess Canning Company at Yavne. Its excellent laboratory of about 2000 sq ft was divided equally into control and research sections, and the supervisor, another Ph.D., was allowed a free hand in her study of methods for pectin and pectinase analysis with particular reference to the testing of processed juices for residual enzyme at low levels of activity.

Citrus Processing in Israel

Several general observations emerge from visits to these four plants and to a small, completely modern cannery at Nazarea, about 30 miles north of Haifa. This fifth plant had been designed by the FID for Milos Citrus Processors, a combine of kibbutz orchard units, the nearest thing in Israel to the Australian cooperative canneries. These were only five of the more than 30 plants which between them processed almost 500,000 tons of citrus last season, more than any other Mediterranean country exports.

The canneries in Israel are not, however, without problems. Many are old and require modernization of plant and premises. Replacement of the older extraction equipment with the latest FMC, Brown, and Indelicato machines is proceeding fairly rapidly since it must have high priority in what is obviously an organized step-wise modernization programme. On the other hand, the most advanced methods for juice concentration, commonplace in the U.S.A. and becoming accepted in Australia, are comparatively rare in Israel since most of the concentrators were installed more than 10 years ago; the juice processed is still mainly sold as single-strength canned juice and as hot-filled and sulphited concentrate in drums and large cans.

Canneries also face problems arising from the major raw material, the seedless Shamouti which constitutes about two-thirds of the oranges grown in Israel. Besides being susceptible to bitterness on processing, this variety is prone to limb sports and to over-large and misshapen fruit under unfavourable growing conditions. Such fruit is culled out before export and diverted to processing where it is subject to damage in the large storage bins and interferes with the free flow of fruit to the juice extractors.

Technical problems are accentuated by language difficulties faced by factory managers, since the majority of factory staff are Arabs with limited education, training, and comprehension of Hebrew or English. This situation is not likely to be improved by legislation for equal pay for Jews and Arabs since there is a great shortage of good unskilled workers in the country. These three factors (plant, raw material, and staff) inevitably give rise to problems in cannery efficiency and sanitation, and the high reputation of citrus products from Israel is greatly to the credit of the quality control laboratories.

Deficiencies in factory staff, however, are counterbalanced by efficiency in research and development, and processors are quick to adopt such new developments as comminuted juices and flavour concentrates. With highly trained research personnel, they are able to take full advantage of advances in the knowledge of citrus constituents and their effect on citrus quality, and on this depends Israel's outstanding success with comminuted juices. It is no accident that comminuted products have been perfected in this country. Whereas methods for increasing the *yield* of high-quality beverages from citrus fruits would arouse opposition from citrus growers elsewhere, in Israel any such opposition is stifled by the country's need to exploit fully its agricultural resources as a matter of survival, irrespective of the effects on any particular section of the community.

Citrus Marketing Board

Coordinating citrus activities in Israel is the Citrus Marketing Board which supervises all citrus sales, local and export, fresh and processed, and controls the quality of the products through the standards it enforces; details of the Board's quality criteria for fresh and processed products, and the methods for their determination, were not made available to me. The Board also operates promotional campaigns and extension services, organizes transport, arranges loans, and provides highly effective liaison (through an American-trained Ph.D.) between industry, universities, and government. The mechanisms of the Board's operation, particularly in respect to relations with growers and financing, have been discussed in more detail by Cary (1970), Turpin (1971*a*), and Dornan (1971).

In brief, the Board pays growers through a pool system whereby all income from sales throughout the year is distributed equitably to growers on the basis of weight of fruit supplied, with equal prices paid for each kind and size of fruit for export or processing, as defined by the Board. These basic prices operate regardless of fluctuating prices on different markets and at different periods, although premium prices, again on the pool system, are paid for high-grade fruit, for 'late-hung' fruit, and for other fruit requiring special efforts from the growers. This system seems to operate satisfactorily and certainly avoids direct disputes between growers, packers, and processors, but it would be easier to apply to Israel, a small country existing on a war-time economy, than to a large, free-enterprise country like Australia.

At the time of my visit an expansion of the Board's activities into research was under consideration, with an increased levy to provide a research fund. The suggestion had not received wholehearted support, since many processors believed themselves capable of handling any research they required, while the academics felt the scheme did not sufficiently guarantee continuity of support.

However, the Board's possible participation in research was only one small item for disagreement in the generally cooperative atmosphere in which the citrus industry has developed in Israel. It is this atmosphere, the coordination and promotion of the industry by the Citrus Marketing Board, and the activity of Israel's scientists and technologists which have established that country within three decades as one of the principal citrus areas of the world in terms of production, research, and technology.

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Unconventional Sources of Fish Protein

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This article is based on a paper delivered to the Twelfth Pacific Science Congress in a symposium on Protein Nutrition in the Pacific Area. The author has confined herself to aspects of the preservation of unconventional sources of fish protein in which she and her scientific contacts have had experience. The author draws attention to the utilization of waste products, the current emphasis on the products of advanced technology, and the lack of biochemical knowledge of traditional products, particularly those of South-east Asia.

The modern trend has been to get the greatest cash return from a resource rather than make the maximum use of it; this pattern will have to be reversed in the future. This statement is made in the current climate of awareness of the necessity for conservation and control of pollution.

Fish Viscera

In the seas around Britain, 50,000 tons of fish viscera are thrown overboard from trawlers each year (Olley, Ford, and Williams 1968) and it is estimated that 20,000 tons of fish viscera could be collected in Iceland from ungutted codfish in the first five months of the year (Arnesen and Einarsson 1967). Work in these two countries has shown that fish visceral meals are as good as commercial fish meals for feeding chicks, providing the raw material is fresh. The visceral meals have lysine and methionine contents comparable to conventional fish meals (Olley, Ford, and Williams 1968; Arnesen and Einarsson 1967; Kawada *et al.* 1955). This point was made earlier in Canadian work (Larsen and Hawkins 1961). However, the first two groups of workers emphasize that if the viscera have autolysed, i.e. undergone self-induced digestive change, which they do very rapidly, they have reduced nutritive value. The material of lower nutritive value autolyses to amino acids and small peptides which may be of less nutritional value than whole protein. Moreover, Simidu, Ikeda, and Kurokawa (1953) have shown that decarboxylation of histidine, i.e. removal of the acid group from the amino acid, occurs rapidly during spoilage of entrails of some fish. Thus histamine or other toxic imidazole compounds may be produced (Hughes 1959; Stewart 1958; Shifrine *et al.* 1959). Autolysed white fish viscera had a low net protein utilization (NPU) value, and were low in histidine, which is not usually considered a limiting amino acid in NPU tests (Olley, Ford, and Williams 1968). The NPU rat test measures the percentage of dietary nitrogen retained in the body and a shortage of one amino acid prevents others in the protein from being utilized for body protein synthesis. The meal was rich in lysine and methionine which are often limiting. Stale viscera handled by chemical or enzymic hydrolysis or fermentation can only be used as a fertilizer. The use of fish residues as fertilizers has been described (Anon. 1953*a,b*).

Unfortunately, fresh viscera are difficult to screw press in a fish meal plant unless mixed with quantities of more conventional fish meal material such as whole fish or filleters' offal, which includes heads and backbones. It is therefore desirable to find a method for processing which can be applied to fresh viscera without necessarily transporting the material to a central processing plant. The production of fish silage would seem to be advantageous if the product could be used by a community with both fishing and farming. The viscera could either be preserved with acid (Peterson 1953) (a pH of 2 is necessary with mineral acids and pH 4·5 with organic acids such as formic, lactic, and acetic) or fermented with an inoculum of *Lactobacillus* and a carbohydrate source (Roa 1965). These silages give normal growth in pigs and chicks when fed as sources of protein and are used in Finland (Wirahadikusumah 1969) where they were first developed.

Abalone viscera, which when mixed with 10% malted barley are self-fermenting, reach a pH of about 4·2 when held at 25°C for four days. Agriculture students at the University of Tasmania developed this process when given the problem of making a silage for a practical exercise by CSIRO officers (James and Olley, unpublished data). Fish viscera may not be self-ensiling when mixed with the same quantity of carbohydrate; trumpeter viscera, for example, when mixed with 10% malted barley showed little production of acid, and dangerous quantities of sulphuretted hydrogen were produced. Abalone viscera probably ensile more rapidly because they have a lower initial pH and contain seaweed residues and their concomitant bacteria, and seaweeds themselves have been found to be self-ensiling (Black 1955). Nilsson (1970) recommends addition of 18% cereal and 2% malt for ensilage of fish, slaughter-house, and kitchen waste.

Fish Sausage

An important use of fish protein in the Pacific area is in manufacturing fish sausages for the Japanese market. The production of sausage and ham has been described by James (1969). The fish used to prepare the products are classified according to their ability to form an elastic jelly (Okada 1962). Marlin and croaker have high jelly-forming properties, flounder and cod intermediate, while those of sardine and mackerel are poor. Shoaling pelagic fish such as sardine and mackerel are in greatest supply (Lovern 1966), but are the least suitable for fish sausage manufacture.

Japanese fish sausages contain nitrofurazone and sodium nitrite preservatives; the former is not permitted elsewhere. Nitrite may react with fish amines to produce nitrosamines, which are known to be toxic. In one case, mink were killed by ingesting dimethylnitrosamine contained in Norwegian fish meal. At the time of the mink deaths it was not realized that the compound was particularly toxic to mink or indeed that it was present in herring meal made from fish treated with nitrite. Despite this, the Great Britain House of Lords (1971) held the vendors of the product responsible for the mink deaths.

Fish Protein Concentrate

Fish protein concentrate (FPC) is the name that has been coined for dried fish, to be used as a food supplement to upgrade the value of the protein in human diets (Anon. 1968).

FPC production (Glicksman 1971) utilizes all parts of the fish; flesh, bones, and viscera are converted to a dry powder, while fat, water, and vitamins are extracted by solvent. Use of viscera was permitted by the Food and Drug Administration of the U.S.A. only after many years of costly argument. FPC production requires large plant, expert supervision, and high capital investment and does not lend itself to the developing Pacific area. Meade (1971) is of the opinion that 'the return to capital is far greater when the raw material is processed into fish meal and oil than would be the case for the production of fish protein concentrate'.

Although FPC has a high nutritive value, the dry FPC powder has no physical characteristics that improve the product to which it is added, so attempts are now being made to convert the protein to a soluble form, with some functional properties. The first attempts have been with alkali. Thus an expensive solvent extraction process is followed by an alkaline digestion of the dry powder (Tannenbaum, Ahern, and Bates 1970; Tannenbaum, Bates, and Brodfeld 1970). Yet, just after World War II gluts of herring were solubilized *directly* with alkali. In Britain there was a shortage of edible oil and also of fish reduction plants. The Herring Industry Board attempted to obtain herring oil for margarine by treating herring with dilute alkali. By the time the plant, situated at Wick in the far north-east of Scotland, was in production, it was realized that protein was as valuable as oil and attempts were made to recover the protein. This was done by neutralizing the protein to the isoelectric point with acid. That is the point at which the protein carries least electrical charge and is most insoluble. The precipitated protein held large quantities of water even after centrifuging and the costs of removing this would have been considerable. Moreover, it was soon found that the strength of the alkali and the temperature used in digesting the herring were extremely critical (Carpenter and Duckworth 1950; Lovern and Preston 1952; Carpenter *et al.* 1952). Heating herring with 3% alkali for 30 min at 90°C produced a product toxic to chicks; there was a 25% mortality when the product was fed as 10–15% of the diet (Carpenter and Duckworth 1950) and only 46% of the protein was precipitable at the isoelectric point (Lovern and Preston 1952). Heating FPC for 20 minutes with 0·5% alkali produces an effect which equally enables only 40% of the protein to be precipitated at the isoelectric point. The L-methionine content of the protein was reduced by 20% in both instances. The Scottish workers found that lower alkali strengths and lower temperatures improved the nutritional value of the product. Nottingham (1955) has discussed the relative importance of temperature and alkali strength on ammonia production and peptide bond splitting with model actomyosin systems. The nutritional value of alkali-solubilized FPC has not yet been assessed, but the even more recent development of enzyme digestion (Cheftel *et al.* 1971) may well produce a product of higher nutritive value than the alkali-solubilized product.

Smoking of Press-cake

The pelagic oily fish when processed for animal feeding are usually cooked and pressed to squeeze out the oil. The press-cake, which still contains much oil, is then dried. It is generally accepted that for human feeding the oil in the meal should be removed. Dr Edwardo Loayza-Salazar, while under the tenure of a UNICEF student fellowship in food science at Torry Research Station, theorized that if the press-cake from oily fish was smoked during drying, the polyunsaturated fats would be stabilized. Loayza-Salazar (unpublished data 1965) dried herring press-cake at 75°C in a Torry kiln in the presence of wood smoke for between 3 and 4 hr; 1·5 units of phenols, of which two-thirds were volatile, gave stabilization of the fats for 2–3 months. Once the protective period is over, oxidation of the fat takes place rapidly and 21 weeks after smoking 90% of the polyunsaturated acids was found to have been destroyed (Olley, Pirie, and Stephen 1966). Fish meal, if finely ground, can be incorporated into fish biscuits and experimental samples are of similar quality to Australian milk biscuits. However, they are savoury, as opposed to sweet, so some ethnic groups may object to the smoky-flavoured tangy biscuit. The calorific value and the polyunsaturated nature of the fat should be appreciated. Smoke, being an antioxidant, also protects the remaining vitamins but the shelf life of the biscuit is limited.

Fish Sauces and Fish Pastes

Each South-east Asian country has its typical fish paste or sauce, the local names of which have been listed by Amano (1961). These fermented products are described in some detail by Amano (1961) and van Veen (1953, 1965). Little is known of their nutritive value;* their amino acid composition has not been included in the new handbook, 'Amino Acid Content of Foods', compiled by FAO Nutrition Division (1970). Lafont (1955), however, has pointed out that *patis* (the Philippine product), *nuoc-man* of Vietnam, and *nam-pla* of Thailand should not just be considered as condiments. Those with 1% nitrogen could be considered little better than condiments, but some of these products have from 2 to 2·5% nitrogen and may be significant sources of food protein or its equivalent.

As the process for making fish sauce in some areas consists of little more than macerating the whole fish with 20–25% of its weight of salt, a whole year's production can be handled in a few days, if there happens to be a glut of fish. This is in contrast to the expensive plant and the skilled operators required for an advanced technological solvent extraction plant for producing fish flour (Ernst 1971). The high salt content of these Asian products might seem to be a disadvantage, but if the sauce constitutes one-tenth of the meal, the salt content of the food would only be reduced to an acceptable level of 2–2·5%. Amano (1961) states that 40 g of *nuoc-man* eaten daily by the Vietnamese provides 11 g of salt. The American daily intake of salt is from 7·5 to 18 g (National Research Council 1964). In Northern Honshu, Japan, 30–52 g are taken daily, but this high level is thought to lead to hypertension and cerebral haemorrhage (Denton 1967).

A high-protein product as one-tenth of the diet would make up the equivalent of 1·2% protein in the meal. If the minimal daily protein requirement for a 65-kg man is about 25 g of protein (Miller and Payne 1969), the 2500 g of food with fish sauce gives the minimum protein requirement, even if the rest of the food is protein-free. Tracey (1969) has pointed out that man requires a minimum of 400 g dry food a day and *a litre of water*. However, he eats wet food (80% water, 2000 g), so fish sauce eaten together with food supplying enough calories could constitute an adequate diet. van Veen and Steinkraus (1970) have shown that the protein efficiency ratios of fish pastes are unchanged by fermentation. These authors also mention that fish pastes and sauces in the Philippines have a reputation for causing occasional nightmares. The effect of carbohydrates, visceral enzymes, and bacteria on the beneficial flavour and aromas of these products is appreciated, but the underlying biochemistry and microbiology are almost unknown.

Histamine has been found in *nuoc-man* (Cousin and Noyer 1944), but should not be toxic when taken by mouth as it is altered by the intestinal bacteria, by the gastrointestinal wall, and also by the liver (Goth 1964). Ingestion of histamine does, however, lead to clinical symptoms almost identical with those of histamine shock (Shewan 1955), and it may

* While this paper was in press a new publication from Norway was received: Sorasuchart, T. (1972).—The nutritive value of Thai fish products. II. Amino acid composition. *FiskDir. Skr. Ser. Teknol.* **5**(9). The essential amino acid patterns were compared with that in teleost fish muscle. Most of the products showed fairly good essential amino acid patterns. Two products were very low in arginine.

be that some other basic substance produced during spoilage may release histamine from the histamine–heparin complex in mast cells (Riley 1959), thus producing localized symptoms. Scandinavian workers traced the heparin of the body to these cells, particularly numerous in connective tissue, which were named *Mastzellen* by Paul Ehrlich in 1877. Schmidtsdorff (1970) points out that histamine, due to its ready formation, can be used as a tracer for other poisonous amines such as saurine; however, quite ordinary amines could cause histamine release. Riley (1958) has shown that ethanolamine, a simple hydrolysis product of natural phospholipids, brings about a rapid swelling, vacuolation, and even disruption of mast cells.

Utilization of Products

This article, because of the venue of the original talk, has been slanted towards the developed and developing areas of the Pacific. The products which could be made or are produced for human feeding ranged from sterile powders produced by solvent extraction and drying of fish, through products conserved with chemical preservatives or smoke, to liquid products preserved by salt and fermentation. The former products are unattractive and tasteless; the fish sausages and hams based on chemical preservatives are more like natural food and have had tremendous popularity in Japan. The sauces and pastes add piquant flavours to the diets of South-east Asia.

The products suitable for animal feeding which have been described are liquid and would need to be either dried or utilized where distances were short or transport cheap.

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Cool Storage of Apples and Pears

Directions for Practical Scald Control

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There are now several methods available for the control of superficial scald of apples and Packhams and Anjou pears in cool storage. As stronger treatments are needed for the more susceptible fruits, it is important to understand the factors that affect susceptibility to the disorder.

Factors affecting Scald

Variety

Granny Smith is the most susceptible apple variety, Delicious and Rome Beauty are moderately susceptible unless well matured, and immature Delicious may be very susceptible in controlled-atmosphere storage and require strong treatment. Jonathan, Democrat, Golden Delicious, and other varieties may develop scald under conditions strongly favouring the disorder.

Maturity

The less mature the fruit is at picking, the more it will scald. There is usually a critical date after which scald susceptibility falls sharply. In the main areas this is usually about 25 April for Granny Smith apples. Delicious, picked when the ground colour is definitely greenish, especially when there is little blush, will often scald severely.

Delay before Storage

The effects of a short period of shed storage before cool storage have been inconsistent and therefore delaying the storage of Granny Smith apples or other varieties is not recommended.

Climate and Weather

Fruit grown in warm, dry (inland) climates is much more susceptible than fruit grown in cool, moist climates. Similarly, scald liability is increased by warm, dry weather during the last few weeks before harvest especially if it follows cooler, wetter weather in early summer.

Storage Temperature

Scald develops at temperatures up to about 40°F and develops earlier, but less severely, the higher the storage temperature within the range 30–40°F. Scald can be reduced by storage at 40°F for the first 4–6 weeks and then dropping the temperature to 30–32°F, compared with storing at 30–32°F from the first.

Ventilation

Scald is increased by poor ventilation and is therefore commonly increased by storage in perforated or folded polyethylene bags and by C.A. storage. It is worse in inner fruit in the box than in outer fruit, and is reduced by periodic ventilation with outside air and by removing the fruit for a day or two, allowing it to warm up, and then returning it to the cool store.

C.A. Storage

Scald is decreased by increasing the carbon dioxide content and by reducing the oxygen content of the atmosphere. However, because of restricted ventilation, C.A. storage or storage in sealed polyethylene bags commonly increases scald. Therefore, all apples and Packhams and Anjou pears going into C.A. storage should be treated against scald.

Length of Storage

Scald increases with time in storage and fruit destined for long storage requires stronger treatment.

Humidity

Scald tends to be worse in atmospheres of high relative humidities with low weight loss than in those of lower relative humidities where weight loss is greater. This is an important factor in polythene bag or C.A. storage.

Bruises and Other Injuries

Scald is induced by bruises and other skin injuries and such scald is not prevented by oiled wraps or treatment with chemicals.

Sun Scald

Sunburned or sun-bleached areas on the skin will become dark brown to black in storage, especially on Granny Smith apples. Neither oiled wraps nor chemicals will control sun scald and sun-damaged fruit should not be used for long storage.

Treatments

All treatments must be applied before storage or, as a second best, early in storage, but not later than 4 weeks after picking for Granny Smith apples and probably not later than 2 weeks for other varieties of apples and pears.

Oiled Wraps

The effectiveness of oiled wraps depends on the actual amount of oil held in the paper around each apple. Oiled wraps should comply with Australian Standard Specification N29—1959, which specifies an oil content of not less than 3·1 g/m² of paper (200 mg/100 in²). Ordinary mineral oil wraps should not be used on Sturmer apples, as the oil damages the skin of this variety. Oiled wraps may be used on fruit treated with chemicals.

Use of Chemicals

Chemical treatment is more effective than the use of oiled wraps and scald can be completely controlled, even in highly susceptible fruit, by treating it with either of the chemicals diphenylamine (DPA) or ethoxyquin as follows:

- Spraying the fruit on the trees within 48 hr of harvest
- Dipping after harvest
- Flood spraying after harvest
- Wrapping the fruit in treated wraps
- Packing in cell-packs or tray-packs in which the cells or trays have been impregnated with the chemical
- Wiping on over brushes
- Incorporation in a wax emulsion skin coating

Comparison of Diphenylamine and Ethoxyquin

Diphenylamine is more effective than ethoxyquin against apple scald so that in dips or sprays twice as much ethoxyquin is needed, about three times as much in wraps, and much more in cells and trays. Ethoxyquin is the more effective on pears. Diphenylamine tends to keep the fruit greener whereas ethoxyquin tends to hasten yellowing of the skin. The amounts of active material required are listed in Table 1.

Table 1

Method of application	Diphenylamine	Ethoxyquin
Tree spray	0·3–0·4%	
Dip or spray after harvest	0·1–0·25%	0·2–0·5%
Wraps, plain	31 mg/m²	76 mg/m²
Wraps, oiled	23 mg/m²	54–62 mg/m²
In tray-packs	300 mg per tray	1·5 g per tray
In cell-packs	50–80 mg/kg in cell dividers and layer pads	4 g per carton (20 kg fruit)

Permitted Use

In Australia.—Both diphenylamine and ethoxyquin are permitted on apples and pears.

Export (as at November 1971).—Diphenylamine is permitted on apples and pears in Sweden, Denmark, Hong Kong, Iran, and New Zealand; permitted on apples only in Canada and the U.S.A. Ethoxyquin is permitted on apples and pears in Canada, Denmark, Eire, Hong Kong, Iran, New Zealand, Philippines, Singapore, Sweden, Britain, and U.S.A.

Export of treated fruit to other countries is not permitted by the Department of Primary Industry unless the exporter produces documentary evidence that the importing country will accept fruit so treated.

Accepted residue tolerances.—Diphenylamine up to 7 p.p.m. and ethoxyquin up to 3 p.p.m. at the time of sale. When used as recommended, residues would normally be well within these limits.

Availability

Diphenylamine is available as a liquid miscible oil or wettable powder concentrate, e.g. Scal-dip, for making up dips or sprays with water, and as oiled DPA wraps containing 23 mg diphenylamine per sq m.

The liquid formulation is normally to be preferred to the wettable powder, since although more inclined to foam, it is more effective.

Ethoxyquin is available as a liquid miscible oil concentrate, e.g. Stopscald.

Diphenylamine Dip or Spray

Tree Spray

A thorough drenching spray is required to wet every fruit completely. Tree spraying is ineffective if picking is delayed more than two days after spraying. Use at a strength of 0·3–0·4% (3000–4000 p.p.m.). Do not spray when fruit temperatures exceed about 27°C. Spraying fruit on the tree is considerably more expensive of material than treatment after harvest.

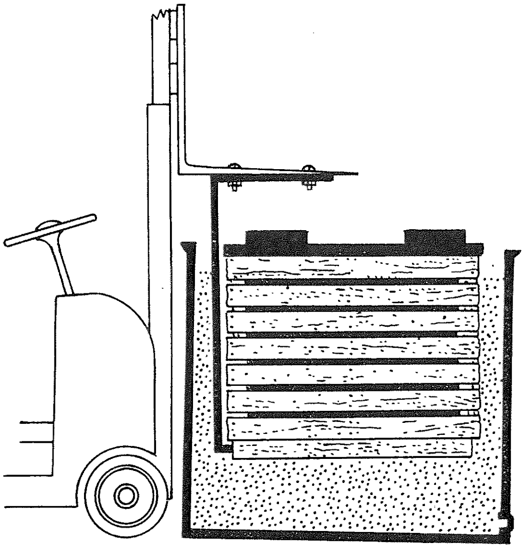

Fig. 1.—Method of dipping bins of apples in anti-scald solution. Instead of the modified fork shown, the attachment can be picked up by the standard fork through top box sections into which the standard fork blades can be placed.

Post-harvest Dip

Equipment.—The dipping tank may be made of galvanized iron or of black iron protected with a suitable paint (e.g. a cold-curing epoxy coating); bare iron should not be used. It may also be made of smoothly finished (steel floated) concrete or of plastic. If dipping in bins a hoist or a modified fork lift (Fig. 1) is needed; if dipping in boxes by hand, waterproof gloves must be worn. Some means of running drainings back into the tank is needed. As apples float in water, a weighted cover must be placed over the bin or box during dipping to ensure that every fruit is fully immersed.

Timing.—Fruit should be treated as soon as possible after harvest. If it must first go into cool storage it should preferably not be held in the cool store for more than 14 days before treatment. Longer delays will reduce the effectiveness of the treatment.

Dipping period.—Normally the fruit should remain in the dip for *5 seconds only.* It should then be drained thoroughly and the drainings returned to the dip tank. It is good practice to tilt the bins once or twice after initial draining to reduce the risk of excess diphenylamine remaining in fruit cavities or at points of contact and consequent possible diphenylamine injury (dark spots or greyish discoloration of the skin). The fruit should be placed in the cool store on the same day while it is still damp. Putting the fruit in store while wet hastens cooling and reduces weight loss. If dipped fruit is left out in the store overnight or left in the sun diphenylamine burn may result.

Fruit temperature.—Fruit should not be dipped (or sprayed) when its temperature is above 27°C as excessive amounts of diphenylamine may be taken up causing injury and/or excess residues. Fruit taken from cool store for dipping should be allowed to warm up to 10°C before it is treated. If fruit at a lower temperature must be dipped the time in the dip should be increased to 10 or even 15 seconds.

Concentration of dip.—Granny Smith apples: ordinary storage 0·15% (1500 p.p.m.), C.A. storage or polyethylene bag storage 0·2% (2000 p.p.m.). *Other varieties:* ordinary storage 0·1% (1000 p.p.m.), C.A. storage 0·15% (1500 p.p.m.). *Packham's pears:* 0·15% (1500 p.p.m.). Stir the solution well before use. For highly susceptible fruit, e.g. Granny Smith apples in Western Australia and Queensland, the concentrations may need to be further increased, with an absolute maximum of 0·25% (2500 p.p.m.), *or* the dip times could be doubled. Early picked, poorly coloured Delicious going into C.A. may need 2000 p.p.m. However, all other factors, especially maturity, should be taken into consideration and it is better to pick the fruit a little later than to increase the concentration beyond 2000 p.p.m. for Granny Smith apples and 1500 p.p.m. for other varieties.

Wetting.—The fruit must be completely wetted; if tests indicate blotchy wetting add *small* amounts of the recommended wetting agent (Agral 60 for Scal-dip) until wetting is complete. Too much wetting agent will cause increased run-off from the fruit and possibly too little uptake of the chemical.

Topping up.—Maintain the level of solution in the dip tank, required for easy total immersion of the fruit, by topping up with normal solution (fully diluted concentrate).

Renewing the dip.—It is recommended that the old solution be discarded and replaced with fresh solution after treating no more than 80,000 kg of fruit. However, the same solution should not be used continuously for more than 3–4 days. With intermittent use the solution could be effective for longer periods but it is generally then advisable to replace it with fresh solution after treating about 60,000 kg. The solution should always be discarded and replaced with fresh whenever it becomes dirty, settles out, separates, or shows a distinct colour change.

Spray after Harvest

A high-volume (at least 11 l per 20 kg of fruit in 3–4 sec), low-pressure, drenching shower spray that completely wets every fruit is fully effective. The fruit may be sprayed in bins or boxes or in any other practicable way, observing all the precautions outlined above. The solution is pumped from a relatively small reservoir to the spray (which may be just a large flooded pan with many small holes in it) so that a large volume of solution is not required. A disadvantage is that the solution may froth excessively, especially if there is appreciable pressure in the sprays or too much wetting agent. An anti-foaming agent, such as Antifoam D (0·5 kg/1000 l), 'No bloat' oil, or 2–3% of calcium chloride, may be added.

Table 2

Concentrations of Scal-dip and Stopscald of Equal Effectiveness as Dip or Spray

Scal-dip (diphenylamine)					Stopscald (ethoxyquin)				
%	p.p.m.	Litres of concentrate (25% w/v) to be diluted to 1000 l	Quantity of concentrate (25% w/v) to be diluted to 100 gal Pints	Fl. oz	%	p.p.m.	Litres of concentrate (72% w/v) to be diluted to 1000 l	Quantity of concentrate (72% w/v) to be diluted to 100 gal Pints	Fl. oz
0·05	500	2	1⅗	32	0·09	900	1·25	1	20
0·1	1000	4	3⅕	64	0·18	1800	2·5	2	40
0·15	1500	6	4⅘	96	0·27	2700	3·75	3	60
0·2	2000	8	6⅖	128	0·36	3600	5·0	4	80
0·25	2500	10	8	160	0·45	4500	6·25	5	100

Ethoxyquin Dip or Spray

Use at a concentration of 0·2–0·3% (2000–3000 p.p.m.) following the general directions outlined for Scal-dip. Dip temperature is more important with ethoxyquin than with diphenylamine, therefore when the dip temperature is less than 10°C immerse the fruit for 1 min, if 10–16°C immerse the fruit for 30 sec, if 16–21°C immerse the fruit for 10 sec, and if over 21°C for 5 sec. Do not dip or spray when the temperature of the fruit is more than 27°C or less than 10°C.

Additives

Fungicides

When the same solution is used for treating a large quantity of fruit a build-up of fungal spores in the solution may increase rotting. If fruit rots or late black spot are a problem in storage add 0·05–0·1% (500–1000 p.p.m.) of thiabendazole (TBZ), e.g. as Tecto wettable powder, or 250–500 p.p.m. of benomyl, e.g. as Benlate wettable powder, to the dip and agitate thoroughly each time before use as these fungicides tend to settle out. Benomyl is *not permitted* on export fruit. Either captan at 750 g/1000 l or Dithane M45 at 1·5 kg/1000 l may be used but are less effective than the above.

Calcium

Adding 2–3% (20–30 kg/1000 l) of calcium chloride to the dip or spray will reduce bitter pit and reduce foaming. However, the liquid Scal-dip formulation of diphenylamine, calcium, and captan are incompatible and must not be used together though both calcium and captan can safely be added together to wettable powder diphenylamine.

DPA Wraps

DPA wraps should contain 23 mg of diphenylamine per 100 m^2 of wrap and are used like oiled wraps. Do not use on fruit previously treated by dipping or spraying as this would probably damage the fruit and produce excess residues. DPA wraps have proved very satisfactory and are ideal for packed fruit going into C.A. storage as the diphenylamine is available to the skin of the fruit over a long period. They must *not* be confused with diphenyl wraps which are for citrus only and which will taint and injure apples or pears.

DPA in Wax

A wax emulsion (Prima Fresh 32) containing diphenylamine is available and may be applied to fruit by dipping or spraying, in the same way as oranges are waxed, before storage. The wax reduces shrivelling and improves the appearance of the fruit and has given good results in both ordinary and C.A. storage.

General Recommendations for Dipping and Spraying

- Handle fruit carefully, treatment will not stop scald developing on bruises.
- Sort out sunburned and sun-bleached fruit, treatment will not prevent affected areas blackening in storage; diphenylamine may enhance this discoloration.
- Do not use stronger solutions than those recommended. Do not double up on treatments, i.e. do not dip or spray after harvest fruit which has been sprayed on the tree, or wrap in DPA wraps or pack in treated cell-packs or tray-packs fruit which has been dipped or sprayed with DPA or ethoxyquin. Otherwise the fruit may be damaged and the permissible residue levels may be exceeded.
- Do not leave dipped fruit in the sun.
- Avoid breathing spray mist. Avoid prolonged or repeated contact with the skin. Do not take internally. Wash after handling.
- Do not use DPA in any form on Sturmer apples (it causes black spots and grey scald on this variety) and use lower concentrations only, or ethoxyquin, on Golden Delicious.
- Do not put freshly dipped fruit into polyethylene bags before it has dried in the cool store.
- Use DPA on Granny Smith apples going into C.A. storage or polyethylene bags to ensure full scald control until the end of the year; oiled wraps are not good enough.
- READ THE INSTRUCTIONS ON THE LABEL AND FOLLOW DIRECTIONS EXACTLY.
- If in any doubt consult your local Department of Agriculture adviser. Always consult him before treating fruit for export.

Application by Brushing

DPA or ethoxyquin may be applied to apples or pears by a 'wipe-on' device developed by Martin and Miezitis* of the CSIRO Tasmanian Regional Laboratory, Hobart.

In most packing sheds the fruit is passed over transverse, rotating, cylindrical brushes before sorting and grading. This brushing removes dust and to some extent polishes the fruit. This presents the possibility of applying a material towards the end of the brushing, to be spread over the fruit by the final polishing by the last few brushes. The device described below does this and is simply

*CSIRO Div. Plant Ind. Fld Stn Rec. 3(1), 77–80 (1964).

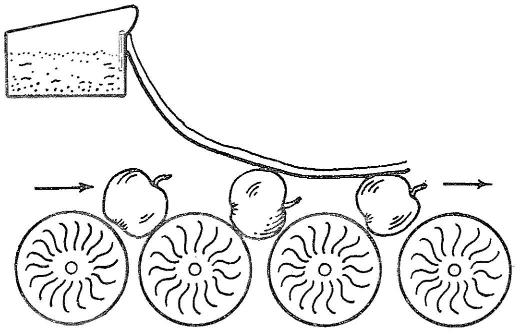

Fig. 2.—Apparatus for applying diphenylamine or ethoxyquin to apples or pears by brushing.

constructed and uses relatively small quantities of inexpensive solvent.

Equipment

The device (Fig. 2) consists of a narrow trough 10 cm × 5 cm in section and mounted 15 cm above and parallel to the fifth brush from the discharge end of the set of brushes. To this trough a piece of 9·5-mm-thick industrial wool felt 46 cm long and as wide as the length of the trough is fastened so that one end extends to the bottom of the trough and the other falls over the fruit as it passes below the trough over the brushes. The liquid in the trough is kept at constant level from a reservoir by means of a controller made from the float chamber of an old carburettor. The liquid soaks into the felt and is transferred to the fruit as it passes beneath the trailing edge of the felt which is slit into 2·5-cm strips to give a better distribution of liquid onto the fruit.

Evaporation from the upper surface of the felt is reduced by a loose cover of heavy polyethylene sheet fixed over the top of the felt and the same size as it. Evaporation from the trough is reduced by a hinged lid.

When the fruit passed over the brushes at the rate of 40 kg per min the liquid applied was used at the rate of 40 ml per 20 kg or approximately 0·3 ml per fruit.

A suitable mixture for applying diphenylamine was found to be 0·25% diphenylamine, 0·1% vegetable oil (castor or peanut), in 80% commercial ethyl alcohol (80% alcohol was equally satisfactory for Stopscald).

Tests indicate that this method is at least as good as 1·75-mg DPA wraps and would give a satisfactory control of scald under normal storage conditions.

Readership Survey

As well as the Supplement on Storage and Market Diseases of Fruit, this issue carries a survey questionnaire. Readers are urged to complete this and return it as soon as possible.

News from the Division

FRL, Food Research Laboratory; MRL, Meat Research Laboratory;
DRL, Dairy Research Laboratory; PPU, Plant Physiology Unit

New Appointments

Mr S. J. Thrower joined the Division's staff located at the Tasmanian Regional Laboratory in Hobart as an Experimental Officer late in December 1971. He graduated B.Sc. from the University of Sydney in 1967 and is currently completing the requirements for the M.Sc. degree. Mr Thrower will be working on problems of processing and preservation of fish, arthropods, and molluscs.

Dr J. M. O'Shea was appointed Experimental Officer at MRL, to participate in a programme seeking to improve the manufacturing properties of meat. After graduating B.Sc. from the University of Adelaide in 1961, Dr O'Shea was awarded an M.Sc. in Chemical Engineering by the University of New South Wales in 1967, and a doctorate by the Australian National University in 1971.

Retirement

Dr Thelma Reynolds.

Dr T. M. Reynolds recently retired from the Division after 30 years' service. After a brilliant career at the University of Sydney Thelma Reynolds was awarded an 1851 Exhibition Fellowship and proceeded to Oxford University where she graduated as Doctor of Philosophy in Organic Chemistry. On her return to Australia she joined the Division of Forest Products of CSIR, but in 1941 transferred to the Division of Food Preservation because she wished to contribute more directly to the war effort.

Dr Reynolds was placed in charge of the Division's programme on dehydrated foods, and entered enthusiastically into laboratory and field investigations associated with the setting up of a number of vegetable dehydrators in Australia under wartime conditions. After the war Dr Reynolds returned to basic chemical studies on non-enzymic browning, a reaction that had repeatedly come to her notice as a cause of quality deterioration in dehydrated foods. She and the group under her leadership established a world reputation for their contributions to knowledge of the mechanisms of non-enzymic browning. More recently Dr Reynolds assumed responsibility for investigations on honey undertaken at the request of the Australian Honey Board and out of this work has come information on the chemical composition of Australian honeys which should assist greatly in export marketing.

Dr Reynolds represented scientific staff in discussions with the architects during design of the laboratories at Ryde, and was largely responsible for planning the landscaping and tree planting in the grounds.

Visiting Workers

Professor H. S. Olcott of the Institute of Marine Resources, University of California, Davis, recently spent three months at the Tasmanian Regional Laboratory, investigating the bluing discoloration of abalone with Dr June Olley.

Dr F. Parrish of the U.S. Army Natick Laboratories is in Australia on a Secretary of the Army Fellowship. For the past six months he has been working on the interactions of metal ions with carbohydrates, at the University of New South Wales with Professor S. Angyal. Dr Parrish will spend the next six months as guest worker in the Food Microbiology Section at FRL.

General

Mr L. E. Brownlie, leader of the Industry Section at MRL, has resigned from CSIRO to become Assistant Director of Technical Services (Meat) with the Australian Meat Board. The appointment became effective in mid March.

The University of Queensland has awarded the Ph.D. degree to Mr K. G. Newton of MRL for his thesis, 'Studies on a group of actinomycetes'.

Mr R. W. Sleigh received an M.Sc. from the University of New South Wales for his thesis, 'An immunochemical and structural investigation of some egg white proteins'.

Selected Publications of the Division

From the Dairy Research Laboratory

Copies of these papers are available from the Librarian, CSIRO Division of Food Research, Dairy Research Laboratory, Box 20, P.O., Highett, Vic. 3190 (Telephone 95 0333).

LAWRENCE, A. J. (1971).—Some recent Australian patent applications (for dairy products and processes: a list). *Aust. J. Dairy Technol.* **26**(2), 66–8.

WILMHURST, J. K.,* and HORWOOD, J. F. (1971).—Vibrational spectrum and molecular structure of methyl pyruvate. *Aust. J. Chem.* **24**(6), 1183–91.

From the Food Research Laboratory and the Tasmanian Regional Laboratory

Copies of most of these papers are available from the Librarian, CSIRO Division of Food Research, Food Research Laboratory, Box 52, P.O., North Ryde, N.S.W. 2113 (Telephone 888 1333).

BAIN, JOAN M., and GOVE, D. W. (1971).—Rapid preparation of plant tissues for electron microscopy. *J. Microscopy* **93**, 159–62.

BEATTIE, B. B.,* HALL, E. G., COOTE, G. G.,* and BAXTER, R. I. (1971).—Effects of temperature and time in cool storage on the ripening and storage life of pears. *Aust. J. exp. Agric. Anim. Husb.* **11**, 576–81.

JAMES, D. G., and OLLEY, JUNE (1971).—Studies on the processing of abalone. II. The maturometer as a guide to canned abalone texture. III. The effect of processing variables on abalone texture with special reference to brining. *Fd Technol. Aust.* **23**, 394–8, 444–9.

MCGLASSON, W. B., and LEE, T. H.* (1971).—Damage and repair of protein in gamma irradiated tomato fruit. *Radiat. Bot.* **11**, 239–41.

MARSHALL, BETTY J., OHYE, D. F., and CHRISTIAN, J. H. B. (1971).—Tolerance of bacteria to high concentrations of NaCl and glycerol in the growth medium. *Appl. Microbiol.* **21**, 363–4.

MURRAY, K. E., SHIPTON, J., ROBERTSON, A. V.,* and SMYTH, M. P.* (1971).—The introduction of minute amounts of volatile components trapped from a gas chromatograph into a high resolution mass spectrometer. *Chemy Ind.* **1971**, 401–2.

SCOTT, K. J., BLAKE, J. R.,* STRACHAN, G.,* TUGWELL, B. L.,* and MCGLASSON, W. B. (1971).—Transport of bananas at ambient temperatures using polyethylene bags. *Trop. Agric. Trin.* **48**, 245–54.

STANLEY, G., and MURRAY, K. E. (1971).—A technique for the hydrogenation or hydrogenolysis of sub-microgram amounts of material collected from a gas chromatograph. *J. Chromat.* **60**, 345–50.

SZULMAYER, W. (1971).—From sun-drying to solar dehydration. I. Methods and equipment. II. Solar drying in Australia. *Fd Technol. Aust.* **23**, 440–3, 494–501.

TRACEY, M. V. (1971).—Unity and diversity in biochemistry. *Search* **2**, 357–62.

VENDRELL, M., and MCGLASSON, W. B. (1971).—Inhibition of ethylene production in banana fruit tissue by ethylene treatment. *Aust. J. biol. Sci.* **24**, 885–95.

VICKERY, J. R. (1971).—Possible developments in the supply and utilization of food in the next 50 years. *Fd Technol.* **25**, 619–24.

From the Meat Research Laboratory

Copies of these papers are available from the Librarian, CSIRO Division of Food Research, Meat Research Laboratory, Box 12, P.O., Cannon Hill, Qld. 4170 (Telephone 95 2122).

ROWE, R. W. D., and MORTON, D. J. (1971).—Faults in the square lattice of mammalian skeletal muscle Z-disks. *J. Cell Sci.* **9**, 139–45.

ROWE, R. W. D., MORTON, D. J., and WEIDEMANN, J. F. (1971).—Irregular Z bands occurring in rat soleus muscles. *J. Ultrastruct. Res.* **36**, 205–10.

THOMAS, P. L. (1971).—Chilled beef to Britain. *Aust. Refrig. Air Condit. Heat.* **25**(8), 44–5.

* Not an officer of the Division.

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