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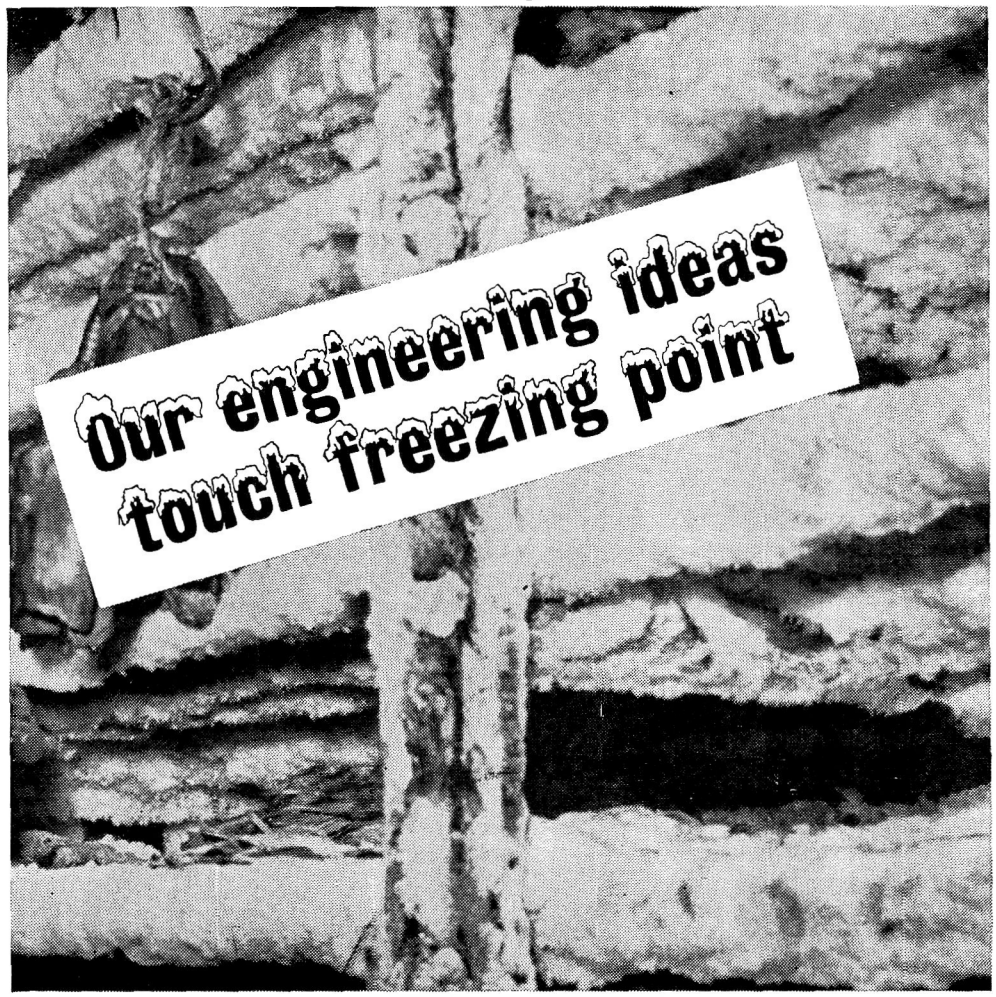

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EDITOR'S NOTE

Consumer and Food Technology

The other day a visitor from U.K. remarked in a press conference that food adulteration is very uncommon in England. The proceedings of the cases which frequently appear in the U.K. food journals also bear this out and emphasize that wilful food adulteration does not pay. Unfortunately in India this is scarcely the situation. Food adulteration is widespread and spurious branding is practiced by many manufacturers and traders.

There can be no doubt that the government is well aware of this problem and many attempts are being made to prevent food adulteration. But this is a matter in which government alone can do very little. To institute analytical laboratories with enough facilities all over the country is a stupendous task involving large expenditure. Food inspectors could sample only a fraction of the foods from the market. Often the lack of specific standards is taken advantage of by the dealers to evade conviction.

It was recently reported that, out of 34,640 food samples analysed in Uttar Pradesh, a quarter were found to be adulterated. The extent of adulteration in food articles has increased from 16.9 per cent in 1965 to 51.3 per cent this year. As a preventive measure the union government is intending to provide analytical laboratories for food manufacturers. The Prevention of Food Adulteration Act has not proved very effective because of the lack of such facilities and the inspection staff is handicapped in bringing the offenders to book.

Adulteration harms the individual purchaser by giving him short weight of the genuine material for which he pays; not only that, it places the food technologists in a very adverse position. Where adulterated material is available at a lower price, the purchaser thinks twice before paying for the genuine material. The food manufacturer who is bound by scruples, finds the market unfavourable to him. No better example could be found for this than the dairy industry. It is well known that the progress of the industry has, to a great extent, been hampered by the private milk vendor who sells low quality milk at a cheaper rate. The dairy is often not even in a position to fix rigorous standards for incoming milk because the private dealer will resist this, often in an organised way.

An equally unfortunate situation is the competition between manufacturers, often resulting in spurious claims and spurious products. To take an example, again from the dairy field, is the emergence of baby foods, many of them substandard during the time when there was shortage. Beverage foods are another example to emphasize the point.

What is the function of the food technologist in preventing this? Could they form themselves into groups and bring to the notice of the authorities when spurious products come on the market? The ethical aspects of such a move have to be carefully considered. The feeling of guilt of spying on other manufacturers should be weighed against the service which they will be doing to the industry as such, and to the helpless public.

Need the public be so helpless either? In other countries, consumer organisations are formed in each town which generally crusade on behalf of the public to see that substandard products are discouraged. If the consumers, helped by government organizations, form themselves into units which could bring moral pressure on manufacturers to see that their products pass minimum tests of purity and genuineness before they come on the market, it will overcome this canker to a very great extent. If such units are formed, it should not be difficult for them to obtain certificates of purity from research laboratories. The public could be educated to look for the mark of genuineness before they purchase any article.

The Indian Standards Institution is attempting to bring about this public awareness of the quality of the products. But even then, a necessity for obtaining the standard mark by all food manufacturers has not become compulsory and till this is done, the public will not be in a position to judge the genuineness or otherwise of a food product. The magnitude of the waste of money of the public in purchasing products which do not satisfy minimum standards can only be imagined. The need for a concerted move by the food technologists, consumers and the government to overcome this widely practised evil is imperative.

"Packaging India" Journal of the Indian Institute of Packaging

It is gratifying to note that the Indian Institute of Packaging has initiated a quarterly Journal "Packaging India". The Chairman of the Institute in his foreword has said "The Institute of Packaging has, in its short existence, already done valuable work in the dissemination of information to members of the packaging industry. This is the first attempt of the Institute to broadcast such information on a wide basis, through the medium of a quarterly organ. Through this Journal the Institute will endeavour to keep readers informed about the latest developments in packaging technology in India and the world at large." Considering the importance of packaging in many fields the publication of this Journal is welcome. The food industry in India has faced the problem of packaging for quite some time; tin is costly and involves foreign exchange. Many foods that are now being packaged in tin containers could conveniently be packed in paper boxes or in synthetic films. It is our hope that the Institute of Packaging by its endeavours will bring about a revolution in packaging techniques in India and place many of the foods in cheaper packs.

REVIEW

Factors Affecting the Quality of Fresh Fish and its Retention by Chilling

R. Balakrishnan Nair and N. L. Lahiry

Central Food Technological Research Institute, Mysore

Introduction

The major portion of the total fish eaten in the world continues to be used in fresh state, despite slight increase in freezing and processing, noticed in recent years. In 1965, almost a third of the total fish landings was marketed fresh[1]. The fresh fish trade is sustained in countries like Britain largely due to consumer preference and a streamlined distribution system. But in less developed areas, due to lack of adequate refrigeration and transportation facilities, most of the seasonal landings is sold in the local markets and the rest is cured or dried by traditional methods. In India where production falls far short of demand, curing and drying methods are resorted to, not out of choice, as evidenced by the fact that with slight increase in icing and transportation facilities, there has been an increase from 43 per cent in 1958 to 68 per cent in 1965 in fresh fish utilization. This increase took place at the expense of cured and dried fish, which registered a decline from 50 per cent to 26 per cent during the same period.

For marketing the fish in fresh state, it is necessary to retain the flavour, texture, odour and appearance. In fish intended for frozen storage or processing, even latent changes, either biochemical or bacterial, should be prevented in order to retain the quality even at a later stage. Temperature, as in other perishable foodstuffs, is by far the largest single factor determining the course and extent of spoilage of fish. Some of the basic factors responsible for fish spoilage and how temperature variations influence them,will be discussed here.

Spoilage of Fish

The complex process of fish spoilage is governed by a number of factors like species differences, catching methods, fishing grounds and seasons and nature and load of bacterial contamination. The deteriorative changes in fish after death, however, generally follow three courses viz. (*i*) chemical (e.g., lipid oxidation), (*ii*) autolytic and (*iii*) bacterial[2]. The existing evidence indicates that bacterial spoilage is the one that produces more undesirable alterations in the flavour, odour and appearance of fish; in fatty fishes, however, under certain conditions oxidative rancidity may precede bacterial deterioration.

Types of fish and fishery: Marine fishes fall into two main groups, i.e., demersal and pelagic. The former (e.g., cod, dog fish, skates, etc.) usually non-fatty, are generally caught by trawl net or line, from or near the sea bottom. They are often gutted, washed and iced at sea. The pelagic fishes (e.g. herring), usually fatty, are caught near the shore and are marketed without gutting. Considerable differences in the courses of spoilage between these two types of fish have been reported[3, 4]. In the pelagic fishes which generally have red muscle and vigorous metabolic activity, autolysis proceeds more rapidly than in the demersal fish[5]. However the differences are more predominant in the alterations in the non-protein fractions of the muscle. The onset of *rigor mortis* also may vary with species[6-8]. Bramsnaes[9] has summarised the storage life of different species of North Atlantic fish, stowed in hold with ice; it ranged from 9 days for whiting to 21 days for halibut. Presence of certain body components (e.g. urea in elasmobranchs) can also characterize the nature of spoilage in some species.

It is suggested that the storage life of fish is likely to alter during different seasons[9-11]. Biological factors like spawning or seasonal fluctuations in temperature may be responsible for this phenomenon. Environmental conditions such as the type of bacterial flora are held responsible for changes in the keeping qualities of fish caught from different fishing grounds[12-14].

Fishing methods are likely to exert some influence on the course of spoilage. It is well known that the *post mortem* biochemical changes in fish muscle are related to the reserve muscle glycogen at the time of death. The latter is related to the degree of exhaustion or the amount of struggle prior to death. This

relationship is well established in the case of mammals. Parallel data in the case of fish are, however, scarce. But it has been observed that *rigor mortis* sets in and disappears earlier in trawler caught fish than in hand-line caught fish[15, 16], suggesting a similar mechanism. Again, Jones *et al.*[17] have shown the relationship between the time required to reach rigor in cod and the time of exercise. Initially, it decreased rapidly and then levelled out as the fish became increasingly exhausted.

The bacterial flora of freshly caught fish and sources of contamination: Since bacterial growth predominates all other causes of deterioration in fish, this is the most extensively studied aspect. Exhaustive reviews are available on the subject[18, 19]. Although the flesh and body fluids of newly caught fish are considered to be sterile, it is known that the slime, gills, and the intestines carry heavy bacterial load (10^2 to 10^5 per cm^2 of skin or the gill; and 10^3 to 10^5 per ml of intestinal fluid). A general similarity is supposed to be present between the bacterial flora responsible for the spoilage of fish and that existing in its marine surroundings[20]. Species of *Achromobacter*, *Pseudomonas*, *Flavobacterium*, and *Micrococcus* are usually predominant and *Sarcina*, *Proteus* and *Bacillus* are found to a lesser extent. At first there is commonly a predominance of *Micrococcus* and *Flavobacterium* which, as spoilage progresses, are over grown by *Pseudomonas* or *Achromobacter* species. A large proportion of bacteria responsible for fish spoilage are members of the genera *Corynebacterium* and *Mycoplana*[20-25].

The variations that occur quantitatively and qualitatively on the bacterial flora on fish are caused by: (*i*) temperature variations due to seasonal and geographical factors, (*ii*) fishing methods, (*iii*) and handling of fish either on board the vessel or on shore.

Peak bacterial loads in sea are said to coincide with maximum water temperature[24]. While in Northern waters over 95 per cent of the microorganisms are psychrophilic, in warmer waters such as those off the coast of Africa, India and Australia, more mesophilic types are encountered[18]. Environmental factors are found to exert some influence on the natural flora of fish[19, 21, 26, 27]. According to Kreuzer[22], there exists a 'special spoilage microflora' with regard to fresh water fish. Again, even in the same fishing ground, variations in the flora are observed in different species[21] possibly due to differences in the constitution of the slime substratum. Seasonal differences in the relative proportions of *Pseudomonas*, *Achromobacter* and *Corynebacterium* spp. probably related to temperature variations, were also noted by Shewan[19], Liston[23] and Georgala[24].

Method of catching often affects the bacterial load. Trawled fish are shown to carry loads 10 to 100 times more than lined fish[28]. This is probably the result of dragging on the sea floor.

The deck, the hold surfaces and the pound or pen boards of the ship are known to be heavily contaminated, particularly if made of wood, and almost certainly would infect the fish in contact with them[29]. Since the viscera of fish contains heavy load of bacteria, their contact with the rest of the fish during gutting is bound to increase the surface load. Ice itself can be a source of contamination[19].

Containers used in the market, fish market floors and atmosphere are additional sources of infection[30]. Spencer[31] has shown that the wooden boxes used at Aberdeen carry loads of 10 to 20×10^6 per cm^2 of surface at 0° and 20°C. He also showed that the flora of wooden boxes differ markedly from that of fresh and spoiling fish.

Perhaps the most direct access for bacteria to fish muscle occurs during filleting. Though there are a multiplicity of vehicles of infection at this stage, the greatest single source is the filleting bench[32, 33].

The spoilage process: The term spoilage implies broadly two types of alterations occurring in fish. They are: (*i*) the gradual loss of the desirable attributes of texture and flavour, making the fish insipid, and (*ii*) development of undesirable odours and an unwholesome appearance. Considering the whole process of spoilage as a complex set of biochemical changes (except such reactions as the autoxidation of lipids which are of a purely chemical nature) involving a host of enzymes naturally present in the fish or of bacterial origin, it is easy to understand that the course and extent of such changes will depend mainly on three factors viz., the substrates, pH and temperature. The muscle protein and other organic components in the flesh constitute the substrate, and break down of these components bring about textural changes and alterations in taste and flavour. The bad odours are produced mainly by bacterial metabolites and excessive growth of bacteria itself leads to the repulsive appearance of spoiled fish.

The flesh of living fish is sterile and it is generally considered that bacterial spoilage of the flesh does not commence until *rigor mortis* has been resolved. This is due to the low pH during *rigor* which is unfavourable to bacteria[34, 35]. There is experimental evidence with animals that the longer the *rigor* lasts the better is the keeping of the carcass meat[36]. The amount of glycogen in fish muscle just after death and the amount of lactic acid formed during *rigor* are not as great as in mammals[37]. In haddock, whiting and related species, the ultimate pH, when *rigor* is at maximum, is normally

6.2—6.6[2]. But even at this level the growth of organisms responsible for spoilage appears to be effectively checked. Consequently, a longer period of *rigor* is desirable from the point of view of keeping quality. *Rigor mortis* in fish generally has a shorter duration than in mammals[37]. It starts 1-7 hours after death and the peak in slaughtered fish, kept in ice, lies between 5 and 22 hours after death. The total duration of the *rigor* covers 30-120 hours. It is obvious that any procedure that lengthens the duration of *rigor* ensures longer storage life.

Immediately after the *rigor*, decomposition of the highly complex protein of the muscle into simpler proteins, polypeptides and amino acids begins. This change is known as autolysis. Apart from proteolysis, autolytic changes include several other reactions also. It is believed that the products of autolytic action would provide a readily assimilable source of nutrients for the growth of spoilage organisms[38]. It is, however, incorrect to say that at a certain stage autolysis ends and bacterial action begins. The deteriorative changes are brought about by: (*i*) muscle enzymes, (*ii*) enzymes from the gut and (*iii*) bacterial enzymes. The existing evidences suggest that all these changes take place side by side.

As mentioned above, the more prominent reaction during spoilage, either autolytic or bacterial degradation, is proteolysis. If it be assumed that autolysis precedes bacterial degradation, proteolysis due to the former should be less compared to the latter, because the changes in the free amino acid composition tend to be small during the early stages of spoilage[39]. But evidence of definite though small proteolytic activity by muscle enzymes has been established in muscle preparations wherein bacteria have been suppressed[40-44]. Also, the proteolytic activity within the flesh was highest in the region of pH 4—well removed from the *post-rigor* pH of 6-7[45]. In order to study the course of autolytic and bacterial proteolysis, Bradley and Baily[46] developed the 'tyrosine' colour test, and these values have been used as a broad index of autolytic and bacterial degradations in proteins[47-49]. Fish muscle in general shows much more cathepsin activity than mammalian muscle[50]. Proteolytic activity within a species was invariably higher in the red muscle than in white and predominantly red muscle-species contained the highest activity[51, 52]. Most evidence suggests that the white muscle of fish does not normally suffer significantly the spoilage through the action of its own enzymes, although enzymes do affect subsequent bacterial attack[39]. Much of the spoilage that occurs in fresh water fish is from intestinal enzymes because of the common practice of storing this type of fish uneviscerated[53].

Among the many changes taking place during fish spoilage, the reduction of trimethylamine oxide to trimethylamine (TMA) has been studied by many workers. Reay and Shewan[2] quoting extensively from various workers concluded that the post mortem bacterial spoilage of marine fish proceeded in two main phases, viz., the reduction of trimethylamine oxide to its amine and the degradation of protein. The formation of dimethylamine was found to precede the appearance of TMA. Suryanarayana Rao[54] has discussed the origin and distribution of TMAO in marine organisms. The muscles of marine elasmobranchs have been found to have TMA oxide content ranging from 1000 to 1500 mg per cent, while the figures for marine teleosts range from 120 to 980 mg per cent, the majority of the latter lying between 200 and 400 mg per cent[55]. Beaty[56] has shown that about 95 per cent at least of the trimethylamine found in spoiling cod muscle arises from the oxide and from no other source. Though the conversion is supposed to be bacterial, the occurrence of trimethylamine oxide reductase activity in the flesh of some species have been reported[39].

A few of the other important changes occurring in fish muscle, autolytic, bacterial or both are (*i*) formation of histamine mainly in species of mackerel and tuna through the action of L-histidine decarboxylase on muscle histidine; (*ii*) cleavage of thiamine by thiaminase (*iii*) formation of β-alanine and methyl histidine from anserine (*iv*) ammonia from urea by urease in elasmobranchs. Change of the muscle pH also takes definite courses. As fish pass out of *rigor mortis* and bacterial spoilage develops, the pH of the flesh of lean fish rises from the *rigor* minimum to neutrality and then beyond to 7.5 to 8 or even higher, as putrifaction proceeds[2]. Sigurdsson[49] records pH value not exceeding 6.9 for completely spoiled herrings which suggests that reduction of acidity proceeds more slowly during the spoilage of fatty fishes, probably owing to hydrolysis of fats. The rise in pH in general can be explained by the accumulation of basic end products of putrifaction.

The putrefactive odours are mainly due to bacterial metabolites like amines, skatole, indole, hydrogen sulfide, aldehydes, etc. For example lysine is converted to cadaverine and putrescine, and arginine to δ-amino valeric acid or the corresponding aldehyde. Lysine can further be transformed to piperidine and N-amino piperidine as well as to pyridine. In general, amino acid precursors can produce amines, aldehydes or fatty acids. Sen[57] has recently dealt with the odour components of fish and stored fish and their precursors.

It is generally agreed that bacterial growth commences externally with particular intensity at the

gills. Infection of flesh can proceed along all obvious routes, including penetration of the skin. But Dyer *et al.*[58] have claimed that bacterial action in fish spoilage normally proceeds almost wholly on the external surface and that diffusion maintained the nutrient supply and the fish is rendered stale by penetration of end products of putrefaction. However, the main route of attack appear to be from the gills and the kidney into the flesh via the vascular systems and directly through the skin and peritoneum[19].

In recent years, interest has increased in the relation of the nucleotides and their derivatives to the flavour of fish flesh and its changes during storage. Adenosine-triphosphate breaks down rapidly during the early stages of spoilage with the formation of such derivatives as adenylic acid, inosinic acid, inosine and hypoxanthine and ribose[59].

Rancidity results from the chemical deterioration of fats; in the case of fish it is chiefly due to the oxidative deterioration of the unsaturated fatty acids. Rancidity is apt to develop in many fatty fishes during storage and handling since fish oils are particularly rich in highly unsaturated fatty acids. But the problem of oxidative rancidity is not so acute in the case of chill stored fish as in the case of frozen because the duration of storage is much less and also because other types of spoilage are dominant. Charnley[60] has examined at intervals the changes in acid value of the oil in the flesh of herrings stored at 2-4°C and shown that the acid value becomes after 2 days, about twice the original value (0.554), after 4 days about 3 times and after 6 days about 4 times.

Freshness Tests

One has to take into account two factors while considering the quality of a given specimen of fish—its wholesomeness as a food material and its keeping quality. Two apparently acceptable samples may not have the same keeping quality. This fact has to be remembered while advancing any systematic methodology for assessing the quality of fish. Two fish samples of equal freshness as measured organoleptically or by objective chemical or physical tests, but differing in bacterial load, would have different keeping quality. Again, freshness tests are based either on such basic changes which are directly related to quality as changes in texture, flavour or odour, or on accessory changes, e.g., changes in the eye fluids, or the electrical properties of the flesh which do not have any direct bearing on the edible quality of the fish. The tests based on the former are of wider applicability. They directly measure the quality. The latter type of tests are often limited to a particular phase in the spoilage process (e.g., the pH of the muscle) or to particular types or species. Another point often forgotten is that while determining the microbial load, it is not the total bacterial count that is important, but the number of spoilage organisms.

Several reviews on the methods of evaluation of freshness in sea foods have appeared before[2, 5, 61, 62]. An exhaustive summary of the literature in this subject is provided by Farber[59]. Hence only a few of the more promising methods will be listed here.

(*i*) *Sensory evaluation:* Organoleptic methods are universally applied in estimating quality in the market, in the retail shop and at the table. A trained panel of persons can, within reasonable limits of accuracy, give consistent assessment.

The criteria associated with freshness of fish have been known for years. They are mainly odour, condition of the eyes, texture of the flesh and skin, appearance of the abdominal walls, the colour and odour of the gills and the amount of slime on the skin. To overcome some of the disadvantages associated with sensory judgement such as personal uncertainties and also to minimise the qualitative nature of the tests, attempts have been made to evolve trained and experienced panels to judge the samples and recording the judgement through elaborate numerical scoring systems[63-70]. Nevertheless, the line dividing fresh fish from those with some early signs of spoilage is not very well defined and is most often subject to differences in personal opinions. At this stage of the so called incipient spoilage, sensory judgements become more variable and less reliable. At this critical stage, sharp objective tests become most handy, especially when strict quality control measures are to be enforced.

(*ii*) *Objective tests:* The objective methods can be broadly divided into: (*a*) physical; (*b*) physico-chemical, (*c*) chemical, and (*d*) biological[59].

The physical methods include measurements of the firmness of flesh. Buttkus[71] has developed a device to measure the energy required to cut the muscle fibres. Optical measurement of the textural changes in fish muscle during spoilage have been made[72]. Proctor *et al.*, have reported good correlation between the changes in the refractive index of the fluid in fish eyes and organoleptic judgement during storage of white haddock[73]. Love describes a method of comparing the turbidity of the eye lenses of fish to assess the storage time in ice[74].

Though many workers have attempted to correlate the electrical conductivity of the fish flesh with freshness, the value of this test remains uncertain[59]. The 'Intelectron fish tester V' developed by Hennings[75]

makes use of the progressive decrease in the dielectric nature of the cell walls during storage. Optical methods based on the measurement of fluorescence caused by bacterial activity, turbidometric methods etc., have been reported.

There has been an extensive series of studies on the usefulness of pH as a measure of fish spoilage. Variations in the pH of both muscle tissue and the surface of the fish were studied; but from what has been reported so far, reliability of pH as an index of spoilage remains debatable.

Among the chemical methods, more stress has been laid on the products of degradation, especially volatile basic nitrogen compounds. Though it is agreed that there does exist a relationship between total volatile bases (TVB) and degree of spoilage, it is difficult to prescribe an uniform index of incipient spoilage because of variations among species. Tillmans and Otto[76] suggested an upper limit of 30 mg nitrogen per 100 g for acceptability. This figure is more or less agreed on by many of the later workers, although few others have set the limit at different levels for individual species.

Reay and Shewan[2] have stated that the most useful chemical test was that based on trimethylamine (TMA) and dimethylamine. But the literature is full of contradictions in this regard. Nevertheless, it is a test almost universally accepted ever since Beatty and Gibbons developed a simple conway micro diffusion technique for the determination of trimethylamine[77]. Dyer has later developed a colorimetric method for this compound in fish muscle[78]. TMA is not produced in fresh water fish[79] because TMAO itself does not occur in them except in rare cases.

Volatile acids are formed in fish muscle in the process of autolysis and as bacterial metabolites of amino and other acids. Hillig and his co-workers have published a series of papers on steam-volatile acids as a spoilage index of fish during the past two decades[80-82].

One of the more promising indices of fish spoilage is based on the reducing capacity of the volatile degradation products. Lang *et al.*[83], proposed a method which was later modified by Farber and others[84] and which measures the reduction of alkaline permanganate solution by the volatile vapours liberated from fish muscle juice by aeration.

Degree of proteolysis also proved to be a useful criterion in following the course of fish spoilage. This could be done by measuring the free amino or carboxyl groups that were liberated, changes in the sulfhydril groups or by the 'tyrosine values' referred to previously. Recently, interest has centered on the breakdown of nucleotides and their relation to loss of flavour. It has been suggested that the content of hypoxanthine which is one of the break-down products of adenosine-triphosphate may be a useful index of quality and freshness of fish muscle during the early stages of chill storage.

Most of the chemical methods mentioned above are based on the quantitative determination of bacterial metabolites. Apart from those mentioned earlier, products of putrefaction such as indole, skatole, hydrogen sulfide, carbonyl compounds, histamine and related substances have also become the subject of investigation. But there are also methods which involve the measurement of the chemical activity of the micro-organisms. They include nitrate reduction and oxygen uptake, but the most widely studied method is that of dye-reductions. Methylene blue, resazurin and tetrazolium derivatives are some of the dyes that have been used. Various enzyme activity tests e.g., catalase, peroxidase, succinic dehydrogenase etc., have also been attempted.

Among bacteriological studies, total bacterial load by determining the total viable count has been the most commonly used practice. This is time consuming and not applicable for routine inspection. Techniques have been developed for the direct count of bacteria including the non-viable organisms as well, notable among them being those developed by Tarr[85] and Wittfogel[86].

Influence of Temperature on Quality of Fish

For most foods, storage at and around 5°C is almost as good as storage at ice temperature, since most bacteria present in them do not grow at either temperature. But this does not hold true in the case of fish. Due to the unique nature of spoilage bacteria in fish especially of the marine species, small variations in the vicinity of freezing point produce significant changes in the keeping quality. Added to this, biochemical changes in fish flesh also are influenced by the temperature of storage.

Temperature of storage and rigor mortis: Ewart observed as early as 1887 that as the temperature was lowered, *rigor mortis* was delayed in making its appearance in trout[87]. He also found considerable individual differences. Cutting[6] examined various white fishes among which were cod, haddock, whiting and lemon sole; the fish were not stunned but were allowed to struggle without interference. In some instances he found that icing immediately after the fish were caught did not affect the rate at which *rigor* sets in as compared with storage in air (12-16°C). With other species he recorded periods of only 2-3 hours at 0°C against 1-2 hours at 11-16°C. Schlie[88] has recorded the marked influence of chilling in prolonging the final resolution

of *rigor mortis* by examining fish at 30°, 18° and 3.5°C. Cutting found that even though chilling of trawled fish in ice did not affect the rate of onset of *rigor* appreciably, as compared to fish left in the air at deck temperature, it delayed resolution of *rigor* by about 10 hours. Amlacher[37] quoting several workers[89-91] concludes that in fish of the same species which die in the same way, the duration and intensity of *rigor* increases with a lowering of the body temperature, provided the experimental conditions in other respects are identical.

Temperature and bacterial growth: The influence of temperature on the growth of bacteria of the fish-spoilage type is considerable and the growth is markedly curtailed by small decreases in the range —1°C to 5°C[9]. Similar information has been acquired by examining changes in the fish itself. Because bacteria play the greatest role in the spoilage of fresh white fish, these species have been the main objects of such research.

It is well known that when the temperature of a substrate containing a mixed microbial population is lowered, there is first an extension of the lag phase of growth[92-94] followed by a gradual elimination of the various bacterial types as their minimum temperature is reached and passed. At about +5°C the mesophiles generally cease to grow and as the temperature is further lowered, various members of the psychrophilic group are eliminated[19]. The work of Bedford[95], Hess[92, 96, 97] and Kiser[93] have clearly shown that the great majority of marine bacteria responsible for the spoilage of fish are psychrophilic in type, growing at temperature between 30° and 0°C, some, however, growing at even lower temperatures down to —7.5°C. The optimum temperature for growth for most of these types are in the range of 10-20°C. Another significant fact about psychrophilic bacteria is that they increase in numbers approximately twice as fast at 3.5°C and five times as fast at 10°C as at 0°C[18].

The extension of the lag phase, i.e., the whole period of adjustment preceding logarithmic growth, that results from lowering the temperature below that of maximum growth rate, for several species of spoilage bacteria has been summarized by Reay and Shewan[2]. In the case of *Pseudomonas fluorescens* the lag phase is extended from about one day at optimum growth temperature to about 4-5 days at 0°C and to about 6 days at —3°C. Extension upto 8 days is obtained at —4°C in the case of species of *Achromobacter*.

Hess[92] has also made the important observation that although growth was most rapid at 20-25°C, the maximum total growth or crop was obtained at 5°C using strains of *Pseudomonas fluorescens*, *Flavobacter deciduosum* and *B. vulgatus*. Even at 0°C and at —3°C, in some of these cases greater crops were obtained than at 20°C and 37°C.

Hess[92] and Kiser[93] have calculated temperature coefficients (Q^{10}) of growth in the case of three species from the equation $Q^{10}=(K2/K1)^{10/(\theta_2-\theta_1)}$ where K_1 and K_2 are reaction or bacterial growth rates at temperatures θ_1 and θ_2 °C. It gives the change in the rate of growth of bacteria for every degree change in temperature within a given range of temperature. They found a steep rise in the acceleration of the growth rate with rise of temperature, as the temperature is lowered into the 'chilling' range.

Temperature and rate of spoilage of fish: Hess[96] also made a thorough study of the influence of temperature on the growth of spoilage bacteria on the fish itself, within the range of —1.1°C to 2.2°C. He studied haddock muscle extracts and emulsions together with a few headed and gutted fish. Total volatile basic nitrogen was used as an index of bacterial decomposition. Calculating the temperature co-efficients (Q^{10}) for the interval 2.2 to 1.1°C, values between 2.2 and 12.7 were found, while the values for the range 0°C to —1.1°C were much higher (ranging from 7 to several thousands). He concluded that a lowering of temperature becomes more effective in retarding bacterial decomposition in the lower temperature range.

The above mentioned observations on the behaviour of spoilage organisms in fish are in full agreement with the results of many workers who have studied the influence of temperature on the keeping quality of fish, based on taste panel or objective tests. Reay and Shewan[98] observed that the TMA-nitrogen values of herring stored at 10° to 15°C were 2-4 mg per 100 ml of juice after 24 hours and then rose to 20-40 mg after 48 hours, whereas in herrings kept in ice, the rise was only upto 2-3 mg even after 100 hours. Sigurdsson's[99] values agreed closely. Reay and Shewan also using sensory assessment of quality, found that herring kept at 10-15°C, as an average, passed a minimum standard of freshness 9 hours after catching, as opposed to 32 hours for adequately iced fish. Castell and MacCallum[100] stored fresh market cod and determined the keeping time as the mean time required for the middle muscle to reach a spoilage threshold of 15 mg TMA-nitrogen per 100 g fish. They found that the keeping time in days were respectively 8, 4.3 and 1.5 for storage temperatures of 0, 3 and 10°C. They also noted in the case of fillets of cod and haddock cut from normal quality fish that the reduction in storage temperature of a few degrees immediately after freezing adds proportionately far more to the keeping time than a greater reduction at higher temperatures. Somewhat similar results were obtained

by Dyer and Dyer[101] using taste panel methods. They observed that fillets cut from fish still in *rigor* became unacceptable after 3 days storage at 5°C and after 8 days at 0°C. Ludorff and Kreuzer[102] have shown that in terms of TVB and electrical resistance of muscle, the loss of freshness in cod and haddock stored at 3°C in 3-4 days was the same as that when stored at 0°C (in ice) for 9 days. By taste panel assessment, Bystedt[103] found that when mackerel was stored at 0°C in ice and 5°C in air loss in quality occurred in 9 days and 5 days respectively for ungutted fish, and 7 and 5 days respectively for gutted and cleaned fish.

Hansen[104] stored cod in still air at —1.3, 0.6 and 3.5°C and plaice at —0.6, 0.6 and 5.3°C. In the case of cod, the corresponding keeping times were 16, 11.9 and 8.6 days and for plaice 13.1, 11.3 and 7.0 days. In the experiment with cod the difference in keeping quality per degree centigrade for the two intervals were calculated as 2.5 and 1.1 days. The corresponding figures for plaice were 1.5 and 0.9 days. Luijpen[105] while studying the suitability of various objective tests for the spoilage of cod fillets stored in refrigerator has shown that fish stored at +4, +2, +1, —1.25 and —2°C became unacceptable at the end of 3, 5, 6, 11 and 16 days.

According to Cutting *et al.*[106] cod spoils about 2½ times as fast at 4.4°C and about 5½ times as fast at 10°C as they do at 0°C. The close parallel with the growth pattern of psychrophilic bacteria is remarkable.

Spencer and Baines[107] using sensory, chemical and bacteriological tests examined the relationship between spoilage rate and temperature of storage of cod over a wide range of temperatures from —1°C to 25°C. They observed that the effect of temperature on the rate of spoilage was approximately linear and could be expressed as $\mu = v(1 + C\theta)$ where μ is the rate of spoilage at temperature θ°C, v the rate at 0°C and C a constant, values of which ranging from 0.25 to 0.36 for the different spoilage tests. Vyncke[108] reports about the recent Belgian studies on cod, red fish, herring and dog fish, stored at 20, 15 and 0°C. The rate of spoilage was measured by a number of objective tests, all being able to clearly differentiate the influence of temperature variations.

The influence of temperature on the keeping quality is believed to be more pronounced in the case of white fish than fatty fish[9].

The foregoing account relates to changes in fish stored at constant temperature. Low temperatures never completely stop bacterial growth, hence it is obvious that the subsequent keeping quality at any given temperature will be related to the initial bacterial load at the commencement of storage at that particular temperature. Exposition of fish to higher temperature even for a short duration can boost the bacterial load to appreciable levels so that further storage even at reduced temperatures becomes less effective. Experiments in which white fish were exposed to 7°C for 18 hours before packing in ice showed that the average storage life was reduced by 2 days as compared with controls iced immediately after catch[101]. Castell *et al.*[109] examined the storage life of fish in ice after removing them from the top of a pile on deck. The storage life in ice was not affected much by exposure in cold weather (5°C), but there was perceptible changes after 5 days storage, when the exposure temperature was 15°C. Reimann and Bramsnaes[110] obtained similar results with fish allowed to stand for 8-13 hours at 10°C before being iced; shelf life was shortened by 1-3 days.

Chilling of Fish

There are possibly three methods of chilling fish. They are by cooling fish in (*i*) cold air (*ii*) ice or (*iii*) chilled water or brine.

Due to several reasons, aerial cooling of fish is not advantageous. Firstly, the rate of cooling of fish by cold air is several times less than by water or ice at the same temperature[9]. Moreover, dehydration takes place, and further, the washing effect by melting ice or chilled water to remove the surface bacteria is absent.

Icing remains to be probably the best system of chilling fish because of certain unique features. There appears to be no other medium which can replace such attributes of ice as the high specific heat and heat of fusion. Moreover mixing with ice brings about rapid cooling due to the intimate contact of the fish with ice-water. The melting ice brings about a constant washing effect, thereby reducing bacterial load on the surface. The undesirable attributes of ice are (*i*) tendency to injure and bruise the flesh (*ii*) leaching of flavour components and nutritionally desirable minerals and water soluble proteins[111].

Ice has the double function of cooling the fish from its temperature at the time of stowing, which lies somewhere between that of sea water and that of air, and of keeping it chilled. Every kilogram of ice, on melting, absorbs 80 Kcals of heat from its surroundings. Assuming the specific heat of fish to be 0.9, the theoretical weight of ice necessary to cool fish from 25°C to 0°C is about 28 per cent of the weight of fish[9]. But in actual practice, the heat transfer from environments may equal or even exceed the heat transfer from fish depending on the nature of containers, ambient temperature and various other

factors[102] necessitating the use of much larger proportions of ice.

The incorporation of antibiotics into ice has been recognised and the use of 'chemical ice' has been the subject of much investigation. Tarr[113] has reviewed the subject in some detail. The use of carbon dioxide with iced fish is reported to give an extension of shelf life[114] particularly for white fish, but a concentration of the gas above 30 per cent gave undesirable appearance and texture.

Mechanical refrigeration is sometimes recommended to conserve ice, especially in fish holds in vessels. But this takes away the advantage accrued by the melting of ice. Experiments with well-iced fish in individual boxes have shown that, within normal limits, the higher the temperature of the air around iced fish, the better the fish keep, despite the fact that the temperature of the fish in all cases was very near 0°C[115]. The effect is presumably due to removal of bacteria and leaching of decomposition products.

The influence of ambient temperature on the rate of cooling in fish has been examined by Lumley *et al.*[116]. It was found that fish buried in crushed ice took twice as long to cool in a refrigerator at 0°C than in a room at about 8°C. Similar findings were recorded later[117]. If this were true, refrigeration of rooms stored with iced fish would actually delay cooling. But Osoling[118] and Cutting[119] have experimentally found that the temperature of surrounding air had no effect on the rate of cooling of iced fish.

Keeping in view the tremendous advantage of even minute reduction of temperature around the freezing point, Castell and MacCallum[100] used salt water ice (about 3 per cent sodium chloride) which has a melting point of approximately —2°C. In an experiment, where sub-cooled flaked salt water ice and ordinary crushed ice were used in icing similar lots of fish, both held under otherwise similar conditions of storage the flesh temperature of the salt water iced fish ranged from —1°C to 0°C which was about 3° lower than the temperature range of the fish iced with crushed fresh water ice[120]. The fish stored in the salt water ice were superior in quality at the end of the test.

The cooling of fish in circulating sea water is more efficient than cooling in curshed ice[121]. The advantage arises from the fact that the cooling medium surrounds the fish entirely, making the heat transfer more rapid. Similar results are reported by Sigurdsson[122] who found that herring stored in refrigerated brine at 0°C showed superior keeping quality to those held either in crushed ice or in air at 0°C. Roach *et al.*[123] have outlined the factors contributing to good design and operation in the use of refrigerated sea water based on laboratory tests and experience in the salmon and halibut fisheries of the Pacific North West. The rapidity of chilling is said to be two to three times as fast as with ice. Other advantages are (*i*) elimination of crushing and ice pitting, (*ii*) washing effect (*iii*) labour saving in stowage and ease of unloading while used on board vessels (pumps can be used for unloading).

Super chilling or partial freezing, the application of temperature just below the freezing point, has given an extension in storage life of more than 10 days for cod[114]. The method is commercially used in Portugal. Refrigerated plates cool the fish that are bulk stowed in ice in fish rooms. In the United Kingdom, tests have been made in super chilling iced fish in boxes[114]. It is claimed by Canadian workers[124,125] that partial freezing prevents proteolysis of visceral cavity (belly burn) without appreciably sacrificing quality of protein.

Concluding Remarks

The problem of chilling fish to the desired minimum and maintaining it at that level continues to be a major one. There has not been any novel approach in evolving a new system of chilling fish apart from modifying the older practice such as in the design of containers, etc. Even in adequately iced fish, the observed temperatures are usually much higher than 0°C. In an extensive investigation of this problem made in U.K.[126] nearly 30,000 temperature measurements of fresh fish were taken at all stages in the distribution chain. The temperature of the fish varied from 0 to 4.4°C at the time of unloading to 4.4 to 21.1°C at the time of distribution. A survey made in Belgium showed similar results[127]. If the situation is so bad in temperate countries where the maximum recorded temperature at the time of distribution is 21-22°C[126], it can be expected to be worse in tropical countries. In India some recorded figures indicate that temperature of iced fish transported to various markets ranges between 7 and 20°C at the destination[128]. No data regarding the temperature during distribution is available. In the absence of any inspection procedure, the choice of acceptability is largely left to the consumer. To a large section of the latter the cost is a more decisive factor than quality. As such, practically no fish is rejected on the basis of acceptability, and hence an evaluation of the extent of spoilage in the marketed fish has become rather difficult.

Since the spoilage largely depends on the nature of microflora, a thorough study of the type and size of microbial population of the tropical waters is useful. This is especially desirable in the case of fresh water fish and their habitat in this region because not much

data is available at present. More work needs to be done to establish the relationship between *rigor mortis* and keeping quality of fish.

There is also need for evolving more reliable and, as far as possible, quick and universally applicable objective tests for the evaluation of freshness. Chemical and bacteriological tests, though useful in the laboratory, cannot be recommended for routine inspection. In this context the 'Intelectron fish tester V' developed by Hennings[75] is said to be of some value. At any rate, any objective method can be expected to serve only as complementary to sensory evaluation and cannot replace the latter altogether.

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References

1. *F.A.O. Year Book of Fisheries Statistics*, 1965, 21, Fishery Commodities, F.A.O.
2. Reay, G. A. and Shewan, J. M., *Advances Fd Res.*, 1949, II, 343.
3. Kimata, M., *J. imp. Fish. Inst., Japan*, 1941, **34,** 115.
4. Schimizu, W., Hibiki, S. and Nagasaki, S., *Bull. J. Soc. sci. Fish.*, 1955, **20,** 804.
5. Yukio Tomiyasu and Buhei Zenitani, *Advances Fd Res.*, 1957, VII, 41.
6. Cutting, C. L., *Gt Brit. Dep. sci. ind. Res. Rep. Fd Invest. Bd*, 1939, 39.
7. Messtorff, J., Diplomarbeit, Universitat Hamburg, 1954.
8. Hjorth-Hansen, *Rep. Norwegian Fish. Res. Lab.*, 1943 **1** (4), 57.
9. Bramsnaes, F., in *Fish as Food*, Edited by Borgstrom, G., Academic Press, New York and London, 1965, Vol. IV, 1.
10. Castell, C. H., Dale, J. and Greenough, M. F., *J. Fish. Res. Bd Canada*, 1959, **16,** 223.
11. Castell, C. H. and Giles, J. G., *J. Fish. Res. Bd Canada*, 1961, **18,** 295.
12. Ehrenburg, A. S. C. and Shewan, J. M., *J. Sci. Fd Agric.*, 1955, **6,** 207.
13. Fletcher, L. I., Hodgkiss, W. and Shewan, J. M., *Fish. News*, 1951, 11, 2007.
14. Love, T. D. *Comm. Fish. Rev.*, 1961, **23** (8), 9.
15. Anderson, A. G. *26th Annu. Rep. Fish. Bd Scotland*, 1907, Part III, Sci. Invest., 13.
16. Leim, A. H., MacLeod, J. J. R. and Simpson, W. W., Contrib. *Canada Biol. and Fish.*, 1927, **3,** 459.
17. Jones, N. R., Burt, J. R., Murray, J. and Stroud, G. D., in *The Technology of Fish Utilization*, Edited by Rudolf Kreuzer, F.A.O., Fishing News (Books) Ltd., 1965.
18. Shewan, J. M., *Recent Advances Fd Sci.*, Edited by Hawthorn J. and Leitch, J. M., 1962, Vol. I, 167.
19. Shewan, J. M., in *Fish as Food*, Edited by Borgstrom, G., 1961, Vol. I, 487.
20. Zobell, C. E. and Upham, H. C., *Bull. Scripps Inst. Oceanog.*, Univ. Calif., 1944, **5,** 239.
21. Wood, E. J. F., *Aust. J. Marine Freshwater Res.*, 1953, **4,** 160.
22. Kreuzer, R., *Arch. Fischereiwiss.*, 1954, **5,** 47.
23. Liston, J., Ph.D. Thesis, Aberdeen University, Aberdeen, Scotland, 1955.
24. Georgala, D. L., *J. gen. Microbiol.*, 1958, **18,** 84.
25. Tarr, H. L. A., *Bact. Rev.*, 1954, 18, 1-15.
26. Venkataraman, R. and Sreenivasan, A., *Indian J. med. Res.*, 1952, **40,** 529.
27. Venkataraman, R. and Sreenivasan, A., *Proc. Indian Acad. Sci.*, 1954, **40B,** 161.
28. Shewan, J. M., *J. roy, Sanit. Inst.*, 1949, **59,** 394.
29. Fischer, E., *Prace Morskiego Inst. Rybackiego Gdyni*, 1954, **7,** 245.
30. Wood, E. J. F., *Aust. Commonwlth. Coun. sci. ind. Res., Div. Fish. Rep.*, 1940, No. 3.
31. Spencer, R., *J. appl. Bact.*, 1959, **22,** 73.
32. Castell, C. H., *Bull. Fish. Res. Bd Canada*, 1954, No. 100.
33. Georgala, D. L., Ph.D. Thesis, Aberdeen University, Aberdeen, Scotland, 1957.
34. Tarr, H. L. A. and Ney, P. W., Progr. Rep. Pacif. Coast Stas., *Fish. Res. Bd Canada*, 1949, No. 78, 11.
35. Kimata, M., *Bull. J. Soc. sci. Fish.*, 1936, **5,** 143.
36. Bate-Smith, E. C., *Advances Fd Res.*, 1948, **1,** 1.
37. Amlacher, E., in *Fish as Food*, Edited by Borgstrom G., 1961, Vol. I, 385.
38. Bramstedt, F. A. L., in *Fish in Nutrition*, Edited by Heen, E. and Kreuzer, R., F.A.O., Fishing News (Books) Ltd., London, 1962.
39. Jones, N. R., *Recent Advances Fd Sci.*, 1962, **I,** 151.
40. Nickerson, J. T. R. and Proctor, B. E., *J. Bact.*, 1935, **30,** 383.
41. Nickerson, J. T. R., Goldblith, S. A. and Proctor, B. E., *Fd Technol., Champaign*, 1950, 4, 84.
42. Proctor, B. E., Nickerson, J. T. R. and Goldblith, S. A., *Refrig. Engng*, 1950, **58,** 375.
43. Hodgkiss, W. and Jones, N. R., *Biochem. J.*, 1958, **61,** iv.
44. Shewan, J. M. and Jones, N. R., *J. Sci. Fd Agric.*, 1957, **8,** 491.
45. Baily, B. E., Karan, P. and Bradly, H. C., *Biol. Bull.*, 1942, 83, 129.
46. Bradly, H. C. and Baily, B. E., *Fd Res.*, 1940, **5,** 487.
47. Tarr, H. L. A. and Baily, B. E., *J. Fish. Res. Bd Canada*, 1939, **4,** 327.
48. Wood, A. J., Sigurdsson, G. J. and Dyer, W. J., *J. Fish. Res. Bd Canada*, 1942, 6, 53.
49. Sigurdsson, G. J., *Ind. engng Chem., anal. Edn*, 1947, **19,** 892.
50. Siebert, G. and Schmitt, A. in *The Technology of Fish Utilization*, Edited by Rudolf Kreuzer, F.A.O. Publication, 1965, 47.
51. Saito, K. and Sameshima, M., *Bull. J. Soc. sci. Fish.*, 1958, **24,** 201.
52. Saito, K. and Sameshima, M., *Bull. J. Soc. sci. Fish.*, 1958, **24,** 648.
53. Bramstedt, F. and Auerbach, M., in *Fish as Food*, Edited by Borgstrom G., 1961, Vol. **4,** 613.
54. Suryanarayana Rao, S. V., Ph.D. Thesis, University of Hamburg, W. Germany, 1960.
55. Reay, G. A., Cutting, C. L. and Shewan, J. M., in The Nation's Foods, 1943, VI., *J. Soc. Chem.* Ind., 1943, **62,** 77.
56. Beatty, S. A., *J. Fish. Res. Bd Canada*, 1938, **4,** 63.
57. Sen. D. P., *J. Fd Sci. Technol.*, 1966, **3,** 142.

58. Dyer, W. J., Dyer, F. E. and Snow, M., *J. Fish. Res. Bd Canada*, 1946, **6**, 403.
59. Farber, L., in *Fish as Food*, Edited by Borgstrom, G., Academic Press, New York and London, 1965, Vol. IV. Part II, 65.
60. Charnley, P., *Analyst Lond.*, 1945, **70**, 168.
61. Allison, A. M., *Quart. Bull. Ass. Fd and Drug Offic.* 1948, 12, 129.
62. Tarr, H. L. A., *Bact. Rev.*, 1954, 18, 1-15.
63. Young, O. C. *Prog, Rep., Pacif. Coast Sta., Fish. Res. Bd Canada*, 1938, No. 37, 12-16.
64. Griffiths, F. P. and Stansby, M. E., *Trans. Am. Fish. Soc.*, 1934, **64**, 401.
65. Castell, C. H., Rodgers, R. S. and McFarlane, A. S., F.A.O. Interim Comm. on Fish Handling and Processing, Fish Process Technologists Meeting, Rotterdam 1956, Symposium paper No. 16.
66. Castell, C. H., Greenough, M. F., Rodgers, R. S. and McFarlane, A. S., *J. Fish. Res. Bd Canada*, 1958, **15**, 701.
67. Hansen, P., F.A.O. Interim Comm. Fish Handling and Processing, Fish Process Technologists Meeting, Rotterdam, 1956, Symposium Paper No. 15.
68. Shewan, J. M., MacIntosh, Ruth, G., Tucker, C. G. and Ehrenberg, A. S. C., *J. Sci. Fd Agric.*, 1953, **4**, 283.
69. Soudan, F., Bazin, J., Chapel, G., Seynave, E. and Daknoff, A., F.A.O. Interim Comm. Fish Handling and Processing, Fish Process Technologists Meeting, Rotterdam, 1956, Symposium Paper No. 25.
70. Jensen, P. F., F.A.O. Interim Comm. Fish Handling and Processing, Fish Process Technologists Meeting, Rotterdam, 1956, Symposium Paper No. 13.
71. Buttkus, H., *J. Fish. Res. Bd Canada*, 1963, **20**, 181.
72. Love, R. M., *Texture in Foods*, Soc. Chem. Ind. Lond. Monograph No. **7**, 1960.
73. Proctor, B. E., Nickerson, J. T. R., Fazzina, T. L., Ronsivalli, L., Smith, R. K. and Stern, J., *Fd Technol. Champaign*, 1959, **13**, 224.
74. Love, R. M., *J. Sci. Fd Agric.*, 1954, 5, 566.
75. Hennings, C., *The Technology of Fish Utilization*, Edited by Kreuzer, R., F.A.O., Fishing News (Books) Ltd., London, 1965.
76. Tillmans, J. and Otto, R., as quoted in Ref. 59.
77. Beatty, S. A. and Gibbons, N. E., *J. biol. Bd Canada*, 1937, **3**, 77.
78. Dyer, W. J., *J. Fish. Res. Bd Canada*, 1945, **6**, 351.
79. Jackquet, R., in *Fish as Food.*, Edited by Borgstrom, G,. 1961, Vol. I.
80. Hillig, F., *J. Ass. Off. agric. Chem.*, 1944, **27**, 237.
81. Hillig, F. and Knudsen, L. F., *J. Ass. Off. agric. Chem.*, 1942, **25**, 176.
82. Hillig, F., *J. Ass. off. agric. Chem.*, 1959, 42, 286.
83. Lang, D. W., Farber, L., Beck, C. and Yerman, F., *Ind. engng Chem., anal. Edn*, 1944, **16**, 490.
84. Farber, L. and Lerke, P. A., *Fd Technol., Champaign*, 1958, **12**, 677.
85. Tarr, H. L. A., *Progr. Rep. Pacif. Coast Sta. Fish. Res. Bd Canada*, 1945, **62**, 7.
86. Wittfogel, H., *Arch. Lebensmittelhyg.*, 1955, **6**, 279.
87. Ewart, J. C., *Proc. roy. Soc.*, 1887, 1342, 439-459, as quoted in Ref. No. 9.
88. Schlie, K., *Adances Fd Res.*, 1934, II, 343.
89. Caracciolo, S., in *Fish as Food*, Edited by Borgstrom, G., 1954, Vol. I, 385.
90. Gianelli, F., *Atti. Soc. ital. Sci. Vet.*, 1954, **8**, 464.
91. Pavlov, E. G., Pischtepromizdat, in *Fish as Food*, 1956, Vol. I.
92. Hess, E., *Contrib. Can. Biol. Fish.*, 1934, **8**, 491.
93. Kiser, J. S., *Fd Res.*, 1944, **9**, 257.
94. Ingraham, J. L., *J. Bact.*, 1958, **76**, 75.
95. Bedford, R. H., *Contrib. Can. Biol. Fish.*, 1933, **7**, 433.
96. Hess, E., *Contrib. Can. Biol. Fish.*, 1932, **7**, 149.
97. Hess, E., *Contrib. Can. Biol. Fish.*, 1934, **8**, 464.
98. Reay, G. A. and Shewan, J. M., *The Technology of Herring Utilization*, Directorate of Fisheries, Bergan, Norway, 1953, 164-185.
99. Sigurdsson, G. J., *Ind. engng Chem., anal. Edn*, 1947, **19**, 891.
100. Castell, C. H. and MacCallum, W. A., *J. Fish. Res. Bd Canada*, 1950, **8**, 111.
101. Dyer, F. E. and Dyer, W. J., *J. Fish. Res. Bd Canada*, 1949, **7**, 449.
102. Ludorff, W. and Kreuzer, R., in *Fish as Food*, Edited by Borgstrom, G., Academic Press, New York and London, 1965, Vol. IV, 1.
103. Bystedt, J., *Kyltek Tidsker.*, 1953, 12, 43.
104. Hansen, P., *Chilling of Fish*, F.A.O. Fish Process Technol. Meeting 1956 (Hess, E. and Subba Rao, G. N. Editors), Ministry of Agriculture, Fisheries and Food, The Hague, Netherlands, 1960, 151.
105. Luijpen, A. F. M. G., *J. Sci. Fd Agric.*, 1958, **9**, 410.
106. Cutting, C. L., Eddie, G. C., Reay, G. A. and Shewan, J. M., *Gt Brit. Dep. sci. ind. Res. Fd Invest. Bd Leafl.*, No. 3, 1953.
107. Spencer, R. and Baines, C. R., *Fd Technol. Champaign*, 1964, **18**, 769.
108. Vyncke, W., *Fishing News, Internat.*, 1967, **6** (4), 39.
109. Castell, C. H., Macallum, W. A. and Power, R. E., *J. Fish. Res. Bd Canada*, 1956, **13**, 21.
110. Reimann, H. and Bramsnaes, F., *Fish. Bull.*, F.A.O., 1954, **7**, 49.
111. Holston, J. and Slavin, J. W., *The Technology of Fish Utilization*, Edited by Kreuzer, R., F.A.O. Fishing News (Books) Ltd., London, 1965, 41.
112. Dassow, J. A., *Handling Fresh Fish*, U.S. Dept. of the Interior, Fish and Wildlife Service, Fish, Leafl., 428, 1956.
113. Tarr, H. L. A., in *Fish as Food*, Edited by Borgstrom, G., Academic Press, New York and London, 1961, Vol. I., 639.
114. Merritt, J. R., *Suppl. Fish. News Internat.*, July 5, 1965, 14.
115. Anonymous, *Gt Brit. Dep. sci. ind. Res. Rep. Fd Invest Bd*, 1955, 24.
116. Lumley, A., Pique, J. J. and Reay, G. A., *Gt Brit. Dep. sci. Ind. Res. Fd Invest. Bd, Sp. Rep.*, No. 37, 1929.
117. Anonymous, *Annu. Rep. Fish. Ind. Res. Inst.*, Cape Town, S. Afr. 1953, **6**, 8.
118. Osoling, V. C., *Trans. Inst. Marine Fish. Oceanog.*, U.S.S.R., 1937, **6**, 139.
119. Cutting, C. L., *Gt Brit. Dep. sci. ind. Res. Rep. Fd Invest. Bd*, 1939, 41.
120. Fields, C., *Fish. Gaz.*, 1953, **70**, 54.
121. Kanokotin, G., *Kholodilnaja Technica* (Russian), 1949, 26 (2), 66, No. 2, 66, (Refrig. Engng, **57**, No. 12, 1186).
122. Sigurdsson, G. J., *Proc. Inst. Fd Technol.*, 1945, 91-114.
123. Roach, S. W., Harrison, J. S. M. and Tarr. H. L. A., *Bull. Fish. Res. Bd Canada*, 1951, No. 2, 126.
124. Tomlinson, N., Geiger, S. E. Key, W. W., Uthe, J. and Roach, S. W., *J. Fish. Res. Bd Canada*, 1965, **22** (4), 955.
125. Dollinger, E., *J. Fish. Res. Bd Canada*, 1966, **23** (5), 701.
126. Burgess, G. H. O., Cockburn, R. M., Cutting, C. L. and Robb, W. B., *Gt Brit. Dep. sci. ind. Res., Torry Tech. Pap.*, No. 1, 1959.
127. Howart, P., Vandamme, E. and Vyncke, W., *Revue de l' Agriculture*, 1964, 17, 647.
128. Subba Rao, G. N., *Indo-Pacif. Fish. Coun. Regional Stud.* F.A.O., Regional Office, Bangkok, No. 3, 1965.

Seasonal Variation in the Amount and Characteristics of the Oil of Oil-Sardine (*Sardinella longiceps*) Fish

D. P. Sen and G. L. Chaluvaiah
C.F.T.R.I. Fish Technology Experiment Station, Mangalore

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Data on the seasonal variation in the amount and characteristics of the oil of oil-sardine (*Sardinella longiceps*) covering a period of one year from May, 1966 to April, 1967, are presented. The fish have a maximum fat content (11.0—15. 7 per cent) during the months of September to December and a minimum (2.7—4.4 per cent) during June and July.

Whether used as feed or as food (in the form of fish-protein concentrate) the economics of the production of fish meal depends among other things, on the amount of body-oil that can be extracted per unit weight of fish. The quantity of oil that can be recovered from fish depends primarily on the fat content of fish. Seasonal variation in the fat content can be a significant factor in determining the quantity of oil extractable from oil sardine fish during any one season. The present study carried out during a period of one year from May 1966 to April 1967 is intended to cover this aspect. The oil extracted during the different parts of a year was also analysed with respect to its physical and chemical characteristics.

Materials and Methods

Collection of samples: Fresh oil-sardine captured at Mangalore or its adjacent areas (from Kasargod, 46 km. North to Baikampady, 11 km. South) was used for the present study.

Sampling: 30-40 fish weighing about 1.5 kg picked up at random from a lot of about 30 kg constituted a sample. In the case of juvenile sardines, about 100 fish weighing about 1 kg constituted the sample.

Length and weight: Individual lengths and total weight of 20 fish from each day's sample were recorded. Length was measured from snout to the base of tail fin.

Frequency of analysis: Depending upon the availability of fish, the samples were analysed for fat content once every week. Once a month, a duplicate sample was dressed and fat content of (*i*) heads and visceral portion and (*ii*) body portion were estimated separately. The samples were minced twice in a meat mincer and used for the determination of moisture and fat.

Extraction of oil: Depending upon the availability and fat content of fish, once a week oil was extracted from whole fish. On a few occasions, oil was extracted separately from (*i*) heads and visceral portions and (*ii*) body portions.

Whole sardine fish (30-60 kg) or heads and visceral portions or body portions from about the same quantity was cooked in open aluminium or stainless steel pans with an equal volume of water with stirring for a period of about 30 minutes. The cooked fish was pressed in a hand driven basket press. The oil was recovered from the press-liquor by gravity separation, washed several times with hot water and centrifuged in a De laval separator (Laboratory model-201). The oil sample, treated with anhydrous sodium sulphate and centrifuged to remove last traces of moisture, was used for various determinations.

The press-liquor was handled immediately for the separation of oil from water or was kept at 1-2°C overnight storage when found necessary.

Determination of moisture and fat: Moisture was determined by drying 5-10 g of minced sample at 98±5°C in a hot air oven. Fat was determined in the dried sample by extraction with petroleum ether (40-60°C) for 16-18 hr in a Soxhlet apparatus.

Iodine value and saponification value: Iodine value (Wij's method) and saponification value of the oil samples were determined according to A.O.A.C.[1].

Saturated fatty acid and cloud point: Saturated fatty acid content (by modified Twitchell method) and cloud point of oil samples were determined according to A.O.C.S.[2]

TABLE 1. SEASONAL VARIATION OF FAT AND MOISTURE CONTENTS OF OIL-SARDINE FISH (*Sardinella longiceps*)

Month	No. of samples	Average length (cm)	Average weight of each fish (g)	Moisture (%)	Fat (%)
January	4	13.7 (13.5-14.0)	30.9 (28.0-33.6)	66.9 (62.9-70.2)	10.9 (6.6-13.4)
February	4	13.1 (12.9-13.4)	27.5 (25.5-29.0)	68.7 (67.9-69.5)	8.8 (8.2-10.0)
March	4	13.6 (13.4-14.2)	33.0 (29.5-35.0)	66.9 (63.5-68.6)	9.1 (6.9-11.0)
April	4	14.1 (14.0-14.2)	34.0 (33.0-35.0)	69.9 (68.8-71.7)	6.2 (4.3-7.2)
May	4	...	...	70.9 (70.1-71.4)	6.0 (5.3-6.7)
June	2	...	...	72.7 (71.5-73.9)	4.0 (3.5-4.4)
July	2	14.1 (14.1-14.1)	40.5 (38.0-43.0)	73.2 (71.8-74.5)	3.3 (2.7-3.8)
August	4	14.3 (14.2-14.4)	43.1 (41.5-46.0)	69.8 (68.0-71.7)	9.4 (6.8-11.5)
September	4	14.3 (12.6-14.8)	42.8 (37.0-46.0)	64.7 (61.7-69.6)	14.6 (12.6-15.6)
October	3	15.2 (14.8-15.6)	47.0 (46.0-48.0)	63.8 (63.7-64.0)	12.6 (11.5-13.7)
November	4	14.6 (14.4-15.0)	41.0 (38.0-44.0)	64.6 (63.3-66.2)	13.0 (11.0-14.2)
December	4	13.8 (13.2-14.4)	33.6 (28.0-39.0)	63.2 (66.1-63.0)	14.0 (11.1-15.7)

Figures in the parenthesis indicate the range

Solid fat content at 25°C and at room temperature: 10 ml of the oil sample was kept at 25±1°C for seven days or at room temperature (26.0-36.5°C) for one month and was centrifuged. Values were expressed as percentage (v/v).

Refractive index: Refractive index was measured at 37-38°C in an Abbe Refractometer and readings were corrected for 30°C.

Results and Discussion

Seasonal variation of fat-content of whole fish: Seasonal variation of moisture and fat content of the fish is given in Table 1 and Figure 1. Oil-sardine have a maximum fat content during the months of September-December (11.0-15.7 per cent fat). Minimum value was observed during June-July (2.7-4.4 per cent fat). Spawning period of oil-sardine is protracted over a period extending from July to October or even November[3]. Thus the period of maximum fat content coincides with the period of spawning.

Fat content of (i) heads and visceral portion and (ii) body portion: Edible fish protein concentrate (fish flour) from whole fish may not be acceptable from various considerations. In that case fish-flour should be prepared from body portions only. Keeping this in view, fat content of (*i*) heads and visceral portions and (*ii*) body portions were estimated (Table 2).

During December to April, the fat content of heads and visceral portions were higher than that of body portions. During September to November, the fat contents were more or less equal. No correlation between these could be drawn during the remaining part of the year.

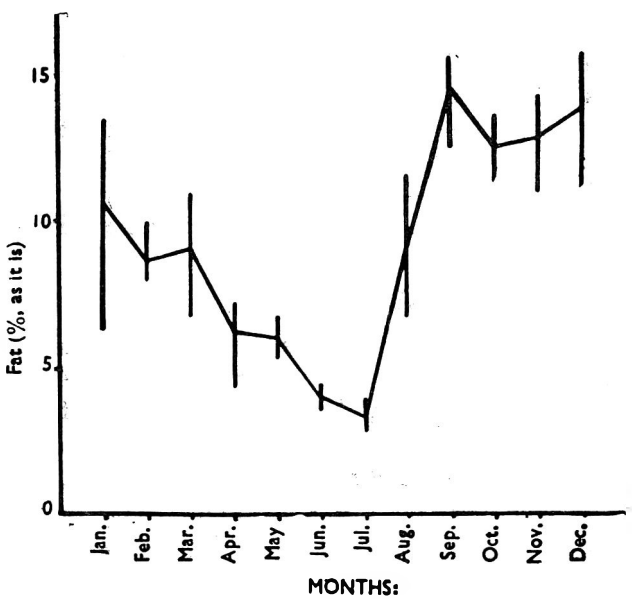

Fig. 1. Seasonal variation in fat content of oil-sardine fish

Fat content of juvenile sardines: Occasionally juvenile sardines (length about 10 cm., age less than 1 year[3]) constituted a catch. These fish were found to be comparatively lean (1.1-5.8 per cent fat) (Table 3).

TABLE 2. FAT AND MOISTURE CONTENTS OF (i) HEAD AND VISCERAL PORTIONS AND (ii) BODY PORTIONS OF OIL-SARDINE FISH

Month	Moisture (%)		Fat (%)	
	Body	Head and viscera	Body	Head and viscera
January	64.9	60.3	12.2	15.5
February	69.1	64.7	7.6	10.5
March	68.1	63.9	8.4	11.6
April	69.9	66.9	5.3	10.0
May	71.5	69.2	7.4	7.0
June	72.0	69.9	4.0	6.7
July	72.9	72.7	3.0	4.2
August	68.3	70.1	8.8	8.2
September	63.8	62.7	13.4	13.6
October	65.3	64.8	11.6	12.2
November	64.5	62.6	13.0	13.3
December	64.8	62.1	12.6	14.5

TABLE 3. FAT AND MOISTURE CONTENTS OF JUVENILE SARDINE

Sl. No.	Average length (cm)	Average weight of fish (g)	Moisture (%)	Fat (%)
1	11.8	18.4	73.6	3.8
2	10.9	15.5	70.3	5.8
3	7.8	6.5	74.8	3.7
4	8.2	5.5	78.8	1.1
5	8.9	8.0	77.3	2.1

Length, weight and fat content: No correlationship between length or weight and fat content of fish was observed (Fig. 2). But in the same catch, with fish of larger lengths and weights, the fat content was more (Fig. 3).

Relationship between fat and moisture content: Fat and moisture contents were found to be related. The relationship between the above two indices for (*i*) whole fish (*ii*) head and entrail portions and (*iii*) body portions are given in Fig. 4, 5, and 6. The relationship was found to be governed by the following equations:

For whole fat ... fat (%) + 0.9714 moisture (%) = 75.28
For body portion ... fat (%) + 1.120 moisture (%) = 84.92
For head and entrail portion fat (%) + 0.9707 moisture (%) = 74.84

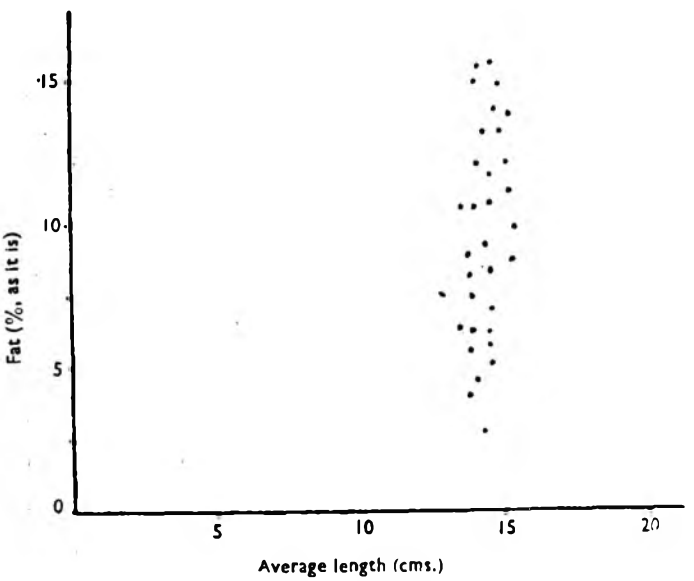

Fig. 2. Fat content and length of oil-sardine fish

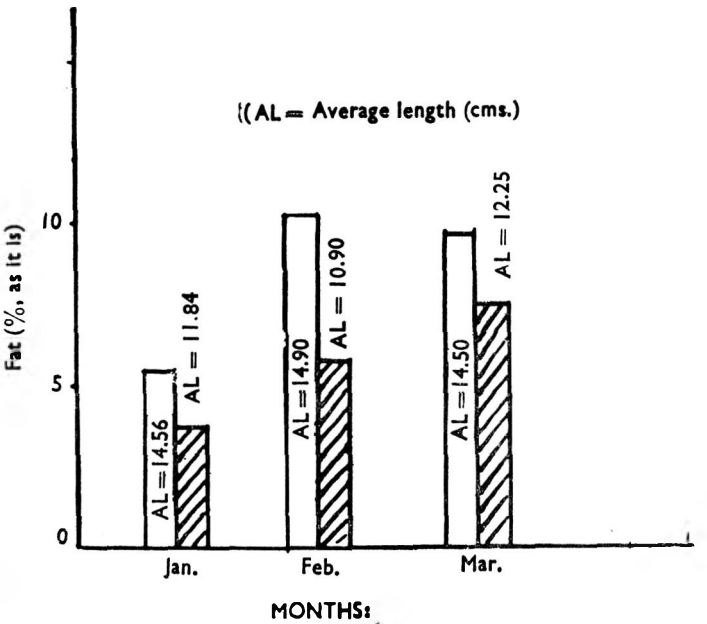

Fig. 3. Fat content and length of oil-sardine fish of the same catch

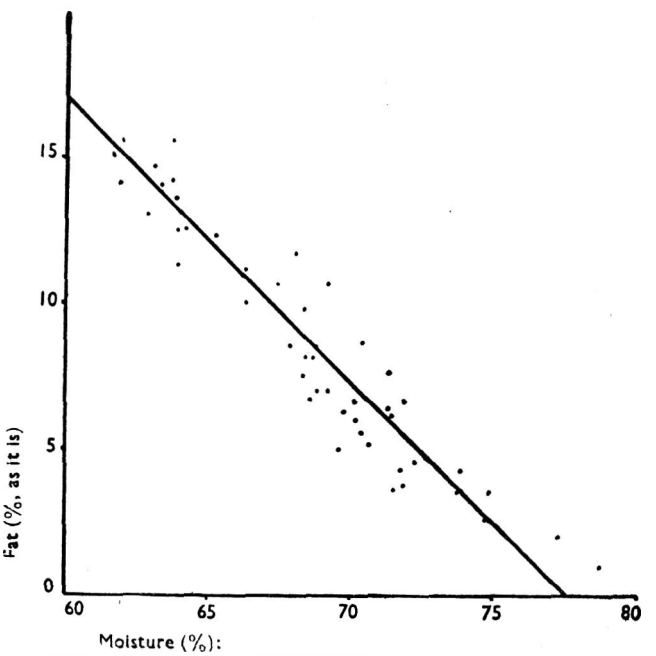

Fig. 4. Fat and moisture contents of whole oil-sardine fish: Fat (%) + 0.9714 Moisture (%) = 75.28

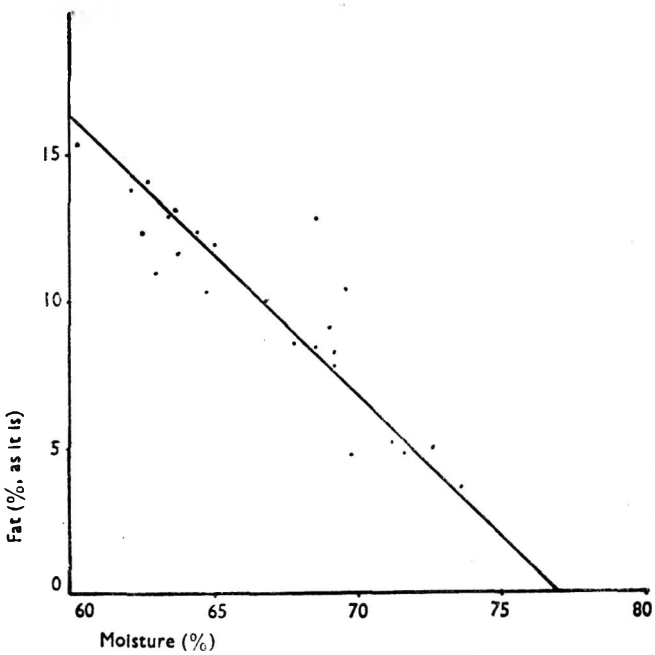

Fig. 5. Fat and moisture contents of head and entrail portions of oil-sardine fish
Fat (%) + 0.9707 Moisture (%) = 74.74

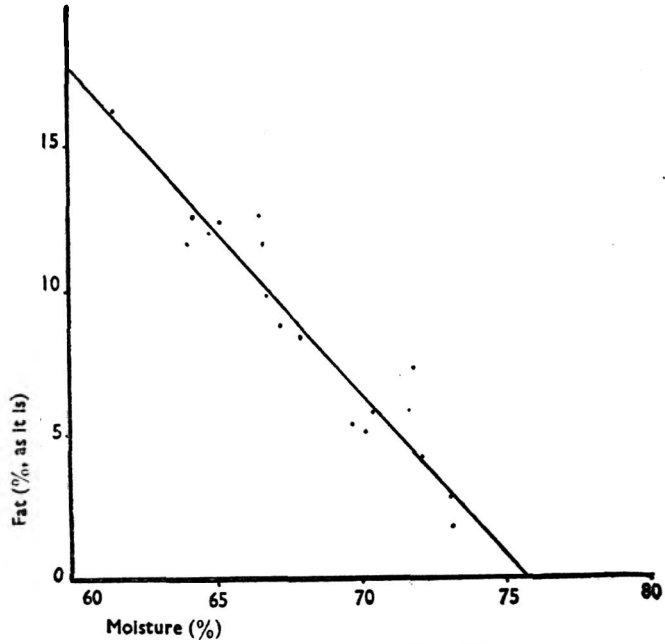

Fig. 6. Fat and moisture contents of body portion of oil-sardine fish
Fat (%) + 1.120 Moisture (%) = 84.92

Seasonal variation of the characteristics of sardine oil from whole fish: The physical and chemical characteristics of sardine oil extracted from whole fish during the different months are given in Table 4. The colour of the oil was greenish, straw, or golden yellow.

Iodine value was found to vary with season, showing two peaks once in August (171) and again in December (161). Minimum values were recorded once in October (158) and again in March (149). The variation in the iodine value of sardine oil during the different months is shown in Fig. 7. Saturated fatty acid content, solid fat content (at 25°C) and refractive index were found to be minimum in August, June—August and April—August respectively.

TABLE 4. SEASONAL VARIATION OF CERTAIN CHARACTERISTICS OF SARDINE-OIL FROM WHOLE-FISH

Month	No. of samples	Iodine value	Saponification value	Saturated fatty acid (%)	Cloud point (°C)	Solid fat content at 25°C (% v/v)	Solid fat content at R.T. (%) (v/v)	Average minimum and maximum Room Temperature	Refractive index (at 30°C)
January	4	156.5 (153.8–160.8)	192.5 (191.5–194.2)	27.3	18.9 (17–21)	29.5 (26–37)	26.0 (22–33)	26.0–32.5	1.4756 (1.4752–1.4763)
February	4	153.9 (152.0–155.2)	193.5 (192.9–194.2)	29.3	17.0 (16–18)	27.3 (25–32)	20.0 (16–23)	26.5–33.5	1.4764 (1.4761–1.4771)
March	4	149.3 (154.8–152.7)	195.9 (187.8–200.1)	29.2	18.5 (17–20)	26.5 (23–30)	23.8 (16–30)	29.0–34.0	1.4757 (1.4740–1.4766)
April	4	150.2 (147.9–154.3)	194.9 (192.7–199.1)	27.7	19.0 (17–20)	21.2 (18–26)	25.8 (21–35)	31.0–36.5	1.4738 (1.4734–1.4744)
May	4	154.3 (150.1–158.1)	193.7 (191.6–193.6)	28.6	16.0 (13–20)	25.7 (17–31)	20.3 (16–34)	30.5–36.0	1.4744 (1.4744–1.4744)
June	2	160.3 (158.6–162.0)	193.6 (193.5–195.5)	26.6	14.5 (14–15)	16 (13–19)	17.0 (16–18)	27.5–33.5	1.4744 (1.4744–1.4744)
July	1	155.2	...	...	...	...	...	27.0–32.0	1.4749
August	5	171.1 (166.7–176.5)	196.1 (195.8–196.3)	23.7	14.7 (14–15)	17.7 (15–22)	13.0 (10–16)	27.5–32.5	1.4742 (1.4739–1.4744)
September	4	160.7 (157.7–164.8)	198.8 (195.8–201.8)	26.0	16.5 (15–18)	25.2 (21–31)	13.5 (10–21)	27.5–33.0	1.4756 (1.4754–1.4759)
October	4	157.4 (156.6–158.8)	199.5 (199.2–199.8)	28.3	16.3 (17–17)	34.0 (31–39)	16.3 (15–19)	27.5–33.0	1.4757 (1.4754–1.4761)
November	4	158.9 (157.6–160.0)	200.7 (198.7–202.3)	28.1	16.3 (15–17)	36.0 (26–40)	15.5 (13–19)	27.0–31.5	1.4756 (1.4753–1.4760)
December	4	161.2 (160.6–161.8)	199.6 (197.0–200.9)	30.1	15.3 (14–17)	27.5 (24–27)	18.0 (17–19)	27.0–33.0	1.4755 (1.4753–1.4756)

Figures in the parenthesis indicate the range.

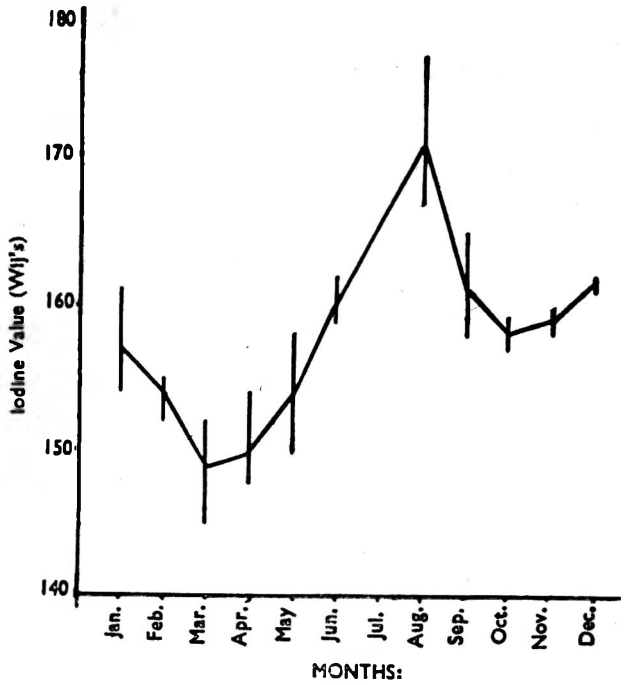

Fig. 7. Seasonal variation in iodine value of oil from oil-sardine fish

Characteristics of oil from (i) head and visceral portions and (ii) body portions: Oil from body portion was found to be more saturated than oil from head and visceral portion as was evident from iodine value, cloud point, solid fat content and refractive index (Table 5). Oil from body portion contained 46-73 per cent solid fat at 25°C whereas with oil from head and visceral portions it was only 14-26 per cent. As many industries prefer fish oil without foot, oil from body portion with a higher amount of solid fat will not be suitable.

However, oil from whole fish was similar or only slightly more saturated than oil from head and visceral portions. Oil from body portion was more saturated and had different characteristics *vis-à-vis* oil from head and entrails.

Seasonal variation of the fat content and amount of recoverable oil: The present study helps us to calculate the recovery of oil expected during a year with a fair amount of accuracy. Theoretical amount of oil recoverable will be the amount of oil present in fish less the amount present in meal. Meal contains about 15 per cent fat if a hand-driven basket press is used and it is about 10 per cent if a screw press is used. On the basis of proportionate monthly landing of the fish in Baikampady (11 km. South of Mangalore) and fat content during the month, theoretical amount of recoverable oil has been worked out in Table 6. It appears that an amount of 91 kg./1000 kg. fish can be recovered during October-March if 10 per cent fat is left in fish meal. If 15 per cent fat is left, the figure is 80 kg. Actual recovery will be 10-15 per cent less due to handling and technological losses.

TABLE 5. CHARACTERISTICS OF OIL EXTRACTED FROM (i) BODY PORTION (ii) HEADS AND VISCERAL PORTIONS AND (iii) WHOLE FISH

Sl. No.	Oil	Iodine value	Saponification value	Cloud point °C	Solid fat at 25°C (% v/v)	Refractive index at 30°C
1.	Body	144.1	198.0	18	73	1.4751
	Head and viscera	150.9	197.2	19	21	1.4769
	Whole	147.4	199.5	17	30	1.4761
2.	Body	141.1	200.5	19	69	1.4759
	Head and viscera	151.1	199.5	16	19	1.4761
	Whole	152.1	200.1	18	24	1.4766
3.	Body	146.8	194.1	20	46	1.4756
	Head and viscera	151.0	194.8	17	19	1.4763
	Whole	152.7	196.3	19	23	1.4761
4.	Body	140.9	193.6	21	46	1.4734
	Head and viscera	154.7	194.3	19	14	1.4744
	Whole	154.3	193.8	17	20	1.4734
5.	Body	149.0	204.3	19	47	1.4760
	Head and viscera	160.0	199.7	17	26	1.4761
	Whole	159.3	200.2	17	26	1.4757

TABLE 6. SEASONAL VARIATION IN THE FAT CONTENT OF OIL SARDINE AND THE AMOUNT OF RECOVERABLE OIL UNDER DIFFFRENT CONDITIONS OF PRESSING

Month	Average fat content %	Proportionate landing for the month (Kg)	Quantity of oil recoverable kg/m. ton fish		Proportionate recoverable oil for the month (Kg)	
			10% fat in meal	15% fat in meal	10% fat in meal	15% fat in meal
January	10.9	182	89	77	16.2	14.0
February	8.8	201	68	56	13.7	11.3
March	9.1	66	71	59	4.7	3.9
April	6.3	12	43	21	0.5	0.4
May	6.0	4	40	28	0.2	0.1
June	4.0	0.5	20	8	...	...
July	3.3	0.5	1.3	0.1	...	...
August	9.4	10	74	62	0.7	0.6
September	14.6	32	126	114	4.0	3.7
October	12.6	57	106	94	6.0	5.4
November	13.0	192	110	98	21.1	18.8
December	14.0	243	120	108	29.2	26.2
		1000	...	...	96.3	84.4

Acknowledgment

Our thanks are due to Dr B. L. Amla, Chairman, Discipline of Experiment Stations and Dr H. A. B. Parpia, Director, Central Food Technological Research Institute, Mysore, for their keen interest in the work. Our thanks are also due to Sri K. P. Hegde, Assistant Director of Fisheries, (Govt. of Mysore) Mangalore for making available the data of day-to-day landing of oil-sardines at Baikampady.

References

1. Association of Official Agricultural Chemists, *Official and Tentative Methods of Analysis*, Washington D.C., 1960. 19 Ed.
2. American Oil Chemists Society, *Official and Tentative Methods*, Chicago, Illinois, 1946 (with additions and revisions upto 1957).
3. Prabhu, M. S., *The Oil Sardine*, in Central Marine Fisheries Research Institute Souvenir 20th Anniversary, Mandapam.

Studies on the Artificial Drying of Salted Mackerel

S. V. Suryanarayana Rao and V. S. Khabade
Central Food Technological Research Institute, Mysore, India

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A study of the drying characteristics of salted mackerel was undertaken with the object of designing a commercial dryer. The scope of the investigation was limited to the study of the drying rate under controlled conditions. The optimal condition for artificial drying of fish in a tray drier with cross flow air current was found to be hot air temperature 45°C at a relative humidity level of 50%. Salting of mackerel before mechanical drying was found to be more advantageous.

Sun dried fish marketed in India is of a low quality because of the acute spoilage during the drying stage especially in monsoon seasons. Apart from the high residual moisture content (around 45 per cent) sun dried fish show excessive and contamination and insect infestation. Mechanical dehydration can, not only overcome these adverse conditions but will also ensure a more uniform and reliable finished product. Although artificial drying of salted fish has been in vogue in Canada for some years, it is not common in tropical countries. A few dryers have been installed at Hong Kong and Colombo but since these are based on the processes developed in temperate countries for drying at 27°C and need dehumidification equipment, attempts have been made to dry fish at higher temperatures[1]. In confirmation of these earlier Canadian studies more evidence is now available that tropical fish can safely withstand higher temperatures without showing evidence of cooking[2]. Based on these observations, preliminary investigations on the drying of mackerel have been undertaken, to standardise conditions for artificial drying. A study of the drying characteristics is the first step towards the design of a commercial dryer.

Materials and Methods

Study of the drying characteristics of mackerel were conducted in an experimental dryer designed and fabricated at this Institute. Essentially it was a batch operated dryer employing cross flow of hot air with controls for temperature and air velocity. Relative humidity of the inflowing air was regulated by injecting steam at constant pressure. Overall dimensions of the drier were 33 cm×33 cm×168 cm. Air flow was maintained by a fan working under variable voltage and air was heated by 6 kw. coil heaters—the air was humidified with steam and entered the drying cabinet through a 15 cm. diffuser. Fish were placed in three wire net trays, the size of each being 55 cm×32 cm. Humidity and temperature were recorded at the centre of the drying chamber by dry and wet bulb thermometers.

The fish used for drying were of medium size (15 to 17 cm) and the weight of each fish was 50-65 g. Thickness of the fish varied from 1.0 to 1.2 cm. on the side with the vertebral column and 0.7 to 0.9 cm. on the thinner side. Surface area of each was of the order of 75 to 87.5 sq. cm. Fresh mackerel transported in ice were used for the study. The fish were eviscerated, split and washed before curing with salt. Salt ratio employed was 1:5 and salting was terminated after 20 hours. Salted fish were rinsed slightly in water for removing adhering salt. Outside moisture was removed carefully and 5 to 10 fish were placed in each tray for drying. Weights of five selected fish were followed at intervals to obtain the drying rate.

Initial moisture content of the fresh fish was about 75.0 per cent and the moisture content after salting varied from 57.0 to 60.0 per cent (whole fish), the muscle moisture content was 63.5 per cent. Moisture content of the whole fish (with head, skin, the skeletal portion and the tail) was employed in computing the drying characteristics. On dry weight basis it was 150 g. per 100 g. of fish solids.

Fat content of the fish employed was in many cases 1.5 to 7.6 per cent on original moisture basis but it was within the range observed by Chidambaran *et al.*[3] for fish of this size. Quality of the raw material used was satisfactory as evidenced by the low

total volatile nitrogen, (TVN) value (11.6 to 20.0 mg. N per cent).

Initial investigations : In preliminary studies, mechanically dried fish were compared with samples obtained by sun drying with regard to colour, reconstitution and general quality. Drying temperature of the range 35°C to 60°C were tried before choosing 45°C as the optimum temperature for hot air drying. Initial attempts towards mechanical dehydration were also concerned with the possibility of drying fresh mackerel without preliminary salting. In one experiment, fish salted in the usual manner were desalted partially before the commencement of drying. Results of these experiments are discussed along with the observations in final studies. The salt content of the final product was 24.92 per cent on dry weight basis when the salt ratio was 1:5 but at a higher ratio of 1:3 the salt content was 28.71 per cent.

A few chemical observations were made on the changes during processing by standard methods for TVN, free fatty acids and extractable colour with 50 per cent alcohol.

Calculation of drying rate : Drying rate under controlled conditions was obtained by weighing five fish at intervals of 0.5 to 12 hours and obtaining loss of moisture, (W_o-W_t) (Table 1). Drying rate $\triangle l/\triangle t$ was read from the moisture loss curve (Fig. 1) and the same has been recorded in Table 2. Drying was interrupted after 6 hours and continued the next day, storing the material in air tight packings.

TABLE 1. LOSS OF MOISTURE (W_o—W_t) AS GRAMS/100 G OF DRY MATTER

(Air velocity 150 m/min unless otherwise stated)

Sl. No.	Processing conditions	Loss of moisture after specified hours					
		1	2	4	6	8	12
1.	Temp. 45°C; R.H. 50%	18.3	30.8	51.1	63.9	77.0	89.5
2.	Temp. 45°C; R.H. 30%	18.0	24.0	31.3	35.1	41.0	49.7
3.	Temp. 50°C; R.H. 50%	26.2	39.3	48.4	55.0	67.5	78.5
4.	Temp. 45°C; R.H. 50% Velocity of air 180 m/min	25.3	37.6	48.0	56.0	68.1	76.4
5.	Accelerated drying — R.H. 50%; initial temp. 40°C raised to 45°C after 4 hr and to 50°C after 8 hr.	20.3	32.0	45.0	53.0	60.0	68.5
6.	Temp. 45°C; R.H. 50%; large fish (18-20 cm) employed for drying	22.8	38.0	52.7	60.7	73.2	90.6
7.	Temp. 45°C; R.H. 50%; fish dried with splitting	15.4	24.0	37.5	45.2	54.3	64.4

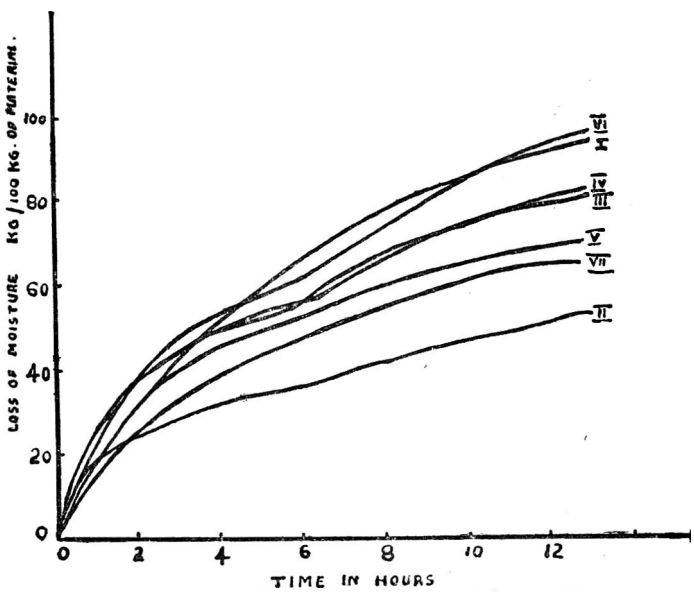

Fig. 1. Drying rate of eviscerated and fully split, eviscerated but not fully split

TABLE 2. DRYING RATE OF SALTED MACKEREL

Group No.	Method of dressing	Size of fish cm	Temp. of hot air	R.H. %	Drying rate ($\triangle l/\triangle t$) 1 hr	2 hr	4 hr	6 hr	8 hr	12 hr
1.	Eviscerated and fully split	15-17	45°C	50	16.0	10.0	8.0	6.5	5.0	3.0
2.	,,	,,	,,	30	9.0	4.0	2.5	2.5	2.5	2.0
3.	,,	,,	50°C	50	18.0	10.0	4.5	4.0	5.0	2.5
4.	,,	,,	45°C	50	18.0	8.0	4.5	4.5	5.0	2.5
5.	,,	,,	40° to 50°C*	50	16.5	10.5	4.0	3.5	3.0	2.0
6.	,,	18–20	45°C	50	19.0	11.0	4.0	5.0	5.0	3.5
7.	Eviscerated but not split fully	15–17	45°C	50	11.0	8.0	5.0	4.5	2.5	1.5

* Temperature increased by 5°C every 4 hours.

Although this introduced a break in the drying rate curve, such interrupted drying was found actually beneficial in cutting down the period of drying as shown by Canadian workers[1].

Results and Discussion

But for a preliminary report on the possibility of artificial drying of Indian fish by Prabhu *et al.*, critical investigations on the mechanical dehydration have been lacking in India. Earlier authors have dried several types of fish under arbitrarily chosen conditions instead of a detailed study of the drying characteristics of any single species of commercial importance as in the present study. Moreover, many of their drying experiments were carried on fish rubbed with salt and placed

immediately in the dryer. This entailed extra load on the dryer. If salt curing was completed before the commencement of drying, large quantity of moisture was leached out and drying was easier. Although light salting was reported to be their objective, it was observed that such light salted fish do not keep well under tropical conditions. Moreover, light salting can be achieved by a preliminary dip treatment in brine and not by placing salted fish in the dryer.

The preliminary investigations showed that fresh mackerel without salt curing was unsuitable for drying. Although the rate of drying was higher (22.0 after 1 hr as against 16.0 for salted fish) with fresh fish, prolonged drying was necessary (4 days involving 24 hr of drying) since the products were susceptible to mould growth and insect attack during storage. It took 24 hr to reduce the moisture to 17.6 per cent suitable for such products. Moreover, intensive browning was also observed during the drying of fresh fish (Klett reading 204 with 42 filter as compared to 60 for salted fish). Drying of partially desalted fish was also unsuccessful since mould growth was common in such products as residual salt was insufficient to prevent microbial spoilage. It was therefore profitable to employ salted mackerel for mechanical dehydration.

Temperature of hot air employed was adjusted to 45°C after preliminary trials. Cooking of the fish and yellowing was observed in half an hour at 50°C which became more marked at 60°C; drying at lower temperature (35° and 40°C) showed a slight increase in the free fatty acid content. Moreover it may be observed from Table 2 that the drying rate at 40°C showed (under accelerated drying) a marked fall after the first 2 hr as compared to drying at 45°C.

It may be observed from the data that hot air temperature of 45°C at a relative humidity level of 50 per cent offered the optimum conditions for the artificial drying of fish. Reduction of the humidity level had no advantage since drying rate came down rapidly in half hour. When the rate of drying was too rapid in the initial stages, case-hardening appeared to set in and brought down the rate within a few hours. It was necessary to maintain the RH per cent high enough in later stages as reported by earlier workers.

Fish dried as above were found to be comparable in quality to sun dried products. Colour of the products was of the same order (57 per cent as against 55 per cent transmission) and TVN value was 25.95 mg per cent as against 31.2 mg per cent in the case of sun dried fish. Organoleptically the taste panel could not distinguish between the two samples. Mould growth during storage was less in the case of mechanically dried fish. It is therefore evident that artificial drying is suited for salted fish. This would ensure products of a more uniform and reliable quality.

The majority of fish dried during these trials were of 16-17 cm. in length. With larger fish of 18-20 cm. length a slight reduction in drying rate in latter stages was observed, but the period of drying did not exceed 12 hr and the final moisture content after this period was found to be 33.9 per cent. Final moisture content varied from 30.0 to 38.4 per cent in the drying experiments (Table 2).

Velocity of air employed during these trials was adjusted at 150 m/min but lower velocities may also be employed since drying rate is better during the initial stage when a lower velocity of 120 m/min is employed and drying rate reached a higher level again after the renewal of drying in the second stage of drying. Attempts to increase the rate of drying by a gradual increase of temperature from 40° to 50°C during the period did not appear to be advantageous since higher temperature had no effect in raising the rate of drying in later stages, probably due to the case hardening taking place when the fish gets dried too rapidly at 40°C in the first few hours.

Another point investigated during these trials was the possibility of drying mackerel without splitting them and spreading them fully since unsplit fish present a better appearance. Drying rate was very much lower in this case and the final moisture content was slightly high (38.7 per cent). It may however be possible to dry the fish without splitting if preservatives like sorbic and propionic acids were incorporated.

Table 3 shows the chemical changes observed during the drying of fish. There was no change in FFA and the increase in TVN was slightly less compared to sun dried fish in which severe deterioration is fairly common.

The possibility of combining mechanical dehydration with partial sun drying was also investigated. This reduces the cost of drying and increases the production capacity provided the hygienic conditions during sun drying are improved. It was found that artificial

TABLE 3. CHEMICAL CHANGES DURING THE DRYING OF SALTED MACKEREL AT 45°C AND R.H. 50%

	Time in hr			
	0	6	12	18
Moisture (%)	64.71	47.05	35.02	23.8
TVN (mg%)	11.66	16.8	17.0	20.0
FFA (ml. N/10 NaOH/g fat)	22.09	18.8	18.68	18.67
Colour by Klett (42 Filten) reading	33	57	60	95

drying in the initial stages gave better results than the reverse procedure of dehydrating partially sun dried samples. This aspect needs further investigation.

Results of the present investigation may now be compared with the earlier studies by Canadian and Indian workers. Among the Cambodian fish studied by Legendre[1] 'Trey Chdor' can be compared with mackerel in the initial moisture and fat contents. Drying rate observed with mackerel was much higher but the difference might be due to the size and thickness of the fish which are unknown. Prabhu *et al.*[4] have reported only one experiment wherein they dried mackerel at 40°C and 55 per cent RH and comparable air velocity. It was observed that the drying rate curve was similar to their study although they have recorded a higher drying rate. Comparison with Canadian work showed that the fall in drying rate was more gradual. Although Prabhu *et al.* have continued the period of drying salted mackerel upto 24 hours to obtain a product of 20-25 per cent moisture content, such prolonged drying is not recommended for salted fish since the texture becomes quite hard with intensive drying.

The authors feel that artificial drying for 12 hours at 45°C and 50 per cent RH would be satisfactory leaving the fish at 30-35 per cent final moisture content. Alternatively mechanical drying for 6 hours (reducing moisture level to 45-50 per cent) can be followed by sun drying if it is conducted in a hygienic manner.

Acknowledgment

The authors thank Dr H. A. B. Parpia, Director of this Institute and Dr N. L. Lahiry, Chairman of the Meat, Fish and Poultry Technology Discipline, for their keen interest and encouragement. Thanks are also due to Sri G. D. Revankar who helped in the preliminary investigations.

References

1. Legendre, R., *J. Fish. Res. Bd, Canada*, 1961, **18**, 147.
2. Cutting, C. L., *Technological Problems of Dehydration and Freeze Drying of Fish and the Possible Contribution of Fundamental Research*, Symposium on Technology of Fish Utilization, Husum, 1964.
3. Chidambaram, K., Krishnamurthy, C. G., Venkataraman, R. and Chari, S. T., *Proc. Ind. Acad. Sci.*, 1952, **35**, 43.
4. Prabhu, P. V. Swaminathan, M., Venkataraman, R. and Bose, A. N., Investigations on Dehydration of Some Commercial Fish in India, Tech. Paper IPFC/C62/Tech. 22, Seoul.

Effect of pre-Harvest Spray of *alpha*-Naphthalene Acetic Acid and *para*-Chloro Phenoxyacetic Acid on Control of Berry Drop in *Anab-e-Shahi* Grapes (*Vitis vinifera* Linn.)

M. Madalagatti Rao*, P. Narasimham, N. Nagaraja and B. Anandaswamy
Central Food Technological Research Institute, Mysore

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Post-harvest berry drop in *Anab-e-Shahi* grapes was nearly 10 per cent during transit and storage. Both *para*-chloro phenoxy acetic acid and ∝-Naphthalene acetic acid at three concentrations, viz., 50, 100 and 250 ppm with either 4 per cent Waxol-O or water containing 0.5 per cent Tween-80 as carrier, when sprayed 3 days prior to harvest onto *Anab-e-Shahi* grape bunches, resulted in reduction of berry drop. ∝-NAA at 100 ppm either with water or 4 per cent Waxol-O as carrier was found to be optimum for checking berry drop both during transit and storage, while increasing its concentration to 250 ppm did not show substantial further reduction in berry drop.

The authors have reported earlier that *alpha*-naphthalene acetic acid (∝-NAA) is effective in checking berry drop[1] in *Bangalore Blue* grapes (*Vitis labrusca* Linn.). But, grape varieties have been reported to differ in their response to growth regulators. Lavee[2] reported that pre-harvest application of ∝-NAA or *para*-chlorophenoxy acetic acid (PCPA) effectively checked berry drop in *Muscat* of *Hamburg* variety, but failed in *Dabouki* variety. Pentzer[3] reported that pre- or post-harvest application of ∝-NAA did not increase the berry adherence in any of the *vinifera*, *labrusca* and *rotundifolia* varieties. Weaver[4], however, reported better adherence of berries with *Thomson Seedless* grapes by the application of PCPA. This varietal difference in response to growth regulator may be due to the existence of different types of berry shatter[5, 6].

Materials and Methods

The study was carried out in February 1966 at Hyderabad in a healthy vine yard where conditions of manuring and irrigation were uniform. The plot was divided into rows demarcated by stone pillars. The different rows were picked at random for each of the treatments. Fifty bunches of uniform size and maturity were selected for each treatment and were sprayed with the growth regulator formulations. Two growth regulating chemicals ∝-NAA and PCPA were used at levels of 50, 100 and 250 ppm either in water with 0.5 per cent Tween-80 or in 4 per cent Waxol-O as carrier; 4 per cent Waxol-O was prepared by diluting the 12 per cent stock emulsion with water[7].

Three days after spraying, the treated bunches were harvested and packed (according to trade practices) in deal-wood fruit packing cases of 5 kg. capacity, using the same quantity of cushioning; three replicates were taken for each treatment. The packages were transported by rail to Mysore, over a distance of 800 km by passenger train, thereby subjecting the fruits and packages to normal transport hazards like vibration, shunting, dropping, etc. In the laboratory the packages were opened and weights of the healthy intact bunches, dropped sound berries, crushed and decayed berries were recorded separately. Four kilograms of the healthy and intact bunches were placed in each wooden crate, in duplicate for each treatment and stored at 0°C, 85-90 per cent R.H. Periodical observations were made of the weight of intact bunches, dropped sound berries as well as decayed berries and

* Present address: University of Agricultural Sciences, Bangalore.

TABLE 1. BERRY DROP DURING TRANSIT AND STORAGE AT 0°C IN *Anab-e-Shahi* GRAPES TREATED WITH GROWTH REGULATORS BEFORE HARVEST

Treatment	Per cent berry drop during					
	Transit	Storage after weeks (cumulative)				
		2	3	4	5	6
1. PCPA 50 ppm in 4% Waxol-O	3.6	1.5	1.5	2.6	2.6	3.5
2. PCPA 100 ppm in 4% Waxol-O	2.0	1.9	2.4	3.4	3.4	4.5
3. PCPA 250 ppm in 4% Waxol-O	3.2	0.7	1.5	2.9	3.4	3.9
4. ∝-NAA 50 ppm in 4% Waxol-O	1.8	1.2	1.4	2.2	2.5	3.6
5. ∝-NAA 100 ppm in 4% Waxol-O	2.3	1.2	1.6	2.3	2.6	3.1
6. ∝-NAA 250 ppm in 4% Waxol-O	0.5	0.6	1.2	2.1	2.1	2.7
7. PCPA 100 ppm in water with 0.5% Tween-80	1.4	1.7	2.2	4.3	5.2	8.5
8. ∝-NAA 100 ppm in water with 0.5% Tween-80	0.7	0.3	0.6	1.7	2.0	2.7
9. Waxol-O 4%	3.3	1.6	2.1	2.8	4.0	5.0
10. Control (no treatment)	8.7	2.0	2.8	6.6	7.6	9.1

the cumulative percentage berry drop was worked out. The data on berry drop is presented in Table 1.

Results and Discussion

During transit by rail, treated lots showed less berry drop than untreated control lot. ∝-NAA at 250 ppm, in 4 per cent Waxol-O and PCPA at 100 ppm in water containing 0.5 per cent Tween-80 showed minimum berry drop, closely followed by ∝-NAA at 50 and 100 ppm in Waxol-O treatments (Table 1).

Data on cumulative berry drop during storage at 0°C and 85-90 per cent R.H. showed that in general, the berry drop was less in treated bunches compared to untreated control. At the end of 6 weeks storage, least berry drop was observed in ∝-NAA at 100 ppm in water containing 0.5 per cent Tween-80 and ∝-NAA 250 ppm in Waxol-O. Between PCPA and ∝-NAA with Waxol-O as the carrier, ∝-NAA showed less berry drop both at 100 and 250 ppm concentration. The treatment with the water solution of PCPA at 100 ppm, showed less berry drop in initial stages of storage but still recorded the highest overall berry drop (8.5 per cent) among the treatments at the end of 6 weeks. This was next only to the control.

Acknowledgment

The authors are thankful to Dr H. A. B. Parpia, Director, C.F.T.R.I., Mysore and Mr H. C. Bhatnagar, Chairman, Fruit and Vegetable Technology Discipline, C.F.T.R.I., Mysore, for their keen interest in this investigation.

References

1. Narasimham, P., Madalagatti Rao, M., Nagaraja, N. and Anandaswamy, B., *J. Fd Sci. Technol.*, 1967, **4** (4), 162.
2. Lavee, S., *Vitis*, 1959, **2**, 34.
3. Pentzer, W. T., *Proc. Am. Soc. hort. Sci.*, 1941, **38**, 397.
4. Weaver, R. J., *Calif. Agric. Exp. Sta. Bull.*, 1956, 752.
5. Nelson, K. E., *Blue Anchor*, 1955, **32** (2), 6.
6. Winkler, A. J. *General Viticulture*, Univ. Calif. Press, Los Angeles and Berkeley, 1962.
7. Dalal, V. B., Singh, N. S. and Eipeson, W. E., *Annu. Rep.* Central Food Technological Research Institute, Mysore, 1966, 40.

Preparation of Liquid Fruits by Enzymic Processing

K. R. Sreekantiah, S. A. Jaleel and T. N. Ramachandra Rao
Central Food Technological Research Institute, Mysore

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A pectinolytic enzyme developed in this laboratory was utilized to express juice from guava fruits. The enzyme shows maximum activity when used at 0.5 per cent level and incubated at 40°C for 18 hours. Original flavour and other constituents are preserved in the 'liquid fruit'.

Microbial enzymes are being used in the food industry in various processing operations. Newer applications are being found every day for enzymes. Pectinase is being used for the clarification of wines and fruit juices since 1930. Pectinolytic enzymes used in commercial operations hydrolyse pectic substances and thus aid in the flocculation of suspended particles and clarification of the juice. In some fruits like banana, guava, mango, etc., it is not possible to press the juice out by conventional methods. When the fruit pulp is treated with pectinolytic enzymes, extraction and clarification of juice are made easy. Even in fruits like grapes, where the juice can be pressed out easily, the yield of free run juice is increased by enzymic treatment[1-4]. Sreekantiah *et al.*[5] have reported, in different fruits, an increase in the juice yield, from 5 to 42 per cent. Joseph *et al.*[6] have obtained 13 per cent increase in the free run juice from grapes by enzyme treatment. In the earlier experiments, two types of enzyme sources, viz., mouldy bran (MB) and crude enzyme powder (CEP) were utilized. Recently a third type, enzyme liquid concentrate (ELC) has been developed, and its efficacy in liquifying guava (*Psidium guajava* L) fruits and clarification of juice were studied. The findings are recorded here.

Materials and Methods

Ripe guava fruits of Allahabad variety were obtained from the local market. Fruits were washed in running tap water and pulped in a pulper. The pulp was warmed to inactivate the innate enzymes. In addition to the enzyme preparation developed at this laboratory (ELC)*, commercial samples were also used for comparison. Acidity and pectin content were determined as per methods given by Ruck[7]. Total tannin was estimated as gallotannic acid by AOAC[8] procedure. Ascorbic acid was estimated colorimetrically by indophenol method. Soluble solids content expressed as °Brix was determined by a hand refractometer. pH was determined by a Photovolt bench pH meter.

Results and Discussion

Effect of pectinolytic enzymes on the liquefaction of guava pulp: Guava pulp prepared as described earlier, was divided into lots and pectinolytic enzyme was added according to the recommended dosages. The mixture was allowed to stand on the laboratory bench for 16 hours. The juice was expressed through a cheese cloth in a basket press and analysed for important constituents. The data are presented in Table 1.

The results show that both CEP and MB give similar values and are comparable to those of commercial preparations. ELC is as effective as precipitated

Table 1. Comparative efficacy of pectinolytic enzyme preparations for the extraction of fruit juices

Enzyme source	Concentration	Yield of juice % by wt.	pH	°Brix	Acidity %	Ascorbic acid mg/100 g
ELC	0.3	86	4.3	11.0	0.37	186
MB	0.3	84	4.3	11.0	0.37	185
MB (Commercial$_1$)	0.3	84	4.3	11.0	0.37	185
MB (Commercial$_2$)	0.3	85	4.3	11.0	0.37	185
CEP	0.1	86	4.3	11.0	0.37	187
CEP (Commercial$_1$)	0.1	86	4.3	11.0	0.37	187
CEP (Commercial$_2$)	0.1	86	4.3	11.0	0.37	187
Pulp (Control)	...	...	4.1	10.0	0.35	190

* The enzyme liquid concentrate (ELC) was produced in this laboratory by cultivating a strain of *A. niger* on a suitable substrate, extracting in water and concentrating.

enzyme powder. Yield of juice obtained from different treatments was almost similar and there was no variation in composition.

Effect of concentration of enzyme on the yield of juice: The dosage of enzyme used in the previous experiment was based on the manufacturer's recommendations. In order to find out the concentration of ELC at which maximum yield of juice is obtained, the enzyme was used at concentrations of 0.25 to 5.0 ml. per kg. of pulp. The quantity of juice obtained and other data are plotted in Figure 1.

The results indicate that the yield of the juice increased upto 1 per cent enzyme level, even though the increase was not commensurate with the quantity of enzyme added. When the concentration of enzyme was 0.5 per cent, the yield of juice almost reached a maximum. There was a gradual increase in acidity and soluble solids content also, upto 0.5 per cent enzyme concentration.

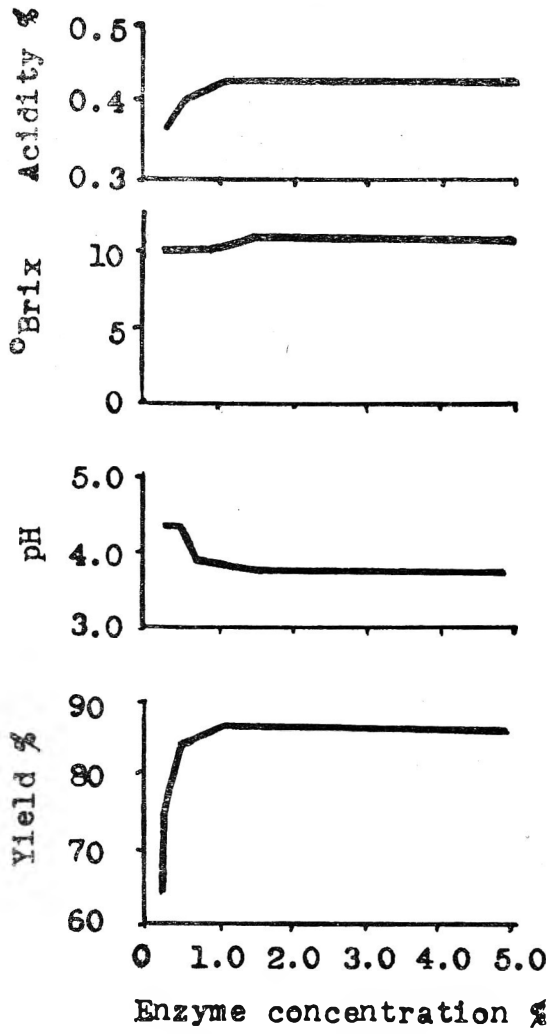

Fig. 1. Effect of enzyme on the processing of guava fruit

Effect of temperature on enzyme activity : After adding enzyme at 0.5 per cent level, samples of the pulp were incubated at different temperatures ranging from 25 to 50°C for 18 hours. Juice was then expressed from these. Results are recorded in Table 2.

The results show that there was very little change in the yield of juice up to 40°C. Increase in tempera-

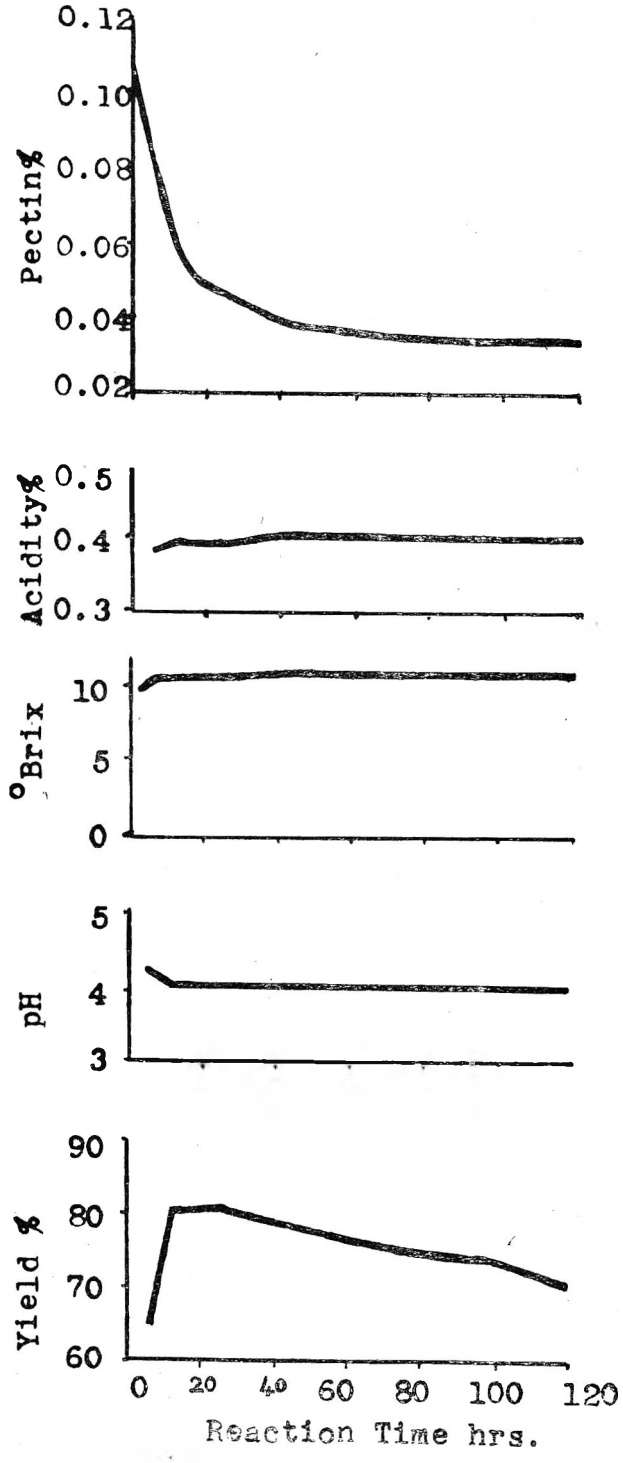

Fig. 2. Effect of time on enzyme activity

TABLE 2. EFFECT OF TEMPERATURE ON THE ACTIVITY OF PECTINOLYTIC ENZYME

(Incubation time—18 hours)

Temp. °C	Yield	Acidity-%	pH	°Brix
25-28	84	0.44	3.8	11.0
30	85	0.44	3.8	11.0
40	85	0.44	3.8	11.0
45	80	0.46	3.75	12.5
50	74	0.48	3.75	13.0

tures above 40°C reduced the yield, due to evaporation. This was confirmed by the increase in acidity and soluble solid content of the juice obtained at higher temperatures. Enzyme treated pulp was incubated at 40°C and samples were withdrawn at different intervals to find out the optimum time for enzyme treatment. The relevant data are plotted in Fig. 2.

The pectin content of the pulp decreased rapidly due to the enzyme treatment. After 18 hours the rate of degradation was slowed down and almost came to a standstill in 48 hours. The yield showed a lower value after prolonged incubation, probably due to evaporation. Consequently, the values for other constituents showed an increase.

Thus, it was observed that the optimum conditions for processing guavas were: an enzyme concentration of 0.5 per cent on the basis of pulp, and an incubation temperature of 40°C for 18 hours. This treatment did not completely degrade the pectin. This was desirable because it had been reported by Charley[9] that a small quantity of pectin gives 'body' to the juice.

Large quantities of guava pulp (20-100 kg. batches) were treated with the enzyme under the above mentioned conditions, and the juice was expressed in a filter press. The juice was filled in carboys and held at 2-3°C for 48 to 72 hours. This facilitated the settling of suspended particles and a clear supernatant was obtained (Fig. 3). After filtration, a sparkingly clear juice was obtained. Another point which had to be considered in the preparation of clear juices by enzymic treatments was the tannin content of the fruit, which ranged from 200 to 500 mg. per 100 g. of the pulp, depending on the maturity of the fruit. The enzyme treated juice contained only 30 to 55 mg. of tannin per 100 ml. of juice. Unripe fruits have generally high tannin content. According to Sastry[10] tannin content rises till 60 days (950 mg/100 g)

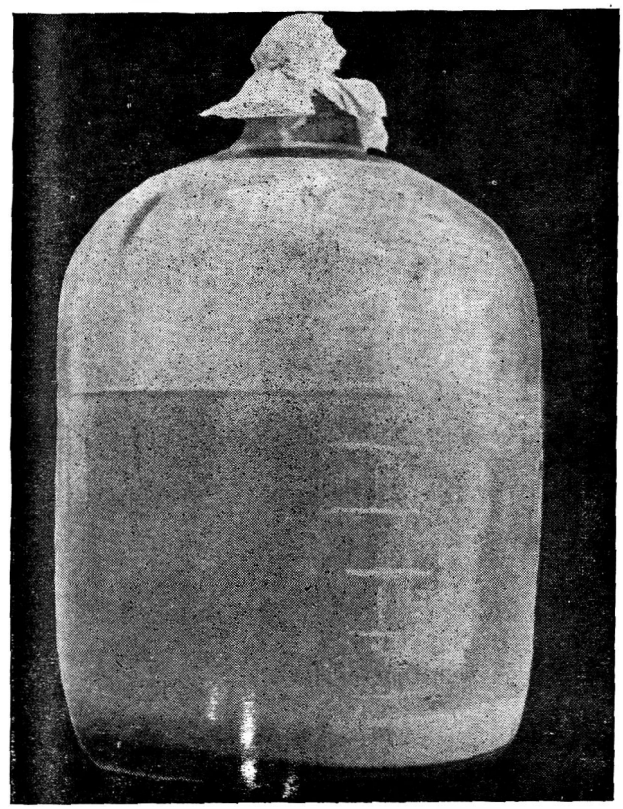

Fig. 3. Deposition of suspended particles at the bottom in a carboy racked at 35°F for three days after expression of juice from the pulp after enzyme treatment

during the development of fruit and gradually comes down to 290 mg. after 150 days, i.e., at maturity. This value further comes down in enzyme treated juice. Polyphenols not only prevent the settling of suspended particles, but also act as inhibitors of pectinolytic enzymes as reported by Mehlitz and Mass[11] and Kieser *et al.*[12]. However, if the tannin content of the juice interfered with clarification, necessary quantity of gelatine can be used to separate out tannin.

In the conventional process, the pulp is boiled with water and extracted, as reported by Waldt and Mahoney[18]. By this method, the natural flavour of the fruit, and certain valuable constituents like ascorbic aeid (160-200 mg. per cent) are lost.

From the foregoing, it is evident that 85 per cent yield of juice is obtained by enzyme treatment of pulp. The juice obtained has the natural flavour of the fruit.

Acknowledgment

The authors wish to express their gratitude to Dr H. A. B. Parpia, Director, C.F.T.R.I., Mysore for his continued interest and useful suggestions during the course of this work.

References

1. Hickinbottam, A. R. and Willium, J. L., *J. agric. Sci.*, 1940, **43,** 491.
2. Cruess, W. V. and Kilbuck, J. N., *Wines and Vines*, 1957, **28,** 23.
3. Kasano Yoshiyasa, *Makko Kyokaishii*, 1959, **17,** 265.
4. Newbeck, C. E., *J. Ass. Off. agric. Chem.*, 1959, **42,** 373.
5. Sreekantiah, K. R., Shastry, M. C. S., Johar, D. S., Ramachandra Rao, T. N. and Bhatnagar, H. C., *Fd Sci.*, 1963, **12,** 364.
6. Joseph, R., Sreekantiah, K. R. and Johar, D. S., *Fd Sci.*, 1963, **12,** 369.
7. Ruck, J. A., Bull No. 350, Canad. Dep. of Agric., Summerland, 1956.
8. *Official Methods of Analysis*, Assoc. of agric. Chem., Washington, 1950.
9. Charley, V. L. S., *Production and Application of Enzyme Preparations in Food Manufacture*, Published by Soc. Chem. Ind., London, 1961.
10. Sastry, M. V., *Indian Fd Packer*, 1965, **19** (5), 5.
11. Mehlitz, A. and Mass, H., *Untersuch. Lebensmitt*, 1935, **68,** 91.
12. Kieser, M. E., Pollard, A. and Williams, A. H., *Chem. Ind.*, 1953, 1260.
13. Waldt, L. M. and Mahoney, R. D., *Fd Technol. Champaign*, 1967, **21,** 87.

THE KAIRA DISTRICT CO-OPERATIVE MILK PRODUCERS' UNION LTD., ANAND

Organised a Seminar on the 'Protein Crisis in India' under the auspices of the Indian Medical Association (Baroda Branch) on 6 October 1968. Among the speakers were: Dr P. R. Krishnaswamy on 'Protein and Calorie Needs of the Young Child and Ways to Meet Them.' Dr H. A. B. Parpia on Protein deficiency in the Indian diet and the ways to over come it. Dr (Mrs) Nirmala Swamy on Protein Requirements in Pregnancy. Dr P. M. Trivedi on Protein Requirements in Surgical Conditions. Dr V. P. Vaishnav on 'Protein in Immunology'. The occasion was also used to release Bal-Amul—a high protein weaning food prepared by K.D.C.M.P., to the medical profession. A brochure giving details of this product was also distributed.

Trials with an Infant Food Supplement Based on Groundnut Flour in the Diets of Young Children*

SHEILA M. PEREIRA, G. JESUDIAN, R. SAMBAMURTHY AND V. BENJAMIN
The Christian Medical College and Hospital, Vellore

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Two feeding trials with an infant food supplement based on peanut flour were carried out in a village, with children aged six to eighteen months. A milk food served as a control supplement. In the first trial twentyseven children ranging from six to eighteen months of age were allocated to two groups and both groups given *ad libitum* supplementation with the infant food based on peanut flour and control food for six months. In the second trial, infants were allocated to the two groups sequentially at the age of six months and maintained on the trial for ten months. In both studies, the increases in height and weight of the children on the infant food based on peanut flour were comparable to those of the children given the full cream milk supplement.

The milk available in India would, if shared equally by the population, provide five to six ounces per person per day[1,2]. Increasing dairy production is often a slow and expensive undertaking; milk and milk products are not likely to be freely available in our country over the next few years. Babies and young children, in particular, require protein foods of good biological value during the years of rapid growth and development and food technologists have explored available sources of protein other than milk for this purpose.

This paper presents the results of feeding an infant food based on peanut flour to infants and young children.

Materials and Methods

Test food: The spray dried infant food based on peanut flour ('test' food) was processed by the Central Food Technological Research Institute, Mysore[3]. It contained about 25 per cent skimmed milk solids. The protein content of the food was 26 per cent; of this sixty per cent was provided by peanut flour, thirty per cent by skim milk solids and ten per cent by cereal. It was fortified with vitamins and minerals. A widely used infant food prepared from buffalo milk[4] served as the control. For these studies, the protein content of the test food was adjusted from twenty six to twenty two per cent (by the addition of powdered sugar), to make it equivalent to that of the control food. The chemical composition of the foods is given in Table 1.

Experimental subjects: Two feeding trials were conducted with the infant food based on peanut flour, with children resident in a village, from 1965 to 1967.

In the first study, thirty three children between six and eighteen months of age were divided into two groups on the basis of age, height and weight. There were eight boys and eight girls in the experimental group and six boys and eleven girls in the control group.

At the start of the study, the children were examined by a physician and their nutritional status assessed. A field worker, who resided in the village, distributed the test food and the control food to the mothers of

TABLE 1. COMPOSITION OF THE INFANT FOOD BASED ON PEANUT FLOUR AND THE CONTROL FOOD SUPPLEMENT (VALUES/100 GS)

	Infant food based on peanut flour	Infant food based on buffalo milk (Control)
Protein (g)	22	22
Fat (g)	16	18
Carbohydrate (g)	54	52
Calories	448	458
Calcium (g)	1	1
Phosphorus (g)	1	0.8
Iron (mg)	6	4
Vitamin A (I.U.)	1500	1500
Thiamine (mg)	0.6	0.6
Riboflavin (mg)	1	1
Pyridoxine (mg)	0.3	0.3
Niacin (mg)	6.0	6
B_{12} (μg)	2.2	...
C_a Pantothenate	3.8	...
Vitamin D (I.U.)	400	400
Vitamin E (mg)	2	...
Vitamin C (mg)	30	30
Moisture (g)	3	...

* This study was supported by Agreement No. 114302 P.L. 480 funds from the National Institutes of Health, United States Public Health Service.

the children on an *ad libitum* basis. Each mother was given a 500 g. packet of test food (or control food) and instructed in the mixing of the formula. When the contents of the packet were totally consumed, she was given a fresh supply of the food. By visiting the homes of the children at least once a week, the field worker ensured that instructions were being followed. The number of breast feeds taken by the children was recorded. The supplementary foods eaten by the children were assessed by questionnaire at fortnightly intervals. Records of illnesses were also maintained.

The heights and weights of the children in the experimental and control groups were measured every two weeks. The children were maintained on the study for six months: at the end of this period, the children were again examined by the same physician and their nutritional status reassessed.

The children who took part in the first study varied in age from six to eighteen months. To assess the value of the test food as a weaning supplement in the younger child, a second and sequential study with the same product was undertaken.

In the second study, infants in the village were examined and nutritionally assessed when they had attained six months of age. They were then allocated at random to the control and experimental groups and each child continued in the study for at least ten months. As previously, the infants' mothers were given 500 g. packets of the test food or the control food and instructed in the preparation of the feeds. Fresh packets of the foods were distributed when required. The field worker visited the homes of the infants, checked on their feeding, and recorded the number of breast feeds and the amount of supplementary foods given to the children as in the previous study. Minor illnesses among the children were recorded. The children were weighed and their heights recorded every fortnight.

At the end of ten months on the test or control foods, the children were nutritionally assessed and taken off the trial. Capillary blood was obtained from eleven infants for serum protein estimations, after ten months on the test or control food supplement. Total protein was estimated by biuret method[5]. The fractions were separated by paper electrophoresis at pH 8.6 followed by staining with bromphenol blue; the various fractions were eluted and estimated colorimetrically in a spectrophotometer.

Results

First study: Six children were excluded from the trial for various reasons. Three children, one from the control group and two from the experimental group, left the study as their families moved to other villages. Of the three other children, all from the experimental group, one died of an intercurrent gastrointestinal infection, another had pulmonary tuberculosis and the third persistently refused all weaning foods and had to be dropped from the trial.

The results reported therefore apply to the twenty-seven children, eleven from the experimental (four boys and seven girls) and sixteen in the control group (six boys and ten girls) who completed the trial.

The ages of the children in the experimental and control groups at the time of admission to the first study are given in Table 2.

In the experimental group, each child on an average, consumed 81 g. of the test food a day. Other foods, apart from the supplement and breast milk, provided an average of 75 calories a day (range 0-165 calories). In the control group, each child took an average of 74 g. of the control food supplement daily. In addition to the calories provided by the control supplement and breast milk the children in the control group had an average intake of 93 calories per day from other foods (range 0-164 calories). The intake of both groups exclusive of breast milk is compared in Table 3.

TABLE 2. AGES OF CHILDREN ON ADMISSION TO FIRST FEEDING TRIAL

Age in months	Children on test food	Children on control food
6	3	3
9	4	7
12	4	4
15-18	...	2

TABLE 3. INTAKE OF CALORIES AND PROTEIN BY CHILDREN IN THE FIRST FEEDING TRIAL

Subjects	Daily intake from: Supplement — Mean intake (g)	Supplement — Calories mean intake	Supplement — Protein (g) mean intake	Other foods* (approximate) — Calories mean intake	Other foods* (approximate) — Protein (g) mean intake
Children on test food (11)	81 (58-112)	363 (260-502)	17.8 (12.8-24.6)	75 (0-165)	1.98 (0-4.64)
Children on control food (16)	74 (31-133)	339 (142-609)	16.3 (6.8-29.3)	93 (0-164)	2.17 (0-3.39)

* Exclusive of breast milk

Figures in the parenthesis indicate range.

None of the children in either group showed any signs of nutritional deficiency at the beginning or during the trial.

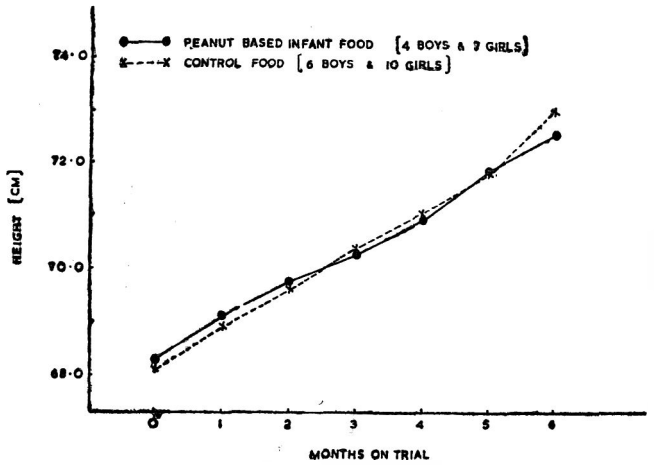

Fig. 1. The mean increase in height of the children during the first trial

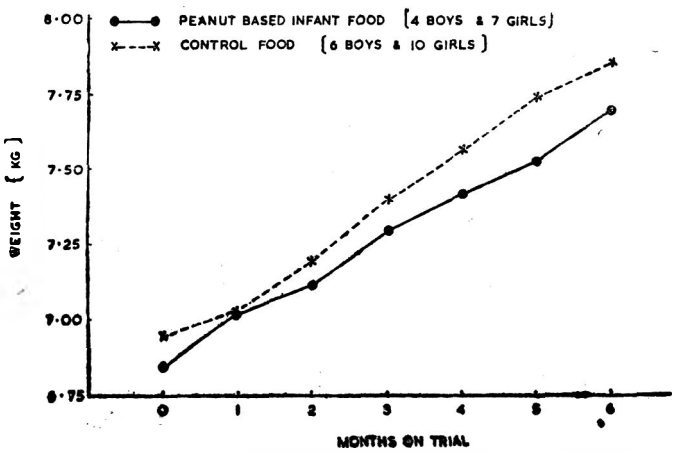

Fig. 2. The mean increase in weight of the children taking part in the first feeding trial

TABLE 4. MEAN INCREASES IN HEIGHT AND WEIGHT OF CHILDREN ON EXPERIMENTAL AND TEST FOOD SUPPLEMENTS IN THE FIRST FEEDING TRIAL

Subjects	Initial	Final	Increase ± S.E.	
		Height (cm)		
Children on test food (11)	68.20	72.59	4.39 ± 0.445	N.S.*
Children on control food (16)	68.15	73.00	4.85 ± 0.269	
		Weight (kg)		
Children on test food (11)	6.87	7.70	0.83 ± 0.163	N.S.*
Children on control food (16)	6.88	7.85	0.97 ± 0.118	

* Differences not significant ('t' test)

TABLE 5. INTAKE OF CALORIES AND PROTEIN BY THE CHILDREN IN THE SECOND FEEDING TRIAL

Subjects	Daily intake from Supplement: Mean intake and range (g)	Supplement: Calories mean intake and range	Supplement: Protein (g) mean intake and range	Other foods* (approximate): Calories mean intake and range	Other foods* (approximate): Protein (g) mean intake and range
Children on test food (12)	97 51–169	439 (228–757)	21.3 11.2–37.1	103 65–135	2.44 1.50–3.00
Children on control food (12)	91 55–126	417 (252–577)	20.0 12.1–27.7	112 68–164	2.67 1.64–3.39

* Exclusive of breast milk

Minor illnesses occurred among the children in both groups. Gastrointestinal symptoms (vomiting, diarrhoea, dysentery) were more common among the children on the control food supplement (45 episodes) than among the children on the test food (31 episodes).

The mean heights of the children as recorded each month shown in Fig. 1; the average weights are shown in Fig. 2 (Table 4). There was no statistically significant difference in the increases in heights and weights between the groups.

Second study: Twelve infants in the experimental group (seven girls and five boys) and twelve in the control group (eight girls and four boys) completed the trial.

In this study, the infants in the experimental group took on an average 97 g. of the test food a day. They obtained about 103 calories a day from other foods exclusive of breast milk. The infants in the control group consumed daily on an average, 91 g. of control food supplement. Other foods exclusive of breast milk (Table 5) consumed by these children provided on an average 112 calories.

During the study none of the children on the test or the control supplements showed signs of nutritional deficiency.

Both groups of children had episodes of minor illness; gastrointestinal symptoms (vomiting, diarrhoea, dysentery) were more common among the children on the test food supplement (54 episodes) than among those on the control food supplement (40 episodes).

The mean increases in height and weight of the children receiving the test food and of the children on the control food supplement during the ten months on the feeding trial are tabulated (Table 6). The

TABLE 6. MEAN INCREASES IN HEIGHT AND WEIGHT OF CHILDREN ON EXPERIMENTAL AND TEST FOOD SUPPLEMENTS IN THE SECOND FEEDING TRIAL

Subjects	Initial	Final	Increase ± S.E.	
	Height (cm)			
Children on test food (12)	64.39	74.75	10.36±0.384	N.S.*
Children on control food (12)	63.47	73.56	10.09±0 483	
	Weight (kg)			
Children on test food (12)	6.41	8.39	1.98±0.176	N S.*
Children on control food (12)	6.06	7.88	1.82±0.213	

* Differences not significant ('t' test)

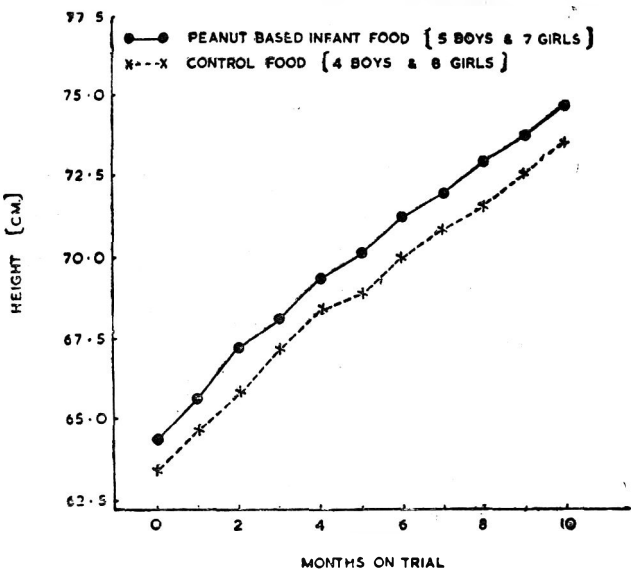

Fig. 3. The mean increase in height of the children during the ten months of the second feeding trial

mean heights and weights of the children in both groups are compared in Figures 3 and 4 respectively. The increases in heights and weights of the children receiving the test food supplement were not statistically different from the increase in heights and weights of the children on the control food supplement.

Total serum proteins and serum albumin were estimated on samples of capillary blood obtained from five children in the experimental group and six in the control group after they had been on the trial for ten months. The mean serum albumin of the five children getting the test food supplement was 4.11 g. ± 0.37, per cent and that of the six children on the control food supplement was 4.2 ± 0.34 g. per cent. The differences in levels of serum albumin between the

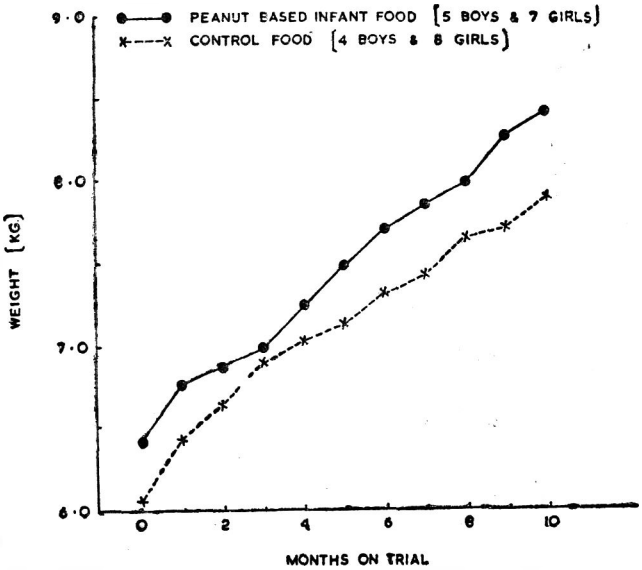

Fig. 4. The mean increase in weight of the children during the ten months of the second feeding trial

children on the test food and those on the control food were not statistically significant.

Discussion

In both the studies, the infant food based on peanut flour and the milk food from buffalo milk which served as the control food were fed to babies and young children to supplement their diets of breast milk and other foods.

It might be contended that such a trial is not a good way of testing the efficacy of the supplementary foods. The children would have a sufficiency of protein and calories from breast milk and other weaning foods and the supplements given would be redundant and do not contribute significantly to the diets of such children. Gopalan[6] has shown that up to the age of six months, babies of the lower socio-economic groups in India grow at a rate comparable to that of babies in more industrialised countries. After the age of six months, however, breast milk alone is insufficient to maintain the same rate of growth.

Surveys[7] of the dietary intakes of infants and preschool children in this area have shown that weaning foods offered to young children are totally inadequate in caloric content (Sundararaj, R. unpublished). Infants over six months of age and the young preschool child therefore have an inadequate diet to maintain optimal growth. The testing of supplementary foods in this age group in a village situation is therefore valid.

In the children who took part in the studies, other weaning foods supplied not more than 100 calories/ per child/day. The amount of breast milk available to

each child was not assessed, but the quantity available would be in the region of 450-600 ml.[9] and would supply about 300-400 calories. The supplementary food tested, and the control food used in these trials supplied approximately half the total calories necessary for children of this age group. The caloric intake of the children from all sources was therefore adequate (800-900 calories) and an inadequate diet did not hinder the assessment of the supplementary food tested. The supplements used contributed significantly to the child's protein and caloric intake and the continued growth of the children was a measure of the adequacy of the supplements provided.

Malnourished infants fed exclusively on foods based on fish protein concentrates and vegetable protein have had serum albumin values lower than those of children fed on milk[10]. Skimmed milk supplied thirty per cent of the protein in the infant food based on peanut flour used in these trials. The inclusion of milk protein in the formula of the supplementary food and the breast milk taken by many children, probably accounted for the lack of significant differences in the serum albumin level of the children fed the infant food based on peanut flour and those fed the control food.

This study has shown that the infant food based on peanut flour containing only 25 per cent skimmed milk solids, is as adequate as whole milk based infant foods as a supplement to the diets of infants in the age group of six months to eighteen months.

Acknowledgment

The authors thank Mr P. R. Krishnaswamy, field Worker at Sathuvachari for the enthusiasm and care in conducting these trials. They also thank Mr P. F. S. Venkatarangam for the technical assistance given. They are grateful to Dr H. A. B. Parpia and Mr M. R. Chandrasekhara of the Central Food Technological Research Institute, Mysore, for the supply of the infant food based on peanut flour and the milk food used in these trials.

References

1. Kuppuswamy, S., Srinivasan, M. and Subrahmanyan, V., *Proteins in Foods*, Indian Council of Medical Research, New Delhi, 1956.
2. Special Report Series No. 48, *Diet Atlas of India* (1964) Indian Council of Medical Research, Nutrition Research Laboratories, Hyderabad.
3. Chandrasekhara, M. R., Shurpalekar, S. R., Aswathanarayana, S. and Parpia, H. A. B. *Foods Based on Vegetable Proteins for Infant Nutrition*, presented at VIIth International Congress of Nutrition, Hamburg, 1966.
4. Chandrasekhara, M. R., Srinivasamurthy, V., Swaminathan, M., Bhatia, D. S. and Subrahmanyan, V., *Fd Sci.*, 1957, **6**, 228.
5. Reinhold, J. G., *Standard Methods of Clinical Chemistry*, Academic Press Inc., New York, 1963, Vol. I, 88.
6. Gopalan, C., *J. Trop. Ped.*, 1956, **2**, 89.
7. Devadas, R. P. and Easwaran, P. P., *J. Nutr. Dietet.*, 1967, **4**, 156.
8. Gopalan, C., *J. Trop. Ped.*, 1958, **4**, 87.
9. Graham, G., Baertl, J. M. and Cordano, A., *Am. J. clin. Nutr.* 1966, **18**, 16.

Free Amino Acid Analysis of *Phaseolus* Seeds

Amino acids of leguminous seed, irrespective of their occurrence in free or protein-bound state are essential factors in nutrition, particularly those assigned as the 'essential amino acids'. The present investigation was aimed to analyse the free amino acid content of *Phaseolus* seeds (*Pink Rajmah*-1, *Red Rajmah*-2, *Bakla*-3, *Urd*-4 and Moth-5) of Indian origin and compare the patterns obtained with those of the *Phaseolus* seeds (Pink bean-6, Red bean-7, Kidney bean-8, Small lima bean-9 and Large lima bean-10) of American origin. The total free amino acid content of the seeds in terms of glycine was also estimated by employing the method of Rosen[1].

Seeds 1-5 were obtained locally from the market and 6-10 were bought at Palo Alto, California U.S.A. by the senior author. They were powdered in a grinder to 100 mesh, defatted in a Soxhlet apparatus with petroleum ether (60-80°C) and preserved in air-tight bottles. One gram each of the defatted seed powders was well-stirred with ethanol (10 ml., 70 per cent, v/v) for 30 minutes. After centrifugation the residue was re-extracted with 70 per cent ethanol, spun and the two supernatants combined. This process was repeated 7-8 (times) till the supernatant was negative to ninhydrin test. The pooled supernatant was evaporated to dryness *in vacuo*, dissolved in distilled water (0.5-1.0 ml.), centrifuged and the clear supernatant (2-10 μl) was employed for qualitative and quantitative analysis of free amino acids.

The two-dimensional chromatographic technique of Datta, Dent and Harris[2] was employed using phenol (80 per cent, w/v)-NH_3 and n-butanol-acetic acid-water (4:1:5) as the developing solvents. The chromatograms after development were sprayed with ninhydrin (0.1 per cent, w/v) in n-butanol. The different amino acids present were confirmed by special spray reagents described by previous workers (Sakaguchi[3], Smith[4], Pant and Agrawal[5], Block *et al*[6]., and Dent[7]).

For estimating the total free amino acid content, an accurately measured volume of seed extract (2-10 μl) was diluted with glass-distilled water (1 ml.) followed by the addition of acetate-cyanide buffer (0.5 ml.) and ninhydrin solution (0.5 ml., 0.5 per cent w/v) in methyl cellosolve. The tubes were heated in a water bath at 100°C for 15 minutes and quickly diluted by the addition of iso-propanol (5 ml., 50 per cent, v/v) with constant shaking. The solution was cooled to room temperature and colour density read in a colorimeter at 570 mμ with a reagent blank and standard glycine solution.

Table 1 represents the qualitative pattern and total content of free amino acid composition of the ten *Phaseolus* seeds analysed. Each seed has its

TABLE 1. QUALITATIVE PATTERN AND TOTAL CONTENT OF FREE AMINO ACIDS IN 10 SPECIES OF PHASEOLUS SEEDS

Amino acid	*Phaseolus vulgaris* (*Pink Rajmah*)	*Phaseolus vulgaris* (*Red Rajmah*)	*Phaseolus vulgaris* (*Bakla*)	*Phaseolus mungo* (*Urd*)	*Phaseolus aconiti-folius* (Moth bean)	*Phaseolus vulgaris* (Pink bean)	*Phaseolus vulgaris* (Red bean)	*Phaseolus vulgaris* (Kidney bean)	*Phaseolus lunatus* (Small lima bean)	*Phaseolus lunatus* (Large lima bean)
α-alanine	−	+	−	+	−	−	+	+	+	+
α-amino butyric acid	−	−	−	+	−	−	−	−	−	−
Arginine	+	+	+	+	+	+	+	+	+	+
Asparagine	+	+	+	+	+	+	+	+	+	+
Aspartic acid	+	+	+	+	+	+	+	+	+	+
Citrulline	−	+	−	+	−	+	+	+	−	−
Cysteic acid	+	−	−	−	−	−	−	−	−	−
Cystine	−	−	+	−	+	+	+	+	−	−
Glutamic acid	+	+	+	+	+	+	+	+	+	+
Glutamine	−	−	−	+	−	−	−	−	+	+
Glycine	+	+	+	+	+	+	+	+	+	+
Leucine-isoleucine	+	+	+	+	+	+	+	+	+	+
Lysine	+	+	+	−	+	+	+	+	+	+
Methionine	+	+	−	+	−	+	+	+	+	+
Proline	+	+	+	+	+	+	+	+	+	+
Serine	+	+	+	+	+	+	+	+	+	+
Taurine	−	−	−	+	−	−	−	−	+	+
Threonine	−	+	+	+	+	+	+	−	−	−
Valine	+	+	−	−	+	+	+	+	−	−
Total free amino acids g/100g seeds	0.33	0.27	0.36	0.22	0.21	0.15	0.19	0.16	0.28	0.25

own pattern of amino acids and no single seed is found to be complete in itself with respect to the essential amino acids. All the seeds contain 11-15 amino acids in the free state. Arginine, asparagine, aspartic acid, glutamic acid, glycine, proline, leucine-isoleucine and serine were common to all. α-alanine was detected in seeds 2, 4, 7, 8, 9 and 10, whereas α-amino butyric acid was found in seed 4 which however, does not contain the essential amino acid lysine. An examination with respect to the essential amino acids revealed that the various *Phaseolus* seeds examined contain only 3-5 amino acids. The total free amino acid content of the seeds varies in the order of 0.15-0.36 g. (in terms of glycine) per 100 g. of dry seed powder.

Acknowledgment

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Biochemistry Section,
The University of Allahabad
28 Feb. 1968.

RADHA PANT
D. R. P. TULSIANI

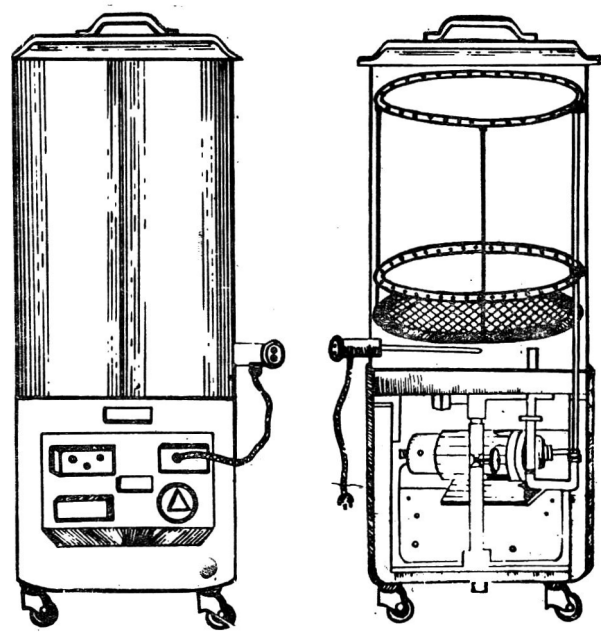
References

1. Rosen, H., *Arch. Biochem. Biophys.*, 1957, **67**, 10.
2. Datta, S. P., Dent, C. E. and Harris, H., *Science*, 1950, **112**, 620.
3. Sakaguchi, S., *J. biol. Chem.*, (Tokyo), 1925, **5**, 25.
4. Smith, I., *Nature, Lond.*, 1953, **43**, 171.
5. Pant, R. and Agrawal, H. C., *Naturwissenschaften*, 1963, **50**, 530.
6. Block, R. J., Winegard, H. M. and Toennies, G., *Science*, 1948, **108**, 506.
7. Dent, C. E., *Biochem. J.*, 1948, **43**, 169.

A Simple Mechanical Device for Washing Eggs

The poultry farms in India which do not generally adopt cage system have to deal with a sizeable percentage of soiled eggs. Under present egg production practice, about 30 per cent of eggs become soiled or show dirty spots on the surface of the shell. These areas facilitate growth and multiplication of micro-organisms and lead to the spoilage of egg during storage. Besides fetching a low price, such eggs may prove to be a source of public health hazard. Cleaning of such eggs manually by buffing each egg or by wiping with a wet cloth, becomes tedious and time consuming. The use of mechanical aids for cleaning would be of great advantage but the fragile nature of shell eggs precludes use of abrasion techniques in large scale operation. Hence, cleaning through use of detergent sanitizer wash is advisable. The scale of operation should suit the medium or small size farms and avoid highly sophisticated machinery. With this background in view, an effort has been made to develop a simple mechanical device for egg washing which can handle about 1000 to 1500 eggs per hour.

EGG WASHING MACHINE



GENERAL VIEW INTERNAL VIEW

The unit (Fig. 1) is essentially a thermostat in which the detergent sanitizer solution is continuously recirculated in the form of a fine spray or jet causing sufficient impingement to loosen the adhering dirt and wash it away. It consists of a cylindrical vessel of capacity 80 litres, made of 18 SWG SS sheet with a 60 SS mesh removable base plate at about 1/4 the height from the bottom. This plate serves as a support for the egg laden basket during the use and protects the heating element. An immersion type 2 kw. heater is fixed horizontally to the side wall very close to the bottom of the tank. Two circular rings made of

9.5 mm. diameter SS tube are held in position by 4.75 mm. diameter SS vertical stud and have their outer diameter equal to the inner diameter of the vessel, so that they snugly fit into the vessel. The lower surface of the top ring and the upper surface of the bottom ring have holes 0.8 to 1 mm. diameter drilled all along the circumference so that they subtend an angle of 11° with the vertical. This will ensure that the water jets from these orifices are directed towards the eggs in the basket placed in the middle of the vessel. These rings are connected to the out put side of 1/6 H.P. centrifugal pump by 12.7 mm. I.D. SS tube through a collar as indicated. This arrangement makes it possible to remove the rings out of the vessel and also adjust the distance between the rings. A gate valve is fixed to the bottom of the vessel through a ½" collar to drain away the spent solution. The vessel is mounted on MS angle base with caster wheels. The suction line to the pump terminates very close to the SS wire mesh base; this would ensure that the liquid level is always above the heating element. Also there would be some turbulence near the bottom of the egg basket which aids the cleaning operations. The MS angle base frame is covered with 22 SWG painted MS sheet for stream-lining the unit. The control switches for the heater and pump are provided on panel surface on the MS sheet cover.

The vessel is filled with about 40 to 50 litres of water and the heater and pump are switched on and after some time the energy regulator of the heater is adjusted so as to maintain a constant temperature of about 42 to 44°C. The detergent sanitizing agent is then mixed into the water to get the desired composition (0.2 per cent) and the basket containing 130-150 eggs is placed in the vessel. After 5 minutes, it is removed and kept hanging in front of a fan so that the eggs are dried and cooled before storing or packaging. The procedure is repeated for about 8 to 10 baskets. In this manner about 1000 to 1500 eggs can be cleaned in one hour. The solution has to be changed after washing 1500 eggs. In case of eggs with firmly adhering dirt, buffing or rubbing with hand is necessary.

The above equipment costs approximately Rs 2,000 and it costs approximately 15 paise to operate this unit for washing 100 eggs. The cost of the detergent mixture is Rs 12 per kg.

Central Food Technological Research Institute, Mysore.

M. C. BADARINARAYANA
B. PANDA
P. C. PANDA

2 April 1968

OBITUARY

We regret to announce the passing away of Dr Z. I. Kertesz and Dr M. L. Anson who were active members of the Association of Food Technologists. Dr Anson, as a keen promoter of research in the field of oil seed proteins and their utilisation and Dr Kertesz as the Secretary of the Protein Advisory Group of the U.N. agencies, were active participants both in the organisation and in the deliberations of the Symposium on Protein Foods and Concentrates held in Mysore in June-July 1966.

Methodology in Flavour Chemistry

Dr Irwin Hornstein
Chief, Food Quality Laboratory, Human Nutrition Research Division, U.S.D.A.

Flavour is a complex sensation of taste, odor, texture, pungency or blandness and colour. Of these, odor and taste are the major flavour contributors, odor playing the dominant role.

Our sense of smell is so sensitive that we can, for example, detect β-ionone in concentrations of less than 1 part per billion in air. The ability of submicrogram amounts of volatile compounds to profoundly influence odor and thus flavour is apparent.

The low thresholds for odoriferous compounds and the low concentrations of these materials in foods make chemical analysis for flavour components difficult. Concentration, isolation, separation, and identification of these trace components becomes a formidable problem. In many instances, thousands of kilograms of a food product must be processed to yield milligrams of a flavour concentrate. This concentration must be accomplished without destroying the compounds responsible for the aroma and without introducing artifacts. Distillation, extraction, crystallization, freeze-drying and zone-refining are among the concentration methods used. Distillation, in any of several ways, is probably most widely used.

Problems are associated with each of the concentration procedures. For example, in distillation, the greatest hazard is heat damage to the aroma compounds; in extraction it is contaminants from solvents.

The concentrated oil that is isolated is a very complex mixture. Using gas chromatographs with very low limits of detection, microgram quantities and submicrogram quantities can however be separated and detected.

Coffee oil exemplifies this complexity; over 350 compounds have been identified. To separate such a complex mixture all the resolution possible is needed. To simplify the separation, reduced-pressure fractional distillation, functional group separations based on derivative formation and liquid-liquid or liquid-solid chromatography may serve to give preliminary separations. It must be remembered however that a certain overlap will unavoidably be encountered in the fractions prepared by such procedures.

To adequately handle these complex mixtures, columns with more than 100,000 theoretical plates and a variety of liquid phases with a range of selectivities are necessary. The highest resolution in gas chromatography (G.C.) is obtained with 0.01 inch ID capillary columns; however these columns have a capacity of only a few micrograms per peak. This may be too little for further analytical studies. Recently, large bore capillaries, 0.02 and 0.03 inch ID have been introduced; up to 100-200 micrograms per peak can be tolerated without undue loss of resolution. Such quantities can be trapped for IR and even NMR studies.

Because GC is essentially a separation technique, retention data provides only tentative identification. To establish chemical structure ancillary methods of identification are needed.

Infrared spectroscopy can determine the functional groups present as well as fingerprint a compound. Micro KBr pellets and the use of micro cells can give usable spectra at the 50-100 microgram level. Scale expansion and beam condensors can push this down to 1-10 micrograms.

Mass spectrometry (MS) is the most sensitive analytical method used in combination with GC. Two basic methods of sample introduction are used for MS analyses, the batch and continuous methods. In the batch method, each GC fraction is trapped and analyzed at leisure. In the continuous method, the effluent from the gas chromatograph is introduced directly into the mass spectrometer (GC-MS). If the material is available and stable then the batch method can be used. For microgram quantities, direct flow into the mass spectrometer minimizes manipulation losses, contamination, decomposition, etc. Combined GC-MS presents the problem of coupling the two instruments without losing GC resolution and MS sensitivity. The effluent from the gas chromatograph is at atmospheric pressure while the mass spectrometer operates under high vacuum. Techniques have been developed for overcoming this problem. One example, the Watson-Biemann separator utilizes preferential effusion of the carrier gas, helium, through a fritted glass tube for carrier gas removal and sample enrichment.

Despite the steadily increasing accumulation of data, concerning the volatile compounds associated with flavour, a breakthrough has not been achieved. In some instances, one, or more probably several compounds account for much of a flavour. In general, however, a given food flavour consists of a mixture of many compounds. The major problem facing the flavour chemist is how to make organoleptic 'sense' out of the information he is accumulating.

Microbiology in Food Technology

Address to Calcutta Branch of the Institute of Food Technologists—July 26, 1967

CARL S. PEDERSON
New York State Agricultural Experiment Station, Cornell University, Geneva, New York

Dr Pederson first gave a resume of the organisation and development of Institute of Food Technologists and later discussed his special interests in the field of food preservation. In the years 1938 and 1939, Dr Pederson was interested in fermentation of *sauerkraut* and other vegetable products, the preservation as well as the spoilage of acid foods such as canned tomatoes, tomato juice, catsup, various fruit juices and more specifically the microorganisms responsible for the alterations in these food products. These studies were of a chemical as well as a microbiological nature and were related to food problems. The bacteria responsible for spoilage of catsup were isolated and characterized. It was noted that catsup made by some companies was not spoilt because salt, sugar and acid were present in such concentrations that did not permit the growth of microorganisms. This was one of the first demonstrations of the combined effect of edible ingredients of food in controlling the growth of microorganisms.

Later it was observed that tomato juice spoilt by growth of the flat sour organism *Bacillus coagulans*, was always less acid than tomato juice in which no spoilage occurred. By slight adjustment of acidity, spoilage by this organism could be avoided.

In another instance occasional five gallon carboys of grape juice were fermented by mould growing on the surface. The heat applied was sufficient to sterilize the juice; however, bits of cork in the carboy or the cork closures harboured the mould spores. By simply removing all bits of cork and by sealing the cork closures with hot paraffin, such spoilages were eliminated. But in this study, it was observed that the moldy juice always clarified itself. This was due to a clarifying enzyme produced by the mold. Since then, the enzyme has been isolated and is now used as a clarifying enzyme.

With this background, Dr Pederson was interested in the organization of the Institute of Food Technologists and a journal in which the practical aspects of such research could be published and would not be lost among the numerous more basic science papers.

Dr Pederson was on his way home from a two year stay at the University of Philippines, College of Agriculture. Cornell University has a co-operative mutual aid programme with the University of Philippines, College of Agriculture at Los Bannos, Philippines. His particular programme involved the organization of Food Science and Technology at the College of Agriculture. In an active programme of teaching, research and industrial contacts, it was found that some of the fermented foods native to the Philippines were extremely interesting. One of their products 'Puto' steamed rice bread product made him think of Mr Mukherjee's work on the fermentation of *idli*. Mr Mukherjee's results indicated that *idli* is leavened entirely by the lactic acid bacterium *Leuconostoc mesenteroides*. The presence of yeasts is incidental. The bacterium produces not only lactic acid, but lesser amounts of lactic acid, ethyl alcohol and carbon dioxide, with traces of minor substances. These are all important in imparting the desirable flavour to good *idli*. The carbon dioxide is the leavening agent. More work of this nature should be conducted with the various foods we consume. Incidentally, if the *idli* dough is allowed to ferment longer than normal, other lactic acid bacteria develop which play no part in leavening the dough but also produce a dough that is too acid. It is important to understand these facts and establish an environmental condition favourable to the growth of the one microorganism, *Leuconostoc mesenteroides*. Other fermented foods of the Philippines in addition to 'puto' and bread are wines from different fruits, fermented fish with rice, a cheese made from carbao milk, a product used as a dessert made by fermenting with acetic acid bacteria and a fermented native sausage. The cucumber pickle industry is developing rapidly.

It is now 37 years ago since Dr Pederson published a paper demonstrating that *Leuconostoc mesenteroides* was the important organism in initiating the fermentation of *sauerkraut*. Previous to this, the organism was known only as a spoilage organism, particularly in sugar factories. The significance of the observation, that this organism was so important in vegetable fermentations, was not fully appreciated until further study revealed the complete role played by the

organism. Since then we have observed that this role is significant in fermentation of many other food products.

Leuconostoc mesenteroides initiates growth in vegetables more rapidly than any other lactic acid bacterium and over a wide range of temperatures and salt concentrations. It produces carbon dioxide and acids quickly to lower the pH, thereby inhibiting the development of undesirable microorganisms and the activity of their enzymes. The carbon dioxide produced replaces air and provides an anaerobic condition favourable to stabilizing the ascorbic acid and the natural colour of the vegetable. The growth of this organism apparently changes the environment making it more favourable for the growth of other lactic acid bacteria in the bacterial sequence. The combination of acids, alcohol, esters, and other growth products imparts a unique and desirable flavour. The species converts excess sugars to manitol and dextrin which are generally non-fermentable to organisms other than lactic acid bacteria. *Leuconostoc mesenteroides* is truly a very valuable bacterial species whose role should be studied and appreciated in many food fermentations.

These facts about the growth of this organism in *sauerkraut*, are equally true in the fermentation of *idli* and of many other food products. Since 1930, this bacterial species has been found important in initiating the fermentation of many other vegetable products, i.e., beets, turnips, chard, cauliflower, green beans, sliced green tomatoes, whole head cabbage, brussels sprouts, mixed vegetables, cucumbers, the *kimchi* of Korea and *mostasa*, *puto* and *burong dalag* of the Philippines. Each of these fermented foods should be studied further to determine the environmental conditions most suitable for producing the most satisfactory products. In the case of *sauerkraut* and pickles, salt concentration, sanitation and temperature are the important controlling factors. These are problems for the research scientist but the information is of little value unless absorbed and used by technical men in industry.

A most striking example of the effect of environment was observed in the fermentation of cucumbers in the Philippines. One company was using a salt brine which was so concentrated, that the organism *Leuconostoc mesenteroides* could not grow. In addition, the water temperature was so high that the enzymes native to the cucumbers softened the cucumbers. If fermentation had occurred, the pH would have been lowered so that the activity of these enzymes would have been retarded. In fact, by cooling the water used in preparing the brine and at the same time lowering the salt concentration of the brine, a normal fermentation was permitted and the cucumbers were cured properly. Many scientists fail to realize the importance of pH in delaying the action of enzymes which may alter a food.

These are the type of studies which he believed could be adopted in many countries of the East. Drs Kim and Whant of Korea have conducted some fine work recently on the fermentation of 'kimchi' prepared from a blend of vegetables. Mr Mukherjee's studies on 'idli' should be continued. The relationship between quality and nutritive value should be established. Environmental conditions for the most suitable fermentation should be studied.

In a reference to the work being done at the New York State Agricultural Experiment Station, Geneva, New York he said that there were 20 professors working on 50 to 60 research projects. Some of them are basic, some are technological and some are combinations of both. In many cases, attempts are made to conduct basic research and apply the results to industry. The food processing industries on the other hand are glad to co-operate with them, not only in discussing problems and results but also in the use of their facilities when deemed necessary. The researches are, however, in no way controlled by the food processing industry. The real leaders in the industry encourage basic research feeling that they can adapt the results of such research to their problems.

A few examples may be cited. Recent work on the activity of enzymes in beans have resulted in changes in the canning as well as the freezing of beans to avoid sloughing. Isolation and characterization of the yeasts that develop in grape juice stored at 24 to 28°F have caused industry to change their type of storage so as to introduce sterile juice into sterile tanks. These yeasts are true psychrophils. Study of the activity of enzymes of fruit that cause browning, change of flavour and chemical composition, has resulted in processing to yield more stable tomato juice, apple juice and frozen peaches. Numerous other examples could be cited in which the results of basic research have been utilized by the food industry to improve their products.

The work of Dr Pederson during the past 42 years has not only involved practical application of scientific studies to problems of the industry, but has included basic studies on the physiology and classification of the various microorganisms. He has always interested himself in the variability in morphology and physiology exhibited by the various lactic acid bacteria. He has prepared the sections on the genera *Lactobacillus*, *Leuconostoc* and *Pedicoccus* for the last four editions of Bergey's Manual of Determinative Bacteriology.

Book Reviews

Tree Nuts—Production, Processing, Products, Vol. II: By JASPER GUY WOODROOF, AVI Publishing Company, Inc., Westport, Connecticut, U.S.A., 1967, pp. 352, Price $ 19.50.

Volume II, of Woodroof's book on Tree Nuts, is concerned mainly with the culture, harvesting, drying, grading, storing, shelling, marketing and use of pecans. The first eleven chapters (ch. 13 to 23—comprising of 254 pages) are devoted to this particular nut. The last six chapters (98 pages) present the latest available information on the production, processing and use of pine nuts, pistachio nuts, black and English walnuts and a few other nuts of minor importance. The material is well substantiated by 105 pictures, 35 tables and 12 charts covering practically every aspect of the nut industry. At the end of the book are given four appendices on U.S. Standards for Grades of Shelled Pecans in the Shell, Shelled Walnuts (*Juglans regia*), and Walnuts in the Shell.

The coverage given to pecans clearly indicates that this nut along with almonds, is one of the most important tree nuts of the U.S.A. Although walnuts are very much similar to pecans, in their structure and growth requirements, yet they do not seem to be so popular from the horticultural point of view. The author has not given any reasons why Americans prefer pecans to walnuts, or why walnuts have not been given the same importance as pecans. It could be possible that this special treatment is because, in America, pecans are much more expensive than walnuts and are also used more extensively in confectionery and bakery. More than 26,000,000 lb. of pecan meats are used in excess of 400 baked pecan products. There are over 300 bakery products containing pecans—159 cakes, 94 yeast breads, and 49 pies and pastries. Approximately one-third of the pecan crop is used in more than a dozen bakery products. Twenty three per cent of bakers, report the use of pecans only for nut-enriched products. The consumer appeal of the pecan products rates highest in practically every case. The author has devoted three full chapters (72 pages) to pecan in bakery products, candies, ice-cream, salted pecans, pecan butter, and the use of pecan shells.

The information, about pecans, furnished by the author is so exhaustive that it could have been given the status of a separate book. For the Asian countries, it would have been more beneficial if a detailed account of pine nuts, pistachio nuts, walnuts and apricot nuts was given.

In the last chapter, on tree nuts of less importance, a brief description of apricot nuts, beechnuts, butternuts, Chinquapins, heartnuts and hickory nuts, has been given. The information about the apricot nut has been covered in just one page. The author states 'a considerable quantity of apricot and peach pits and kernels have been exported from the United States to more than eight other countries'. All that is mentioned about the use of apricot nuts is that the sweet 'nuts' are roasted, salted and used in confectionery and cookery. Detailed information about the use of apricot and peach pits and kernels would have been more than welcome as these are by-products of the Fruit Preservation Industry, and in India they are more or less treated as waste products.

For the Indian student this volume is only of academic interest. However, confectioners can derive immense benefit from the treasure of recipes given in the book.

W. B. DATÉ

Milk Pasteurization: by CARL W. HALL AND G. MALCOLM TROUT. The AVI Publishing Company, Inc., Westport, Connecticut, U.S.A. 1968, pp. 234, Price $ 15.50.

This publication is an important addition to the field of dairy technology and is perhaps the only book in English entirely devoted to various aspects of milk pasteurization. It gives all the pertinent technical information in a language so simple that it can be easily understood by even a layman. The book contains 7 chapters and appendix, with appropriate references at the end of each chapter.

In the first chapter, the authors have discussed the historical background and the difficulties encountered early in the development of pasteurization. In chapter 2, the various physical and chemical changes that occur in milk constituents when subjected to different temperature—time combinations, normally used in pasteurization—are described. Some information on the nutritive value of pasteurized milk is also given.

The various types of pasteurizer units and the developments that have taken place during the recent years in the holding method, the high temperature short

time pasteurization and the vacreator method have been described in detail in chapter 3 indicating their advantages and disadvantages. The chapter 4 describes the various auxiliary equipments namely clarifier, separator, homogenizer, filter, booster pumps, vacuum equipment and additional heat exchangers. The description of the various equipments and the unit processes have been illustrated by appropriate photographs and flow diagrams in these chapters.

In the chapter on milk plant automation, the authors have described how automation can be introduced advantageously at various points in the dairy operation, which will eventually result in saving of labour and increase in the productivity per worker without affecting the final quality of the product.

The economics of pasteurization and the costs of various operations have been discussed with illustrations in chapter 6. In chapter 7, various theoretical and practical aspects of importance, namely location, layout, designs, plant services and utility requirements and waste disposals have been discussed. This information will be of great importance in establishing and operating a new plant economically and to produce quality products.

This book will prove not only useful as a text book for students of dairy technology, but also for plant workers and managers in the market milk industry.

V. R. Bhalarao

Carotenoids other than Vitamin A: International Union of Pure and Applied Chemistry, Butterworths, London, England, 1967, Pp. 215-278, Price 20 *s*.

This is a collection of four main lectures presented at the symposium on 'Carotenoids other than Vitamin A' held in Trondheim, Norway in June 1966; these lectures have appeared in *Pure and Applied Chemistry*, 1967, Vol. **14**, No. 2.

Carotenoids are one of the most important groups of natural pigments. They are responsible for many of the brilliant yellow and red colours of flowers, vegetables, fruits, mushrooms, insects, feathers and egg yolks. It has been estimated that the annual production of these pigments is about 100 million tons. Altogether about 180 different carotenoids have so far been reported and with the use of modern techniques the number continues to grow rapidly.

In his lecture on 'Biosynthesis of Carotenoids', Dr C. O. Chichester (U.S.A.) deals with the intermediate compounds in carotenoid synthesis, mechanism of synthesis and biosynthetic oxidation and reduction in carotenoids. In the second lecture on the 'Recent Advances in the Chemistry of Natural Carotenoids', Prof. S. L. Jensen (Norway) discusses the recent applications of electronic, infra-red, proton magnetic resonance and mass spectroscopy and the classical chemical methods for the elucidation of structures of the various carotenoids. In the next lecture on 'Carotenoids as Food Colourants', Drs O. S. Isler, R. Rüess and U. Schwieter (Switzerland) review the production of carotenoids from natural sources and also the commercial synthetic production of some carotenoids such as β-carotene, canthaxanthin, rhodoxanthin and diketospirolloxanthin. It includes a fine account of the uses of the carotenoids as food colourants and also the analysis of carotenoids in foods. Finally, Prof. B. C. L. Weedon (U.L.) in his lecture on 'Some Studies on Carotenoid Synthesis' describes the synthesis of some typical carotenoids based on the symmetrical C^{10} and C^{20} dials.

Each of the above lectures gives an excellent account of the present status on the topics discussed and also indicates the work that remains to be done.

Recently, Prof. B. C. L. Weedon in a review article on the 'Recent Advances in Carotenoids', (*Chemistry in Britain*, (1967) Vol. 3, pp. 424) has discussed the carotenoproteins which constitute an important group of natural compounds. Of the thousands estimated to occur in nature, only 3 carotenoproteins—crustacyanin, ovoveridin and ovorubin have so far been isolated in a pure state. The functions of the carotenoproteins are not understood. The carotenoproteins have opened a new field for the chemists for further investigations.

The collected lectures of this symposium make a valuable contribution to our knowledge of the chemistry of carotenoids and, workers in this field will find much of interest in this volume.

M. L. Shankaranarayana

Notes and News

Protein Recovery Installation for Rumania

Continental Engineering N. V. (a subsidiary of the Stork/Werkspoor Concern) of Amsterdam is to build a plant, to the north of Brasov in Rumania, for the recovery of protein from the effluent of a potato starch factory.

The process to be used was developed by 'AVEBE' (Co-operative Potato Starch Sales Bureau) at Veendam (Holland). The protein to be produced will be obtained as a by-product in the manufacture of potato starch, and will be used in the production of feeding stuffs.

Two similar protein recovery plants were delivered in 1967 by Continental Engineering to the Japanese agricultural enterprise Hokuren of Sapporo.

World Livestock Figures

At the beginning of 1967, the livestock figures for the world attained a record total of more than 1 millard head. Compared with the average figures for the period 1956-1960, this is an increase of 17 per cent. It is specially the result of the expansion of the cattle herds in the U.S.S.R., the countries of the Eastern block, South America and Western Europe.

The herds in the U.S.A. and Canada decreased in size.

In Western Europe, the cattle figures had again risen by 1.5 million head (+2 per cent) at the beginning of 1967. The greatest increase took place in the E.E.C. England's cattle herd amounted to about 12 million head (+1.5 per cent) at the same time.

The promotion of the breeding industry has stimulated cattle farming in the U.S.S.R. At the beginning of 1967 there were about 97 million head in that country (+4 per cent).

Drought has held back expansion in Australia. The figures for 1967 were practically the same as those for 1966. The livestock in New Zealand increased by 6 per cent.

The following table gives a survey of the world livestock figures.

	(× 1,000 head)			
	1967 (provisional)	1966	1965	average 1956/1960
North America	159,700	159,000	158,200	135,700
South America	188,300	185,700	176,100	154,700
Western Europe	87,400	85,900	83,300	77,200
Eastern Europe	34,800	34,100	33,100	30,300
U.S.S.R.	97,100	93,400	87,200	66,400
Africa	129,700	128,600	127,200	112,500
Asia	416,800	413,800	413,700	377,200
Oceania	26,100	25,400	25,900	22,800
World total	1,139,900	1,125,900	1,099,700	976,800

Milk Refrigeration Tanks

The dairy factories 'De Maatschap' and 'Domo-Bedum' have placed a big order for milk refrigeration tank installations to the value around Dfl. 750,000.

This means an important step in the direction of mechanization in milk production.

The milk refrigeration tank installation is set up in the farm. The milk obtained by mechanical milking is stored in the milk refrigeration tank. The tank-car from the dairy factory pumps the milk from the refrigeration tank and transports it to the factory. (Agricultural News letter from the Netherlands).

Microflake Dehydration

The technique is among the recent developments in speciality drying techniques to obtain quality products at a reasonable cost. Product obtained in this method has qualities similar to those from vacuum drying methods, but cost of processing is comparable to atmospheric pressure drying. Essentially the process consists of drying foams cast from a variety of liquids and pastes at atmospheric pressure on a continuous belt. The engineering equipment permit operation at low temperatures for short periods, resulting in better quality products at a fast rate of drying. Thus the actual rate of drying is about 4 to 5 times faster than conventional foam-mat drying. By proper change of residual time, temperature, foam density, a final moisture content as low as 0.5 per cent can be attained.

The product which has a shelf-life of one year undergoes minimal changes in taste, colour, texture and vitamin content.

Here the feed material which is in the form of a solution or slurry is continuously dried into small porous flakes by steam or forced air drying of this foam of slurry and solution as moving belt. The cost of processing which is about 4 cents per lb. of dry product. Though slightly higher than that of solvent drying (3 cents per lb.) it compares very favourably with freeze drying (15 cents per lb.) [Chem. Engng, Vol. 75, No. 10, p. 104, 1968.]

New Equipment: Versatile Filter

A filter adoptable to gravity feeding, pressure feeding or vacuum operation has been developed by Stockdale Engineers Ltd., Bollington, England. This has an advantage over conventional rotary vacuum filter in that it has no moving part which results in appreciable wear and tear. This filter requires only a centrally nailed rotating distributor that effects

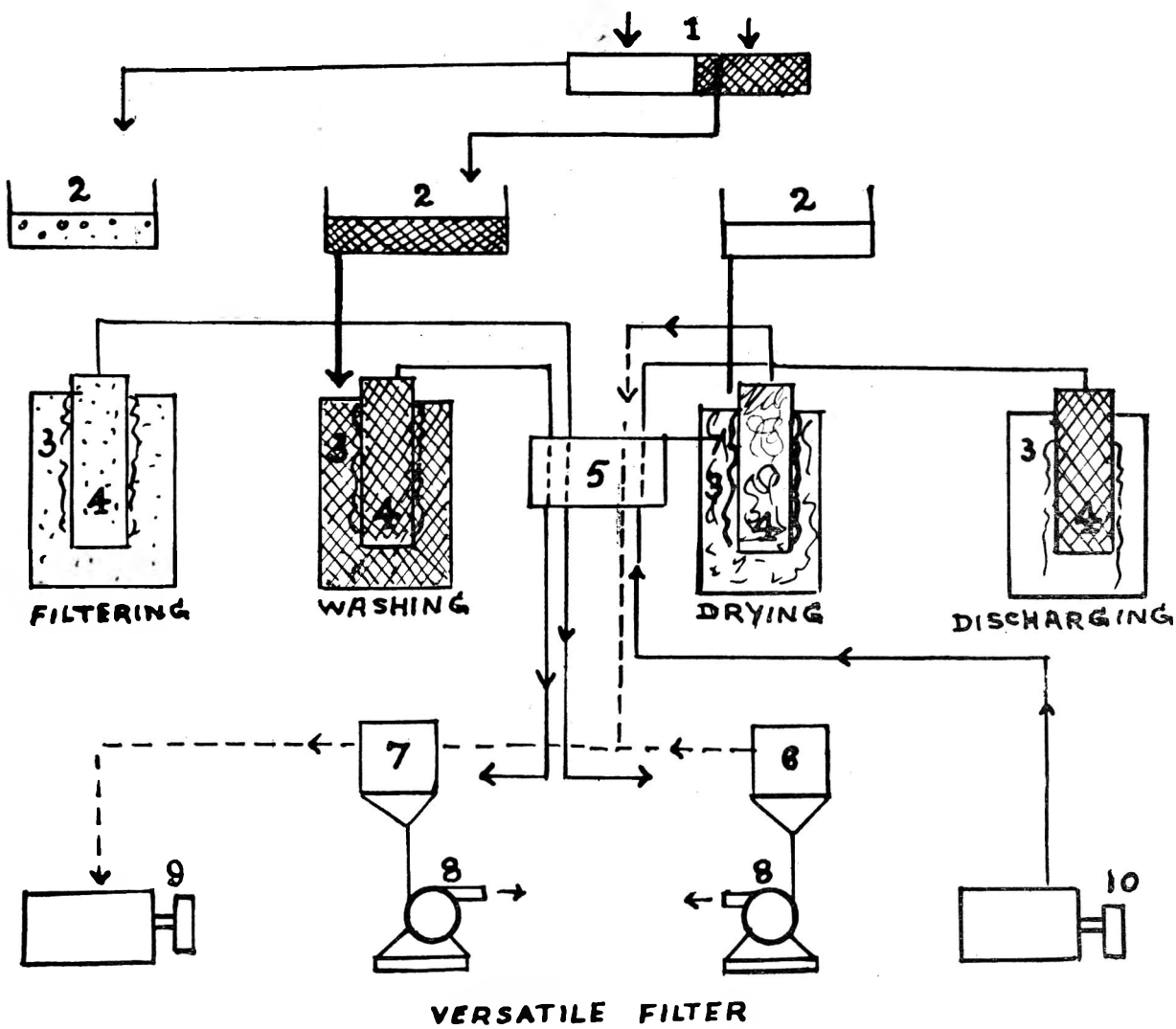


Fig. 1. Flow diagram of versatile filter

feeds of slurry, wash liquor and drying gas as well as blow back for cake discharge.

Operation: Feed ports for slurry and wash liquor (Fig. 1) (1) and the drying and discharge valves (5) are maintained on the distributor shaft. Annular liquid collectors (2) convey first slurry feed, then wash liquor to the individual filters' outer edge (3). In the centre of each filter is an element or plate (4), connected to discharge valve (5).

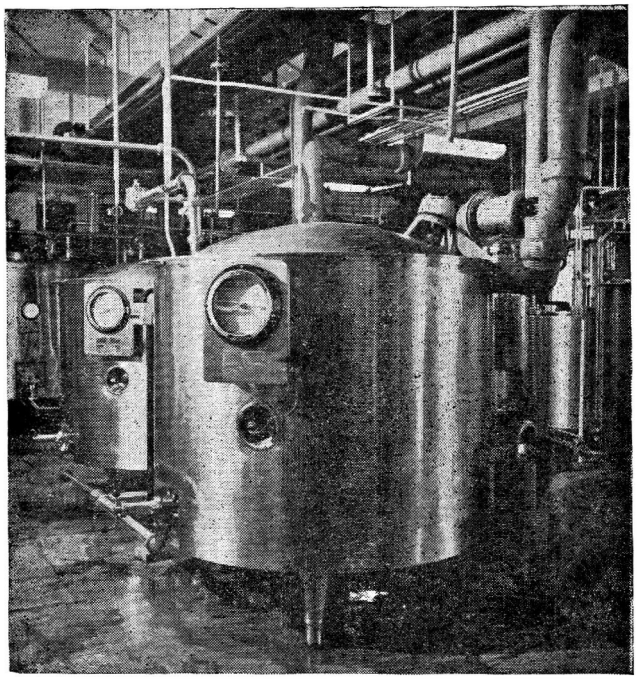
During distributor rotation, slurry is introduced to two or more cells simultaneously, then followed by a wash if required. Extraction pumps (8) draw filtrate into tank (6) and wash liquor into tank (7). Following washing the distributor shaft moves to the drying valve; a vacuum pump (5) pulls the remaining wash liquor from the cakes now formed on the elements (4), adding this to the wash already collected in (7).

Finally air supplied by compressor (10) is forced back through the filter, thus blasting off the cake. Meanwhile, the bottom of the filter cell is opened, permitting the cake to fall out into a collection hopper or tray. (Chem. Engng, Vol. 75, No. 8, p. 90, 1968.)

Convention on Flour Milling and Baking Industries in India

The Association of Food Technologists (India) is holding a Convention on 'Flour Milling and Baking Industries in India' on November 14-15, 1968 at the Central Food Technological Research Institute, Mysore.

It is planned to organize technical sessions on flour milling and baking industries followed by panel



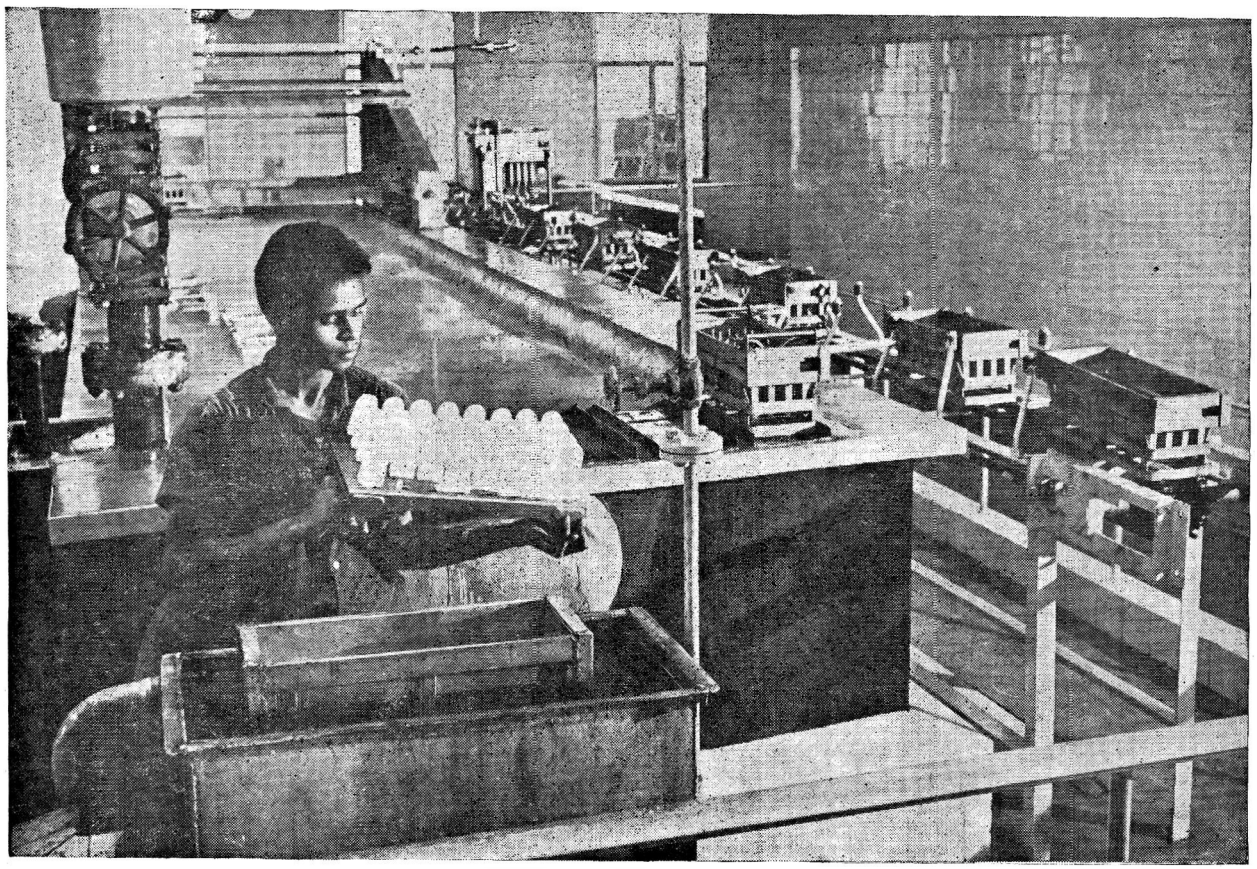
Stainless steel tanks of Larsen & Toubro make

discussions. The Convention will provide a forum for discussing the technical problems of these industries at the present time and an opportunity to exchange views and information between the representatives of the industry and the scientists and technologists. The Convention will be addressed by prominent representatives of the flour milling, baking and biscuit manufacturing industries and other organizations. It is also planned to devote sufficient time to discuss in detail the various problems pertaining to the flour milling and the baking industries in India.

Volga Ice Cream Factory—Asia's most modern

Volga Frozen Food and Ice Cream Company's five million rupee, automatic plant at Mahalaxmi in Bombay, the largest and the most modern in Asia, with an installed capacity of 18,000 litres of ice cream per shift and 5,000 lollies a day, was inaugurated recently.

Planning and installation of the plant was carried out under the supervision of J. Lyons & Co. Limited, London, which has also given the technical know-how in the manufacture of Volga's full range of ice



Lolly freezing tank fabricated by Larsen & Toubro Limited

cream products. The products are made strictly to J. Lyons' international standards and under their supervision. While the major part of the equipment was imported from U.K. and U.S.A., the lolly freezing tank, mixing vats and other ancillary equipment, including switchgear, were manufactured and supplied by Larsen & Toubro Limited. The new plant offers a wide range of ice cream products ranging from cups, family and party bricks to lollies and quenchies in different flavours. Eventually the plant will make an even wider variety of products with new flavours and combinations never before made in India.

Dr Parpia Heads U.N. Panel

Dr H. A. B. Parpia, Director, Central Food Technological Research Institute, Mysore has been made Chairman of the Protein Advisory Group (PAG), jointly set up by the three U.N. Agencies, namely, FAO, WHO and UNICEF.

Dr Parpia was formally installed as Chairman of PAG by the Deputy Director-General, FAO at the meeting of the group held in Rome from September 9-13, 1968.

Dr Parpia has been a member of PAG from 1964.

The PAG consists of experts in the fields of food science, technology, nutrition, agriculture, economics and sociology from ten countries. Normally, the PAG meets once a year.

One of the challenging tasks that the UN is facing is the growing menace of protein malnutrition to man's welfare and existence which has obvious implications for the future man power and economic development of the countries in which it occurs. The PAG has been assigned the task of advising the three UN agencies on a number of technical matters pertaining to protein malnutrition that are referred to it from time to time so that these agencies could take appropriate action on a world scale.

Dr Parpia returned to Mysore on September 16, after participating in the meeting held in Rome.

It is indeed a matter of pride to the Association of Food Technologists (India) that one of its distinguished ex-President and a very active member of the Association was singled out for this distinction.

Indian Standards Institution

The following standards have been published :

		Price Rs P.
Requirement for an Abattoir	IS: 4393–1967	5.00
Glossary of Tea Terms	IS: 4541–1968	6.50
Wheat Atta	IS: 1155–1968	4.00
Maida	IS: 1009–1968	4.00
Toxophene	IS: 4451–1967	7.00

Copies could be obtained from Indian Standards offices at New Delhi, Bombay, Calcutta, Hyderabad, Kanpur, and Madras.

Association News

Life Member

1. Mr Rajinder Pal Khosla, M/s Khosla Oil and General Mills, R-578, New Rajinder Nagar, New Delhi 5.

List of New Members

1. Mr C. T. Vora, Kushal Kung, Panchgani, Satara District, Maharashtra State.
2. Mr Kailash Vyas, Project Officer, Amul Dairy, Anand, (Gujarat).
3. Mr B. J. Lakhani, Khandesh Extractions, Oil Extraction, The Dept. of Amalgamated Electricity Company Limited, 17 B, Hornimal Circle, Fort, Bombay 1.
4. Miss Meizar Tandiin, Horticulture Research Institute, Gasarmingeu-Makarta, Indonesia. Student, I.F.T.T.C., C.F.T.R.I., Mysore.
5. Mr B. R. Ramanna, Discipline of Protein Technology, C.F.T.R.I., Mysore-2A.
6. Mr Kantilal Gopaldas Parekh, Dept. of Food Science, Rutgers the State University, Ag. Campus, New Brunswick, N.J. 08903, U.S.A.
7. Mr Chilasani Sri Rama Rao, Gorramandal Canning Company (P) Ltd., Gannavaram Post, Krishna Dt., Andhra Pradesh.
8. Arun Kumar V. Shah, A.V. Shah Flury's Swiss Confectionery Pvt. Ltd., 18, Park Street, Calcutta 16.
9. Mr Anil Kumar Mitter, c/o Miter Sircar & Co., 86, Serpentine Lane, Calcutta 14.
10. Mr Lakho L. Khatri, Tims Products, Ltd., Belgharia, Calcutta 56.
11. Mr P. K. Bose, Indian Oxygen Limited, Mona Road/Burmamines, Jamshedpur.
12. Lt. Col. N. G. C. Iengar, QMS's Branch (ST7), Army HQ, Room No. 153, Old Secretariat Building, Delhi 6.
13. Mr W. V. B. Sundara Rao, Head of the Division of Microbiology, Indian Agricultural Research Institute, New Delhi 12.
14. Mr G. L. Tandon, c/o Victoria Manufacturing Co., 1/2, Roop Nagar, Delhi 7.
15. Mr Virendra Kumar Labroo, Junior Scientific Officer, Accelerated Freeze Drying Unit, Najafgarh Road, Delhi Cantt 10.
16. Mr K. L. Maheswari, Senior Scientific Officer, Grade II, Accelerated Freeze Drying Unit, Najafgarh Road, Delhi Cantt 10.
17. Mr I. S. Verma, c/o Glaxo Laboratories (India) Pvt. Ltd., P.O. Box 1, Manzurgarhi, Aligarh, U.P.
18. Brigadier A. S. Bhujwala, Chief Director of Purchase, Army Purchase Organisation, Department of Food, Room No. 259, Krishibhavan, New Delhi 1.
19. Mr Raj K. Bhargava, D 11-5, D.M.S. Quarters, West, Patel Nagar, New Delhi.
20. Dr V. B. Mitbander, Institute of Hotel Management, Catering and Nutrition, Pusa, New Delhi 12.
21. Mr Ravi Awasthi, Food Technologist, M/s Narang Bros. & Co. (Pvt), Ltd., 3, Cavalry Lines, Delhi 7.
22. Mr S. G. Shaikh, Asst. Manager-Emulsion, Hindustan Photo Films Mfg. Co., Ltd., 'Indunagar', Ootacamund-5.
23. Prof. S. A. Khuraishi, Head, Department of Agriculture, Regional College of Education, Mysore-6.
24. Mr Moon Juhn Woong, Student, I.F.T.T.C., C.F.T.R.I., Mysore-2A.
25. Mr Lee, Young Chun, Student, I.F.T.T.C., C.F.T.R.I., Mysore-2A.
26. Miss M. N. Guttiker, C.F.T.R.I., Mysore.

Change of Address

1. Mr G. V. Krishnamurthy, c/o South India Research Institute (Hyderabad) Pvt. Ltd., Saroornagar, P.O., Hyderabad 35.
2. Mr B. C. Sen, Sencoise Products Ltd., 10, Crooked Lane, Calcutta 1.
3. Mr N. C. Roy, 61, Jatindas Road, Calcutta 29.
4. Mr A. G. Naik Karade, Chief Technical Executive, 4, Friends' Colony (West) Mathura Road, New Delhi.
5. Mr Chandra B. Gupta, Student, Department of Food Engineering and Technology, University of Manitoba, Winnipeg, Canada.

6. Mr M. L. Grover, The Britannia Biscuit Co. Ltd., Reay Road East, Bombay 10 DD.
7. Mr L. Weerasinghe, 77/4 Galpotta Road, Nawala-Rajaginya, Ceylon.
8. Mr Suchon Nimmannitaya, 511, Siphaya Road, Bangkok, (Thailand).
9. Mr Kil Hwan Kim, 530-39, 3 Tong 3 Ban, Junnong, L. Dong, Dong Dal Moon Ku, Sepul, Korea (South).
10. Mr Lee Bock Hyun, 199 dong sung Dong. chong Ro Ku, National Industrial Research Institute, Food Industry Section, Seoul, Korea (South).
11. Dr N. Satpathy, Chief Animal Nutritionist, M/s Tata Oil Mills Co. Ltd., Sewri, Bombay 33.

Association of Food Technologists, Eastern Branch

EXECUTIVE COUNCIL FOR 1968-69

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,,	Sri G. Basu
,,	Sri R. N. Dutta

Food Science and Technology Abstracts

1. General

1.10 *Design of a food service system*, G. E. LIVINGSTONE, *Fd Technol. Champaign*, 1968, **22** (1), 35.

1.11 *Food quality control*, N. GOLDENBERG, *Fd Mf*, 1968, **43** (1), 29.

Deals with the selection and use of raw materials and processing techniques, codes of safety during manufacture, plant sanitation, safe packaging, handling and transport to retailer as a safe, attractive and high quality product.

B. S. N.

1.12 *Quality and the consumer*, J. R. BLANCHFIELD, *Fd Mf*, 1967, **42** (12), 21.

General.

1.13 *Total electronic data processing*, *Fd Technol. Champaign*, 1968, **22** (1), 44.

1.14 *Food technology in Latin America*, *Fd Technol. Champaign*, 1968, **22** (2), 158-171.

A special symposium round up. Eight papers were presented.

1.15 *EDP in food plant*, *Fd Technol. Champaign*, 1967, **21** (12), 1564.

Description of how computors are moving into operations and material planning, production scheduling; production, processing and quality control; laboratory test analysis; and operation research.

A. A.

2. Cereals

2.47 *An alkali index for rice quality estimation*, VERNON L. HALL AND JIMMY R. JOHNSON, *Rice J.*, 1967, **70** (9), 22.

The alkali degradation scale combined the spreading and clearing action of raw milled rice into a continuous scale which will be more useful for variance analysis and correlation comparisons. A method of calculating a duplication limit for each set of samples was also presented. The calculated limit was a guide to determine which samples should be reanalysed. The alkali indexes are negatively correlated with the preference ratings for cooked rice. Of the two concentrations of KOH used, the 1.7 per cent solution gave the more accurate relationship between alkali indexes and the score card points for the taste panel analysis of cooked rice.

K. A. R.

2.48 *High protein flour can be made from all types of milled rice*, D. F. HOUSTON, *Rice J.*, 1967, **70** (9), 12.

Rice flours with about double the protein occurring in the original milled rices have been prepared from six widely differing types of rice by milling off the outer layers with a small commercial abrasive—type rice whitener. The process is applicable to all types of rice.

K. A. R.

2.49 *Conditions of drying parboiled paddy for optimum milling quality*, KSHIROD R. BHATTACHARYA AND Y. M. INDUDHARASWAMY, *Cereal Chem.*, 1967, **44** (6), 592.

Parboiled paddy dried in the shade had excellent milling quality, but rapid drying without air (40°-80°C) or in the sun, gave high breakage. The damage started as the moisture content reached 15 per cent and increased sharply with further drying. Milling at different time intervals after drying demonstrated further that damage to the paddy occurred gradually only subsequent to its removal from the drier. From this it was found that keeping the paddy hot after drying (conditioning) for 2 hours prevented the milling breakage. Drying in two stages with a tempering (2 hr if hot, 8 hr at room temperature) just before attainment of the critical moisture content (at 15.5—16.5 per cent) also preserved milling quality. Tempering at higher moisture contents was less beneficial, and multiple tempering gave no additional benefit. Drying in two passes with a tempering in the moisture range 15 to 19 per cent followed by hot conditioning after the final drying, was convenient in practice and satisfactory; a drying temperature up to 80°C could be used. After parboiled paddy was dried in this way, milling breakage would not exceed 1-2 per cent.

A. A.

2.50 *Effects of metabolic poisons on rice: the comparative sensitivity of aerobic and anaerobic modes of germination*, S. M. SIEGEL, MURIEL LEDERMAN, OLIVE DALY AND KAREN ROBERTS, *Pl. Physiol. Wash.*, 1967, **42** (11), 1489.

Experiments were started with the assumption that (A) metabolic poisons would differentiate aerobic from anaerobic modes in germinations and (B) that distinctions would be largely consistent with their defined activities as enzyme inhibitors. The results from the present study do not properly support these assumptions. Inhibitors tested were, $AgNO_3$, $HgCl_2$, phenyl mercuric acetate, iodoacetamide, KCN, $NaNO_3$, NaF, fluoroacetate 2, 4-dinitrophenol, Na_2HAsO_4 and CO. J. V. S.

2.51 *Recent trends in wheat research*, R. S. RANA, *J. sci. industr. Res.*, 1967, **26** (12), 521.

Review. 72 references.

2.52 *Lipids in wheat kernels of varying size*, C. M. CHIU AND Y. POMERANZ, *J. Fd Sci.*, 1967, **32** (4), 422.

The hard red spring kernels had generally more lipids than hard red winter kernels; differences in bound lipids were small. Total lipid content per kernel depended primarily on kernel size, and was affected little by wheat class or variety. Thin layer chromatography showed triglycerides as the major non-polar component, and digalactosyl glyceride and phosphatidyl choline as the major polar components. Concentrations of individual non-polar or polar components were not affected significantly by kernel size.

A. A.

2.53 *A study on the relative Pelshenke values of improved Indian and Dwarf Mexico wheats*, A. AUSTIN AND A. RAM, *Bull. Grain Technol.*, 1967, **5** (4), 232.

Pelshenke value is an important quality characteristic which determines the suitability of a wheat variety for chapati or bread making. The values range from 56 min. to 235 min. in the varieties examined. On this basis, the different wheat varieties have been classified into: weak (less than 75 min.); medium strong (75-149 min.); strong (150-200 min.); very strong (above 200 min.).

B. S. N.

2.54 *Quality of American wheat*, D. D. HILL, *Bull. Grain Technol.*, 1967, **5** (4), 227.

General.

2.55 *The oxidation-reduction enzymes of wheat. III. Isoenzymes of lipoxidase in wheat fractions and soybean*, P. L. Guss, T. Richardson and M. A. Stahmann, *Cereal Chem.*, 1967, **44** (6), 607.

Crude aqueous extracts from wheat milling fractions, soybeans and mung beans, in addition to a commercially purified soybean lipoxidase, were subjected to electrophoresis on polyacrylamide gels. A specific shaking procedure involving incubation of gels containing 0.5 per cent soluble starch with linoleate substrate, followed by treatment of gel with acidic potassium iodide, revealed lipoxidase as brown to blue bands. Mung beans and purified commercial soybean lipoxidase each showed one band. Break shorts, reduction shorts, and flour from Selkirk, Lee Bison and Triumph varieties of wheat showed two major bands; the break shorts of Selkirk and Lee also showed two minor bands with lower Rf values. Crude aqueous extracts of soybean showed four bands that stained positive for lipoxidase.

A. A.

2.56 *Immunochemical comparisons of antigenic proteins of Durum and hard red spring wheats*, C. C. Nimmo and Mary T. O. Sullivan, *Cereal Chem.*, 1967, **44** (6), 584.

Immunochemical studies of wheat types showed that except in gliadins and salt soluble proteins, the protein component of one type showed reaction of identity with a protein component of similar migration rate of another type. The investigation indicates that baking quality differences of wheat types are not related to individual protein differences.

B. S. N.

2.57 *Characterization of the acetic acid-insoluble fraction of wheat gluten protein*, J. E. Cluskey and R. J. Dimler, *Cereal Chem.*, 1967, **44** (6), 611.

The acetic acid-insoluble protein in wheat gluten was extracted in good yield by using a hydrochloric acid-2-chloroethanol solvent after acetic acid extraction. This protein appears to be mixture of high molecular weight constituents consisting in part, of a variety of polypeptides inter molecularly linked together through disulfide bonds and resembling most closely those of water-soluble proteins of wheat flour.

A. A.

2.58 *Lipid distribution in the protein matrix of wheat endosperm as observed by electron microscopy*, H. L. Seckinger and M. J. Wolf, *Cereal Chem.*, 1967, **44** (6), 669.

Free and bound lipids were extracted from hard red spring wheat flour. Free lipids were distributed throughout the protein matrix rather than in distinct bodies. Bound lipids, however, appeared in small inclusions throughout the protein matrix and are assumed to be remnants of cytoplasmic structures occurring in endosperm cells at maturity. No difference was observed in the protein matrix which would suggest that it could be prepared into wedge protein and a lipid-rich, fibrous, adhering protein fraction.

A. A.

2.59 *A method for detecting mixtures of artificially dried corn with high moisture corn*, Joe R. Hart, *Cereal Chem.*, 1967, **44** (6), 601.

On the basis of variance and mean of moisture contents of individual kernels, a mixture of high and low moisture (artificially dried) corn may be detected; with 0.2392 variance at 15.5 per cent mean moisture content, the sample is a mixture. The method is advantageous as heat damaged corns have a wider range of moisture than normal kernels.

B. S. N.

2.60 *Relationship between crude protein content and amino acid composition of Irish barleys*, Patricia Mcgeown and M. F. Maguire, *Ir. J. agric. Res.*, 1967, **6** (3), 221.

Amino acid composition of Irish barleys using automatic amino acid analyser.

J. V. S.

2.61 *A new strain of barley with starch of high amylose content*, N. R. Merritt, *J. Inst. Brew.*, 1967, **73** (6), 583.

A type of barley (Glacier, Scottish plant breeding station No. AC 38), where amylose content of starch (44 per cent) is about double that of normal varieties.

J. V. S.

2.62 *The role of proline in the amino acid metabolism of germinating barley*, Margaret Jones and John S. Pierce, *J. Inst. Brew.*, 1967, **73** (6), 577.

Most of the amino acids are produced in endosperm, in right quantities required for protein synthesis in embryo. During growth, total concentrations of free and combined glutamic acid, NH_3 and glycine decrease with simultaneous increases in the total concentrations of free and combined proline, aspartic acid and lysine. No evidence was found for the presence of an end product inhibition of peptidase activity in endosperm. In malting, the growth of embryo is shown to be useful in removing amino acids from endosperm.

J. V. S.

2.63 *The effect of grain moisture at time of harvest on yield and milling quality of rice*, M. D. Morse, J. H. Lindt, E. A. Oelke, M. D. Brandon and R. G. Curley, *Rice J.*, 1967, **70** (11), 16.

The total grain yield per acre recedes to about 20 per cent at harvest. The increase in yield is slow after rice reaches 26 per cent moisture. The per cent head rice generally peaks as kernel moisture declines to between 30 and 26 per cent. Total milled rice per acre continues to increase as grain moisture decrease to 12 per cent; however not rapidly once the grain is down to 26 per cent moisture.

A. A.

2.64 *Physico-chemical properties of brown rice from Oryza species and hybrids*, Cynthia C. Ignacio and Bienvenido O. Juliano, *J. agric. Fd Chem.*, 1968, **16** (1), 125.

Analysis of 29 samples of brown rice representing 11 wild species and 2 interspecific hybrids of genus Oryza.

J. V. S.

2.65 *Physico-chemical properties of protein of developing and mature rice grain*, Evelyn P. Palmiano, Aurea M. Almazan and Bienvenido O. Juliano, *Cereal Chem.*, 1968, **45** (1), 1.

Analysis was carried out on acetone powders of whole grain of *Oryza sativa* L. (var IR8) during development. Non-protein N decreased in concentration, but the amount per grain remained relatively constant. The protein fractions per grain increased during first 2 weeks after flowering, but only glutelin and prolamine continued to increase in amount throughout development. Albumin-globulin per grain and the concentration of urea-sodium chloride extract of the acetone powder decreased during the later phases of development. Gel filtration of urea-salt extract on Sephadex G-100 gave 3 fractions corresponding to molecular weights of > 2, 0.8 and 0.3×10^5. A four-day sample of grain had higher lysine content than did either the 14-day sample or mature grain.

A. A.

2.66 *Processed rice products*, Joseph T. Hogan, *Rice J.*, 1967, **70** (11), 25.

Information on parboiled rice, quick cooking rice, canned rice, breakfast foods, rice baby foods, and rice flour are given. 19 references.

2.67 *Note on limitation of starch-iodine blue test for milled rice amylose*, Bienvenido O. Juliano, Artemio V. Cartano and Amanda J. Vidal, *Cereal Chem.*, 1968, **45** (1), 63.

2.68 *Quality test on rice for world trade*, G. HAMPEL, *Cereal Sci. Today*, 1968, **13** (2), 64.

Correlations between the different methods used for testing quality of rice are given and the importance of measuring the absolute viscosity is stressed.

J. V. S.

2.69 *Changes in biochemical and bread making properties of storage damaged flour*, Y. POMERANZ, R. D. DAFTARY, M. D. SHOGREN, R. C. HOSENCY AND J. F. FINNEY, *J. agric. Fd Chem.*, 1968, **16** (1), 92.

Damage to bread making potentialities of stored wheat flour was accompanied by almost complete breakdown of free flour lipids and by a substantial decrease of bound lipids. Starch gel electrophoresis patterns indicated that proteins of storage damaged flour had undergone only minor changes. Mixing time of damaged flour was more than twice as long as that of sound flour. Gassing power of the damaged flour could be restored by adding polar or total lipids. Fractionation studies showed that the damage was due to the breakdown of the lipids rather than to changes in the gluten proteins or starch and water solubles.

A. A.

2.70 *Reactive and total sulfhydryl and disulfide contents of flours of different mixing properties*, C. C. TSEN AND W. BUSHUK, *Cereal Chem.*, 1968, **45** (1), 58.

Total and relative SH and S-S contents were determined for 7 flours having mixing times between 25 (very strong) and 2 (weak) minutes. For the flours examined mixing strength appears to be inversely related to the relative SH and S-S groups.

A. A.

2.71 *Fractionation and characterisation of purothionin*, N. FISHER, D. G. REDMAN AND G. A. H. EBTON, *Cereal Chem.*, 1968, 45 (1), 48.

Purothionin isolated from wheat flour by the methods of Balls and Hale (*This Journal, 1940*, **17**, *243*) has been fractionated on Sephadex G-75 to give 2 products with differing composition and properties.

J. V. S.

2.72 *Effect of disulfide bond cleavage on wheat gliadin fractions obtained by gel filtration*, HERALD C. NIELSEN, A. C. BECKWITH AND J. S. WALL, *Cereal Chem.*, 1968, **45** (1), 37.

This paper describes viscosity studies on classical gliadins, low MW-glutenin and purified gliadin in the presence of mercapto ethanol as well as studies of MW before and after disulfide bond cleavage. The study reveals that low MW glutenin contains intermolecular disulfide bond as does glutenin, whereas most of the disulfide bonds in purified gliadin are intramolecular. Also described are the starch-gel electrophoretic investigations on reduced alkylated glutenin, classical gliadin, purified gliadin, and low MW-glutenin. The electrophoretic studies indicate that peptide units resulting from disulfide cleavage of glutenin and gliadin are different and that the peptide units of the low MW glutenin fraction are similar to those of glutenin.

A. A.

2.73 *The relationship of a globulin component of wheat flour to purothionin*, C. C. NIMMO, MARY T. O'SULLIVAN AND J. E. BERNARDIN, *Cereal Chem.*, 1968, **45** (1), 28.

The most rapidly migrating protein component of wheat flour is apparent on gel electrophoresis in aluminium lactate buffer, pH 3.1, as a pair of bands having the same position as purothionin (the low molecular weight, high sulfur protein). The component has now been separated from the crude globulin by preparative electrophoresis and gel filtration (Sephadex G-50, 0.05 M acetic acid, 0.01 M KCl_2) to yield a water soluble material ('globulin') resembling purothionin in elution volume, UV absorption spectrum and amino acid composition.

A. A.

2.74 *Some properties of dough and gluten in D_2O*, R. TKACHUK AND I. HLYNKA, *Cereal Chem.*, 1968, **45** (1), 80.

Extensigraph, farinograph, mixing and baking characters of dough in D_2O, are described and compared with properties of dough in H_2O. Farinograph mixing behaviour of D_2O gluten was also studied. The results showed that a stronger dough and gluten is formed in D_2O than in H_2O.

A. A.

2.75 *An automatic machine for the manufacture of bread*, E. MAES, *Inds aliment. agric.*, 1967, **84** (2), 139.

Four Belgian laboratories have elaborated an automatic equipment in which kneading lasts 20 seconds, fermentation (at high temperature) 25 minutes, and cooking 10 minutes in a high frequency oven.

A. A.

2.76 *Studies with radioactive tracers. XII. Further investigations on the neutral extracts from bread baked with sucrose—^{14}C. XIII. Fate of starch ^{14}C during bread baking*, C. C. LEE AND Y. H. LIAU, *Cereal Chem.*, 1968, **45** (1), 66, 73.

XII. The neutral fractions from the 70 per cent ethanolic extract of the crumb and crust of bread made by straight dough method with 5 per cent sucrose ^{14}C have been subjected to further investigation by paper chromatography in conjunction with acid and enzymic hydrolyses.

XIII. Analagous studies have been made on the fate of uniformly labelled starch ^{14}C during bread making and results reported.

J. V. S.

2.77 *Improving the biscuit baking process*, G. R. WINCH, *Fd Mf*, 1968, (Feb.), 39.

2.78 *The chemical composition and nutritive value of maize grit*, K. CHANDRA, *Indian Vet J.*, 1968, **45** (3), 248.

Maize grit was quite palatable to experimental animals, fairly rich in crude protein and poor in mineral content. The average digestibility co-efficient of total carbohydrates, ether extract and crude protein were 76, 67 and 82 respectively.

K. A. R.

2.79 *Nutritionally unavailable niacin in corn isolation and biological activity*, D. D. CHRISTIANSON, J. S. WALL, R. D. DIMLER AND A. N. BOOTH, *J. agric. Fd Chem.*, 1968, **16** (1), 100.

Commercial corn gluten was found to contain a substance having (extracted by 50 per cent ethanol water) bound niacin which could be made available only by alkali treatment. The substance was separated from extracted protein through its insolubility in water and its non-absorption in cation exchange resin. The isolate contains carbohydrates, nitrogenous compounds and niacin.

J. V. S.

2.80 *Phosphorylases I and II of maize endosperm*, C. Y. TSAI AND D. E. NELSON, *Pl. Physiol. Wash.*, 1968, **43** (1), 103.

2.81 *The proteolytic enzymes of barley and malt. I. Extraction of peptidyl peptide hydrolases (endopeptidases) with activity at pH 5 from malt*, H. J. G. TEN HOOPEN, *Cereal Chem.*, 1968, **45** (1), 49.

The effects of pH, temperature and additions to the extractant were investigated. The extraction of water soluble proteases is optimal after some minutes at room temperature. Addition of cysteine and nylon 6.6 to the extractant increases the yield. The extraction of proteases soluble in 8 per cent NaCl is completed after an extraction time of approximately 30 min. at 40°C, provided

the extractant is buffered to pH 5. The proteolytic activity in the extracts is most stable at pH 5.

A. A.

3. Pulses

3.6 *Nitrogen fixing capacity of guar beans*, O. L. Oke, *Trop. Sci.*, 1967, **9** (3), 144.

Of particular interest in this paper to a food technologist is a reference made to the occurrence of HCN in guar beans which has limited its use in Nigeria (O. L. Oke, *Nature*, 1964, 204, 405).

J. V. S.

3.7 *Guar has many uses*, Surat Bhan and Ram Prasad, *Indian Fmg N.S.*, 1967, **17** (6), 17.

3.8 *Feeding trial on guar meal*, V. R. Thatte, M. R. Kaduskar and R. T. Desai, *Indian Vet. J.*, 1967, **44** (8), 701.

There was no difference in the efficacy of groundnut cake and guar meal for milk production and growth.

K. A. R.

3.9 *Biological assay of guar meal (Cyamopsis psoraloides) on growth rate of Hariana calves*, 1. *Guar meal as a substitute for groundnut cake in actively growing Hariana calves*, V. R. Sadagopan and S. K. Talapatra, *Indian Vet. J.*, 1967, **44** (12), 1061.

Guar meal appears to replace groundnut cake quite successfully when fed at 20 per cent level to Hariana calves.

K. A. R.

3.10 *Biological assay of guar meal (Cyamopsis psoraloides) on growth rate of Hariana calves. II. The effect of feeding guar meal as the sole concentrate to growing Hariana calves as compared with wheat bran as the only concentrate*, V. R. Sadagopan and S. K. Talapatra, *Indian Vet. J.*, 1968, **45** (3), 241.

Guar meal can successfully replace groundnut cake. Its use as a sole concentrate is liable to cause diarrhoea in animals. In spite of the disadvantages the sole feeding of guar meal showed an average growth rate of about 1.28+0.11 lb. against 1.17+0.09 lb. in bran group.

K. A. R.

3.11 *Pea lipoxidase, distribution of enzyme and substrate in green peas*, C. E. Eriksson, *J. Fd Sci.*, 1967, **32** (4), 438.

The concentration of extractable enzyme was highest in the cotyledons. The concentration of the enzyme was higher in the inner than outer part of the cotyledon. Both free and bound fatty acids were found in all parts of the pea. The respiratory rates of intact and damaged green peas were determined.

K. A. R.

3.12 *Distribution of nutrients in the anatomical parts of Indian pulses*, Shalini Singh, H. D. Singh and K. C. Sikka, *Cerea Chem.*, 1968, **45** (1), 13.

Seven common pulses (cajanus, pea, lentil, mung bean, cowpea, French bean, guar) were separated, each into seed coat, cotyledon, embryo, and endosperm (in guar only), and analysis was carried out for ash, protein, fat, fibre, N-free extract, P, Ca, and Fe. Cotyledon accounted for almost the entire food value of the whole seed.

J. V. S.

3.13 *Effect of blanching and dehydration on the conversion of chlorophyll to pheophytin in green beans*, Y. H. Foda, A. El-Waraki and M. A. Zaid, *Fd Technol. Champaign*, 1968, **22** (2), 233.

The effect of blanching upon the per cent retention of both chlorophyll and pheophytin was contrary to the effect of combined blanching and dehydration. Chlorophyll retention decreased and pheophytin formation increased with the increase of time and temperature of blanching. A noticeable increase in the retention of both chlorophyll and pheophytin was observed with increased time and temperature of blanching prior to dehydration.

J. V. S.

4. Fruits, Vegetables and Tubers

4.51 *Creamed honey-fruit spreads*, Robert Berthold Jr. and Allen W. Benton, *Fd Technol. Champaign*, 1968, **22** (1), 83.

Fruits (sun dried, and freeze-dried) and fruit extracts have been blended with crystallised honey to produce highly acceptable spreads. Commercial production of these products has been found economical and may boost sales of honey.

J. V. S.

4.52 *Diacetyl test as a quality control tool in processing frozen concentrated orange juice*, D. I. Murdock, *Fd Technol. Champaign*, 1968, **22** (1), 90.

Data have been presented to show that the diacetyl test can be used as an index of juice quality and poor sanitation in processing frozen concentrated orange juice.

A. A.

4.53 *The role of wounds in the infection of oranges by Penicillium digitatum Sacc.*, J. A. Kavanagh and R. K. S. Wood, *Ann. appl. Biol.*, 1967, **60** (6), 375.

Spores of *P. digitatum* in water, when applied to wounds made between oil vesicles, developed only from those which extended into the albedo. The flavedo of most oranges appeared resistant to infection even when damaged. Lesions developed more rapidly and readily when suspensions of spores in water were applied to wounds in skin that damaged oil vesicles.

J. V. S.

4.54 *Isolation and identification of two isomeric naringenin rhamnodiglucosides from grape fruit*, J. W. Mizelle, W. J. Dunlap and S. H. Wender, *Phytochem.*, 1967, **6** (9), 1305.

Two isomeric rhamnodiglucosides of naringenin have been isolated from the segments of Texas Ruby Red grape fruit and identified as 4′β-D-glucosyl—7-β-neohesperidosyl naringenin and 4′β-D-glucosyl—7-β-rutinosyl naringenin.

4.55 *Leucoanthocyanidins of sapota fruit*, S. Lakshminarayana and A. G. Mathew, *J. Fd Sci.*, 1962, **32** (4), 451.

Sapota fruit (Sapodilla) especially at the early stages of development, contains large amounts of leucoanthocyanidins. By characterisation of anthocyanidins formed from purified leucoanthocyanidins, the presence of leucodelphinidin and leucocyanidin as major components, and leucopelargonidin as a minor component was established. Two other anthocyanidins have been observed as trace components.

A. A.

4.56 *Pectic substances of sweet cherries and their alteration during SO_2 brining*, J. P. Van Buren, *J. Fd Sci.*, 1967, **32** (4), 435.

During ripening the proportion of protopectin in the cherries decreased as did the average intrinsic viscosity of the pectic material. Brining of the cherries resulted in a further decrease in the intrinsic viscosity and a conversion of protopectin and pectinic acid to the pectic acid form. The texture of the brined cherries softened with increasing maturity of the starting material. On prolonged storage in SO_2 brine, the texture of the cherries softened as did the intrinsic viscosity of the pectic materials.

4.57 *Greening of potatoes: CA Cure*, F. R. Forsyth and C. A. Eaves, *Fd Technol. Champaign*, 1968, 22 (1), 48.

A green pigmentation develops on the surface of potatoes when they are exposed to light during post-harvest handling and marketing. This is objectionable because of the altered appearance and bitter taste in potatoes (due to solanine formation). The green pigmentation was found to be prevented by storage of white

potatoes (*Sebago* variety) in atmosphere containing at least 15 per cent of CO_2.

J. S. V.

4.58 *Prospects for the utilization of refrigerated containers for transport of tropical fruit by sea*, R. DEULLIN, *Fruits*, 1967, 22 (8), 368.

The author examines the possibility of sea transport of tropical fruits in refrigerated containers. He concludes in favour of retaining multi-temperature ships and the use of refrigerated containers with refrigerated groups on ships of classic construction.

A. A.

4.59 *Evaluation of the content of pulp held in suspension in fruit drinks*, P. DUPAIGNE, *Fruits*, 1967, 22 (7), 305.

The proposed method is based on the rapid deposition of pulp after the addition of acetone to the juice in question. The deposit obtained in these conditions is centrifuged and weighed after the elimination of the serum. A. A.

4.60 *Production and export of Bulgarian fruits and vegetables in the fresh or processed state*, D. SARMADJIEV, *Fruits*, 1967, 22 (4), 189.

Bulgaria produces a plentiful supply of certain fruits and vegetables: apples, peaches, table grapes, water and other kinds of melons, tomatoes and pomentoes which are the subject of a very lively export trade and a modern processing industry.

K. M. D.

4.61 *The French market for tropical fruit in 1966*, R. NAVILLE, *Fruits*, 1967, 22 (2), 101.

4.62 *Industrial preparation of fruits meant for canning*, A. JACQUEL, *Inds aliment. agric.*, 1967, 84 (9-10), 1299.

The industrial preparation of fruits canned as whole or halves, in tin and glass containers with syrup or water, is now realized mechanically in France. Various machines are proposed for the following operations: receiving, washing, sorting, grading, stemming and bunch breaking, pitting, peeling.

A. A.

4.63 *Banana cultivation in Colombia*, B. MOREAU, *Fruits*, 1967, 22 (11), 557.

4.64 *The place of cut hands in the banana trade*, R. NAVILLE, *Fruits*, 1967, 22 (10), 517.

4.65 *Packing bananas in hands. II. Packing stations*, J. CHAMPION, *Fruits*, 1967, 22 (2), 63.

Account of the conditions of harvest and transport of the stems to the packing stations, to avoid all damage. Different arrangement of these stations, and organisation of the successive operations of cutting into hands or clusters, washing and rinsing, and placing in the various types of cases and cartons.

A. A.

4.66 *Damp-absorption by cartons of bananas during warehousing and transport by sea*, R. DEULLIN, *Fruits*, 1967, 22 (6), 273.

A rise in the moisture of banana cartons lowers their mechanical strength and increases their heat condition. It is therefore important to study the absorption of water by this material in various circumstances—in a saturated atmosphere at tropical temperature; in the prerefrigeration chamber; and in the hold of the banana boat. The results of observations made in these different circumstances are recorded in tables and graphs.

A. A.

4.67 *The market for citrus in Western Europe*, R. NAVILLE, *Fruits*, 1967, 22 (11), 579.

4.68 *Studies on the storage of Mandarin oranges (Citrus reticulata Blanco) treated with wax or wrapped in diphenyl treated paper*, K. R. SUBBA RAO, P. NARASIMHAM, B. ANANDASWAMY, AND N. V. R. IYENGAR, *J. Fd Sci. Technol.*, 1967, 4 (4), 165.

4.69 *Respiration of oranges and grape fruits harvested at different stages of development*, Y. AHARONI, *Pl. Physiol. Wash.*, 1968, 43 (1), 99.

Young and unripe oranges and grape fruits stored at 15° or 20°, shortly after harvest, showed markedly increased respiration and then a maximum after which decrease occurred. Ethylene production in oranges was parallel to respiration. The respiratory upsurge in both fruits was accompanied by colour changes typical of maturity and by stem end abscission. When fruit was harvested at close to or at commercial maturity it evidenced a gradual respiration decrease without any upsurge. No ethylene production was detected in oranges at this stage.

A. A.

4.70 *The pineapple in Mexico*, R. M. CADILLAT, *Fruits*, 1967, 22 (8), 371.

Techno-economic report.

4.71 *Precursors of volatile components in tomato fruit. I. Compositional changes during development*, MING-HO YU, L. E. OLSON AND D. K. SALUNKHE, *Phytochem.*, 1967, 6 (11), 1457.

Glutamic acid was present in high concentration and its concentration doubled during ripening. A concomitant decrease in the concentration of several other amino acids was noted. Compositional changes in dry matter, total nitrogen, and starch (and its components) during ripening were followed up.

K. A. R.

4.72 *Effect of dimethyl sulfoxide (DMSO) on the biosynthesis of carotenoids in detached tomatoes*, L. C. RAYMUNDO, A. E. GRIFFITHS AND K. L. SIMSON, *Phytochem.*, 1967, 6 (11), 1527.

Beta-zeacarotene was isolated from the tomato fruit. Treatment with DMSO reduced the total carotenoid in ripening fruit. The synthesis of phytoene, phytofluene, zeta-carotene, and lycopene was inhibited. The levels of beta-zeacarotene, gamma-carotene and beta-carotene remained essentially unchanged.

A. A.

4.73 *Physiological aspects of accelerated ripening and yellowing of Golden Delicious apples*, C. LEBLOND, *Fruits*, 1967, 22 (11), 543.

The fundamental agents to be employed are: heat, oxygen, ethylene and an atmosphere very poor in carbon dioxide. The results of a systematic study show that the conditions of application of these agents differ according to the age of the fruits and their condition.

K. M. D.

4.74 *The respiration climacteric in apple fruits: some possible regulatory mechanisms*, A. C. HULME, M. J. C. RHODES AND L. S. C WOOLTORTON, *Phytochem.*, 1967, 6 (10), 1343.

The inhibition of succinate and malate oxidation by added oxaloacetate has been studied in mitochondria isolated from the peel of apple fruits at various stages of respiratory climacteric.

K. A. R.

4.75 *The respiration climacteric in the apple. Production of ethylene and fatty acids in fruits attached to and detached from the tree*, D. F. MEIGH, J. D. JONES AND A. C. HULME, *Phytochem.*, 1967, 6 (11), 1507.

At the start of ripening, the rise in lipoxidase activity precedes the evolution of ethylene, which in turn precedes the respiratory climacteric. The rise in respiratory activity is accompanied by rapid accumulation of free and esterified fatty acids. Subsequently free acids begin to disappear, followed later by a loss of esterified acids. Metabolism of triterpinoid components of the skin shows no relation to the respiratory changes of ripening. Ethylene production is higher in detached fruit than in fruit freshly picked from the tree.

K. A. R.

4.76 *Apple polyphenol oxidase (PPO) activity in relation to various phenolic compounds*, C. T. SHANNON AND D. E. PRATT, *J. Fd Sci.*, 1967, **32** (5), 479.

Quercetin, quercitrin, rutin, cyanidin chloride, phloroglucinol, and resorcinol were neither substrates nor inhibitors of apple polyphenol oxidase. Phloroglucinol and resorcinol increased the rate of PPO catalysed oxidation of chlorogenic acid. Esculetin and dihydroquercetin were found to be substrates of PPO. No synergistic effect was detected in the browning rates of an esculetin-chlorogenic acid mixture. Ferulic acid, fisetin, and a *p*-coumaric acid were generally non-competitive inhibitors, although ferulic acid inhibited competitively in one test.

A. A.

4.77 *Volatiles in controlled atmosphere apple storage: Evaluation by gas chromatography and mass spectrometry*, P. ANGELINI AND I. J. PFLUG, *Fd Technol. Champaign*, 1967, **21** (12), 1643.

Ethylene concentration in eleven controlled atmosphere (CA) apple storages was followed by direct chromatographing of CA storage atmosphere. Effects of apple variety, CO_2 removing equipment and presence/absence of activated carbon on ethylene concentration were traced. Saturated and unsaturated hydrocarbons dominated in number and quantity. Several esters, primary and secondary alcohols and a few aldehydes were also identified.

J. V. S.

4.78 *Study of the combined effects of temperature and the composition of the atmosphere on the ripening of fruit, using a variety of pear*, S. GUCLU, *Fruits*, 1967, **22** (9), 433.

No particular attention has been paid to the combined effects of temperature, oxygen content and the carbon dioxide content of the atmosphere. The author has studied this problem. *II.* Description of the apparatus and techniques used for the assessment of the stage of development of the fruit; measurement of respiratory intensity; measurement of total carbon dioxide in the tissues of the fruit.

K. M. D.

4.79 *Study of the combined effects of temperature and the composition of the atmosphere on the ripening of fruit, using a variety of pear*, S. GUCLU, *Fruits*, 1967, **22** (10), 503.

The author reports on the action of atmospheric composition at constant temperatures in two cases: (*a*) influence of the combined action of temperature and gaseous mixtures on the respiratory intensity of the fruit; and the influence of the combined action of temperature and gaseous mixtures on the total carbon dioxide content of the fruit tissues.

A. A.

4.80 *Changes in the nitrate and nitrite contents of fresh and processed spinach during storage*, W. E. J. PHILIPS, *J. agric. Fd Chem.*, 1968, **16** (1), 88.

The presence of nitrites in foods causes health hazards particularly in children. The fresh spinach from some Canadian markets did not contain any nitrite. Processed spinach, like canned, pureed baby food and frozen spinach did not produce appreciable quantities of nitrite. The nitrite-N accumulated when frozen spinach was allowed to thaw at room temperature for long periods. Cooking reduced nitrate as well as nitrite content.

J. V. S.

4.81 *Digestibility co-efficient and nutritive value of cauliflower leaves and stems*, B. M. PATEL, M. B. VAIDYA AND P. M. PATEL, *Indian J. Dairy Sci.*, 1967, **20** (2), 150.

The leaves and stems fed in proportion of 4:1 were quite palatable. Cauliflower leaves and stems can make a good supplementary fodder if fed along with poor quality fodder. On green basis 42 kg. of cauliflower leaves and stems (4:1) can provide a maintenance ration for an animal weighing 400 kg.

J. V. S.

4.82 *New products based on potatoes*, K. G. BERGNER, *Inds aliment. agric.*, 1967, **84** (2), 195.

The new products processed from potatoes and currently consumed in Germany are surveyed. Peeled raw potatoes and canned potatoes seem to have found a market. Mashed potatoes and Knödel are still difficult to add to frozen prepared foods. Finally, the same products, after dehydration, are the main outlet; therefore their preservation is described with more details (chemical alterations, enzymatic browning, rancidity, problems of texture).

A. A.

4.83 *Deterioration of frozen-par-fried potatoes upon holding after thawing. I. Objective colour measurements and fat absorption*, R. M. REEVE, F. P. BOYLE, B. FEINBERG AND G. K. NOTTER, *Fd Technol. Champaign*, 1968, **22** (2), 205.

Colour of French fries from frozen par-fried stock is impaired by prolonged holding at 55° to 35° F. Deterioration is visibly detectable when the par-fried have been held 2 days at 55°, 6 days at 45°, or 10 or 12 days at 34° F. Holding par-fries in frozen state or at very low temperature after thaw significantly reduces oil absorption after frying.

A. A.

4.84 *Deterioration of frozen par-fried potatoes upon holding after thawing. 2. Composition, histology and objective measurements of texture*, R. M. REEVE, B. FEINBERG, F. P. BOYLE AND G. K. NOTTER, *Fd Technol. Champaign*, 1968, **22** (2), 208.

Lee-kramer shear press measurements showed linear correlation with total solids gain and per cent of water lost upon finish-frying. After 1 day of holding at 55° F, inverse relation was obtained between shear-press values and time held before finish fry. Cells from interiors of par-fries thawed and held at temperatures above freezing tended to be more shrunken or irregular than those from samples thawed for only 1 hour.

A. A.

4.85 *Simplified test system for measuring reducing sugar in potatoes*, J. R. WISLER AND A. H. FREE, *Fd Technol. Champaign*, 1968, **22** (2), 212.

4.86 *Changes in lipid composition of sweet potatoes as affected by controlled storage*, T. S. BOGGESS JR., J. E. MARION, J. E. WOODROOF AND A. H. DEINPSEY, *J. Fd Sci.*, 1967, **32** (5), 554.

Lipids were extracted from Georgia Red and continental varieties which were stored at 15.5, 10 and 4.5° C. The two varieties did not differ initially in the relative proportions of fatty acids. However, the short chain fatty acids including palmitic decreased during cure and storage, while linoleic, linolenic and tetracosaenoic acids increased.

A. A.

5. Oilseeds and Nuts

5.20 *Cryoprecipitation of soybean 11S protein*, W. J. WOLF AND DAYLE ANN SLY, *Cereal Chem.*, 1967, **44** (6), 653.

Cryoprecipitation mostly of 11S ultracentrifugal fraction of soybean protein occurs when a concentrated aqueous extract of defatted soybean meal is cooled. Extracts with meal: Water ratio 1:5 prepared at 40°C had more 7S, 11S and 15S which on cooling yielded almost double quantity of 11S than those prepared at 25°C. Cryoprecipitation was prevented by NaCl solutions of more than 0.3M.

B. S. N.

5.21 *Separation of soybean whey into fractions with different biological activities for chicks and rats*, WALTER SAMBETH, M. C. NESHEIM AND A. SERAFIN, *J. Nutr.*, 1967, **92** (4), 479.

Four fractions of soybean whey prepared by a batch fractionation technique on DEAE cellulose and fed to chicks and rats, differed very much in relative stimulation of pancreas of chicks to enlarge and gall bladder to contract, growth rate, fat absorption and dietary metabolizable energy value.

B. S. N.

5.22 *A comparative study of nutritional and physiological significance of pure soybean trypsin inhibitors and ethanol-extracted soybean meals in chicks and rats*, A. GERTLER, YEHUDITH BIRK AND A. BONDI, *J. Nutr.*, 1967, 91 (3), Part I, 358.

Soybean trypsin and chymotrypsin inhibitors appear to play an insignificant role in growth suppression of rats fed soybean meal diet.

B. S. N.

5.23 *Purification and structural studies of the* 11S *component of soybean proteins*, N. CASTIMPOOLAS, D. A. ROGERS, S. J. CIRCLE AND E. W. MEYER, *Cereal Chem.*, 1967, **44** (6), 631.

Soybean globulins were separated into at least 12 components by disc electrophoresis on polyacrylamide gel. The 11S component of the cold precipitated globulins was purified by ammonium sulfate precipitation followed by DEAE-sephadex column chromatography. The 11S protein was dissociated by 6M guanidine hydrochloride containing 0.2M mercaptoethanol into at least 12 sub-units. Quantitative N-terminal amino acid analysis of the 11S component indicated that the protein contains at least twelve polypeptide chains, eight of which end in glycine, two in phenylalanine, and two in either leucine or isoleucine. Amino acid analysis showed that several of the essential amino acids exhibit lower values in the 11S protein than in the whole soybean globulin fraction.

A. A.

5.24 *Correlation of amino acid indexes with nutritional quality of several soybean fractions*, L. R. HACKLER, H. R. STILLINGS AND R. J. POLIMENI JR. *Cereal Chem.*, 1967, **44** (6), 638.

Amino acid compositional studies were made on several soybean fractions. An essential amino acid index and a requirement index were calculated, based on the amino acids of the soybean fractions, and the results failed to demonstrate a good correlation between the chemical indexes and protein efficiency ratio (PER) values. Available lysine was determined for the fractions, and it also failed to correlate with PER. The residue which is the most nutritious fraction as measured by growth and PER, contained more cystine and consequently more total sulfur amino acids. This apparently accounts for superior utilisation of residue proteins.

A. A.

5.25 *Purification of the 11S component of soybean protein*, A. C. ELDRIDGE AND W. J. WOLF, *Cereal Chem.*, 1967, **44** (6), 645.

Solubilities of the 2S, 7S, 11S and 15S components in the cold-insoluble fraction of soybean protein were determined in sodium acetate, sodium chloride buffers at pH 4.6, 0°-2°C; solubility of some components varied considerably with ionic strength. Extraction of the cold-insoluble fraction at 25°C with pH 4.6, 0.5 ionic strength buffer, followed by cooling to 0°-2°C, yielded 3-4 mg. per ml. having a composition of 8, 21 and 70 per cent for the respective 2S, 7S and 11S components. When these solubles were diluted to pH 4.6, 0.3 ionic strength and cooled to 0°-2°C, a precipitate formed. The precipitate contained 5-8 per cent 7S component and 92-95 per cent 11S component. It was devoid of 2S and 15S material. Further fractionation of this precipitate on sephadex G-200 resulted in an 11S fraction which appeared to be homogenous.

A. A.

5.26 *Oilseed technology*, K. T. ACHAYA, *Indian Fmg, N.S.*, 1967, **17** (9), 49.

5.27 *Sesamum: high productivity potential*, S. S. RAJAN, *Indian Fmg, N.S.*, 1967, **17** (9), 14.

5.28 *Cotton seed: prospects of cutting down edible oil imports worth Rs 250m.*, K. T. ACHAYA, *Indian Fmg, N.S.*, 1967, **17** (9), 9.

5.29 *Immunochemical study of soybean proteins*, N. CATSIMPOOLAS AND E. W. MEYER, *J. agric. Fd Chem.*, 1968, **16** (1), 128.

Soyabean protein fractions were analysed by double jel difusion and disc immuno-electrophoresis with antiwhole soya-bean extract and anti-11S soybean protein antisera and the data have been discussed.

J. V. S.

5.30 *Studies on the nutritional value of protein from soybean milk powder*, J. E. DUTRA DE OLVEIRA AND L. SCATENA, *J. Fd Sci.*, 1967, **32** (5), 592.

When soy milk or skim milk combined with different amounts of corn starch to give a range of dietary protein levels was fed to rats the nutritive value of vegetable milk compared favourably with that of animal milk at the highest level of protein intake. The growth response was generally less with soy milk at low protein levels; this could be corrected by supplementation with methionine.

A. A.

5.31 *Gel filtration fractionation of the whole water-extractable soybean proteins*, TETSUJIRO OBARA AND MIYO KIMURA, *J. Fd Sci.*, 1967, **32** (5), 531.

The four fractions obtained by gel filtration with sephadex G-200 column of water extractable soybean proteins were protein fractions and the fifth one was non-protein fraction. The first two fractions were heterogenous by sedimentation analysis, while the third and fourth fractions gave homogenous fractions with 7S and 2S respectively. The trypsin inhibitor activity was in the fourth fraction.

K. A. R.

5.32 *The cultivation of the pistachio in Turkey*, M. AYFER, *Fruits*, 1967, 22 (8), 351.

Turkey produces an appreciable amount of pistachio nuts for market. The questions studied are: origin of the pistachio, regions where cultivated, species and varieties, development of the flower and fruit, environmental and cultural conditions having an influence on the production of pistachios (temperature, moisture, soil, varieties cultivated). The establishment of a plantation, pruning, grafting, pollination and harvest are discussed as well as conditions of storage and marketing.

A. A.

6. Oils, Fats and Waxes

6.21 *Marketing essential oils*, W. A. ENNEVER, *Trop. Sci.*, 1967, **9** (3), 136.

6.22 *Determination of butter fat in margarine fat by transesterification and GC*, D. F. WITHINGTON, *Analyst, Lond.*, 1967, **92** (1100), 705.

Margarine fat is transesterified to form the ethyl esters of the fatty acids. The reaction mixture is examined by temperature —programmed GC, and the amount of fat calculated from the ethyl butyrate formed.

A. A.

6.23 *Identification of 2-Pentylfuran in fats and oils and its relationship to the reversion flavour of soybean oil*, R. G. KRISHNAMURTHY, T. H. SMOUSE, B. D. MOOKERJEE, B. R. REDDY AND S. S. CHANG, *J. Fd Sci.*, 1967, **42** (4), 372.

2-Pentylfuran is identified as a component of the volatile decomposition products of slightly auto-oxidized soybean and cotton seed oils and those of thermal oxidation of corn oil and hydrogenated cotton seed oil. The flavour threshold of this compound in oil at room temperature is 1 p.p.m. At 1-10 p.p.m.,

it imparts to the oil, a beany odour. Expert organoleptic panels identified a deodorized oil containing 5 p.p.m. of 2-pentylfuran as a reverted soybean oil.

A. A.

6.24 *Trends in fat disappearance in the United States*, 1909-65 DAVID L. CALL AND ANN MACPHERSON SANCHER, *J. Nutr.*, 1967, **93** (2), Part II, 1.

Review. 34 references and 7 tables.

6.25 *Pro- and antioxidants in the field of fats. XXII. The influence on the growth and lipid metabolism of Saccharomyces cerevisiae*, H. P. KAUFMANN AND A. K. S. AHMAD, *Fette Siefen Anstr.*, 1967, **69** (11), 837.

The growth of *Saccharomyces cerevisiae* can be greatly influenced by the addition of certain antioxidants, although to different degrees under aerobic and anaerobic conditions. The qualitative composition of the lipids does not change, however, their amounts do.

A. A.

6.26 *Deviation in fat content of different oil yielding plants. I. Winter rape and sunflower*, W. SCHUSTER, *Fette Seifen Anstr.*, 1967, **69** (11), 831.

6.27 *India's hidden wealth: Minor and non-edible oils*, J. G. KANE, *Indian Fmg, N. S.*, 1967, **17** (9), 44.

6.28 *Polycyclic aromatic hydrocarbons in solvents used in extraction of edible oils*, JOHN W. HOWARD, THOMAS FAZIO AND RICHARD H. WHITE, *J. agric. Fd Chem.*, 1968, **16** (1), 72.

The hydrocarbons are isolated by partition, column and thin layer chromatography and measured by UV and spectrofluorometric procedures. Average recoveries of some five hydrocarbons added to 500 g. of hexane at 2 p.p.b. level ranged from 86-95 per cent. No carcinogenic hydrocarbons were detected.

J. V. S.

6.29 *Effect of batter ingredients on changes in fatty acid composition of fats used for frying*, MARTON PENNION, *Fd Technol. Champaign*, 1967, 21 (12), 1638.

Iodine values showed a significant decrease with time in both frying fat and absorbed fat. The presence of egg in the batter influenced the iodine values of the two frying fats differently. There was also a significant interaction among type of frying fat, presence of baking powder, and presence of egg. Mean iodine values were increased when baking powder was present. The effect of egg on the absorbed fat was masked by the dilution of fat with egg fat, especially when baking powder was not present.

A. A.

6.30 *Vegetable oil pigments carotenoids and phaeophytins in soybean, rapeseed and linseed oils*, J. A. G. BOX AND H. A. BOCKENOOGEN, *Fette Seifen Anstr.*, 1967, 69 (10), 724.

The pigments in the raw soybean, rapeseed and linseed oils comprise of 25 to 50 p.p.m. of carotenoids mainly lutein (xanthophyll) and partly esterified neoluteins and 20 p.p.m. of chlorophylls, which occur mainly as phaeophytin A.

A. A.

6.31 *Effect of varietal or subvarietal alterations on the high order compositeness (HOC) status of fats from the same biological species. The glyceride structures of three Myristica malabarica Mace fats*, A. R. S. KARTHA AND R. NARAYANAN, *J. Am. Oil Chem. Soc.*, 1967, **44** (12), 733.

A detailed report of the glyceride structure of the fats is given from the point of view of variations in HOC indices which were produced during changes in component acid composition. HOC is seen to be a new, independent structural feature of natural fats, which has to be considered along with theories of bioesterification to give complete explanation for triglyceride structure.

J. V. S.

6.32 *Segregation of fish oils with liquid propane and butane*, JAIMIE WISNIAK AND JORGE BARRIENTOS, *J. Am. Oil Chem. Soc.*, 1967, **44** (12), 743.

The possibility of using liquid propane near its critical temperature for separating fish oils in 2 fractions of different iodine value. The separations were performed at 65.6, 77.1 and 94.6°C. The separation range was found to decrease with increase in temperature. No segregation was observed with liquid butane.

J. V. S.

6.33 *Aromatic acids of carnauba wax*, L. E. VANDENBURG AND E. A. WILDER, *J. Am. Oil Chem. Soc.*, 1967, **44** (11), 659.

Parahydroxy as well as paramethoxy cinnamic acids have been isolated from carnauba wax: parahydroxy cinnamic acid forms 75 per cent of the total aromatic acids. These hitherto unreported aromatic acids occur mainly as part of a polymerisable diester. Certain properties of carnauba wax are reported to be due to the presence of about 30 per cent of these diesters.

J. V. S.

7. Starch, Sugar and Confectionery

7.10 *The effect of acid and salt on farinogram and extension of dough*, K. TANAKA, KAZUYO FURUKAWA AND H. M. ATSUMOTO, *Cereal Chem.*, 1967, **44** (6), 675.

In the farinograph test, the consistency of dough was increased by decreasing the pH with acetic acid in the absence of salt (Sod. chloride): in contrary, it tended to decrease from a lower value to the lowest, in the presence of salt. With the extensograph, the resistance showed a fixed lower level at the pH range 5.9-4.3 without salt; however, with salt, it was increased from a low level to the highest value by decreasing the pH from 5.8 to 4.2. The extensibility showed a marked decrease in both cases with or without salt.

A. A.

7.11 *Studies of the carbonyl compounds produced by sugar amino acid reactions. II. In bread systems*, ALI SALEM, LLOYD W. ROONEY AND JOHN A. JOHNSON, *Cereal Chem.*, 1967, **44** (6), 576.

Reaction of amino acids with sugar increased the colour intensity of bread crust; xylose producing a darker crust colour than glucose. Colour was influenced by the kind of amino acid which acts with a particular sugar. Carbonyl content in bread increased with addition of amino acid. Formaldehyde, acetaldehyde, isobutyraldehyde, isovaleraldehyde, 2-methyl butanol, phenylacetaldehyde and methionol were produced from glycine, alanine, valine, leucine, isoleucine, phenylalanine and methionine respectively. Aroma of bread varied with the type of aldehyde formed.

B. S. N.

7.12 *Some rheological properties of crude gluten mixed in farinograph*, M. DOGUCHI AND I. HLYNKA, *Cereal Chem.*, 1967, **44** (6), 561.

Farinograph mixing curves for gluten indicate that water content plays a greater role in determining gluten mobility, while salt accounts for its increase. Addition of urea acetanimide and guanidine hydrochloride decrease consistency of gluten and make it sticky; $MgSO_4$ counteracts this effect.

B. S. N.

7.13 *Stabilization of pH of corn syrup for hard candy*, B. R. SURI, *Mfg Confect.*, 1967, **47** (7), 35.

Addition of buffers like sodium-acetate, citric acid buffer and sodium succinate-succinic acid buffer control the inversion of sucrose during candy cooking process. The buffers improve the shelf-life of candy and also help in controlling and maintaining the pH of ion exchange.

K. A. R.

7.14 *Wheat starches. II. Effect of polar and non-polar lipid fractions on pasting characteristics*, L. G. MEDGALF, V. L. YOUNGS AND K. A. GILLES, *Cereal Chem.*, 1968, **45** (1), 88.

7.15 *Continuous manufacturing process for the starch industry*, E. ESPIARD, *Inds aliment. agric.*, 1967, **84** (9-10), 1243.

Continuously operating installations have permitted very great economies in the starch industry, and an insignificant improvement in quality. Risks of fermentation during manufacture are very small, because of the shortness of time. Minor problems that remain to be solved relate to the soaking of grains, filtration of gluten, and automation.

K. M. D.

8. Spices and Condiments

8.2 *Some minor sesquiterpene hydrocarbons of black pepper*, C. J. MILLER, A. K. CREVELING AND W. G. JENNINGS, *J. agric. Fd Chem.*, 1968, **16** (1), 113.

α-cubebene, isocaryophyllene, and γ-muurolene have been identified among other minor constituents, and an additional major constituent has been isolated and identified as β-farnesene.

J. V. S.

9. Meat, Poultry and Fish

9.78 *Meat science and technology—an industrial view of the present position*, G. B. GALLIVER, *J. Fd Technol.*, 1967, **2** (4), 255.

9.79 *Forty years of research on meat*, E. C. BATE-SMITH AND M. INGRAM, *Fd Preserv. Q.*, 1967, **27** (3), 67.

Review. 22 references.

9.80 *Relationship between meat quality and cooking losses*, G. Y. GANTNER, L. KORMENDY, M. LOSONCZY AND F. LORINCZ, *J. Fd Technol.*, 1967, **2** (4), 371.

On the basis of visual assessment of exudative appearance, hams and shoulders were divided into two categories before curing the 'normal' and the exudative ones. The normal category included the DFD (dark, firm, dry) and the intermediate types having significantly lower average cooking loss. The efficiency of selection depends on the incidence of exudative meat to be processed. In the case of high incidence, selection may improve uniformity of pork products by decreasing cooking losses.

A. A.

9.81 *Molecular properties of post mortem muscle. 3. Electron microscopy of myofibrils*, M. H. STROMER AND D. E. GOLL, *J. Fd Sci.*, 1967, **32** (4), 386.

Studies on myofibrils sampled immediately after death showed that sucrose isolation gave the best structural preservation as indicated by maintenance of Z-line structure. Although the appearance of resting muscle was maintained in both sucrose and KCl preparations, several myofibrils from the KCl treated preparations showed stretched sarcomeres. Glycerol treated myofibrils usually had shorter sarcomere lengths than myofibrils prepared with the other solvents.

A. A.

9.82 *Electron microscopy of meat emulsion*, L. L. BORCHERT, M. L. GREASER, J. C. BARD, R. G. CASSENS AND E. J. BRISKEY, *J. Fd Sci.*, 1967, **32** (4), 419.

Fat globules as small as 0.1 μ in diameter were observed to have distinct protein membranes. The continuous phase of the emulsion was fibrous, but homogeneous. After thermal processing the globule membrances were highly disrupted and the protein of the continuous phase was coagulated into dense, irregular zones.

A. A.

9.83 *The reaction of mysoin with malonaldehyde*, H. BUTTKUS' *J. Fd Sci.*, 1967, **32** (4), 432.

Myosin, a structural protein of muscle, was reacted at pH 6.8 and ionic strength 0.5 with malonaldehyde, an oxidation product of polyunsaturated fatty acid. The rate of reaction with the E-amino groups of myosin was greater at -20°C than at 0°C and was almost as great as that at + 20°C.

A. A.

9.84. *Bovine collagen. 1. Changes in collagen solubility with animal age*, D. J. CARMICHAEL AND R. A. LAWRIE, *J. Fd Technol.*, 1967, **2** (4), 299.

The five forms of collagen differing in solubility in bovine *dorsi*, skin and tendon increased, during gestation and fall, between birth and 1-2 years of age. After birth, there was a rapid rise in the concentrations of the more insoluble forms of collagen. In muscular tissue only, after about 2 years of age there was some diminution in total collagen and also in the proportion of the latter which resisted extraction.

K. A. R.

9.85 *Bovine collagen. II. Electrophoresis of collagen fraction*, D. J. CARMICHAEL AND R. A. LAWRIE, *J. Fd Technol.*, 1967, **2** (4), 313.

The neutral salt soluble (NSS) and acid soluble (AS) collagens and eucollagens, from muscle, skin and tendon of bovines were separated by electrophoresis. AS was more difficult to extract than NSS; this reflected that there was greater measure of cross bonding between the α-chains of the AS. There was a marked increase in components having intramolecular cross bonds, in both NSS and AS collagens, and in the three tissues studied, between 5th and 9th month of gestation. In older animals there were also indications of an enhanced intermolecular cross bonding.

K. A. R.

9.86 *Nutritive value of edible parts of Fulani cattle*, O. L. OKE, *J. Fd Sci.*, 1967, **32** (4), 453.

All the parts of the Fulani cattle examined, contained 68-79 per cent protein; fat contents and calories were similar to those already reported. All parts were rich in calcium, iron and phosphorus.

K. A. R.

9.87 *The elastin content of various muscles of beef animals*, J. R. BENDALL, *J. Sci. Fd Agric.*, 1967, **18** (12), 553.

Most of the choice cuts of meat from the hind quarter and loin contain less than 0.2 per cent elastin on the dry weight basis. The muscle semitendinosus contains only 2 per cent dry fat free solids (DFFS). In the fore quarter, the *latissimus dorsi* is the only muscle which contains as much elastin as the semitendinosus. Muscles of trapesius, rhomboideus and pectoralis superficialis contain about 0.4 to 0.8 per cent DFFS. The muscle of the skin, pauniculus contains 1.2 per cent DFFS.

K. A. R.

9.88 *Response of the phenomena of extract-release volume and water holding capacity to irradiated beef*, JAMES M. JAY, *J. Fd Sci.*, 1967, **32** (4), 371.

Beef irradiated at levels from 0.3 to 2.4 Mrads with cobalt -60 showed much greater changes in extract release volume than water holding capacity as measured by the filter paper press method. The difference was even greater after storage at 5°C for 30 days. This difference appears to be a consequence of the greater amount of meat shrinkage after irradiation. Meat shrinkage increased both with increased levels of radiation and time of holding.

A. A.

9.89 *A study of the histological changes in the growing muscles, of beef animals*, J. R. BENDALL AND C. A. VOYLE, *J. Fd Technol.*, 1967, 2 (4), 259.

Studies have been made of the growth of the longissimus dorsi (LD) and semitendinosus (ST) muscles of Hereford and Freisian steers. A standard sarcomere length of muscle fibre is defined and a value of 2.60 μ is fixed for reference after due corrections. The internal diameters of the muscle fibres increased with age. The collagen content of muscles was higher at the calf stage than later. The elastin content was very low in LD muscles when compared to that in the ST muscles (about 37 per cent).

K. A. R.

9.90 *Studies on cattle for varying growth potential for beef production. II. Growth rate feed efficiency, carcass yield and offals. The relation of rate of live weight gain to measure of feed conversion efficiency in cattle*, F. J. HARTE AND D. CONNIFFE, *J. agric. Res.*, 1967, 6 (2), 137, 171.

I. Three breeds of cattle i.e., Ir. Freisians, Hereford × short horns and Aberdeen Angus × short horns were investigated. Growth rate of the first two breeds was similar and was more rapid than the last. No differences were found in conversion efficiencies between breeds. Dressing out percentages were similar in all breeds when animals were slaughtered at the same degree of finish; when slaughtered at the same age, Freisians showed lower dressing percentages than others.

J. V. S.

9.91 *Freeze-drying of cooked beef: some effects of freezing rate, and freezing method*, N. E. BENGTSSON, *J. Fd Technol.*, 1967, 2 (4), 365.

Cooked beef was little affected by freezing rate in connection with freeze-drying, except for markedly poorer appearance in the dried condition for the very slowly frozen product. Thermal treatment seemed to have no positive effect on drying rate or quality.

K. A. R.

9.92 *Freeze drying of beef. I. Theoretical freeze drying rates of beef*, R. BRALSFORD, *J. Fd Technol.*, 1967, 2 (4), 339.

A theoretical model of freeze drying is developed from which the dependence of drying rate and ice temperature on processing conditions can be calculated. When applied to beef steaks, the theory predicts that, at acceptable surface temperatures, the system is heat transfer limited; also the fastest sublimation rates should be obtained at high product surface temperatures combined with high cabinet pressures; if, however, the cabinet temperature is low (less than 20°C) the cabinet pressure should also be kept low.

K. A. R.

9.93 *Freeze drying of beef. II. A calorimetric method for comparing theoretical with actual drying rates (measurement of freeze drying rates of beef)*, R. BRALSFORD, *J. Fd Technol.*, 1967, 2 (4), 355.

A calorimetric method by which some of the predictions of the theory in Part I are compared with the actual freeze drying behaviour of beef. The method permits the continuous measurement of heat transfer into the sample as it dries. From this, the sublimation rate at any time may be deduced and the end of the sublimation is readily determined. For the most part the agreement between theory and experiment is good.

K. A. R.

9.94 *Cooling and freezing of lamb and mutton carcasses. 2. Weight loss during cooking*, A. K. FLEMING AND R. L. EARLE, *Fd Technol. Champaign*, 1968, 22 (1), 100.

The rates of evaporation of water from the surface of lamb, and mutton carcasses during cooling were measured over a range of air temperature and humidities. As a theoretical model for a lamb carcass, a cylinder of meat was considered, the surface of which cooled at the same rate as the surface of carcass. Used in heat balance calculations, the model allowed the prediction of rates of evaporation which agreed closely with experimental results, both under controlled laboratory conditions and also under operating conditions in meat works.

A. A.

9.95 *Action of dinitrophenyl amino acids on skeletal muscle proteins. II. Absorption of bis-dinitrophenyl-lysine by light and heavy meromyosins and by light meromyosin fraction*, R. W. BURLEY, W. J. H. JOHNSON, JEAN P. ROBERTSON, *Aust. J. biol. Sci.*, 1968, 21 (1), 141.

The quantity of bis (2, 4-dinitrophenyl) -L-lysine (abbreviation bis-DNP-lysine), absorbed at 5°C by myosin and meromyosins of rabbit skeletal muscle was estimated in phosphate buffer (pH7, ionic strength, 0.5) by 2 methods—one based on equilibrium dialysis, the other on high speed centrifugation. It is concluded that strong absorption is confined to the heavy meromyosin region of the myosin molecule and the weak absorption is an attribute largely associated with certain non-helical regions of the molecular structure of myosin.

J. V. S.

9.96 *The effect of post mortem conditions on the extractability and adenosine triphosphatase activity of myofibrillar proteins of rabbit muscle*, I. F. PENNY, *J. Fd Technol.*, 1967, 2 (4), 325.

9.97 *Relationship of colour with certain chemical and physical properties of porcine muscle*, M. A. JANICKI, J. KORTZ AND J. ROZYCZKA, *J. Fd Sci.*, 1967, 32 (4), 375.

The dominant wavelength of muscle colour depended almost exclusively on pH. A high pH was associated with a high dominant wavelength. Muscle colour saturation was associated with moisture content, pH, water holding capacity, and myoglobin content. The colour exhibited the highest degree of purity in muscles that were high in myoglobin content and low in pH, water holding capacity, and water content. Colour lightness was negatively associated with pH, water holding capacity and muscle pigments.

A. A.

9.98 *The effect of microorganisms on the emulsifying capacity and extract release volume of fresh porcine tissues*, R. J. BORTON, N. B. WEBB AND L. J. BRATZLER, *Fd Technol. Champaign*, 1968, 22 (1), 98.

A procedure for slaughtering and processing pork was used to obtain muscle samples relatively free of bacteria. A paired sample was inoculated with a bacterial culture to compare with the control. The initial bacterial count of the inoculated samples was approx. 5 million/g. The samples were analysed throughout a storage period of 17 days at 4°C to determine bacterial development extract release volume (ERV), and emulsifying capacity. The extent of bacterial growth reduced to ERV significantly and effectively lowered the emulsifying capacity of porcine muscles. The inoculated sample had a lower emulsifying capacity than the control throughout the 17 day storage period.

A. A.

9.99 *Shelf-life of fryer chickens packed in carbonated ice*, ANTHONY W. KOTULA AND JACK A. KINNER, *Poultry Sci.*, 1967, 46 (5), 1041.

Chickens stored at 1.0°C up to 11 days had total aerobic and psychrophilic counts that did not differ from chickens stored in ordinary water ice. Panelists could not detect any difference in colour or odour of the raw or cooked samples as a result of the use of carbonated ice. Differences in bacterial counts between chickens stored in wire bound crates and fibre board containers were not evident.

K. A. R.

9.100 *Tenderness of dystrophic chicken meat*, S. SCHOLTYSSEK, L. M. BELE, R. N. SAVRE AND A. A. KLOSE, *Poultry Sci.*, 1967, **46** (5), 1050.

Dystrophic birds weighed less and had a lower eviscerated yield than normal birds, although breast measurements differed little. Dystrophic muscle had higher pH and had very high fat content. All shear measurements on the *Pectoralis superficialis* revealed a significantly greater tenderness in the dystrophic muscle.

K. A. R.

9.101 *The effect of liquid nitrogen freezing on the taste, tenderness and keeping qualities of dressed turkey*, L. D. PICKETT AND B. F. MILLER, *Poultry Sci.*, 1967, **46** (5), 1143.

No significant difference in tenderness was observed when eviscerated turkey was frozen in liquid nitrogen. Slight preference for the commercially processed bird was indicated by the taste panels. Keeping qualities were nearly identical in both the methods. Nitrogen frozen birds were shown to shrink 3 per cent less during cooking.

K. A. R.

9.102 *Formation of myofibrillar fragments and reversible contraction of sarcomeres in chicken pectoral muscle*, K. TAKAHASHI, T. FUKAZAWA AND T. YASUI, *J. Fd Sci.*, 1967, **32** (4), 409.

As morphological changes occurred in the pectoral muscle of chicken carcasses during 48 hr storage at 5°C, two notable phenomena were observed: (1) fragmentation of myofibrils and (2) reversible or irreversible contraction of sarcomeres. When blendorized, myofibrils tend to break into small fragments composed of 1-4 sarcomeres with time post-mortem.

A. A.

9.103 *Fifty years of research on egg quality*, G. F. STEWART, *Fd Preserve. Q.*, 1967, **27** (3), 73.

Review. 114 references.

9.104 *Fish freezing*, *Fd Mf*, 1968, **43** (1) 26.

Review of FAO technical conference at Madrid.

9.105 *The supplementation of the Puertorican rural ration with fish protein*, J. A. GOYCO AND C. F. ASENJO, *Arch. Latino Nutr.*, 1967, **17** (3), 241.

The present study deals with the supplementation of the Puertorican diet with dried-salted cod fish, (2) whole fish flour Vio Bin, deodorized and (3) fish meal (Type C, from Nova-Scotia). As the only source of protein in the diet, they were found to be biologically complete proteins demonstrating PER and lactation values comparable to those of whole egg protein. The red-kidney bean protein was found to be an incomplete protein unable to support either normal growth or lactation.

K. M. D.

9.106 *Utilization of fish byproducts as cattle feed: Digestibility and nutritive value of a mixed fish meal including a shark liver meal*, S. S. NEGI AND N. D. KEHAR, *Indian Vet. J.*, 1968, **45** (2), 151.

The apparent average percentage digestibilities of crude proteins and ether extract in the mixed meal containing shark liver meal were 75 and 150 respectively and the nutritive value (in per cent on dry matter basis) was: DCP 45.7, TDN, 56.0 and SE., 53.2 Inclusion of shark liver meal imparted a disagreeable odour.

K. A. R.

9.107 *Nature of the residual lipids in fish protein concentrate*, B. F. MEDWARDOWSKI, J. VAN DER VEEN AND H. S. OLCOTT, *J. Fd Sci.*, 1967, **32** (4), 361.

Isopropanol-extracted samples had 0.1-0.2 per cent residual lipid and an ethylene dichloride-extracted sample had approximately 0.5 per cent residual lipid. The lipids contained 50-60 per cent neutral lipid, 20-25 per cent phospholipid, 5-10 per cent acidic lipids and the remainder uncharacterised. The saturated fatty acids of the lipids were mainly palmitic and stearic and the unsaturated fatty acids were mainly oleic and palmitoleic.

A. A.

9.108 *Volatile constituents of fish protein concentrate*, E. L. WICK, E. UNDERRINER AND E. PANERAS, *J. Fd Sci.*, 1967, **32** (4), 365.

Lyophilization of slurries of FPC yielded condensates from which a neutral fraction and a mixture of amine chlorides were isolated. The quantity of amine mixture present was dependent on processing conditions used in the FPC preparation and was related to the flavour intensity observed. Based on chromatographic separations and by mass spectrometry dimethylamine, trimethylamine, ammonia, ethylamine, diethylamine, n-propyl amine and a butylamine were identified.

A. A.

9.109 *Freeze drying of Atlantic cod steaks*, R. LEGENDRE, *J. Fish. Res. Bd, Canada*, 1967, **24** (7), 1461.

Study was made of the freeze-drying of steaks 6-18 mm, thick, at sample temperature from 38 to 98°C, and under total dryer pressures from 20 to 2000 μ, from pre- and post rigor, quick and slow frozen cod. The drying time varied directly with the thickness, inversely with the temperature of the sample, and was not affected by total pressure within the dryer with the thinner samples, but appeared to vary inversely with pressure for those 12 mm thick. Total drying time was the same for 16 mm thick samples from pre- or post rigor, quick or slow-frozen fish, but varied with 6 mm thick steaks. Quality varied inversely with thickness and temperature but not by dryer pressure.

A. A.

9.110 *Preparation of light salted fish by brining*, R. LEGENDRE, *J. Fish. Res. Bd, Canada*, 1967, **24** (8), 1693.

In a batch operation using an equal weight of fish and brine, good results were obtained with 25 per cent by weight salt solution and 5 hr of salting. With continuous circulation of brine of constant strength at 18°C, optimum conditions were achieved for salting using an 18 per cent brine solution and an 8 hr exposure period. With a brine temperature of 10°C, at a brine concentration of 22 per cent, a curing period of 12 hr was required. In each case the salted product must be 'water horsed' for about 24 hr before drying.

K. A. R.

9.111 *Hypoxanthine in iced fresh water fish*, L. C. DUGAL, *J. Fish. Res. Bd, Canada*, 1967, **24** (11), 2229.

The average content of hypoxanthine in yellow walleye (*Stizostedion vitreum*) and white fish (*Coregonus clupeaformis*) at the time of death was almost same (0.25/μmole/g); but it increased gradually to 1.52/μmole/g in 22 days and to 2.54/μmole/g in 18 days in yellow walleye and white fish respectively. Large variation in formation was noticed between individual yellow walleyes. The average hypoxanthine content of both yellow walleyes and white fish taken as group was found to be proportional to the number of days in storage. The hypoxanthine content appears to be suitable as an index of freshness for groups of fish not of individual fish.

K. A. R.

9.112 *Amino acid composition from trout muscle*, H. BUTTKUS, *J. Fish. Res. Bd, Canada*, 1967, **24** (7), 1607.

The amino acid composition was closely similar to that of rabbit myosin. Valine, glycine and methionine were present in slightly greater proportions in white muscle of trout. The histidine and proline contents of trout myosin differed from rabbit myosin by three residues per 10^5.g of protein.

K. A. R.

9.113 *Interaction between polyphosphates and meat*, P. A. INKLAAR, *J. Fd Sci.*, 1967, **32** (5), 525.

About 60 per cent of the calcium and 20 per cent of the magnesium naturally present in meat are firmly bound to the meat proteins and are not available to react with added phosphates.

K. A. R.

9.114 *A comparison of solvent and thermal techniques for determining the fat content of ground beef*, D. R. BELLIS, J. L. SECRIST AND M. J. LINSKEY, *J. Fd Sci.*, 1967, **32** (5), 521.

Results obtained by thermal extraction procedure correlate significantly (1 per cent level) with the results obtained by the official AOAC solvent extraction procedure. The fat levels investigated ranged between 14 and 29 per cent. As the amount of sample grinding increased the fat variation within thermal extraction replications decreased, while the differences between the thermal and solvent extracted fat became larger.

K. A. R.

9.115 *Molecular properties of post mortem muscle. 5. Nucleoside triphosphatase activity of bovine myosin B*, R. M. ROBSON, D. E. GOLL AND M. J. MAIN, *J. Fd Sci.*, 1967, **32** (5), 544.

There was very little difference in enzymic activity between myosin B isolated from pre-rigor, rigor (24 hr post mortem) or post rigor (312 hr post mortem) muscle stored at either 2° or 16°C.

K. A. R.

9.116 *Fatty acid compositions of bovine subcutaneous fat depots determined by gas liquid chromatography*, R. N. TERRELL, R. W. LEWIS, R. G. CASSENS AND R. W. BRAY, *J. Fd Sci.*, 1967, **32** (5), 516.

The outer subcutaneous fat over the triceps brachii (OSTB) had larger percentage of $C_{14:1}$ (5 per cent level) and $C_{16:1}$ (1 per cent level) acids than the fat sampled between the semimembranosus and biceps femoris (SEAM). The SEAM had a larger percentage of C_{14} than the inner subcutaneous fat over the semitendinosus (INST) (at 5 per cent level). The SEAM also had a larger percentage of C_{14} than the INST (at 5 per cent level).

A. A.

9.117 *Factors affecting collagen solubility in bovine muscles*, H. K. HERRING, R. G. CASSENS AND E. J. BRISKEY, *J. Fd Sci.*, 1967, **32** (5), 534.

Collagen solubility decreased significantly with each advancing maturity group in both *longissimus dorsi* and semimembranosus muscles. It was also related to panel tenderness in both muscles.

A. A.

9.118 *Response of striated muscle to electrical stimulation*, J. C. FORREST AND E. J. BRISKEY, *J. Fd Sci.*, 1967, **32** (5), 483.

9.119 *Muscle properties of physically restrained stressor susceptible and stressor-resistant porcine animals*, M. D. JUDGE AND R. G. CASSENS, *J. Fd Sci.*, 1967, **32** (5), 565.

9.120 *Rate of heating during precooking in foil and quality of boneless Turkey roasts stored at* 0°F, C. S. MARTINSON AND A. F. CORLIN, *Fd Technol. Champaign*, 1968, **22** (2), 223.

Roasts prepared from breast and thigh muscles of frozen turkeys were precooked with or without foil to 160°F at oven temperature of 225, 350 and 450°F. Total cooking losses were not different for turkeys cooked in foil but the proportion of drip to volatile losses were reversed compared to roasting without foil. The precooked roasts were stored at 0°F for 2 weeks, 2 months or 7 months. The overall weight losses were affected only by oven temperature and not by precooking in foil or by storage period. Flavour scores by a panel of judges indicated significant storage effect.

J. V. S.

9.121 *Cellular distribution of lactate dehydrogenase in chicken breast muscle*, H. O. HULTIN AND J. H. SOUTHARD, *J. Fd Sci.*, 1967, **32** (5), 503.

The lactate dehydrogenase was widely distributed among the subcellular fractions with the outer cell membrane and the mitochondrion. A 4-hr ageing period of the whole excised muscle had only a minor effect on the subcellular distribution of the enzyme. In aged muscle there was an increase of enzymic activity in the soluble supernatant fractions. K. A. R.

9.122 *Detection of egg-white in commercial liquid yolk*, K. N. NEY, *Fette Seifen Anstrmittel*, 1967, **69** (10), 794.

On the basis of the intensity of the ovalbumin band, it could be shown by paper electrophoresis that one sample A of commercial yolk contains approximately 15 per cent egg white while another sample D contains only 10 per cent. Thus it explains the fact that the sample A flocculated during pasteurization.

K. M. D.

9.123 *Studies of Kusaya. I. Chemical composition and preserving effect of the curing brine for Kusaya*, WATARU SIMIDU, ATSUSHI MOCHIZUKI, USIO SIMIDU, AND KAZUYOSHI AISO, *Bull. J. Soc. sci. Fish.*, 1967, **33** (12), 1143.

Kusaya is a traditional salt-dried fish known in Japan for a few hundred years. In this product, curing brine is used successively with fresh concentrated brine. Some of the curing brine have been used for 400 years. The product has a fermented smell but excellent taste. Analysis of the curing brine revealed that it contains less than 4 per cent salt, 490 mg per cent of total volatile basic nitrogen and has a pH of 7.8. Despite low salt concentration fillets of jack mackerel dipped in brine for 24 hours showed marked delay in the development of total volatile basic nitrogen during storage.

9.124 *Studies on the volatile fatty acids and volatile bases in Shiokara. I. Volatile fatty acids and volatile bases in Shiokara from commercial sources*, SHIN-ICHI TESHIMA, AKIO KANAZAWA AND KEN-ICHI KASHAWADA, *Bull. J. Soc. sci. Fish.*, 1967, **33** (12), 1147.

Shiokara is a product made by fermenting the cuttle fish muscle and viscera in the presence of salt; it has saltish bitter taste with agreeable flavour. The GC analysis showed that the acidic fraction of Ika-Shiokara (Squid) showed formic, acetic, propionic, isobutyric, n-butyric and n-caproic acids. The basic fraction contained 10 components those identified being, trimethylamine, ammonia, dimethylamine, monomethylamine, iso-butylamine and n-butylamine. In Katsuo Shiokara (Skip jack) the same components were found except iso-valeric acid and small quantity of 3 unknown substances. In both the Shiokara, the chief acidic and basic ingredients were acetic acid, iso-butyric acid, propionic acid, ammonia, iso-butylamine and an unidentified substance.

J. V. S.

9.125 *Quality changes during storage of boiled fish product prepared from Pacific herring by an improved method*, R. NITIBASKARA AND A. M. DOLLAR, *Bull. J. Soc. sci. Fish.*, 1967, **33** (11), 1028.

Products prepared by boiling fish with 40 and 50 per cent salt concentrations were best but had strong, salty taste. Those prepared with 10, 20 and 30 per cent concentrations of salt were acceptable from the view point of saltiness, rancidity and overall odour scores. They kept well and retained original fish odour characteristics for 4 weeks of storage under tropical conditions of temperature and humidity.

J. V. S.

9.126 *The fish protein concentrate story. 6. Quintero fish protein concentrate: protein quality and use in foods*, E. YANEZ, I. BARJA, F. MONCKBERG, A. MACCIONI AND G. DONOSO, *Fd Technol. Champaign*, 1967, **21** (12), 1004.

A description of pilot plant operation at Quintero, Chile. The unit can produce 300 tons of FPC (defatted, deodourised) per year. Animal and human feeding trials showed that the quality of FPC was good.

J. V. S.

9.127 *Studies on fish solubles. IV. Effect of unidentified growth factor in fish soluble on growth rate of rats* (2). *V. Effect of unidentified growth factor in fish soluble on growth rate of rat* (3), MASAAKI YANASE AND KIMIE ARAI, *Bull. J. Soc. sci. Fish.*, 1967, **33** (11), 1057, 1064.

Tests were made on weaning rats (four each of male and female) for 6 weeks. Control group received a basal casein diet at 15 per cent level; in test groups, tank mackerel meat meal, liver solubles and liver meal from blue fin tuna replaced casein at 15 per cent level. Supplementation with the 2 fish materials improved the PER of females during the latter half of the test period. Male rats did not show any effects during the entire test period. In another test, dietary proteins were provided at 15 and 8 per cent levels and saury fish solubles were used as substitute. At 8 per cent protein level, the fish solubles improved PER in female rats by 12 per cent. Further tests with other fish solubles of Alaska Pollack confirmed the earlier findings.

J. V. S.

9.128 *Edible protein—developmental work in the Netherlands for the manufacture of an edible and durable protein from fish*, L. VAHL, *Inds aliment. agric.*, 1967, **84** (2), 121.

The TNO Institute of the Netherlands is developing a new process for fish protein concentrate. Ground fishes are rid of oil, then proteins are precipitated, washed and dried. A technique based on a counter flow extraction with a combination of solvents has been employed to separate oil and meal for this. A plant which is continuously working is described.

K. M. D.

9.129 *EDTA inhibition of inosine monophosphate (IMP) dephosphorylation in refrigerated fishery products*, H. S. GRONINGER AND J. SPINELLI, *J. agric. Fd Chem.*, 1968, **16** (1), 97.

IMP has an important role in enhancing flavour of fish. The stabilisation of endogenous IMP would appear to favour the maintenance of high quality in refrigerated fishery products. Treatment of muscle with 0.8 μ mole of EDTA per gram inhibited dephosphorylation of IMP in those species of fish which had medium to low rates of dephosphorylation. The treated muscle showed significantly more acceptable flavour than control.

J. V. S.

9.130 *Distribution of β-glucuronidase in fish*, FUMIO NAGAYAMA, YUJI SAITO AND MASARO HAYASHI, *Bull. J. Soc. sci. Fish.*, 1967. **33** (12), 1132.

9.131 *Inhibition of β-glucuronidase by serum and bile of fish*, FUMIO NAGAYAMA, MASARO HAYESHI ANE KATSUO SAKAMOTO, *Bull. Soc. sci. Fish.*, 1967, **33** (12), 1139.

9.132 *Effects of radiation heating and storage on volatile carbonyl compounds in clean meats*, D. F. GADBOIS, J. M. MENDELSOHN AND L. J. RONSIVALLI, *J. Fd Sci.*, 1967, **32** (5), 511.

When air packed samples were irradiated and/or heated, the concentration of carbonyl compounds increased immediately except some low boiling compounds that reduced in concentration when the samples were heated. Storage of non-irradiated air packed samples at 33-35°F increased the concentration of volatile carbonyl compounds upto 20th day at which time the trend was reversed. Vacuum packing minimised the effects of irradiation, heating and storage. The pattern of volatile carbonyls in irradiated fresh clams is similar to that found in non-irradiated clams stored at 33-35°F for 20 days.

A. A.

10. Milk and Dairy Products

10.24 *Effect of oxygen removal technique on flavour stability of low heat foam spray dried milk*, A. TAMSMA, F. E. KURTZ AND M. J. PALLANSCH, *J. Dairy Sci.*, 1967, **50** (10), 1562.

Holding the powder for 18 hr under pressure of 1 mm and then packing in nitrogen ($O^2 < 0.002$ per cent) reduced the development of oxidized flavour during six months of storage at 4°C. Storing by packing the powder in cans containing a noble metal catalyst pellet plus nitrogen containing 5 per cent hydrogen eliminated the development of flavour. Holding the powder for 15 min at 1 mm pressure before filling cans with $N_2 + H_2$ mixture was sufficient to effectively pack the foam dried material.

K. A. R.

10.25 *Properties of Latin-American white cheese as influenced by glacial acetic acid*, L. G. SIAPANTAS AND F. V. KOSIKOWSKI, *J. Dairy Sci.*, 1967, **50** (10), 1589.

Latin-American white cheese made from cow's milk containing 3 per cent fat, showed best flavour and texture qualities and highest yields when a glacial acetic acid concentration of 110 to 130 ml per 35.5 kg milk was used.

K. A. R.

10.26 *Detecting antibiotics and inhibitors in milk*, J. HOLEC, *Prumysl Potravin*, 1967, **18** (8), 399.

10.27 *Quantitative recovery of carboxymethyl cellulose (CMC) from milk*, P. M. T. HANSEN AND J. C. CHANG, *J. agric. Fd Chem.*, 1968, **16** (1), 77.

The food stabiliser, CMC can be recovered from a tryptic digest of milk by solvent precipitation of fraction soluble in 12.5 per cent trichloracetic acid. The isolation is quantitative and can be measured by spectrophotometry. The material isolated is free from protein and is identical to the original material.

J. V. S.

10.28 *Lactone precursor in fresh milk fat: Isolation and characterisation of the precursor*, C. JANE WYATT, R. L. PEREIRA AND E. A. DAY, *J. Dairy Sci.*, 1967, **50** (11), 1760.

Fresh milk fat was separated into polar and non-polar glyceride fractions by silicic acid chromatography. Hydrolysis of the polar fraction which contained the precursor, at 140°C for 30 min resulted in the production of a series of delta lactones of even numbered chain lengths of from 8 to 18 carbon atoms; gamma undecalactone was also identified.

K. A. R.

10.29 *Determination of some physical and mechanical properties of curd supplied to cheese industry*, Z. KRCAL, *Prumysl Potravin*, 1967, **18** (8), 429.

Results given of measurements made on physical and mechanical properties of curd, used in cheese industry for making the Olomouc curds.

A. A.

10.30 *Storing curd designed for making Olomouc cheese in large capacity bins*, Z. KRCAL, S. SLAMA AND F. VADURA, *Prumysl Potravin*, 1967, **18** (10), 534.

The authors have designed a bin of 60-100 ton capacity specially adapted for storing curds at plants making Olomouc cheese. Curds are stored in hermetically closed bins filled with carbon dioxide. The bin is fitted with an auger-type unloader. The system meets the requirements of complete mechanization and permits the plants to arrange the production in lines.

A. A.

10.31 *Proteolytic and microbial changes during ripening of cheddar cheese using bacterial enzymes as milk coagulating agent*, AJAIB SINGH, AJIT SINGH, R. K. KUILA, S. M. DUTTA, I. J. BABBAR, R. A. SRINIVASAN AND A. T. DUDANI, *J. Dairy Sci.*, 1967, **50** (11), 1887.

10.32 *Continuous production of cheese—Continuous production of curd starting from concentrated milk*, M. F. X. TSCHERET, *Inds. aliment. agric.*, 1967, **84** (2), 129.

Merits of the Hutin-Stenne process for continuous curd production, based on the use of concentrated milk are described. The milk is prerenneted at low temperature, then continuously coagulated by hot water. Production is made in the paracurd machine which also ensures continuous draining and subsequent washing or scalding of the curd.

A. A.

11. Coffee, Tea and Cocoa

11.8 *Determining volatile acids in coffee beverages by NMR and gas chromatography*, J. T. KUNG, R. P. MCNAUGHT AND J. A. YERANSIAN, *J. Fd Sci.*, 1967, **32** (4), 455.

Acetic acid and formic acid are the major volatile acid components; C_3 to C_{10} acids are present only in relatively small amounts in the three varieties investigated. Robusta coffee was found to be significantly higher in formic acid and slightly lower in acetic acid than Colombian and Santos.

K. A. R.

11.9 *Composition and chemical characteristics of the wild coffee of Madagascar. II. An analytical research for caffeine and other methyl xanthines in the leaves and seeds of wild and cultivated coffee trees. III. The cafamarine and trigonelline contained in the seeds of three wild coffee trees*, ORNANO, M. D., CHASSEVENT, AND S. POUGNEAUD, *Cafe Cacao The*, 1967, **11** (3), 235.

Ammonia-chloroform extracts of leaves of cultivated coffee trees (arabica, dongusta, excelsa) seem to show a normal sequence of caffeine elaboration (xanthine, theobromine, theophylline, caffeine); the leaves of wild coffee trees (*buxifolia*, *mangoroensis*, *lancifoli*), do not apparently contain either caffeine or methyl xanthines. The same applies to *C. exelsa*, whose leaves are in this respect allied to those of wild coffee trees, while its seeds, like those of other cultivated coffee trees seem to contain xanthine as well as caffeine.

III. The cation eluates of the water extracts of seeds of three wild coffee trees contain some trigonellin, two of them (*buxifolia* and *resinosa*), some cafamarine, and the third (*mauritiana*) a substance very like cafamarine but seemingly free of bitterness.

A. A.

12. Food Additives

12.24 *Endemic goiter, the supply of iodated salt and urinary iodine excretion in the state of Sao Paulo*, Y. R. GANDRA, *Arch. Latino Nutr.*, 1967, **17** (2), 129.

The present paper describes work carried out in the State of Sao Paulo, Brazil, in an endemic goiter area which, for seven years, has been under a salt enrichment programme (1 part of iodine to 100,000 of salt). Although the goiter endemy has been reduced by the iodine enrichment of salt, it still is considered a public health problem, since almost 20 per cent of the school children have goiter. A higher level of iodine in the salt must be provided as well as a more effective programme of control in order to reduce goiter more efficiently.

K. M. D.

12.25 *Role of tocopherol as an antioxidant in safflower oil*, M. K. GOVINDA RAO AND K. T. ACHAYA, *Fette Seifen Anstr*, 1967, **69** (10), 711.

In a mixture of oleic and linoleic acids in equal proportions, the latter dominates the autoxidation pattern. At 63°C, γ-tocopherol offered the best protection to linoleate-rich substrates, with α-and δ-next in order. Safflower oil is insufficiently protected by its own tocopherols. Doubling the tocopherol content by supplementation or increasing the cephalin content effected only slight improvement.

A. A.

13. Food Analysis

13.22 *Determination of aldrin residues in vegetables by the chemical conversion of aldrin to dieldrin*, KOIDU NOREN, *Analyst, Lond.*, 1967, **93** (1103), 705.

13.23 *Determination of isopropyl alcohol in fish protein concentrate by solvent extraction and gas-liquid chromatography*, R. G. ACKMAN, H. J. HINGLEY AND H. E. POWER, *J. Fish. Res. Bd, Canada*, 1967, **24** (7), 1521.

Isopropyl alcohol residues in fish protein concentrates (FPC) prepared with this solvent can be determined by a hot extraction technique employing methyl acetate as the solvent and GLC analysis of the extract. Studies on vacuum stripping of FPC and analysis of various samples suggest that the isopropyl alcohol is trapped mechanically inside particles because of formation of an impervious shell during drying.

A. A.

13.24 *Studies on the density of water adsorbed on low protein fraction of flour*, C. GUR-ARIEH, A. I. NELSON AND M. P. STEINBERG, *J. Fd Sci.*, 1967, **32** (4), 442.

A pycnometric method was used for measurement of the density of a low protein fraction of flour at different moisture levels. In the range of 0.26 per cent moisture, two definite transition points exist in the density of adsorbed water. The first occurs at approximately 7 per cent, and the density of this adsorbed water is 1.48 g/c.c. After this point the density of the adsorbed water decreases to 1.11 g/c.c. The second transition point occurs at approximately 14 per cent moisture and from there on to 26 per cent, the density of the adsorbed water remains constant at 0.97 g/c.c.

A. A.

13.25 *A simple flame ionisation detector for gas-liquid chromatography*, J. DUTTA, ANITA GHOSH, M. HOQUE AND AMITABHA GHOSH, *Sci. & Cult.*, 1967, **33** (11), 477.

A simple flame ionisation detector without the need for air supply and impedance converter has been designed. Although the detector has some disadvantages, it is found to be suitable for analytical work where very high sensitivity is not required.

B. S. N.

13.26 *Studies with radio-active tracers. IX. The use of N-ethylmalemide—1-^{14}C in the determination of flour sulfhydryls and correlations between masked sulfhydryls and loaf volumes*, C. C. LEE AND TZEN SON LOW, *Cereal Chem.*, 1967, **44** (6), 620.

The sulfhydryls of flour may be separated into water soluble and water insoluble fractions and into masked and accessible types by hydrolysis of flour proteins using radio-chemical methods. The reaction of -SH group with N-ethylmalemide-1-^{14}C, followed by hydrolysis, yields ^{14}C-labelled S-succinyl-L-cysteine (III- ^{14}C), which on separation by paper chromatography and conversion with the aid of calibration of known amounts of glutathione yields —SH concentration. 21 such determinations for flours on statistical analysis with loaf volume data established close correlation between masked sulfhydryls and maximum loaf volume (+0.78) and protein contents and masked sulfhydryls.

B. S. N.

13.27 *Study of gluten proteins by dispersion in acetic acid and chromatography on sephadex dextran gel. I. Experimental methods*, H. RICHARD AND L. PETIT, *Inds aliment. agric.*, 1967, **84** (1), 9.

A cautious dispersion in acetic acid followed by gel-filtration chromatography on sephadex G-100 can quantitatively separate gluten proteins into five distinct fractions. The fractions are

characterized specially by their solubility and behaviour in starch-gel electrophoresis. According to these properties the glutenin seems to be distributed in the three fractions.

K. M. D.

13.28 *Solvent techniques for the direct colorimetric determination of copper and iron in oils*, T. P. Labuza and M. Karel, *J. Fd Sci.*, 1967, **32** (5), 572.

The iron procedure is based on the standard aqueous 1, 10-0-phenanthroline method modified to employ an initial solvent extraction procedure. Iron in quantities of 0.1 p.p.m. in oil can be determined. The direct solvent copper procedure based on the sodium diethyldithiocarbamate aqueous method showed similar results. The ashing step is eliminated in both.

K. A. R.

13.29 *Ribonuclease activity and its estimation in cereals*, J. L. Multon, *Inds aliment. agric.*, 1967, **84** (6), 895.

Compared to pancreatic ribonuclease, very little is known about the ribonuclease of plants. The place of ribonuclease among enzymes which decompose nucleic acids, its characteristics and estimation of its activity are reviewed briefly. Determination, evolution, and role of the activity of this enzyme in cereals are discussed.

Because of the sensitivity of ribonuclease activity to heat, its measurement can constitute a test for the degree of alteration of grains under given conditions (temperature, moisture content) of storage and their suitability for further storage.

K. M. D.

13.30 *Analysis of oil of soyabeans by wide line NMR*, F. I. Collins, D. E. Alexander, R. C. Rodgers and Silvelas, *J. Am. Oil Chem. Soc.*, 1967, **44** (12), 708.

Soyabean (single seed to 25 g) were scanned by NMR and then gravimetrically analysed for oil content, high correlations of NMR and oil for single seed and 25 g of seeds were noticeable. NMR scans for less than 30 seconds gave accurate estimates of oil content in samples dried to below 4 per cent. Test scaning by NMR of about 15 samples with made up oil content have revealed that wide line NMR can be an accurate non-destructive and rapid tool for determining oil content in soyabeans.

J. V. S.

13.31 *Rapid method for isolation of unesterified sterols and its application to detection of milk fat adulteration with vegetable oils*, Ira Katz and Mark Keeney, *J. Dairy Sci.*, 1967, **50** (11), 1764.

Unesterified sterols were isolated from 900 mg samples of fat by using a column of digitonin impregnated on celite 545, then eluting the sterols with dimethyl sulfoxide. By using hexane-benzene mixture and GLC the sterols can be extracted and analysed. Addition of 1 per cent corn, cottonseed, soybean, or peanut oil and coconut and safflower oil at 2 per cent could be detected by the presence of β-sitosterol.

K. A. R.

13.32 *Analysis for geometrical and positional isomers of fatty acids in partially hydrogenated fats*, C. R. Scholfield, V. L. Davison and H. J. Dutton, *J. Am. Oil Chem. Soc.*, 1967, **44** (11), 648.

In the method described here, the esters of fats are first separated by liquid chromatography into 5 fractions on a partially vulcanised rubber column; the monoenoate-palmitate fraction is separated by liquid chromatography, on a silver saturated cation exchange resin into palmitate *trans*-mononeoate, and *cis*-monoenoate fractions. Double bond positions are located by ozonisation and GC of fragments.

J. V. S.

13.33 *The identification of essential oils of citrus by gas chromatography*, R. Huet, *Fruits*, 1967, **22** (4), 177.

A method for routine analysis of essential oils by gas chromatography based on the work of L. M. H. Rasquinho. Use of temperature programming and flame ionisation detector enables chromatograms or 'profiles' reflecting the composition of the whole of the essential oil to be compiled. This method is illustrated by 35 'profiles' of different species and varieties of citrus.

A. A.

13.34 *Spectrophotometric determination of limonene in orange juice*, K. D. Wilson and C. A. Crutchfield, *J. agric. Fd Chem.*, 1968, **16** (1), 118.

Limonin (bitter flavour causing) in navel orange juice was extracted twice with dichloromethane; the combined extract treated with acid washed alumina and filtered. The alumina was then washed with chloroform. The chloroform and dichloromethane extracts were combined and evaporated. The residue was partitioned between acetonitrile and petroleum ether. Limonin in acetonitrile layer was determined by treatment with alkaline hydroxylamine followed by addition of acid ferric perchlorate solution and measurement of the absorbance of solution at 510 m μ. The method was useful for determining limonin at 5 to 40 p.p.m. levels. It was not satisfactory for orange peel, grape fruit juice, etc.

J. V. S.

14. Food Microbiology and Fermentation

14.31 *Fungal proteins for food and feeds. IV. Direct use of cane juice*, William D. Gray and Roscoe Paugh, *Econ. Bot.*, 1967, **21** (3), 273.

By using *Cladosporium* sp. as test organism, 4.43 g of dried mycelium containing 10.8 per cent protein is produced from 20 g of sugar. Addition of both KH_2PO_4 and NH_4NO_3 resulted in greater yield of both mycelium and protein than did addition of NH_4NO_3 alone. Addition of corn steep liquor resulted in increased mycelium yield and total crude protein per litre (TCPL). Addition of vitamins resulted in slightly decreased TCPL. Addition of trace elements plus $FeCl_3$ solution increased mycelium production, but showed little decrease in TCPL. Addition of $MgSO_4$, $7H_2O$ at 0.3 g/litre of cane juice resulted in 40.5 per cent increase in mycelium yield and a TCPL increase of 10.9 per cent over controls.

K. A. R.

14.32 *Fungal cellulases. XXII. The hexanols as indicators of a hydrophobic interaction between the β-glucosidase of Stachybotrys atra and the acceptor substrate*, M. A. Jermyn, *Aust. J. biol. Sci.*, 1967, **20** (6), 1227.

14.33 *Prepackaging and shelf-life of mushrooms*, T. R. Gormley and C. Mac Canna, *Ir. J. agric. Res.*, 1967, **6** (4), 255.

Mushrooms covered with PVC film Resinite in a Hartmann food container dish and stored at 15-21°C had a shelf-life of 5-7 days; uncovered mushrooms had a shelf-life of 2-4 days under similar conditions. Treatments with antioxidants followed by prepackaging with Resinite showed a shelf-life of 3-5 days. Toughness increased (in covered/uncovered) mushrooms during 5 days. Covered mushrooms lost less of colour and moisture than uncovered ones.

J. V. S.

14.34 *Dichlorodifluoromethane-ethylene oxide mixture as a sterilant at elevated temperatures*, Tien Szu Liu, Gloria L. Howard and C. R. Stumbo, *Fd Technol., Champaign*, 1968, **22** (1), 86.

Death kinetics of spores of *B. subtilis* exposed to a mixture of ethylene oxide (12 per cent) and dichlorodifluoromethane (88 per cent) at elevated temperatures. Ethylene oxide concentration in the exposure atmosphere was controlled, by pressure, at 700

mg/litre. RH of the exposed atmosphere was maintained at 33 per cent. Temperatures employed were 40°, 50°, 60°, 70° and 80°.

J. V. S.

14.35 *Germination of spores of Clostridium botulinum type E in fish and shell fish extracts*, G. A. STRASDINE AND JOANNE M. KELLY, *J. Fish. Res. Bd, Canada*, 1967, **24** (8), 1883.

Spores germinated rapidly in the presence of the cod extract; salmon, sole and to a lesser degree, herring, also demonstrated good activity. Cod tissue is more than twice as active as any other tissue examined in promoting rapid spore germination.

Extracts of shrimp, oyster and crab were relatively inactive in allowing rapid germination. No correlation between the concentration of any single or group of amino acids and the germinating activity of spores was observed. However, some relation found between spore germination and the ratio of peptide concentration to free amino acid concentration.

K. A. R.

14.36 *Observations on the inhibition of vegetative cells of Clostridium sporogenes by nitrite which has been autoclaved in a laboratory medium discussed in the context of sub-lethally processed cured meats*, J. A. PERIGO, E. WHITING AND T. E. BASHFORD, *J. Fd Technol.*, 1967, **2** (4), 377.

The inhibitory activity of sodium nitrite to the vegetative cells of *Clostridium sporogenes* is influenced by the temperature at which the nitrite containing medium was held prior to inoculation. At pH 6.0 and above, the inhibitory effect of nitrite is substantially enhanced when it is first autoclaved in the medium. It is believed that the nitrite, on heating, reacts with some component of the medium producing an unknown substance which is extremely inhibitory to *Cl. sporogenes*.

K. A. R.

14.37 *Dehydrogenase activity of Lactobacillus species*, T. W. KEENAN AND R. C. LINDSAY, *J. Dairy Sci.*, 1967, **50** (10), 1585.

Significant differences in the quantities of acetaldehyde and ethanol produced by single strain cultures of *Lactobacillus brevis, L. casei, L. lactis and L. plantarum* were noted both between species and between strains. All organisms were capable of reducing added acetaldehyde and propionaldehyde to the corresponding alcohol.

K. A. R.

14.38 *Experimental food poisoning with heat susceptible Clostridium perfringens, Type-A*, A. H. W. HAUSCHILD AND F. H. THATCHER, *J. Fd Sci.*, 1967, **32** (4), 467.

Clostridium perfringens Type A, S-79 behaves like a gas-gangrene producing strain in its production of heat susceptible spores both in broth and in the intestinal tract of man. However, vegetative cells ingested by human volunteers produce the food poisoning syndrome characterized by abdominal pain and diarrhoea.

A. A.

14.39 *Variations of recoveries of Clostridium perfringens on commercial sulphite—polymyxin—sulphadiazine (SPS) agar*, A. H. W. HAUSCHILD, I. E. ERDMAN, R. HILSHEIMER AND P. S. THATCHER, *J. Fd Sci.*, 1967, **32** (4), 469.

Recoveries on laboratory prepared SPS agar and on one lot of commercial SPS agar were the same as on non-selective media. Recoveries on three commercial lots of SPS agar were significantly lower. Replacement of phosphate buffer with 0.1 per cent peptone allowed quantitative recoveries of *C. perfringens* on three out of four lots of commercial SPS agar, irrespective of whether the cells were grown in liquid cultures or on meat and meat products.

A. A.

14.40 *Factors affecting growth and interaction of the rough and smooth variants of Bacillus stearothermophilus. 1. Oxygen tension and temperature*, W. M. HILL AND M. L. FIELDS, *J. Fd Sci.*, 1967, **32** (4), 458.

The exclusion of oxygen did not prevent the growth of *Bacillus stearothermophilus* but did influence the generation time of the two variants. At 55°C the pure rough population had a lower generation time when grown under anaerobic conditions while the generation time of the smooth variant was increased by low oxygen tension. Oxygen tension also affected the amounts of acid produced by the variants.

A. A.

14.41 *Quantitative analysis of beer bittering substances by thin-layer chromatography*, R. A. AITKEN, A. BRUCE, J. O. HARRIS AND J. C. SEATON, *J. Inst. Brew.*, 1967, **73** (6), 528.

Bittering substances in beer have been isolated by TLC, and some have been identified. The method can be used for the quantitative assessment of isohumulones A, isohumulones B, hulupones and a further directly derived α-acid material. In beers hopped with hops of a normal age in breweries, 80 per cent of the total material extractable with petroleum ether consists of these substances.

A. A.

14.42 *The chemistry of hop constituents. XXX. Synthetic iso-α-acids*, P. R. ASHALST AND D. R. LAWS, *J. Inst. Brew.*, 1967, **37** (6), 535.

(±)-isocohumulone and (±)-iso-adhumulone have been synthesized in low overall yield by a route similar to that used to synthesise (±)-isohumulone (*J. Chem. Soc. C.*, 1966, 1615).

A. A.

14.43 *Effect of oil content on the loss of alpha-acid from hops during storage*, R. D. HARTLEY, *J. Inst. Brew.*, 1967, **73** (6), 538.

A number of hop varieties were examined and it was found that percentage loss of α-acid was related to the essential oil content of samples.

J. V. S.

14.44 *Some effects of aeration on the continuous fermentation of hopped wort*, T. W. COWLAND, *J. Inst. Brew.*, 1967, **37** (6), 542.

Smaller quantities of air stimulated yeast growth, and also increased the consumption of sugar and production of alcohol (by unit wt. of yeast); the rate of production of esters and higher alcohols was not greatly affected. Large quantities of air, stimulated the growth further, but decreased the rate of fermentation and production of esters; large quantities of acetaldehyde and acetoin were formed.

J. V. S.

14.45 *Study of the fate of volatile hop constituents in beer*, R. G. BUTTERY, D. R. BLACK, M. J. LEWIS AND L. LING, *J. Fd Sci.*, 1967, **32** (4), 414.

None of the major volatile terpenoid hydrocarbons of hops (myrcene, caryophyllene, humulene) could be detected in beer volatiles. The only volatile constituents in the beer which could be assigned to hops were ethyl dec-4-enoate and ethyl deca -4, 8- dienoate, which exist in the hop oil as methyl esters. A capillary gas chromatography analysis of a beer which was brewed without hops but with methyl dec-4-enoate (0.02 g/l) showed that this ester was converted to the ethyl ester by the fermentation.

A. A.

14.46 *The rapid detection of brewery contaminants belonging to the genus Saccharomyces by a serological technique*, M. RICHARDS AND T. W. COWLAND, *J. Inst. Brew.*, 1967, **37** (6), 552.

Wild yeast contaminants in brewer's yeast are rendered fluorescent by fluorescein chemically bound to antibody protein. The

fluorescent contaminants are examined microscopically to obtain the level of contamination in brewery in about 3 hours. A serum of proper specificity is obtained by cross-absorption with a brewing yeast and by combining two sera the brewery contaminants are detected.

J. V. S.

14.47 *A practical approach to the assessment of head retention of bottled beers*, R. G. AULT, E. J. HUDSON, D. J. LINEHAN AND J. D. WOODWARD, *J. Inst. Brew.*, 1967, **37** (6), 558.

A small volume of CO_2 is injected under pressure into a known volume of beer previously transferred into a calibrated glass vessel without fobbing so that foam is formed immediately. Measurements are then made at intervals on the foam to derive mathematical expressions for maximum head formation, percentage of adhesion and rate of collapse of head. The method is quick and inexpensive.

J. V. S.

14.48 *The identification of carbonyl compounds in beer*, PENTTI-RONKAINEN, VILHO ARKIMA AND HEIKKI SUOMALAINEN, *J. Inst. Brew.*, 1967, **37** (6), 567.

The carbonyl compounds were separated from beer by extraction with a diethylether-pentane mixture and precipitation as 2, 4-dinitrophenyl hydrazones. The diketones (diacetyl and 2, 3-pentanedione) were identified as bishydrazones by TLC. Aldehydes found were: acetaldehyde, isobutyraldehyde, isovaleroand/or opt. act. valeraldehyde, valeraldehyde and butyraldehyde.

J. V. S.

14.49 *Determination of the sugar composition of wort and beer by gas liquid chromatography*, G. E. OTTER AND L. TAYLOR, *J. Inst. Brew.*, 1967, **73** (6), 570.

The samples are vacuum-dried and converted into trimethylsilyl derivatives for GLC analysis. The peak areas of sugars are corrected to an internal standard and the concentrations calculated by applying the suitable detector response factors. Fructose, glucose, maltose, maltotriose and maltotetraose can be quantitatively determined by this method with quickness.

J. V. S.

14.50 *Microflora of rye and rye flour*, H. CHRZANOWSKA, *Inds aliment. agric.*, 1967, **84** (1), 17.

The various species of fungi and bacteria liable to grow on the rye kernel have been identified; the developments of these contaminants during cleaning, milling and flour storage have also been traced.

K. M. D.

14.51 *Microbes harmful to meat products*, J. LAC, *Prumysl Potravin*, 1967, **18** (8), 393.

To secure high quality of final product it is necessary to adhere strictly to sanitary and hygienic rules and to control all processing operations.

A. A.

14.52 *Microbiological condition of sausage preserves in various stages of manufacture*, J. CERVENKA, *Prumysl Potravin*, 1967, **18** (8), 396.

When the meat is still green, the number of microbes present in the sausage is gradually rising and keeps rising during cold storage. The number of germs is subsequently reduced by smoking. Pasteurization kills some 90 per cent of germs surviving smoking. About 30 per cent of preserves are sterile after pasteurization. No gelatin liquefying, gas generating or anaerobic microbes were detected in the Frankfurt sausage during manufacture. Beef sausage contained no gelatin liquefying and anaerobic microbes, but in some 30 per cent of preserves gas generating species could be traced prior to smoking. Smoking kills them.

A. A.

14.53 *The isolation and characterisation of the tribe Mimeae in food stuffs*, CHARLOTTE J. SNODGRASS AND JOHN A. KOBURGER, *J. Fd Sci.*, 1967, **32** (5), 589.

Mima and Herella (both of tribe Mimae) were isolated from fresh and processed products; their characters are described.

K. A. R.

14.54 *Aspergillus niger growing in coconut oil*, K. G. MUKERJI, *J. gen. appl. Microbiol.*, 1967, **13** (4), 407.

A. niger was found growing in coconut oil mixed with leaves of *Eclipta erecta* (L). This organism did not grow when inoculated in pure coconut oil.

J. V. S.

14.55 *Staphylococci in milk of freshened heifers following the use of milking machine*, H. B. WARREN AND R. E. ARENDS, *J. Milk Fd Technol.*, 1967, **30** (12), 363.

A transmission of staphylococcal strains prevalent in milk of 3 dairy herds to their respective freshened heifers following use of a milking machine was traced by phage typing.

J. V. S.

14.56 *Taxonomical studies on glutamic acid producing bacteria*, SHIGEO ABE, KEN-ICHIRO TAKAYAMA AND SHUKUO KINOSHITA, *J. gen. appl. Microbiol.*, 1967, **13** (3), 279.

Study of taxonomical characters of 208 strains of glutamic acid producing bacteria and the base composition of DNA isolated from representative strains. All strains examined are considered to belong to a single or very closely related species in genus *Corynebacterium*. They can be physiologically classified into 12 types.

J. V. S.

14.57 *Microbial production of amino acids from hydrocarbons. III. L. ornithine production by an arginine auxotrophic mutant of Corynebacterium hydrocarboclastus*, RYOSUKE UCHIO SHIN-ICHIRO OTSUKA AND ISAMU SHIRO, *J. gen. appl. Microbiol.*, 1967, **13** (3), 303.

An arginine auxotroph mutant strain RN-362 was derived from *C. hydrocarboclastus* R-7 and accumulated L-ornithine at the expense of hydrocarbon. Highest accumulation occurred after 80 hr of cultivation and amounted to 9 g/litre of culture containing initially 10 per cent (v/v) n-tetradecane as carbon source. The maximum yield obtained corresponded to 32 per cent (w/w) of n-tetradecane added, when 1 per cent (v/v) n-tetradecane was added as sole source of carbon.

A. A.

14.58 *Production of cellulase for processing groundnut cake*, A. CHANDRASEKHARAN AND M. S. SHANTAMMA, *Curr. Sci.*, 1968, **37** (9), 256.

Syrrotrichum pruinosum and *Trichoderma viride* elaborated more potent enzyme than *Pestalatiopsis westerdijkii*, *Myrothesium verrucaria* and *Chaetomium globosnm.* Wheat bran was the best substrate for enzyme production.

J. V. S.

14.59 *Inequality in the values of the oxidation reduction potential in different layers of grape wines and fermenting grape musts*, J. MOURGUES AND L. DEIBNER, *Inds aliment. agric.*, 1967, **84** (11), 1483.

Electrometric evaluations of the redox potential at different level of red wines stored in wooden casks or in tanks, have confirmed the existence of an inequality in the values of this potential between the upper and the bottom levels; the differences noted are of 28 to 40 mV for the tanks, and of 34 to 65 mV for the casks, the difference between the middle level and the bottom one being very small. This phenomenon occurs also during the alcoholic fermentation of grape musts in tanks. To the reverse of what happens in wines, the difference between the values

of the redox potential between the middle level and the bottom one is not only considerable, attaining sometimes 121 mV, but may be inversed, the bottom level having the higher potential. This is an interesting fact not reported up to now.

A. A.

14.60 *Continuous fermentation and a continuous vinification with multiple action*, R. H. REMY, *Inds aliment. agric.*, 1967, **84** (9-10), 1265.

One of the essential and totally new advantages in the technique of vinification, consists in separating the crushed grapes into must and liquid marc and in ensuring their separate introduction into distinct zones of the vinificator, thus enabling a controlled disjunction of the two essentially different processes consisting of fermentation and diffusion.

A. A.

14.61 *Continuous alcoholic fermentation of the drips and molasses of the sugar industry*, B. REVUZ, *Inds aliment. agric.*, 1967, **84** (9-10), 1253.

14.62 *Molasses and animal feeding*, J. ARCHAMBAUD AND S. CONTOUR, *Inds aliment. agric.*, 1967, **84** (7-8), 1065.

Production of alcohol directly from beet may make it necessary to find other outlets for molasses, e.g., animal feeds. Its use in animal feeds has been restricted so far by difficulties of incorporation. These difficulties have now been overcome, and it is possible to control automatically the incorporation of a determined quantity of molasses into animal feeds. As heavy investment is necessary, the new technology can be exploited only when the daily production is sufficiently large.

K. M. D.

14.63 *A new aroma bearing substance from Shiitake an edible mushroom*, SHYOZO WADA, HIROMT NAKATANI AND KATSURA MORIJA, *J. Fd Sci.*, 1967, **32** (5), 559.

The threshold level of lenthionine (present in Shiitake) is between 0.27 and 0.53 p.p.m. in water.

K. A. R.

15. Toxicology

15.25 *Aflatoxin in the groundnut crop at harvest in Nigeria*, D. MCDONALD AND C. HARKNESS, *Trop. Sci.*, 1967, **9** (3), 148.

Results of harvesting trials at Mokwa and Kano agricultural research stations at N. Nigeria in 1963 and 1964. Crops harvested at or earlier than normal time were free from aflatoxin, but late harvesting showed some toxicity. Weather and age of crop exerted some effect on toxicity; wet weather delayed the appearance of aflatoxin. Damage to shells when the crop was in the ground, predisposed the kernels to aflatoxin contamination.

J. V. S.

15.26 *Preliminary observations on biological activity of pure aflatoxin B_1 in chick embryos*, P. G. CHOUDHARY AND S. L. MANJREKAR, *Indian vet. J.*, 1967, **44** (7), 543.

Chick embryos were inoculated with 0.02, 0.03, 0.04 and 0.05 μg of aflatoxin. Toxicity was exhibited more in young embryos as evidenced by mortality pattern. Histopathological lesions like congestion, fatty degeneration, necrosis, ductile proliferation were more evident in embryos which were more than 8 days old. Use of chick embryo for routine biological test has been recommended.

K. A. R.

15.27 *Formation of aflatoxin in cheddar cheese by Aspergillus flavus and Aspergillus parasiticus*, JENNIE L. LIE AND E. H. MARTH, *J. Dairy Sci.*, 1967, **50** (10), 1708.

Cheddar cheeses were inoculated with *A. flavus* and *A. parasiticus*. When *A. flavus* serves as the test organism, the mold mycelium, top 0.64 cm layer on cheese and second 0.64 cm layer of cheese contained 49,600, 2,900 and 4.8 μg toxin B_1 per kg respectively and 49,600, 14,400 and 9.6 μg toxin G_1 per kg after 10 days. After 52 days the contents of B_1 and G_1 toxins in samples (same sequence as above) were 7,700, 1.960 and 120 μg/kg. *A. parasiticus*, after 10 days produced 9,780, 2,930 and $<$9.6 μg toxin B_1 and 48,900, 7,340 and 9.6 μg toxin G_1 per kg of sample in the sequence listed above. No toxin was detected in cheese more than 1.3 cm from the surface.

K. A. R.

15.28 *The problem of aflatoxin in groundnut*, P. G. TULPULE, *Indian Fmg, N.S.*, 1967, **17** (9), 41.

15.29 *Non-productivity of aflatoxin by Japanese industrial strains of Aspergillus. I. Production of fluorescent substances in agar slant and shaking cultures*, HIDEY A. MURAKAMI, SUMIO TAKASE AND TORU ISHII, *J. gen. appl. Microbiol.*, 1967, **13** (4), 323.

In the agar slant cultures only a few strains produced greater blue or greenish fluorescence than control (aflatoxin producing strain ATCC 15517). Statistically the yellow-green spored *Aspergillus* appeared to possess certain mycological characters which were associated with the production of fluorescence. Chloroform solutions of yellow spored *Aspergillus* prepared from shake culture broth did not show the same excitation wavelength as control in blue fluorescence. In the green fluorescence majority of strains showed the same excitation wavelength and emission wavelength as control.

J. V. S.

15.30 *Modified procedures for determination of free and total gossypol pigments*, B. D. DEACON, *J. Am. Oil Chem. Soc.*, 1967, **44** (12), 580 A.

The inclusion of HCl and thiourea in the gossypol blanks, in the present AOCS methods for free and total gossypol produced equivalent absorbance identical to those obtained in the AOCS procedure for gossypolin oils. The treatment relieved the darkening of the reagent blanks and allowed the same calibration data to be used for all 3 methods. Aniline was the reagent in each.

A. A.

16. Infestation, Pesticides and Fungicides

16.37 *National programme for preservation of foodgrains*, RAMACHANDRA, *Indian Fmg, N.S.*, 1967, **17** (6), 7.

16.38 *Hapur Thekka-safe structure for rural storage of foodgrains*, *Indian Fmg, N.S.*, 1967, **17** (7), 23.

This consists of a round tub-shaped metal base (ht. 45 cm) with eight bamboo sticks placed vertically all round its inner circumference. When the grain is filled the top of the structure is covered with rubberised cloth. Removal of the grain can be made either from the top or from the sliding door provided on metal base of the structure. Advantages are: It is stable and can be dismantled and erected easily. Fumigation is possible and cross infestation is less. The rubberised cloth is found to ward off rat attacks. The metallic base prevents the pick up of moisture.

K. A. R.

16.39 *Dietary efficacy of natural foods for the growth and development of Tribolium castaneum Hbst and Corcyra cephalonica Staint*, G. H. PUNJ, *Bull. Grain Technol.*, 1967, **5** (4), 209.

Among the various powdered foods investigated wheat flour with 5 per cent brewers' yeast appears to be the best medium for growth and development of *T. castaneum* and *C. cephalonica*. While barley and green gram (powdered) also produce similar results.

B. S. N.

16.40 *Reassessment of some amino acid requirements of larvae of Oryzaephilus surinamensis (L.) (Coleoptera: Silvanidae)*, G. R. F. DAVIS, *J. Nutr.*, 1967, **91** (2), 255.

In the absence of nucleic acid, addition of alanine improved rate of survival and growth of *O. surinamensis;* 0.67 per cent of

arginine hydrochloride in diet appears to be optimum, whereas under certain circumstances, cystine is toxic to insect. The limiting factor inhibiting the determination of dietary requirements of some amino acids, appears to be the presence of nucleic acids. This has now to be replaced by substances of known composition to achieve the results.

B. S. N.

16.41 *Nutritional relationships in larvae of Oryzaephilus surinamensis*, G. R. F. Davis, *J. Insect Physiol.*, 1967, **13** (11), 1737.

Insects were reared on synthetic diets at 32±2°C and 75 per cent R.H. In the absence of RNA, dietary aspartic acid increased survival and rate of development. By the addition of putrescine dihydrochloride to the diet, the dietary aspartic acid increased survival. Putrescine had vitamin activity for this insect. Interaction of dietary components was important in regulating survival and rate of development of *O. surinamensis*. Weight of emergent adults were not good criteria for evaluating the nutritional quality of diets.

K. A. R.

16.42 *Compatibility studies on Bacillus thuringiensis Berlinar with chlorinated hydrocarbons*, M. R. Rajasekharan, R. N. Pillai, N. Raghava Rao and Edwin Dharmaraju, *Andhra agric. J.*, 1967, **14** (5), 167.

It is concluded that *Bacillus thuringiensis* is compatible with 50 per cent DDT up to 0.1 per cent concentration and endosulfan and carbaryl up to 0.4 per cent concentration under laboratory conditions.

K. A. R.

16.43 *Can we achieve rat free towns?* D. C. Drummond, *Int. Pest Control.*, 1967, **9** (6), 22.

16.44 *The role of synergists in the formulation of insecticides*, N. C. Brown, P. R. Chadwick and J. C. Wickham, *Int. Pest Control.*, 1967, **9** (6), 10.

General. 6 references.

16.45 *Phosphine-a versatile fumigant*, Prem Singh, J. N. Sarid and K. Krishnamurthy, *Bull. Grain Technol.*, 1967, **5** (4), 214.

Review. 72 references.

16.46 *Organophosphates for control of Mediterranean fruit fly on peaches*, A. Damiano, *Int. Pest Control*, 1967, 9 (6), 14.

The systemic action of the tested insecticide is considered effective up to 19 days of treatment. After 21 days of treatment, although the treated plots showed an increased ratio of rotten ones, yet the ratio was much higher in the untreated plots. Dimethoate and Anthio gave the best results, but close to them was Fitios. Anthio and Fitios are less toxic than dimethoate and can substitute it, giving the same good results. No phytotoxic action was observed in the plots treated with Anthio and Fitios.

K. A. R.

16.47 *Residual mercury content of seed potatoes treated with organo mercurial disinfectant solutions*, G. A. Hamilton and A. D. Ruthven, *J. Sci. Fd Agric.*, 1967, **18** (12), 558.

Organo mercurial fungicides were applied to seed potatoes to control some of the seed borne diseases. The results indicated that the levels of mercury present would make treated potatoes unacceptable for consumption. However, potatoes grown from treated seed were found to contain very small amounts of mercury, which were no greater than untreated control material and which were of no toxicological significance.

K. A. R.

16.48 *The chromatographic determination of organophosphorus pesticides. III. The effect of irradiation on the parent compounds*, T. H. Mitchell, J. H. Ruzicka, J. Thomson and B. B. Wheals, *J. Chromatog.*, 1968, **32** (1), 17.

Irradiation of 7 pesticides resulted in their decomposition; and the new compounds formed corresponded to the oxidation products of parents in GC and TLC characters. The irradiation products were more stable than parent pesticides.

J. V. S.

16.49 *Removal of DDT, malathion, and carbaryl from tomatoes by commercial and home preparation methods*, R. P. Farrow, F. C. Lamb, R. W. Cook, J. R. Kimball and E. R. Elkins, *J. agric. Fd Chem.*, 1968, **16** (1), 65.

Tomatoes used here had been grown in separate plots treated with DDT, malathion and carbaryl. Commercial canning and juicing operations virtually removed the residues of all 3 insecticides. Home canning of whole tomato and tomato juice left only traces of residues. About 8 per cent of carbaryl remained in home canned whole tomatoes and about 23 per cent in home canned juice. About 85 per cent of DDT, 96 per cent of malathion and 69 per cent of carbaryl were removed by home cooking. Raw, unwashed tomatoes stored at 50°F suffered no significant losses in DDT or carbaryl; about 30 per cent of malathion was found to decrease during a 7 day storage period.

J. V. S.

16.50 *Metabolic studies with O, O-diethyl O-(3, 5, 6, -trichloro-2-pyridyl) phosphorothioate (Dursban) insecticide in a lactating cow*, W. H. Gutenmann, *J. agric. Fd Chem.*, 1968, **16** (1), 45.

The milk and urine of cows fed 5 p.p.m., of Dursban with feed did not contain any Dursban; but a compound having the same retention time as Dursban was found in the feces. Two metabolites which had identical retention time to the methyl esters of diethylthiophosphate and diethyl phosphate were excreted in urine.

J. V. S.

16.51 *Enzymic browning and free tyrosine in potatoes as affected by penta chloronitrobenzene (PCNB)*, J. P. Sweeney and P. A. Simandle, *J. agric. Fd Chem.*, 1968, **16** (1), 25.

The results indicate that PCNB used as a soil fungicide, tended to decrease tyrosine content in 2 potato varieties and may also increase enzymic browning. Storage for a month at 70°F generally increased tyrosine.

J. V. S.

17. Nutrition and Biochemistry

17.44 *Land marks of a half century of nutrition research*, *J. Nutr.*, 1967, **91** (2), Part II, 1.

The Symposium papers presented are:

(1) Reminiscences on the discovery and significance of some of the B-vitamins (Paul Gyorgy).

(2) The paths to discovery of vitamins A and D (Elmer Verner-McCollum).

(3) The fatty acid story-lessons and expectations (Wendell Griffith).

(4) Studies on nutritional factors in mammalian development (Lucille S. Hurley).

(5) Building blocks and stepping stones in protein nutrition (Ruth Leverton).

(6) The relation of nutrition to cellular Biochemistry (Thomas H. Jukes).

(7) Nutritional Status, U.S.A. (Oladys A. Emerson).

(8) Some of the developments in food production and their impact on nutrition (Emil M. Mrak).

17.45 *Symposium: Putting nutrition to work, 27th Annual meeting of IFT, Minneapolis, May, 1967, Sponsored by IFT and Nutrition Foundatoin, Fd Technol. Champaign*, 1968, **22** (1), 54-67.

The following papers have been given:

(1) Putting nutrition to work: introductory remarks (H. L. Sipple).

(2) Combating pre-school child malnutrition in Venezuela (Werner G. Jaffe).

(3) Food technology and nutrition of pre-school child in tropics (D. B. Jelliffe).

(4) Food technology problems in India and other developing countries (H. A. B. Parpia).

(5) The programme of IMIT on plant protein food stuffs (I. Deschamps, A. Gonzalez and R. Calderon).

17.46 *Nutrition Research in Indonesia and Thailand*, *Am. J. J. Nutr.*, 1967, 20 (12), 1258.

The special number of the Journal covers: deficiency diseases, malnutrition, mental development, rational use of SMP, diet habits, urinary diseases, and the impact of diet on disease.

B. S. N.

17.47 *Effect of protein calorie deficiency on prenatal mortality*, S. R. Gupta and B. Christie, *Indian J. med. Res.*, 1967, **56** (1), 114.

Prolonged protein calorie deficiency of mild degree reduces the capacity of the mother to maintain her young throughout the gestation period. The embryonic loss tends to be during the critical stages of implantation and placentation. It is suggested that the disturbance of pituitary-ovarian function, along with placental insufficiency, is the cause of high prenatal mortality in rats maintained on diets of low protein value.

K. A. R.

17.48 *Decreased elasticity of the auricular cartilage in Ugandan children with Kwashiorkor*, R. E. Brown, *Am. J. clin. Nutr.*, 1967, **20** (11), 1230.

In each group of children, mean value of ear elasticity with kwashiorkor was markedly below that of normal, well nourished children. As a result of treatment, these values were found to be approaching close to those of normal children.

B. S. N.

17.49 *Effect of reduced protein intake on nitrogen loss from the human integument*, Ellen Rehr Sirbu, Sheldon Margen and Doris Howes Calloway, *Am. J. clin. Nutr.*, 1967, **20** (11), 1158.

Rate of hair and beard growth was not effected by varying levels of nitrogen intake. Nails grew at 0.093 mm/day, whereas head hair growth was 160 mg/day. About 24 mg of nitrogen loss is attributed to head hair and nail replacement.

B. S. N.

17.50 *An approach towards the solution of the world food problem with special emphasis on protein supply*, E. E. Howe, G. R. Jansen and M. L. Anson, *Am. J. clin. Nutr.*, 1967, **20** (10), 1134.

Review. 33 references.

17.51 *Concordance among clinical signs suggestive of malnutrition*, R. W. Hillman, *Am. J. clin. Nutr.*, 1967, **20** (10), 1118.

Significant variation was found among individuals when 12 selected tissue changes suggestive of malnutrition were investigated in 2,729 nutrition clinic patients. Subjects with least common tissue changes showed greatest number of total lesions. Subjects with lowest hemoglobin concentrations showed least common changes.

B. S. N.

17.52 *Space feeding—meeting the challenge*, H. A. Hollander, Mary V. Klicka and P. A. Lachance, *Cereal Sci. Today*, 1968, **13** (2), 44.

Review.

17.53 *Individuality and nutrient requirements for astronauts*, LeRoy Voris, *Cereal Sci. Today*, 1968, **14** (2), 55.

17.54 *Space feeding: approach to the chemical synthesis of food*, J. Shapira, *Cereal Sci. Today*, 1968, **13** (2), 59.

Review. 28 references.

17.55 *Space feeding: acceptability and palatability of foods for space—Some fundamental considerations*, Morris H. Woskow, *Cereal Sci. Today*, 1968, **13** (2), 73.

17.56 *Evaluation of space feeding concepts during the Mercury and Gemini space programmes*, R. A. Nanz, E. L. Michel and P. A. Lachance, *Fd Technol. Champaign*, 1967, **21** (12), 1596.

A report of co-ordinated efforts at providing suitable space foods. Photographs of some foods given.

17.57 *Space feeding: cereal food products utilised in U.S. manned space programme*, P. A. Lachance, Mary V. Khicka and H. A. Hollander, *Cereal Sci. Today*, 1968, **13** (2), 49.

Descriptive.

17.58 *Diet, cholesterol metabolism and atherosclerosis*, K. K. Carroll, *J. Am. Oil Chem. Soc.*, 1967, **44** (11), 607.

17.59 *Application of a modified riboflavin load test to a field study of riboflavin nutritional status in Navajo Indians*, M. Lee and R. H. Davis, *Arch. Latino. Nutr.*, 1967, **17** (3), 207.

A modified riboflavin load test, consisting of collection of a single two hour urine sample following administration of 1 mg riboflavin intramuscularly and a simplified fluorometric assay of riboflavin, was studied in 13 male and 51 female Navajo Indian volunteers. Average excretion values by this method correlated closely with values by a more complex assay procedure. Average riboflavin excretion values fell within an acceptable range (200 μg or more) but a disproportionately large number of women under 30 and of post-partum women excreted less than 100 μg of riboflavin in 2 hours.

A. A.

17.60 *A history of rickets in the United States*, Mary Theodora Weick, *Am. J. clin. Nutr.*, 1967, **20** (11), 1234.

Review. 61 references.

17.61 *Long term studies on the hypolipemic effect of dietary calcium in mature rats fed cocoa butter*, Alan I. Fleischman, Harold-yacowitz, Thomas Hayton and L. Bierenbaum, *J. Nutr.*, 1967, **91** (2), Part I, 151.

Fecal lipids increased markedly in rats fed between 0.2 per cent and 1.2 per cent calcium level due to a rise in free fatty acids, whereas fecal bile acids rose with the 0.2 per cent level of calcium. No pathological disorders could be traced in kidneys due to high dietary calcium.

B. S. N.

17.62 *Plasma lipids in maternal and fetal rabbits fed stock and peanut oil-cholesterol diets*, J. A. Sisson and E. J. Plotz, *J. Nutr.*, 1967, **92** (4), 435.

Rabbits fed a peanut oil-cholesterol diet did not differ significantly from those fed a stock diet with regard to their plasma lipids except that a small increase occurred in the cholesterol ester level of the fat-cholesterol diet group.

B. S. N.

17.63 *Estimation of body water compartments of pre-school children. I. Normal children. II. Undernourished children*, M. A. Flynn, F. M. Hanna and R. N. Lutz, *Am. J. clin. Nutr.*, 1967, **20** (10), 1125, 1129.

17.64 *Bacteria, absorption and malabsorption*, Martin H. Flotch, *Am. J. clin. Nutr.*, 1967, **20** (11), 1244.

Review. 12 references.

17.65 *Uncoupling of energy linked functions of corn mitochondria by linoleic acid and monomethyldecenly succinic acid*, M. Susan-baddely and J. B. Hansen, *Pl. Physiol. Wash.*, 1967, **42** (12), 1702.

J. V. S.

17.66 *Properties of higher mitochondria. III. Effects of respiratory inhibitors*, Hiroshi Ikuma and Walter D. Bonner Jr., *Pl. Physiol. Wash.*, 1967, **42** (11), 1535.

The effects of inhibitors (I) Malonate, (II) amytal and rotenone (III) antimycin A and 2-n-nonyl-4-hydroxyquinoline N-oxide (NOQNO) and (IV) cyanide and azide were tested on respiration of mung bean mitochondria using succinate and 1-malate as substrates.

J. V. S.

17.67 *Invertase inhibitor from potatoes: Purification, characterisation and reactivity with plant invertases*, RUSSEL PRESSEY, *Pl. Physiol. Wash.*, 1967, **42** (12), 1780.

17.68 *Multiple forms of phenoloxidase*, S. M. CONSTANTINIDES AND C. L. BEDFORD, *J. Fd Sci.*, 1967, 32 (4), 446.

The phenoloxidase system in the tissues of mushrooms, potatoes and apples was investigated using a polyacrylamide electrophoretic technique. The enzyme system exhibits the phenomenon of multiple forms. The pattern obtained was characteristic for each species and variety. The mushroom phenoloxidase system (*Agaricus campestris*) consists of at least nine distinct dl-dopa reactive multiple forms, and at least three forms reacting with l-tyrosine.

A. A.

17.69 *Nitrogenous factors affecting the adequacy of rice, meet the protein requirements of human adults*, SHIRLEY CHI-SHYA CHEN, HAZEL METZ FOX AND CONSTANCE KIES, *J. Nutr.*, 1967, **92** (4), 429.

0.5 g of rice nitrogen provided when supplemented with amino acids gave in the human subjects nitrogen balance of +0.15 (essential amino acid + cystine and tyrosine), + 0.26 (lysine + threonine), 0.14 (lysine), -0.32 (threonine), and 0.03 g/day (methionine + cystine). The study indicates that the first limiting amino acid in rice protein for supporting and nitrogen retention is lysine.

B. S. N.

17.70 *Methods of composing protein quality of soybean infant formulas in the rat*, ROBERT, W. HARKINS AND ROBERT P. SARETT, *J. Nutr.*, 1967, **91** (2), Part I, 215.

Lyophilised soybean formula products and liquid diets formulated with them, and carbohydrate when fed to rats, showed that formula A (97 per cent PER), B (80 per cent PER) and C (66 per cent PER) produced better growth results than formula D (62 per cent PER) as compared with casein.

B. S. N.

17.71 *Growth of young rats after differential manipulation of material diet*, ANDIE M. HSUCH, CONRADO E. AUGUSTIN AND BACON F. CHOW, *J. Nutr.*, 1967, 91 (2), Part, I., 195.

Protein appears to be the critical dietary factor which predetermines growth of young rats.

B. S. N.

17.72 *Nutritive value for rats of certain byproducts of the corn refining industry. 1.* D. A. CHRISTENSEN, L. E. LLOYD AND E. W. CRAMPTON, *J. Nutr.* ,1967, 91 (2), Part I, 137.

Rats were fed with 12.4 per cent crude protein solely from whole dried egg, corn-steep water solids, corn gluten, corn germ meal, corn fine grain, zein, zein-extracted gluten, or reconstituted starch-free corn. Except proteins of corn fine grain, all others were found to have lower egg replacement values although they had a better essential amino acid index and chemical score. At 17 per cent crude protein level, reconstituted starch free corn induced most rapid growth rate and growth gain in comparison with each of the corn byproducts.

B. S. N.

17.73 *Metabolic studies with a corn and soya mixture for infant feeding*, J. E. DUTRA DE OLIVEIRA AND N. DE SOUZA, *Arch. Latino Nutr.*, 1967, **17** (3), 197.

Nitrogen balance was used to study, in normal and malnourished children, the nutritive value of a vegetable protein mixture. When the undernourished children received this mixture as the only source of food, absorption and retention of nitrogen were 70.1 and 21.3 per cent respectively. These values were inferior to those obtained with children fed cow's milk. In the group of normal children, this vegetable mixture increased the absorption and retention of nitrogen when substituted for part of their basic diet. This absorption and retention showed to be equal and even greater than when cow's milk substituted part of the basic diet.

A. A.

17.74 *Vegetable protein mixtures for human consumption. The development and nutritive value of INCAP mixture 15, based on soybean and cottonseed protein concentrates*, R. BRESSANI, L. G. ELIAS, J. EDGAR BRAHAM AND MARIS ERALES, *Arch Latino Nutr.*, 1967, **17** (3), 177.

A series of studies indicated that cottonseed and soybean protein complement each other when each provided the same concentration of protein in the diet. From this, INCAP vegetable mixture 15 containing 25 per cent crude protein was formulated with 10 per cent cottonseed flour, 19 per cent soybean flour, 58 per cent corn flour, 3 per cent torula yeast, 1 per cent calcium phosphate and 4500 I.U. vitamin A. The mixture has 80 per cent of the nutritive value of casein. A significant improvement in protein quality was obtained when the mixture was supplemented with 0.2 per cent methionine and 0.1 per cent lysine or with 0.2 per cent each of lysine, methionine and threonine. The corn can be replaced by other sources of calories such as corn starch or banana flour, corn starch and corn, processed in different ways.

A. A.

17.75 *Methionine, lysine, cystine and tryptophan in some Venezuelan foods*, S. H. BERTA NOLBERGA, *Arch. Latino Nutr.*, 1967, **17** (2), 111.

Thirty-five Venezuelan foods were analyzed by microbiological methods for 4 amino acids and compared with the FAO reference pattern. All were more or less low in sulfur containing amino acids. In some legumes tryptophan was also low while in some edible roots high values of this amino acid were found. Plantains and bananas were low in methionine-cystine.

K. M. D.

17.76 *Biological response of rats fed amino acid supplemented pea bean (Phaseolus vulgaris) diets*, M. E. PURDOM AND R. V. BROWN, *Arch. Latino Nutr.*, 1967, **17** (2), 117.

Sqrague-Dawley immature male white rats were fed a 10 per cent level (1.6 per cent nitrogen) isocaloric defatted whole dried egg control diet and four pea bean (*Phaseolus vulgaris*) test diets without amino acid supplementation or supplemented with either 0.3 per cent DL-methionine, 0.1 per cent DL-tryptophan or both, for 28 days. Analysis of mean differences indicates that methionine supplementation was effective in increasing consumption and weight gains.

Tryptophan supplementation reduced fecal nitrogen excretion, but greatly increased urea nitrogen and total urine nitrogen excretion. The results indicate that tryptophan supplementation did not increase nitrogen utilisation. Excess free amino acids, not used in metabolism were proportionately excreted as amino nitrogen.

A. A.

18. Food Processing, Packaging and Engineering

18.49. *Automated potato crisp production, Fd Mf*, 1968, **43** (1), 35.

Various aspects of potato crisp manufacture including plant

details, quality control, flavour problems, various operations involved and facilities provided are discussed.

B. S. N.

18.50 *Materials of construction. I. Aluminium-light, strong, resists corrosion*, *Fd Mf*, 1968, **43** (1), 23.

Details the advantages, fabrication of food and agricultural products storage and processing equipments, and the applications of Al containers and equipment in the food industries in future.

B. S. N.

18.51 *Mobility in the food factory. I. The economics of materials handling: II. Aids to handling*, *Fd. Mf*, 1967, **42** (12), 31, 35. General.

18.52 *Criteria for selection of packaging materials for roasted Macadamia kernels*, CATHARINE G. CAVALLETTO AND HARRY Y. YAMAMOTO, *Fd Technol. Champaign*, 1968, **22** (1), 97.

Flavour and texture evaluations of kernels stored in flexible materials indicated that moisture barrier capacity of the packing material is the most important factor in preserving roasted *Macadamia* kernel quality. Moisture absorption as measured by per cent weight gain in the packages, was highly correlated with texture and flavour quality. Shelf-life of at least 6-7 months can be expected when kernels are packed in flexible materials with a water vapour transmission rate of less than 0.02 g/100 sq. in./24 hr at 90 per cent RH and 100° F.

18.53 *Engineering development in crop processing, drying and storage*, J. W. SORENSON JR., *Rice J.*, 1967, **70** (10), 12.

18.54 *Finished product testing*, D. R. ERICKSON, *J. Am. Oil Chem. Soc.*, 1967, **44** (11), 534 A.

A broad picture is presented of finished product testing; the principle discussed here, specifically refers to edible fats and oils.

J. V. S.

18.55 *Malt suspension mixers*, R. GREE, *Prumysl Potravin*, 1967, **18** (8), 407.

A well functioning mixer must suck-in ground malt fed into it and mix it with water making thus a homogeneous suspension of desired density. The results of experiments indicate that the most efficient mixer is one with rotary cage enclosed in a housing without stops. Its principal parameters should be kept in the following relations: D/d=3.38; H/d=3.75; H/D=1.25, speed= 400-500 r.p.m.

A. A.

18.56 *Diffusion rates in the desalting of pickles*, I. J. PFLUG, P. J. FELLERS AND D. GUREWITZ, *Fd Technol. Champaign*, 1967, **21** (12), 1634.

The rate of NaCl diffusion from salt stock pickles was evaluated under equalisation conditions similar to those practiced in pickle industry; and in flowing water where zero salt concentration existed outside the pickles.

J. V. S.

18.57 *Designing a hot air dryer*, C. G. TUCKER, *Fd Mf*, 1968, **43** (2), 34.

18.58 *Expansion drying of food products*, J. SUCHY, M. ADAM, M. BORTLIK AND H. HAJKOVA, *Prumysl Potravin*, 1967, **18** (8), 403.

A new technology of drying vegetables and fruits based on expansion of compressed medium. Information available from foreign literature is supplemented with the results achieved with a pilot plant.

A. A.

18.59 *An experimental apparatus for drying particulate foods in air*, H. J. SINNAMON, M. KOMANOWSKY AND W. K. HEILAND, *Fd Technol., Champaign*, 1968, **22** (2), 219.

An apparatus has been described which can be used to study through circulation air drying of particulate foods at low and moderate temperatures. As an 'atmospheric freeze dryer' a dew point temperature of −80°F can be attained at a dry bulb temperature between 20° and 32°F with the dry bulb temperature between 32° and 160°F the dew point temperature can be controlled between 0° and 80°F. Air rate can be controlled between 100 and 300 standard cu. ft./min.

A. A.

18.60 *Spray drying and automation*, M. TOURNIER, *Inds aliment. agric.*, 1967, **84** (9-10), 1227.

18.61 *Continuous freeze drying of liquid and semi-liquid food products*, M. Z. CHARON, *Inds aliment. agric.*, 1967, **84** (9-10), 1235.

This continuous process of freeze-drying has been applied for liquid or semi-liquid products, which are injected into a spray tower. Particles are immediately frozen, then scattered in regular layers on a drying belt leading them to a regulating tank before the wrapping machine. This operation is not longer than a few minutes. In the case of a plant with a capacity of 25,000 litres a day, freeze-drying seems to be competitive.

A. A.

18.62 *Effect of freezing speed upon bacteriological conditions of food products*, J. ARPAI AND J. TOMISOVA, *Prumysl Potravin*, 1967, **18** (11), 567.

A series of 15 experiments has been carried with several groups of microbes with various resistance to low temperatures. The results show a significant relation between the temperature, freezing and defrosting speeds and inherent resistance of microorganisms to low temperatures on one hand, and microbiological conditions of the product on the other.

A. A.

18.63 *Experimental equipment for cooling and packaging foam-spray-dried milk in the absence of oxygen*, F. P. HANBAHAN, R. L. SELMAN AND B. H. WEBB, *J. Dairy Sci.*, 1967, **50** (11), 1873.

Liquified inert gas is used to cool the powder and form a protective blanket in the conveying system, which prevents oxygen absorption. The powder is transferred without exposure to air to a specially designed glove box where it is packaged under an inert atmosphere.

K. A. R.

18.64 *Measurement of rate of crystallization. Influence of various parameters*, P. DEVILLERS, *Inds aliment. agric.*, 1967, **84** (7-8), 1037.

In a continuous circulation apparatus, the rate of crystallization is not proportional to the degree of supersaturation; for low supersaturations, however, it increases more and more rapidly. On passing from 40° to 70°C at the same supersaturation, the rate of crystallization is quadrupled. On varying the rate of displacement of crystal to syrup at 40°C from 0 to infinity, the rate of crystallization is doubled at the same supersaturation. The pH does not seem to exert any influence. Ionizable impurities (non-sugars) reduce the rate without changing the shape of the crystal, and large doses of raffinose reduce the rate very much and profoundly alter the shape of the crystal.

K. M. D.

18.65 *Plastics in dairy industry—A critical study. III. Behaviour of the packed milk products in relation to the impervious properties of plastic films*, G. WILDBRETT, *Fette Seifen Anstr.*, 1967, **69** (10), 781.

It is shown, as to how, according to present knowledge, uptake and liberation of water vapour, carbon dioxide, oxygen and aroma affect the quality of milk products. The optical transparency

of the plastic packings is of special interest in connection with the oxidative changes. For an effective protection of milk products by a packing with adequate impervious properties, a combination of foils must often be employed.

A. A.

18.66 *Stainless steel, Fd Mf*, 1968, **43** (2), 27.

Durable and versatile, it is virtually immune to chemical attack by foodstuffs.

18.67 *New food products developed by the U.S. Department of Agriculture*, J. E. SIMPSON, *Inds aliment. agric.*, 1967, **84** (2), 153.

The author presents ten new processes and products which are typical of USDA development works: two cereal products: Wurld wheat (peeled bulgur) and a protein enriched rice flour processed by abrasion; low fat peanut grains and a cheddar containing less than 5 per cent fat; bacterial enzymes which may replace veal rennet; and finally, four dehydration techniques, dry blanch dry for fruits, foam mat drying for liquids, explosive puff drying for diced vegetables and fruits, and conventional drum drying for apple sauce.

19. Food Texture and Flavour

19.24 *The synergistic taste effect of monosodium glutamate and disodium 5′-inosinate*, S. YAMAGUCHI, *J. Fd Sci.*, 1967, **32** (4), 473.

The synergistic phenomenon between the taste of monosodium glutamate (MSG) and disodium 5′-inosinate (IMP) was studied and the relationship expressed as a mathematical model. The phenomenon could be measured quantitatively by fitting the proposed model to the results of the experiment.

K. A. R.

19.25 *Cysteine induced odour intensification in onions and other foods*, S. SCHWIMMER AND D. G. GUADAGNI, *J. Fd Sci.*, 1967, **32** (4), 405.

Adding cysteine to food products prepared from onion and other species of the genus Allium results in 10 to 40 fold increase in odour intensity and in alteration of GLC patterns of the volatiles. Other non-volatile sulfhydryl compounds, but not ascorbic acid also intensify the odour.

K. A. R.

19.26 *The precursors of chocolate aroma: Application of gas chromatography in following formation during fermentation of cocoa beans*, T. A. ROHAN, *J. Fd Sci.*, 1967, **32** (4), 402.

An improved method of roasting milligram order quantities of chocolate aroma precursors in a flash heater attached to a gas chromatograph has permitted semi-quantitative measurements of the aroma volatiles produced from samples withdrawn at intervals from fermenting heaps of cocoa beans. The observed increase in aroma concentration with increased duration of fermentation, and the time at which maximal concentration occurs, are in line with previous experience and recent investigation.

A. A.

19.27 *The precursors of chocolate aroma: Production of reducing sugars during fermentation of cocoa beans*, T. A. ROHAN AND T. STEWART, *J. Fd Sci.*, 1967, **32** (4), 399.

The sucrose in fresh cocoa beans is hydrolyzed to glucose and fructose during fermentation and the rate of the reaction confirms the possible inclusion of reducing sugars among the precursors of chocolate aroma. In the bean, the optimal concentration of reducing sugars is reached at about the same time as maximal flavour development, and coincides approximately with the peak in amino acid concentration.

A. A.

19.28 *The precursors of chocolate aroma: Production of free amino acids during fermentation of cocoa beans*, T. A. ROHAN AND T. STEWART, *J. Fd Sci.*, 1967, **32** (4), 395.

Amino acids are produced during fermentation of cocoa beans at a rate which is in agreement with the already established rapid rate of flavour and aroma development. The role of these compounds as aroma precursors receives further confirmation and an objective method of assessing the ' degree of fermentation ' has been described and tested.

K. A. R.

19.29 *Objective measurement of connective tissue tenacity of poultry meat*, M. F. POOL, *J. Fd Sci.*, 1967, **32** (5), 550.

The method consists of cutting out uniform cylinders of cooked muscle with the fibres parallel to the plane ends of the cylinder, attaching metal plates to the cylinder ends by a special adhesive that forms strong bonds with moist tissue, and measuring the force and work required to tear the meat sample apart in a recording tensile tester.

A. A.

19.30 *Collagen content and subjective scores for tenderness of connective tissue in animals of different ages*, C. W. KIM, G. P. HO AND S. J. RITCHEY, *J. Fd Sci.*, 1967, **32** (5), 586.

Collagen nitrogen in raw steaks was related to subjective scores for tenderness of connective tissue in cooked steaks of certain soups like veal, baby beef and mature beef.

K. A. R.

19.31 *The effect of stretch tension during rigor on certain physical characteristics of bovine muscle*, E. M. BUCK AND D. L. BLACK, *J. Fd Sci.*, 1967, **32** (5), 539.

Individual muscle fibre extensibility was less in stretched muscle strips ($P<0.001$). The average muscle fibre diameter was also significantly smaller in stretched muscle strips ($P<0.001$). Tenderness as determined by A 110-Kramer shear press showed that less force was required to shear samples from the stretched muscle strips in five of seven trials ($P<0.001$).

K. A. R.

19.32 *Deformation testing of foods. I. A precise technique for performing the deformation test*, M. C. BOURNE, *J. Fd Sci.*, 1967, **32** (5), 601.

A universal testing machine has been developed. A number of foods were compressed to a standard force and the deformation of foods were then measured off the strip chart recorder.

K. A. R.

19.33 *Deformation testing of foods: 2. A simple spring model of deformation*, M. C. BOURNE, *J. Fd Sci.*, 1967, **32** (5), 605.

The model consists of a set of true springs of differing heights and with differing Hooke's constants arranged in a parallel. One or more springs are required to represent a given food depending upon the degree of curvilinearity of the force compression curve of the food. No dash pots are needed in this simple model. The one restriction on the model is that it is intended to represent the physical response of the food to a single compression.

A. A.

19.34 *Is the mistrust of synthetic aroma justified?* E. M. VERBEEK, *Inds aliment. agric.*, 1967, **84** (6), 879.

In this article, the author refers to fears concerning the use of synthetic flavouring substances in food, and shows that there are few grounds for such mistrust.

A. A.

19.35 *Laboratory preference and acceptance panels: a case in point*, S. S. CONGER AND K. ZOOK, *Fd Technol. Champaign*, 1968, **22** (2), 189.

The way of choosing taste panel judges by Quaker Oats Company and description of panel test evaluation procedures used.

J. V. S.

19.36 *Methodology studies with laboratry and home preference panels*, L. A. SATHER, *Fd Technol., Champaign*, 1968, 22 (2), 188.

Reports product preference in single, paired or multiple serving of samples as evaluated by paired preference, hedonic scoring and reference preference criteria.

A. A.

19.37 *A comparison of methodology used in determining the flavour effect of 5'-ribonucleotides on processed foods*, ELIZABETH F. STIER, F. MILES SAWYER AND P. EVERETT FERGENSON, *Fd Technol. Champaign*, 1967, 21 (12), 1627.

The effects of nucleotides in enhancing the flavour of processed foods were tested by paired comparison tests and multiple comparison tests. Data from both methods showed that IMP-GMP (disodium 5'-inosinate-disodium 5'-guanylate) is more effective than IMP alone in enhancing the flavour of foods tested. At lower levels, in chicken soup, comparable data showed that 2-3 times as much IMP was required to produce the same effect. With beef bouillon, at least twice the IMP concentration was required. Paired comparison on beef gravy showed trends in the direction of more IMP being needed than the mixture; whereas multiple comparison tests showed that 4 times the IMP concentration were required to produce comparable effects.

J. V. S.

19.38 *Stability of single strength orange juice made with aroma solution or cut back juice*, J. L. BOMBEN, D. G. GAUDAGNI AND J. G. HARRIS, *Fd Technol. Champaign*, 1968, 22 (2), 230.

Orange concentrate reconstituted with aroma solution made from WURVAC process was stored at 33°F for over 1 month and evaluated organoleptically and by chromatography. The stability of such reconstituted juices was similar to that of products made with pasteurised cut back solution.

J. V. S.

19.39 *Flavour of recombined milk*, A. TAMSMA, F. E. KURTZ, E. BERLIN AND M. J. PALANSCH, *J. Dairy Sci.*, 1967, 50 (12), 1878.

When butter oil and non-fat dry milk were packed in nitrogen and stored at 18°C for six months, no change occurred in the flavour of the recombined milk. Higher storage temperature caused changes in the butter oil which resulted in a stale flavour appearing in the recombined milk.

K. A. R.

19.40 *A microbial proteolysate of non-fat milk solids as a potential food additive and flavour supplement*, T. J. CLAYDON, R. MICKELSEN, PHYLLIS J. PINKSTON AND NANEY L. FISH, *Fd Technol. Champaign*, 1968, 22 (2), 120.

A product with beef-extract type flavour was produced by fermenting reconstituted non-fat milk solids by proteolytic organism *Ps. fluorescens*. The final product contained average of 28 per cent solids. It showed no adverse effects on growth, gross condition of internal organs or reproduction in rats. The product improved the flavour of several food preparations as evidenced by taste panel scores.

J. V. S.

19.41 *Effect of processing method on oxidative off-flavour in soybean milk*, W. F. WILKINS, L. R. MATTICK AND D. B. HAND, *Fd Technol. Champaign*, 1967, 21 (12), 1630.

An acceptable, bland, soybean milk was produced by grinding unsoaked, dehulled soyabeans with water at temperatures 80° to 100°C, and maintaining the temperature for 10 minutes to completely inactivate the lipoxidase system. Lower temperatures (60°-80°) can be used if antioxidants are added to water. Maximum yield of soybean milk solids was obtained when the extraction temperature was 60°C. The contribution of non-enzymic fat oxidation to off flavour was insignificant.

J. V. S.

19.42 *An evaluation of oxidative and flavour stability of stored soybean oils*, L. A. BAUMANN, D. G. MCCONNELL, HELEN A. MOSER AND C. D. EVANS, *J. Am. Oil Chem. Soc.*, 1967, 44 (11), 663.

Results of 4-year storage tests of curd and refined soybean oil held in drums simulating field tank storages. Stored, crude or refined oil with peroxide values below 60 could be deodorised to obtain salad grade oils. Analysis of data reveal that once refined soybean oil held under large field tank storages may not reach peroxide levels of 60 until after 3-4 years, even in warm areas.

J. V. S.

19.43 *Laboratory techniques used for identification of aroma of wines*, J. N. BOIDRON AND P. RIBEREAU-GAYON, *Inds aliment. agric.*, 1967, 84 (6), 883.

Review of researches during the last ten years would show that organoleptic differences in different types of wines of varying origin can be partially interpreted on the basis of their content of acetates and lactates, n-butanol, n-hexanol and 3-methyl-2-butanol, and ratio of diethyl succinate to butyrolactone and of 3-methyl-2-butanol to 2-methyl-1-butanol.

At present, the variations in wine aroma are attributed to different proportions of the same substances. This needs to be confirmed. And it would be interesting to study if this diversity is due to fermentation of different substrates by the same yeasts, or to a different population of yeasts in each case.

The most sensitive methods of detection are accurate to 10^{-7} g while the olfactory perception has a sensitivity somewhere between 10^{-11} and 10^{-13} g. Therefore threshold of detection by laboratory techniques has to be improved 1,000 to 10,000 times.

K. M. D.

A. A. = Author's Abstract

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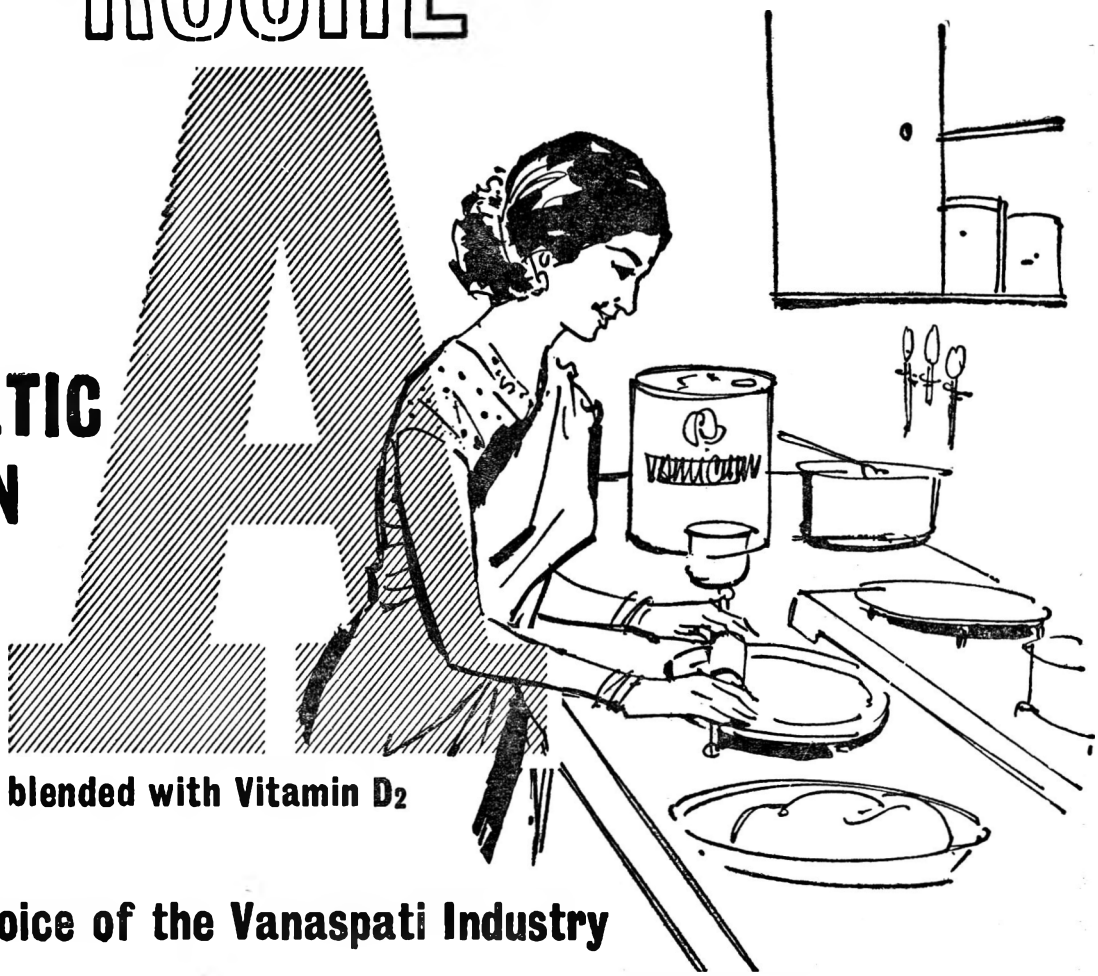

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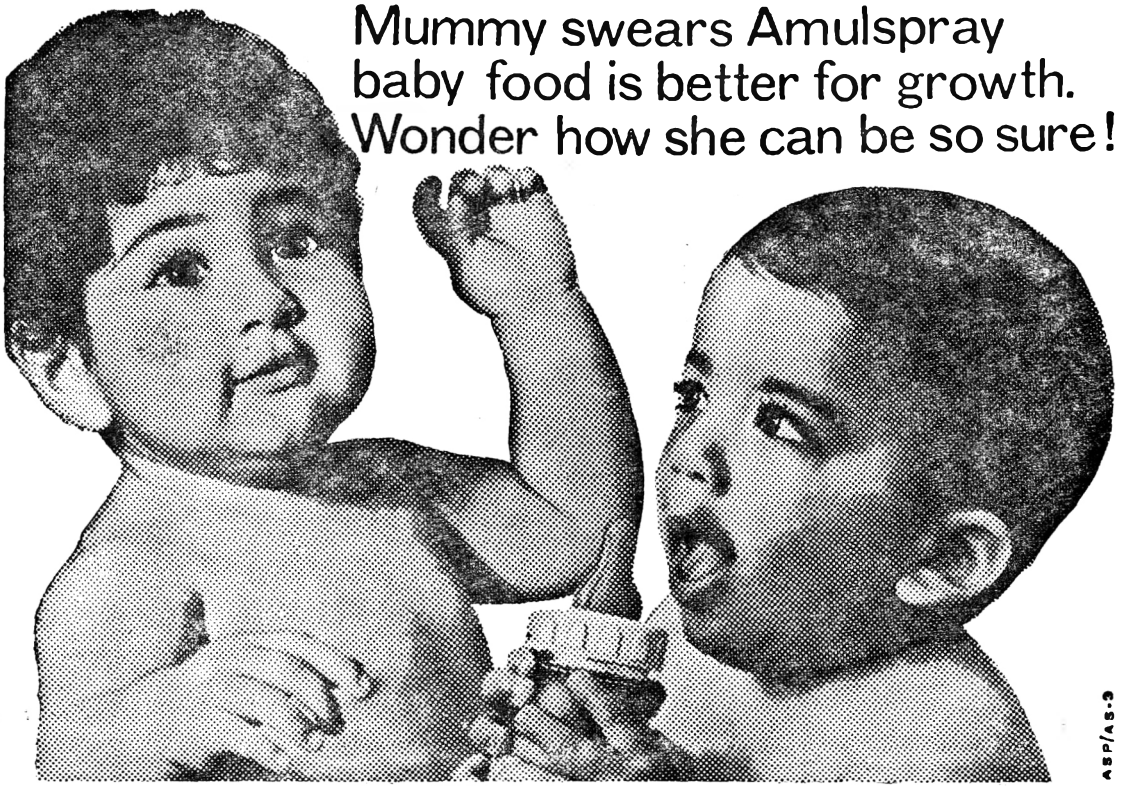

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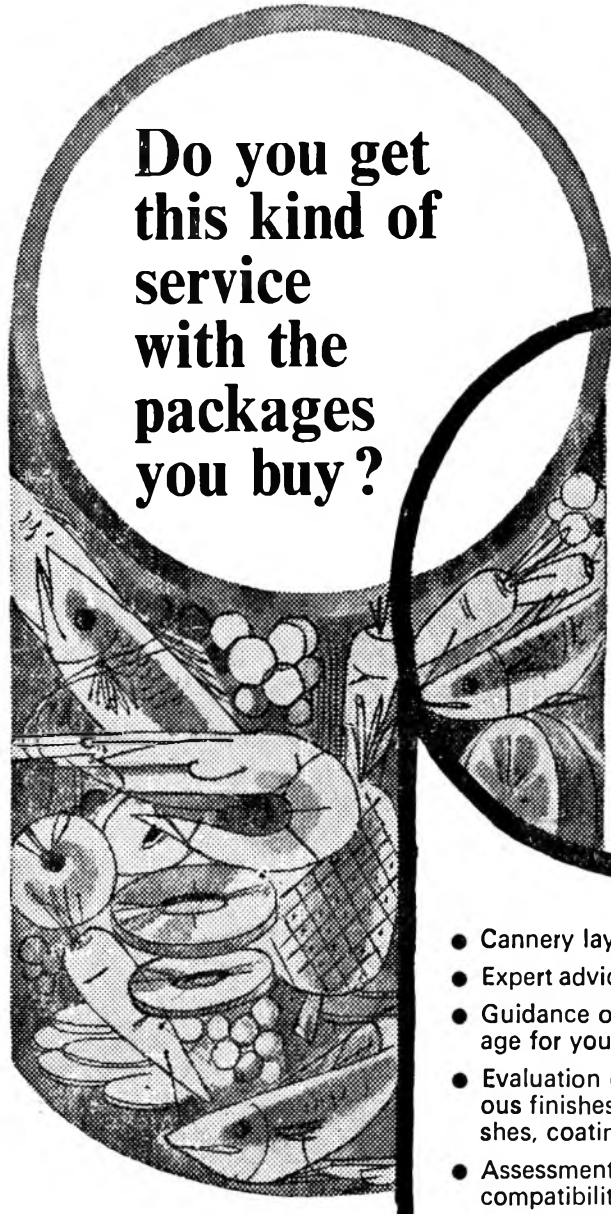

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