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CONTENTS

Myriad Uses of Hydrogen Peroxide in Dairy Industry*

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Introduction

Milk is a biological package of nutrients. Its ubiquity in the nutritional market is solely due to its function as a source of food for vulnerable groups. Almost similar nutrients are present in the milk of all species but variations in levels of the latter seem to be in consonance with the nutritional requirements of the offspring of each species.

Since milk has a large spectrum of nutrients, it forms an excellent medium for the growth and metabolic activities of microbial organisms, both pathogenic and non-pathogenic. Hence preservation of milk against microbial growth is the primary endeavour for its effective utilization. Procedures involving excellent sanitary production, refrigerated transport and pasteurized distribution are common to high quality milk supplies in advanced countries. Such steps seem to be costly and impractical during the first stages of dairy development in under-developed countries. Addition of a preservative will not only help in the collection of milk from widely scattered farms, but also in the facile transport of milk to the central processing plant. Hydrogen peroxide is generally held to be the least objectionable preservative in that it can be removed easily, quickly and completely through the action of catalase, an enzyme which is already present in milk. The breakdown products are oxygen and water, which are undetectable and nontoxic, and have no residual effect in food on hydrogen peroxide removal. Moreover, under certain conditions, traces of hydrogen peroxide produced by anaerobic *Lactobacilli* can even be found naturally in milk and milk products. Extensive studies on the properties of hydrogen peroxide preserved milk have been carried out in almost all parts of the world.

In a warm country like India, chilling has been almost imperative to preserve milk. In the wake of the power shortage, there is good case to consider hydrogen peroxide as a suitable candidate to replace refrigeration units for milk preservation. A collation of available data is made in this review as a ready—made catalogue on this subject. Hydrogen peroxide henceforth will be referred as HP.

A. General aspects of use of HP as a milk preservative

HP is a strong oxidising, bleaching and germicidal agent. The germicidal property of HP has been known since its discovery by the French chemist Thenard in 1818. The quantity of HP to be added depends on both the catalase index and the age of milk. To be effective HP should be added at the collecting farm within one hour of milking.

The use of HP as a milk preservative was first reported about the turn of the century by various workers[1–6]. Budde[7] used HP alongwith heat treatment (0.05% HP for 8-10 hr at 52°C and 2·3 hr at 52°C), and Much and Romer[8] used HP decomposing enzymes like hamase and hepin to destroy residual peroxide.

Tentoni *et al*[9]. reported the use of HP for preservation of fresh milk upto 24 hr at 32°C. Using milk with catalase at various levels of HP upto 550 ppm, the authors reported that (*a*) a delay of 3-4 hr between milking and addition of the preservative did not adversely affect milk quality, though bacterial development was sometimes greater when HP was added immediately; (*b*) the quantity of HP required to ensure satisfactory preservation increased with increase in the catalase index of milk, but a minimum continuous level of 30 ppm residual HP was necessary; and (*c*) the action of HP on the milk microflora was initially bactericidal following the splitting off of molecular oxygen immediately after addition, followed by a bacteriostatic action observed during the preservation period.

Zeehuizen *et al*[10] observed in four small scale trials that the addition of 10 ml of 20 per cent HP to 3 lit of milk resulted in a decreased bacterial count which was maintained during 6 days storage at 8°–10°C; no ill-effects were observed on persons subsequently drinking the milk. Rosell *et al*[11] recommended the addition of 0.06 per cent HP (2 ml of 100-110 vol HP per lit) within an hour of milking. Toma *et al*[12] reported that the addition of 0.2 per cent of 30 per cent HP to milk before transport for 8-10 hr at 23°-32°C prevented any increase in acidity, while in samples with HP the acidity increased. Siegenthaler[13] found under tropical conditions that low-grade milk treated with 0.04 and 0.08 per cent HP (diluted

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5-10 times with known volume of cold water) could be stored at 4°C and 30°C for 24 and 48 hr respectively.

The composite samples of buffalo milk containing 0.04, 0.06 and 0.08 per cent HP stored for 36 hr in glass flasks and also 0.06 per cent HP in aluminium and earthenware containers were not affected in treated or untreated samples[14]. The authors did not observe any change in taste until an hour before coagulation and no off-flavour due to HP was noticeable with 0.06 and 0.08 per cent HP. Coagulation occurred within 11-14 hr in untreated samples, but only in 9 out of 10 within 22-34 hr with 0.04 per cent HP, 4 out of 10 within 22-36 hr with 0.06 per cent HP and in none within 36 hr with 0.08 per cent.

Santha and Ganguli[15] determined the quantity of HP required for preserving milk under Indian conditions. They found that cow milk utilized HP more quickly than buffalo milk. They suggested use of 3 ml and 4 ml HP (30 per cent or 100 vol) per litre of buffalo and cow milk respectively for preserving them at 37°C for 24 hr. Milk thus preserved showed no development in acidity and did not clot on boiling. When the milk preserved with HP was stored at low temperatures, HP utilization was decreased. It was found that 0.01 ml catalase could remove 4 ml of HP in milk within 15-20 min, but a distinct phenomenon of frothing was noted when buffalo milk was treated with catalase, though this frothing could be suppressed if the catalase treatment was carried out below 30°C.

The expert group which met in 1957 under the auspices of FAO stated[16] "If, owing to difficult conditions, permission is given for HP to be used, either by the producer or by the collector of milk, the quantity to be used should in no circumstances exceed 0.8 g of HP per litre of milk and should usually for milk for liquid consumption, be between 0.10 and 0.40 g of HP per litre.

Since the function of HP is merely to delay the souring of the milk and since this preservative at any permissible strength does not destroy certain types of pathogenic micro-organisms (including *Mycobacterium tuberculosis*) any milk treated by HP must subsequently be subjected to effective heat treatment before being distributed to the consumer or during course of manufacture.

It must be clearly recognized, both by controlling authorities and the technical personnel concerned, that use of HP is not a hygienic measure and substitute for efficient heat treatment.

In short, it is a method which in other than exceptional circumstances is not to be recommended".

B. Effect on the milk constituents

(i) Taste

Milk treated with HP in the concentrations normally used retains no undesirable taste once complete decomposition of HP has taken place. Off-flavour may develop if a high concentration of HP is used for preservation, e.g. more than 0.06 per cent by weight of HP. Nambudripad *et al*[17] reported that milk containing an appreciable amount of undecomposed HP depending on the material of the container, may develop a slight "oxidized" flavour after prolonged storage. The treatment of milk with HP can prevent the development of a typical solar-activated flavour in homogenized milk[18]. HP-treatment can delay the formation of oxidized flavour[19,20] and also the development of tallowy flavour[21] during cold storage. When HP-treated milk is heated, no undesirable flavour is detectable even after long storage.

(ii) Effect on milk proteins

(*a*) *Casein:* HP in higher concentrations oxidises proteins to yield aldehydes, ketones and acids. Dilute peroxide solutions do not show this effect. Luck and Joubert[22,23] reported that treatment of milk or calcium caseinate solutions with 0.25 or 1.0 per cent HP increased the rennet clotting time, the increase being proportional to the HP concentration and the duration of treatment. Santha and Ganguli[24] observed similar effect. They did not note any change in the release of glycomacropeptide by rennet, but observed that the percentage increase in clotting time was greater in buffalo milk than in the three other types of milk samples examined. Luck and Joubert[22,23] observed that casein of fresh milk had two components with sedimentation constants of 6.2 and 1.4. Both HP-treatment and storage at 4°C replaced the first component by a slower one with a sedimentation constant of 3.8, the quantity of which fell with increasing HP concentration. They found no difference in particle size between casein isolated from untreated and HP-treated milk. Further they also found that the ethanol concentration causing casein flocculation was first decreased and then increased by HP.

Santha and Ganguli[24] observed that the particle size of buffalo casein was not altered by HP treatment at a concentration of 3 ml (100 vol) per litre of milk, and subsequent preservation of milk at 37°C for 24 hr. The starch gel electrophoretic pattern of the casein isolated from HP-treated milk did not differ from that of the untreated sample, though the authors suspected a qualitative difference in the β–and k-casein areas in the polyacrylamide gel electrophoretic pattern of HP-treated samples.

Buruina and Pavlu[25] observed that treatment of milk for 2 hr with 0.2 per cent of 33 per cent HP resulted in increased polarographic activity, which was explained by a change in hydration of milk proteins. Fox and Kurukowsky[26] reported that after treatment of casein with 1 per cent HP at 55°C for 15 min, rennin, pepsin and trypsin (particularly rennin) reacted faster with casein

than before. Fox[27] found that HP-treated casein was susceptible to precipitation by Ca^{++}, but at the point of minimum solubility, 40 per cent of the protein remained soluble as compared with 30 per cent untreated casein. The solubility of α-casein in $CaCl_2$ at pH 6.5 or 4.6 was not significantly affected by HP, but β-casein became completely soluble in presence of 50 m moles $CaCl_2$ at pH 6.5 and 55 per cent soluble at pH 4.6. HP-treated α-casein did not gel with rennin either in the presence or absence of Ca^{++}. The author concluded that action of HP was not due to the cleavage of the disulphide linkages in the protein. HP-treatment of pure casein solutions in 0.1 and 0.4 per cent concentrations by weight decreased the viscosity of the solutions and increased the proportion of nitrogen not precipitated by trichloroacetic acid[28]. Giolitti[29] found that 0.04 per cent by weight of HP-treatment increased the albumin content and decreased the casein content but Santha and Ganguli[24] observed no significant changes in the proportions of fractions such as casein, total albumin, β-lactoglobulin, residual albumin, globulin and non-protein nitrogen on HP-treatment.

Schmidt *et al*[30] observed an increase in rennet coagulation time, a retardation of GMP release from *k*-casein, and a reduction in completeness of casein clotting in HP-treated skim milk. HP-catalase treatment reduced the methionine content of iso-electric caseins. The sialic acid and phosphate levels of casein isolated from HP-treated buffalo milk were unaltered from those of casein isolated from untreated milk.

(*b*) *Whey proteins:* On HP-treatment, the β-lactoglobulin peak was diminshed with 0.25 per cent HP and abolished with 1.0 per cent HP, being replaced by a slower component. The number of sulphydryl groups in whey proteins was hardly affected by 20 min treatment with HP at temperatures below 45°C. It was slightly decreased by 1.0 per cent HP for 2 days at 18°C[23]. Treatment of pure β-lactoglobulin with 0.25 or 1.0 per cent HP for 7 days slightly decreased the electrophoretic mobility and flattened both ascending and descending peaks, while the sedimentation constant fell from 2.5 to 2.11. Treatment of skim milk with 1.0 per cent HP split it into two slow moving components. The sedimentation constants of these components were half that of the original β-lactoglobulin. Spectrographic examination of whey treated with 1.0 per cent HP for 24 hr showed an increase in the absorption at 2,750–2,800Å (tyrosine and tryptophan peaks). After 4-7 days' treatment however, the absorption at this wavelength was less than that of untreated whey. These changes did not occur if the treated whey was kept in the dark[31]. Grindrood and Nickerson[32] studied the effect of HP on skim milk and individual proteins there-from using electrophoretic mobility on polyacrylamide gel with and without urea and 2-mercapto-ethanol (ME). They found that, following HP-treatment of individual proteins, the migration rates on PAG-electrophoresis were reduced for α_s-casein and β-lactoglobulin, and were increased for β-casein and bovine serum albumin (BSA) while they were unchanged for *k*-casein or β-lactalbumin. In skim milk, β-casein migration was slowed down. When the samples and the gel both contained urea-ME, α_s-and β-casein migration rates were reduced, those of BSA and β-lactoglobulin were increased whereas *k*-casein and α-lactalbumin remained unchanged. Whey protein nitrogen decreased and non-protein nitrogen increased as a function of HP concentration and time. HP did not induce complex formation between β-lactoglobulin and *k*-casein. Perlmutter and Brunner[33] could not observe any discernible change in composition and physical properties of protein (β-lactoglobulin AB in simulated milk dialysate plus 5 per cent lactose) which was subjected to HP-alone (0.01 to 0.1 per cent w/v), but when HP was present during heat treatment (85°C for 12 min), all the protein sulphydryls were destroyed and converted to cysteic acid, the effect being partial with 0.01 per cent HP or total with 0.1 per cent HP. Methionine residues were reduced from 7 to 4.5 per cent in the heated samples. Neither methionine sulfoxide nor methionine sulfone was detected in amino acid chromatograms. Turbidity measurements and acrylamide gel electrophorograms indicated that the presence of peroxide during heat treatment inhibited aggregation of β-lactoglobulin.

Non-protein nitrogen determinations on heated samples indicated that there was no significant breakdown of the peptide chain. Cooney and Morr[34] studied the extent of denaturation or physical aggregation of individual and total whey proteins produced by treating whey and concentrated whey systems with HP. They analysed the samples by preparative ultracentrifugation, Sephadex G-150 gel filtration and zone electrophoresis and observed that proteose-peptones were most susceptible, and immunoglobulins, β-lactoglobulin and BSA were rather less susceptible to alterations by HP. Variations in pH of the reaction mixture had only a minor influence upon whey protein alteration, whereas all the other variables, namely peroxide concentration, temperature and reduction time, greately affected the extent of total and individual whey protein produced by the peroxide-catalase treatment.

(iii) Heat stability of proteins in HP-treated milk

Nancy and Mickelsen[35,36] studied the effect of heat (85°C for 30 min) on whey protein nitrogen value of skim milk treated with different concentrations of HP, which was found to decrease denaturation of skim milk. The β-lactalbumin band was lighter in the HP-treated sample than in the normal or heated samples. BSA was

denatured by heat, but HP prevented its total denaturation, β-lactoglobulin was denatured by heat treatment and extensively modified by HP. The electrophoretic pattern of HP-treated acid whey had a darker band in the position normally occupied by β-lactalbumin. A component not found in the HP-treated acid was found in the electrophoretic pattern of acid whey from HP-treated skim milk, possibly from a product not precipitated with the casein. The authors also observed in the polyacrylamide gel electrophoretic pattern that the β-lactoglobulin was modified by treatment with HP to form an electrophoretic component of reduced mobility that appeared as a diffuse band. The HP-modified β-lactoglobulin retarded formation of the complex with *k*-casein, but it did not completely prevent interaction.

Koops and Westerbeek[37] reported that HP strongly affects the heat stability of concentrated milk. Stabilization or destabilization of peroxide treated milk to heat depends on the stage of addition and the amount of HP added. The observed effects were discussed in relation to the mechanism of thiol-disulphides interchange presumably leading to complex formation between β-lactoglobulin and *k*-casein. Heat stability of concentrated skim milk was increased by small addition of HP if made before preheating, and markedly reduced by further additions. Heat stability was also increased if small additions of HP were made after preheating, but was depressed only slightly, still remaining fairly high, on further addition. It was suggested that depending on its concentration, HP might influence the thiol disulphide interchange which is thought to be involved in the heat-induced formation of β-lactoglobulin—casein complex in milk. It was also further observed that low concentrations of HP oxidising excessive amounts of sulphydryl groups might have aided the formation of the complex, or contributed to its stability if already formed. High concentrations if present before heating might interfere with the formation of the complex by strongly oxidising the —S—S—containing groups of its protein constituents. If present only after preheating, such concentrations might well be less effective in disturbing a complex already formed.

(iv) Effect on milk enzymes

HP preservation affects milk enzymes to a certain extent. The phosphatase test for distinguishing raw and pasteurized milk is applicable to peroxide treated milk. It was found that 0.08–0.012 per cent weight of HP, both at freezing point and at 20-30°C, did not affect amylase, lipase, protease and phosphatase, but nearly destroyed peroxidase, catalase and reductase activities[38]. Phosphatase is strongly inhibited when HP-treated milk is kept for a long period (10-20 days)[39]. HP, at 0.06 per cent by weight, was able to destroy all peroxidase in milk, where as smaller doses of peroxide disappear and allowed some peroxidase to persist[40]. Luck and Schillinger[41] observed that the destruction of catalase which is accelerated at increasing temperature, is accompanied by the decomposition of HP. Catalase and peroxidase are destroyed.

(v) Vitamins

The vitamins of milk are very little affected by normal treatment with HP. Only ascorbic acid is seriously affected, but this is not important because milk is not a significant source of this vitamin. After addition of 0.04 per cent by weight of HP, the loss of ascorbic acid in milk held for 20 hr at 15°, 22°, 26° and 32°C was 54, 78, 85 and 92.5 per cent as against 84 per cent in the controls[42]. None of the B-complex vitamins examined by Nambudripad *et al*[17] was found to be affected by peroxide treatment of milk. The thiamine, riboflavin, nicotinamide and cobalamine contents were nearly the same in HP-treated pasteurized milk (0.03 per cent by weight HP added, and the milk pasteurized at 63°C for 1-2 hr) as in the control milk, which was only pasteurized. Luck and Schillinger[43] found that thiamine is partly destroyed but riboflavin is quite stable even under relatively extreme conditions. A peroxide concentration of 0.25 per cent destroys 20-25 per cent of the riboflavin. The authors observed a similar destruction of thiamine after 5 min heating of the milk at 60°-65°C. Giolitti[29] noted that HP treatment (0.04 per cent by weight) decreased vitamin A content by 22-42 per cent. Satta *et al*[42]. observed that the addition of 0.12 per cent by weight of HP at 20° or 30°C for 36 hr reduces the vitamin content from 158 to 125 I.U. per 100 g. The corresponding figures for the stored controls without HP were 130-135 I.U. The thiamine content in the same treated samples dropped from 25-30 to 12-15 I.U., and in the controls to 15-18 I.U. per 100 g.

Luck and Schillinger[43] found that fat-soluble vitamins are quite stable to peroxide treatment. Even a concentration of 0.3 per cent by weight could not destroy β-carotene, vitamin A and vitamin E. Fat-soluble vitamins added to milk were more sensitive to HP.

(vi) Milk sugar and butterfat

Giolitti[29] found no change in lactose content, total nitrogen and pH after the addition of 0.04 per cent by weight of HP to milk. Banerjee[40] and Arnaudi and Treccani[45] found that lactose content of peroxide-treated milk was somewhat lower than that of untreated samples. The sugar content of untreated milk was 5.01 per cent but, after treatment with 0.01, 0.02, 0.04 or 0.08 per cent by weight of HP at 30°C for 16 hr, the figures were 5.01, 4.95, 0.05 and 4.06 per cent respectively.

HP treatment (0.3 per cent by weight for 20 hr at 51 °C) did not change the ultraviolet absorption spectrum of butterfat[43]. Butter prepared from preserved milk (0.03 per cent by weight of HP) did not differ appreciably in quality from that made from fresh milk[17,46].

C. Effect on nutritive value of milk

Biological protein evaluation, approximate composition and vitamin analysis indicate little change in composition and nutritive value of milk treated with 0.1, 0.2, or 0.5 per cent HP or of whey or cheese obtained from such milk[47]. HP destroys a large proportion of vitamin C, but this is not a serious problem.

The tryptic digestion of casein pre-treated with HP is augmented[28,48]. Gregory *et al.*[49] reported that HP had little effect on B-complex vitamins, vitamin A, carotene, xanthophyll or tocopherol, but did decrease the nutritive value of milk proteins; this loss being probably connected with methionine. None of the B-complex vitamins examined by Nambudripad *et al.*[17] was found to be affected by HP-treatment of milk.

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Nisin as an Aid for Extending Shelf Life of Sterilized Milk

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The effect of nisin in reducing the thermal resistance of the spores of *Bacillus subtilis* 9144 and *B. strearothermophilus* 1-63 in sterilized milk has been investigated. The reduction in the D-value of the spores of these organisms (100 spores/ml) in presence of 100 Reading units/ml of nisin was 44.96 and 71.22% at 109 and 115°C, respectively. The keeping quality of the sterilized milk in the presence of nisin was extended upto 60 days while the corresponding samples without nisin got spoiled within 3 to 7 days.

Nisin, a polypeptide antibiotic, produced by certain strains of *Streptococcus lactis* has been found to decrease the thermal resistance of spores of both aerobic and anaerobic spore formers. It has been thus successfully used for reducing the intensity of heat treatment during sterilization without increasing the risk of bacteriological spoilage in heat processed foods[1,2]. Nisin is safe for use in foods since it is readily destroyed by digestive enzymes[3].

Heinemann *et al.*[4,5] used nisin to aid heat treatment of chocolate flavoured milk and evaporated milk. Aplin and Barrett Ltd.[6] used nisin for controlling spoilage due to aerobic sporeformers in recombined milk products. The present communication reports the effect of nisin in reducing the thermal resistance of aerobic spore formers in sterilized milk.

Materials and Methods

Nisin preparation: 'Nisaplin' brand of nisin preparation obtained from Aplin and Barrett Ltd, England, containing 25,000 parts per million of nisin (10 lakh Reading units/g) was employed in the study. To get the desired level of nisin in sterilized milk, its solution was prepared in sterile distilled water just before use.

Bacterial strains: 1. *Bacillus strearothermophilus* 1-63 and 2. *Bacillus subtilis* 9144.

Culture conditions: The culture of *B. stearothermophilus* was maintained on starch nutrient agar slants, whereas the culture of *B. subtilis* was maintained on tryptone dextrose yeast extract agar slants. The cultures were transferred every week. Between transfers, the cultures were kept in a refrigerator at 2-5°C.

The agar slants were inoculated with actively growing cultures of the test organisms and incubated for 2-3 days at 55°C in case of *B. stearothermophilus* and 5-6 days at 37°C in case of *B. subtilis*. When microscopic examination showed a high percentage of mature spores, the slants were removed from the incubator and the surface growth was suspended in sterile distilled water. To suspend the growth, 3 ml of water was added to each tube and the growth was removed by scrapping the surface with a sterile inoculation loop. Growth from a number of slants was collected in sterile screw cap dilution bottles. The spore suspension was then heated for 30 min at 100°C in case of *B. stearothermophilus* and 20 min at 80°C in case of *B. subtilis* to destroy vegetative cells and to activate the spores for germination[7]. The spores were washed[8], and the suspension adjusted to 50 per cent transmittance at 610 mμ in Leitz photometer.

Milk treatment: Standardised pasteurised milk obtained from the Experimental Dairy, National Dairy Research Institute, Karnal containing 4.5 per cent fat and 8.5 per cent solids not fat was used. The milk was homogenised at 2500 psi to prevent cream layer formation and distributed in clean bottles in 250 ml quantities. The bottles were sealed using crown corks and sterilised by giving a momentary pressure of 15 lb psi in an autoclave on the first day followed by steaming for 30 min on the subsequent day for trials with *B. stearothermophilus*, whereas for trials with *B. subtilis* the milk was steam sterilised for 30 min on 3 consecutive days.

Determinations: The spore count was determined by plate count technique[9] and the D-value* was calculated by plotting log survivors against time in minutes at a constant temperature.

Results and Discussion

The effect of incorporating nisin on the thermal resistance of spores of *Bacillus subtilis* 9144 and *Bacillus stearothermophilus* 1-63 in milk using different time and temperature combinations has been studied (Table 1 and Fig. 1). It is apparent from the results that there was

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*D-value is the time required under particular conditions of temperature medium and number of spores to kill 90% of the spores of a given organism and is numerically, equal to the number of minutes required for the survivor curve to traverse one log cycle.

TABLE 1. EFFECT OF NISIN ON THE THERMAL RESISTANCE OF SPORES* OF THE TEST ORGANISMS IN MILK

Test organisms	Nisin level (Ru/ml **)	Heat treatment Time (min)	Temp (°C)	Total spore count of heated milk/(ml)
B. subilis 9144	0 (Control)	5	109	92
		10	109	6
	100	5	109	12
		10	109	0
B. strearothermo-philus 1-63	0 (Control)	5	115	58
		10	115	24
		10	115	24
	100	5	115	6
		10	115	0

*Spore load: 100/ml
**Ru = Reading Units

Reading unit is defined as that amount of nisin which will delay the growth of *Streptococcus agalactiae* in 1 ml broth for about 16 hour (40 Reading units are approximately equivalent to 1 part per million of nisin).

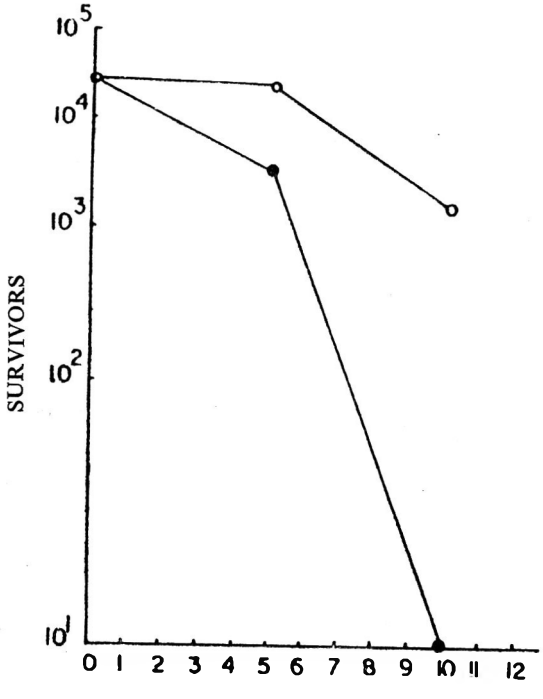

Fig. 1 (a) Survivor curve of *Bacillus subtilis* 9144 at 109°C with (●) and without (O) nisin treatment (100 Ru/ml)

definite reduction in the thermal resistance of spores of both the species in presence of nisin as evidenced by reduction in number of the spore count. The reduction in the D-value of the spores of *B. subtilis* 9144 and *B. stearothermophilus* 1-63 was 44.96 and 71.22 per cent at the temperature of 109 and 115°C, respectively. The effect on the D-value of the spores of *B. stearothermo-*

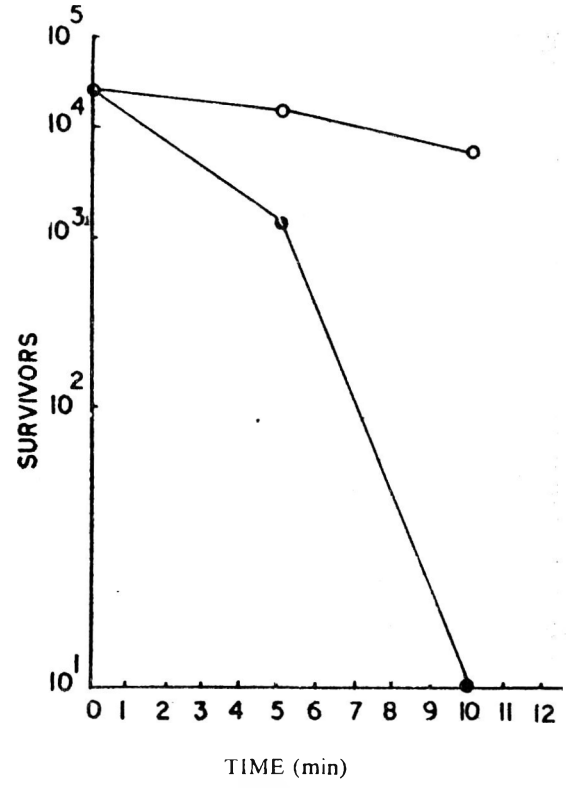

Fig. 1 (b) Survivor curve of *Bacillus stearothermophilus* 1-63 at 115°C with (●) and without (O) nisin treatment (100 Ru/ml)

philus was not significant at 109°C. It further revealed that the extent of reduction in the thermal resistance of the spores increased with increasing heat damage to the spores.

The role of nisin in decreasing the thermal resistance of various spore formers has been reported by several workers. O'Brien *et al.*[10] reported that in the presence of nisin there was reduction in the D-value of spores of *B. coagulans* and *B. stearothermophilus* by 7 and 30 per cent respectively. In a similar study, Campbell, *et al.*[1] reported considerable decrease in the D-value of spores of *B. coagulans* in tomato juice. The reduction in the D-value reported by these workers was much higher as compared to the values obtained in the present study. This could possibly be due to much higher concentration of nisin used by these workers. Further the D-value of a process is known to be influenced by several factors such as nature of food, type and size of container, temperature of processing and type and number of spores used[2].

Trials were also conducted to study the effect of nisin on keeping quality of sterilized milk. It was observed that the sterilized milk bottles containing nisin (100 Ru/ml) and inoculated with the spores of *B. subtilis* 9144 remained normal upto 60 days while the bottles without nisin got visibly spoiled in 3-7 days at 37°C. The milk bottles were examined organoleptically for appearance,

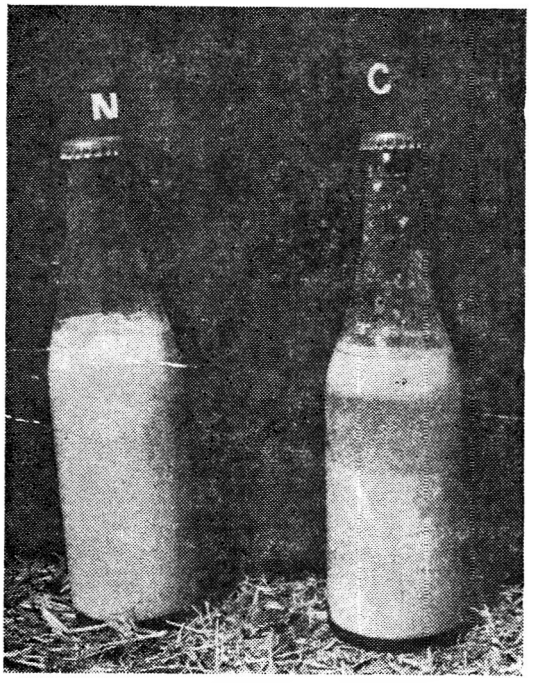

Fig. 2: Preservative effect of nisin in sterilised milk inoculated with spores of *Bacillus subtilis* 9144
N = with nisin; C = without nisin.

odour and taste. In case of the spoiled bottles there was distinct curdling leading to whey separation at the top (Fig 2). The spores of each test organism were inoculated at a level of 100 spores/ml. Similar results with regard to increase in shelf life of sterilized milk were obtained when the spores of *B. stearothermophilus* 1-63 were used and the bottles were incubated at 55°C.

While studying the effect of nisin on the keeping quality of chocolate flavoured milk, Heinemann *et al.*[5] also observed that nisin at a concentration of 100 Ru/ml could effectively control spoilage of the product due to the growth of spores of *B. stearothermophilus*. It was observed that the cans of chocolate flavoured milk containing nisin did not spoil at all, whereas the corresponding cans without nisin got spoiled within 7 days at 130°C. Similarly, beneficial effect of nisin in preventing spoilage of reconstituted milk due to aerobic spore formers has been reported.[6] The samples of reconstituted milk with the spore load of 20-30 spores per ml and containing nisin did not spoil upto 28 days, whereas the control samples were spoiled in 6-14 days when stored at 45°C and 2 days when stored at 55°C.

Spoilage of sterilized milk due to curdling in case of the samples inoculated with *B. subtilis* 9144 could be due to elaboration of rennin like enzyme. Sweet curdling in the sterilized milk due to the growth of *B. subtilis* has been reported earlier[11,12]. In case of the samples inoculated with *B. stearothermophilus* 1-63, the spoilage was suspected to be due to 'flat souring'. Stumbo[7], while studying keeping quality of low acid foods, also observed that strains of *B. stearothermophilus* and related species were implicated in 'flat souring' of these products.

On the basis of the results of the present investigation nisin can be recommended as an aid in reducing the thermal resistance of aerobic sporeformers in sterilized milk thereby considerably increasing its shelf life. This will further help to conserve the nutritive value of the product by reducing the intensity of the heat treatment in addition to overall economy of processing.

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Studies on the Starches of Ragi and Red Gram

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Starches isolated from ragi and red gram had iodine affinity of 3.08 and 3.13% respectively. The gelatinization temperatures ranged from 56–72°C. When tested in an amylograph, both these starches were found to be stable to heat upto 90°C.

Food industry has been using starches from corn, rice, wheat, barley, rye, potato, sweet-potato, arrow root, tapioca, etc. Many other indigenous starchy raw materials can however be useful in food industries. However, with a view to study this possibility, starches were isolated from a cereal like ragi and a legume like red gram. Ragi (*Eleucine coracana*) is typically a tropical crop[1,2] which is usually used in the form of flour or as a nourishing food for infants and invalids in the form of flour of malted grain. This carbohydrate rich cereal also contains good amounts of calcium, phosphorus, B-complex vitamins and iron[3]. The legume red gram (*Cajanus cajan*) is consumed largely in India in the form of dhal as the main preparation and is a good source of protein.

Materials and Methods

Raw materials: Mature, healthy seeds of ragi and red-gram dhal were obtained from the local market and after cleaning thoroughly were used for extraction of starch.

Preparation of starch: Starches were isolated from cleaned seeds of ragi and red gram by using the alkali steeping method[4]. The starches obtained by this method were suspended in methanol, filtered and washed with acetone, ether and dried at room temperature and then at 50°C overnight.

Determinations: Starches obtained as above were analysed for the moisture, protein, fat, fibre and ash contents by A.O.A.C. methods[5].

Microscopic examination: The isolated starch granules were studied microscopically as described by MacMasters[6].

Fractionation of starch: Fractionation of starches into amylose and amylopectin was carried out according to the method of Haworth *et al*[7].

Determination of amylose and amylopectin contents of starch: Amylose and amylopectin contents were determined colorimetrically as described by McCready and Hassid[8]. Solubility of starches in water was determined at room temperature as described by Kerr[9]. Iodine affinity of starch was determined according to Schoch[10]. Gelatinzation temperature of starch was determined by the method described by MacMasters[11].

Pasting characteristics: The starch paste consistency was studied by means of Brabender amylograph viscometer[12]. Starch solids 9.3 parts per 100 parts of water (total volume 530 ml) were heated to 95°C with a constant temperature rise of 1.5°C/min.

Results and Discussion

The average values for composition of ragi and red gram starches are shown in Table 1. The chemical composition of these starches was practically the same except that the protein and fat contents of ragi starch were higher. Microscopy of the starches revealed that the red gram starch granules were oval in shape, and larger in size ranging from 20.80 to 33.92 μ while ragi starch granules were polygonal and 6.72 to 8.8 μ in size.

Table 2 shows values of amylose and amylopectin contents obtained by fractionation procedure and by colorimetric method. On fractionation, ragi yielded 13.8 per cent amylose as against 26.5 per cent obtained from red gram, whereas, by colorimetric method, ragi showed 16 and red gram 27 per cent. The relative proportion of the two polysaccharide fractions of starch may usually reflects the general properties of the native starch.

TABLE 1. ANALYSIS OF STARCHES

Starch	Moisture g/100 g	Protein g/100 g	Fat g/100 g	Fibre g/100 g	Ash g/100 g
Ragi	12.30	1.57	0.74	0.60	0.60
Red gram	13.35	0.65	0.24	0.60	0.90

TABLE 2. PERCENTAGE OF AMYLOSE AND AMYLOPECTIN IN STRACHES

Starch	By fractionation			By colorimetric method		
	Amylose	Amylopectin	Total	Amylose	Amylopectin	Total
Ragi	13.8	63.3	77.1	16.0	84.0	100
Red gram	26.5	43.5	70.0	27.0	73.0	100

TABLE 3. SOLUBILITY, IODINE AFFINITY AND GELATINIZATION TEMPERATURE RANGE OF STARCHES

Starch	Solubility %	Iodine affinity %	Gelatinization temp. °C
Ragi	0.8	3.08	60–72
Red gram	0.6	3.13	56–70

One such property is solubility in water. Since amylopectin is more soluble in water than amylose, the more the amylopectin content of a starch, the more may be its solubility in water. In the present case, as shown in Table 3, ragi starch had a solubility of 0.8 per cent while it was 0.6 per cent for red gram. The iodine affinity also seems to be influenced by the relative proportion of amylose and amylopectin present in a starch. As shown in Table 3, a lower iodine affinity of 3.08 was obtained with ragi having a lower per cent of amylose while it was 3.13 for red gram having a slight higher amylose content. The gelatinization temperature of a starch is dependent on the size and maturity of the granule[13] and probably also on the amylose and amylopectin make up. In the present case, the range of gelatinization for red gram and ragi was 56-72°C as determined by MacMaster's method. Ragi starch granules which were of smaller size (6.72 to 8.8 μ) and containing slightly more per cent amylopectin than red gram tended to resist initial gelatinization with the result that the initial temperature of gelatinization for ragi was also slightly higher, i.e. 60°C as compared to 56°C for red gram.

Paste viscosity curves for the two starches are as shown in Fig 1. The pasting temperatures for ragi and red gram were 73 and 81°C respectively which were different from the corresponding gelatinization temperature ranges determined by MacMaster's method, as the conditions used in these determinations were different. It was also observed that red gram starch had a peak viscosity of 800 B.U. at a temperature as high as 95°C, indicating the presence of strong homogeneous bonding forces capable of hindering the granules to break during heating as is also observed with Guandu, navy bean, yellow pea and lentil starch[14,15]. Ragi however had peak viscosity of 660 B.U. at 86°C which could be maintained even at 90°C but dropped to 590 B.U. on additional heating to 95°C, suggesting comparatively more thinning tendency at high temperatures like 95°C compared to red gram. The starches studied here, viz. ragi and red gram were therefore quite stable during heating to as high as 90°C, indicating the possibility of their use in such preparations in which viscous pastes are prepared by using high temperatures.

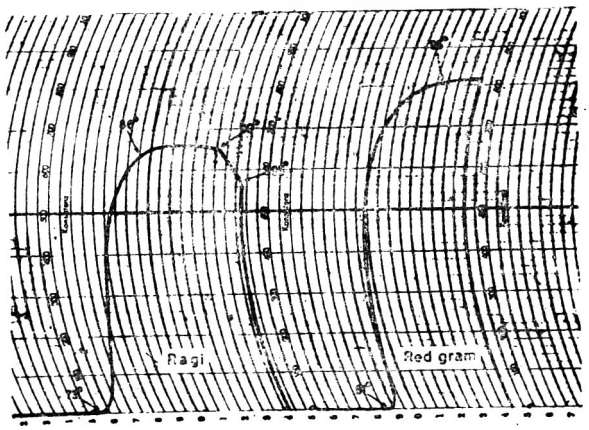

Fig. 1. Amylograms of ragi and red gram starch

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Studies on the Changes of Electrophoretic Mobility and Solubility of Casein Isolated from Fermented Milk in Making Curd

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None of the casein components is destroyed during fermentation of milk by lactic acid bacteria. Only relative electrophoretic mobility is slightly increased in the case of casein fractions isolated from fermented milk compared to those from fresh milk. The solubility of whole casein in 1 per cent sodium chloride solution at room temperature (20-25°C) gradually decreases with the progress of fermentation.

Considerable amount of literature has accumulated on the separation of various casein fractions by electrophoretic technique[1-3] and by chemical methods[4-6]. The starch gel electrophoresis of casein was also reported by Smithies[7] and Wake and Baldwin[8]. Also there are many reports[9-15] disclosing the species variation in the composition of milk proteins, using paper electrophoretic technique. The polyacrylamide gel electrophoresis of casein has also been reported[16-18] by various workers in recent years.

It was reported[19] that electrophoretic pattern of rennet treated caseins differed from that given by the same casein in solution treated with boiled rennet in that α-casein was split in two peaks as compared to acid α-casein. Baisya *et al*[20-21] reported that lactic acid bacteria have also got a little proteolytic activity and its role in the formation of curd by fermentation was also discussed. The present study was, therefore, undertaken to know whether there is any change in the electrophoretic mobility and the solubility of the casein component during fermentation.

Materials and Methods

Milk samples: Buffalo milk was used for making curd by fermentation according to the method desercibed by Baisya *et al*[22]. The casein samples of raw buffalo milk, heat treated (85°C, 30 min) milk, partial and complete fermented milk and also of freeze dried curd powder were used for gel electrophoresis study. Fat was removed by centrifugation at 3000×g for 10 min for three times before it was used for casein isolation. Curd powder was mixed with sufficient water thoroughly and skimmed as stated for isolation of casein.

Preparation of casein samples: Skim milk samples were diluted four times with warm water (30-40°C) and casein was separated by isoelectric precipitation using 1N HCl, washed twice with water, alcohol and ether and finally dissolved in veronal buffer (pH 8.6) containing 40 per cent urea according to the procedure of Aschaffenburg[12]. The casein samples obtained from approximately 10 ml of milk were dissolved in 2.0-2.5 ml of buffer urea solution.

Gel electrophoresis of casein: Polyacrylamide gel electrophoresis of casein samples was carried out according to standard procedure[23]. The casein solution (containing 100γ casein/ml) in buffer-urea solution was used per tube. The tray buffer was tris-glycine (pH 9.5). Five mA current was applied for each tube for a period of 45 min and staining was done with aniline blue black. All samples were run at the same time under identical experimental conditions.

Solubility of casein in 1 per cent sodium chloride: The casein samples isolated at different stages of fermentation as described earlier were mixed with a definite volume of 1 per cent NaCl solution and stirred thoroughly to prepare a saturated solution at room temperature (20–25°C). The mixture was then filtered to get a clear solution of casein in 1 per cent NaCl. The protein content of the solution was estimated by Biuret method[24].

Results and Discussion

The solubility of casein samples isolated from fermented milk in 1 per cent NaCl solution are given in Table 1.

The gel electrophoretic pattern of the buffalo milk casein samples isolated from fermented milk at various stages is shown in Fig. 1.

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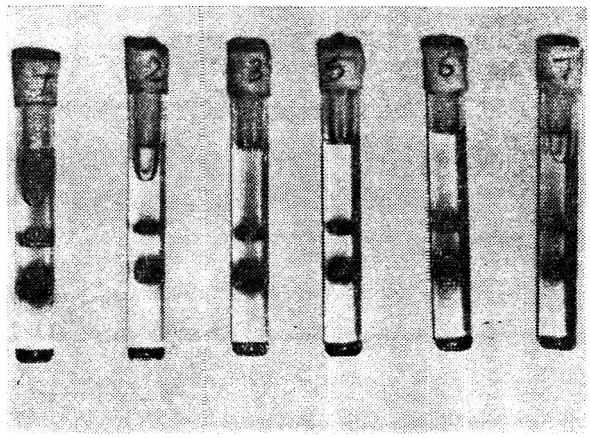
TABLE 1. CHANGES IN THE SOLUBILITY OF CASEIN IN 1% NACL SOLUTION DURING FERMENTATION

Fermentation time (hr)	% Casein soluble	% Reduction in solubility
0	1.550	—
3	1.490	3.871
5	1.120	21.290
6	1.030	33.548
7	0.965	37.742
8	0.680	56.129

From the results of the solubility of whole buffalo milk casein isolated from fermented milk in 1 per cent NaCl solution it appears that the solubility gradually decreases with the progress of fermentation which might be due to the combined effect of proteolytic action[20] and change in pH caused by the production of lactic acid during fermentation.

From the gel electrophoretic pattern of casein samples it seems that there are slight alterations in the relative electrophoretic mobility of the casein isolated from fermented milk compared to that from fresh milk, and unlike in the case of rennet action[19] α-casein did not split into two fractions. There is however, no further change of the casein with regard to its mobility during freeze drying of curd as it is apparent from the Fig. 1. In fresh casein sample there is one more band at the upper portion of the separating gel (Fig. 1) which disappears on heating the milk as the curd is being prepared usually from boiled milk.



1 2 3 5 6 7

Fig. 1 Gel electrophoresis of whole buffalo milk casein

1. Fresh milk casein; 2. heat treatd (85°C, 30 min) milk casein; 3. three hr fermented milk casein; 5. five hr fermented milk casein; 6. eight hr fermented milk casein; and 7. freeze dried curd powder casein.

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Influence of Germinated Green Gram and Chick Pea on Growth of Broilers

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Green gram (*Phaseolus aureus*) and chick pea (*Cicer arietinum*) in ungerminated and germinated forms were incorporated at 15% level in the place of jowar for growth studies of broiler chicken. Improvements in growth were found in legume supplemented diets, with germinated green gram giving significantly higher weight gain during ten weeks growth period. Chicks fed on ungerminated and germinated green gram diets showed better growth than those on chick pea diets. No significant difference was noticed in the feed conversion between control diet and legume based diets.

Legumes, both ungerminated and germinated constitute important source of protein and energy[1] in human nutrition and some are used in animal feeds. Beans are used extensively by humans and according to Fernandez *et al*[2] in situations of excess or unsuitability of the beans for human consumption, they may be used as feed ingredient for poultry. Kienholz *et al*[3] observed increase in the nutritional value for young chicks when autoclaved peas (*Pisum sativum*) were used as part of the rations. Significant increase in broiler growth was reported with kidney beans (*Phaseolus vulgaris*) by Wagh *et al*[4] and field beans (*Dolichos lablab*) by Davidson[5] when included in poultry rations. Goatcher and McGinnis[6] incorporated autoclaved bean, peas or lentils (*Lens culinaris*) with supplementation of antibiotics and recorded marked body weight gains in broilers.

Though India is a leading producer of legumes, incorporation of legumes in poultry diets has not received serious consideration. There is very little information on the incorporation of some of the common Indian legumes like green gram (*Phaseolus aureus*) and chick pea (*Cicer arietinum*) in poultry rations, either in germinated or ungerminated form. Germinated legumes are reported to be better nutritionally[7–10]. Venugopal[11] while evaluating the nutritional value of germinated black gram (*Phaseolus mungo*) at 10 per cent level, as a replacement of jowar found significant gain in body weight of broilers. Since germinated legumes are considered better nutritionally, it will be of interest to evaluate their quality in the growth of chicken. There are no reports available on the use of germinated legumes on broiler growth.

The present study is a part of a larger work on the nutritional evaluation of germinated legumes and is limited to the growth studies of broiler chicken for a period of ten weeks. Two of the common legumes, green gram, and chick pea were included in the normal poultry ration both in ungerminated and germinated form, as a partial replacement of a conventional ingredient—jowar at 15 per cent level. No pretence is made in this study to evolve a poultry diet with legume supplementation. The study has been primarily to evaluate the effect of germinated legumes on chick growth, meat yield and quality.

Materials and Methods

Day old Shaver strain broiler chicks were housed in standard brooders (thermostatically regulated) and were fed on control diet for the first two days before grouping. The brooder temperature was initially 35°C decreased by 3°C per week to 29.4°C. This was maintained till 4th week. After four weeks the birds were reared in fenced pens.

The birds were statistically grouped as per randomized block design and each dietary treatment was replicated. There were five diets which included a control (no legume diet), two each of green gram and chick pea (ungerminated and germinated). The ingredient and nutritent composition of these diets are shown in Table 1. The legumes were soaked in water for 4 hr and then germinated in moist cloth for 48 hr, dried in vacuum shelf-drier and powdered to pass through 20 mesh. The powdered legumes were incorporated at 15 per cent level in place of jowar in the respective diets (Table 1).

The essential amino acid contents were estimated by microbiological assay[9]. Feed and water were provided *ad libitum*. Weight, initial and at the end of fourth, eigth and tenth week, quantity of feed consumed and mortality, if any, were recorded. At the end of the tenth week, six randomly selected birds from each group were starved overnight, weighed, slaughtered and dressed. Dressed weight, giblet weight, breast angle and keel length were recorded. Feed efficiency, conversion effici-

TABLE 1. INGREDIENT AND NUTRIENT COMPOSITION OF EXPERIMENTAL DIETS (IN PER CENT)

Ingredient	Diets A	B	C	D	E
Maize	20	20	20	20	20
Jowar	35	20	20	20	20
Legume	—	15	15	15	15
Groundnut cake	20	20	20	20	20
Fish meal	14	14	14	14	14
Rice polish	8	8	8	8	8
Starmin P.S.	3	3	3	3	3
Bifuran	0.05	0.05	0.05	0.05	0.05
Nutrient level (%)					
Energy (Kcal)	982	985	984	990	984
Crude protein	22.00	23.00	23.00	22.00	22.50
Fat	5.90	5.00	5.00	5.70	5.50
Crude fibre	5.00	5.00	4.90	5.00	5.00
Calcium	1.10	1.10	1.12	1.13	1.13
Phosphorus	0.40	0.44	0.44	0.44	0.44
Arginine	1.40	1.67	1.78	1.65	1.66
Lysine	0.88	1.06	1.09	1.01	1.01
Methionine	0.31	0.34	0.36	0.30	0.32
Tryptophan	0.23	0.24	0.24	0.24	0.24
Cystine	0.18	0.18	0.19	0.18	0.18

A: Control, B: Ungerminated green gram, C: Germinated green gram, D: Ungerminated chick pea, E: Germinated chick pea.

ency and dressing percentage were calculated as follows. Feed efficiency is the weight gained per unit of feed consumed. Conversion efficiency is the weight of feed consumed to dressed weight while dressing percentage refers to the ratio of dressed weight to live weight at slaughter (weight of bird after starvation). Significance of the data was tested by Duncan's new multiple range test.

For organoleptic evaluation, light and dark meat of each lot were cooked at 15 lb pressure for 8 min with 2 per cent salt. The meat was evaluated for colour, flavour and texture by a semi-trained panel of 15 people. Scoring was done on a seven point hedonic scale. The sensory evaluation data were analysed by comparing the significance in quality between pairs of diets using Chi square test.

Results

Data on body weight gain, feed consumption and feed efficiency in broiler chicks fed on control and experimental diets are presented in Table 2. The gain in body weight in chicks ranged from 1263g for control diet to 1526g in germinated green gram diet for a ten week growth period. Birds on germinated green gram diet have a significantly higher weight gain ($P<0.01$) compared to birds in all the other diets. The chicks fed on ungerminated green gram diets and germinated chick pea diets were comparable in weight gains and were better than those on control diet. The growth rate of ungerminated chick pea diet was similar to the control diet. No loss in weight or mortality was recorded in any of the legume diets. Feed efficiency was much higher in the first four weeks for all diets as compared to later weeks. The feed efficiency was only comparable in all diets (Table 2).

Quantitative evaluation of meat is shown in Table 3. Slaughter weight and dressed weight were significantly higher in green gram diets compared to the control. Dressing percentage was highest for germinated green gram diets and lowest for the control group which contained no legume. Germinated green gram diet showed better meat yield compared to the ungerminated diets. The dressed weight in chick pea diets were lower than green gram diets. Even in chick pea supplemented diets higher dressing percentage was obtained in germinated compared to corresponding values of ungerminated ones. Conversion efficiency was better in germinated green gram (3.27) compared to the control (3.82) and also other diets.

Birds having higher dressed weight and dressing percentage viz. legume supplemented diets showed greater

TABLE 2. FEED EFFICIENCY OF BROILER CHICKS ON GREEN GRAM AND CHICK PEA SUPPLEMENTED DIETS

	Diet	Gain in wt. (g)* 4 weeks	8 weeks	10 weeks	Feed intake (g)** 4 weeks	10 weeks	Feed efficiency 4 weeks	10 weeks
A	No legume	353	978	1263	706	3272	0.50	0.39
B	Green gram (UG)	390	1165	1383	810	3548	0.48	0.39
C	Green gram (G)	398	1283	1526	866	3768	0.46	0.41
D	Chick pea	354	98.9	1282	739	3357	0.48	0.38
E	Chick pea (G)	356	1078	1385	819	3510	0.43	0.39
	S.E. of mean	±9.2 (66)	±14 (66)	±15 (6)	±18 (6)	±78 (6)		

*Based on 12 chicks per group; **Based on average of two replicates.
Figures in the parenthesis denote degrees of freedom.

TABLE 3. QUANTITATIVE EVALUATION OF BROILER CHICKS FED FOR 10 WEEKS ON GREEN GRAM AND CHICK PEA SUPPLEMENTED DIETS

	Diets	Feed intake g.	Slaughter wt g.	Dressed wt g.	Breast angle degree	Keel length cm.	Conversion* efficiency g.	Dressing** %
A	No legume	3272	1222	855	78	10.0	3.82	70.0
B	Green gram (UG)	3548	1373	1012	88	10.5	3.50	73.7
C	Green gram (G)	3768	1487	1182	86	10.8	3.24	79.5
D	Chickpea (UG)	3357	1287	910	80	9.8	3.68	70.7
E	Chickpea (G)	3510	1380	1022	86	10.0	3.43	74.1
	S.E. of mean.	±78 (6)	±15 (6)	±23 (30)	±1.4 (30)	±0.11 (30)		

*Conversion efficiency = $\frac{\text{Feed intake}}{\text{Dressed wt.}}$ **Dressing percentage = $\frac{\text{Dressed wt.}}{\text{Slaughtered}} \times 100$

Figures in the parenthesis indicate degrees of freedom.

TABLE 4. ORGANOLEPTIC EVALUATION OF THE BROILER MEAT (SIGNIFICANCE IN QUALITY BETWEEN PAIRS BY CHI SQUARE TEST)

Pairs based on diets	Texture		Flavour		Colour	
	LM	DM	LM	DM	LM	DM
(A, B)	B**	A**	B**	A**	A^{NS}	A^{NS}
(A, C)	C^{NS}	A**	C**	A**	C^{NS}	A**
(A, D)	D**	A**	D**	A**	D^{NS}	A^{NS}
(A, E)	E**	A^{NS}	A**	A**	A^{NS}	A**
(B, C)	B**	C**	B^{NS}	B^{NS}	C^{NS}	B**
(D, E)	E*	E^{NS}	D**	D*	D^{NS}	D^{NS}

*P 0.05; ++P 0.01; NS = Not significant; L.M. = Light meat; DM = Dark meat; A = control; B = Green gram (ungerminated); C = green gram (germinated); D = chick pea (ungerminated); E = chick pea (germinated)

breast angle and keel length (Table 3) and consequently were more robust in build compared to control.

Sensory evaluation of broiler meat (Table 4) showed that legume based diets yielded significantly better meat in terms of texture and flavour over the control diet. No difference was found in the meat quality of broilers fed on diets containing either ungerminated or germinated legumes.

Discussion

Several workers[2–6,11,13–15] have incorporated legumes as a primary protein source in poultry diets. Beans, peas and lentils when incorporated in diets to provide 67 per cent dietary proteins[6] failed to bring about good growth in broilers. This has been attributed to severely limiting methionine deficiency[6]. Methionine supplementation resulted in a marked improvement in growth in chicks fed on legume diets. Cuca[13] included Garbanzo at 76 per cent of chick diet and found significant imrpovement by addition of 0.15 per cent methionine. As the proteins in legumes are particularly deficient in methionine and cystine, gainful inclusion in poultry rations cannot be achieved without adequate supplementation of limiting amino acids. In the present study, the legumes were not used as a primary protein source. In the conventional poultry diet jowar contributed only about 3.5 per cent out of the total 22.5 per cent crude protein in the control diet, while in experimental diets the replacement of jowar by legumes contributed about 2 to 2.5 per cent of total crude protein. In this experimental set up there is no limiting amino acid problem encountered. The better performance of legume diets, particularly that of germinated green gram, may be attributed to better arginine and lysine content in diets. However, overall improvement of broiler growth in germinated green gram diets cannot be adequately explained within the limited scope of this experiment and detailed investigations are needed on biochemical qualities of germinated green gram. The higher feed consumption by chicks fed on legume diets may be due to better palatability. Greater body weight was a result of larger feed in take. Initial weights were equal.

The presence of antinutritional factors like trypsin inhibitors, amylase inhibitor, hemagglutinins and some other toxic principles in many legumes have been a limiting factor in their utilization in poultry feeds. Growth retardation in chicks has been reported on including kidney beans at 30 per cent level in diets[4] and the effect was reversed by autoclaving the kidney beans. In the case of *Clitoria termata*[13] the chicks fed with raw legume lost weight, and when this legume was autoclaved a significant increase in body weight was observed. Autoclaving of legumes was found to increase the nutritional value, probably due to destruction of antinutritional factors. In contrast, Mukerjee *et al*[16]. while incorporation of green gram and black gram in the ration of growing chicks, found no benefit from autoclaving these legumes. Growth was found to be better in untreated black gram.

Our other studies[17] have shown that green gram and chick pea did not contain any detectable amount of

hemagglutinins and amylase inhibitors. Only very low trypsin inhibitor content (15 TIU/mg protein in green gram and 21 TIU/mg protein in chick pea) was found which did not affect the growth of rats in our other experiments. Hence, these two legumes were used raw. No mortality or growth retardation was observed in any of the legume diets. These criteria have been used by several workers as an indication of the presence of toxic principles, in some legumes, when fed to chicks.

It is necessary to find out the optimal level of legume incorporation, to obtain maximum weight gain in chicks. Blair *et al*[18] found that the efficiency of weight gain was slightly less when beans were incorporated at a level of 45 per cent and concluded that for best results, diets should contain 25 to 30 per cent of beans, with supplementation to compensate the low methionine content.

In investigating a new source of dietary ingredient for meat type birds, it is important to assess its effect on eating quality as well as on performance. Mere gain in weight is not a determinent of quality like tenderness, flavour, etc. Grey *et al*[15] did not observe any unacceptable flavour and quality of broiler meat in broilers fed on diets containing raw and autoclaved field beans upto 60 per cent level. With respect to the legumes used in this study, the taste panel found the experimental meat to be not only acceptable but also better than the control both in terms of tenderness and flavour. More studies are needed to investigate the feasibility and profitability of legume incorporation in poultry diets, both in ungerminated and germinated forms.

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Influence of Tinplate Variables on the Internal Corrosion of Tinplate Containers with Mango and Orange Products

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Electrolytic tinplate with 1 lb tin-coating per base box and grain size structure equivalent or larger than ASTM No. 9. were found to be suitable for canning mango nectar, orange segments and orange concentrate. Tinplate with tin coating of 0.75 lb per base box and grain size structure equivalent to ASTM No. 10. were also found suitable for canning orange juice. Corrosion was found to be more in big size cans (A $2\frac{1}{2}$) as compared to small size ($5\frac{1}{2}$) cans with mango nectar. Hot dipped tinplates were found to be better than electrolytic tinplate for canning mango nectar and orange segments.

Resistance of tinplate to corrosion depends on many factors including the method of manufacture, composition of base plate, canning procedure and the type of product canned[1]. This has been attributed to many factors. Among different manufacturing variables, tinning method, thickness of tincoating and porosity, grain size structure of the tincoating, size of the can, plain and lacquered cans affect the process of corrosion.

Effect of varying phosphorus contents in the base plate of Indian hot dipped tinplate on corrosion with fruit and vegetable products has been studied by Mahadeviah *et al*[2]. Tinplates with phosphorus content of 0.02 and 0.025 per cent were found to be suitable for canning fruit and vegetable products and tinplate with 0.03 per cent phosphorus content was suitable for canning mildly corrosive products like vegetables. Effect of sulphur[3,4] and copper[5] present in base plate on corrosion has been reported by several workers. Suitability of electrolytic tinplates with varying thickness of tincoating have been studied by Davis[6], Hartwell[7] and Vaurio[8]. The corrosion resistance of tinplate depends partly on the tin-iron alloy layer[9,10]. Small grain size structure of tincoating was found to give more corrosion with some fruit and vegetable products[11,12].

At present practically there is no published literature regarding the influence of different tinplate variables on corrosion with Indian fruit products. Hence investigations were undertaken to study the influence of some of the tinplate variables with few commercially important fruit products such as mango and orange.

Materials and Methods

Raw material: 'Badami' ('Alphonso') variety of mango (*Mangifera indica* L.) and Coorg mandarin (*Citrus reticulata* Balnco) oranges obtained from the local market were used in these experiments.

Tinplate: Electrolytic tinplates with varying thickness of tincoating and hot dipped tinplates having 1.25 lb tin coating per base box manufactured indigenously at Rourkela steel plant by M/s. Hindustan Steel Ltd., were used in these experiments. Cans fabricated from imported electrolytic tinplate (E 100) were also used.

Mango nectar: Mangoes were thoroughly washed, hand peeled and passed through the pulper fitted with 24 mesh sieve. Nectar was prepared so as to contain 20 per cent pulp, 15°Brix and 0.3 per cent acidity (as anhydrous citric acid). After raising the temperature of the nectar to 85°C, it was filled into cans. The cans [A $2\frac{1}{2}$ size (401×411] were sealed and processed for 30 min in boiling water and cooled.

Orange juice: Oranges were washed, peeled, segments separated and juice was extracted using screw type juice extractor. The extracted juice was passed through a finisher having a 24 mesh sieve. Brix of the juice adjusted to 15° using cane sugar and the original acidity (0.5 per cent) was maintained. The juice was heated to 85°C filled into cans (A $2\frac{1}{2}$ size) and processed for 25 min in boiling water (98°C) and cooled.

Orange juice concentrate: The juice was extracted in a citrus juice extractor designed and fabricated in this Institute. The working principle is almost similar to that of Taglith juice extractor. The juice so extracted was practically free from bitterness.

The juice was pasteurised by heating to 85°C, cooled and concentrated to 60°Brix in an APV plate evaporator. The concentrate was heated to 85°C, filled hot into cans (1 lb jam size) sealed and processed in boiling water for 25 min and cooled.

Orange segments: Orange segments were canned by the method described by Girdhari Lal, *et al*[13].

Model systems: To study the corrosion behaviour in the model systems tinplate was cut into strips of 8×2 cm.

Tinplate strips were put into the test tubes covered with the respective juices, heated to 85°C and the tubes were heat sealed immediately. Sealed tubes were processed in boiling water (98°C) for 25 min and then cooled in running cold water. After cooling, these tubes were stored at 37°C for periodical observation and to determine the corrosion rate.

Porosity: Porosity of the tinplate was determined by the thiocyanate method[14].

Grain size structure of tin coating: It was observed by immersing the tin strip for about 3 min in a solution containing 1000 g ferric chloride and 0.5 to 1g of sodium sulphide in one litre of water and compared with ASTM numbers[15]. (ASTM have standards for grain size from No. 7 to 12). As the number increases the grain size decreases and the corrosion resistance also decreases.

Thickness of tin coating: (*a*) Total thickness of tincoating was determined gravimetrically by Clark's test[16]. (*b*) Coulometric method[16] was adopted to determine the thickness of free tin layer and the tin iron alloy layer.

Corrosivity of tinplate: The alloy tin couple test (ATC) developed by Kamm *et al.*[17] was used to find the corrosion behaviour of different types of tinplates.

Measurement of corrosion: Corrosion rate was measured by determining the tin and iron content in the canned product and the percentage loss in weight of the tinstrips used in the model systems.

Tin and iron content: Tin content was determined using the volumetric method as described by Mckenzie[18] and iron by Wong's[19] method from the composite sample of six cans.

Hydroxymethyl furfural: This was determined colorimetrically by the modified method of Luh *et al*[20].

Effect of thickness of tincoating: Electrolytic tinplates with tincoating of 0.25 (E-25), 0.50 (E-50), 0.75 (E-75) and 1.0 lb (E-100) per base box were initially analysed for thickness of free tin and alloy layer, porosity, alloy tin couple (ATC) value. These tinplate strips were separately packed in test-tubes along with mango nectar and orange juice (separately) and stored at 37°C.

Influence of grain size structure: Two types of electrolytic tinplates with different grain structure of tincoating were packed in test tubes along with mango nectar and orange juice separately and stored at 37°C.

Effect of size of the can: Mango nectar was canned in A 2½ (401×411) and 5½ oz (202×308) cans fabricated from the same lot of electrolytic tinplate (E-100) and stored at R.T. (25-30°C) and 37°C.

Effect of hot dipped and electrolytic tinplate: Mango nectar was canned in two types of A 2½ cans fabricated from imported electrolytic tinplate (E-100) and Indian hot dipped tinplate (1.25 lb/b.b.) stored at 37°C for 12 months.

Orange segments were canned in sugar syrup using three different types of (A 2½) cans. (1) Plain imported electrolytic (E-100). (2) Plain body-lacquered ends imported electrolytic (E-100). (3) Plain Indian hot dipped (1.25 lb/b.b.). Canned products were stored at room temperature (25-30°C) and at 37°C for 12 months.

Orange juice concentrate was canned separately in 1 lb jam size (301×309) cans fabricated from (1) plain imported electrolytic (E-100); (2) plain hot dipped (1.25 lb/b.b.); and (3) lacquered (citrus-k-type lacquer) imported electrolytic (E-100) tinplates. Canned product was stored at 1.1°C, R.T. (25-30°C) and 37°C for 12 months.

Results and Discussion

Effect of thickness of tincoating: As indicated in Table 1, thickness of free tin layer and alloy layer increased whereas porosity value decreased with an increase in the thickness of tincoating. In general alloy tin couple values decreased with increase in the thickness of tincoating which may be attributed to the characteristic of the alloy layer formed with different thickness of tincoating.

(*a*) *Mango nectar:* In E-25 and E-50 tinplates corrosion was rapid even in the initial stages as compared to E-75 and E-100 tinplates. With E-75 and E-100 tinplates, upto 6 months corrosion rate was low and thereafter it increased (Fig. 1).

TABLE 1. PHYSICAL CHARACTERISTICS OF TINPLATES WITH VARYING THICKNESS OF TINCOATING

Tinplate type	Coating (lb/b.b) Total*	Free**	Alloy**	A.T.C. (μA/sq. cm.)	Porosity (mg. iron/ sq. dec.)
E–100	0.99	0.82	0.08	0.11	0.087
E–75	0.80	0.74	0.04	0.26	0.189
E–50	0.53	0.45	0.05	0.13	0.520
E–25	0.27	0.23	0.05	0.30	1.704

*By Clark's method
**By Coulometric method
b.b.: Base Box.

E–100, E–75, E–50 and E–25 are electrolytic tin coating of 1, 0.75, 0.50 and 0.25 lb/b.b. respectively.

Regarding the appearance of the tinplate strips, after 6 months of storage, heavy feathering with heavy detinning and medium detinning was noticed in E-25 and E-50 tinplates respectively. In E-75 and E-100 only medium feathering with slight detinning was observed. Complete detinning was noticed after 8, 10 and 12 months in E-25, E-50 and E-75 tinplates respectively. In the case of E-100, heavy feathering with heavy detinning was noticed after 12 months.

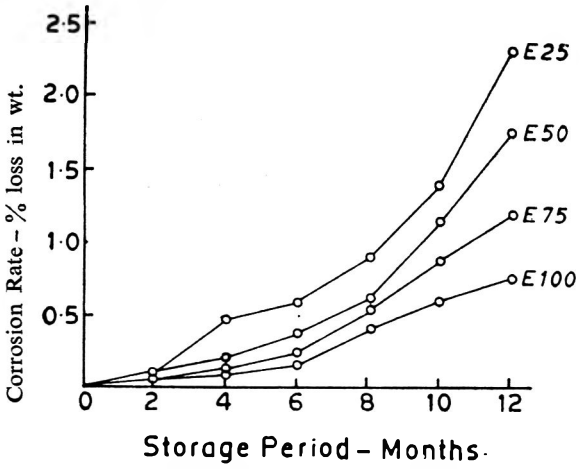

Fig. 1. Effect of thickness of tincoating and porosity on corrosion with mango nectar in the model systems.

E 25, E 50, E 75 and E 100 represent tincoating of 0.25, 0.5, 0.75 and 1.0 lb/base box respectively.

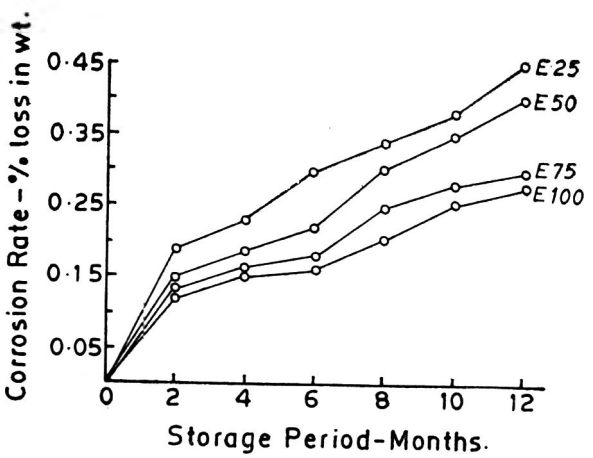

Fig. 2. Effect of thickness of tincoating and porosity with orange juice in the model systems.

E 25, E 50, E 75 and E 100 represent tincoating of 0.25, 0.5, 0.75 and 1.0 lb/base box respectively.

(*b*) *Orange juice:* As shown in Fig. 2 the corrosion rate during storage was considerably high with E-25 and E-50 tinplates as compared to E-75 and E-100 tinplates. Upto 6 months of storage corrosion was slow with E-100, E-75 and E-50 tinplates, but therefater a gradual increase was noted which was more with E-50 as compared to E-75 and E-100 tinplates. In the case of E-25 tinplate, corrosion rate was rapid even from the initial stages. Between E-75 and E-100, there was no appreciable difference in the rate of corrosion and extent of feathering and detinning.

These results indicate that the corrosion rate increases with a decrease in the thickness of tincoating. E-25 and E-50 tinplates are not suitable for canning mango nectar and orange juice. E-75 tinplate can be used with risk for mango nectar, but it can be used safely for orange juice. E-100 tinplate can be safely used for both mango nectar and orange juice. Similar results have been observed by Davis[6], Hartwell[7] and Vaurio[8] with some products such as peach, pear, tomato, grape fruit juice, dried prunes, cherries, green beans, green peas, etc.

Influence of grain size structure: Preliminary analysis of the tinplate indicated that porosity and ATC value (Table 2) were slightly more for small grain size plate as compared to large grain size plate. Grain size structure of the first plate was small and was equivalent to ASTM No. 10 while that of second tinplate was equivalent to ASTM No. 9, which is the prescribed minimum grain size for tinplate.

(*a*) *Mango nectar:* The corrosion rate of both the tinplate strips was almost same upto 6 months of storage (Fig. 3). Thereafter, the corrosion rate increased in both the cases but the percentage loss in weight was found to be more in No. 1 as compared to No. 2. After 12 months, heavy feathering and heavy detinning were noticed in No. 2 and complete detinning in No. 1.

(*b*) *Orange juice:* Corrosion rate was slightly higher with small grain structure and increased from 0.17 to 0.3 per cent as compared to the big grain structure which increased from 0.12 to 0.27 per cent (Fig. 4). Extent of detinning was also slightly more in tinplate with small grain size structure but it was not appreciable. Big grain structure tinplate showed better performance than the

TABLE 2. PHYSICAL CHARACTERISTICS OF TINPLATES WITH DIFFERENT GRAIN STRUCTURE

Tinplate type	Coating wt. (lb./b.b) Free in layer	Coating wt. (lb./b.b) Alloy layer	Porosity (mg. iron/ sq. dec.)	A.T.C. (μA/ sq. cm.)	Grain size structure
Small grain*	0.808	0.075	0.606	0.22	Equal to ASTM No. 10
Big grain**	0.851	0.105	0.228	0.15	Equal to ASTM No. 9

*Tinplate with small grain structure

**Tinplate with big grain structure.

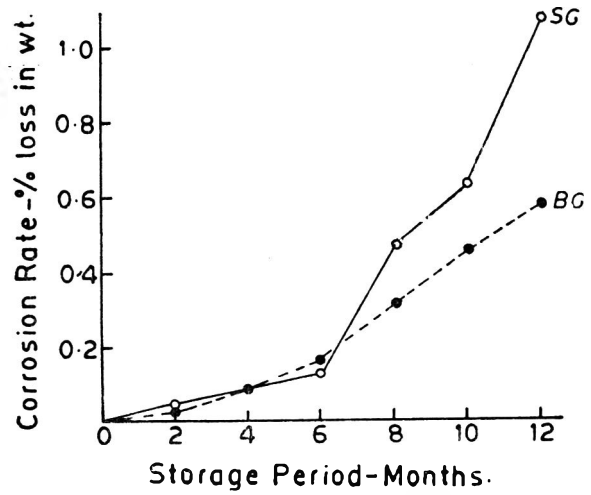

Fig. 3. Effect of grain structure of tincoating on corrosion with mango nectar in model systems.

SG and BG represent tin plate with small grain and big grain size respectively.

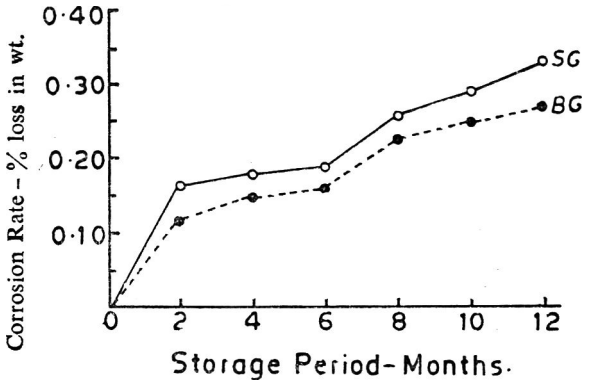

Fig. 4. Effect of grain structure of tincoating with orange juice in the model systems.

BG—Tinplate with big grain structure of tincoating.
SG—Tinplate with small grain structure of tincoating.

tinplate with small grain structure. This has been noticed with potato by Mahadeviah *et al*[12]. First observation on the effect of grain structure was that a high percentage of early failures in some canned fruit products was associated with a particularly small grain size of the tincoating[11]. Heavy detinning in the case of tinplate with small grain size structure may be attributed to the presence of more grain boundaries which will have different potential than the other points. This may lead to the formation of more electrochemical couples which may cause the acceleration of corrosion process. From the results obtained it may be inferred that tinplate with grain structure smaller than ASTM No. 9, is not suitable for canning mango nectar, but for canning orange juice, tinplate with grain structure upto ASTM No. 10 may be used.

Effect of size of the can: The internal surface area of A 2½ can is 2½ times more than that of 5½ oz can, but capacity of the former is nearly 5 times that of latter (Table 3).

It can be seen from Table 4, that the organoleptic quality of mango nectar was satisfactory in both sizes of cans even after 12 months of storage at room temperature but the tin content was 148 ppm less in 5½ oz. cans as compared to A 2½ cans and only light feathering without detinning was noticed. In A 2½ cans the can interior was showing heavy feathering with detinned patches. Vacuum loss was not appreciable in both the cans.

At 37°C after 9 months storage the tin content was more in A 2½ cans (340 ppm) and very heavy feathering with heavy detinning was noticed in the can interior. In 5½ oz. cans tin content was only 138 ppm and medium feathering with slight detinning was noticed in the can interior.

After 12 months storage, complete detinning was observed in A 2½ cans and heavy feathering with slight detinning in 5½ oz cans. Tin content of the product was almost double in A 2½ cans as compared to 5½ oz. cans. Vacuum loss during storage was found to be more in the latter.

According to Hirst and Adam[21], smaller cans have a larger corroding area of metal in proportion to their volume and this might have been the cause for less corrosion in small size cans.

Effect of hot dipped and electrolytic tinplate

(*a*) *Mango nectar:* As shown in Table 5, tin content, extent of feathering and detinning were more in electrolytic cans than in hot dipped cans throughout the storage period. At the end of 12 months storage at 37°C complete detinning was noticed in electrolytic cans, whereas in hot dipped cans, heavy feathering with only medium detinning was noticed. Tin content was 196 ppm more in electrolytic cans than in hot dipped cans.

TABLE 3. DETAILS OF DIFFERENT SIZES OF CANS USED IN THE STUDY

Type of can	Trade size Dia. ht.	Size (mm) Dia. ht.	Internal surface area (sq. in)	Capacity	Tin content* ppm
A 2½	401×411	102×114	77.8	847	590
5½ oz	202×308	55× 89	30.5	171	1148

Dia—Diameter ht—Height
*Tin content in a product—if completely detinned

(*b*) *Orange segments:* The extent of corrosion was considerably less at room temperature in both hot dipped and electrolytic tinplates and the tin content was within the permissible limit of 250 ppm[22] after 12 months storage. Tin content, feathering and detinning were less in hot dipped tinplate as compared to electrolytic tinplate. Quality of the product was also better in hot dipped cans (Table 5).

After 6 months at 37°C, tin content was more than 250 ppm in electrolytic cans having lacquered ends and the product gave slight metallic taste. In hot dipped tinplate, the quality of the product was satisfactory and the tin content was within the permissible limit[22]. Tin content was more than 250 ppm after 9 months storage in both hot dipped and electrolytic tinplates.

After 12 months storage, complete detinning was

TABLE 4. EFFECT OF DIFFERENT SIZE OF THE CAN ON CORROSION WITH MANGO NECTAR

Storage period (months)	Storage temperature	Type of can	Vacuum in.	Tin (ppm)	Product quality	Can interior
Initial		1	15	35	Satisfactory	LF
		2	10	20	-do-	VLF
3	R.T.	1	14	52	-do-	LF
		2	8	25	-do-	VLF
	37°C	1	13	123	-do-	MF, SD
		2	8	38	-do-	VLF
6	R.T.	1	12	80	-do-	MF
		2	7	55	-do-	LF
	37°C	1	10	183	-do-	HF, SD
		2	6	75	-do-	MF
9	R.T.	1	11	107	-do-	MF, SD
		2	7	63	-do-	LF
	37°C	1	8	340	SMT	VHF, HD
		2	5	138	Satisfactory	MF, SD
12	R.T.	1	10	243	SMT	HF, MD
		2	6	95	SMT	LF
	37°C	1	+Pressure	460	MT	CD
		2	2	238	Satisfactory	HF, SD

SMT — Slight metallic taste
MT — Metallic taste
1. — A 2½ size can } Electrolytic
2. — 5½ oz. can } (E-100)

VLF — Very light feathering
LF — Light feathering
MF — Medium feathering

MD — Medium detinning
HD — Heavy detinning
CD — Complete detinning

TABLE 5. INFLUENCE OF ELECTROLYTIC AND HOT DIPPED TINPLATES ON CORROSION WITH MANGO NECTAR AND ORANGE SEGMENTS

Storage period at 37°C (months)	Type of tinplate	Mango nectar			Orange segments		
		Tin (ppm)	Quality of the product	Can interior	Tin (ppm)	Quality of the product	Can interior
Initial	E	40	Satisfactory	LF	38	Satisfactory	LF
	H	25	,,	VLF	29	,,	LF
3	E	112	,,	MF, SD	120	,,	MF
	H	92	,,	MF	95	,,	MF
6	E	168	,,	HF, MD	232	Slight metallic taste	MF, MD
	H	130	,,	MF	168	Satisfactory	MF, SD
9	E	382	Metallic taste	VHF, HD	369	Metallic	VHF, HD
	H	190	Satisfactory	HF	265	Slight metallic taste	HF, SD
12	E	483	Metallic taste	CD	460	Metallic taste	CD
	H	287	Slight metallic taste	VHF, MD	368	,,	HF, HD

E — Electrolytic tinplate (1 lb/b.b.)
H — Hot dipped (1.25 lb/b.b.)

LF — Light feathering
MF — Medium feathering
HF — Heavy feathering
VHF — Very heavy feathering

SD — Slight detinning
MD — Medium detinning
HD — Heavy detinning
CD — Complete detinning

TABLE 6. CORROSION OF TINPLATE IN CANNED ORANGE CONCENTRATE (CUT-OUT ANALYSIS DURING STORAGE)

Storage period (months)	Storage temp.	Type of tinplate	Vacuum (inch. Hg)	Quality of the product Colour	Taste	Flavour	HMF (mg/100g)	Tin (ppm)	Can interior
Initial		1	10	OY	Slightly acidic and bitter after taste	Mild orange flavour	5.2	35	VLF
		2	12	OY	,,	,,	4.5	22	VLF
		3	12	OY	,,	,,	3.7	—	No scratches or peeling of lacquer
3	1.1°C	1	10	OY	,,	,,	5.8	35	VLF
		2	11	OY	,,	,,	5.0	23	VLF
		3	10	OY	,,	,,	4.3	—	Normal
	R.T.	1	8	LBY	,,	,,	6.0	53	VLF
	(25–30°C)	2	10	LBY	,,	,,	5.5	38	VLF
		3	10	LBY	,,	,,	4.8	—	Normal
	37°C	1	MS	BY	,,	,,	19.5	192	MF, SD
		2	MS	BY	,,	,,	21.0	150	MF, SD
		3	MS	BY	,,	,,	25.0	—	Few black scratches
6	1.1°C	1	9	OY	,,	,,	8.9	78	VLF
		2"	10	OY	,,	,,	10.3	57	VLF
		3	8	OY	,,	,,	12.5	—	Normal
	R.T.	1	5	LBY	,,	,,	12.4	150	MF
		2	6	LBY	,,	,,	15.0	123	MF
		3	5	BY	,,	,,	10.3	—	Normal
	R.T.	1	HS	DB	caramelized	caramelized	44.1	360	CD
		2	HS	DB	,,	,,	44.3	242	HF, SD
		3	HS	DDB	,,	,,	33.9	—	Few black scratches
9	1.1°C	1	6	OY	slightly acidic	Mild orange flavour	9.5	155	MF, MD
		2	7	OY	,,	,,	14.0	100	MF, MD
		3	4	LBY	,,	,,	16.0	—	Normal
	R.T.	1	MS	BY	,,	,,	38.0	180	MF, MD
		2	MS	BY	,,	,,	42.0	155	MF
		3	MS	BY	,,	,,	29.5	—	Few black streaks
	37°C	1	VHS	DB	caramelized	Caramelized	89.5	561	CD
		2	VHS	DB	,,	,,	88.5	363	CD
		3	HS	DDB	,,	,,	83.0	—	Few black streaks
12	1.1°C	1	5	OY	slightly acidic	Mild orange flavour	15.0	168	MF
		2	6	OY	,,	,,	15.5	132	MF
		3	3	LBY	,,	,,	19.5	—	Normal
	R.T.	1	MS	B	caramelized	caramelized	110.0	218	HF, SD
		2	MS	B	,,	,,	100.0	185	HF, SD
		3	MS	DB	,,	,,	95.0	—	Few light black scratches
	37°C	1	VHS	DB	,,	,,	335.0	580	CD
		2	VHS	DB	,,	,,	449.5	620	CD
		3	HS	DB	,,	,,	355.0	—	Black spots and streaks

OY — Orange yellow
DB — Dark brown
BY — Brownish yellow
LBY — Light brownish yellow
DDB — Deep dark brown
MS — Mild swell
HS — Hard swell
VHS — Very hard swell
1—Plain electrolytic (E 100)
2w.—Plain Indian hot dipped (125 lb/b.b.)
3—Citrus lacquered (Expoy-phenolic) electrolytic (E 100)

noticed in both the electrolytic tinplates (1 and 2) and the cans were showing hard swell. In hot dipped tinplate extent of detinning was less as compared to electrolytic tinplates. Use of lacquered ends did not help in reducing corrosion.

(*c*) *Orange juice concentrate:* Upto 12 months of storage at 1.1°C and R.T., tin content was within the permissible limit[22] and the feathering of the can interior was also less (Table 6). At 1.1°C, the quality of the product was satisfactory even after 12 months whereas at R.T. colour of the product was slightly affected. The quality of the product started deteriorating after 6 months of storage. The product had caramelized and complete detinning was noticed in plain electrolytic cans and heavy feathering with slight detinning in hot dipped cans. Few black streaks have been noticed in lacquered cans. At the end of 12 months storage, complete detinning was noticed with both plain electrolytic and plain hot dipped cans. Black spot and streaks were observed in lacquered cans. In lacquered cans at 37°C the colour of the product was more brownish and had lacquer taste and flavour. The quality of the product was also affected at room temperature but at 1.1°C it was satisfactory.

Hydroxymethyl furfural (HMF) content was determined periodically during storage (Table 6). Formation of HMF was slow at 1.1°C and R.T. but at 37°C it was rapid. Heavy corrosion at 37°C may be attributed to the HMF content which has been reported[23] to act as corrosion accelerator. Corrosion was less in hot dipped cans as compared to electrolytic cans with this product also.

These results confirm the observation by Hartwell[24] that even the heaviest coating of 1 lb per base box in electrolytic tinplates does not have as good corrosion resistance as hot dipped tinplate of similar weight of tincoating. Hot dipped tinplate is considered as more versatile whereas electrolytic tinplate is considered as more sophisticated[1]. The thickness of tin iron alloy layer in hot dipped tinplate was found to be more than in electrolytic tinplate[23] and the corrosion resistance of tinplate depends on this alloy layer[9,10].

The entire quality of tinplate used for canning fruit and vegetable products in India is imported from other countries. As these plates are supplied from different sources, there is possibility of variation in thickness of tincoating, grain size structure of tincoating, etc. The results of investigation on these variables are useful in selecting the suitable tinplate for canning mango and orange products which are two commercially important products.

Results obtained on the influence of different sizes of cans, hot dipped and electrolytic tinplates are very useful in selecting a suitable size and type of tinplate to minimise the extent of corrosion thereby extending the shelf life of the product.

Acknowledgement

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Complexes of Phenolics with Amino Acids

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The visible absorption spectra of complexes of amino acids with tannic and gallic acids were obtained. The intensity of colourati on of amino acid-phenol complexes measured at 590 mμ declined when the pH was lowered from 7.5 to 6.5. The colour reaction between a p-quinone (menadione) and glycine was studied to ascertain its possible application to the assay of vitamin K activity.

Phenolic compounds have been reported to undergo chemical reactions in presence of amino acids, peptides or proteins leading to colour formation or discolouration[1]. Quinonoids derived from phenols by oxidation with phenolases from several sources give coloured products with amino acids and peptides[2–6]. Such interactions are likely to be the cause of discolouration reactions in food processing. An attempt has been made in the present work to study the interaction of phenolic compounds with amino acids.

Materials and Methods

Materials used were menadione and amino acids from E. Merck, AG Darmstadt and gallic and tannic acids from Sigma Chemicals, U.S.A. Other laboratory chemicals were of AR grade.

Change in visible absorption of amino acid—phenol complexes with pH variation: To 25 ml of 10^{-3} M amino acid solution was added 25 ml of 10^{-4} M solution of phenolic compounds and the pH adjusted to 6.5, 7.0 and 7.5 with dilute alkali solution. The visible absorption of the reaction mixture was measured using amino acid solution as blank in a DK-2 Beckmann spectrophotometer. Amino acids used were lysine, glycine cysteine, glutamic acid, arginine and tyrosine.

Amino acid—quinone colour reaction: To 50 ml of aqueous solution containing 5 mg of 2-methyl—1,4—naphthoquinone (menadione) in a concial flask was added 25 ml aqueous glycine solution at different concentrations (0-10 per cent) and the mixture kept in boiling water-bath for 10 min just sufficient to get a clear solution. The mixture was cooled and filtered through a filter paper. The intensity of the reddish colour of the filtrate was measured at 540 mμ using Klett-Summerson photoelectric colorimeter.

The estimation of menadione in the residue after dissolving in ethyl alcohol was carried out by the colorimetric method of Irreverre-Sullivan[7].

Results and Discussion

The changes in visible absorption of certain amino acids with tannic and gallic acid are presented in Fig. 1 and 2. The effect of variation of pH on amino acid—tannic acid reaction is represented in Fig. 1. When cysteine, lysine, glutamic acid, glycine, arginine and tyrosine were tried, tannic acid exhibited more or less the same behaviour with all these amino acids. Lowering the pH from 7.5 to 7.0 and then to 6.5 reduced the absorption of glycine—tannic acid and lysine-tannic acid complexes at 590 mμ to a considerable extent. Similar observations were also obtained when gallic acid was used in place of tannic acid as shown in Fig. 2. It is evident that the complex forming behaviour of amino acids with phenolics is pH dependent.

In addition to hydrogen-bonding, phenolics in presence of amino acids, peptides or proteins have been reported to undergo chemical reaction leading to colour formation or discolouration[1]. This colour reaction is reportedly rapid at pH 6.5—8[2]. In the present work, it is observed that lowering of intensity of discolouration for phenol-amino acids reaction at 590 mμ was effected as the pH was brought down from 7.5 to 6.5. On the basis of the overall information available on the intensely coloured products of amino compound reactions with quinones, a modified reaction sequence from Trautner and Roberts[6], has been postulated by Singleton[8].

The interaction between enzyme-generated quinones and N-terminal primary amino groups and secondary amino acids encountered in proteins has been studied by Mason and Peterson[9]. It was also observed by Mason[10] that reaction between o—quinones and pentides or proteins resulted in N-or S-catechol derivatives. In the presence of excess of o—quinones, catecholic amino acid derivatives are oxidised to the corresponding quinonoid compounds.

Browning and blackening, the most significant types of phenolic discolourations involve the production of

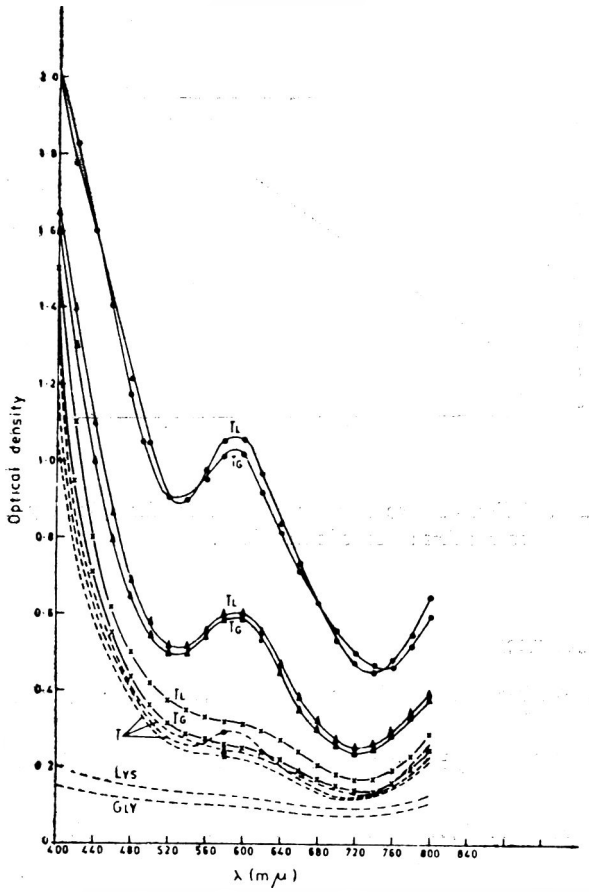

Fig. 1. Change in visible absorption of amino acid—tannic acid complexes with pH variation.

TL = Lysine—Tannic acid — ● — pH 7.5; — △ — pH 7.0
TG = Glycine—Tannic acid — × — pH 6·5
T = Tannic acid — ● — pH 7.5; — △ — pH 7.0; — × — pH 6.5
LYS = Lysine, GLY = Glycine — pH 7.0

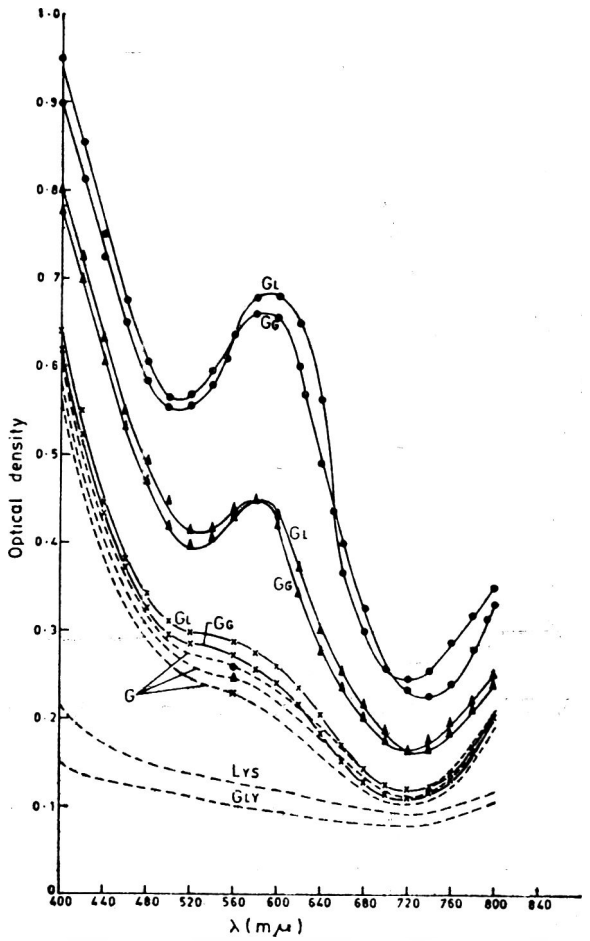

Fig. 2. Change in visible absorption of amino acid—gallic acid complexes with pH variation.

GG = Glycine + Gallic acid — ● — pH 7.5; — △ — pH 7.0
GL = Lysine + Gallic acid — × — pH 6.5
G = Gallic acid — ● — pH 7.5; — △ — pH 7.0; — × — pH 6.5
LYS = Lysine, GLY = Glycine — pH 7.0

many overlapping chromophores to produce the required absorbance through much or all of the visible region. On the contrary, phenolic brown polymers do not appear to involve extended conjugated double bond systems to achieve this effect. Rather the browning system involves chromophores of many different types[8].

Glycine undergoes substitution with o—diphenols during oxidation process as postulated by Trautner and Roberts[6]. It was of interest to know whether p—diphenol could also participate in browning. It was therefore decided to study the interaction between 2-methyl—1, 4-naphthoquinone (menadione) and glycine. In this reaction, a water soluble red pigment was formed. Fig. 3 represents the contribution of glycine in the colour reaction with menadione. The intensity of the red-brown colour formed has a linear relationship with the glycine concentration upto 0.44 M. It was also observed that the solubility of menadione increases upto a maximum of 0.003 M at the glycine concentration of 0.08 M and then remains constant. However, such a high excess of glycine that is apparently required for this reaction with menadione may, in reality, only be utilized for the solubilization of the latter. In case this is correct, the excessively high ratio observed of glycine to quinone in this case of the order of 440:3 does not in reality reflect the chemical stoichiometry.

This reaction between menadione and glycine was studied in detail with a view to find out whether this can

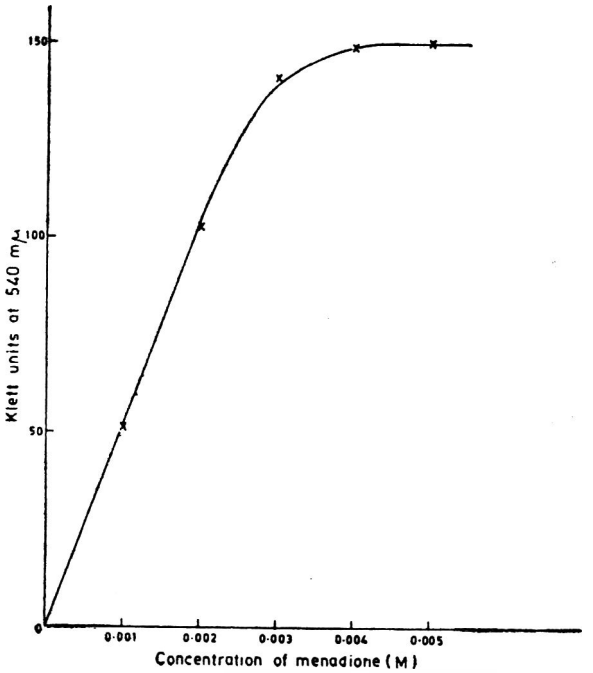

Fig. 3. Effect of menadione concentration on the colour formation with glycine.

be used as a practical method for solubilizing menadione in aqueous media which is a problem faced by pharmaceutical manufacturers. However, in view of the need for 33 times the molar concentration of glycine, the feasibility is questionable.

It was also attempted to ascertain the possible application of this reaction for the assay of vitamin K activity. It was observed that the colour formation of menadione was linear with the glycine concentration of 0.05 to 0.5 M (Fig. 4) and at the fixed concentration of glycine at 0.222 M, the colour formation was proportional to menadione concentration up to 0.002 M (Fig. 4).

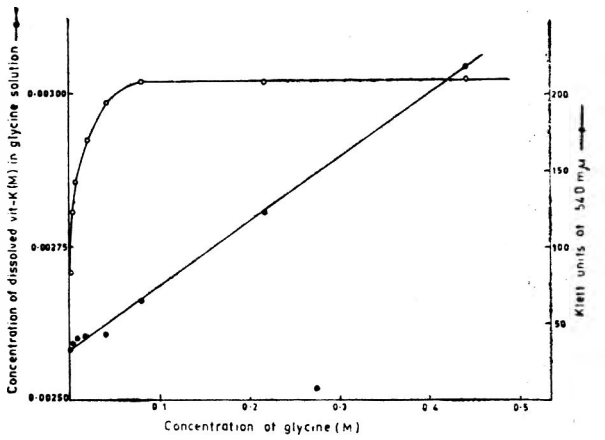

Fig. 4. Effect of glycine concentration on the solubility and colour formation of menadione.

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Development of High Protein Bread. Part II. Mixability of Soya Flour with Different Wheat Varieties

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Ten per cent soya fortified bread of excellent dough characteristics could be prepared from the Indian wheat varieties i.e. 'Shera', 'Hira', 'Kalyan Sona' and 'Moti', by using the short straight dough method with 100 min fermentation time. Excellent loaf volume, crumb, grain, texture could be obtained with the use of 1.0% sodium stearoyl-2-lactylate dough conditioner.

A number of new varieties of wheat have been introduced in recent years for large scale cultivation in the country. The criteria for selection of varieties for large scale cultivation are mainly high yield potential, disease resistance and consumer acceptability of the grain. Most of the varieties fall under the soft-to-semihard class with only medium protein content. Fortification of these wheat with soya will enhance its nutritive value. However, problems encountered in developing fortified bread with different high yielding varieties of wheat are not worked out. Earlier the authors described optimum conditions necessary for preparation of soya fortified bread with one of the high yielding varieties namely 'Sharbati Sonara'[1]. Investigations were carried out at present to study the mixability of soya flour in different proportions with flour of different high yielding wheat varieties to produce soya fortified bread and the results obtained are reported in this communication.

Materials and Methods

The high yielding varieties of wheat viz. 'Shera', 'Hira', 'Kalyan Sona' and 'Moti', were obtained from the All India Wheat Coordination Programme, IARI, New Delhi. These varieties are highly suitable for the production of paned bread. The straight grade flour used in this study was obtained by milling the wheat varieties in a Brabender quadrumate junior experimental mill. Defatted, solvent extracted soya flour (100 mesh) was obtained from M/s. Prag Oil Mills, Aligarh. Sodium stearoyl-2-lactylate (Emplex) was obtained from M/s. C. J. Peterson & Co., USA. Tower brand yeast manufactured by M/s. Indian Yeast Co., Calcutta was used in these studies.

For physical dough characteristic studies, Brabender farinograph employing 50 g of flour at 14 per cent moisture basis was used. When the SSL was used, the powdered material was blended with the flour in the farinograph mixing bowl by running the machine for one minute before adding water.

For baking test straight dough method with 100 min fermentation time as described in the earlier paper was used[1].

Results and Discussion

Physical dough characteristics: The results of farinograph characteristics of pure wheat varieties, blends with 5, 10 and 15 per cent soya flour with and without SSL are given in Table 1. Stability and mechanical tolerance index which are criteria to classify the wheat varieties from weak to hard showed variation of 6.0—9.5 min and 60-80 B.U. and these confirm that the 'Shera', 'Hira', 'Kalyan Sona' and 'Moti' have the desired dough characteristics for the production of bread. Mixing of 5, 10 and 15 per cent soya flour with straight grade flour showed an increase in water absorption ranging 2.4-3.0; 4.8-6.8 and 8.0-8.8 per cent respectively. The stability was decreased 0.5 min in 'Shera', 0.75 min in 'Hira', 1.0 min in 'Kalyan Sona' and 0.75 min in 'Moti' with the addition of 5 per cent defatted soya flour. With the addition of 10 per cent soya flour the stability was decreased about 2.0 min in 'Shera', 1.5 min in 'Hira', 1.5 min in 'Kalyan Sona' and 2.0 min in 'Moti'. Stability was decreased about 3.0 min in 'Shera', 4.0 min in 'Hira', 2.5 min in 'Kalyan Sona' and 3.25 min in 'Moti' with the addition of 15 per cent soya flour. The mechanical tolerance index (MTI) was increased 5, 10, 20 and 10 B.U. at 5 per cent soya flour, and 15, 25, 20 and 25 B.U. at 10 per cent soya flour and 30, 35, 40 and 40 B.U. at 15 per cent soya flour in 'Shera', 'Hira', 'Kalyan Sona' and 'Moti' respectively.

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TABLE 1. EFFECT OF ADDITION OF DEFATTED SOYA FLOUR AND SSL ON THE FARINOGRAPH CHARACTERISTICS OF WHEAT FLOUR/ WHEAT SOYA FORTIFIED FLOUR*

Wheat variety	Soya flour %	SSL %	Water absorption %	Stability time min.	MTI in B.U.
Shera	—	—	62.0	9.5	50
	5	—	64.8	9.0	55
	5	0.5	64.8	11.5	30
	5	1.0	64.8	15.5	10
	10	—	68.0	7.5	65
	10	0.5	68.0	10.5	45
	10	1.0	68.0	13.5	20
	15	—	70.0	5.5	80
	15	0.5	70.0	8.5	50
	15	1.0	70.0	11.0	30
Hira	—	—	60.8	8.25	80
	5	—	63.8	7.5	90
	5	0.5	63.8	10.5	65
	5	1.0	63.8	13.5	30
	10	—	65.4	6.0	105
	10	0.5	65.4	8.5	75
	10	1.0	65.4	12.25	50
	15	—	69.6	4.75	115
	15	0.5	69.6	8.0	85
	15	1.0	69.6	11.25	50
Kalyan Sona	—	—	61.4	6.0	50
	5	—	64.0	5.0	70
	5	0.5	64.0	8.25	50
	5	1.0	64.0	11.5	25
	10	—	66.6	4.5	80
	10	0.5	66.6	7.75	50
	10	1.0	66.6	10.5	30
	15	—	69.6	4.5	90
	15	0.5	69.6	6.0	65
	15	1.0	69.6	9.25	40
Moti	—	—	60.8	8.25	50
	5	—	63.0	7.50	60
	5	0.5	63.0	10.25	45
	5	1.0	63.0	12.75	25
	10	—	66.6	6.25	75
	10	0.5	66.6	9.50	50
	10	1.0	66.6	12.25	30
	15	—	69.8	5.00	90
	15	0.5	69.8	8.25	65
	15	1.0	69.8	10.50	45

*Results are expressed on 14% moisture basis

TABLE 2. EFFECT OF ADDITION OF DEFATTED SOYA FLOUR AND SSL ON THE BREAD LOAF AND BREAD SCORE

Wheat variety	SSL %	100% wheat flour ml	5% soya flour ml	10% soya flour ml	15% soya flour ml
Shera	—	484.8	441.5	404.5	356.0
	0.5	—	486.6	433.5	386.6
	1.0	—	514.0	478.0	410.0
Hira	—	5.50	470.0	442.6	384.0
	0.5	—	504.7	474.5	405.7
	1.0	—	524.5	506.8	435.0
Kalyan Sona	—	480.7	455.5	415.0	380.0
	0.5	—	482.4	462.5	412.5
	1.0	—	514.5	485.0	432.5
Moti	—	522.5	484.5	434.5	384.5
	0.5	—	505.4	463.5	416.0
	1.0	—	534.8	484.5	432.0
Bread score out of 60					
Shera	—	35.2	30.7	26.5	20.3
	0.5	—	32.8	28.5	21.8
	1.0	—	35.0	30.8	24.6
Hira	—	35.5	30.3	28.0	22.2
	0.5	—	32.8	30.2	24.4
	1.0	—	35.0	32.5	27.0
Kalyan Sona	—	35.0	29.8	26.0	20.0
	0.5	—	31.8	28.5	21.6
	1.0	—	35.0	30.8	24.9
Moti	—	36.5	31.3	28.5	21.5
	0.5	—	32.8	29.8	24.8
	1.0	—	34.5	31.0	25.8

This increase in water absorption and MTI and decrease in stability time with the addition of soya flour depends upon the physical dough characteristics of wheat flour and type of processed soya flour. Although the farinographic characteristics of studied varieties are not identical but there is some similarity in decrease in stability and increase in MTI between the varieties.

Addition of SSL at 0.5 and 1.0 per cent level did not affect the water absorption but increased the stability and decreased the MTI which are well comparable with wheat flour farinograph characteristics.

Baking test: The results of bread produced with 5, 10 and 15 per cent soya fortified flour of different wheat varieties, with and without SSL are summarised in Table 2. To overcome the adverse effects i.e. decrease in volume, grain, texture score created due to addition of soya flour, the short time fermentation straight dough method[1] was used.

Bread scoring and loaf volume data showed that pure wheat varieties have good baking characteristics. Addition of 5 per cent soya flour showed decrease in volume and bread score by about 27.2-43.5 ml and 4.5-5.2 respectively. Addition of 0.5 per cent SSL the volume of breads were identical to wheat flour breads but the bread scores were less. Addition of 1 per cent SSL to 5 per cent soya fortified flour showed increase in the volume by about 10-30 ml than wheat flour but the bread score was identical to that of wheat flour bread.

By the addition of 10 per cent soya flour the volume of bread decreased about 60-90 ml and bread score 7.5-9.0;

the breads were of acceptable quality. With the addition of 0.5 per cent SSL although the volume was increased about 30-50 ml but the total scores were not improved appreciably. At 1.0 per cent SSL the loaf volume was identical to that of wheat flour but the total score was less. With 15 per cent soya flour the loaf volume and bread score were reduced about 100-140 ml and 13.0-15.25 respectively. Bread produced from 15 per cent soya fortified flour was not acceptable. With the addition of 1.0 per cent SSL the volume and the total score increased about 40-55 ml and 4.25-4.80 respectively but the bread produced was of unacceptable quality.

Conclusion: Five per cent soya flour addition did not affect significantly the baking quality of flours from 'Shera', 'Hira', 'Kalyan Sona' and 'Moti' wheat varieties. Ten per cent soya fortified bread with 0.5 and 1.0 per cent SSL produced bread of acceptable quality. Addition of 15 per cent soya flour produced bread of very unacceptable quality which could not be improved even by the addition of 1.0 per cent SSL.

Acknowledgement

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Studies on the Development of Some Dehydrated Instant Soup Cubes for Use in Emergency Rations

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Tomato powder was prepared by foam-mat drying and spray drying and chicken powder by spray drying and these were used in formulations of dehydrated instant tomato and chicken soups respectively for use in emergency rations. When compressed into single-serve cubes (15 g) and sealed first in cellophane followed by paper-foil-polythene laminate, the soup cubes had shelf life identical to powders packed in cans under nitrogen.

Soup cubes from foam-mat dried tomato powder retained their acceptability upto 6 months at room temperature and 2 months at 37°C while those from spray dried powder were acceptable upto 9 months at room temperature and 3 months at 37°C and chicken soup cubes for 12 and 6 months at RT and 37°C respectively. Spray dried tomato powder was superior in colour, flavour and shelf life to the one made with foam-mat dried powder.

Dehydrated instant soups are desirable components of Service rations such as the emergency flying ration and the ration for submarine crew where quick or instant reconstitution coupled with convenience of serving are called for. Various types of soup powders are available in the trade but, besides having poor acceptability and shelf life in majority of the cases, they require simmering in water for varying periods of time prior to consumption and are not available in ready-to-use single serve unit packs.

Bhatia *et al.*[1] have developed different types of soup powders using hot-air-dried ingredients. These also require simmering in water for varying periods of time.

It was felt necessary to develop soups in single serve tablet (cube) form which would reconstitute instantly in hot water with a view to meet logistic requirements for inclusion in emergency rations. This communication reports the work on the development of dehydrated instant tomato and chicken soup cubes.

Materials and Methods

Raw material: Ripe tomatoes and dressed chicken procured from the local market were used in the studies.

Preparation of foam-mat or spray dried tomato powder: Juice extracted from tomatoes by cold pressing using a screw type juice extractor was sieved through 30 mesh,

treated with potassium metabisulphite at a level of 0.05 per cent on juice weight basis, concentrated and dehydrated in the same manner as described earlier[2]. The tomato puree was dried either as such by foam-mat drying or in admixture with skim milk powder (1:1 on the basis of soluble solids) by spray drying technique. The important steps involved in the preparation of the tomato powder by the two methods are given in Fig. 1. Cold pressing of tomatoes was preferred over the conventional hot break method as the latter yielded a puree with more suspended solids (pulp) which interfered seriously with subsequent concentration of the juice and with the foaming in foam-mat drying and spraying in spray drying.

Preparation of spray dried chicken powder: Flow sheet for the preparation of spray dried chicken powder is given in Fig. 2. The cooked chicken mince, after cooling to 0°C, was ground along with the gravy to a fine paste to pass through 30 mesh sieve in a hammer mill, then diluted with water to give a slurry with about 15-20 per cent solids to get a sprayable consistency, passed through a colloid mill and then spray dried using an inlet air temperature of 150°-160°C, product temperature of 75°-80°C, using a nozzle spray and compressed air at a pressure of 2 kg/cm^2. The material was fed at a rate of 3.0-3.5 kg/hr.

Dehydration of onion and fresh ginger: Onion was dehydrated by the method described by Gururaja Rao *et al.*[3] and fresh ginger as per the method described by Jayaraman *et al*[4].

Formulation, compression and packaging: All ingredients (except oil hydrogenated) used in the formulation of soup mixes were powdered to pass through 60 mesh and dried to a moisture content of about 3 per cent wherever necessary using in-pack desiccant.

The instant soup formulations as per Table 1 were mixed uniformly in a dry mixer, allowed to cure for about 2 to 3 days in a friction top tin preferably in presence of a desiccant and then compressed in a dry atmosphere at ambient temperature into cubes of 1 cm side, each weighing 15 g, using a laboratory model 12 ton Carver-Hydraulic Press and iron mould. A pressure of 100 psig for tomato soup cubes and 200 psig for chicken soup with a dwell period of 10 sec were found optimum for

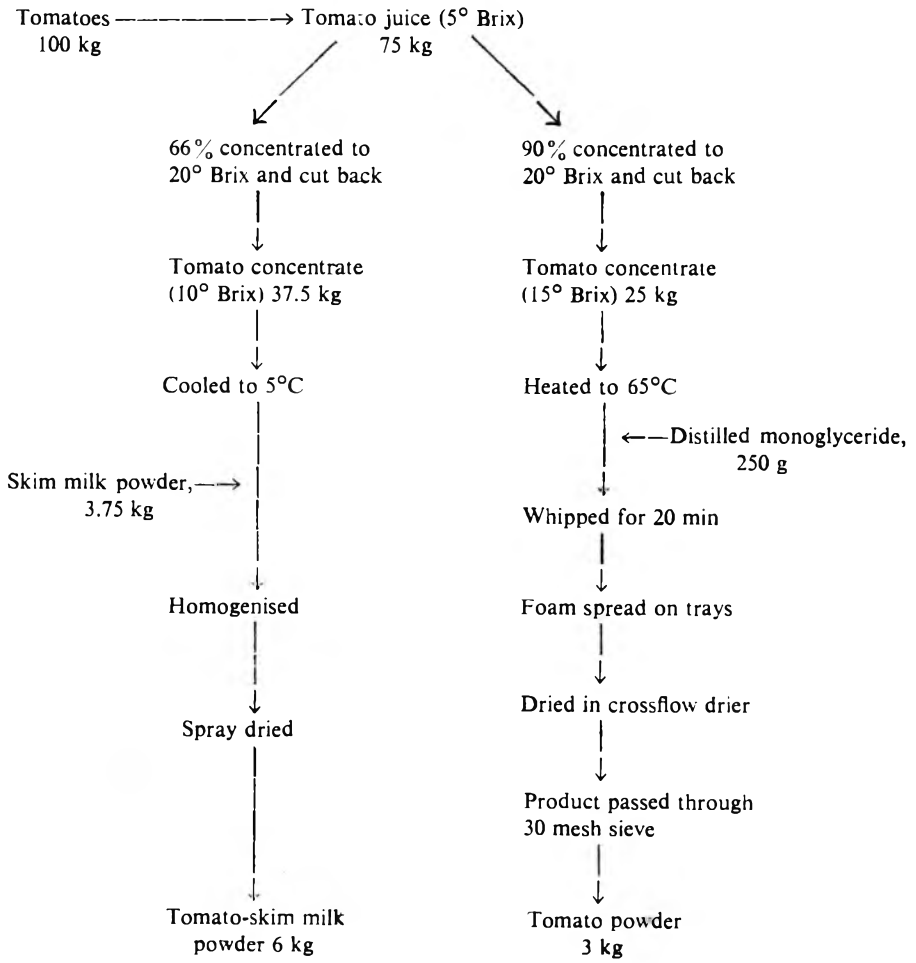

Fig. 1 Flow sheet for the preparation of spray dried and foam-mat dried tomato powder.

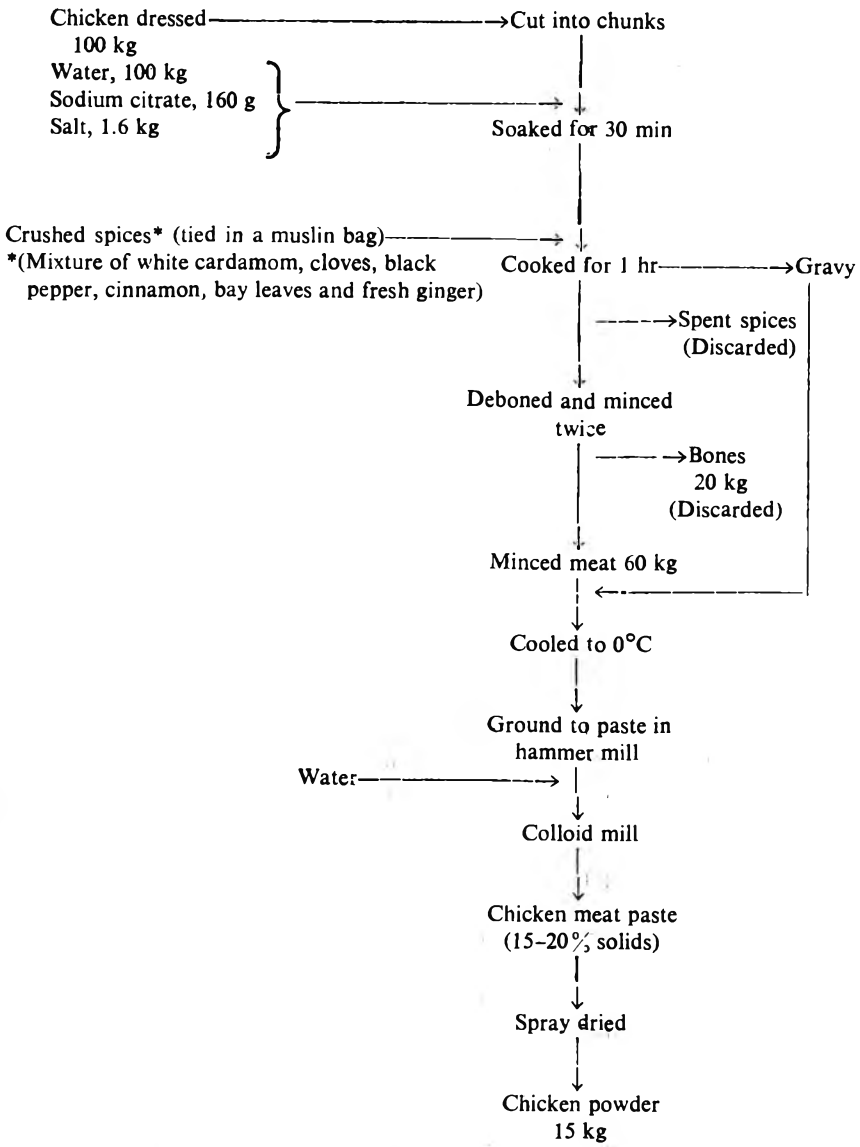

Fig. 2 Flow sheet for the preparation of spray dried chicken powder.

TABLE 1. RECEIPES FOR INSTANT TOMATO AND CHICKEN SOUP CUBES

Ingredients	Tomato soup		Chicken soup
	Foam-mat dried	Spray dried	
Tomato powder %	40.8	67.4	—
Chicken powder %	—	—	69.0
Hydrogenated vegetable oil %	10.0	10.0	10.0
Salt %	5.0	5.0	5.0
Sugar %	10.0	10.0	0.5
Skimmed milk powder %	26.6	—	10.0
Onion dehydrated powder %	5.0	5.0	4.5
Spice mix powder* %	0.6	0.6	1.0
Carboxymethyl cellulose %	2.0	2.0	—

*Comprising of dehydrated and powdered fresh ginger and powdered white pepper in the ratio of 1:1.

compression. The tablets, immediately on removal from the mould, were heat sealed in an inner wrap of MST cellophane (300 gauge) followed by an outer wrap of kraft paper (60 B.C.)—aluminium foil (0.02 mm)—polythene (150 G) laminate (PFL). For comparative assessment the powders were also packed as such in cans under nitrogen.

Analysis and storage studies: The proximate composition of the instant tomato and chicken soup cubes was determined by the AOAC methods[5]. Equilibrium relative humidity (ERH) was determined by a modification of the graphical interpolation method of Landrock and Proctor as described earlier[6] using saturated solutions of different salts to give different relative humidities ranging from 0 to 96 per cent at room temperature.

Samples of the instant soup cubes and powders packed as above were stored at 0°C, room temperature

TABLE 2. PROXIMATE COMPOSITION OF INSTANT TOMATO AND CHICKEN SOUP CUBES

Type	Composition (g/100g)							
	Moisture	Protein	Fat	Crude fibre	Ash	Carbo-hydrate	NaCl	Calories/ 100 g
Tomato soup (foam-mat dried)	3.2	15.1	14.3	1.7	11.1	54.6	7.3	407
Spray dried	3.9	18.5	10.0	1.6	11.7	54.3	7.2	381
Chicken soup (spray dried)	3.0	64.0	16.8	—	12.2	4.0	9.5	423

TABLE 3. ACCEPTABILITY OF INSTANT TOMATO SOUP DURING STORAGE

Sample	Pack	Storage period (months)	Storage temp. (°C)	Browning				Organoleptic quality
				% Reflectance	Lovibond Tintometer units			
					Y	R	B	
Foam-mat dried								
Powder	Can with N:	2	0	53	6.0	3.0	—	Good; acceptable
			RT	52	7.0	3.0	—	As good as control; acceptable
			37	26	7.0	4.3	—	Dark brown; scorched flavour. Sediments on reconstitution; not acceptable
		4	0	50	6.0	3.0	—	Good; acceptable
			RT	48	6.9	3.2	—	Slightly brown; acceptable
		6	0	51	6.0	2.5	—	Good; acceptable
			RT	45	6.4	3.1	—	Yellowish brown; just acceptable
Cubes	PFL	3	0	50	6.0	2.4	—	Good; acceptable
			RT	48	7.0	2.4	—	Lighter colour and slightly hard compared to control; acceptable
			37	33	7.0	3.8	1.0	Brown; scorched flavour. Sediments on reconstitution; not acceptable.
		6	0	50	6.0	2.4	—	Good; acceptable
			RT	45	7.0	2.7	—	Light brown and slightly hard; just acceptable.
Spray dried								
Powder	Can with N:	3	0	54	4.2	3.5	—	Good ; acceptable
			RT	50	4.0	3.5	—	As good as control; acceptable
			37	44	7.4	3.8	0.5	Yellowish brown. Slightly scorched and weak flavour; just acceptable.
		6	0	52	4.0	3.4	—	Good; acceptable
			RT	49	4.6	3.3	—	As good as control; acceptable
			37	33	8.0	5.2	1.1	Reddish brown; cake formation; scorched flavour; not acceptable.
		9	RT	—	4.7	3.2	—	As good as control; acceptable
		12	RT	—	5.0	3.1	—	Light brown; weak flavour; just acceptable.
Cubes	PFL	3	0	54	4.3	3.2	—	Good; acceptable
			RT	49	4.6	3.1	—	As good as control; acceptable
			37	43	7.0	4.4	0.7	Slightly brown and hard; just acceptable.
		6	0	54	4.3	3.2	—	Good; acceptable
			RT	49	4.7	3.1	—	As good as control; acceptable
			37	35	8.0	4.3	1.0	Dark brown and hard; highly scorched. Sediments on reconstitution; not acceptable.
		9	RT	—	4.7	3.2	—	As good as control; acceptable
		12	RT	—	5.0	3.1	—	Light brown; weak flavour; just acceptable.

(25°-30C°) and 37°C and examined periodically by a taste panel for colour, flavour and reconstitution characteristiscs. The samples maintained at 0°C served as control for comparison. Non-enzymatic browning was measured using Lovibond Tintometer and the colour expressed in yellow, red and blue units. It was also recorded as per cent reflectance using a reflectance meter.

Results and Discussion

The proximate composition of the instant tomato and chicken soup cubes are given in Table 2. Both could be reconstituted instantly by crushing and mixing into a cup (150 ml) of hot water.

Spray dried tomato powder gave a product superior in colour and flavour to the one made with foam-mat dried powder. The former had an attractive red colour while the latter was distinctly yellowish. Dehydrated green ginger imparted a better flavour to both tomato and chicken soups as compared to dry ginger while carboxymethyl cellulose (CMC) imparted a desirable smooth and viscous consistancy to the tomato soup.

The ERH of the instant tomato soup made using spray dried tomato powder, as determined by the graphical interpolation method, was found to be 24.0 per cent, while that of the instant chicken soup 18.0 per cent.

Data on the acceptability of the instant tomato soups during storage are given in Table 3 and those of instant chicken soup in Table 4.

In case of tomato soup, the foam-mat dried product retained its acceptability upto 6 months at room temperature and less than 2 months at 37°C when packed both as powder in cans under nitrogen and as cubes in PFL pouches, while the spray dried product was acceptable upto 9 months at room temperature and 3 months at 37°C under similar conditions of packing. There was fading (bleaching) of the lycopene colour during storage which was more pronounced in foam-mat dried sample than in spray dried. In general, the spray dried tomato soup had better acceptability and longer shelf life than foam-mat dried product. Instant chicken soup similarly packed was acceptable upto 12 months at room temperature and 6 months at 37°C.

TABLE 4. ACCEPTABILITY OF INSTANT CHICKEN SOUP DURING STORAGE

Sample	Pack	Storage period (months)	Storage temp. (°C)	Browning				Organoleptic quality
				% Reflectance	Lovibond Tintometer units			
					Y	R	B	
Powder	Can with N:	3	0	50	2.5	1.5	0.2	Good; acceptable
			RT	49	2.9	1.9	0.9	As good as control; acceptable
			37	45	4.0	2.8	1.3	,, ,,
		6	0	50	2.5	1.5	0.2	Good; acceptable
			RT	47	3.4	2.0	0.9	As good as control; acceptable
			37	42	6.0	3.0	1.0	Slightly darker; weaker flavour than control; just acceptable.
		9	0	50	2.5	1.5	0.2	Good; acceptable
			RT	45	3.2	2.1	0.9	Slightly brown; weak flavour; acceptable
			37	39	5.0	3.5	0.9	Brown; scorched smell; not acceptable.
		12	RT	43	3.0	2.2	0.9	Light brown; weak flavour; just acceptable.
Cubes	PFL	3	0	50	2.5	1.5	0.2	Good; acceptable
			RT	49	2.9	1.9	0.9	As good as control; acceptable
			37	45	4.0	2.8	1.3	,, ,,
		6	0	50	2.5	1.5	0.2	Good; acceptable
			RT	47	3.4	2.0	0.9	As good as control; acceptable
			37	42	6.0	3.0	1.0	Slightly brown; weak flavour; just acceptable.
		9	0	50	2.5	1.5	0.2	Good; acceptable
			RT	45	3.2	2.1	0.9	Slightly brown; weak flavour; acceptable.
			37	41	6.0	3.3	1.0	Brown; scorched smell; not acceptable.
		12	RT	43	3.0	2.2	0.9	Light brown; weak flavour; just acceptable.

Storage of all the above products beyond the specified period at 37°C caused rapid and significant browning with scorched smell and flavour loss and tendency to curdle or sediment on reconstitution while the onset of these changes at room temperature was considerably slow and less drastic. In fact, some samples of spray dried tomato soup and chicken soup tested after 22 months and 16 months at room temperature respectively were found to still retain their acceptability somewhat without significant change in colour as compared to sample at 37°C but with slight browning, loss of flavour and scorched smell as compared to control and were considered to be acceptable under conditions of duress as likely to be encountered during emergency feeding.

No rancid flavour was noticed in any of the stored soups during sensory evaluation. Non-enzymatic browning measured in terms of per cent reflectance and tintometer units generally confirmed the visual observation.

In general, the soup cubes packed in flexible laminate pouches had a shelf life identical with that for the powder packed in cans under nitrogen. As such compression into cubes can replace nitrogen packing effectively thereby effecting considerable saving in packing cost besides saving space.

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Relative Cooking Behaviour of Semolina from Maize, Sorghum, Wheat and Rice

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Comparative studies were made on cooking time, and swelling properties of semolina from wheat, rice, maize and sorghum. While cooking time increased with increasing average mesh grade of semolina in all the cereals, maize and sorghum semolina required disproportionately longer cooking for softening as compared with rice and wheat. Grinding to about −40+60 mesh, however, brought down the cooking time of the former to about 10 min. Highest swelling was observed in wheat semolina and least in sorghum whereas it was intermediate in maize and rice.

Wheat semolina is a popular article in oriental diets as it cooks to a soft consistency fairly quickly and is used for preparing a variety of products. Semolina from rice, maize and sorghum are however less popular because of unsatisfactory cooking properties. They cook to pasty viscous or stiff products. A study of the comparative cooking behaviour of semolina from these important foodgrains has been therefore undertaken and the results are presented here.

Materials and Methods

Hybrid white maize (*Ganga Safed*), hybrid sorghum (*CSH* 1), and hard wheat (*Bansi*) were dehusked with a McGill miller as described earlier[1], ground coarse in a disintegrator and graded by passing through standard BSS sieves into +22, −22 +30, −30 +44, −44 +52 and −52 +60 size fractions. Milled white rice (*S*-1069) was also ground and graded similarly. Adhering husk or bran particles were separated by gentle aspiration and the following studies were made on the semolina fractions.

Swelling in water: Since cooking in boiling water resulted in high leaching and thereby loss of surface solids, swelling was determined at 70°C by method similar to that used by Leach *et al*[2]. The semolina was added to 10 parts of water held in a centrifuge tube and maintained at 70±1°C. At 10 min intervals the tubes were removed from the bath, centrifuged at 2500 rpm for 10 min and the total weight of sediment noted. Swelling number was calculated as weight of water absorbed per unit weight of semolina while cooking.

Cooking time vis a vis particle size of semolina: The semolina sample was cooked in boiling water until it became soft as judged by pressing between two glass plates and the time taken was recorded. Sorghum and maize semolina (+22 and —30 +44 BSS grades) were extracted with 70 per cent alcohol for 36 hr to effect partial dissolution of the alcohol soluble prolamins and the extracted samples were air dried. The effect of alcoholic extraction on cooking time was determined as described above.

In the case of maize the horny endosperm and the opaque central core were separated by hand dissection of individual grains and semolina (—22 +44 grade) was prepared from the respective fractions. Relative differences in cooking time between them were also determined as above.

Microscopic examination of swollen semolina: The semolina was held in water at 70°C and at the end of 15 min, samples were withdrawn and examined under a stereo microscope.

Results and Discussion

Swelling quality, cooking time and softness during cooking: Swelling number data for the semolina (Fig 1) showed that, at all stages, wheat semolina exhibited the highest swelling number while sorghum semolina recorded the lowest values. Maize semolina was found to have higher swelling number than rice as can be expected from the relative swelling power of their starches[3]. However at 50 and 60 min the rice semolina showed slightly higher swelling than the former. The reasons for this behaviour have to be further examined.

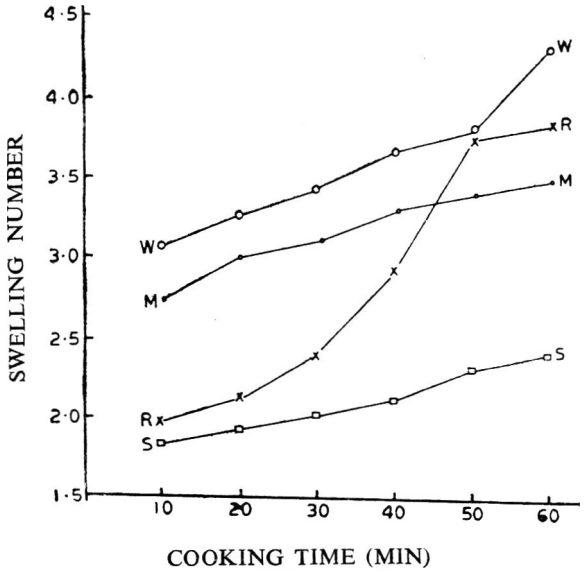

Fig. 1. Comparative swelling quality of semolina from wheat (W), rice (R), maize (M) and sorghum (S) with progressive cooking.

Data on cooking time as influenced by semolina grade presented in Fig 2 show that in all samples, cooking time increased with higher average mesh size of the semolina. While rice and wheat semolina cooked to soft product within a short period (5-15 min) the corresponding cooking periods for the maize and sorghum semolina ranged from 10 min to more than 3 hr. It is interesting to note that the cooking time is not correlated with the swelling quality. For instance the swelling of the maize semolina is generally higher than that of rice but it takes a longer time to cook to soft consistancy. Cooking time, as judged in these studies, is determined by the penetration and absorption of moisture by the core of the semolina. The longer cooking time and higher swelling observed in maize semolina might indicate higher water absorption by the peripheral part of semolina as compared to its core.

Alcoholic extraction which would partially extract the prolamins of the maize and sorghum reduced the cooking time slightly (Fig. 2). In the case of maize, it was found

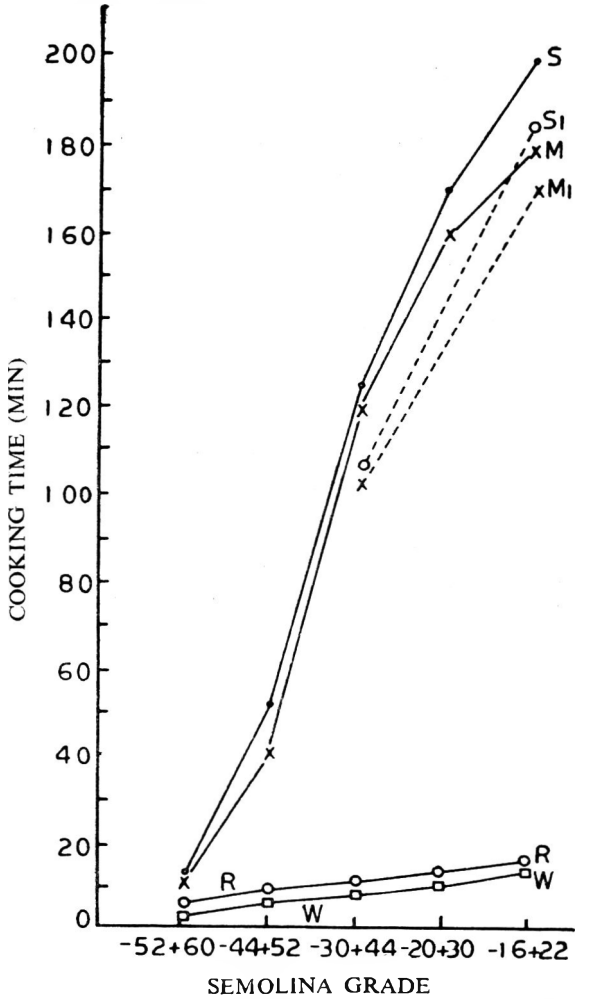

Fig. 2. Effect of semolina grade on cooking time of wheat (W), rice (R), maize (M, M_1) and sorghum (S, S_1); M_1 and S_1 are alcohol extracted.

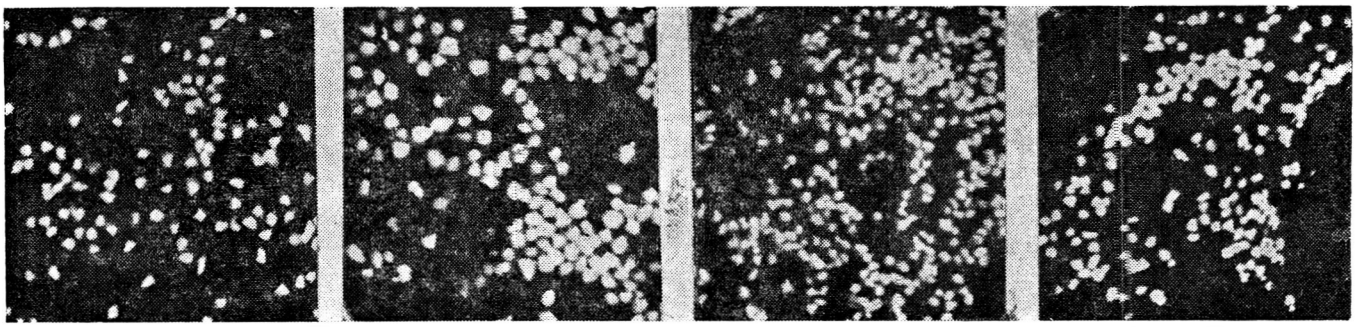

Fig. 3. Comparative appearance of semolina after swelling in water for 15 minutes

that cooking time for semolina from the horny endosperm was slightly longer (32 min) than for the central core particles (27 min).

Microscopic examination of swollen semolina particles: Wheat semolina swelled rather rapidly and remained intact in swollen condition with minimum disintegration. Rice, maize and sorghum semolina swelled more slowly than wheat and when the swollen particles were examined with the stereomicroscope it was found that after a certain extent of swelling, there was disintegration of the cooked surface layers, the uncooked portion in the centre appearing opaque and intact. Sorghum semolina was highly resistant to swelling changes and the particles presented a white angular appearance with poor particle swelling. The relative appearance after swelling for 15 min at 70°C of the semolina samples is presented in Fig. 3. The comparatively larger size of the swollen wheat semolina can be seen from the figure.

It is known that wheat and rice semolina used for making soft cooked products like *Upmav*, *Bhath* and *Idli* can be cooked within 5-15 min while semolina of the same grade from maize and sorghum cooks to a stiff product and also takes a much longer time to cook. The present results suggest that if fine grade semolina (-44 +60 mesh size) is prepared from maize and sorghum the cooking time can be brought down to the range of 10-15 min. Fine grinding and grading could therefore be used as a method of improving the popularity of maize and sorghum semolinas for making culinary dishes. Cooking trials have shown that more water (2.75-3 parts per unit weight of semolina) would be needed for getting a soft but non mashy cooked product from maize. Wheat and rice semolina normally need 2.25-2.5 parts of water for soft cooking. These are generally in keeping with the results on swelling number of the semolina samples. It has also been found that if maize grits as well as sorghum are flaked to 0.5 to 0.2 mm thickness the cooking time of these products can be reduced to the same level as that of rice.

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Biochemical Characteristics of Some of the Coliforms Isolated from Spices

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Coliform organisms (167) isolated from certain spices have been subjected to detailed biochemical examinations. Of these 129 strains have been classified as *Escherichia coli*(10), *Klebsiella pneumoniae*(41), *Klebsiella ozaenae*(6), *Enterobacter hefniae*(5), *Enterobacter liquefaciens*(6) and *Pectobacterium*(42). *Pectobacterium* and *K. pneumoniae* predominated. Isolates of *Escherichia coli* have been serologically typed.

Spices are known to be contaminated with bacteria, yeasts and moulds, causing spoilage[1,2]. Among different bacteria in foods, coliforms (especially *Escherichia coli*), are considered to be indicative of sewage or faecal pollution and the possible presence of pathogens. The coliform density of spices varied with the different types of these commodities and modes of processing[2,3]. *Enterobacter aerogenes* were predominant in dehydrated onion and garlic[4]. *Escherichia coli*, *Escherichia freundii* and *Klebsiella* sp. were isolated from black-pepper by Christensen *et al*[5].

In the present paper, an attempt has been made to classify some of the coliforms isolated from black pepper, dry-ginger, coriander, fennel, red-chillies, cumin, garlic, fenugreek, turmeric, mustard, tea-masala, curry powder, based on a variety of biochemical tests.

Materials and Methods

Samples of spices listed above were examined for coliforms using brilliant-green lactose bile broth (BGLB) and eosin-methylene blue agar (EMB)[3,6]. Further isolation of coliforms were done by transferring typical colifrrm organisms from EMB agar to BGLB. BGLB positive growths were cultured in nutrient broth for further biochemical tests[7].

167 cultures of coliforms were tested for indole, methyl-red (MR), Voges-Proskauer (VP), citrate (Simmon's citrate), motility, growth on urease agar, KCN and gelatin liquefaction. Indol, M.R. and V.P. tests were performed after 48 hr incubation at 37°C in per cent tryptone and MR-VP broths, respectively. Reactions in Simmons' citrate slants were observed upto 7 days at 37°C. Motility test was performed by hanging drop method from young broth cultures. Liquefaction of gelatin was observed upto 15 days at 37°C in 12 per cent gelatin medium after chilling it at 20°C. Urease production was tested on Christensen's medium at 37°C for 7 days. They were also tested for fermentation of malonate, glucose, lactose, sucrose, mannitol, dulcitol, salicin, adonitol, inositol, sorbitol, arabinose, raffinose and rhamnose. Carbohydrate fermentation was carried out at 1 per cent concentration at 37°C for 7 days. Ability to hydrolyse pectate gel was noted after 24 hr at 37°C and the negatives were incubated further upto 2 weeks. *E. coli* strains were serotyped according to Difco[8].

Results and Discussion

A total of 167 coliforms isolated from spices were subjected to biochemical characterisation and classified as stated in Table 1.

The classifications used in the present study was based on the data collected by Edwards and Ewing[7].

Escherichia coli: The biochemical characteristics of isolated cultures are compared with that cited in the literature and recorded in Table 2. From Table 2, it is seen that most of the isolates had the typical biochemical characteristics. Except for indole, citrate, motility and inositol, there was close agreement in biochemical

Table 1. Types of coliform organisms present in spices and curry powders

Organisms	No. of isolates
Escherichia coli	10
Klebsiella pneumonia	41
Klebsiella ozaenae	6
Enterobacter cloacae	13
Enterobacter aerogenes	6
Enterobacter hafniae	5
Enterobacter liquefaciens	6
Pectobacterium	42
Unclassified	38
Total	167

TABLE 2. SUMMARY OF THE BIOCHEMICAL REACTIONS (37°C) OF 10 STRAINS OF ESCHERICHIA COLI ISOLATED FROM SPICES

Biochemical tests	Sign	No. of isolates giving +ve reactions
Indole	+	8
Methyl-red	+	10
Voges-Proskauer	—	0
Citrate (Simmon's)	—	0
Motility	+or—	10
Urease	—	2
KCN	—	0
Gelatin liquefaction (37°C)	—	0
Malonate	—	0
Glucose	+	10
Lactose	+	10
Sucrose	d	7
Mannitol	+	10
Dulcitol	d	8
Salicin	d	4
Adonitol	—	1
Inositol	—	3
Sorbitol	+	10
Arabinose	+	10
Raffinose	d	7
Rhamnose	d	10

+ = 90% or more strains positive
— = No growth in 90% or more strains
+or— = Majority positive
d = Different reactions.

TABLE 3. SEROTYPES OF E. COLI ISOLATED FROM SPICES AND CURRY POWDERS

Serotype	No. of strains
01	3
17	1
69	2
Rough strain	2
Untypable	2

reactions observed in the present study and that of Edwards and Ewing[7] and Dube *et al*[8]. Indole and MR positive, VP, citrate, KCN, gelatin, malonate, urease and pectate negative strains can be classified as *E. coli*. However, indol and urease variables were observed. *E. coli* strains were confirmed by serotyping and recorded in Table 3.

On the basis of specific *E. coli* 'O' antiserum reaction *E. coli* strains were classified into 01, 17, 69, rough and untypable serotypes as reported in Table 3. Rough types indicated that the colonies were rough on the plate and granular growth were observed in the broth culture. Cross reactions with many antisera occurred. It would be difficult or impossible to identify the 'O' antigens of the rough strains. Two *E. coli* strains were untypable.

Klebsiella: The biochemical characteristics in comparison with typical biochemical reactions for (*a*) 41 isolates of *K. pneumoniae* and (*b*) 6 isolates of *K. ozaenae* are shown in Table 4.

TABLE 4. SUMMARY OF THE BIOCHEMICAL REACTIONS (37°C) GIVEN BY SOME STRAINS OF *Klebsiella* ISOLATED FROM SPICES

	K. pneumoniae (41)*		*K. ozaenae* (6)*	
Biochemical tests	Sign	No. of isolates giving +ve reactions	Sign	No. of isolates giving +ve reactions
Indole	—	0	—	0
Mathyl-red	—or+	12	+	6
Voges-Proskauer	+	35	—	0
Citrate (Simmon's)	+	39	d	4
Motility	—	0	—	0
Urease	+	39	d	2
KCN	+	41	+or—	5
Gelatin liquefaction	—	0	—	0
Malonate	+	41	—	1
Glucose	+	41	+	6
Lactose	+	41	d	6
Sucrose	+	41	d	3
Mannitol	+	41	+	4
Dulcitol	—or+	16	—	0
Salicin	+	41	+	6
Adonitol	+or—	32	+	6
Inositol	+	41	d	4
Sorbitol	+	41	d	4
Arabinose	+	41	+	6
Raffinose	+	41	+	6
Rhamnose	+	41	d	4
Pectate	—	0	—	0

*Figures in the bracket indicate No. of isolates studied.
— = 90% or more strains negative
+ = 90% or more strains positive
+or— = Majority are positive
—or+ = Majority are negative
d = Different reactions

(*a*) K. pneumoniae: It is seen from Table 4 that all isolates were negative for indol, motility, pectate and gelatin liquefaction. Twenty nine per cent of the strains were M.R. positive. Edwards and Ewing[7] reported 6 per cent of their strains positive for indole, 13 per cent M.R. positive and 3 per cent liquefied gelatin. However, Dube *et al*.[9] observed that 22 per cent of their strains were indol positive, 20 per cent M.R positive, 15 per cent liquefied gelatin and 6.2 per cent were motile. The biochemical reactions of the isolates in this study closely agreed with that of Edwards and Ewing[7]. Indol, motility, gelatin and pectate negative isolates can be classified as *K. pneumoniae*. However, M.R., dulcitol, adonitol and other variable reactions were encountered.

(*b*) K. ozaenae: From Table 4, it is seen that these organisms were negative for indole, Voges-Proskauer, motility, gelatin and pectate. Malonate and dulcitol were

not fermented. The biochemical reactions more or less agreed with the report of Edwards and Ewing[7]. Though V.P. positive and M.R. negative reactions have been stressed as important characters of *Klebsiella*[10], they have been found to be variable by several workers[9,11].

Enterobacter: The biochemical reactions of *E. cloaxae*, *E. aerogenes*, *E. hafniae* and *E. liquefaciens* along with those typical reactions are given in Table 5.

E. cloacae: In the present study (Table 5), 7 per cent of the strains were indole positive, 25 per cent M.R. positive, 38 per cent fermented dulcitol, 53 per cent adonitol and 46 per cent inositol. Edwards and Ewing[7] reported 0.5 per cent indole and 0.3 per cent M.R. positive. Thirteen per cent fermented dulcitol, 28 per cent adonitol and 34 per cent inositol. Except for these minor differences, the biochemical reactions of the isolated strains agreed with that of Edwards and Ewing[7]. Indole, M.R. and pectate negative KCN, motility and gelatin positive can be classified as *E. cloacae*. However, indole, M.R., urease, dulcitol, adonitol and other variables were observed.

E. aerogenes: From Table 5, it is seen that these organisms were indole and M.R. negative. All of them were urease positive, 50 per cent liquefied gelatin and 16 per cent fermented dulcitol, while Edwards and Ewing[7] reported only 3 per cent urease positive, 77 per cent liquefied gelatin and 4 per cent fermented dulcitol. Except for urease reaction, there was not much variation in the biochemical characteristics of the isolates from those observed by the above authors. Indol, M.R., urease, dulcitol and pectate negative strains can be classified as *E. aerogenes*. However, urease and dulcitol variables were observed.

E. hafniae: From Table 5, it is seen that all strains were negative for indole, citrate, urease, adonitol, inositol, sorbitol, raffinose and pectate. 20 per cent were V.P. positive, 40 per cent liquefied gelatin, 80 per cent motile and KCN positive. All isolates were positive for M.R. malonate, glucose, lactose, mannitol, dulcitol, salicin, arabinose and rhamnose. The V.P. and gelatin liquefaction reactions did not agree with the observations of Edwards and Ewing[7] who reported 50 per cent V.P.

TABLE 5. SUMMARY OF BIOCHEMICAL REACTION (37°C) OF SOME STRAINS OF *Enterobacter* ISOLATED FROM SPICES

Biochemical tests	*E. cloacae* (13)*		*E. aerogenes* (6)*		*E. hafniase* (5)*		*E. liquefaciens* (6)*	
	Sign	No. of isolates giving+ve reactions	Sign	No. of isolates giving+ve reactions	Sign	No. of isolates giving+ve reactions	Sign	No. of isolates giving+ve reactions
Indole	—	1	—	0	—	0	—	0
Methyl-red	—	3	—	0	+or—	5	+or—	4
Voges-Proskauer	+	12	+	6	+or—	1	—or+	3
Citrate (Simmon's)	+	13	+	6	+or—	0	+	6
Motility	+	12	+	6	+	4	d	5
Urease	+or—	9	—	6	—	0	d	2
KCN	+	13	+	6	+	4	+	6
Gelatin liquefaction	+	12	+or—	3	—	2	+	6
Malonate	+or—	13	+or—	6	+or—	5	—	2
Glucose	+	13	+	6	+	5	+	6
Lactose	+	13	+	6	—or+	5	d	6
Sucrose	+	12	+	6	d	1	+	6
Mannitol	+	13	+	6	+	5	+	6
Dulcitol	+or—	5	—	1	—	5	—	0
Salicin	d	13	+	6	d	5	+	6
Adonitol	+or—	7	+	6	—	0	d	0
Inositol	d	6	+	6	—	0	+	6
Sorbitol	+	13	+	6	—	0	+	6
Arabinose	+	13	+	6	+	5	+	2
Raffinose	+	12	+	6	—	0	d	4
Rhamnose	+	13	+	6	+	5	—	2
Pectate	—	0	+	0	—	0	—	0

* = Figure in the bracket indicates nc. of siolates studied.
+ = 90% or more strains positive.
— = 90% or more strains negative
+or— = Majority are positive
—or+ = Majority are negative
d = Different reactions

TABLE 6. SUMMARY OF BIOCHEMICAL REACTIONS (37°C) OF 42 STRAINS OF *Pectobacterium* ISOLATED FROM SPICES

Biochemical tests	Sign	Number of strains giving +ve reactions
Indole	—or+	7
Methyl-red	+or—	10
Voges-Proskauer	—or+	35
Citrate (Simmons')	d	39
Motility	+or—	36
Urease	d	6
KCN	+or—	35
Gelatin liquefaction	+	42
Malonate	—or+	14
Glucose	d	42
Lactose	d	42
Sucrose	+or—	34
Mannitol	+or—	40
Dulcitol	—	3
Salicin	d	35
Adonitol	—	0
Inositol	—	0
Sorbitol	—	6
Arabinose	+or—	5
Raffinose	d	39
Rhamnose	d	42
Pectate	d	42

\+ = 90% or more strains positive
— = No growth in 90% or more strains
+or— = Majority positive
—or+ = Majority negative
d = Different reactions

positive and non-liquefaction of gelatin. V.P., gelatin, motility, KCN, sucrose and dulcitol variables were observed.

E. liquefaciens: From Table 5, it is observed that all the isolates were negative for indole, dulcitol and adonitol and 66.7 per cent were negative for urease, malonate, arabinose and rhamnose. 50 per cent of the strains were positive for V.P., 66 per cent were positive for M.R. and raffinose and 83.4 per cent were motile. Mostly all the strains were positive for citrate, KCN, gelatin, glucose, lactose, sucrose, mannitol, salicin, inositol and sorbitol. Edwards and Ewing[7] reported 75 per cent of the strains positive for M.R., 31 per cent V.P., 92 per cent arabinose and 7.4 per cent malonate positive and negative for indole and rhamnose. Except for these minor variations our observations closely agreed with that of Edwards and Ewing[7]. Gelatin positive, indol, dulcitol, adonitol, malonate, rhamnose and pectate negative strains can be classified as *E. liquefaciens*. However, M.R., V.P., motility, urease, malonate, arabinose, raffinose and rhamnose variables were observed.

Pectobacterium: The biochemical reactions of the isolates along with those of the typical reactions are given in Table 6. This genus is heterogeneous possessing the general characteristics of *Enterobacter* and *Klebsiella* which has been classified as irregular or intermediates by Collins[12] and Thatcher and Clark[6]. The outstanding characteristic of *Pectobacteria* is their ability to liquefy pectate gel. a characteristic that is not shared by other coliforms[13].

The isolated strains did not ferment adonitol, 16 per cent were indol positive, 24 per cent M.R. positive, 14 per cent urease positive, 7 per cent dulcitol positive, 14 per cent sorbitol positive, and 12 per cent arabinose positive. Except for glucose, dulcitol and arabinose, other biochemical reactions agreed with the observations of Edwards and Ewing[7]. Pectate positive, adonitol, inositol and dulcitol negative strains can be classified as Pectobacterium. Many variable biochemical reactions were observed.

Thirtyeight isolates with many variable biochemical reactions encountered in the study could not be classified.

Acknowledgement

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Comparative Performance of Purebreds, F1 and F2 Generation Broiler Chickens for Edible Meat Per Cent and Meat-Bone Ratio

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Comparative performance of purebred broilers of White Cornish, New Hampshire and Australorp and their crossbreds in F1 and F2 for per cent edible meat and meat bone ratio in the raw and cooked form was studied. The order of ranking was F1, F2 and purebreds. The decline in performance of F2 was almost 50 per cent of the increase of F1 over purebreds, thereby indicating the presence of heterosis for these two traits.

Good strain broilers possess high dressing yield and meat-bone ratio. The meat-bone ratio differs in different breeds and the differences depend upon several genes having additive and non-additive effects. Edible meat and meat-bone ratio increases with live weight[1]. Mahadevan and Bose[2] reported that the percentage of edible meat in *Desi* chicken is comparatively more than in White Leghorn and Rhode Island Red at different stages of growth. In view of this, evaluation of the available broiler breeds and their inter crosses in India for edible meat and meat-bone ratio, is prerequisite for making a choice of most efficient meat birds. Since these characteristics greatly influence the acceptability, yield of raw and cooked meat of the three purebreds, F1 crossbreds and F1 inter-se progeny (F2 group) were compared.

Materials and Methods

For this investigation, four randomly selected 12 week old birds of the three following groups were selected.

(*i*)	Purebreds	(*a*) New Hampshire (N)
		(*b*) White Cornish (W)
		(*c*) Australorp (A)
(*ii*)	F1 Crossbreds	(*a*) N × W
		(*b*) N × A
		(*c*) W × A
		(*d*) A × W
(*iii*)	F2 Crossbreds	(*a*) NW × NW
		(*b*) NA × NA
		(*c*) WA × WA
		(*d*) AW × AW

Twenty two raw carcasses were used for estimating the percentage edible meat and meat-bone ratio. In another study, 22 carcasses of the same traits were estimated after cooking them in an electric hot air oven at a temperature of 163°C for 90 min. The bones and edible meat were separated manually in both cases.

Results and Discussion

Per cent edible raw meat: Crossbreds of White Cornish × Australorp in F1 and F2 generations and Australorp purebreds yielded highest edible meat average being 55.2, 51.6 and 54.0 per cent respectively (Table 1). The F1 crossbreds were distinctly superior to either parent strain except in the case of Australorp × White Cornish. But the inter-se progenies yielded less edible meat than F1 except Australorp-White Cornish × Australorp-White Cornish, which was higher than Australorp × White Cornish. The intermediate values in F1 as compared to purebreds and F1 are probably due to the presence of heterosis for this trait.

Per cent edible cooked meat: The yield of cooked edible meat showed the trend similar to raw meat (Table 1). The loss of moisture on cooking was variable among the various genetic groups and thus the ranking for yield of new and cooked edible meat did not correspond completely. Penteado *et al*[3]. and Stotts and Darrow[4] also observed that crossbreds were superior to purebreds for meat production. Whether variability in cooking yield in the different groups is due to cross breeding or not, it is rather difficult to decide on the basis of the available data. This needs to be studied as detailed under controlled experiment.

Meat-bone ratio: The meat-bone ratio ranged between 4.10 and 5.47, there being practically no difference between parent strains and F1. But F2 crosses were comparatively lower. The ranking of crosses were not the same in different generations.

The ratio on cooked basis ranged between 2.52 to 3.99. The trend of the observation was same as in the case of the meat-bone ratio on uncooked basis.

TABLE 1. EDIBLE MEAT AND MEAT-BONE RATIO ON RAW AND COOKED BASIS IN F1 AND F2 CROSSBREDS OF BROILERS

Generation	Genetic group	% Raw meat	% Cooked meat	Meat:bone (raw)	Meat:bone (cooked)
F1	N×W	54.12 (2)	38.59 (2)	4.52 (2)	3.22 (2)
	N×A	54.30 (2)	39.35 (2)	5.47 (2)	3.99 (2)
	W×A	55.25 (2)	44.44 (2)	4.88 (2)	3.94 (2)
	A×W	46.09 (2)	33.53 (2)	4.43 (2)	3.21 (2)
F2	NW×NW	49.40 (2)	35.58 (2)	4.61 (2)	3.41 (2)
	NA×NA	50.90 (2)	36.58 (2)	4.23 (2)	3.11 (2)
	WA×WA	51.67 (2)	40.05 (2)	4.10 (2)	3.10 (2)
	AW×AW	51.27 (2)	32.55 (2)	4.87 (2)	3.10 (2)
	N×N	51.34 (2)	30.72 (2)	4.22 (2)	2.52 (2)
Purebreds	W×W	52.66 (2)	37.83 (2)	5.41 (2)	3.89 (2)
	A×A	54.04 (2)	33.55 (2)	4.78 (2)	2.79 (2)

The number of observations are given within parentheses.

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RESEARCH NOTES

INSECTICIDAL DOSES OF METHYL IODIDE IN FOODS AND ITS RESIDUE

Insecticidal dosages of the fumigant, methyl iodide (MeI) for *Tribolium castaneum* in the presence of different food commodities are reported. MeI residue remaining in different food commodities at different dosages have also been determined. It was found that the nominal concentration-time product for 100% effect was highest for groundnut meal which showed a residue level of 0.45 ppm.

Methyl iodide (MeI) has shown promise as an effective fumigant for the control of stored product beetles[1]. The present investigation is an effort to determine the insecticidal dosages of this fumigant in the presence of different types of food grains, oil seeds, nuts, dry fruits and processed foods and the residue left as MeI after normal aeration in atmospheric air.

One hundred to 150 g of the food materials (load) were filled into 355 ml capacity glass jars with B24 standard joint openings and B24 hollow stoppers with rubber (septum) plugs. The variation in the weights was due to the different bulk densities. Low bulk density materials filled up the available space necessitating reduction in the mass used. Thirty 3-4 weeks old *Tribolium castaneum* Herbst adults held in open end glass tubes with coarse cloth diaphgram closures were inserted in the middle of the load.

MeI was introduced as vapour[1] under a slight suction brought about by forcibly withdrawing about 20 ml air using a syringe. Atmospheric pressure was restored immediately. Exposure periods of 24 and 48 hr were given based on mortalities obtained in trial experiments. Sets of dose-exposure combinations giving only 100 per cent effect are given Table 1.

Commodities were sampled for estimation of MeI residue after one week of aeration at $27\pm2°C$ under static conditions, without forced aeration. Free MeI residue was determined colorimetrically after eluting MeI with ice-cold methanol from the commodities[2].

TABLE 1. MEI DOSE/EXPOSURE REQUIRED FOR 100% EFFECT (*T. castaneum* ADULTS) AND RESIDUE

Material	Dosage mg/l	Exposure hr	Nominal c.t. mg.hr/l	MeI residue. (p.p.m.)
Pulses				
Red gram (Tur dhal) splits	32	48	1536	1.14
Bengal gram (dhal) splits	16	24	384	0.73
Black gram (dhal) splits	16	24	384	0.43
Green gram (dhal) splits	48	48	2300	0.65
Oil seeds & nuts				
Groundnut kernels (with cuticle)	16	48	768	0.22
Groundnut (pieces)	96	24	2304	—
Groundnut meal	128	48	6150	0.45
Cashew kernels	48	24	1150	2.20 (64 mg/l)**
Walnuts	64	24	1540	0.96 (48 mg/l)**
Almond kernels	8	24	192	0.97
Copra	97	24	2330	*
Til seed (Sesamum)	8	24	192	1.19
Dry fruits				
Apricots	8	24	192	*
Figs	4	24	96	*
Raisins	8	24	192	*
Spices				
Coriander	8	24	192	0.96
Cumin	8	24	192	*
Chillies (red pepper)	16	24	384	*
Processed foods				
CSM (corn-soya-milk powder mix)	64	48	3072	—
Groundnut cake	32	24	770	0.80
Coffee beans	8	24	192	0.83

*Estimation of MeI was not possible by the method followed, due to turbidity which masked the yellow colour of Ce (IV).
**In these two cases the residual MeI was estimated when the dosage was at the indicated levels.

Among the commodities tested nominal concentration time (c.t.) products for 100 per cent effect were highest for groundnut meal followed by CSM, copra, groundnut pieces, green gram splits, walnuts, tur dhal, cashew kernels (range: 6150-1150 mg hr/L). Groundnut cake and groundnut kernels were next (770-768 mg hr/L) followed by Bengal gram, black gram splits and chillies (384 mg hr/L). Almonds, til seeds, raisins, apricots, coriander, cumin and coffee seeds required 192 mg hr/L. Figs required the lowest nominal c.t. product of 96 mg hr/L.

The residue of MeI was highest with cashew kernels (2.2 ppm) followed by til seeds (1.19 ppm), tur dhal (1.14 ppm), almonds (0.97 ppm), walnuts (0.96 ppm), coriander (0.96 ppm), coffee beans (0.83 ppm), groundnut cake (0.8 ppm), green gram dhal (0.65 ppm), groundnut meal (0.45 ppm) and black gram dhal (0.43 ppm). The lowest residue was shown by groundnut kernels with cuticle (0.22 ppm). Residue determinations in dry fruits and copra could not be carried out by the method followed due to formation of turbidity which masked the yellow colour of Ce (IV). It is possible that foods rich in protein and fat absorb more MeI. This has been shown in the case of MB[3].

When compared to methyl bromide (MB) as regards effective dosages[4] generally MeI appears to require higher doses with exposures of 24-48 hr which is to be expected, as MeI is a liquid fumigant (lower vapour pressure) and hence is likely to be sorbed more by the commodities. Except for flour, nut, meats or meals, the dosages required for the whole grains, pulses, dry fruits and spices are not very high for an effective treatment and hence shows promise as a good alternative to MB, especially for in-package treatments. The 100 per cent effect on *T. castaneum* adults serves as a parameter for an effective treatment with MeI as Muthu *et al.*[5] have shown that *T. castaneum* adults are more tolerant than pupae and eggs although the larvae are a little more tolerant.

The residues as MeI also appear to be quite low (maximum being 2 ppm) and are not likely to be of any toxicological significance. According to Johnson[6] repeated daily doses of even 30-50 mg MeI per kg body weight showed no effect.

No attempt is made in the present work to investigate the reaction products of MeI with the food constituents. Majumder *et al.*[7] reported 12 per cent reaction with methionine with MeI compared to 52 per cent with MB. No taint or off flavour could be discerned in the treated foods.

In view of the above evidence it appears possible to utilise MeI for fumigation of stored products, especially for in-package and rigid container treatments of processed foods, dry fruits, nuts and spices.

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RENNET SUSCEPTIBILITY OF CASEIN MICELLES FROM POST-PARTUM MILK*

Casein (irrespective of its physical status, i.e. micellar or acid) isolated from the first day colostrum was found to contain much higher (approximately double) concentration of bound sialic acid, but exhibited much less release of the same on rennet action, compared to casein from normal milk (10th day post-partum). The sialic acid content in casein gradually decreased, but its rennet dependent release increased with the post-partum period till the 5th day. Micellar caseins, irrespective of post-partum period, also had lower sialic acid content, but gave higher sialic acid release on rennet action, than the corresponding acid caseins.

The initial secretion of the mammary glands of mammalian species is termed as colostrum or post-partum milk and the animal starts secreting normal milk usually after 7-10 days of parturition. During the transitory period from colostrum to normal milk, the milk constituents undergo a rapid change both quantitatively and qualitatively[1]. Besides other constituents, changes in the proteinous contents have been of great interest because of their pivotal position in dairy industry. Porter and Conard[2] have made a study of such changes in milk serum proteins whereas Joshi *et al.*[3] have delineated

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the changes on the proteose peptone fraction. Recently some interest has also been shown in the post-partum changes of casein moeity[4,5]. This stimulated our interest to examine the cow casein micelles isolated from post-partum milk for its rennet susceptibility. Since micellar casein differs markedly from acid casein[6-8], a comparative study with the acid casein from post-partum milk was also made. Such a study is likely to determine the influence of post-partum milk (which may be added by producers in normal milk) on the rennet dependent cheese making process.

The post-partum milk samples were collected from 10 individual animals of Tharparkar (cow) herd of the Institute, every morning, consecutively from Ist to 10th day after parturition (the Ist day sample was collected immediately after parturition). Micellar and acid caseins were then isolated from these samples through ultra-centrifugation and acid precipitation as indicated earlier[6]. Sialic acid content was estimated by Warren's[9] thio-barbituric acid assay method and its release on rennet action was determined according to Gupta and Ganguli[10]. The calf rennet powder used in the study was a preparation of Hansen Laboratory, Copenhagen and the N-acetyl-neuraminic acid was from Sigma Chemical Co., U.S.A. Other chemicals used were of analytical grade.

The results of the study (average values) are depicted in Fig. 1 (A & B). Perusal of Fig. 1A clearly reveals that caseins (micellar and acid) obtained from Ist day colostrum (post-partum milk) contained much higher (almost double) amounts of bound sialic acid as compared

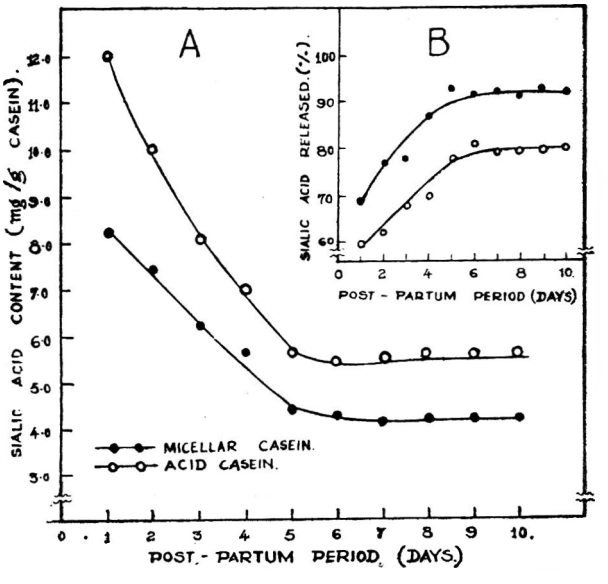

Fig. 1A Sialic acid content of micellar and acid caseins in milk as influenced by post-partum period (1-10 days).

Fig. 1B Extent of sialic acid release by 0.1 ml rennet (of 50 mg/ml conc.)/5 ml casein solution at 37°C from micellar and acid caseins of post-partum milk (1-10 days).

to the caseins isolated from the normal milk obtained after 10 days of parturition. Such contents were 8.23 and 4.20 mg/g of caseins in case of micellar caseins and 12.02 and 5.66 mg/g casein in case of acid caseins, respectively. Fig. 1A further reveals that sialic acid content gradually decreased with the post-partum period. Such a reduction in the sialic acid residue of micellar and acid caseins was observed upto 5th day of post-partum period. It appears that after 5th day (till 10th day) the caseins attained a more or less constant level of sialic acid. Fig. 1A additionally projects the difference between micellar and acid caseins (all days) as regards their sialic acid content, the former being poorer than the latter.

These post-partum milk casein samples were next examined for their rennet susceptibility by studying the extent of sialic acid released. It can be easily noted from Fig. 1B that the caseins of Ist day post-partum milk (colostrum) showed much less release of sialic acid (68.41 per cent micellar and 59.75 per cent acid) as compared to corresponding caseins of 10th day post-partum milk (normal milk) where the release was observed to be 92.28 and 80.68 per cent in micellar and acid caseins respectively. It may be further noted (Fig. 1B) that the rate of sialic acid release gradually increased with post-partum period upto at least 5th day of parturition. Beyond that period (5th day), however, the same became more or less constant (Fig. 1B). It is as well evident from Fig. 1B that micellar caseins released higher amount of sialic acid (sialopeptide) when attacked by rennet as compared to acid casein.

The higher content of sialic acid in colostrum casein and its gradual decrease with post-partum period could be expected due to greater need of sialic acid for the development of gangliosides of the young one during the first stages after birth[11]. From this stand point colostrum could be considered as a valuable food for infant nutrition. The higher sialic acid content in colostrum casein, however, does not seem to be due to greater content of *k*-casein in it, because the electrophoretic studies of Sabarwal[12] did not show any appreciable difference in the intensity of *k*-casein band in colostrum and normal milk. Results on sialic acid release by rennet action on post-partum milk casein show a trend which is just reverse of sialic acid content. A lower sialic acid content and higher sialic acid release in micellar caseins compared to corresponding acid caseins is in confirmation of our earlier findings[7]. A poorer rennet action on colostrum caseins revealed by lesser sialic acid release (Fig. 1B) indicates that the presence of colostrum in normal milk could be detrimental to the process of cheese making.

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USE OF MODIFIED RAGI STARCH IN FOOD PREPARATIONS

On acid modification and pregelatinization of ragi starch, the water solubility increased several fold. Acceptable gum candy could be prepared from acid modified ragi starch and pre-gelatinized ragi starch could be used for preparation of instant puddings.

Starch, which is the most versatile raw material for different industries finds more applications on appropriate modification. In our search for new starches, starch isolated from Ragi (*Eleucine coracana*) was subjected to pre-gelatinization[1] and acid-modification[2] in order to explore the possibility of its substitution in some food preparations like pudding and gum candy. The properties like solubility[3], water-retention capacity[4] and gelatinization temperature[5] of the modified starch were compared with the parent ragi starch.

The unmodified and acid-modified ragi starches were used to prepare gum-candy using the following recipe: sugar, 50 g; corn syrup, 30 g; glucose, 10 g; starch, 10 g; water, 100 ml; edicol egg yellow colour; and mixed fruit flavour. The mixture of sugar, corn syrup, glucose and water was heated slowly with stirring to boiling temperature and concentrated. The starch was added with stirring and the resulting fluid jelly concentrated till it reached 128 to 130°C. The colour and flavour were added and the mass was poured into starch molds. The product was allowed to set for about 24 hr at room temperature. It was then separated from starch, coated with powdered sugar and was packed.

Using unmodified and pre-gelatinized ragi starch, pudding was prepared by using sugar, 15 g; starch, 8 g; salt, 0.3 g; milk, 100 ml; edicol red colour and vanilla flavour. The mixture of salt, sugar and starch was added to milk and stirred for sufficient time to disperse homogeneously. Colour and flavour were added with stirring and the mixture cooled in a refrigerator. In case of pre-gelatinized starch, milk could be used at room temperature at or about 30°C while in case of unmodified starch, the ingredients had to be heated to 90°C with continuous stirring.

It was observed that acid-modification as well as pre-gelatinization increased the cold water solubility, the increase being 5 and 7 fold respectively with respect to the native starch. The water retention capacity was found to be almost unchanged on treatment of acid-modification but on pre-gelatinization this was increased about 5 times. Gelatinization temperature was increased by acid modification which could be due to the cleavage of the molecular chains with a reduction in swelling[6].

It was also observed that gum candy prepared from unmodified ragi starch was unacceptable as it was opaque and had lumps as well as the texture was slightly hard. On the other hand, acid-modified starch gave acceptable gum candy which was characteristically tender and transparent. On testing the unmodified and pre-gelatinized ragi starch for use in preparation of puddings, it was observed that the product obtained with pre-gelatinized ragi starch and warm milk at 50-60°C was the best with respect to taste, flavour, mouthfeel, gloss and texture and it needed only 2-3 min of mixing time as against that obtained from unmodified ragi starch which lacked the smoothness and glossy texture and also needed at least as much as 30-40 min of mixing.

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IN VITRO DIGESTIBILITY OF STARCHES

No significant difference in the *in vitro* digestibility of red gram, ragi and *rajgeera* starches was observed when tested with salivary ∝-amylase, pancreatic ∝-amylase and taka-diastase.

Starch which is a valuable ingredient for food industry because of its unique properties also forms the bulk of carbohydrate in the human diet. In the search for new indigenous sources, starches isolated from ragi (*Eleucine coracana*), red gram (*Cajanus cajan*) and *rajgeera* (*Amaranthus paniculatus* Linn) were studied for their properties and possibility of their substitution in various food preparations in place of the traditionally used starches[1]. To collect data on the *in vitro* digestibility of these starches, the present work was undertaken with a view to utilize this information in formulating new foods based on these starches.

The starches were isolated from ragi (*Eleucine coracana*), red gram (*Cajanus cajan*) and *rajgeera* (*Amaranthus paniculatus* Linn) by alkali steeping method[2]. Gelatinized starch substrates were prepared by holding 1 g starch with about 100 ml water at about 56-70°C for 10 min. At the end of the period, after cooling, volume was made to 100 ml. *In vitro* digestibility was tested with pancreatic ∝-amylase (Nutritional Biochemicals Corporation) and salivary ∝-amylase. The assay system contained in a total volume of 2.5 ml, 1 ml citrate-phosphate buffer of pH 6.9, 1 ml gelatinized starch substrate and 0.5 ml of 0.5 per cent pancreatic ∝-amylase or 0.5 ml freshly drawn saliva diluted with equal volume of water. The tubes were incubated at 37°C for different time intervals and after stoping the reaction, reducing sugars were estimated in terms of milligram maltose liberated according to the method of Sumner[3]. For *in vitro* digestibility with taka-diastase, 1 ml of 1 per cent starch solution was incubated with 1 ml of citrate-phosphate buffer of pH 5.4 and 0.5 ml of 0.2 per cent enzyme preparation (Parke Davis & Co., U.S.A.) at 37°C for different time intervals as described by Widdowson[4].

In the present work, the starches under study were subjected to enzyme hydrolysis after gelatinizing them as the action of amylases on ungelatinized starch granule is much slower than on gelatinized starch[5]. As shown in Table 1, the difference in the amount of maltose formed at the end of 3 min from red gram, ragi and *rajgeera* starches was insignificant and only 7.42 to 7.64 mg maltose could be liberated per 10 mg starch as against 10.5 expected theoretically. This is supported by Vonk and Braak[6], Kohler-Hollander[7] and Myrback[8] according to whom salivary ∝-amylase reaches a limit in hydrolysis when about 80 per cent of theoretical maltose is liberated and at this stage 70 per cent of the reducing value is due to maltose and 30 per cent due to dextrins[6–9]. The

TABLE 1. IN VITRO HYDROLYSIS OF STARCHES WITH SALIVARY ALPHA AMYLASE, PANCREATIC ALPHA AMYLASE AND TAKA-DIASTASE

Enzyme	Time		Maltose (mg) liberated/ 10 mg of		
	hr.	min	Red gram starch	Ragi starch	Rajgeera starch
Salivary-amylase	—	0.5	6.64	6.42	6.77
	—	1.0	7.64	7.52	7.42
	—	3.0	7.64	7.52	7.42
Pancreatic-amylase	—	1.0	5.20	4.90	5.30
	—	3.0	6.00	5.80	5.55
	—	5.0	6.00	5.80	5.55
Taka-diastase	1	—	6.25	6.30	5.50
	4	—	7.20	7.45	6.90
	8	—	7.80	7.80	7.45
	12	—	8.20	8.10	7.60
	16	—	8.90	8.60	8.25
	20	—	9.40	9.10	8.90
	24	—	9.40	9.10	8.90

digestibility with pancreatic ∝-amylase also showed a similar trend as with salivary ∝-amylase as shown in Table 1. Here too, all the three starches tested did not show significant variation with respect to hydrolysis to maltose but the extent of hydrolysis was lower than in case of salivary ∝-amylase and the maximum hydrolysis obtained was in the range of 52-57 per cent in all cases. It has been claimed that the hydrolysis by pancreatic ∝-amylase may stop at formation of 70 per cent[10,11], or even lower[12–14] of theoretical maltose. Also hydrolysis of starch by taka-diastase as shown in Table 1 revealed that during a period of 24 hr for which hydrolysis was carried out, maximum maltose liberation was more or less similar being in the range of 8.9 to 9.4 per cent for all the starches studied. The results obtained here with the 3 different types of amylases therefore do not permit the grading of the above starches on the basis of their digestibility though amylose and amylopectin contents of these starches are known to be different[1] suggesting the possibility of difference in their digestibility.

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RHEOLOGICAL AND PHYSICO-CHEMICAL PROPERTIES OF TRITICALES

Eight triticale strains were studied for protein, sedimentation, Pelshenke, mixographic and alveographic characters. Results indicated that as compared to wheat, triticales are poorer in rheological and physico-chemical characters except proteins.

Triticale, a man made cereal, may assume an important place as food for human beings[3] and feed for livestock[7]. Many rheological and physico-chemical tests are available for determining bread and *chapati* making characteristics of cereals. Though such studies have been conducted on wheat, not much information is available on triticales. The object of this study was to gain information on some rheological and physico-chemical properties of some selected strains of triticales.

The material consisted of eight triticale strains, viz. 'Arm S', 'Arm S 13', 'Arm S 19', 'Bulk Selection 14', 'Tol 1', 'Tol 19', 'Tol 22' and 'Tol 27' grown during *rabi* 1973–74 using the normal doses of fertilizers (N120, P60 and K45 kg/ha), cultural and irrigational schedules[10].

Nitrogen was estimated by Kjeldahl method[5] and protein was calculated by multiplying this value with 5.71. Pelshenke values (whole wheat-meal fermentation time test) were estimated according to Welsh and Norman[12]. The sedimentation test was carried out according to Pinckney *et al*[6]. Mixograms were prepared on a National-Swanson-Working mixogram using 35 g flour (14 per cent moisture basis) at 56 per cent absorption and spring setting at 10. Flour attained optimum consistency at 56 per cent absorption. Calculations for various mixographic characteristics were made according to Swanson and Johnson[9]. Alveographic analysis was performed according to Kent-Jones and Amos[2] at a constant absorption of 47 per cent at which the consistency of dough was found to be optimum. The data were statistically analysed and critical difference values determined ($P<0.05$).

Mean values of all mixographic, alveographic and physicochemical characters are incorporated in Table I.

Out of the six mixographic characters only tolerance angle and height of the peak showed significant differences among eight triticale strains. The tolerance angle ranged from 142-156 in various strains; the height of peak was maximum in 'Tol 1' (47.00 mm).

TABLE 1. MEAN VALUES OF DIFFERENT RHEOLOGICAL AND PHYSICO-CHEMICAL CHARACTERS OF TRITICALES

Parameters	Arm S	Arm S 13	Arm S 19	Bulk Selection 14	Tol 1	Tol 19	Tol 22	Tol 27	C.D. at 5%
Protein (%)	11.6	11.5	13.2	12.8	12.0	12.6	12.9	11.8	NS*
Sedimentation value (ml)	12.6	12.3	12.6	13.6	15.0	15.0	13.3	14.0	NS
Pelshenke value (min)	53.0	49.3	48.3	51.3	55.3	51.6	48.0	54.0	NS
Mixographic characters									
Developing angle	19.6	18.3	13.3	22.6	23.0	20.0	18.3	18.3	NS
Weakening angle	11.3	13.0	10.3	15.0	15.0	11.6	9.0	8.3	NS
Tolerance angle	149.0	148.6	156.3	142.3	142.0	148.3	150.6	153.3	6.28
Developing area (cm)	10.0	11.3	11.0	11.6	12.0	9.0	8.0	10.0	NS
Ht of the peak (mm)	35.3	35.3	35.6	40.3	47.0	34.6	34.6	34.3	8.07
Developing time (min)	1.9	2.3	2.1	2.1	1.8	1.6	1.6	1.5	NS
Alveographic characters									
Stability (ht P in mm)	93.1	71.5	85.8	75.5	96.0	92.0	112.2	105.2	22.97
Extensibility (length L in mm)	23.6	23.3	26.6	27.6	29.0	25.6	29.3	25.6	NS
L/P ratio	0.25	0.33	0.3	0.37	0.3	0.30	0.26	0.25	NS
Baking strength (area in cm)	16.6	10.6	12.6	10.6	13.3	12.0	20.6	15.0	NS

*NS indicates not-significant

Instead of 65 per cent baking absorption used for normal mixographic tests for wheat, only 56 per cent absorption was used in this study because at 65 per cent absorption triticale dough became soft and sticky which resulted in poor mixographic curves. These observations on water absorption are the same as those of Shuey and Gillies[8]. Mixographic values for weakening angle, height of the curve, developing time and area under the curve are almost in complete agreement with those of Lorenz *et al*[4].

The data obtained for various alveographic characters indicated that except for stability, non-significant differences existed for extensibility, L/P ratio and baking strength. Stability was the highest in 'Tol 22' (112.2 mm) followed by 'Tol 27' (105.20 mm). These values were significantly better than two least stable strains, 'Arm S 13' and 'Bulk Selection 14'.

The differences among the various triticale strains for the three physico-chemical characters, viz. protein per cent, sedimentation value (ml) and Pelshenke value (min) were non-significant. In the studies of Villeagas *et al*[11] and Zillinsky and Borlaug[13], triticales ranged in protein from 11.8-22.5 per cent and 12.8-17.9 per cent respectively. They further observed that with the increase in the plumpness of grains, the protein level decreased. As all the strains in the present study had well developed grains, the lower protein values were expected. Pelshenke and sedimentation values were lower in all the triticale strains than the similar values reported in wheat by Gill *et al*[1].

To conclude triticales, as compared to wheat[1] were poorer in respect of various rheological and physico-chemical characteristics, except proteins.

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CHEMICAL COMPOSITION OF SOME IMPROVED VARIETIES OF PULSES

Nineteen improved varieties of five different pulses viz., *Cicer arietinum*, *Phaseolus aureus*, *P. mungo*, *Cajanus cajan*, and *Lathyrus sativus* were analysed for their chemical and limiting essential amino acid composition. Differences between and within the pulses in their ash, crude fibre, protein, ether extractives, soluble carbohydrates, iron, phosphorus, calcium, methionine, threonine and tryptophan content were observed. Variety T-51 of *P. aureus* was found to have a fairly good amount of methionine and appeared to be nutritionally promising.

Pulses occupy an important position in the Indian dietary due to their high protein and vitamin content. In the recent years several high-yielding varieties of pulses have been evolved. Besides the yield potential, their chemical composition from the nutritional point of view is equally important. Chemical composition of various legumes and pulses has been reported[1–4]. In this communication we report the chemical composition of improved varieties of some pulses.

Seeds of improved varieties of *Cicer arietinum* (Bengal gram), *Phaseolus aureus* (green gram), *P. mungo* (black gram), *Cajanus cajan* (red gram) and *Lathyrus sativus* (*Khesari*) were obtained from the Department of Plant Breeding of this university and ground to pass through 40 mesh sieve. The samples were analysed for ash, crude protein, true protein, crude fibre, ether extractives, calcium and iron according to the A.O.A.C. methods[5] and phosphorus according to the method of Bartlett[6]. Carbohydrate content was obtained by difference i.e. by subtraction of the total of all the constituents from 100. For the estimation of limiting essential amino acids one gram defatted sample was hydrolysed with 25 ml of 6 N hydrochloric acid for 24 hr at 110°C in a sealed test tube. After hydrolysis, acid was removed by flash evaporation and the residue was dissolved in 10 per cent isopropanol and filtered. Tryptophan was determined in the defatted sample by the method of Spies and Chambers[7]. Methionine was determined by the method of Horn *et al*.[8] and threonine by paper partition chromatography.

Results presented in Table 1 show that among the varieties black gram had the lowest while *Khesari* had the highest ether extractives. Bengal gram varieties were

TABLE 1. PROXIMATE COMPOSITION OF DIFFERENT VARIETIES OF PULSES (% DRY WT.)

Variety	Ether extractives	Crude fibre	Crude protein	True protein	Carbohydrates
Bengal gram					
C-104	4.7	7.4	21.2	19.1	63.8
G-130	4.5	10.3	21.7	18.4	60.9
G-24	4.7	7.9	22.6	20.1	61.8
L-144	4.6	1.7	20.1	18.2	70.9
C-235	5.1	10.2	21.9	19.0	59.5
L-345	5.2	10.2	24.6	22.1	56.8
Green gram					
70-16	4.7	3.3	26.5	23.3	62.2
J-45	3.9	5.4	25.2	22.7	62.0
T-51	4.8	8.0	28.2	25.7	55.1
J-781	4.9	8.0	26.3	23.7	57.3
Pusa Baisakhi	4.7	8.2	26.6	24.0	56.9
Black gram					
Mash-48	3.0	3.6	24.4	22.4	65.7
Mash-1-1	2.7	4.4	23.2	21.7	66.4
T-27	2.6	4.2	23.7	21.7	66.5
Red gram					
T-21	2.9	6.9	20.5	18.4	65.9
S-5	3.1	6.2	18.2	16.8	68.6
Khesari					
LC-76	5.0	8.5	33.4	30.7	50.5
P-10	5.5	8.3	33.9	31.2	49.7
Rewa-2	5.5	8.1	30.6	28.0	53.3

TABLE 2. MINERAL COMPOSITION OF DIFFERENT VARIETIES OF PULSES

Variety	Ash %	Calcium	Iron	Phosphorus
		(mg/100g dry wt.)		
Bengal gram				
C-104	3.0	184.6	6.06	287.3
L-144	2.7	158.7	7.93	296.2
G-130	3.1	269.2	7.69	406.7
G-24	2.8	246.0	7.85	388.0
L-345	3.2	269.4	8.08	397.3
C-235	3.3	173.3	7.03	420.2
Green gram				
70-16	3.3	216.8	7.12	379.4
J-45	3.5	167.6	6.71	369.0
T-51	3.9	173.3	7.56	453.7
J-781	3.6	201.2	8.01	470.4
Pusa Baisakhi	3.6	198.3	8.00	462.3
Black gram				
Mash-48	3.5	230.8	6.72	359.3
Mash-1-1	3.5	219.2	6.87	397.0
T-27	3.2	161.5	6.61	332.3
Red gram				
T-21	3.7	238.5	5.36	341.3
S-5	3.5	246.2	5.43	365.3
Khesari				
LC-76	2.6	211.5	7.71	460.1
P-10	2.6	205.2	8.10	472.2
Rewa-2	2.4	187.3	8.78	458.7

TABLE 3. LIMITING ESSENTIAL AMINO ACID CONTENT OF DIFFERENT VARIETIES OF PULSES

Variety	Methionine	Threonine	Tryptophan
Bengal gram		g/16 gN	
C-104	1.30	4.13	0.75
L-144	1.08	3.98	0.87
G-130	1.16	3.68	0.80
G-24	1.16	3.42	0.77
L-345	1.10	3.32	0.76
C-235	1.01	4.65	0.44
Green gram			
70-16	0.97	2.68	0.74
J-45	1.12	2.92	0.76
T-51	1.72	3.01	0.62
J-781	1.51	2.81	0.65
Pusa Baisakhi	1.53	2.92	0.73
Black gram			
Mash-48	0.97	3.01	0.70
Mash-1-1	1.11	3.68	0.62
T-27	0.99	3.55	0.79
Red gram			
T-21	0.84	4.01	0.47
S-5	0.98	4.13	0.53
Khesari			
LC-76	0.33	2.72	0.43
P-10	0.32	2.69	0.42
Rewa-2	0.41	2.80	0.48
Human milk	1.18	4.90	1.80

1. National Research Council Bulletin 254, *The Composition of Milk*.

also fairly rich, while the green gram and red gram varieties had low ether extractives. Crude fibre content of *Khesari* and Bengal gram varieties was in general higher than those of black and red gram. However, 'L-144' variety of Bengal gram had as low as 1.7 per cent crude fibre. Two varieties of green gram, '70-16' and 'J-45' also had low crude fibre content, whereas the other three had higher amounts. Nearly all the varieties of different pulses were fairly rich in protein. Varieties rich in crude protein were also rich in true protein content. Varieties rich in protein were poor in carbohydrate content and *vice versa*. In general red gram, green gram and black gram varieties had higher mineral content as compared to the Bengal gram and *Khesari* varieties (Table 2). The pulses also differed in their calcium, iron and phosphorus content. Bengal gram varieties had lower calcium (except 'L-345'), iron and phosphorus content, while *Khesari* varieties were rich in iron and phosphorus. Proximate analysis of Bengal gram[1,9], red gram[10,11], green gram[12], black gram[13] and *Khesari*[14] has been reported and our results are in general agreement with these.

Limiting essential amino acid analysis of the various pulses (Table 3) showed that they differed in their methionine, threonine and typtophan content. Compared to human milk, pulses were found to be deficient in these amino acids. *Khesari* varieties had very low amounts of these three amino acids while other pulses had higher but inadequate amounts. Red gram varieties had fair amount of threonine but very poor in tryptophan. 'T-51' of green gram had the highest methionine content, which is the most limiting essential amino acid in pulses. It appears to be quite promising for further quality breeding work for methionine in green gram. These observations are in general similar to those of other varieties reported[3,15]. These results have revealed differences in the chemical composition and essential amino acid content in some of the improved varieties of different pulses.

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BOOK REVIEWS

Proceedings of the 6th International Colloquium on the Chemistry of Coffee: Association Scientifique Internationale au Cafe (ASIC) 34, rue des Renaudes, 75017, Paris, 1975.

In the above colloquium held at Bogota in June 1973 participants from Germany, Belgium, Brazil, Canada Columbia, Costa Rica, France, Denmark, Eucador, Spain, United States, Great Britain, Gautemala, Italy, Kenya, Norway, the Netherlands, Portugal, Switzerland and Venezuela presented a total number of 41 papers under different heads like—Information, Documentation and Normalisation; Methods of Analysis and Chemical Composition; chemistry and technology; and organoleptic characters and physiological effects. The details of the papers are presented in this book.

In one of the papers under documentation a comprehensive review on different aspects of chemistry and technology of Raw coffee, Roasted coffee, Coffee aroma, Coffee beverage, Instant coffee and analysis has been made. Under methods of analysis and chemical composition number of subjects like the chemical composition in respect to sugars, volatile acids, chlorogenic acid, lipids, minerals, and alkaloids in instant coffees and roasted coffees, basic principles of the technique of combined gas chromatography, mass spectrometry, modern methods like activation techniques for the analysis of chemical elements and their application to biological samples have been covered. Other papers covered various methods of research in the chemistry of natural substances, relationship between some organic compounds of Brazilian green coffee with the quality of the beverage, determination of 3-4 benzpyrene by direct fluorometry in coffee products, chlorogenic acid in regional varieties of Angola, concentration of Free radicals, N.M.R. study in Columbian coffee, and chemical methods and sensory evaluation of the Brazilian Instant coffee. Under chemistry and technology the actual state of coffee packaging techniques with special regard to flavour retention which showed the necessity of using packing materials with low oxygen free permeability and oxygen tight seals for packing roasted coffee powder to increase its shelf life has been described. In one of the papers a brief review of 8 different types of coffee roasters used in the past 15 years has been presented in which continuous 5 minute nitrogen gas pressurised coffee roaster has been described. Pressure roasting of coffee is reported to give more solubles and more mottled bean appearance. Better techniques of drying coffee extracts have been described and the advantages of getting higher soluble yields upto 40 per cent from roasted and ground coffee by the use of high temperatures for hydrolysing cellular coffee have been reported. Freezing of coffee extracts and continuous freeze drying on the plate drier and the processing costs by freeze drying of coffee with minor batch plants as well as large continuous plants have also been described. It has also been shown that there is positive correlation between moisture content of green coffee and mould development which indicated the necessity of air conditioned storage of green coffee under controlled temperature and humidity.

A number of papers are presented on the organoleptic characters and physiological effect of coffee consumption in cardiovascular disease, hyper tension, diabetes mellitus and gout and it was shown that normal coffee drinking does not have any deleterious effects. In one paper the role of volatile pyrazine compounds in contribution of good flavour and aroma of coffee has been presented and in another paper it was shown that there is strong correlation between dimethyl sulphide concentration at the green bean stage and the acidity of the roasted coffee liquor. The role of carboxylic-acid-hydroxy tryptamides and alkali colouration values as guides in assessing the wholesomeness of roasted coffees has been detailed in one paper.

From the above it is seen that coffee research has advanced tremendously in many countries of the world and it is befitting to congratulate the organisers of this sixth colloquium on A.S.I.C. which presented valuable technical knowledge on all aspects of coffee research being carried out in different countries.

This book is a valuable guide for all workers connected with coffee research and is a good reference book.

N. GOPALAKRISHNA RAO

Lactic acid Bacteria in Beverages and Food: Edited by J. G. Carr, C. V. Cutting and G. C. Whiting; Academic Press, Ny. 1975, pp. 413; Price: £ 10.80 $ 28.50.

This book contains the proceedings of a Symposium on "Lactic Acid Bacteria in Beverages and Food" held at Long Ashton Research Station, University of Bristol during September, 1973.

This compilation has been brought out at a time when the recognition of 'lactic acid' bacteria as a distinct group was being questioned. There are 23 papers covering different aspects of lactic acid bacteria. All these papers tend to bring out clearly the variability as well as diversity of their habitat and also the extremist features in some of their characters. The Symposium is organised

into six sections covering (*i*) fundamental considerations and (*ii*) technological significance of lactic acid bacteria as well as their importance in fish and meat, dairy products and acidified foods and the last section deals with classification and overall aspects of lactic acid bacteria. Each one of the papers gives a comprehensive literature review on the subject and presents results of considerable significance in their respective fields.

In the first section on fundamental considerations, seven papers were presented. The first paper presents results on the conversion of malic acid to lactic acid without the participation of lactate dehydrogenase. The second paper describes a second type of enzymatic activity in the conversion of malic acid to lactic acid. The third paper defines new criteria for selection of bacterial strains best adopted to particular wines to bring about malolactic fermentation. The fourth paper describes a new method for the determination of malolactic enzyme activity of bacteria using a carbondioxide electrode. In the fifth paper, biochemical and flavour aspects of lactic acid bacteria and some important metabolic pathways leading to the formation of flavour compounds have been discussed. The sixth paper deals with the growth factor of the organisms carrying out malolactic fermentation. The last paper in this section discusses the chemical structure of the above growth factor and concludes that it is a derivative of pantothenic acid and is present in tomato juice.

Section II is concerned (*i*) with the technological significance of lactic acid bacteria in the control of malolactic fermentation in wines by the addition of fumaric acid (*ii*) with the factors which affect spontaneous initiation of malolactic fermentation and (*iii*) with spoilage of beer with lactic acid bacteria and their role in distillery fermentations and sugar industry.

Section III on fish and meat presents papers on the significance of lactic acid bacteria in marinated herring in fresh and cured meat and then includes a paper on classification problems, ecology and some biochemical problems of lactobacilli of meat products.

Section IV on dairy products gives a useful review of literature on the part played by lactic acid bacteria in flavour of cheese. Microbiology of yoghourt is another useful paper presented in this section with a good discussion on the physiological effects of yoghurt. Under Section V, papers on acidified foods are included. The first paper reviews recent development in the fermentation of Sauerkraut and highlights the importance of controlled fermentation. The second paper deals with the factors influencing the growth of lactic acid bacteria during fermentation of brined cucumbers. In the third paper the present state of science and technology of the lactic acid fermentation of olives in California is described. The last paper of this section describes the role of lactobacilli in the production of soy sauce, sour dough bread and parisian barm.

The last section, i.e. VI Section of this Symposium is confined to the most complicated subject of classification of lactic acid bacteria and presents data on similarities between Leuconostoc and heterofermentative *Lactobacilli*. In the first paper of this section, evidence has been presented to divide heterofermentative bacteria into atleast 5 groups. The author reviews critically the available evidence on this topic. The second paper is a review on the biochemical techniques in the classification of lactobacilli. On a critical assessment, the author considers that features of the cell which are more conservative such as cell wall structure and DNA base composition are considered more significant than enzyme polymorphism in classification. The third paper of this section bears a provocative title "Lactics of the World Unite" coined after the message of Karl Marx in das Capital. But the author of this paper J. C. Carr recognises that the process of change in ideas about lactics should be by evolution and calls for all the workers on lactics to unite to understand better the complexities of the problem of classification.

The activities of the lactics cover a very broad habitat spectrum. There is hardly any publication which carries all these activities under one cover. Such a comprehensive publication is essential to understand the versatility of lactics and their metabolic behaviour with a view to utilise their potentialities for the good of mankind. The book under review fulfills such a longfelt need and deserves the place of a reference book.

V. SREENIVASA MURTHY

You and Your Health: Edited by V. N. Bhave, N. S. Deodhar, and S. V. Bhave, National Book Trust, India, New Delhi 110016, 1975, pp. 421+*vii*, Price: Rs. 20.00.

This is a reprint of the book published earlier in 1969. This book gives in simple language a wealth of information useful and necessary to the general reader on various aspects of health. The authors have taken great pains to deal with various aspects of health—physical and mental and social well-being. The book is divided into several small chapters each written in simple language by eminent persons in the field. Starting with the general concept of health and disease, the book deals with the structure and functions of the body, the nature and causes of illness, the various types of infections caused by microbes, their prevention through immunisation programmes, the significance of nutrition and

health problems of childhood, adolescence and old age in men and women. It provides a good deal of practical information which will be useful to the general public. The material will also be found useful to the general practioners, nurses and others in the field of health. The book is well illustrated.

Attention to one or two minor points may help to enhance the value of the book. The earlier edition was brought out in 1969 and has been reprinted in toto in 1975. Some of the information contained in the earlier edition has not been updated. For instance, the composition of balanced diet given in the chapter on Nutrition has been revised in 1968 by the Nutrition Advisory Committee of the Indian Council of Medical Research. Likewise, the latest dietary allowances for various nutrients recommended by the ICMR do not find a place in the book. Unfortunately, the book abounds in printing mistakes. More careful proof-reading would appear to be necessary. But for these minor drawbacks, the book is a valuable addition to the popular scientific literature available in India.

S. C. BALASUBRAMANIAN

Your Food and You: by K. T. Achaya, National Book Trust, New Delhi, India, 1975, pp. 97; Price: Rs. 5.50.

This booklet aims to provide basic knowledge in nutrition and dietetics to the common man in this country. It contains 10 chapters. The first chapter deals with the essential nutrients like calories, proteins, minerals, vitamins, etc. provided by foodstuffs and discusses briefly their functions and food sources. Various foodstuffs needed to give a balanced diet to an average family are detailed in the next chapter. The importance of blends based on foods like cereals, pulses, green leafy vegetables, milk, etc. is also stressed. Chapter 3 discusses the food pattern in India in a general way based on the survey conducted in some selected regions of the country. Chapter 4 details the digestion and absorption of food in the body. Some of the food fads and taboos commonly prevalent in India are discussed in Chapter 5. The next chapter gives the feeding pattern for babies and balanced diets for pregnant and nursing women. A working daily schedule for feeding infants is given and this will be useful to the young mother. Recipes and menus for pre-school children, pregnant and nursing women are also given. Hints for selecting and making the best use of common foods are outlined in Chapter 7 which will benefit greatly the low income groups. Chapter 8 discusses the effects of consuming ill-balanced diets deficient in essential nutrients like calories and proteins, vitamin A, fluorine, iodine and iron. The need for the prevention of the clinical condition (lathyrism) caused by toxic factors present in lathyrus seeds is stressed. Suggestions for special diets suitable for feeding persons suffering from diabetes mellitus, peptic ulcer, diarrhoea. obesity and fever are given in Chapter 9. The last chapter deals with the dangers caused by infection, unhygienic conditions and consumption of contaminated foods and methods for their elimination. The booklet does not contain a subject index which is essential and will be useful to the reader in locating the desired topics.

Summing up, the author has succeeded to a considerable extent in presenting in this booklet, all the relevant facts about nutrition and dietics in a simple language. This booklet will help the common man and homemaker in understanding how better nutrition and health can be attained by using commonly available food materials within the purchasing power of the community.

M. SWAMINATHAN

Commercial Fruit Processing: by J. G. Woodroof and B. S. Luh, The Avi Publishing Company, Inc. Westport, Connecticut, U.S.A., 1975; pp. 710+x; Price: Rs. 40.00.

"Fruit Processing" is one of the wheels or legs that supports the food industry. It is constantly changing (*a*) to accommodate the supply and demand of fruits and the diets, and (*b*) to keep abreast of the horticultural, engineering and nutritional needs. The claimed purpose of this publication is to present the available knowledge on different aspects of fruit processing covered in 16 chapters, out of which 8 are written singly by Prof. Woodroof, 3 by Dr. Luh in collaboration with other specialists and the remaining 5 chapters by other specialists. Thus in all ten specialists, all from USA, contribute 16 chapters covering processing of about 40 fruits. The book has a fairly comprehensive subject index.

Chapter 1 covers brief history of canning or thermal processing, drying, chemical preservation, dehydration, concentration, radiation, freezing or combination of 2 or 3 techniques, development of thermo-couples, techniques for better preservation of nutritional quality and commercial sterlising methods with merits and demerits. At the end, production and processing data relating to manufacture of fruit products, etc. in USA and Argentina have also been presented, by loading the first chapter with as many as 19 tables.

The second chapter on harvesting, handling and storing of fruits deals with fruit maturity, ripening and harvesting by different techniques such as mechanical and shake—catch methods of some individual fruits are

discussed. Fruit handling, conveyers and containers like bulk fruit bins, containers for hydro-cooled peaches, and bulk storage, pre-cooling and C.A. storage of several fruits are covered. However, harvesting and handling of tropical fruits like mango, banana, papaya, passion fruit, etc. are not discussed. Illustrations though numbered, (2.1 to 2.3) are not cited in text for quick reference.

The third chapter on washing, peeling and preparation for processing covers different methods of peeling such as by hand, by using boiling water or steam, lye-peeling, dry caustic peeling with infra-red heat or by using high pressure steam, freeze peeling, cryogenic freezing and acid peeling, preparation, electronic grading, bleaching of cherrys, factors affecting cherries scald pesticides in handling fruits and irradiation of fruits.

In the fourth chapter on suitability of fruits for processing, primary factors like latitude, altitude, closeness to the sea and lakes, type of soil, rainfall and available irrigation water are first discussed. Then primary industrial factors such as processing for local, national and international markets, source of water supply, disposal of waste, labour supply, importance of leading varieties, etc. are also discussed.

Chapter 5 deals with factors affecting microflora in dehydrated, frozen, and canned fruits, fruit juices, catsups, pickles and preserves. The examination and identification of spoilage fungi and yeast has also been discussed briefly.

Chapter 6 on canning of fruits is the biggest one (125 pp.) and covers the various factors governing the setting up of cannery whereafter canning of about 40 fruits are also discussed individually. However, canning of important tropical fruits like mango, papaya and passion fruits are not covered.

Freezing of fruits is discussed in chapter 7, which covers statistics of the American frozen fruit industry, factors affecting quality of frozen fruits, handling of fruits for freezing and processing problems relating to colour, flavour, and texture changes. Quality changes resulting from processing and thawing discussed are the effect of delayed processing and mechanical damage, subjective and objective methods of quality evaluation. Frozen fruit juice concentrate, usage of pectic enzymes, concentration, colour loss at high temperature, methods of fruit juice concentration including freeze concentration, low-temperature vaccum evaporation, high-speed, high temperature evaporation, volatile essence recovery, de-eration of citrus juices and concentrates, reverse osmosis, freezing methods and freezing preservation of fruit purees and concentrates, packaging of fruit juice concentrates, preparation and freezing of individual fruits are discussed in fair detail.

In chapter 8, brief history, present prospects and advantages of dehydration of fruits, pre-drying treatments including sulfuring, individual quick blanch (IQB), osmovac drying, blanching and partial dehydration by centrifugal fluidized bed (CFB), different drying and dehydration techniques and equipments have been discussed. The drying processes include explosion puffing, foam-mat drying, spray drying, drum drying, micro-wave heating, vacuum drying and freeze drying etc. Post-dehydration treatments like sweatting, screening, inspection, instantization process, packaging, in-package desiccation, compression, dehydro-freezing and quality control and practical drying processes for pome, drupe, tropical and sub-tropical fruits, etc. are also discussed.

Bringing of cherries and other fruits and factors affecting quality and yield are dealt with in chapter 9, while other methods of fruit processing like manufacture of jams, jellies, marmalades, perserves, candied fruits, pickles, fruit buters, fruit essences and essential oils, wines, dehydrated protein-fortified fruit juices, concentrates, pineapple granules, fruit flakes, tit-bits, pellets, etc. are discussed in chapter 10. In addition, fortification of fruit juices with vitamin C, prevention of fruit browning and vacuum packaging are also discussed.

Flavour and colour of fruits as affected by different methods of processing are discussed in Chapter 11, while chapter 12 covers in fair detail the composition and nutritive value of raw and processed fruits. Quality grades and standards for raw and processed fruits as laid down by the U.S. Food and Drug Administrations are covered in chapter 13, while chapter 14 covers the storage life of canned, frozen, dehydrated and preserved fruits. Trends in plant senitation and waste disposal are dealt with in chapter 15, which covers in detail the waste pollution evaluation and waste treatment management, etc. In the last chapter, consumption trends and prospects for processed fruits and factors influencing consumption, etc. are discussed.

The present volume provides excellent compilation of the present knowledge on practically all the important facets of fruit processes and should be of practical interest to fruit processers, post-graduate teachers and students in fruit technology and all those interested in the manufacture, quality control and standardization of fruit products. However, one cannot fail making one observation after going through the entire book that most of the references deal with the American and Western literature while significant contributions have been made by some fellow fruit technologists from the developing countries, notably on tropical fruits like mango, papaya, passion fruit, etc. which do not find a place in this book. For example, even standard

references (chapter on Passion Fruit Processing/Canning) covered in standard American books like Advances in Food Research, Vol. 12 have failed to attract the attention of the distinguished authors, which would have provided them ample information and world literature on the subject. Barring this it is an excellent treaties and should find a respectable place in the libraries of Food or Fruit Technological Laboratories and Institutes. Printing, binding and presentation are excellent, but its price is rather on the high side.

J. S. PRUTHI

Freeze Drying and Advanced Food Technology: Edited by A. S. Goldblith, L. Rey and W. W. Rothmayr, Academic Press, London, New York, 1975; pp. 730; Price: £ 17.00.

Ever since the introduction or lyophilisation on a large scale, thirty years ago, the technology of freeze drying has made rapid strides inspite of the high cost of the process. Though it could not replace other conventional methods, food industries are increasingly adapting freeze drying for various products resulting in continuous search for improvements and modifications to make the process economically viable. The magnitude investment, round the globe, in industrial freeze drying, during the last decade or so is a sufficient pointer to the potential of this sophisticated technology. Evolution of the process during this time has also resulted in "technological advances in high vacuum techniques, development of refrigerants, refinement of heat transfer techniques, and control instrumentation". All these facts are well covered in the collection.

The book under review presents the proceedings of an "International Course on Freeze Drying and Advanced Food Technology" held in June 1973, at Burgenstock, Switzerland, and forms a part of Food Science and Technology monograph series.

The book contains 41 chapters divided into nine sections.

The first section, namely Basic knowledge of freezing process, containing five chapters, includes a well documented review on the crystallization of water, principles involved in freezing of biological systems and use of halogenated hydrocarbons and carbon dioxide for freezing.

The second section of six chapters covers the application of freezing process to various systems such as blood, viable tissues, viruses, vegetables and fruit juices; the last two being of particular value to food technologists, as all the theoretical aspects are extensively discussed. The basic knowledge of freeze drying is presented in the section in six chapters. These include theoretical and fundmental aspects of freeze drying of coffee, marine products, and meat with emphasis on the heat and mass transfer in freeze drying and the use of various high powered low temperature refrigeration plants in large scale freeze drying.

Application of freeze drying technology to specified products like sliced beef, the qualitative and quantitative aspects of the collapse phenomenon and the freeze drying of liquid foods like coffee, tea, fruit juices, neer, whole egg and vegetable juices, covering all aspects of technological consideration are dealt with in section IV. The next section deals with the most important aspect namely influences of freeze drying on the quality of the product such as retention of volatile components, as affected by the process and the process conditions, the texture and the reactions of water at the surface of the product.

The next and final section on freeze drying describes at length various industrial freeze drying plants for foods, use of liquid nitrogen for low temperature freeze drying of aqueous and non aqueous solution and physicochemical contamination of freeze dried pharmaceutical products.

The last three sections have been devoted to advanced food technological techniques of concentration like gel filtration, freeze concentration, membrane processing, ultra filtration and hypo filteration.

Principle, technology and the stability of intermediate moisture foods are covered in Section IX.

In the concluding chapter, the well know scientist Dr. S. A. Goldblith, discusses the various principles and applications of radio frequency energy to food preservation, especially for concentration and dehydration.

The galaxy of contributors to this volume includes names familiar to the student of food technology and well recognised in the international field of freeze drying and other futuristic technologies. As rightly put in by Prof. Louis Rey in his introductory paper "Freeze drying has a future and it is likely that this will essentially be in the field of chemistry and food science". The book is extensively illustrated and with excellent printing and presentation will prove to be a valuable source of information to food scientists and technologists who are actively engaged in the field of freeze drying and other concentration techniques, both in research and industry.

T. R. SHARMA

Transport of Perishable Produce in Refrigerated Vehicles and Containers: International Institute of Refrige-

ration Commission D2 Wageningen, The Netherlands BFRAAV 12-235: 1974; pp. 240.

This book is the 33rd Volume of the Series on "Refrigeration Science and Technology" published by International Institute of Refrigeration. It contains 20 papers relating to transport of perishable produce in refrigerated vehicles and containers, and the discussion held in Wageningen on the above subject.

The first Section of the book discusses the requirements, performances and tests of refrigerated vehicles with a view to standards and evaluate transport vehicles for problem solving.

Section Two contains design and performance data of refrigerated transport system with reference to air temperature, humidity, temperature relationship on compressor/evaporator duties, outside conditions and their effect on refrigeration load and finally air-product temperature relationship in cold storage of agricultural produce.

Section Three gives test data on clip-on-refrigeration container, and complete programme on temperature distribution in cargoes.

The problems of refrigerated transport are many, yet the salient aspects of frozen cargoes and refrigerated transport vehicles performances and tests are brought out clearly. The book will be a useful and practical reference on the actual performance of transport vehicles for perishables.

P. K. RAMANATHAN

Cooling and Freezing Aboard Fishing Vessels: International Institute of Refrigeration Commissions B-2, D-3—Tokyo, Japan, BFRAAV 1 1-295, 1974; pp. 300.

The proceedings of the meetings of International Institute of Refrigeration are published under the series- "Refrigeration Science and Technology".

The book under review is the 32nd publication devoted to the cooling and freezing of fish aboard fishing vessel. It contains 31 reports on the subject presented by specialists from 14 countries.

The marine fishing industry has advanced tremendously demanding high capacity refrigeration installations with accurate control of freezing and storage temperatures.

The technical aspects are covered in Part I under 4 sections devoted to general conception of refrigerating installation, compressors and refrigeration circuits, cooling and freezing equipments and handling equipments.

Modern techniques of fish freezing, problems and advances in deep freezing, chilling woth sea water, finely crushed ice are discussed with their economies. The relative merits of freezing equipments for rotary plate freezing, freon freezing are described. Computerised models for design of fish handling and freezing plant are described with the economics of such plants.

Discussing the various types of refrigerating compressors the application of screw compressors and their performances are highlighted. Evaporator performances, refrigerated sea water storage tanks and air coolers are presented in a series of papers. Processing and refrigeration facilities required for a fish factory are indicated with specifications of freezing equipments. Handling equipments and their performances are discussed indicating their capacity limitations.

The second part of the book provides information on the quality aspects of fish frozen aboard the ship with reference to freezing and storage techniques for fish.

As a collection of articles, exhaustive information on various aspects of refrigeration and freezing plants, their operation and economics for fish freezing are readily available. This is a valuable working document for marine engineers and researchers in fish freezing processes.

P. K. RAMANATHAN

Food Process Engineering: by Dennis R. Heldman, Westport, Connecticut, The AVI Publishing Company, Inc., 1975, pp. 401.

"Food Process Engineering" is a useful book for practising food scientists, technologists, engineers engaged in research, teaching and industry. The author after assuming some background information in calculus and differential equations, heat transfer, thermodynamics and fluid mechanics, presents to the reader, the principles of food engineering in simple language.

The book consists of the following chapters: (1) Introduction; (2) rheology of processed foods; (3) heating and cooling processes; (4) thermodynamics of food freezing; (5) evaporation for fluid food concentration; (6) food dehydration; (7) contact equilibrium processes; (8) mechanical separation processes.

The introductory chapter deals with basic principles of thermodynamics, reaction kinetics, mass and heat transfer with adequate examples from food industry. In the remaining chapters, the author discusses the unit processes and unit operations involved in food processing

studies. The author explains parameters and process functions involved in various unit processes and handling equipments; restricting them however to the design aspects only. The book clearly gives an idea to a young food scientist regarding the materials to be handled and a suitable equipment to be used with appropriate schematic illustrations of various equipments, unit processes, phase changes in food products during processing and has reinforced his presentation with his and other workers' experimental data throughout. It also contains an appendix with eleven tables for finding out the thermal properties of various food products, diffusivity data and gas constants and six graphs for determining temperature histories in systems involving unsteady state heat transfer, equilibrium diagram for ethanol-water, propane-oleic acid-cotton seed oil systems.

The book will be a welcome addition to food science and technology libraries and students/scientists engaged in study/research/teaching.

M. M. KRISHNAIAH

NOTES AND NEWS

CFTRI Celebrates Silver Jubilee

Soon after Independence, when national policy on research and development was concretised, a chain of CSIR laboratories and institutes came into existence. The foresightedness of our first Prime Minister Sri Jawaharlal Nehru and the first Director of CSIR, Dr. S. S. Bhatnagar who carved out an imaginative programme of technological development in the country resulted in the creation of these national assets like CFTRI. The Central Food Technological Research Institute was formally opened by Sri C. Rajagopalachari in this beautiful building which was graciously donated by the erstwhile Mysore State in the year 1950. The aims and objectives of the Institute include the development of relevant technologies for the conservation and stretching of our food resources through minimising losses at various levels, develop nutritious food products from indigenous raw materials, provide convenience to the housewives to reduce the drudgery of kitchen practices, provide assistance to the industry and new entrepreneurs in launching new ventures and solving their day-to-day problems of production and quality control, advice government agencies in their food policy and control.

In 1950, the Institute started with a nucleus staff of 65 and an investment of Rs. 4 lakhs annually. Today it has close to 1000 scientists and supporting staff with an annual investment of Rs. 1.20 crores. This is an indication of the expertise which it has built over a period of time in its scientists and technologists. Pioneering scientific work at the CFTRI has resulted in establishing the milk powder industry and saved millions in foreign exchange. The Institute has to its credit 2,400 technical publications, feasibility reports, pamphlets, books etc. It offers turn-key technology in several areas of food processing covering a large number of raw materials. 130 major processes have been transferred to the field, with 275 parties exploiting the same. Besides 41,300 technical consultancies have also been offered and close to 700 parties have taken advantage of it. Training in Food Science and Technology also forms a strong activity of the Institute. It has an International Training Centre for South and South-east Asia and has so far trained 228 students from 20 different countries of the region, besides a large number of Indian students, towards the Master's Degree in Food Technology of the Mysore University. In addition close to 700 participants from industry of the region have benefitted through short-term courses in specialised areas. FAO and the Mysore University are the active partners in this training programme.

The Silver Jubilee Celebrations of the Central Food Technological Research Institute was inaugurated by the Prime Minister of India Smt. Indira Gandhi on February 13, 1976. The Prime Minister was received at the Institute by Dr T. Nayudamma, Director General of CSIR and Dr B. L. Amla, Director of the Institute along with other dignitaries. The Prime Minister after officially opening the Fermentation Technology Block of the Institute went round the pilot plant set up of the Institute, where she evinced keen interest in the working of the mini rice mill, maize de-germer, soji plant, modern dal mill and several other equipment developed by the Institute. She then went round the exhibition where products manufactured by utilising CFTRI technology from different food industries were arranged. Besides this it included several new processes and products that will be ready in the near future for commercial utilization.

The Prime Minister presented awards to Dr. V. Subrahmanyan and Dr. H. A. B. Parpia, in recognition of the meritorius service rendered by these former two directors of the Institute. Momentos were also distributed to 28 staff members of the Institute who have completed 25 years of service. The Chief Minister of Karnataka Sri Devaraj Urs, released the Souvenir brought out on the occasion. The Governor of Karnataka, Sri Uma Shankar Dikshit presided over the function. Dr. Y. Nayudamma, Director General, CSIR also spoke on the occasion. Dr. B. L. Amla, Director of the Institute, delivered the welcome address and Sri S. K. Laxminarayana of the Institute proposed a vote of thanks. The function was attended by a large gathering of scientists, educationists, industrialists and other distinguished elites of the city.

Excerpts from the Inaugural Address Delivered by Smt. Indira Gandhi, Prime Minister of India

Distinguished guests, distinguished scientists and members of CFTRI family,

This institution is doing remarkably good work, and it is located in one of the most beautiful cities of our country. So I am happy to be here on this occasion. I give you on the occasion of your 25 years of useful service my own and nation's greetings.

Our effort has been to use science to overcome poverty and reduce disparities. We believe that it is essential from the human point of view as well as from the nation's that the deprived should have equal opportunity. The sum total of our scientific capacity must be improved.

Double Food Production in Two Decades

In the last twenty five years, we have doubled our food production and if you add potatoes and tapioca and most countries do count tubers in their food production, our production would be ten million more. We must double the production once again in the two decades ahead.

Storage of Food Grains

We were told that if we had had better storage, we would have been able to reduce our import, and that we lost about a fourth of our grain to rats. Since then, our warehousing has improved in quantity and quality. What was not possible ten years ago can be achieved today and this is because of the good work done by our scientists. But the need is to educate our people specially farmers, in storage methods. Only in recent years has the world become aware of the danger of indiscriminate use of pesticides. Besides killing real pests, insecticides destroy many useful species. For instance, I am told that snakes which used to eat rats, are now killed by pesticides and this has increased the rat population.

Science and Nutrition

True science constantly reappraises itself. If earlier work is found to be wrong, you must discard it unceremoniously and without regret. Scientists should educate our people in the elements of nutrition. In food also there seem to be fashions which are not always benefical. You mentioned that you try to produce what the consumer wants. What the consumer wants is not necessarily what is good for him. Eating what he fancies may not give us the nourishment we need. In India, we have seen that even those people who can well afford any amount of nutritious food are not necessarily healthy in fact or in looks.

False values and the desire for imaginary social status have changed taste and demand. Affluence in our country has meant to change over from the so called coarse grains to wheat and rice. People in this region regard ragi as a sign of low status and in our part of the world—in the north—it is the same with bajra, jowar and so on. The use of many kinds of leafy vegetables is being given up. Nutritionally, the various traditional regional diets have much sound sense, which needs to be rediscovered and widely propogated. Waste of any kind anywhere is a crime, and waste of food is doubly criminal in a country like India.

The other point is that of cleanliness. Cleanliness in our homes or cities, and above all in our eating habits. It is the duty of every citizen to protest against unhygienic manner of cooking and serving food in bazaars, along the roadside and sometime even in our homes.

Protein Foods

The protein intake of most Indians is low. The common sources are milk, egg, fish and meat. The affluence of industrial countries is also expressed in terms of per capita consumption of animal protein. In the last 25 years, in some affluent countries, this figure has doubled. It is now considered a health hazard. It is also far more wasteful economically, for one unit of animal protein requires five or six times more investment than the same quantity of vegetable protein. It is evident that economic management of the world's resources demands some shift from animal to vegetable protein. In India we must search for proteins which conserve our restricted resources. I am glad that research in this direction is being carried out here.

Waste Utilization

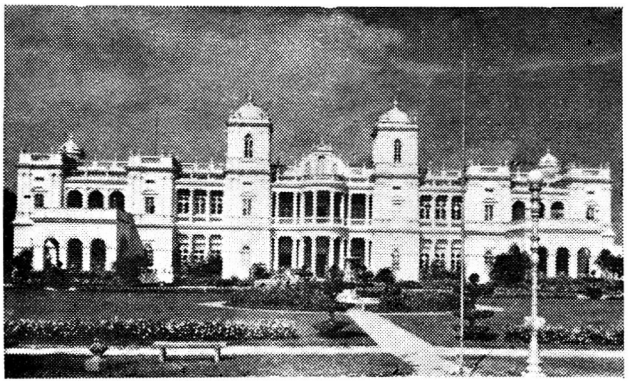
A major lesson for scientists themselves, and for all of us, is that nothing is without use. In nature waste itself is a source of wealth. Experiments are being undertaken in many parts of the world to extract chemicals and nutrients from garbage. Recycling and recovery should be an integral part of our outlook on life. Our young scientists should not wait for guidelines from Government. But should show us the way constantly giving us their ideas and suggestions. A technological institute must find solutions for the problems brought by clients. The nation appreciates the pioneering scientific work which this institute has done in establishing the milk powder industry which has saved us millions in foreign exchange.

Cooperation Among Nations

I was specially happy to learn the high standard maintained in this Institute and that we have a number of students and teachers, experts from other friendly countries. This is the sort of cooperation that is most needed in the world of today that we should share our knowledge and our problems and try and find solutions which will be beneficial to all.

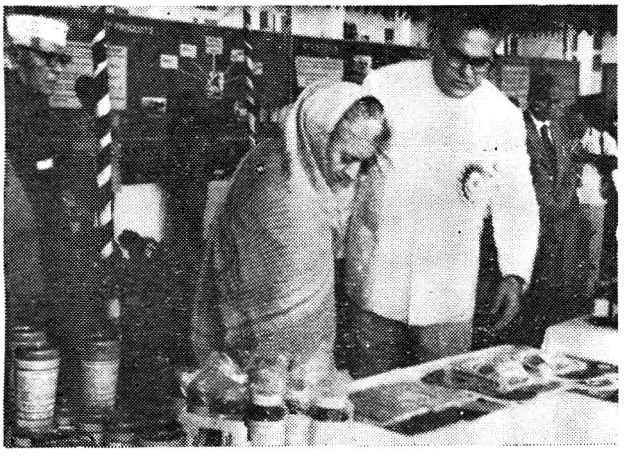
Award of Meritorius Service Medal to Dr. V. Subrahmanyan—Citation

Dr V. Subrahmanyan, the founder Director of Central Food Technological Research Institute, brought into functioning the Institute in a record period. Under his stewardship, he nurtured and built it up into a premier research institution in the tropics with particular emphasis on protein rich foods and on cereal technology. He initiated the idea of the use of the oilseed cakes for human foods 30 years ago and this led to the production of a variety of high protein foods for the vulnerable groups of the population. A signal development is the infant food based on buffalo milk which has laid the



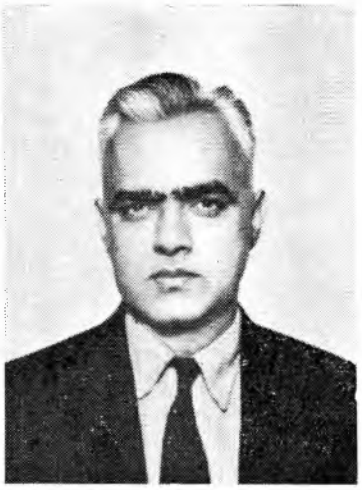
The Central Food Technological Research Institute Celebrated its Silver Jubilee on February 13, 1976.

Prime Minister Smt. Indira Gandhi inaugurates the Silver Jubilee Celebrations of CFTRI.



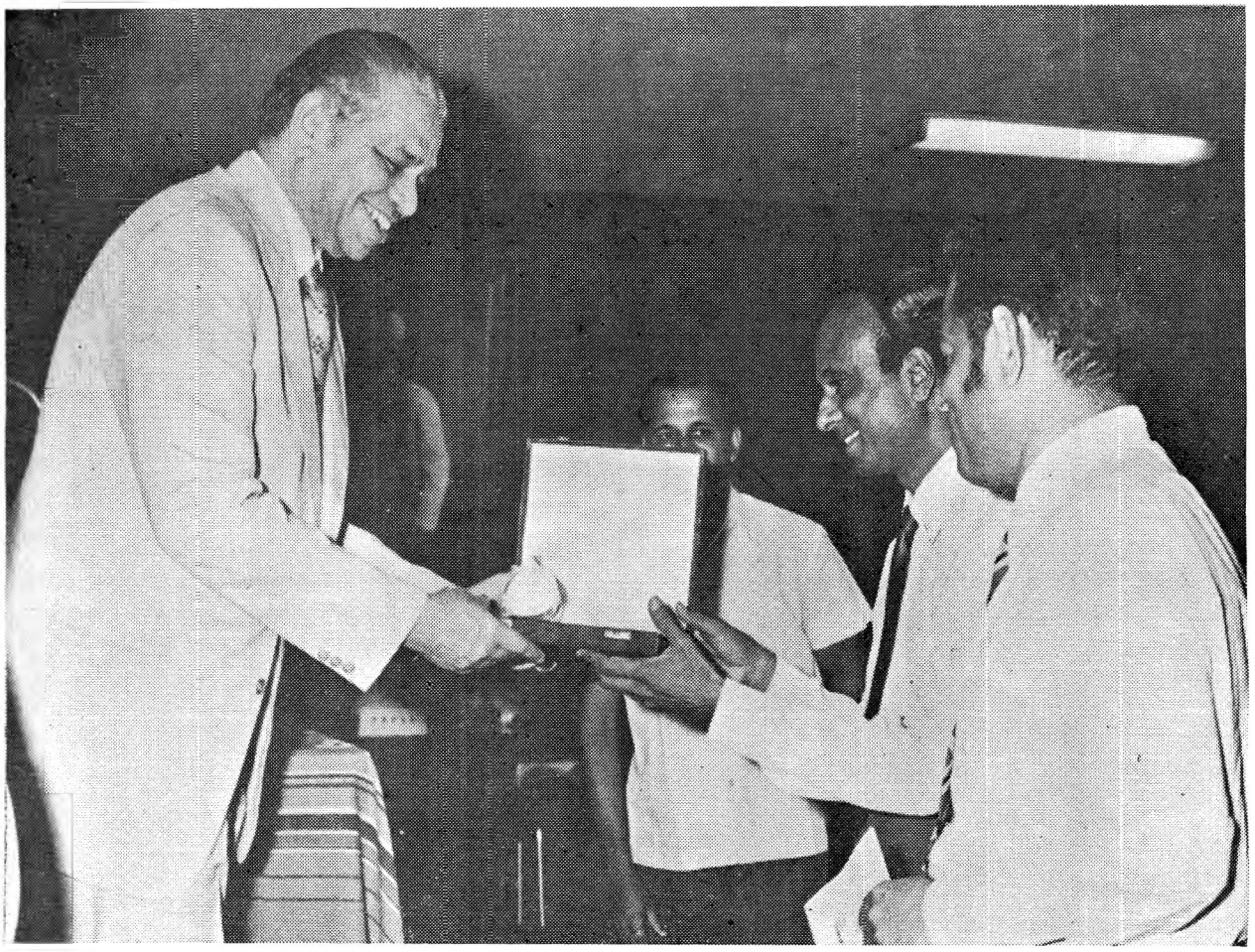
Prime Minister Smt. Indira Gandhi at the Exhibit Stall with Dr. B. L. Amla, Director, CFTRI.

Dr. V. Subrahmanyan



Dr. T. N. Ramachandra Rao

Dr. H. A. B. Parpia



Dr Y. S. Lewis of Central Food Technological Research Institute, receiving the award at Bombay from Sri L. K. Jha, Governor of Jammu and Kashmir.

foundation for a new baby food industry in the country. After retirement from official service in 1963, he for a brief period took up assignment with F.A.O. as Adviser to the Philippines Government. Heactively continues his research on processing and preservation food grains as the Project officer, Paddy Processing Research Station, Thiruvarur.

Award of Meritorius Service Medal to Dr H. A. B. Parpia—Citation

Dr H. A. B. Parpia, during his tenure as the Director of Central Food Technological Research Institute, was primarily responsible for giving a fresh impetus to the development of vegetable protein based beverages and infant and weaning foods. He emphasised the need for post-harvest conservation of food. His untiring efforts in both national and inter-national forums have made the world aware of the importance of proper storage of food especially, in the developing nations. He was the architect of the International Food Technology Training Centre to train scientists and technologists from countries in South and South-east Asia. He continues to serve the cause of food science and technology in the developing nations in his new assignment with FAO of the United Nations.

Rafi-Ahmed Kidwai Memorial Prize

Dr T. N. Ramachandra Rao, Past-president, Association of Food Scientists and Technologists (India), has been awarded the 1972–73 Rafi Ahmed Kidwai Memorial Prize of the Indian Council of Agricultural Research (India) for outstanding research contributions in agriculture and allied fields.

Dr. T. N. Ramachandra Rao retired as the Chairman of Microbiology, Fermentation Technology and Sanitation Discipline, Central Food Technological Research Institute, Mysore in December 1974, after 32 years of service.

Born in January 1915, Tumkur Nanjappa Ramachandra Rao, received his Honours and Master's degree in Botany from the University of Mysore. Later he obtained the Associateship (A.I.I.Sc.) of the Indian Institute of Science, Bangalore, and Doctorate from Mysore University. He received advanced training in Fermentation Technology Systematics and Algal Technology at Tokyo, Prague and Dortmund.

During the years 1942–51, he worked at the Indian Institute of Science, first as a Research Scholar and later as a staff member. As the Microbiologist in charge of the National Collection of Type-cultures (India) he developed new methods for the classification and identification of yeasts. He also contributed in the area of microbiological assay techniques and citric acid.

He spent 5 years at the Biochemistry Department of National Chemical Laboratory working on electron microscopy of lactic acid bacteria and yeasts. In 1955, he moved to the Central Food Technological Research Institute, Mysore, where he developed an active school of research in applied microbiology. The work related to Fermented Foods, Industrial Enzymes, Amino Acids, and Microbial Genetics. This applied work has helped the Indian food processing industry to develop a few products based on indigenous knowhow. He has published over sixty research papers, several reviews and has several patents to his credit. Dr. Rao was the recipient of the Bhabha English Prize of the Mysore University and later received the Prof. M. Sreenivasaiya Memorial Prize of the Indian Institute of Science. He was a founder member of Association of Food Scientists and Technologists (India) and later its president in 1974. He is the President-elect of the Association of Microbiologists (India) for the year 1976. He is one of the Editors of the European Journal of Applied Microbiology. He has been an active member of the Society of Biological Chemists (India).

Dr. Rao, continues to work as an Emeritus Scientist (CSIR) at the CFTRI, Mysore, since retirement.

CAMP Symposium at RRL, Jammu

The Symposium on Cultivation and Utilization of Medicinal and Aromatic Plants held at the Regional Research Laboratory, Jammu from 6th to 8th March 1975 was third in the series of Symposia organised so far by RRL, Jammu, the earlier ones being in 1961 and 1969. The Symposium was attended by a large number of representatives from Industry and Research Institutions from all over the country. About 50 research and review papers were read and discussed during the three days. Although the emphasis was more on medicinal and aromatic (perfumery) plants, there were a number of papers of interest to the food technologists, like those on hops, pyrithrum, spices, mints etc. Special lectures by experts in the field like Dr. T. S. Sadasivan, Dr. Janakiammal, and Mr. Nimbalkar were also arranged. In the concluding session, important recommendations for promoting cultivation and industrial utilization of medicinal and aromatic plants were drawn up.

International Seminar on Pepper, Ernakulam—Cochin

The Spices Export Promotion Council, Ernakulam, organised an International Seminar on Pepper on 12th and 13th March 1976 at Ernakulam, Cochin. Four sessions on (*a*) Production, (*b*) Marketing, Grading and Quality Control, (*c*) Processing and (*d*) World Trade were held. Twenty four papers on various aspects of pepper industry were read and discussed. A large number of delegates from India and abroad took part

in the deliberations. Representatives of trade, industry, research institutions, and planters discussed the problems facing the pepper industry. The American Spice Trade Association, Tropical Products Institute, London, McCormick & Co., USA, International Trade Centre, Geneva and other organisations from Germany, Yugoslavia, Japan, Ceylon etc., participated in the deliberations. Important recommendations were drawn up by the different groups after separate discussions in the end and presented in the Plenery Session. These are bound to have great impact on future research, processing and trade in pepper and pepper products.

The Indian Merchants Chamber Award

The Central Food Technological Research Institute was given the Indian Merchants Chamber Award for the year 1974, for outstanding contribution to the development of Food Industry in India. The Award was in recognition of their process for the production of spice oils and oleoresins which has now been widely used by the industry in the country, increasing employment potential and earning foreign exchange. The group of scientists-E. S. Nambudiri, Y. S. Lewis, A. G. Mathew, N. Krishnamurthy and C. P. Natarajan—were presented the gold and silver shield at an impressive ceremony held in Bombay on 21st February 1976.

American Institute of Chemical Engineers: an Announcement

Asian Pacific and Western Hemisphere Chemical-Engineering Societies will have their first joint meeting August 28-31, 1977, in Denver, Colarado, USA. The four-day meeting will be held at the Denver Hilton Hotel.

With the announcement of the meeting has come a *particular invitation for technical papers from chemical engineers and scientists in India.*

Prospective authors are invited to immediately contact, W. Robert Marshall, Dean College of Engineering University of Wisconsin, 1415. Johnson Drive, Madison, Wisconsin 53706, U.S.A.

ERRATA

Prediction time of hydration during parboiling of paddy from activation energy by S. Bandopadhyay and N. C. Roy, *J. Fd. Sci Technol;* 1975, **12,** (4).

In page 197 the equations should be read as:

$$\bar{X} - X_i = \frac{2}{\sqrt{\Pi}} (X_s - X) \frac{S}{V} D_m \theta + X_i \qquad \ldots\ldots\ldots\ldots (1)$$

$$\bar{X} - X_o = K_m \sqrt{\theta} + X_i \qquad \ldots\ldots\ldots\ldots (2)$$

In page 198, Table 2 (B) variety; Jhingasal X_i: the value should be read as 0.098 instead of 0.046.

ASSOCIATION NEWS

Meeting of the Bangalore Chapter held on 16th December 1975, at Food Craft Institute

Mr. Sharad Dravid, Production Manager, Kissans, presided over the meeting and Miss M. C. Madhura, the Secretary introduced the speaker, Miss Padmasini Asuri, Regional Home Economist (South).

The importance of standardisation of foods formulated specifically for consumption in rural areas was stressed by the speaker and further she elaborated the magnitude of the task and described the factors that are to be considered in evolving such a programme.

One of the important task was the formulation of suitable infant foods using locally available materials (cereals, pulses etc). An optimum combination of these raw-materials is to be achieved for optimum result. Standardisation of cooking and the need to keep in view, the cultural background and dietary habits of the population are the important factors to be considered in formulating such foods. The ease of preparation of these foods and the day's nutritional requirements are other factors to be kept in view. It was not merely a catering problem but should be considered from the overall nutritional requirement and not as a mere nutritional supplement. These foods should possess good taste and should be accetable to the consumer.

Certain raw-materials such as soya need processing before they are consumed. Such processed foods available in the market are expensive and hence not within the reach of a common man. Hence there was a need to develop simple methods of processing to utilise this protein rich-raw material. Similarly developing simple procedures for parboiling paddy on a small scale at home (3-4 kgs per batch) and simple methods for processing of seasonal fruits were required to be developed and standardised. Farmers are to be educated to prepare these products using the seasonal fruits. This would mean more employment opportunity and increased rural transportation. Such programmes aimed at developing foods for rural areas should take into consideration (*a*); the potential cropping pattern (*b*) per-capita availability—expenditure or income per acre; and (*c*) the purchasing power of the rural families.

Meeting of the Bangalore Chapter held at East-West Hotel on 9th Jan. 1976.

Mr. Panduranga Setty, President welcomed the gathering. He distributed certificates to the Ist batch of students from the Food Craft Institute for having completed the course conducted by the Bangalore Chapter of the Association on Prevention and Detection of Food Adulteration.

Chief guest of the meeting Mr. N. Narasimha Rau, Commissioner & Secreatary, Health and Municipal Administration, commeneded the excellent work carried out by the Bangalore Chapter. He himself was not aware of this very useful course on prevention and detection of food adulteration conducted by the Bangalore Chapter, and hence he felt that the work of this chapter should be given better publicity and he hoped that more people would avail this opportunity for getting this training.

Mr. P. Padmanabha, Secretary, Food & Forest, stressed the need for a handy kit for detection of food adulteration and a brochure in English and regional language on simple methods for detection of food adulteration. He suggested that the chapter could take up this task and that it would be most useful to the general public.

New Members

Mr. K. R. Srinivasan, Assistant Director, Central Ware House. Chrompet, Chitlapakkam Post, Madras-600 064.

Mr. T. C. Sunder Raj, C/o M/s Spencer & Co. Ltd., Madras.

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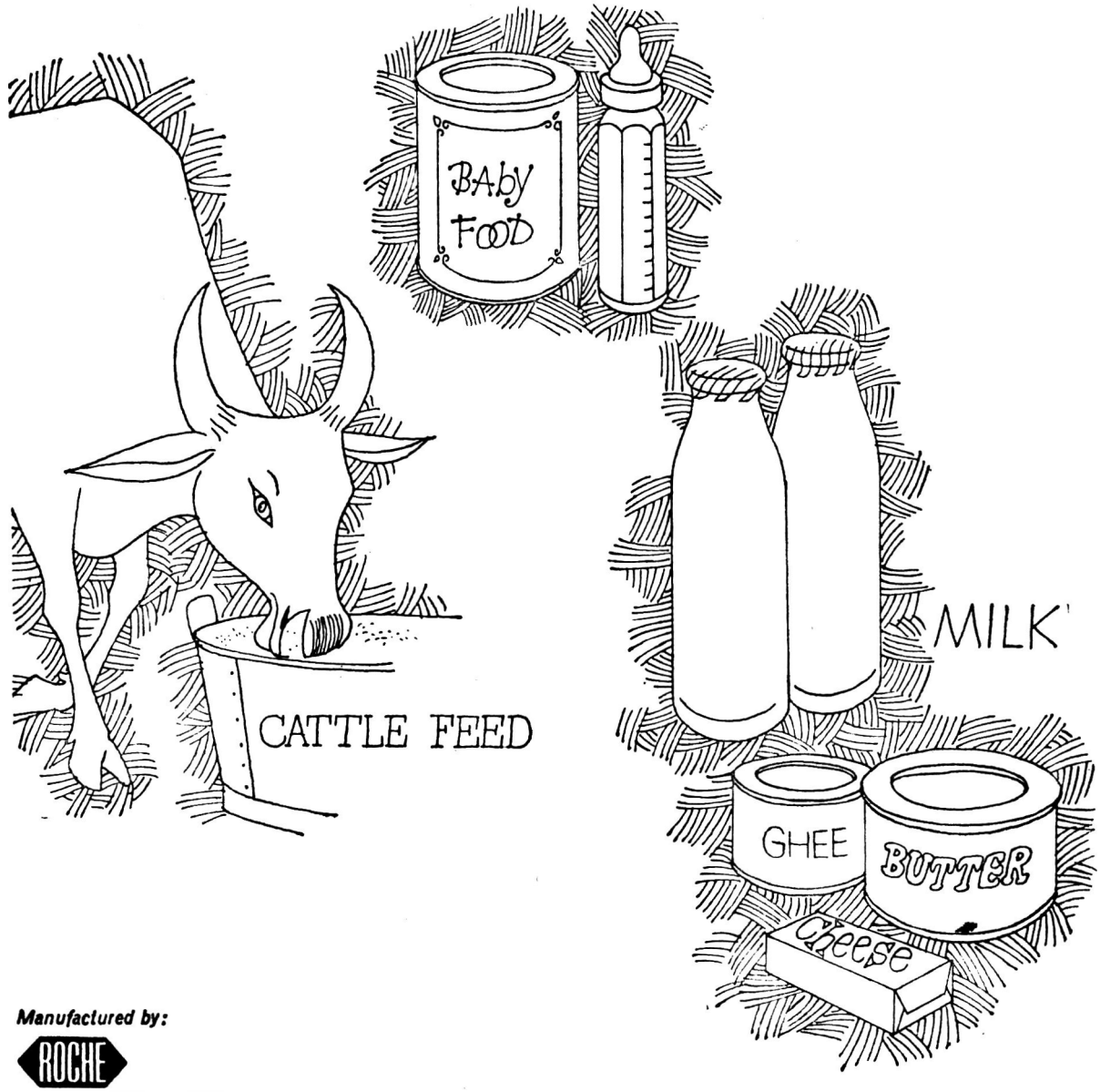

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   (*c*) *References to article in a book:* Joshi, S. V., in the Chemistry of Synthetic Dyes, by Venkataraman, K., Academic Press, Inc., New York, 1952, Vol. II, 966.

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   (*e*) *Thesis:* Sathyanarayan, Y., Phytosociological Studies on the Calcicolous Plants of Bombay, 1953, Ph.D. thesis, Bombay University.

   (*f*) *Unpublished Work:* Rao, G., unpublished, Central Food Technological Research Institute, Mysore, India.

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