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RESEARCH PAPERS

Studies on the Production of ∝-Amylase in Submerged Culture

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Some of the fermentation parameters needed for scale-up of ∝-amylase production by *Aspergillus niger* have been optimised. The optimum carbohydrate content was found to be 3 per cent, air 1.0 VVM and agitation speed 350-450 rpm. Maximum yield of the enzyme was obtained in cultures grown at 35±1°C for 60-72 hr. The measurements of appearent viscosity indicated that this parameter could be used for monitoring the progress of fermentation or the production of ∝-amylase.

Amyloytic enzymes are one of most important of all the commercial enzymes. They find applications in the liquification of starch, brewing, breadmaking, candy making, clarification of fruit juices, removal of starch from textiles, paper making and as a digestive aid[1,2]. A strain of *Aspergillus niger* Vantieghem (CFTRI, 1105) isolated in this institute, has been reported to produce a thermostable ∝-amylase[3]. Preliminary studies with this organism, on the production of amylolytic enzymes in shake flasks have been reported by Ramachandran *et al*[4]. These studies deal with the effect of temperature, pH, calcium ions and media composition on the yield of ∝-amylase and glucoamylase and also some of the characteristics of the crude enzyme.

The objective of the present work was to collect the scale up parameters for the production of ∝-amylase by *Aspergillus niger* (CFTRI 1105).

Materials and Methods

Organism and its maintenance: Aspergillus niger (CFTRI 1105) was grown on PDA slants for 5-6 days at ambient temperature and stored in a refrigerator (5°C). Transfers were made once in two months.

Preparation of inoculum: Sterile wheat bran containing about 60-70 percent mineral solution (0.2N HCl containing 33 ppm $ZnSO_4$, 33 ppm $FeSO_4.7H_2O$ and 3 ppm $CuSO_4.5H_2O$) was inoculated with the spores from PDA slants in sterile distilled water containing 0.10 per cent Tween 80. The fungus was allowed to grow at ambient temperature for 5-6 days till there was good sporulation in the flasks. These flasks were used for inoculation of the fermentor.

Medium composition: The medium used for the production of the enzyme is the same as reported by Ramachandran *et al*[3]. Silicone 21 defoamer was used as an antifoaming agent at 1000-1200 ppm and was added to the medium initially. The medium was sterilized at a pressure of 1.1 kg/cm² for 60 min.

Fermentor: Ten litre capacity EMENVEE fermentor (Model 3F10) supplied by M/s. Emenvee Engneers Ltd., Poona, was used in all these studies. All fermentation trials were conducted at 35±1°C. To compensate the loss of water, due to evaporation, 1.2 l of sterile water was added to each jar at the end of 24 hour of fermentation to make up to original volume.

Analysis: ∝-amylase activity was estimated by the procedure of Manning and Campbell[5] at pH 6.0. One unit of ∝-amylase activity is expressed as the amount of enzyme hydrolyzing 10 mg of starch per minute under the conditions of the assay. Protein was estimated by the method of Lowry *et al*[6]. using bovine serum albumin as the standard. The specific activity is calculated as ∝-amylase units per milligram of enzyme protein. Viscosity of the fermentation broth was measured at different intervals by using rotational viscometer (Rheotest 2, manufactured by VEV MLW Prufgeratewerk Medingen, Sitz Freitaz, GDR). The viscosity was measured at a constant shear rate of 656 per second at 35°C. The apparent viscosity was measured by using the formula given by the manufacturers:

$$\eta = \frac{T_r \times 100}{D_R}$$

Where T_r is the shearing stress (dyn/cm²)=Z. ∝., where Z is a cylinder constant (dyn/cm², skt), ∝, is the reading at the indication instrument (skt), D_R is the shearing gradient per second and η is apparent viscosity in centipoise.

Results and Discussion

Variation of Carbohydrate content: The effect of variation in carbohydrate content on the production of ∝-amylase showed that maximum enzyme activity was obtained at 3 percent cornflour level in 72 hr. At higher concentration of cornflour, lower yield was obtained. This may be due to the presence of higher concentration of free sugars which supresses ∝-amylase production.

Effect of aeration: The aeration rate was varied from 0.25 to 1.25 volume of air per volume of medium per minute (VVM) in each case. The pattern of ∝-amylase production with various air flow rates at different times of fermentation is shown in Fig. 1. Maximum enzyme activity was obtained in 72 hr culture at 1 to 1.25 VVM air supply thus confirming the earlier reports of Kvesitadze *et al*[7]. and LeMense *et al*[8].

Effect of agitation: Fig 2 shows the effect of agitation on the production of ∝-amylase. Six agitation speeds (viz. 210, 275, 440, 510, 560 and 600 rpm) of the impeller were tested. The air was supplied at 1 VVM and enzyme activity was measured after 72 hr in each case. It was observed that there was an upper limit of the shear force in the fermentor owing to impeller movement and maximum enzyme was produced when the impeller rate was between 350 and 450 rpm. LeMense *et al*[9]. and Holme *et al*[10]., have made similar observations.

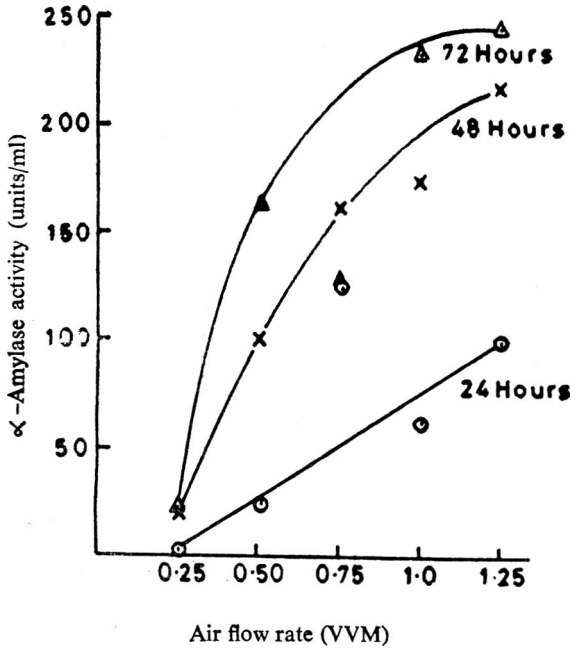

Fig. 1. Effect of aeration on the production of ∝-amylase

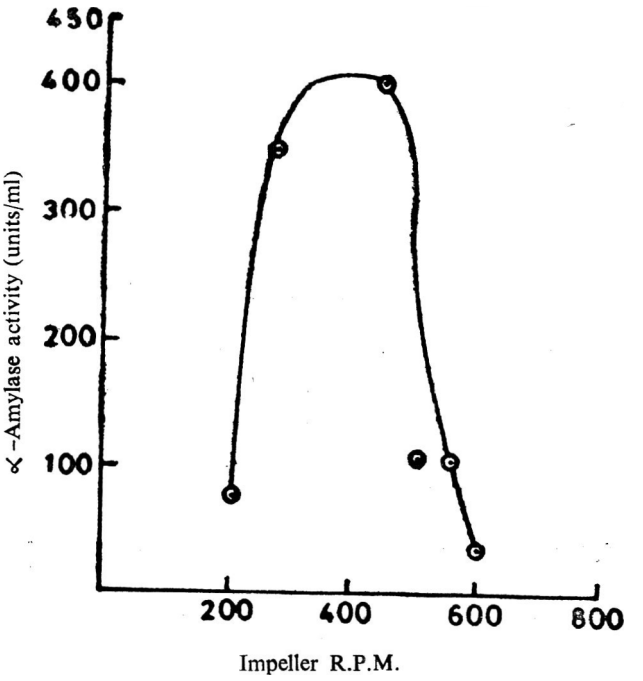

Fig. 2 Effect of agitation on the production of ∝-amylase

Production of ∝-amylase: Fig 3 shows the time course of fermentation. The initial pH of the medium was 5.3 and it remained constant for the first few hours. After 12 hr the pH increased sharply and reached maxium value of 5.8 in about 72 hr. The extra cellular protein showed gradual increase during the first 48 hr and then it increased sharply. Maximum enzyme was produced in about 60-72 hr during which period the pH was at its maximum value and there was a sharp increase in protein content of the culture broth.

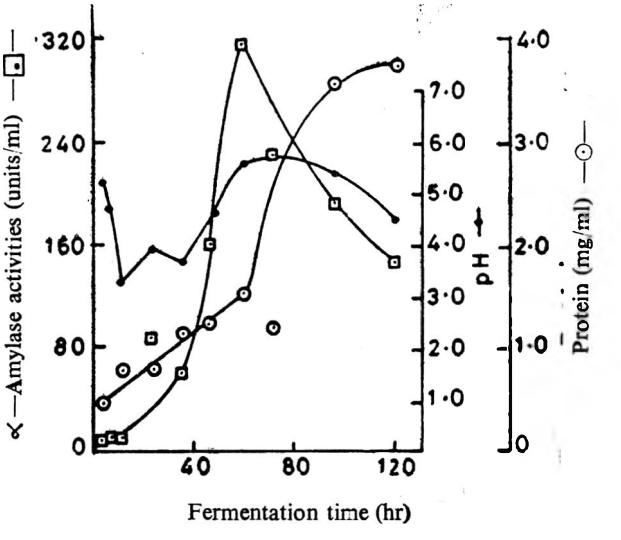

Fig 3. Pattern of ∝-amylase production during the course of fermentation

This shows that there is a relationship between the pH increase and enzyme production. After 72 hr there was a decrease in pH value and sharp reduction in ∝-amylase activity. These results are in agreement with those reported by LeMense *et al*[8]. on the production of ∝-amylase by *Aspergillus oryzae*.

Effect of fermentation time on rheology: The apparent viscosity of the culture broth agaist fermentation time at a constant shear rate of 656 per second is shown in Fig. 4. It is apparent that there was a slow increase in the viscosity of the culture broth during first 12 hr and then it increased sharply. Maximum viscosity was attained in about 24 hr and remained more or less constant up to 60 hr. After this the viscosity started decreasing. The increase in viscosity is attributed to the increase in cell biomass, whereas the fall in viscosity is due to liquification of the starch by the enzyme produced.

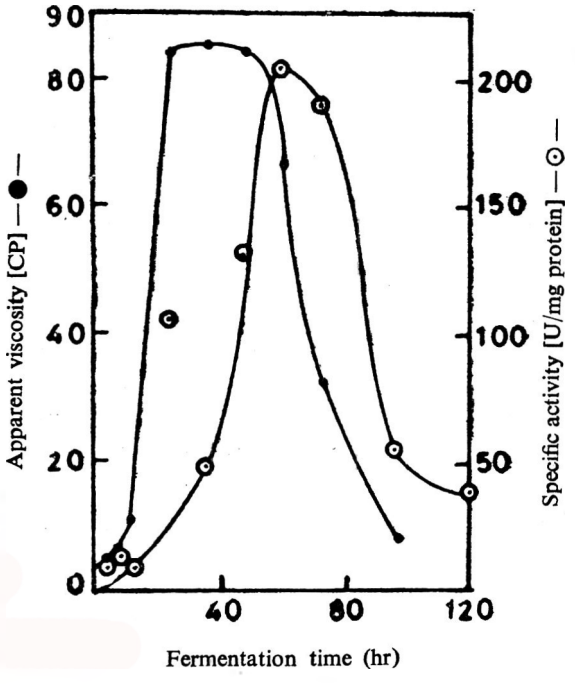

Fig. 4. Variation in apparent viscosity with the age of culture during the production of ∝-amylase by *Asp. niger*

Comparing the viscosity curve with that of specific activity it was observed that yield of the enzyme was maximum when the viscosity of the culture shows a steep fall. The decrease in apparent viscosity after attaining the maximum value may be used as a measure to mark the progress of the fermention i. e. the time required to get the maximum yield of ∝-amylase under the conditions of the experiment. Similar results on the overall changes in the rheological behaviour of the culture broth fermentation with time have been reported by various workers[11-13].

Acknowledgement

The authors wish to thank Sri C.P. Natarajan, Director, of the Institute, for the keen interest in this work.

References

1. Weiser, H. M., *Practical Food Microbiology & Technology*, AVI Pub. Co., Westport, 1962, 37.
2. Reed, G., *Enzymes in Food Processing*, Academic Press, New York, 1975, 123.
3. Ramachandran, N. Sreekantiah, K. R. and Murthy, V. S. *Starke*, 1978, **30**, 272.
4. Ramachandran, N., Sreekantiah, K. R. and Murthy, V. S., *Starke*, 1979, **31**, 134.
5. Manning, G. B. and Campbell, L. L., *J. biol. Chem.*, 1961, **236**, 2952.
6. Lowry, O. H., Rosebrough, N. Z., Farr, A. L. and Randall, R. J., *J. biol. Chem.*, 1951, **193**, 265.
7. Kvesitadze, G. I., Kuznetsov, B. A. and Feniksova, R. V., *Practical Biochem. Microbiol.*, 1969, **5**, 433.
8. LeMense, E. H., Sohns, V. E., Corman, J., Blem, R. H. Lanen. J. M. V. and Langlykke, A. F., *Ind. Engng Chem.*, 1949, **41**, 100.
9. LeMense, E. H., Corman, J., Lanen, J. M. V., and Langlykke, A. F., *J. Bacteriol.*, 1947, **54**, 149.
10. Holme, T., Arvidson, S., Lindholm, B and Pavlu, B., *Process Biochem.*, 1970, **5**, 62.
11. Richard, J. W. *Prog. ind. Microbiol.*, 1961, **3**, 141.
12. Deindoerfer, F. H. and Gaden, E. L., *Appl. Microbiol.*, 1955, **3**, 253.
13. Blanch, H. W. and Bhavaraju, S. M., *Biotechnol. Bioengng.* 1971, **18**, 745.

Effect of Incorporation of Soy, Peanut and Cottonseed Flours on the Acceptability and Protein Quality of Chapatis

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Chapatis made with whole wheat flour and with 10 and 20 per cent substitution with soy, peanut and cottonseed flours were evaluated for sensory quality characteristcs and general acceptability and protein quality. The acceptability scores of chapatis with cottonseed flour were significantly lower but chapatis with soy and peanut flours at both levels received similar scores as chapatis made with all wheat flour. Incorporation of soy, peanut and cottonseed flours at 10% level increased the protein content of chapatis by 17, 22 and 27%, respectively, and increase in available lysine was 73, 27 and 48%, respectively. Incorporation of these flours at 20% level increased the protein content by 38, 41 and 56%, respectively, and the increase in available lysine content was 146, 58 and 87%, respectively.

The protein quality of cereal based Indian diets can be improved by using foods rich in lysine. Addition of soy flour to wheat improves the protein and enhances the lysine content. A mixture of 5 percent soy flour and 95 percent wheat flour would contain more than twice as much lysine as wheat flour alone[1]. Peanut meal also serves as a supplement to wheat diets as reported by Joseph *et. al.*[2] and Subramanyan *et al.*[3]. Cottonseed protein being rather well balanced, can also be used to improve the protein quality of the diet.

Since chapatis are consumed extensively in India, this would be an ideal medium for improving the protein quality of Indian diets. The present study was, therefore, conducted to investigate the effect of incorporation of soy, peanut and cottonseed flours on the acceptability and protein quality of chapatis.

Materials and Methods

Preparation of chapatis: Whole wheat flour was obtained from General Mills, Minneapolis, peanut flour from Gold Kist Inc. Atlanta; Soyfluff 200 w from Central soya Company, Chicago and Liquid Cyclone Process cotton seed flour from U.S.D.A. Southern Regional Research Center, New Orleans, U.S.A.

Chapatis were prepared from 100 g whole wheat flour and substituting 10 and 20 percent by weight each of defatted soy, cottonseed and peanut flour for whole wheat flour. The amount of water used for the dough was as suggested by Yamazaki[4]. One gram of common salt was added per 100 g of flour. The amount of water required with various ingredients is indicated in Table 1.

Each ball of 45 g of dough was rolled into a chapati of 14.5 cm in diameter and cooked on an iron pan(tawa) heated to 200-210°C. Chapatis were cooked in about two minutes.

Selection and training of participants: Ten adult Indian students at the Ohio State University, five of each sex were selected and they were explained the chapati characteristics such as colour, appearance, texture, flavour and general acceptability, Chapatis were evaluated for these parameters using the nine point scale of: excellent, 9; very good, 8; good, 7; below good and above fair, 6; fair, 5; below fair and above poor, 4; poor, 3; very poor, 2; extremely poor, 1.

Analysis of variance was used to determine differen-

Table 1. Water requirement for chapati dough

Wheat flour (g)	Substituted flour		Water (g)
	Type	Amount (g)	
100	—	—	72
90	Soy	10	74
80	Soy	20	76
90	Peanut	10	74
80	Peanut	20	78
90	Cottonseed	10	66
80	Cottonseed	20	62

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ces in scores of the sensory quality characteristics and general acceptability of chapatis and also to estimate reliability of measurement.

Nutritional evalation of chapatis: Flour and chapatis were analysed for moisture, ash, fat and protein content according to AOAC methods.[5] Protein content was calculated using the factors 5.83, 5.71, 5.46 and and 5.30 for whole wheat, soy, peanut and cottonseed flours respectively[6]. Protein content of chapatis were calculated based on the component flours.

The available lysine was determined, by the method of Carpenter[7] with modifications as suggested by Booth[8]. The chemical scores of flours and chapatis were calculated by the method of FAO/WHO Expert Committee[9].

Results and Discussion

Organoleptic evaluation of chapatis: Mean scores of the seven types of chapatis were significantly different ($P \leq 0.05$). The difference among the judges for scores of colour, appearance, texture and flavour and general acceptability were significant (≤ 0.05).

The scores of chapatis with 10 and 20 percent cottonseed flour for colour, appearance, texture, flavour and general acceptability were significantly lower ($P \leq 0.05$) than those for other chapatis (Table 2). The mean scores for chapatis with 10 percent cottonseed flour for all the quality characteristics and general acceptability were more than the minimum acceptable score of five.

The colour of chapatis with 10 and 20 percent cottonseed flour is in agreement with the results reported by Abdou and Kassim[10] who observed a greenish colour in waffles and pancakes. The dough with 10 percent cottonseed flour had a greenish tinge and was darker than plain wheat flour dough. The intensity of greenish colour and darkness of dough increased with increased level of cottonseed flour. Chapatis became dry and leathery within a very short time.

Chapatis with 10 and 20 percent soy and peanut flours received scores well above the minimum acceptable score of five for all the quality characteristics and general acceptability. Rathod and Williams[11] and Tsen and Hoover[12] reported no significant differences in the acceptability of chapatis and breads, made from whole wheat flour and blends containing defatted soy flour. Higher scores for acceptability of chapatis with peanut flour may reflect improved quality of peanut flour and also levels of incorporation of this flour.

TABLE 3. PROXIMATE COMPOSITION (G/100G) OF FLOURS AND CHAPATIS

Sample	Moisture	Crude protein	Crude lipids	Ash	Total carbohydrates
Flours					
Whole wheat	10.6	13.9	1.9	1.5	72.1
Soy	6.7	47.9	1.0	5.9	38.5
Peanut	12.7	49.9	1.4	4.4	32.6
Cottonseed	4.0	53.7	0.4	7.5	34.4
Chapatis					
Wheat flour	35.5	9.6	1.3	1.8	51.8
90% Wheat flour+ 10% Soy flour	36.0	11.2	1.2	2.0	49.6
80% Wheat flour+ 20% Soy flour	37.8	13.3	1.1	2.3	45.5
90% Wheat flour+ 10% peanut flour	36.9	11.7	1.3	1.9	48.2
80% Wheat flour+ 20% peanut flour	38.7	13.5	1.2	2.1	44.5
90% Wheat flour+ 10% Cottonseed flour	32.9	12.2	1.3	2.2	51.4
80% Wheat flour+ 20% Cottonseed flour	32.6	15.0	1.2	2.7	48.5

Values are on fresh weight basis.

TABLE 2. MEAN SCORES FOR SENSORY QUALITY CHARACTERISTICS AND GENERAL ACCEPTABILITY OF CHAPTIS

Wheat flour (g)	Substituted flour Type	Amount (g)	Colour	Appearance	Texture	Flavour	Acceptability
100	—	—	7.5	7.5	7.5	7.5	7.3
90	Soy	10	7.4	7.5	7.2	7.1	7.4
80	Soy	20	7.3	7.3	7.2	6.8	7.2
90	Peanut	10	7.5	7.6	7.4	7.3	7.3
80	Peanut	20	7.5	7.6	7.6	7.2	7.3
90	Cottonseed	10	5.3	5.6	5.6	5.9	5.6
80	Cottonseed	20	4.1	5.1	5.3	4.9	4.8
	C.D. at 5%		0.064	0.123	0.061	0.0873	0.823
	S.E.M.		0.0228	0.044	0.023	0.0312	0.0294

TABLE 4. AVAILABLE LYSINE CONTENT OF FLOURS AND CHAPATIS MADE FROM FLOUR MIXTURES

Sample	Available lysine (%)	% increase in available lysine	% loss of available lysine during cooking	available lysine of the total
Flours				
Whole wheat	0.343	—	—	81.02
Soy	3.020	—	—	81.88
Peanut	1.481	—	—	93.64
Cottonseed	2.170	—	—	90.60
Chapatis				
Wheat	0.327	—	4.7	80.29
90% wheat+ 10% Soy	0.567	73	5.7	83.50
80% Wheat+ 20% Soy	0.804	146	8.1	82.40
90% Wheat+ 10% Peanut	0.414	27	9.4	80.86
80% Wheat+ 20% Peanut	0.518	58	9.3	83.87
90% Wheat+ 10% Cottonseed	0.484	48	8.0	81.46
80% Wheat+ 20% Cottnseed	0.610	87	13.8	75.90

TABLE 5. CHEMICAL SCORES OF FLOURS AND CHAPATIS MADE FROM FLOUR MIXTURES

Sample	Score	First limiting amino acid
Flours		
Whole wheat	50	Lysine
Soy	74	S-containing
Peanut	51	Lysine
Cottonseed	85	Isoleucine
Chapatis		
Wheat	50	Lysine
90% Wheat+ 10% soy	56	Lysine
80% Wheat+ 20% Soy	63	Lysine
90% Wheat+ 10% Peanut	51	Lysine
80% Wheat+ 20% Peanut	52	Lysine
90% Wheat+ 10% cottonseed	53	Lysine
80% Wheat+ 20% cottonseed	56	Lysine

Nutritional evaluation: The proximate composition of flours and chapatis is given in Table 3. Incorporation of 10 and 20 percent soy, peanut and cottonseed flours increased the protein content of chapatis to 11.2 and 13.3, 11.7 and 13.5 and, 12.2 and 15.0 percent respectively as compared to 9.6 percent for wheat flour chapatis (Table 3).

The mean values for available lysine content of whole wheat, soy, peanut and cottonseed flours were 0.343, 3.020, 1.484 and 2.170 per cent, respectively. Chapatis with 10 and 20 per cent soy, peanut and cottonseed flours had the mean available lysine contents of 0.567 and 0.804, 0.414 and 0.518 and 0.484 and 0.610 per cent respectively, compared to 0.327 per cent for whole wheat flour chapatis (Table 4). Soy, peanut and cottonseed flour incorporation at 10 and 20 per cent level increased the available lysine content of chapatis by 73 and 146, 27 and 58, 48 and 87 per cent respectively (Table 4).

The losses in available lysine content of chapatis due to cooking ranged from 4.7 to 13.8 per cent (Table 4). Rosenberg and Rondenburg[13] have reported losses varying from 2.4 to 15.9 per cent in breads supplemented with lysine. Harden and Yang[14] reported losses of 12 to 15 per cent in breads supplemented with cottonseed flour.

Chemical score: Incorporation of 10 and 20 per cent soy flour increased the chemical score of chapatis by 6 and 13 points, respectively (Table 5). Peanut flour incorporation at 10 and 20 per cent level improved the chemical score by one and two points, respectively. Incorporation of cottonseed flour at 10 per cent level increased the chemical score by three points and at 20 per cent level the chemical score increased by another three points. These findings are in agreement with the results of Bean *et al.*[15]. who observed a considerable improvement in the protein quality of breads prepared with incorporation of soy flour.

The results of this study thus reveal that nutritionally superior chapatis prepared by the incorporation of soy and peanut flours are acceptable. However, LCP cottonseed flour needs to be further refined to extract the undesirable colour and flavour for preparation of acceptable chapatis.

Acknowledgement

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References

1. Autret, M., in *Proteins As Human Food*, by R. A. Lawrie, (ed), Butterworths, London, 1970, 3.
2. Joseph, K., Narayana Rao, M., Swaminathan, M. and Subramanyan, V., *Brit. J. Nutr.*, 1967, **11**, 388.
3. Subrahmanyan, V., Joseph, K, Doraiswamy, T. R., Narayana Rao, M., Sankaran, A. N. and Swaminathan, M., *Brit. J. Nutr.*, 1957, **11**, 382.
4. Yamazaki, W. T., Private communication, Soft Wheat Quality Laboratory, USDA, ARS, North Central Region, Wooster, Chio 44691, 1976.
5. *Official Methods of Analysis*, Association of Official Analytical Chemists, Washington, D.C., 1975.
6. *Amino Acid Content of Foods and Biological Data on Proteins*, Food and Agricultural Organisation of the United Nations, Rome, 1970.
7. Carpenter, K. J., *Biochem. J.*, 1960, 77, 604.
8. Booth, V. H., *J. Sci. Fd Agric.*, 1971, **22**, 658.
9. FAO/WHO, *Energy and Protein Requirements*, Report of a Joint FAO/WHO Adhoc Expert Committee, WHO, Geneva, 1973.
10. Abdou, J. A. and Kassim, R. A., In *Protein Enriched Cereal Foods for World Needs*, by Max Milner (ed) Amer. Assoc. Cereal Chemists, St. Paul, Minn., 1969, 174.
11. Rathod, K. L. and Williams, S. W., *Indian J. Nutr. Dietet.* 1973, **10**, 18.
12. Tsen, C. C., and Hoover, W. J., *Cereal Chem.*, 1973, **50**, 7.
13. Rosenberg, M. R. and Rohdenburg, E. L., *J. Nutr.*, 1951, **45**, 593.
14. Harden, M. L. and Yang, S. P., *J. Fd Sci.*, 1975, **49**, 75.
15. Bean, M. M., Mecham, D. K., Hanamoto, M. M. and Fellers, D. A., *Baker's Dig.* 1964, **48**, 32.

Utilisation of Wheat Germ in the Preparation of Bread and Biscuits

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The effect of incorporating 5, 10, 15 and 20% of germ—unprocessed, toasted, steamed and defatted—on the dough characteristics as well as bread and biscuit making quality of wheat flour was studied. The water absorption, dough development time and dough stability decreased as the level of germ increased, the decrease being more marked with raw germ. An acceptable bread could be prepared by incorporating germ upto a level of 10% in a normal recipe and upto 15% with the addition of 60 ppm potassium bromate and 0.6% Sodium Steraroyl lactylate. The biscuits containing upto 20% level of germ were found acceptable.

Wheat germ, a by-product of roller flour milling industry, is a potential source of quality protein. In view of its high content of protein (25-30 per cent) with high biological value, wheat germ can be used with advantage to fortify processed and bakery products. Incorporation of germ improved considerably the nutritive value of bread[1,2] particularly the content of lysine.

The poor shelf-life of germ is the major limitation in its utilization. Simple methods were developed to stabilize and improve the shelf-life of germ for more than 26 weeks[3]. Heat treatment of germ destroyed the trypsin inhibitor and improved its nutritive value[4]. The present study relates to the utilisation of dry or moist heat treated or defatted germ in bread and biscuits.

Materials and Methods

Commercial sample of fresh wheat germ was procured and stored in a freezer in tin container till it was subjected to toasting, steaming or defatting as described earlier[3]. The unprocessed germ had acceptable taste and had a purity[4] of about 85 per cent and contained 25.8 per cent protein and 11 per cent lipids. The processed germ samples were ground in a Kamas Mill (Model Slaggy-200A) using 0.8 mm sieve and were blended at different levels with the straight-run flour obtained by milling commercial varieties of wheats suitable for bread or biscuit making, in a Buhler Laboratory mill (Model MLU-202). The blends were repeatedly passed through a 60 mesh sieve to ensure uniform mixing.

Dough characteristics: Brabender farinograph was used to assess the dough characteristics such as water absorption, dough development time, dough stability and mixing tolerance index, according to AACC procedures[5].

Bread making quality: The malt-phosphate-bromate method[6] was used for test baking trials to assess the

bread making quality. The effect of potassium bromate $KBrO_3$ and/or sodium steraroyl lactylate SSL on the bread making quality of blends containing germ was also studied.

Evaluation of bread: The loaf volume of bread was determined by the rape seed displacement method using loaf volume meter. In the evaluation of overall quality of bread, the criteria followed by a panel of six judges were general appearance, loaf volume, crust and crumb colour, crumb softness, fineness and uniformity of colour, crumb grain, flavour and eating quality.

Biscuit making quality: Biscuits were prepared from the blends containing varying levels of processed germ using the following recipe (100 g basis): blend 64 g; sugar 18 g; fat 16 g; non-fat milk solids 1.0 g; glucose 1.0 g; common salt 0.4 g; baking powder 0.2 g; ammonium bicarbonate 0.5 g; sodium bicarbonate 0.2 g; vanillin 0.05 g; and water 13-15 ml. Sugar, fat and vanillin were creamed in a Hobart mixer for 2 min. To this, a mixed blend containing germ, non-fat milk solids and baking powder were added along with water containing glucose, common salt, ammonium bicarbonate and sodium bicarbonate, and mixed for further 2 min. Using a wooden rolling pin, the dough was sheeted on an aluminium platform to a uniform thickness of 2.5 mm. Circular sheeted dough 5.1 cm in diameter were cut and baked for 8-10 min. at 250°C.

Evaluation of biscuits: The diameter (D) and thickness (T) of five biscuts were recorded Colour, crispness, eating quality and overall acceptability of the biscuits were assessed by a panel of six judges. The biscuits prepared from soft white wheat flour were taken as control for evaluation.

Results and Discussion

Dough characteristics: The effect of incorporation of varying levels of raw or processed germ on some of the dough characteristics is presented in Table 1. Use of higher levels of raw germ in the blend considerably decreased the water absorption, as compared to toasted or steamed germ. Toasted or steamed germ, added upto 20 per cent did not reduce the water absorption significantly. On the other hand, Pomeranz *et al.*[7] observed an increase in the water absorption by incorporating heat treated germ.

Significant decreases in dough development time and dough stability were observed by incorporating raw, toasted or steamed germ; the decrease was more in the raw germ. Pomeranz *et al.*[7] also observed a decrease in the mixing time as a result of blending wheat flour with germ. At 5 per cent level of incorporation of heat processed germ, a significant decrease in dough development time and dough stability was observed (Table 1). Further decrease in these values were, however,negligible beyond 5 per cent level. At 30 per cent incorporation of raw germ, dough stability decreased more than 80 per cent compared to about 55 per cent in toasted or steamed germ.

A significant weakening of the dough was observed when toasted or steamed germ was added. At 15 percent level of incorporation, the weakening due to toasted or steamed germ was 40-45 BU, as against 110 BU for raw germ indicating that toasting or steaming of germ improved the mixing characteristics, as compared to the raw germ.

TABLE 1. EFFECT OF BLENDING WITH VARYING LEVELS OF PROCESSED GERM ON FARINOGRAPH CHARACTERISTICS OF WHEAT FLOUR

Level of germ (%)	Water absorption (%)	Dough		
		Development time (min.)	Stability (min.)	Weakening (BU)
No germ				
0	66.6	6.5	8.0	50
Raw germ				
5	65.6	3.5	3.5	80
10	64.8	3.0	3.0	140
15	64.2	3.0	2.5	160
20	63.8	3.0	2.5	180
30	63.0	3.0	1.5	190
Raw germ+0.5% SSL				
5	65.6	3.0	4.5	60
10	64.8	3.0	3.5	100
15	64.2	3.5	3.0	150
20	63.8	3.5	2.5	170
30	63.0	3.5	2.5	180
Toasted germ				
5	66.5	5.0	5.5	70
10	66.3	4.5	4.5	80
15	66.0	4.5	3.5	95
20	66.0	4.0	3.5	110
30	65.6	4.5	3.5	140
Steamed germ				
5	66.1	4.5	6.0	60
10	66.0	4.5	5.0	70
15	65.7	4.0	5.0	90
20	65.2	4.0	4.0	115
30	64.6	3.5	3.5	130

TABLE 2. EFFECT OF INCORPORATION OF PROCESSED GERM ON THE QUALITY OF BREAD

Level of germ (%)	Loaf volume (ml)	Overall quality*
No germ		
0	710	Excellent
Raw germ		
5	700	Excellent
10	530	Satisfactory
15	435	Fair
20	395	Poor
Toasted germ		
5	685	Excellent
10	590	Good
15	475	Satisfactory
20	455	Fair
Steamed germ		
5	690	Excellent
10	550	Good
15	460	Satisfactory
20	400	Fair
Defatted germ		
5	690	Excellent
10	490	Satisfactory
15	400	Fair
20	370	Poor

*Based on loaf volume, crust appearance, crumb texture and eating quality.

Effect of adding SSL: The data presented in Table 1 indicate that the addition of SSL at 0.5 per cent level to the dough containing 5 to 30 per cent of raw germ showed only a marginal improvement in the dough stability and weakening, but not in dough development time. Improvement in the dough characteristics by the addition of SSL has been reported by Tsen *et al.*[8] in the case of dough containing soya flour.

Effect of incorporating processed germ on the bread-making quality: The data presented in Table 2 indicate that the bread containing 5 per cent raw or processed germ was comparable to control wheat bread in loaf volume, crust and crumb characteristics and acceptability. Breads containing upto 10 per cent of processed germ were acceptable; beyond this the adverse effect on dough handling property and on different quality characteristices as well as acceptability of the bread became increasingly marked. The toasted and steamed germ samples were found to be better than the raw and defatted germ. Incorporation of defatted germ resulted in a relatively poor quality bread, while that of toasted germ was better than steamed germ with respect to the loaf volume.

Effect of potassium bromate and SSL on wheat bread fortified with 15 per cent steamed germ: Potassium bromate upto 80 ppm as oxidising agent was tried to improve the quality of bread containing 15 per cent steamed germ.

The data presented in Table 3 indicate that at 60 ppm of potassium bromate, there was maximum increase in loaf volume (515 ml) as well as improvement in the crust and crumb characteristics of the bread, as compared to the control (without potassium bromate) where the loaf volume was 400 ml. Pomeranz *et al.*[7] observed

TABLE 3. EFFECT OF POTASSIUM BROMATE AND SSL ON QUALITY* OF WHEAT BREAD FORTIFIED WITH 15% STEAMED GERM

Pot. bromate (ppm)	Loaf vol (ml)	Crust		Crumb texture	SSL* (%)	Loaf vol. (ml)	Crumb texture
		Colour	Surface				
0	400	Dull reddish brown	Uneven & depressed, few holes	Slightly hard	0.0	515	Somewhat soft
20	445	,,	,,	Somewhat soft	0.4	540	,,
40	495	,,	Somewhat even	,,	0.5	550	Soft
60	515	Dark brown	Normal	,,	0.6	560	,,
80	490	,	,,	,,	0.8	550	,,
Wheat flour**	700	,,	,,	Soft	0.0	730	,,

*Wheat bread fortified with germ had (*i*) greenish white colour, (*ii*) slightly coarse and fairly uniform crumb grain, and (*iii*) some what inferior taste as compared to creamy white colour, fine and uniform crumb grain and normal taste of the control wheat bread

**15 ppm Pot. bromate was used

that in contrast to the requirement of 10 ppm of potassium bromate for the wheat flour bread, a high level of 70 ppm was required when 15 per cent of heat treated germ was used to fortify the bread.

The use of 0.6 per cent SSL improved the loaf volume and crumb texture to the maximum; the latter being comparable to that of control wheat bread. Thus, it may be inferred that 60 ppm of potassium bromate and 0.6 per cent of SSL are necessary to improve the quality of bread fortified with 15 per cent of steamed germ, which provided about 4 percent extra protein.

Quality of germ-fortified bread as influenced by potassium bromate and SSL: The beneficial effect of 60 ppm potassium bromate and 0.6 per cent SSL on the quality of bread fortified with 15 per cent of raw, toasted, steamed and defatted germ is shown in Fig. 1. Maximum improvement in the loaf volume (135 ml) was observed in bread fortified with raw germ. This bread had loaf volume and crumb texture comparable to that of control bread. This improvement may be attributed to the protective action of the oxidising agent against the reduced glutathione present in raw germ as reported by Sullivan *et al*[9]. However, the beneficial effect was comparatively less marked in steamed or toasted germ, as the adverse effect of glutathione was very much reduced as a result of heat processing.[9]

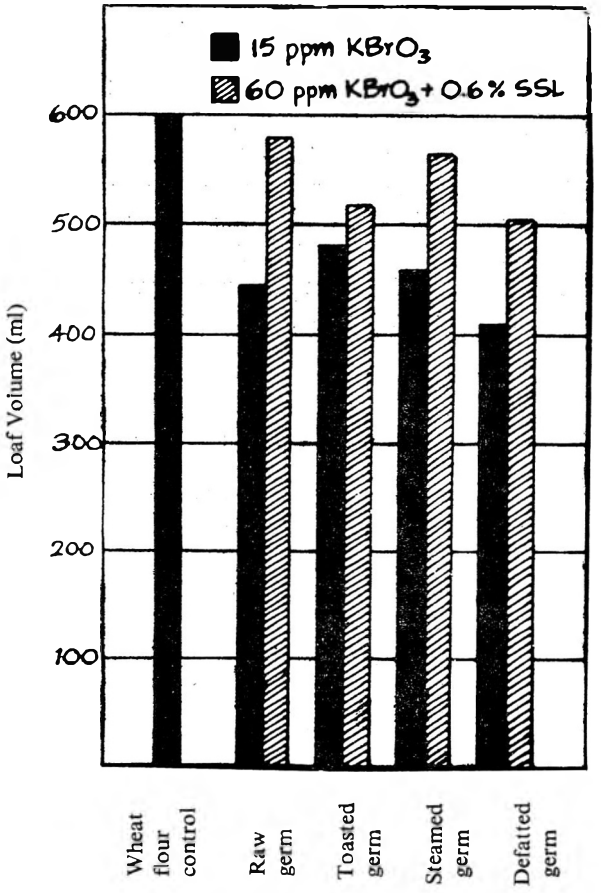

FIG. 1. Effect of Potassium Bromate and S.S.L. on the loaf volume of bread containing 15% differently processed germ.

The overall quality of the bread fortified with steamed germ was found to be comparatively better than that of toasted germ. The bread containing defatted germ was of lowest quality. This might be due to the removal of germ fat, which may have a beneficial effect on the baking quality.

Biscuits from processed germ: Data presented in Table 4 indicate that only steamed germ could be used for making acceptable quality biscuits without any wheat flour. Such product will have a high content (17-20 per cent) of protein of excellent quality and hence can be used in the preparation of protein enriched diets.

The dough obtained from defatted germ was highly sticky with poor handling property, while the toasted germ gave hard and unacceptable biscuits. The biscuits from raw germ possessed raw taste.

Biscuit from blends of wheat flour and germ: Data on the effect of fortification and heat treatment of germ on the quality of biscuits are presented in Table 5. It is evident that raw germ could be used upto 10 per cent to get biscuits which are as good as that obtained from wheat flour. Raw or steamed germ could be used upto 20 per cent level to obtain an acceptable product; while use of 20 per cent toasted germ gave an acceptable, but comparatively inferior product.

TABLE 4. INFLUENCE OF DIFFERENT PROCESSING METHODS ON THE BISCUIT MAKING QUALITY OF WHEAT GERM

Germ treatment	Thickness* (mm)	Diameter (mm)	Colour	Crispness**	Taste**
Raw	5.2	49.0	Light brownish yellow	Satisfactory	Just acceptable
Toasted	3.7	48.3	Brownish yellow	Not satisfactory	Not acceptable
Steamed	4.1	51.8	Creamy yellow	V. good	Acceptable
Defatted	***	***	Light brownish yellow	Satisfactory	Not acceptable

*Initial thickness and diameter of biscuits before baking: 2 mm and 50 mm respectively.

**As compared to control based on wheat flour

***As the sticky dough had poor handling property these values could not be obtained.

TABLE 5. BISCUIT MAKING QUALITY OF WHEAT FLOUR AS INFLUENCED BY THE LEVEL OF INCORPORATION AND PROCESSING OF WHEAT GERM

Germ		Protein (%)	Thickness* (mm)	Diameter (mm)	Colour	Crispness	Taste
Processing	*Level used (%)						
	Nil	7.8	7.3	49.3	Normal	Excellent	Excellent
Raw	5	8.7	6.9	51.3	SGY	,,	,,
Raw	10	9.6	6.5	51.1	GY	V. good	,,
Raw	15	10.5	6.3	51.3	GY	,,	Good
Raw	20	11.4	6.3	51.0	LBY	Good	Good
Toasted**	20	11.4	5.4	50.8	BY	Good	Satisfactory
Steamed**	20	11.4	5.9	52.9	GY	Good	Good
Raw	25	12.3	5.3	51.2	LBY	Satisfactory	Good

*Thickness and diameter before baking : 2.5 mm and 50 mm respectively.

**Germ flavour became more perceptible, when 25% of toasted or steamed germ was used.

SGY — Somewhat golden yellow

GY — Golden yellow

LBY — Light brownish yellow

BY — Brownish yellow

Conclusion: Fortification of about 15-20 per cent of processed germ will provide 4-6 per cent extra protein in the bakery products. However, a higher level of potassium bromate (60 ppm) as well as sodium stearoyl lactylate (0.6 per cent) will be necessary in this case to obtain an acceptable product. Only steamed germ could be used in place of wheat flour for making acceptable quality biscuits containing 17-20 per cent protein. Bread as well as biscuits fortified with wheat germ can be used with advantage in supplementary feeding programmes.

References

1. Gontezea, I., Sutzesco, P. and Popesco, F., *Vitalst. Zivilisationskr.*, 1970, **15**, 63.
2. Cirilli, G., Ghedini, G. and Rocchi, R., *Muellerei*, 1971, **24**, 574.
3. Haridas Rao, P., Kumar, G. V., Ranga Rao, G. C. P., and Shurpalekar, S. R. *Fd. Sci.+Technol.*, (accepted).
4. Kumar, G. V., Emilia Verghese, T., Haridas Rao, P. and Shurpalekar, S. R., *J. Fd Sci. Technol.*, (communicated).
5. *Cereal Laboratory Methods*, American Association of Cereal Chemists, St. Paul, Minnesota, USA, 7th Ed., 1962.
6. Irvine, G. N. and McMullan, M. E., *Cereal Chem.*, 1960, **37**, 603.
7. Pomeranz, Y., Carvajal, M. J., Shogren, M. D., Hoseney, R. C. and Ward, A. B., *Cereal Chem.*, 1970, **47**, 429.
8. Tsen, C. C., Hoover, W. J. and Phillips, D., *Baker's Digest*, 1971, **45**, 20.
9. Sullivan, B., Howe, M. and Schmalz, F. D., *Cereal Chem.*, 1936, **13**, 665.

Lipid Oxidation in Fatty Fish: The Effect of Salt Content in the Meat

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The effect of salting on the development of oxidative rancidity in frozen sardine was studied. Though salt imparts no effect on free fatty acid (FFA) formation in fish at lower concentrations, as the concentration is increased, it is found to inhibit the formation of FFA. NaCl acts as a proxidant in fatty fish, when present at lower concentrarations. As the concentration is increased, it inhibits lipid oxidation as shown by lower values of peroxide and thiobarbituric acid. It is suggested that the adverse effect of higher concentrations of salt on lipid oxidation may be due to the inhibitive effect of salt on the catalysts of lipid oxidation in fish.

Lipids in most fatty fish readily undergo oxidation on exposure to the atmospheric oxygen. It is a primary consideration in the storage stability of meat and meat products[1]. Lipid oxidation in fish is influenced by the concentration of reactants and environmental factors which influence the oxidative deterioration[2]. A combination of heme and fat peroxides can work as active components enhancing rancidity. Fat peroxides react with chloride ions producing free chlorine which brings about further oxidation of fat[3].

The action of sodium chloride on the non-lipid components of fish is of particular interest in the autoxidation of lean fish. One such action is the ability of sodium chloride to denature actomyosin and other proteins in the muscle. The presence of unknown proxidants in fish leaves great variation in their potential oxidative susceptibilities.

However, little work has been carried out on lipid oxidation in fatty fish. The present study was undertaken to determine the effect of various concentrations of salt in the meat of sardine on the rate of lipid oxidation.

Materials and Methods

Sardine (*Sardinella longiceps*) were collected from the landing centre in Cochin immediately after landing. The fish were thoroughly washed with tap water, beheaded and gutted. Sardines were then divided into five batches, the first batch left unsalted and the remaining batches were immersed in 8, 12, 16 per cent and saturated salt solutions. Salt used was of reagent grade. The samples were removed after one hour and stored at 5°C. No packaging was employed for the salted fish.

Thiobarbituric acid (TBA) value: Malonaldehyde in the fish samples was determined by the method of Turner *et al.*[4] Absorbance at 538 nm was read with an Elico spectrophotometer using an isoamyl alcohol: pyridine blank.

$$\text{TBA value} = \frac{\text{Absorbance at 538 nm}}{\text{Sample wt. (g)}} \times 5$$

Free fatty acids (FFA) and crude fat: FFA and fat determinations were done according to the standard and official methods of AOAC[5].

Peroxide value (PV): PV was determined by Lea's[6] method. Results are expressed in milliequivalents of peroxide per kg of oil.

Sodium chloride determination: Salt content of the untreated sardine and the salted samples were determined according to the official methods of AOAC[5].

Samples were withdrawn at intervals of 10 days and analysed for the development of lipid oxidation. The study was continued for a period of forty days.

Results and Discussion

The average fat content of the sardines used was found to be 11.8 per cent. A comparative evaluation of the changes in FFA content in sardine muscle without added salt and with added salt is given in Fig. 1. Lipid hydrolysis proceeds at a moderate rate in the unsalted samples stored at —5°C. Table 1 shows the salt content in sardine meat salted to various levels. From the curves in Fig. 1, it is clear that with the increase in the salt content, the rate of FFA production in the sardine meat decreases. Thus a gradual decrease in lipid hydrolysis is observed in fish muscle salted to 2.20, 3.45 and 8.17

TABLE 1. SALT CONTENT IN SARDINE MEAT

Salt solution (%)	NaCl (%) in sardine meat
Nil	0.29
8	1.80
12	2.20
16	3.45
Saturated	8.17

percent salt content From these results it is evident that higher levels of sodium chloride in sardine meat inhibit lipid hydrolysis.

The increase in TBA values in the stored sardine frozen at—5°C is given in Fig. 2. Low quantities of salt accelerate the development of lipid oxidation in sardine. Thus the rate of development of TBA in the sardine meat salted in 8 percent salt solution is much higher than that in the unsalted samples. This phenomenon gets reversed at higher salt concentrations in fish meat. Malonaldehyde formation as indicated by thiobarbituric acid values in fish salted in 12, 16 percent and saturated salt solutions follows a decreasing rate. This confirms the inhibitive action of higher salt concentrations in sardine meat on lipid oxidation

Peroxide values in the unsalted and salted sardine follow similar development as in the case of TBA values (Fig. 3). Increased development of jellying is observed in the sardine at higher salt concentrations.

The inhibitive effect of higher concentrations of

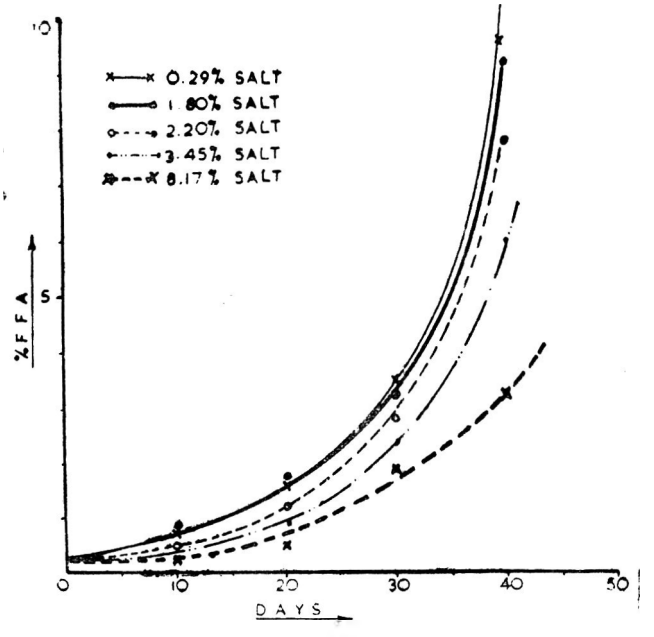

FIG. 1. Change in FFA Value on storage

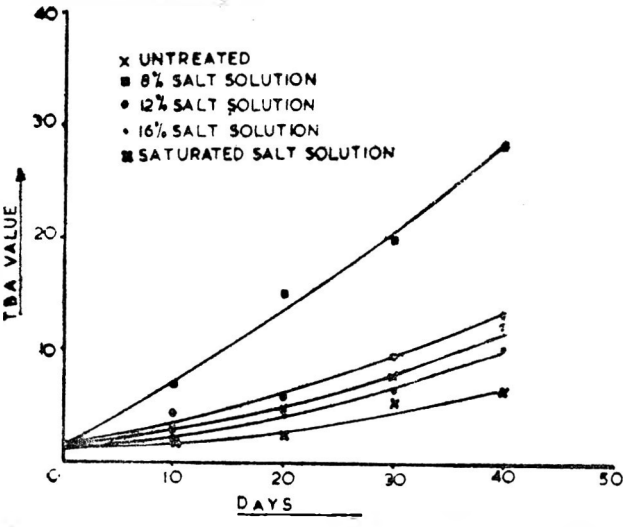

FIG. 2. Development of TBA values in sardine meat treated with salt solulions of various concentrations

sodium chloride may be due to its interaction with the catalysts of lipid oxidation in fish. Hemoproteins are the major catalysts of lipid oxidation in meat and meat products[7,8,9]. The catalytic activity of ferrous and ferric iron on the oxidation of unsaturated fatty acids was very little[10], but Liu[11,12] attributed a dominant role to non-heme iron of shrimp flesh in lipid oxidatien.

Various parts of fish exhibit different degrees of lipid oxidation[13]. Lipid oxidation in the skin (subcutaneous fat) of mackeral was 8 times faster in TBA change than the white and dark muscles. They have also observed unknown prooxidative substances in mackerel skin.

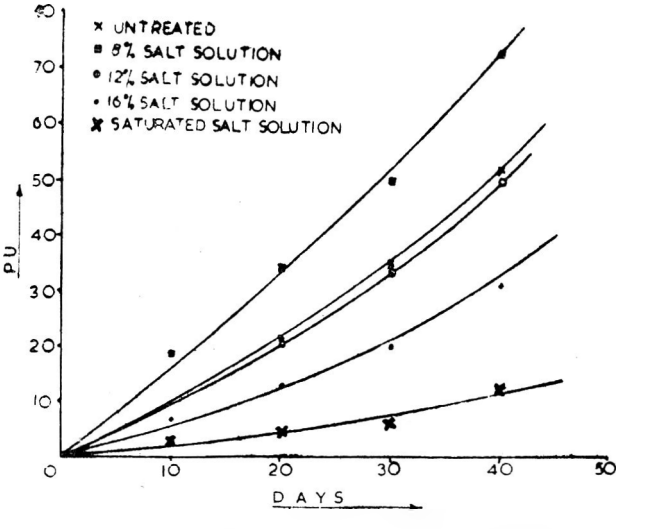

FIG. 3. Peroxide value changes in sardine meat treated with salt solutions of various concentrations

References

1. Tappel, A. L., *Symposium on Food lipids and their Oxidation*, Avi Publishing Co. Inc., West Port, 1962, 122.
2. Castell, C. H., Mac Lean, J., and Moore, B., *J. Fish. Res. Bd Canada*, 1965, **22**, 929.
3. Hills, G. L. and Conochie, J., *J. Coun. sci. ind. Res., Australia*, 1946, **18**, 355.
4. Turner, E. W., Payntes, W. D., Moulic, E. J., Bessert, M. W. Sturck, G. M. and Olson, F. C., *Fd Technol.*, 1964, **8**, 326.
5. *Official Methods of Analysis*, Association of official Agricultural Chemists, 11th Ed, Washington D. C., 1970.
6. Lea, C. H., *Ind. Engng. Chem.*, 1957, **49**, 1933.
7. Tappel, A. L., *Fd Res.*, 1952, **17**, 550.
8. Tappel, A. L., *Fd Res.*, 1953, **18**, 104.
9. Younathan, M. T. and Walts, B. M., *Fd Res.*, 1959, **24**, 728.
10. Wills, E. D., *Biochim. Biophys. Acta*, 1965, **98**, 238.
11. Liu, H., *J. Fd Sci.*, 1970 *a*, **35**, 590.
12. Liu, H., *J. Fd Sci.*, 1970*b*, **35**, 593.
13. Ke, P. J., Ackman, R. G., Linke, B. A. and Nash, D. M., *J. Fd Technol.*, 1977, **12**, 37.

Phosalone Residues on Tomato, *Lycopersicon esculentum* Mill

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The decline of phosalone on the tomato fruits sprayed at a rate of 0.437 kg a.i./ha was studied. Phosalone residues took 1-2 days to reach a level lower than the prescribed maximum residue limit of 1 ppm. Repeated applications did not result in any build-up of the residues. Washing under tap water removed about 40 per cent of phosalone residues from the tomato fruits.

Phosalone (0, 0-diethyl-S-(6-chloro-benzoxazalone-3-yl-methyl) phosphorodithioate) sprayed at the rate of 0.437 kg active ingredient (*a. i.*)/ha has been found to give effective control of *Helicoverpa armigera* (Hubner), the major insect pest of tomato[1]. However, one of the important considerations in the use of this unsecticide is that its residues should rapidly decline to acceptable safe levels. Since no published information on the fate of phosalone residues on tomato is available, the present study was undertaken.

Meterials And Methods

Field experiment: Crops of tomato (variety 'Punjab Tropic No.216') were raised at the University farm (Ludhiana) during 1977 and 1978 from seedlings transplanted in March, according to locally recommended practices[2]. Phosalone 0.06 per cent aqueous emulsion, prepared from zolone^{R}35 per cent EC, was sprayed at 0.437 kg a.i./ha. Spraying of the crop raised in 1977 (first crop) was started on April 30 and continued at intervals of 7-10 days, with a total of 8 sprays. The crop raised in 1978 (second crop), was sprayed at one time on May 12. Control plants, grown similarly were sprayed with water alone.

Sampling: Two to three samples (each weighing 0.5 kg) of marketable size tomatoes were selected at random from the treated and control plants by clipping the fruit into polyethylene bags on 0,1,2,4, and 8 days after the fifth and eighth spray of the first crop. In the case of the second crop, samples were taken after a single application. The effect of washing on the removal of residues, was studied by washing one set of these samples under tap water for about 30 sec simulating the home washing. Tomatoes were cut into small pieces and representative sub-samples of 50 g were taken for analyses.

Extraction and analysis: Extraction of the samples was done on the day they were received to prevent losses during storage. The method described by Luke *et al.*[3] for the extraction and estimation of organophosphorus insecticide residues was followed with slight modifications. Sample was blended with 100 ml of acetone for 2 min in a Waring blendor. The macerate was filtered under vacuum in a suction filter. The residual material was again blended twice using 50 ml of acetone and filtered. The filtrates were combined and concentrated to about 50 ml on a rotary vaccum evaporator at 30°C. This was transferred to a separatory funnel along with 100 ml of water and was partitioned thrice into 110, 60 and 60 ml of dichloromethane. The dichloromethane fraction was vacuum evaporated and the residue was dissolved in 20 ml of acetone. Complete removal of dichloromethane was ensured by repeatedly adding

acetone to the residual material followed by evaporation under vacuum. The residue thus obtained was taken in small volume of acetone and analysed by injecting 2-5 ml aliquots into Packard gaschromatograph (Model 7624) equipped with KCl-coated thermionic detector. Instrumental parameters and operating conditions were as follows:

Column: A glass column (Size 1 m long × 3.2 mm o.d.) packed with 3 per cent DC-200 on 80-100 mesh Gas-chrom Q.

Temperature: Column 200°C; detector 210°C; injector 210°C.

Gas-flow: Nitrogen (carrier) 90; hydrogen 40; air 400.

Phosalone, 10 ng, gave a peak of half-scale deflection with retention time of 9 min. The residues in the samples were quantified by comparing peak heights of the unknown with those of standard material chromatographed under parallel conditions.

Recovery of phosalone was tested by adding standard solution of phosalone at concentrations of 0.25, 0.5 and 1.0 ppm to untreated tomato fruits before extraction. The recovery ranged from 80 to 91 per cent with an average value of 86.26 per cent. Residue data were, expressed as such and not corrected for recovery

Unsprayed tomato fruits when processed following the method described above did not give any interfering peak. Minimum limit of estimation of phosalone residues on tomato was found to be 0.1 ppm. It was, however, observed that the GC response of phosalone was adversely affected by the contamination of the column, which necessitated the frequent replacement of packing material.

Results And Discussion

Table 1 presents the residue data of phosalone on tomato crop raised in the year 1977. Samples of tomato collected immediately after the fifth spray showed the mean initial deposit of 1.84 ppm. The residues at the end of 1, 2, 4 and 8 days were 1.33, 1.02, 0.44 and 0.19 ppm respectively. Thus, the insecticide showed loss of 27.7, 44.6, 76.1 and 89.7 per cent in 1, 2, 4 and 8 days respectively. The results obtained after the eighth spray also showed similar pattern of degradation. The residues of phosalone on tomato reached below the FAO/WHO[4] prescribed maximum residue limit of 1.0 ppm in 2 days. Multiple sprays did not result in the accumulation of the insecticide on tomato, as samples taken before eighth spray showed only 0.13 ppm of phosalone residues (Table 1).

Experiments conducted during 1978 confirmed the results obtained earlier. About 89 per cent of phosalone residues dissipated in 8 days (Table 2). These results are in agreement with those of Mitic-Muzina *et al.*[5], who also reported the rapid dissipation of phosalone in fruits of peach and apricot.

Gas chromatographic analysis of the tomato fruit did not reveal the presence of any organophosphorus metabolite. However, phosalone is capable of undergoing metabolism to form a toxic metabolite, oxaphosalone. Metivier and Petrinko[6] considered that the amount of oxaphosalone in plants was always very low and in no case exceeded 2 per cent of the phosalone content. It was, therefore, considered by them that the

TABLE 1. PHOSALONE RESIDUES (PPM) ON TOMATO FRUITS

Days after spraying	Fifth spray		Eighth spray	
	Range*	% degradation	Range*	% degradation
0	1.72–1.96	—	1.47–2.41	—
	(0.11–0.16)	—	(0.11–0.15)	—
1	1.20–1.46	27.7	1.11–1.51	32.4
2	0.96–1.08	44.6	0.65–0.97	58.2
4	0.34–0.55	76.1	0.23–0.40	83.5
8	0.13–0.25	89.7	0.16–0.20	88.1

	Range of temp.°C		Range of RH	
	Max.	Min	Max.	Min
5th Spray	38.1–44.5	22.4–25.0	31–60	13–31
8th Spray	29.0–42.0	22.9–30.0	46–96	24–89

Rainfall, nil during the period of sampling following the 5th spray; 66.2 mm during 5th to 7th day following the 8th spray.

Results are on fresh wt basis; Figures in the parentheses are values before the respective sprays.

*Based on 2 replicates.

TABLE 2. PHOSALONE RESIDUES (PPM, FRESH WEIGHT BASIS) ON TOMATO FRUITS

Days after spraying	Residue (ppm) Mean ± S.D.	% reduction due to aging	Residue (ppm) after washing in tap water Mean ± S.D.	%reduction in washing
0	1.09 ± 0.21	—	0.61 ± 0.05	39.2
1	0.78 ± 0.07	28.4	0.48 ± 0.06	38.6
2	0.62 ± 0.02	43.1	—	—
4	0.31 ± 0.01	71.6	—	
8	0.13 ± 0.03	88.1	—	

Temp range Max: 41.5–43.5°C. RH Max: 37–53%
Min: 19.3–25.3°C. Min: 10–18%

There was no rain fall during sampling.

Values are based on 3 replicates.

determination of the parent compound would accurately indicate the hazards of its residues to the eventual consumers of the treated commodities.

The present investigation indicates that the residues of phosalone on tomato reached below the prescribed maximum residue limit in 1-2 days. Washing under tap water further reduced the residues by about 40 per cent (Table 2). It may, therefore, be concluded that the spraying of phosalone on tomato crop for its protection from insect attack is quite safe from the point of view of residue hazard.

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References

1. Singh, D., Ramzan, M. and Bindra, O. S., *Indian J. Pl. Prot.*, 1976, **4**, 112.
2. Anon., *Package of Practices for kharif Crops of Punjab*, Punjab Agric. Univ., Ludhiana, 1976.
3. Luke, M. A., Froberg, J. E. and Masumoto, H. T., *J. Ass. Off. anal. Chem.*, 1975, **58**, 1020.
4. FAO/WHO *Pesticide residues in food.* FAO Agricultural Series No. 90, WHO Technical Report Series No. 525, 1973.
5. Mitic-Muzina, N., Adamovic, U., Perntovic, D., Petrovic, O. and Sotic, G., *Zestita Billua*, 1971, **22**, 50.
6. Metivier, J. and Petrinko, P., Phosalone-an organophosphorus compound related to natural benzoxalones. Proc. All India *Symp. on Pesticide Residues in the Environment* held at Bangalore, November 7-10, 1978 (in press).

Characterisation of Pectins from Indian Citrus Peels

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Pectins from lime (*Citrus aurantifolia*), orange (*Citrus aurantium*), sweet orange (*Citrus sinensis*) and grape fruit (*Citrus paradisi*) peels were isolated by acid extraction. The pectin content ranged from 15 to 17 per cent; their jelly grade, molecular weight, degree of esterification, methoxyl, acetyl and anhydrouronide contents were characterised. Lime pectin was of the rapid set type while the other citrus pectins were of the medium set variety. Lime pectin differed from other pectins in its viscosity.

Apple pomace and citrus peels have been preferrentially used as raw materials for the manufacture of pectin. Among the citrus products, Mandarin orange peel[1] and Assam lemon[2,3] have been examined for their pectin content. An earlier report by the authors[4] has pointed out interesting differences between pectic substances of onion and garlic skins. The present work was undertaken to ascertain the characteristics of pectins obtained from lime, orange, sweet orange and grape fruit peels.

Materials and Methods

Raw Materials: Lime (*Citrus aurantifolia*), orange (*Citrus aurantium*), sweet orange (*Citrus sinensis*) and grape fruit (*Citrus paradisi*) were purchased from the local market. Limes were pressed to extract the juice and scrubbed on a rough surface to remove the fruit tissues present on the surface. For the other fruits, the peels were separated from the fruit portion manually. The peels were cut to small size and blanched in boiling water for 2 min to inactivate the pectic enzymes. The peels were dried in a cabinet drier at 65°C to a moisture content of 6 to 8 per cent and stored in a desiccator at room temperature till use.

Extraction of pectin: Pectin was extracted from the dried peels according to the method of Kertesz[5]. Extractions were carried out at 90°C for 30 min using 0.05N HCl followed by precipitation of the pectin by 95 per

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cent ethanol containing 0.01 N HCl followed by 70 and 95 per cent ethanol respectively. The precipitate was redissolved in water and reprecipitated with equal volume of 95 per cent ethanol. The precipitate was dried at 60°C, powdered, packed in air tight bottles and stored in a desiccator at room temperature.

Analytical methods: Total pectic substances were estimated by the method of Carre' and Haynes[6]. Moisture content was determined by drying 1 g of pectin in a silica dish at 90°C to constant weight. Ash content was estimated by ashing in a muffle furnace at 600°C for 4 hr.

Anhydrouronic acid content was estimated by the modified carbazole method of McComb and McCready[7]. Equivalent weight and methoxyl contents were estimated by titration using 0.5 g of pectin sample[8,9]. The acetyl content was determined by the method of McComb and McCready[10]. Degree of esterification was calculated on the basis of methoxyl and anhydrouronic acid contents according to the method of Schultz[9] by the formula

$$\left.\begin{matrix}\%\text{ degree of}\\ \text{esterification}\end{matrix}\right\} = \frac{176}{31} \times \frac{\%\text{ methoxyl}}{\%\text{ anhydrouronic acid}} \times 100$$

Viscosity determinations were made at 28°C using an Ostwald capillary viscometer. Pectin solutions of 0.5, 0.25, 0.125 and 0.0625 per cent (on moisture and ash free basis) in 1 per cent sodium hexametaphosphate (pH 4.5) were employed. The intrinsic viscosity was calculated by plotting $\eta sp/C$ *vsC* (where ηsp is specfic viscosity $= \eta_r - 1$ and C is concentration) and extrapolating to zero concentration. Molecular weights were calculated from the intrinsic viscosities of the pectin solutions by Staudinger equation as described by Christensen[11].

Pectin grade was determined by preparing standard jellies with 65 per cent total solids with varying quantities of pectin according to standard procedures[12]. Setting time was determined by placing a standard jelly in a beaker at 30°C and noting the time taken to form a firm gel[13].

Identification of neutral sugars was carried out after hydrolysing 1 g of the pectin sample with 25 ml of 1 N sulphuric acid for 6 hr[14,15]. The hydrolysate was neutralised with saturated barium carbonate solution and filtered. The filtrate was concentrated under vacuum to a syrup and aliquots were chromatographed on Whatman no. 1 paper using butanol-acetic acid-water (4:1:5) as the solvent system by the ascending technique. Standard sugars were chromatographed under identical conditions and the chromatograms developed by spraying with aniline hydrogen phthalate reagent[16].

Results and Discussion

Total pectic substances of lime, orange, sweet orange and grape fruit peels estimated by the Carre' and Haynes method were 24.50, 22.80, 26.20 and 20.60 per cent respectively on a moisture free basis. Extraction with 0.05 N HCl at 90°C permitted recovery of nearly 70 per cent of the total pectic substances in a soluble form. Final yields of lime, orange, sweet orange and grape fruit pectins on moisture free basis were 17.2, 15.3, 17.8 and 14.5 per cent respectively (Table 1).

The ash content of the pectins ranged between 2.8 and 3.2 per cent which was well below the prescribed limit[17,18]. The jelly grade of sweet orange pectin was the lowest. Lime pectin showed the highest jelly grade of 225 followed by orange and grape fruit pectins with 205 and 200 respectively. Lime pectin was of the rapid setting type while the others belonged to medium setting type. The degree of esterification is an important factor which determines the setting time of pectins[19] and depends on the uronic acid and methoxyl content of pectin[9]. Lime pectin showed esterification in excess of 60 per cent which should be expected from rapid set pectins. The equivalent weights were the highest for lime pectin and lowest for sweet orange pectin. The methoxyl content of lime pectin was 8.62 and was the highest among the citrus peels studied. The uronic acid content was in the range of 73.6 to 77.4 per cent and the acetyl content 0.32 to 0.46 per cent. The high methoxyl and anhydrouronic acid contents as well as the degree of esterification point to the good quality of lime pectin.

TABLE 1. PROPERTIES OF CITRUS PEEL PECTINS

Characteristics	Lime	Orange	Sweet Orange	Grape fruit
Yield[a] (%)	17.2	15.3	17.8	14.5
Moisture (%)	10.1	9.9	8.6	10.6
Ash (%)	2.82	2.97	2.85	3.20
Jelly grade	225	205	180	200
Setting time (min)	1.0	5.0	5.0	4.0
Degree of esterification (%)	63.2	56.1	57.0	57.1
Equivalent weight	1452	969	859	940
Methoxyl[b] (%)	8.62	7.60	7.73	7.40
Anhydrouronic acid[b] (%)	77.4	73.9	76.9	73.6
Acetyl[b] (%)	0.32	0.46	0.35	c
Molecular weight	92600	78000	67000	72700
Intrinsic viscosity (cP)	4.4	3.7	3.2	3.4
Viscosity 0.5% solution (cP)	19.2	10.7	7.2	9.4

a = on dry weight of peel basis

b = on moisture and ash free basis

c = not done

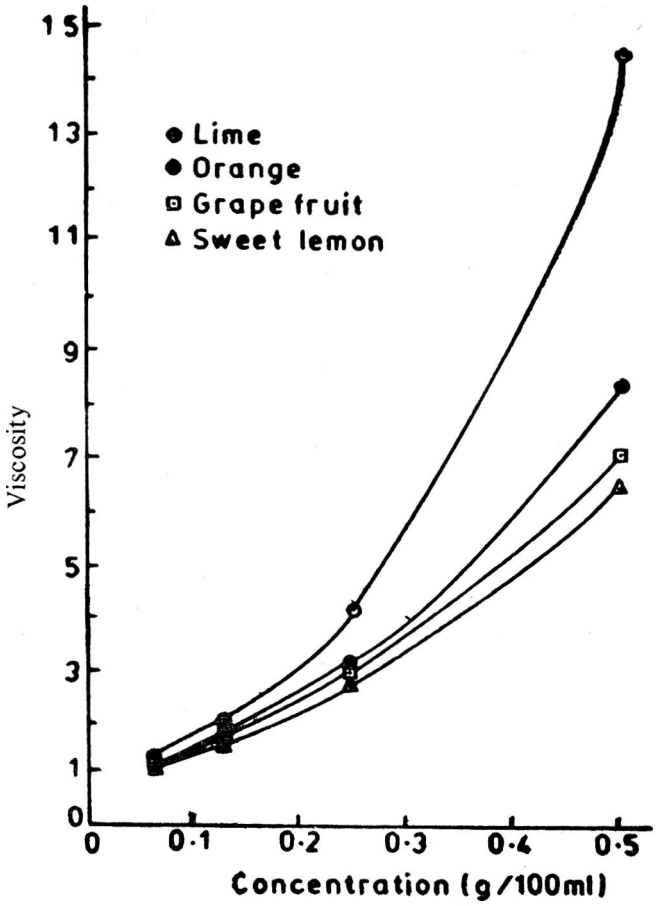

FIG. 1. Relationship between concentration and viscosity of citrus peel pectins

The relative viscosities (η_r) of citrus pectins at different concentrations have been plotted in Fig. 1. Beyond 0.25 per cent concentration, viscosity of the pectin solutions increased markedly, the highest viscosity being obtained with lime pectin. The intrinsic viscosity of citrus pectin reported here is in agreement with the values reported by Christensen[11]. Based on viscosity measurements the molecular weights of lime, orange, sweet orange and grape fruit pectin were 92,600, 78,000, 67,000 and 72,700 respectively. The average molecular weight of pectins is reported to be in the range 30,000 to 3,00,0000 depending on the source, method of preparation and technique employed for measurement[20-22]. The molecular weights are in the range reported for apple and citrus pectins. The viscosity behaviour of lime pectin was strikingly different from the others which could be due to the nature of the macromolecular components in lime pectin. Good correlation between jelly grade, intrinsic viscosity and molecular weight was obtained in the present study.

The pectic substances of all plant materials with a few exceptions, are composed of galacturonic acid and neutral sugars covalently bonded to the polyuronide chains. The amount and nature of neutral sugars and the type of linkages vary depending upon the source of pectin thereby distinguishing pectic substances from one another. Pectins from the citrus peel are characterised by the presence of arabinose, galactose and rhamnose. Trace of xylose was observed in sweet orange peel pectin. Presence of 2-0 methyl xylose, fucose and 2-0 methyl fucose reported in citrus peel pectins[23,24] could not be confirmed in the present study. The arabinose content was nearly double that of galactose and accounted for the major part of the neutral sugars in pectin.

The molecular heterogeneity of citrus pectins will be reported in subsequent papers.

References

1. Pruthi, J. S., Parekh, C. M. and Girdhari Lal., *Fd Sci. Mysore.* 1961; **10**, 372.
2. Chaliha, B. P., Barua, A. D. and Siddappa, G. S., *Indian Fd Packer*, 1963, **17**, 3.
3. Agarwal, P. C. and Pruthi, J. S., *Indian Fd Packer*, 1972, **26**, 9.
4. Alexander, M. M. and Sulebele, G. A., *J. Sci. Fd Agric.*, 1973, **24**, 611.
5. Kertesz, Z. I., *The Pectic Substances*, Interscience, New York, 1951 215.
6. Carre' M. H. and Haynes D., *Biochem. J.*, 1922, **16**, 60.
7. McComb, E. A. and McCready, R. M., *Anal. Chem.*, 1954, **24**, 1630.
8. McCready, R. M. in *Methods in Food Analysis*, by Joslyn, M. A. (Ed)., Academic Press, Inc., New York, 1970, 565.
9. Schultz, T. H., in *Methods in Carbohydrate Chemistry*, by Whistler, R. V. (Ed.), Academic Press, Inc., New York, 1965, 189.
10. McComb, E. A. and McCready, R. M., *Anal. Chem.*, 1957, **29**, 819.
11. Christensen, P. E., *Fd Res.*, 1954, **19**, 163.
12. Final report of the Institute of Food Technologists Committee on pectin Standardisation, *Fd. Technol., Champaign.*, 1959, **13**, 496.
13. Doesberg, J. J. and Grevers, G., *Fd Res.*, 1960, **25**, 634.
14. Abdel-Fattah, A. F. and Edrees, M. *J. Sci. Fd Agric.*, 1971, **22**, 298.
15. Sen, S. K. and Rao, C. V. N., *Indian J. appl. Chem.*, 1966, **29**, 127.
16. Partridge, S. M., *Nature, Lond.*, 1949, **164**, 443.
17. *The National Formary*, 11th Ed (N. F. XI), The American. Pharmaceutical Association, Washington, D. C. 1960, 263.
18. *The National Formulary*, 13th Ed. (N. F. XIII), The American Pharmaceutical Association, Washington D. C. 1970, 525.
19. Smit, C. J. B. and Bryant, E. F., *J. Fd Sci.*, 1968, **23**, 262.
20. Henglein, F. A., in *Methoden der Pflanzenanalyse*, by Paech, K. and Tracey, M. V. (Eds) Springer-verlag, Berlin-Wilmersdorf, 1955, 226.
21. Deuel, H. and Stutz, E., *Adv. Enzymol.*, 1958, **20**, 341.
22. Bender, W. A., in *Industrial Gums*, by Whistler, R. L. and Be Miller, J. N. (Eds), Academic Press, New York, 1959, 377.
23. Aspinall, G. O., Craig, J.W.T. and White, J. L., *Carbohyd. Res.*, 1968, **7**, 442.
24. Hatanaka, C. and Ozawa, J., *Nippon Nogei Kagaku Kaishi* 1968, **42**, 698, (*Chem. Abstr.*, 1969, **70**, 6443u).

Studies on the Preparation and Storage Stability of Intermediate Moisture Banana

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Intermediate moisture (IM) banana slices were prepared using a solution containing glycerol and sugar or sugar syrup and with or without partial hot air drying when the latter was used. The slices had good flavour and texture and could be eaten as such. Use of glycerol and sugar yielded a product having a better appearance and texture than that prepared using sugar. The product treated with 300 ppm SO_2 and packed in flexible laminate pouches remained acceptable upto 9 months at room temperature (RT) and 4 months at 37°C. With 500 ppm SO_2 the shelf life of the slices was 12 months at RT and 6 months at 37°C. The IM banana slices with 0.2% potassium sorbate were microbiologically safe at a water actviity of 0.8. Reuse of the spent solution did not affect the quality and the shelf life of the product.

Banana (*Musa sapientum*) is abundantly grown in India occupying more than 10 per cent of the total area under fruit cultivation. Since fresh bananas are available throughout the year in most parts of the country, processed banana products intended to substitute fresh bananas have not been widely used. The need for such products arises, however, in military feeding situations where fresh bananas are not avilable.

Processing of banana into products have so far been confined to canned slices[1], puree[2], dehydrated products such as figs[3], sheets (fruit leathers)[4] and osmotic dried slices[5]. The technique of preparing intermediate moisture (IM) foods is of recent origin and has considerable scope for making ready-to-eat processed fruits. The IM fruits containing 20-50 per cent moisture are stabilised by a combination of additives like glycerol, sugar and an antimycotic. The products have potential advantages over fully dehydrated or canned fruits to meet special military feeding situations[6]. This technique had been earlier applied to guava[7], pineapple[8] and mango[9] with satisfactory results. Studies on the preparation of IM banana slices are presented in this paper.

Materials And Methods

Raw materials: Firm, ripe bananas of 'Dwarf Cavendish' ('Pachabale') variety purchased from the local market were used in the studies.

Preparation of the product: The fruits were hand peeled, cut transversely into slices of 5-6 mm thickness and transferrred immediately into the soak solution. The IM banana was made by the following methods:

(*i*) *Using glycerol and sugar:* The banana slices were blanched and equilibrated in a solution having a composition similar to the one used by Hollis *et al.*[10] for apple slices. The solution contained glycerol, 42.25; sucrose, 42.25; water, 14.85; potassium sorbate, 0.45; and potassium metabisulphite (KMS), 0.2 per cent.

The slices were added to the preheated (95°C) soak solution in the ratio of 1:2.4, held at 90°C for 3 min with stirring and cooled to room temperature (RT) (25°-30°C). The slices were allowed to equilibrate in the solution overnight in a refrigerator, drained thoroughly over a stainless steel wire mesh and packed.

(*ii*) (*a*) *Using sugar syrup:* The slices were blanched at 90°C for 3 min in twice the quantity of 70° brix sugar syrup containing 0.2 per cent potassium metabisulphite and 0.4 per cent potassium sorbate, cooled to RT, allowed to equilibrate as before and drained. The brix of the drained slices was 54°. The drained syrup was concentrated from 56° to 75° brix under vacuum and used for resoaking the slices at RT. Thereafter the slices were drained and packed. The final brix of the slices was 65°.

(*ii*) (*b*) *Using sugar syrup and partial hot air drying:* After soaking in sugar syrup at 70° brix as in (*ii*) (*a*) above, the slices having a brix of about 54° were dried in a cross flow cabinet drier at 60-65°C for 1.5 - 2 hr to 70° brix and packed.

Analytical methods: Moisture, reducing and total

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sugars, acidity, ascorbic acid and other proximate composition were determined by the AOAC methods[11]. Potassium sorbate was estimated by the method of Nury and Bolin[12]. Total SO_2 was determined by the iodimetric method involving titration of the distillate with iodine.[13] Glycerol content was calculated by difference. Water activity (a_w) was determined by the modified graphical interpolation technique[14].

Storage studies: Banana slices were packed in paper (kraft 60g)—aluminium foil (0.02 mm)—polythene (150 G) laminate (PFL) pouches and stored at 0°C, RT (25-30°C) and at 37°C, and were periodically examined for colour, flavour and texture by a panel of judges.

Nonenzymatic browning was measured by the modification of the method of Hendel *et al*[15]. Five grams of the sample was extracted with 100 ml of 66 per cent alcohol and the colour measured at 420 nm. Results are expressed as $E\ {}^{5\ \%}_{1\ cm}$ 420 nm. Browning was also measured by the diffuse reflectance of the ground sample in AIMIL portable reflectance meter using magnesium oxide to set the instrument to 100 per cent reflectance.

Samples stored at different temperatures were periodically tested for total plate count, *Staphylococcus*, coliforms, yeasts and moulds by the methods of American Public Health Association[16].

Effect of SO_2 content on the shelf life: To study the optimum level of SO_2 the product containing 300, 500 and 800 ppm SO_2 was prepared using soak solution as in (*i*) and having 0.1, 0.2 and 0.3 per cent KMS.

Reuse of soak solution: The spent soak solution containing glycerol and sugar was used twice after concentrating and adjusting the water, sugar, glycerol, potassium sorbate and KMS content to the original level.

Results and Discussion

The composition and other characteristics of IM banana prepared by different methods are given in Table 1. Organoleptic evaluation showed that the products obtained by the different methods had good flavour, colour and texture.

The glycerol and sugar treated slices had better texture than those of sugar syrup treated slices. Slices prepared with sugar syrup, especially those obtained by partial drying, tended to be tough and sticky. However, addition of 0.5 per cent citric acid was necessary for good flavour.

No microbial growth was observed in slices containing 0.16 – 0.2 per cent potassium sorbate and having a water activity of 0.76 – 0.80.

IM slices prepared using glycerol and sugar and containing 250-300 ppm SO_2 were acceptable upto 9 months of storage at RT and 4 months storage at 37°C (Table 2). Increasing the SO_2 to 500 ppm increased the shelf life to 12 months at RT and 6 months at 37°C. SO_2 content of 800 ppm rendered the product organoleptically unacceptable. Samples stored at 0°C were unchanged in organoleptic quality throughout the period of storage. When the optical density of the alcholic extract of the product at 420 nm was 0.09 and the reflectance value was below 30 per cent, the product was unacceptable.

TABLE 1. COMPOSITION AND OTHER CHARACTERISTICS OF IM BANANA PREPARED BY DIFFERENT TECHNIQUES

Parameter	Using glycerol and sugar by infusion	Using sugar alone by	
		Infusion	Infusion and partial drying
Moisture (%)	30.2	23.1	17.9
Protein (N×6.25) (%)	1.3	1.3	1.4
Ether extractives (%)	0.8	0.3	0.3
Crude fibre (%)	1.2	1.0	1.0
Total ash (%)	0.45	0.60	0.77
Reducing sugars (% as dextrose)	4.8	5.5	6.6
Total sugars (% as dextrose)	29.2	62.5	66.7
Glycerol and other carbohydrates (% by diff.)	36.4	—	—
Other carobhydrates (% by diff.)	—	10.7	11.4
Acidity (as % anhyd. citric acid)	0.18	0.21	0.21
pH	4.9	5.2	5.1
°Brix	—	65	70
Sugar/acid ratio	364	324	350
Pot. sorbate (%)	0.19	0.16	0.16
SO_2 (ppm)	501	507	645
Ascorbic acid (mg/100 g)	5.2	6.9	7.5
ERH (%)	80.0	79.5	75.8

Compared to glycerol and sugar treated slices the one with sugar had a shorter shelf life. With 300 ppm SO_2, IM banana was acceptable upto 6 months at RT and 3 months at 37°C and with 500 ppm SO_2, upto 9 months at RT and 4 months at 37°C.

The plate count in the slices prepared using glycerol and sugar and packed in PFL pouches and stored at 0°C, RT and 37°C upto 9 months was negligible (100 colonies/g). Also the *Staphylococcus*, coliforms, yeasts and moulds were negligible.

Reuse of the soak solution, especially the one containing high concentrations of glycerol, is important in view of the high cost of glycerol. IM banana slices

TABLE 2. CHANGES IN IM BANANA PREPARED USING GLYCEROL AND SUGAR DURING STORAGE IN FLEXIBLE LAMINATE POUCHES

KMS in soak solution (%)	Initial SO_2 (ppm)	Temp. (°C)	Storage period (months)	Non-enzymatic browning $E^{5\%}_{1\ cm}$	Non-enzymatic browning % Reflectance	SO_2 (ppm)
0.1	300	0	3½	0.06	40	301
			6	0.05	42	296
			9	0.06	40	290
			12	0.06	40	285
		25–30	3½	0.06	39	206
			6	0.05	36	48
			9	0.06	36	Nil
			12	0.07	34	Nil*
		37	3½	0.08	37	63
			6	0.12	28	Nil**
0.2	500	0	4½	0.06	40	507
			6	0.06	44	500
			12	0.06	44	496
		25–30	4½	0.08	38	269
			6	0.08	38	111
			12	0.06	38	Nil
		37	4½	0.08	38	79
			6	0.09	30	Nil*
0.3	792	0	3	0.05	44	792
			6	0.05	44	785
			9	0.04	43	790
			15	0.06	43	780
		25–30	3	0.05	42	491
			6	0.05	42	352
			9	0.05	42	192
			15	0.09	35	Nil
		37	3	0.05	40	253
			6	0.07	35	Nil*
			9	0.16	25	Nil**

*Sample brownish-yellow with weak flavour and of average acceptability.
**Sample brown and caramelised; unacceptable.
All other samples acceptable in colour, flavour and texture.

TABLE 3. CHARACTERISTICS OF IM BANANA PREPARED BY RECYCLING THE SOAK SOLUTION CONTAINING GLYCEROL AND SUGAR

Analysis	Soak I	Soak II	Soak III
Moisture (%)	32.2	33.0	29.6
Reducing sugars (% as dextrose)	4.0	5.5	7.3
Total sugars (% as dextrose)	28.4	29.4	33.4
Glycerol and other carbohydrates (% by diff.)	35.1	33.3	32.7
pH	5.1	4.9	4.9
Acidity (as % anhyd. citirc acid)	0.14	0.23	0.28
Pot. sorbate (%)	0.16	0.19	0.25
SO_2 (ppm)	496	463	448
Ascorbic acid (mg/100 g)	5.1	5.8	6.5

prepared by recycling the solution twice caused no significant changes in ERH, composition, organoleptic quality and shelf life compared to the product prepared using the fresh solution (Table 3). They were acceptable upto 12 months at RT and 6 months at 37°C.

IM banana slices prepared using glycerol and sugar does not freeze at subzero temperatures, retained the soft texture and is a good substitute for fresh fruit. It was tried in several mountaineering expeditions and found to be acceptable.

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References

1. Board, P. W. and Seale, P. E., *Fd Preserv Q.*, 1954, **14**, 2.
2. Guyer, R. B. and Erickson, F. B., *Fd Technol., Champaign*, 1954, **8**, 165.
3. Anon, *Fruit Culture in India*, Indian Council of Agricultural Research, New Delhi, 2nd Ed., 1967, 406.
4. Mathur V. K., Anthony Das, S., Jayaraman, .K. S. and Bhatia, B. S., *Indian Fd Pckr.*, 1972, **26**, 33.
5. Ponting, J. D., Walters, G. G., Forrey, R. R., Jackson, R. and Stanley, W. L., *Fd Technol., Champaign* 1966, **20**, 125.
6. Brockmann, M. C., *Fd Technol., Champaign*, 1970, **24**, 896.
7. Jayaraman, K. S., Ramanuja, M. N., Bhatia, B. S. and Nath, H., *J. Fd Sci. Technol.*, 1974, **11**, 162.
8. Jayaraman, K. S., Ramanuja, M. N., Venugopal, M. K. Leela, R. K. and Bhatia, B. S., *J. Fd Sci. Technol.*, 1975, **12**, 309.
9. Jayaraman, K. S., Ramanuja, M. N. Goverdhan, T., Bhatia, B. S. and Nath, H., *Indian Fd Pckr*, 1976, **30**(5), 76.
10. Hollis, F., Kaplow, M., Halick, J. and Nordstrom, H., *Parameters for moisture content for stabilisation of food products* (phase 2), U. S. Army Natick Labs, Contract DAAG 17-67-C-0089, 1969.
11. *Official Methods of Analysis*, Association of Official Analytical Chemists, Washington, D. C., 12th Ed., 1975.
12. Nury, P. S. and Bolin, H. R., *J. Fd Sci.*, 1962, **27**, 376.
13. Pearson, D., *Laboratory techniques in food analysis*, Butterworths, London, Ist Ed., 1973, 81.
14. Jayaraman, K. S., Ramanuja, M. N. and Nath, H., *J. Fd Sci., Technol.*, 1977, **14**, 129.
15. Hendel, E. C., Bailey, G. F. and Taylor, D. H., *Fd Technol., Champaign*, 1950, **4**, 344.
16. *Recommended Methods for the Microbiological Examination of Foods*, American Public Health Association, 1966.

Effect of Different Packaging Materials and Storage Periods on Keeping Quality of Orthodox Tea

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Orthodox bulk tea was packed in bulk in different packaging materials and stored for 292 days. The changes in the chemical and sensory qualities were assessed. Aluminium containers and solid fibre board containers with polythene film lining were found to be the best, as they showed lower moisture content and higher scores for colour of liquor, briskness and strength.

In India tea is packed in bulk quantities in plywood chests. This is also used for exporting tea to foreign countries[1]. In recent years, tea chests are becoming costlier. Some times the tea packed in plywood chests looses its characteristics or acquires undesirable odour with consequent loss of quality, essentially due to moisture absorption. Alternate packaging materials have been studied and the chemical and sensory properties of the packed tea have been assessed.

Materials and Methods

The packaging materials used were:

1. Plywood with aluminium foil (PAF) and tissue paper lining—6 cm $\times$6cm $\times$ 6cm containers from 3-ply plywoods (4.7 mm thick) normally used in tea chests were lined with 0.02 mm aluminium foil and backed with tissue paper;

2. similar size containers made of 0.19 mm thick solid fibre boards with similar aluminium (CAF) foil and tissue paper lining;

3. fibre board containers as above with 0.05mm thick plythene film (CPF)

4. screw top plastic containers, 10mm thick and 7.5 cm dia. $\times$ 2.20 cm ht (PL); and

5. aluminium containers, 0.45 mm thick and cylindrical size as in (4) above (AL).

Storage: The tea packed containers were stored at room temperature. During the experimental period from June 1976 to April 1977, the average monthly maximum temperature ranged from 21.3° to 32.1°C and minimum temperature was from 11.55° to 24.7°C; the relative humidity ranged from 87 to 95 per cent during the mornings and 48 to 75 per cent during the evenings. The samples were stored for 292 days and were analysed for different constituents at regular intervals.

Analysis: Samples were drawn and analysed for moisture, the theaflavin and thearubigin. Quality of the tea was assessed at regular periods for colour, briskness strength and quality of liquor under standard

conditions by professional tea tasters. The data collected were analysed for quality changes by analysis of variance followed by Duncan's New Multiple Range test.

Results and Discussion

Representative data and analysis for changes in moisture, colour and briskness are given in Tables 1 and 2. There was significant increase in moisture content in all the samples. The aluminium bottle (AL) container showed the least increase followed by fibre board container with polythene lining. The other three containers showed much higher total and rate of increase reaching up to 16 per cent at the end of storage. The high moisture content in the plastic bottle container and the boxes with aluminium foil container is difficult to explain but the effect of increased moisture is reflected in the liquor characteristics recorded by the professional tasters.

The theaflavin and thearubigin contents of tea considered as indicative of tea quality showed little variation. The values varied from 1.46 to 1.71 for theaflavin and from 10.15 to 13.3 for thearubigin in the aluminium bottle container; 1.46 to 1.59 for theaflavin and 10.15 to 13.25 for thearubigin in harboard with polythene liner. In the other containers there was a general tendency to reduced values of theaflavin. The thearubigin values showed gradual increase of same level in all containers with the storage period. The significant increase in moisture recorded in all packages would explain the possibility of enzymic or non-enzymic formation of thearubigin[2].

The mean values of the scores for sensory rating for colour showed little changes till 232 days in the case of the aluminium bottle and hardboard with polythene lined containers but were stable only upto about 97-112 days in other containers. The sample in aluminium container is shown to be not significantly different from the

TABLE 1. MOISTURE CONTENT OF TEAS PACKED IN DIFFERENT CONTAINERS

Storage period (days)	Type of Containers				
	PAF	CAF	CPF	PL	AL
0	4.0	4.0	4.0	4.0	4.0
22	6.3	7.0	5.5	6.8	4.2
37	7.5	7.9	7.0	8.5	5.0
52	9.0	8.5	7.7	9.0	5.2
67	10.7	10.0	8.5	10.0	6.9
82	11.7	11.0	9.0	10.1	6.1
97	12.1	11.5	9.5	10.9	6.3
112	12.5	11.5	10.0	11.0	6.3
127	12.9	11.8	10.1	11.7	6.5
142	13.2	12.2	10.4	11.3	6.3
172	13.4	13.0	10.3	12.5	7.5
202	13.9	14.2	11.0	13.7	7.4
232	14.0	14.6	11.5	14.4	7.5
262	15.0	15.2	12.0	15.3	8.0
292	16.0	16.5	12.1	17.8	8.8

PAF - Plywood container with aluminium foil lining.
CAF - Cardboard container with aluminium foil lining.
CPF - Cardboard container with polythene film lining.
PL - Plastic container
AL - Aluminium container
Values are on dry weight basis.

TABLE 2. ANALYSIS OF DATA FOR MOISTURE, BRISKNESS AND COLOUR

Packagings	Moisture %			Briskness			Colour		
	Mean	Slope	Correlation coeff	Mean Score	Slope	Correlation Coeff	Mean Score	Slope	Correlation Coeff
PAF	11.47^{c}	0.0341	0.90***	2.30^{a}	-0.0033	-0.49^{ns}	2.39^{b}	-0.0046	-0.84***
CAF	11.26^{c}	0.0359	0.95***	2.55^{a}	-0.0071	-0.71**	2.20^{ab}	-0.0051	-0.69**
CPF	9.23^{b}	0.0241	0.92***	2.98^{b}	-0.0059	-0.78***	2.91^{c}	-0.0018	-0.69**
PL	11.11^{c}	0.0352	0.96***	2.27^{a}	-0.0068	-0.86***	2.00^{a}	-0.0055	-0.89***
AL	6.31^{a}	0.0145	0.97***	3.05^{b}	-0.0032	-0.50^{ns}	$c.03^{c}$	-0.0012	-0.33^{ns}

***Very highly significant; **Highly significant; ns: Not significant.
Means carrying different superscripts in the same column are significantly different.
($P<0.05$) by Duncan's New Multiple Range test.
Legend for abbreviation as in Table 1.

prestorage period sample. The former two containers were scored significantly higher than the latter three containers as seen by the analysis of the mean scores for containers over the total storage period (Table 2).

The scores for the strength of liquor for the sample from aluminium bottle container was always highest at any storage period followed by the sample in hardboard with polythene liner.

The scores for briskness of the liquor showed irregular fluctuations with storage period but these fluctuations were lesser with samples from aluminium bottle and hardboard polythene lined packs as compared to other types of containers. Analysis of the mean scores, however showed that the aluminium bottle and plywood-aluminium foil packed samples were not significantly different from the starting samples while others were poorer. The briskness may be due to increase in the body of the liquor.[3,4]

The scores for quality of liquor is given in Table 3. Here also samples in aluminium container followed by hardboard-polythene containers showed highest scores and smaller fluctuations over longer storage periods. These changes in quality appear to follow the changes in moisture absorption and indicate that changes in quality are essentially the result of this factor.

TABLE 3. MEAN TASTERS' SCORES FOR QUALITY OF LIQUOR OF TEA PACKED IN DIFFERENT CONTAINERS AND STORED FOR DIFFERENT PERIODS

Storage Period (days)	Types of Containers				
	PAF	CAF	CPF	PL	AL
0	2.9	3.0	3.0	2.7	3.0
22	2.3	2.3	3.5	2.5	3.0
37	2.0	3.0	3.0	2.0	3.0
52	3.0	2.0	3.0	2.0	3.0
67	2.5	3.0	3.7	1.0	2.8
82	2.7	1.7	3.3	1.7	3.0
97	2.3	2.0	2.3	2.3	2.1
112	2.3	2.3	2.3	2.0	2.7
127	2.0	2.3	2.3	2.0	3.0
142	2.3	2.3	2.3	2.0	2.3
172	2.0	2.0	2.3	2.0	2.3
202	2.0	1.0	2.0	2.0	3.0
232	1.7	1.3	2.3	1.0	2.7
162	2.0	1.0	2.0	1.0	3.0
292	2.0	1.0	2.0	2.0	2.0

Legend for abbreviation as in Table 1.

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References

1. Broca, T. S., Report of the seminar on bulk packaging of tea for export, sponsored by Tea Board, India and Indian Institute of Packaging, Bombay, 1976.
2. Werkhoven, J., *Tea Processing*, FAO Agricultural Services Bulletin No. 26, Rome, 1974, 92.
3. Deb. S. B., *Two and A Bud.*, 1965, **12**, 77.
4. Robert, E.A.H. and Smith, R. F., *J. Sci. Fd Agric.*, 1963, **14**, 689.

Quality of Indian Rice

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One hundred traditional tall Indian varieties of rice have been assessed for their (a) quality type, (b) gelatinization temperature (GT), (c) grain type, and (d) protein content. The typical Indian rice is of quality type III (non-sticky but soft after cooking) and has an intermediate GT (70-72°C), medium length (5-6 mm), quasislender shape (L/B – 2.4-3.0) and small size (grain weight, 12-18 mg). However, many south Indian varieties are of quality type II (nonsticky and harder upon cooking) and have a moderately high GT (72-74°C); several samples of north India are scented (type IV); a good number are long (6-7 mm) and slender (L/B, > 3). Several rices from Gujarat and Maharashtra are tiny (weight, <12mg); those of Kerala are generally bold (L/B, 2-2.4) and big (18-23 mg). In contrast, the varieties of the north-east and north-west hilly regions of India are typically of quality type V or VII (sticky or very sticky) and have a low to very low GT (<70°C); they are bold or round in shape (L/B, <2.4) and big or giant in size (>18 mg). Protein content (in milled rice) showed wide variation; but 40% of the samples had 9-13% protein (dry basis).

There are thousands of rice cultivars in India. But information on their quality characteristics is lacking. Juliano *et al.*[1] and Japanese scientists[2] studied the quality of many varieties of south-east Asia, but few Indian rice var. were included in these works. Drs. S. Govindaswami and A. K. Ghosh of the Central Rice Research Institute, Cuttack, studied the characteristics of a very large number of commercially important Indian rice varieties over several years; but these results have not been published. Moreover, their study was related to swelling ratio, volume expansion, starch-iodine blue value, etc., which do not give sufficient information on the intrinsic quality of rice. The booklet published by the Food Corporation of India[3] also does not give the necessary information and some values appear to be unrealistic. Attempt has been made to collect information on rice quality from 106 rice samples (100 varieties) belonging to different states of India, the results of which are presented in this paper.

Materials and Methods

Rice: The rice samples used in this study consisted of a few representatives each of the commercially important traditional (tall) varieties of the major rice-growing states of India. They were procured from different agricultural experiment stations and agricultural universities situated in states listed in Fig. 1.

Paddy samples (1-2 kg each) of moisture content 11-13 per cent (wet basis) were stored in cloth bags in large metal drums and were tested roughly 1-2 yr after harvest.

Paddy was milled using a McGill sheller and a McGill miller No. 3 by standard methods (8-10 per cent degree of milling). Rice was ground in a Buhler disc grinder (MLI 204) and then in a Raymond hammer mill to about 65 mesh for viscograph and amylose tests.

Analytical methods: Total amylose[4] and water-insoluble amylose[5] contents; alkali score and type[6-8]; equilibrium moisture content attained by whole grain milled rice upon soaking in water at room temperature (EMC-S)[9]; ratio of water uptake at 80° to that at 96°C[10]; and viscogram type as determined by comparing the observed relative breakdown (BD_r) with the standard curves[11] were determined. Protein content of milled rice was determined approximately by the biuret method[12]. Gelatinization temperature (GT) was calculated from the viscograms as suggested by Juliano *et al.*[1] and also from the alkali score by a regression equation recently described[13]; the latter value was adopted as it was more consistent.

Length and breadth of milled rice were determined by arranging ten randomly selected whole grains end to end for measuring.[14] Grain weight was determined from 100 milled whole grains.

Quality classification of rice: As recently discussed by us[11,15], rice can be tentatively classified into eight quality types based on the total and insoluble amylose contents and certain other properties (Table 1). The main point to note is that rice of type I cooks extremely

TABLE 1. QUALITY CLASSIFICATION OF RICE*

Quality type		Example	Amylose (% d. b.)		Alkali degradation type	EMC-S (approx) (% w.b.)	Cooked rice		BD_r
No.	Designation		Total	Insol			Stickiness	Consistency	
I	High-amylose A	IR 8, IR 22, Jaya	>26	>15	B, mixed B	29	Very low	Very high	Very low
II	High-amylose B	GEB 24, Slo 13, Co 32	>26	12.5-15	A, B_1	28			
III	High-amylose C	T 141, Slo 16, Br 34	>26	≤12.5	A, B_1	28			
IV	Intermediate-amylose A (scented)	Br 9, T 3, Basmati 370	22–26	<10	mixed C	29			
V	Intermediate-amylose B	Kuki, Thevürü, Abor red	22–26	<10	Mixed C	31			
VI	Intermediate-amylose C (Bulu)	Baok, Benong 130	22–26	<10	Mixed C	29			
VII	Low-amylose	Norin 29, Tainan 3, Phoudum	15–22	<9	C	31.5			
VIII	Waxy	Purple puttu, Asm 51, Nyakra	<10	—	D	35	Very high	Very low	Very high

*The following abbreviations have been used: insol = water-insoluble; EMC-S = equilibrium moisture content attained by rice upon soaking in water at room temperature; BD_r = relative breakdown in Brabender viscogram; d.b. = dry basis; w.b. = wet basis.

nonsticky and hard, while that of type VIII cooks extremely sticky and soft; the other types fall in between, generally in the order shown. The pasting behaviour of rice (as determined by a newly developed viscographic technique) bears a striking resemblance to the above classification, in as much as the viscogram patterns also show the same distinct eight types[11,16]. The quality types of the present samples were determined as per the above criteria. The viscogram-based and the amylose-based classifications generally agreed here with a few minor exceptions. In the latter cases, the viscogram pattern was taken as the true quality indicator.

Classification of grain types: In U.S.A., rice is classified by length[14], which is not applicable to other rices. In India, breeders and graders now grade rice as per Ramiah Committee report[17]. However, this classification, although perhaps suitable for marketing, does not give a clear picture of the actual dimensions. The classification based on actual dimensions used in the present work, is as proposed by us earlier[18]:

Length (mm)	Extra long (EL) (>7)	Long (L) (6-7)	Medium (M) (5-5.99)	Short (S) (<5)
Shape (L/B ratio)	Slender (s) (>3)	Quasi-slender (q) (2.4-3.0)	Bold (b) (2.0-2.39)	Round (r) (<2.0)
Size (weight:mg)	Tiny (T) (<12)	Small (S) (12-18)	Big (B) (18.1-23)	Giant (G) (>23)

Any two of these parameters would be generally sufficient to indicate the grain type, the third being largely implied thereby. We have considered only shape and size in the presentation below (Fig. 3).

Presentation of data: The results of individual samples could not be presented because of the large number of samples*. Only their state- and region-wise distribution, in terms of certain quality classifications, is presented in Figs. 1-4. Each dot in these figures represent one sample.

For studying the region-wise distribution, the states (and Union Territories) have been grouped into four major regions as follows: (*a*) the main low-altitude or plain land mass of north and central India, (*b*) western India, (*c*) southern India and (*d*) the hilly border regions of north-east and north-west. These groupings are shown by the demarcations in the Figs. 1-4.

Results and Discussion

The state- and region-wise distribution of different quality attributes of the Indian rice samples tested are shown in Figs. 1-4. Two limitations to be noted while considering these data are: (1) 106 samples may not give a clear picture of the region-wise distribution of property

* These results are available with the senior author and can be obtained from him on request.

profile of rice in such a vast country as India; and (2) the number of samples tested, and hence the number of corresponding dots in the figures, bears no relation to the extent of production and consumption of rice in different states and territories.

Quality type of rice: The region- and state-wise distribution of quality type of the samples as per the classification described in Table 1 is shown in Fig. 1. Quality type VI ('Bulu' rice) is omitted from the figure because none of the samples tested belonged to this class. Quality type IV (scented rice), although falling between types III and V in certain properties, has some distinctiveness of its own[11] and hence is listed in the last column.

Samples from north and western India belonged predominantly to type III. In fact this was the most prevalent type in the samples as a whole. Clearly, the preference of most Indian consumers, especially in north and west, is for a rice that cooks nonsticky (high amylose) but at the same time remains soft (low retrogradation due to low insoluble amylose). In south India, a similar trend is seen in samples from Kerala; but in the other states (as also in Assam and West Bengal in north) type II rice (high total and insoluble amylose, hence rather hard after cooking) appears to be a close second in terms of preference. Interestingly, quite a few varieties from Kerala too had amylose contents characteristic of type II, but their viscogram pattern was of type III. Clearly, the typical Indian rice is qualitatively different from that of south-east and east Asia, which is reportedly of intermediate-amylose (types V and VI) and low-amylose (type VII) types, respectively[1,2,19].

In contrast to the above picture, the varieties tested from the hilly border areas of north-east and north-west India belonged predominantly to semisticky (type V) and sticky (type VII) rice (and VIII: waxy). Presumably high altitude, high latitude (25°N or more)and cold climate may have a bearing on this. It would be interesting in this context to study the properties of rice from Arunachal, Tripura, the hill areas of Assam, Himachal Pradesh, and the northern hill districts of Uttar Pradesh.

Scented varieties (type IV) were fairly common among the samples from the northern region, especially Uttar Pradesh.

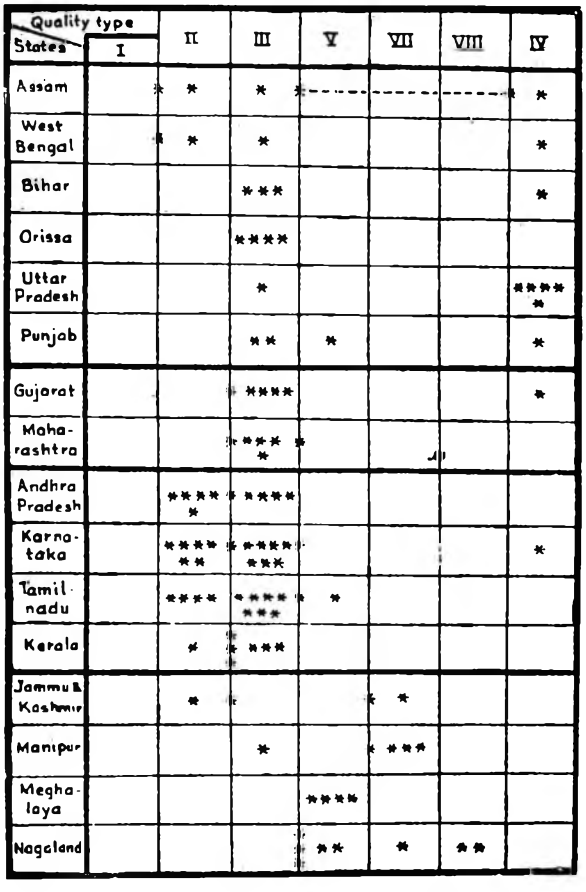

Fig. 1. Distribution of quality type of rice in India. Each dot represents a sample. A dot at the border between two columns indicates characteristics intermediate between the two types. One sample of Assam (Kola Joha) showed characteristics intermediate between types III and IV (joined by a dotted line).

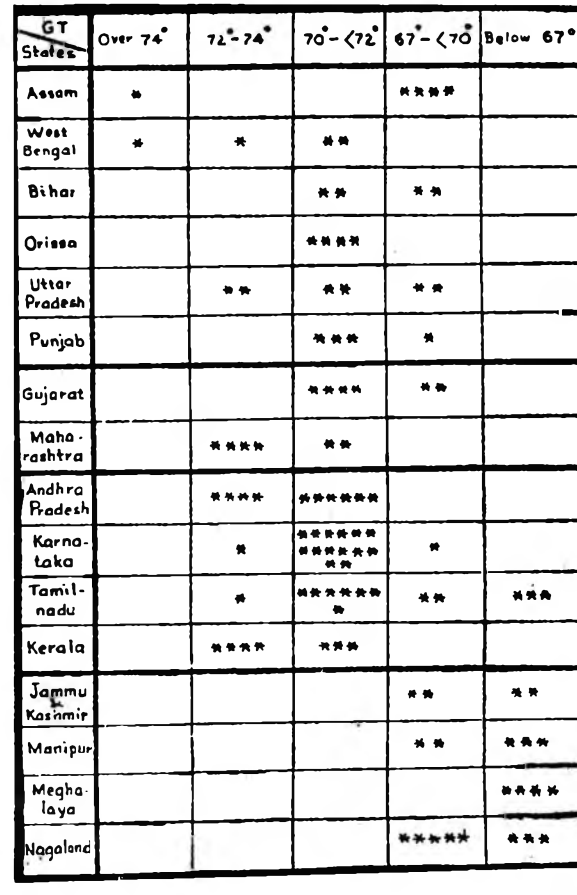

Fig. 2. Distribution of gelatinization temperature of rice in India. See legend to Fig. 1.

None of the Indian rices studied belonged to Type I (nonsticky but very hard after cooking), though two varieties from Assam and West Bengal ('Prosadbhog' and 'Latisail') approached this type. However, type I rice is found only among some Taiwanese semidwarf *indica* rice and some of their progenies.[7]

Curiously, most varieties of Punjab and Tamil Nadu, although belonging to the high-amylose groups (types I-III), possessed amylose contents rather on the low side (26-27 per cent) of the high-amylose range.

Gelatinization temperature (GT): The regional distribution of the rice varieties by GT showed a more or less similar picture as above (Fig. 2). Most Indian varieties studied had an intermediate to moderately high GT, the former being by far predominant especially in the samples from north and west; the southern varieties showed a fair number with moderately high GT. But the samples from north-east and north-west regions invariably had a low to very low GT.

Rice of very high GT appears to be uncommon in India. Only two of the 106 samples studied ('Ch 63' and 'NC 324', from Assam and West Bengal respectively) belonged to this category. Interestingly, two high-amylose varieties (three samples) from Tamil Nadu had an extremely low GT ('Co 25' and 'Co 4').

Grain type: The grain dimensions of the samples, although showing a wider spread of values than above, showed a fair degree of regional specificity (Fig. 3).

The bulk of the varieties were medium in length, quasislender in shape and small in size. However, a good number were long and/or slender. Most varieties from the western region (Maharashtra and Gujarat) were exceptional in being tiny in size (even as small as 7-9 mg). Varieties from Kerala were usually bold and big or giant; they also generally had a coloured pericarp.

In contrast, the varieties from north-west and north-east regions were, by and large, medium in length, bold or round in shape, and big or giant in size. Thus in grain type too, as in their amylose contents and gelatinization temperatures, these *indica* rices simulated temperate (*japonica*) rice.

Only four ('SR 26B', 'Tsalha', 'Nyakra' and 'Nyamhoü') of the 106 samples studied belonged to the giant size, which is fairly common among European, Australian and Japanese varieites.

Grain type / States	qT	bT, rT	sS	qS	sB	bS, qB	rS, bB	rB, G
Assam	*			**		**		
West Bengal	*				**		*	
Bihar		*		***				
Orissa	**			**				
Uttar Pradesh	*		****			*		
Punjab			**	*		*		
Gujarat	***			**		*		
Maha-rashtra	*****						*	
Andhra Pradesh	*		*	*****	*	**		
Karna-taka	*	*		*****		***	****	*
Tamil-nadu		*		*****		**	**	
Kerala				**			****	
Jammu & Kashmir							***	*
Manipur						****	*	
Megha-laya							*	***
Naga-land						*	***	****

Fig. 3. Distribution of grain type of rice in India. s, Slender; q, quasislender; b, bold; r, round; T, tiny; S, small; B, big; G, giant. See legend to Fig. 1.

Protein / States	6-<7	7-<8	8-<9	9-<10	10-<11	11-<12	12-<13	13-<14
Assam		****	*					
West Bengal		****						
Bihar				**	**			
Orissa		**	**					
Uttar Pradesh			**	***		*		
Punjab					*	**	*	
Gujarat	*		*****					
Maha-rashtra	**	***			*			
Andhra Pradesh	**		*	*****		*	*	
Karnataka	*	*****	*****				*	
Tamil-nadu	****	**	**	**	***			
Kerala			**	**		***		
Jammu & Kashmir		***		*				
Manipur		*	*	*			*	*
Megha-laya			*	**	*			
Nagaland			*****	*		**		

Fig. 4. Distribution of protein content of rice (% dry basis, in milled rice) in India. See legend to Fig. 1.

Protein content: Protein contents (as determined approximately by the biuret method) were in general not as low as is usually reported (Fig. 4). As many as 68 per cent of the 106 samples had a protein content of 8 per cent or more (dry basis) in milled rice; 40 per cent had 9 per cent or more protein; 21 per cent had 10 per cent or more; 13 per cent had 11 per cent or more; 5 per cent had 12 per cent protein or more; and 1 sample ('Taothabi' of Manipur) contained as high as 13.1 per cent protein.

Protein content showed no regional distribution. Curiously, certain states seemed to contain predominantly high-protein varieties, while a few other states seemed to contain mostly low-protein ones (see figure).

In conclusion, despite the limitations mentioned earlier, the study seems to have revealed an interesting pattern of regional distribution of rice quality in India. Further studies on these lines with all the commercially important rices in the country, including the modern high-yielding semidwarf crosses now becoming increasingly popular, should be useful.

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References

1. Juliano, B. O., Cagampang, G. B., Cruz, L. J. and Santiago, R. G., *Cereal Chem.*, 1964, **41**, 275.
2. Chikubu, S., in *Rice in Asia*, Assoc. Jap. Agric. Sci. Soc., Univ. of Tokyo Press, Tokyo, 1975, 537.
3. Food Corporation of India, *Quality Characteristics of Indian Rice*, New Delhi, 1972, pp. 66.
4. Sowbhagya, C.M. and Bhattacharya, K.R., *Stärke*, 1971, **23**, 53.
5. Bhattacharya, K. R., Sowbhagya, C. M. and Indudhara Swamy, Y. M., *J. Fd Sci.*, 1972, **37**, 733.
6. Bhattacharya, K. R. and Sowbhagya, C. M., *J. Fd Technol.*, 1972, **7**, 323.
7. Bhattacharya, K. R., Sowbhagya, C. M. and Indudhara Swamy, Y. M., *J. Sci. Fd Agric.*, 1978, **29**, 359.
8. Bhattacharya, K. R. and Sowbhagya, C. M., *J. Sci. Fd Agric.*, (accepted).
9. Indudhara Swamy, Y.M., Ali, S.Z. and Bhattacharya, K. R., *J. Fd Sci. Technol.*, 1971, **8**, 20.
10. Bhattacharya, K. R. and Sowbhagya, C. M., *Cereal Sci Today*, 1971, **16**, 420.
11. Bhattacharya, K. R. and Sowbhagya, C. M., *J. Fd Sci.*, 1979, **44**, 797.
12. Parial, L. C., Rooney, L. W. and Webb, B. D., *Cereal Chem.*, 1970, **47**, 38.
13. Bhattacharya, K. R., in *Chemical Aspects of Rice Grain Quality*, International Rice Research Institute, Los Baños, Philippines, 1979, 231.
14. Adair, C. R., Beachell, H. M., Jodon, N. E., Johnston, T.H., Thysell, J. R., Green, V. E., Jr., Webb, B. D. and Atkins, J. G., in *Rice in the United States: Varieties and Production*, Agric. Handbook No. 289, Agric. Res. Service, U. S. Dept. Agric., 1966, 19.
15. Bhattacharya, K. R., Sowbhagya, C. M. and Indudhara Swamy, Y. M., *Internat. Rice Res. Newslet.*, 1979, **(4)** 7.
16. Bhattacharya, K. R. and Sowbhagya, C. M., *J. Texture Studies*, 1978, 9, 341.
17. Government of India, *Report on the Classification of Rice*, Ministry of Food., Agric., Comm. Dev. and Coop., New Delhi, 1968, pp. 93.
18. Bhattacharya, K. R. and Sowbhagya, C. M., *Riso* (Accepted).
19. Juliano, B. O., in *Chemical Aspects of Rice Grain Quality*, International Rice Research Institute, Los Baños, Philippines, 1979, 69.

RESEARCH NOTES

PRODUCTION OF ETHYL ALCOHOL FROM TUBERS

Acid liquefied tuber starches were saccharified by utilizing mouldy bran of *Rhizopus niveus*, as the source of amyloglucosidase, prior to alcoholic fermentation by *Saccharomyces cerevisiae* var. *ellipsoideus*. Alternatively the fungus was allowed to grow on the starchy substrate and alcoholic fermentation was also carried out simultaneously. This mixed culture technique gave corresponding fermentation efficiencies of 68, 81 and 75 for potato, tapioca and sweet potato.

India produces 12.5 million tonnes of tubers annually from tapioca (*Manihot esculenta* Crantz.), potato (*Solanum tuberosum* L.) and sweet potato (*Ipomea batatas* (L.) Lam.)[1]. Periodically there is glut of these tubers and the farmers get only unremunerative prices for their produce. One of the best ways of utilizing these valuable carbohydrate rich raw materials is to convert them to ethyl alcohol. Besides its potable use, ethyl alcohol is also a basic raw material in the manufacture of a number of organic chemicals. It is also a renewable energy source[2]. Ethyl alcohol is also used as gasoline extender.[3] Attempts made to produce ethyl alcohol starches have been summarized here.

Composition of fresh potatoes and dehydrated tapioca and sweet potatoes used in these studies, is presented in Table 1. Ethyl alcohol washed mouldy bran (MB) of *Rhizopus niveus* was utilized as enzyme (amyloglucosidase (AG) source. Active cultures of *R. niveus* grown on wheat bran (AMB) and *Saccharomyces cerevisiae* var. *ellipsoideus* grown on starch medium were utilized in mixed-culture fermentation. A.O.A.C. procedures from tuber were adopted for chemical analyses[4].

TABLE 1. COMPOSITION OF FRESH POTATOES AND DEHYDRATED TAPIOCA AND SWEET POTATOES

	Potato	Tapioca		Sweet Potato	
		Var.A.	Var.B.	Red	White
Moisture (%)	82.0	11.7	9.0	8.5	3.5
Starch (%)	16.17	64.0	81.0	61.0	65.0
Reducing sugars (%)	nil	nil	1.2	8.2	8.8
Protein (%) (N×6.25)	0.21	1.5	1.8	2.1	2.2

Non-reducing sugars were not present in any of the samples.

Potatoes were minced with a little quantity of water or acid solution while tapioca and sweet potato flours were dispersed in the same solvent at 20 per cent level and then cooked at 1.1 kg/cm^2 for different periods. Efficiency of gelatinization was determined by the extent of hydrolysis by AG when incubated at 60°C for 24 hr. The results are presented in Table 2.

Optimum enzyme required for saccharification was determined by adding 1, 2.5, 5.0 and 7.5 per cent of enzyme to 20 per cent liquefied starch slurry and estimating the reducing sugars formed after 24 hr incubation at 60°C. Yeast culture was added at room temperature (26°C) and fermentation was continued. It is evident from Table 3 that the addition of enzyme at 2.5 per cent level is most economic for saccharification.

Cooking the starch slurry in a steam-jacketted, open kettle was attempted since gelatinization and liquefaction under pressure is not commercially economical.

A portion of the acid solution was brought to boiling in a kettle and tapioca slurry, prepared in the remaining quantity of dilute acid, was slowly poured into the kettle while stirring vigorously. It was observed that the starch

TABLE 2. EFFECT OF COOKING TIME ON THE SACCHARIFICATION OF TUBER STARCHES

Material	Cooking time (min.)	Reducing sugars (%)	Consistency of mash
Potato	15	6.1	Viscous
	30	6.4	Free flowing
Tapioca	15	16.2	Viscous
	30	16.8	Free flowing
	45	16.9	-do-
	60	16.9	-do-
Sweet potato	15	15.1	Viscous
	30	15.3	Free flowing

TABLE 3. YIELD OF ETHYL ALCOHOL FROM STRACH HYDROLYSATE AT DIFFERENT LEVELS OF AMYLOGLUCOSIDASE

Amyloglucosidase (MB) %	Yield of ethyl alcohol from 100g of hydrolysate (ml)
1.0	16.8
2.5	22.2
5.0	23.0
7.5	23.0

TABLE 4. YIELD OF ETHYL ALCOHOL OBTAINED FROM STARCHES OF DIFFERENT TUBERS BY AMYLOPROCESS

Source of starch	Yield of ethyl alcohol/ 100g starch (ml)	Fermentation efficiency (%)
Potato	34.0	68.0
Tapioca	40.5	81.0
Sweet potato	37.5	75.0

was liquefied within 15 min. This liquefied starch when saccharified with AG and fermented, gave 400-420 ml of ethyl alcohol for every kilogram of starch used. Larger batches of starch (10-15 kg.) also gave similar yields of ethyl alcohol.

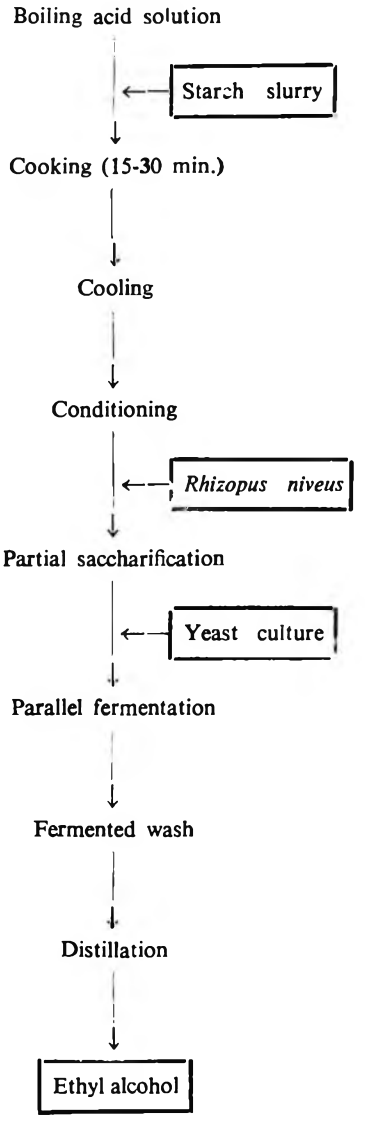

Fig. 1. Flow sheet for ethyl alcohol production by mixed culture technique

Mixed culture process: Grove[5] has described a process for commercial production of ethyl alcohol by employing amylolytic fungi. Stark[6] has reported a similar process followed in European distilleries. A modification of these processes was tried. Liquefied starch was prepared by open pan cooking (after cooling and readjustment of pH) and was inoculated with *Rhizopus niveus* culture (AMB used at the rate of 25 g/kg of starch). After 24 hr, the mash was pitched with yeast culture. As and when the fermentable sugar was formed, yeast converted it to ethanol. This parallel fermentation was carried out for 120 hr after which the wash was distilled. Yields of alcohol obtained with different starches are presented in Table 4.

Bench scale trials as per the above process were done with 10 kg of tapioca flour per batch. The average fermentation efficiency based on the starch works out to 82.9 per cent. The flow sheet of the process is given (Fig. 1).

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References

1. Anon., *Agricultural Situation in India*, 1979, **34**, (1) 63.
2. Malshe, V. C., *Sci. Today*, 1978, **13**, (2), 23.
3. deMenezes, *Process Biochem*, 1978, **11** (9), 24.
4. *Official Methods of Analysis*. Association of official Agricultural Chemists, Washington, D. C., 1965.
5. Grove, O., *J. Inst. Brewing*, 1914, **20**, 248.
6. Stark, W. H., in *Industrial Fermentations* Vol. I (Eds.) L. A. Underkofler and R. J. Hickey, Vol. I. Chem. Pub. Co., New York, 1954.

PHYSICO-CHEMICAL CHARACTERISTICS OF VANASPATI

Four brands of vanaspati (two brands from large and two from small manufacturing concerns) were analysed for their physical and chemical characteristics and the results reported.

During fifties, Kehar *et al.*[1] and Belekar *et al.*[2] studied the physical and chemical constants of a large number of vanaspati samples. With the change of starting stock during recent years, the physico-chemical characteristics of vanaspati are likely to change. From this consideration, four different brands of vanaspati purchased from the market were analysed. In this, two brands (samples A and B) were from the large manufacturing units in India while the remaining two brands (samples C and D)

were from small manufacturing concerns (15-150 tons year).

One kg unit pack of each of samples A and B was purchased, while one kg loose quantity from 15-16 kg tins of each of the samples C and D were procured. Analysis was started immediately after the purchase. However, in between the analysis, the materials were stored in a refrigerator.

Slip point, and colour were determined according to methods described by Cocks and Van Rede[3], smoke point, refractive index, moisture, volatile matter, free fatty acid, iodine value, saponification value and unsaponifiable matter according to AOCS methods[4] Determination of viscosity was done as described by Krammer and Twigg.[5] It was taken in a penetrometer (Type FNA-74 of Associated Instrument Manufacturing India Ltd., Bombay) which was fitted with a standard penetration cone for margarine manufactured by M/s. Sargent-Welch Scientific Co., USA. Cone used had a weight of 45 g and an angle of 20°. Samples were melted and allowed to solidify at ambient temperature (25-28°C) for 3 days in glass containers of cylindrical shape (height 14 cm × internal dia, 4.3 cm). The sample height was 10.5 cm. The Baudoin test was conducted as per Vegetable Oil Products (VOP) order.[6] Nickel content was estimated according to the method described by Beleker *et al.*[2]

Table I gives physical and chemical characteristics of the products.

The samples had slip point varying from 29.0° to 36.5°C, refractive index of 1.4605–1.4621 at 40°C (Butyro refractometer reading 51.7 to 55.7) moisture and volatile matter content of 0.04–0.14 per cent, free fatty acid of 0.09 to 0.15 per cent; smoke point ranged from 210 to 226°C, penetrometer reading had a wide variation of 14-44 mm. Viscosity of different samples at 40°C ranged from 41.5 to 43.0 centipoise. Iodine value (I.V.) ranged from 65.5 to 83.6. The range of I.V. reported by Kehar *et al.*[1] was 56-70 and by Belekar *et al.*[2] was 60 to 71. It seems that at present oil stock is hydrogenated to a lesser extent maintaining a lower melting point.

Saponification values reported by the above authors were 185.6–194.9 and 189.5–196.3 respectively indicating wide variation in the oil stock used for hydrogenation in earlier years. In the present study. saponification value was found to be fairly constant (195.1 to 196.2) indicating that more or less similar stock of oils was taken for hydrogenation.

Nickel content of samples ranged from 0.1 to 0.4 ppm. which was in conformity with earlier observation by Belekar *et al.*[2]

All samples gave positive Baudoin test (not less than 2.0 red units).

The samples A and B conformed to the requirements of VOP order[6] with respect to parameters studied. Sample C had a slip point of 29°C which is lower than the prescribed limit of 31°C. Sample D had a free fatty acid content of 0.33 per cent which is slightly higher than the upper limit of 0.25 per cent as per VOP Order.

TABLE 1. PHYSICAL AND CHEMICAL CHARACTERISTICS OF VANASPATI

Characteristics	Sample A	B	C	D
Colour, Lovibond unit R	0.3	0.2	0.2	1.0
1 cm cell Y	1.1	1.0	1.1	2.2
Slip point (°C)	32.0	31.0	29.0	36.5
Smoke point (°C)	225	225	226	210
Penetrometer reading at 29°C (depth of penetration in 0.1 mm)	190	345	442	140
Viscosity at 40°C (Centipoise)	42.0	42.0	43.0	41.5
Moisture and volatile matter content (%)	0.14	0.05	0.04	0.08
Free fatty acid content (as % oleic acid)	0.09	0.15	0.09	0.33
Iodine value (wijs)	74.0	75.08	83.6	65.5
Refractive index at 40°C (Butyro refractometer reading)	1.4621	1.4620	1.4631	1.4605
	54.2	54.0	55.7	51.7
Saponification value	196.4	196.2	194.9	195.1
Unsaponifiable matter (%)	0.09	0.12	0.10	0.15
Nickel content (ppm)	0.06	0.11	0.36	0.27
Baudoin test	Positive 2.0 red units	Positive 2.0 red units	Positive 2.0 red units	Positive 2.0 red units

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References

1. Kehar, N. D., Krishnan, T. S., Ray, S. N., Joshi, B. C. and Raisaikar, B. C., *Studies on fats, oils and vanaspatis*, Indian Council of Agricultural Research, New Delhi, 1956, 23.
2. Belekar, G. K., Bhinde, P. T. and Kane, J. G., *J. Sci. industr. Res.*, 1952, **11B**, 140.
3. Cocks L. V. and Van Rede *Laboratory Handbook for Oil and fat Analysis.*, Academic Press, London and New York, 1966, 68.

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STUDIES ON PREPARATION OF TUTI FRUITI FROM RAW PAPAYA (*CARICA PAPAYA* LINN.) FRUIT

Methods of preparation of tuti fruiti from raw scarred papaya are presented. Product having one per cent acidity was found to be of good acceptable quality.

Ripe papaya fruit is extensively used for table purposes. The unripe fruit is used as a vegetable and also for preparing pickles. The fruit is also candied. According to Kumar[1], maximum profit could be obtained from papaya if the lanced papaya after extraction of papain could be used for preparation of preserve-like products. The sale value of scarred fruits after papain extraction is very low. Methods of preparation of tuti fruiti from raw scarred papaya is described. Tuti fruiti is a candy like product prepared from raw bits of lanced papaya.

Twenty papaya plants of 'Washington' variety with uniform growth and vigour were selected for the study to assess the commercial availability of papaya fruit. Fruits were analysed for physical parameters at intervals of one month after fruit set. At the full maturity, 10 fruits were collected and analysed for physico-chemical characters to assess their suitability for preparation of the product. Average weight length, diameter and thickness of the fruit were determined. Pulp, peel and seed percentages were also calculated. Total soluble solids (TSS) were determined with a hand refractometer. Moisture and acidity were determined as per standard methods[2]. Reducing and total sugars were estimated by the method of Lane and Eynon[3].

Preparation of tuti fruiti: Lanced papaya fruits were selected. After washing, the fruits were peeled, cut into two halves and seeds removed. The halves were cut into uniform size (0.9 × 0.9 × 0.7 cm) and boiled in water (1:2 ratio) for 15-20 min and cooled.

Preserves: Boiled bits were divided into four lots. Sugar, amounting to half the weight of the prepared fruit was placed in alternate layers and allowed for 24 hr. Sugar was added periodically to raise the TSS and cooked. The procedure was repeated until the final TSS was 68 per cent. During final cooking, varying concentrations of citric acid were added. The papaya bits were analysed for TSS and sugars at regular intervals. The syrup was finally drained and the tuti fruiti was dried in air at room temperature for 24 hr.

Organoleptic evaluation: Sensory characteristics of the finished product were done on a 9-point Hedonic scale[4] by a panel of 12 experts, including 6 females. Market sample akin to the product prepared was taken as a reference material for comparison.

TABLE 1. PHYSICAL CHANGES IN PAPAYA FRUIT DURING GROWTH

Period after fruit set (months)	Av. wt. of fruit (g)	Av. length (cm)	Av. diam. (cm)	Edible portion (%)
1	98	7.50	5.80	69.3
2	402	15.02	28.48	75.9
3	745	20.15	35.75	81.2
4	946	21.25	38.50	80.0

TABLE 2. LOSSES IN SOLUBLE SOLIDS OF RAW PAPAYA BITS DURING COOKING IN BOILING WATER

Particulars	Fresh bits	Boiled bits	% loss
TSS (°Brix)	10.00	4.50	45.0
Reducing sugars (%)	5.29	1.14	21.6
Total sugars (%)	6.66	2.58	38.7

Table 1 shows the changes in physical parameters during fruit development.

The availability of fruit at the right stage of maturity is an important parameter for processing. There was considerable increase in growth rate of fruit upto the third month which levelled off thereafter. Hence, upto third month, it may not be economical to utilize the fruit for the preparation of tuti fruiti. After the 4th month, the fruits softened and the bits disintegrated during cooking. Hence, fruits matured for 3 to 4 months are most suitable for preparing tuti fruiti. At full maturity, the fruits yield 80 per cent of the prepared material suitable for preparation of preserve like products. Losses in soluble solids occurred during the preliminary cooking done to inactivate the enzymes and to render the fruit soft (Table 2).

Losses reported during cooking in boiling water earlier[5] have been confirmed in the present findings.

Sugar concentration of syrup was increased at the rate of 10° Brix every day (Table 3). The reducing sugars increased from 1.02 to 20.0 per cent after 48 hr. which may due to the addition of citric acid after 48 hr.

TABLE 3. CHANGES IN SUGARS IN RAW PAPAYA BITS DURING PROCESSING

Time (hr)	°Brix	SUGARS		
		Reducing (%)	Non-reducing (%)	Total (%)
24	48	1.16	37.97	39.13
48	58	1.02	39.88	40.91
72	68	20.00	42.50	62.50

Sensory evaluation: The different lots of the tuti fruit having 0.5 to 1.5 per cent acid were organoleptically evaluated. The product having one per cent acid scored maximum with respect to colour, flavour and taste compared to other lots and market sample. The score for the texture was quite comparable with the market sample. On the basis of total organoleptic score, the product having one per cent acid was adjudged best. The market sample scored low in comparison to the test product for all the parameters except taste in the samples where no acid was added. This may be due to crystalization of sugar. However, the score for the product in all the lots was never below the acceptable limit.

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References

1. Kumar, V., *Fd Technol. Champaign*, 1952, **9**, 36.
2. *Official Methods of Analysis*, Association of Official Analytical Chemists, 11th Ed, 1970.
3. Lane, J. H. and Eynon, *J. Soc. Chem. Ind.*, 1923, **21**, 463.
4. Amerine, M. A., Pangborn, R. M. and Roessler, E. B., *Principles of Sensory Evaluaton of Food*, Academic Press, London, 1965.
5. Dietrich, W. C. and Neumann, H. J., *Fd Technol. Champaign*, 1965, **19**, 1174.

INTERNAL BREAKDOWN DURING RIPENING OF ALPHONSO MANGO (*MANGIFERA INDICA* LINN.) IN RELATION TO SPECIFIC GRAVITY OF THE FRUIT

Correlation of internal breakdown, a physiological disorder in Alphonso mango with specific gravity of the fruit was studied. Fruits having specific gravity <1.00 did not show internal breakdown, but the quality of the ripe fruit was inferior. Fruits of specific gravity 1.00—1.02 showed 22% internal breakdown and those of specific gravity >1.02 showed 46%. The severity of damage was more in fruits of specific gravity >1.02 as compared to those of specific gravity 1.00-1.02.

'Alphonso' mango is an important cultivar highly valued as a fresh fruit in domestic as well as export markets and also for processing. It is, however, subject to internal breakdown, known as "Soft centre" or "Spongy tissue" during ripening and storage[1]. This disorder has no distinct external symptoms and becomes visible only when the fruit is cut open. A non-destructive method of predicting the incidence of the breakdown will, therefore, be highly useful. The possibility of using the specific gravity of the fruit as an index for this has been studied.

About 2500 mature but unripe fruits were harvested from a group of elven trees, bearing 200-250 fruits each. On the basis of their specific gravity[2], they were graded into three groups, namely fruits with sp. gr. of (*i*) <1.0 (*ii*) 1.0–1.02 and (*iii*) >1.02. They were ripened at room temperature ($28\pm2°C$) and examined for internal breakdown. The symptoms are shown in Fig. 1. In the initial stages, the soft centre was less than 2 cm in diameter and had pale yellow colour in contrast to the bright orange colour of the surrounding healthy pulp and the texture also was highly soft. In the advanced stage, the entire area of the cut half of the fruit had broken down, the pulp was pale yellow in colour and also of leathery texture with air pockets.

Data regarding the specific gravity of the fruits and the incidence of breakdown for the three groups are given in Tables 1 and 2 respectively. The percentage distribution of the fruits was 0-14, 21-50, 42-79 respectively in the three groups on the basis of specific gravity. While fruits of sp. gr. less than one were practically free from internal breakdown, the incidence of breakdown was 7-49 (mean 22) in group (*ii*) and 25-75 (mean 46) in

TABLE 1. DISTRIBUTION OF FRUITS (%) IN RELATION TO SPECIFIC GRAVITY

Tree No.	Group-1 Sp. gr. <1.00	Group-2 Sp. gr. 1.00–1.02	Group-3 Sp. gr. >1.02
1	5	25	70
2	10	38	52
3	4	34	62
4	14	40	46
5	8	50	42
6	0	22	78
7	4	44	52
8	0	24	76
9	0	21	79
10	1	25	74
11	0	38	62
Mean	4	33	63
Significance			
Group 1~2		**	—
Group 2~3			**
Group 1~3	—	—	**

** Significant at 1.0% level

Contribution No. 746.

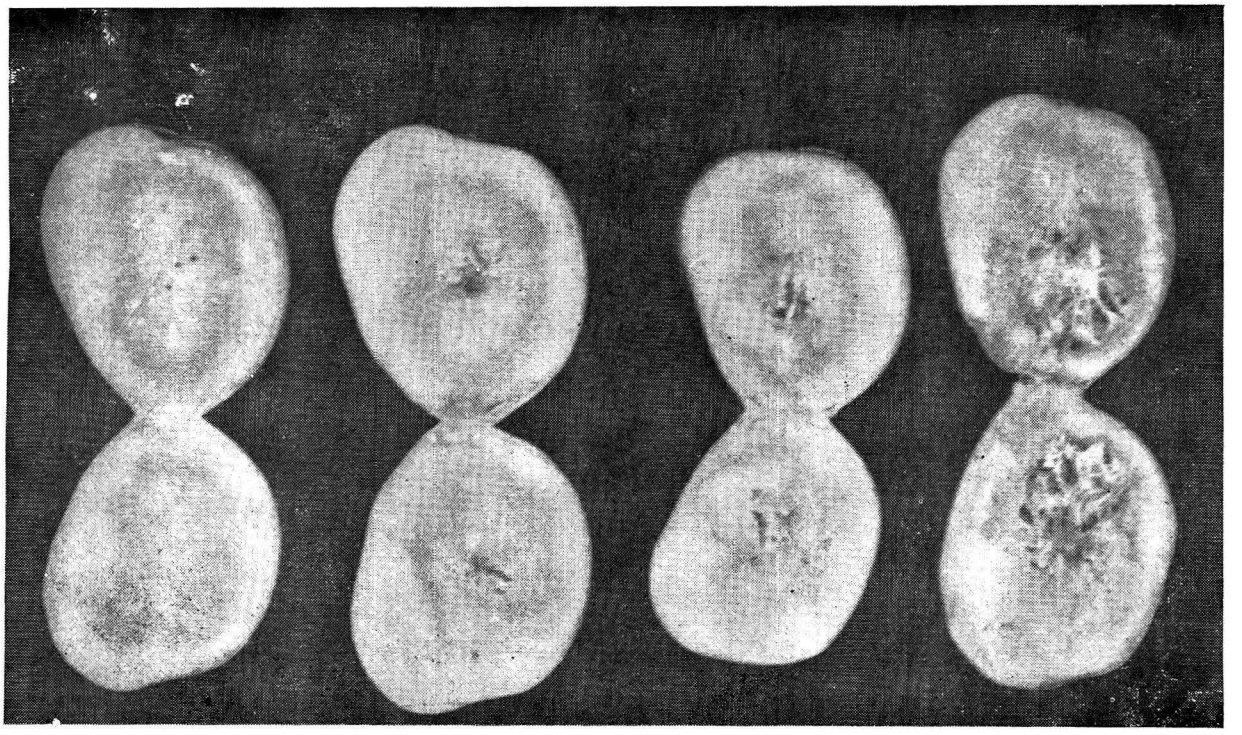

Fig. 1. Stages in internal breakdown of mango fruit

1. Healthy fruit; 2 & 3. Initial stage of internal breakdown; 4. Advanced stage of internal breakdown.

TABLE 2. INCIDENCE OF INTERNAL BREAKDOWN IN RELATION TO SPECIFIC GRAVITY GRADING PERCENTAGE (%)

Tree No.	Group 1	Group 2	Group 3
	Sp. gr. <1.00	Sp. gr. 1.00–1.02	Sp. gr. >1.02
1	1	7	56
2	0	48	75
3	0	49	64
4	0	19	26
5	0	37	59
6	0	21	34
7	0	18	25
8	0	14	35
9	0	9	43
10	0	7	47
11	0	19	38
Mean	0	22	46
Significance Group 2~3		—	**

group (*iii*). Further, the extent of breakdown was higher in group (*iii*) than in group (*ii*), 40 and 10 percent of the fruits being in the advanced stage of breakdown in the two groups respectively.

The incidence as well as the extent of breakdown increases with the increase in the sp. gr. of the fruit. Fruits harvested at a stage when their sp. gr. is < 1.0, are practically free from breakdown, but the ripened fruit is of poor taste and flavour. It is preferable, however, to harvest fruits of 1.0–1.02 sp. gr. to ensure better quality of the ripened fruit which is of primary importance, although there will be some spoilage in the process. It is worthwhile investigating the possibility of overcoming or at least minimising this handicap.

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References

1. Subramanyam, H., Shantha Krishnamurthy, Subhadra, N. V., Dalal, V. B., Randhawa, G. S. and Chacko, E. K. *Trop. Sci.* 1971, **81**, 203.
2. Subramanyam, H., Gowri, S., and Shantha Krishnamurthy, *J. Fd. Sci. Technol.*, 1976, 13, 84.

EFFECT OF TOASTING BENGAL GRAM (*CICER ARIETINUM*) ON LYSINE AVAILABILITY AND *IN VITRO* DIGESTIBILITY OF PROTEINS

The effect of heat treatment imparted to Bengalgram (*Cicer arietinum*) during roasting and puffing on lysine availability and protein digestibility was studied. It was observed that 12-15% of the lysine was rendered unavailable while the *in vitro* digestibility decreased by 15 to 28 percent. Defatting of the unheated Bengal gram flour improved the *in vitro* digestibility considerably.

The nutritional value of legume proteins is enhanced in many instances, by moderate heat treatment, owing to inactivation of protease inhibitors and other anti-growth substances. Overheating, however, adversely affects the nutritional quality of the proteins by the destruction of lysine and cystine[1,2]. Bengal gram dhal is usually roasted to get a pleasing aroma prior to its use in supplementary foods like Multipurpose Food and Energy Food. Alternatively, Bengal gram is puffed whereby it develops aroma and a porous texture. Acharya *et al.*[3] have reported no significant difference in the biological value and digestibility coefficient of parched and unparched Bengal gram dhal. For puffing, the whole seeds are soaked in water and mixed with heated sand at about 250°C for less than a minute. The sand is separated by sieving and the grains are dehusked by passing between a hot plate and rough roller.[4] In view of the high temperature encountered during puffing and roasting, it was considered necessary to understand how the nutritional quality is affected in terms of lysine availability and *in vitro* digestibility.

Roasting of split dhal in the present study is done at 130°–135°C for 30 min in a roaster. The toasted materials were ground to pass through 60 mesh (BSS) sieve in an Apex mill. The *in vitro* digestibility of protein was determined by pepsin-pancreatin digestion according to procedure of Akeson and Stahman[5]. The loss in the availability of lysine was determined by using 2-4 flourdinitrobenzene reagent as per the method of Carpenter[6]. Total lysine was estimated by microbiological assay using *Leuconostoc mesenteroides* P-60.[7] The loss in lysine availability is indicated in Table 1.

TABLE 1. LOSS OF ∈-LYSINE DURING HEAT TREATMENT OF BENGAL GRAM

Bengal gram dhal flour	Protein	Total lysine (g/100g protein)	Available lysine (g/100g protein)	Loss of available lysine (%)
Raw	23.40	6.54	6.39	—
Roasted	23.6	6.50	5.70	12.30
Puffed	22.8	6.50	5.60	13.84

TABLE 2. EFFECT OF HEAT PROCESSING ON *IN VITRO* DIGESTIBILITY OF BENGALGRAM

	Protein (%)	Protein digestibility value*
Raw Bengal gram dhal flour	23.10	79
Roasted ,,	23.10	57
Puffed ,,	23.31	67
Defatted raw ,,	27.10	94
Defatted roasted ,,	28.36	69
Defatted puffed ,,	27.58	77

*Protein used for *in vitro* digestibility: 100 mg

In raw Bengal gram nearly all the lysine is in the available form. Roasting and puffing affect lysine availability by 12.3 and 13.8 per cent respectively. Although the time and temperature of heating vary widely in roasting and puffing, the extent of lysine destruction is nearly the same. The effect of heating on the *in vitro* digestibility of protein is shown in Table 2. In both the cases the digestibility was improved. This is in contrast to the beneficial effects of heating observed in soya bean, Navy bean[8], black bean and kidney bean[9]. The protein digestibility was 79 per cent in raw Bengal gram which came down to 57 and 67 by roasting and puffing respectively. Removal of lipids which are present to the extent of five per cent in the dhal improved the digestibility of the raw dhal proteins from 79 to 94 per cent. The toasted materials also showed improvement in digestibility after defatting. This may be the reason for the *in vitro* digestibility of Bengal gram proteins not being very high inspite of the absence of the protease inhibitors. As regards the effects of these two heat treatments on the lipids it was observed in our earlier studies[10] that puffing imparted greater stability to the unsaturated fat in Bengal gram against oxidative changes than toasting. Comparing the overall effects of the two heat treatments, it may be concluded that puffing is better than roasting in terms of *in viro* digestibility of protein, storage stability of lipids and texturisation of the matetial.

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References

1. Neucere, N. J., Conkerton, E. J. and Booth, A. N., *J. Agric Food Chem.*, 1972, **20**, 256.
2. Anantharaman, K. and Carpenter, K. J., *J. Sci. Food Agric.*, 1971, **22**, 412.
3. Acharya, B. N., Niyogi, S. P. and Patwardhan, V. N., *Indian J. med. Resc.*, 1942, **30**, 73.
4. Kurien, P. P., Desikachar, H.S.R. and Parpia, H.A.B. *Proceedings of a Symposium on Food Legnmes* Tokyo, Japan, Tropical Agriculture Research Series, No. 6. 1972, 225.
5. Akeson, W. R. and Stahman, M. A., *J. Nutr.*, 1964, **83**, 257.
6. Carpenter, K. J., *Biochem. J.*, 1960, **77**, 604.
7. Barton-Wright, E. C., *Microbiological Assay for Vitamins and amino acids*, Issac Pitaman & Son Ltd., London, 1952.
8. Kakade, M. L., *J. Agric. Food Chem.*, 1974, **22**, 550.
9. Honaver, P. M., Shih, C. V. and Liener, I. E., *J. Nutr.*, 1962, **77**, 109.
10. Kowsalya S. Murthy and Kantharaj Urs, M., *J. Fd Sci. Technol.*, 1979, **16**, 87.

INFLUENCE OF pH ON HYDRATION DURING SPOILAGE OF PORK AT REFRIGERATION TEMPERATURE

Hydration of pork has been measured by extract release volume (ERV) technique. The ERV decreased with increase in microbial counts during storage of pork. The increase in hydration of meat proteins during spoilage depends on the pH of raw meat and the extent of change in pH from freshness to the development of off-odours.

Hydration of meat is a function of pH[1] and is influenced by the growth of micro organisms[2]. Hydration capacity of meat proteins is reflected in water holding capacity (WHC), extract release volume (ERV), meat swelling (SW) and viscosity of meat homogenates[3]. The ERV phenomenon has been reported as a rapid test for detecting spoilage of meat[4] and shrimp[5].

Increase in hydration accompanies microbial spoilage at low temperatures and microbial proteolysis occurs after several weeks of storage of meat[2]. The physico-chemical basis of the increase in hydration during storage is not understood, but it is postulated that spoilage flora damage sarcolemma membrane which controls the permeability of muscle fibres[6]. Jay[4] considered pH as an important factor for the increase in meat hydration besides alterations in metal ion balance and production of amino-sugar complexes by spoilage flora. Recently, Shelef[7] studied the ERV homogenates of beef at various stages of freshness and spoilage by adjusting the pH of these homogenates with acid or alkali and reported that maximum ERV or minimum hydration occurred at pH 5.5, which is the isoelectric point of primary meat proteins. This paper presents the response of ERV to the variation in pH that occurs during spoilage of pork at 7°C.

Eleven Landrace pigs weighing 70-100 kg body weight were used in this study. Pigs were individually slaughtered, bled, scalded and eviscerated by the usual plant procedures. Ham portion of the carcass was removed and placed on a clean meat cutting table. After removal of skin and bone, meat was diced into 15 g pieces. The diced pork was pooled and collected in 150 g portions in sterile beakers covered with aluminium foil. The time taken for such collection of samples was 2-3 hr post-slaughter. The sterile beakers containing meat were placed in a refrigerator maintained at 7°C for subsequent analysis. Fresh meat samples were analysed after 2 hr and thereafter every 2-3 days until the first sign of off-odours are perceptible and after clear spoilage. On each sampling day, two sterile beakers were withdrawn at random for determination of total aerobic plate count (TAPC), ERV and pH.

Total aerobic plate count was carried out according to the procedure of Indian Standards Institution[8]. The ERV was measured by the method of Jay[9]. The pH of meat was measured directly on the meat using a pH meter with a probe type electrode. Three pH readings were made on each sample and the mean of these was recorded.

Mean ERV decreased with increase in TAPC during storage of pork (Table 1). Decrease in ERV or increase in hydration from freshness to spoilage has been shown in refrigerated beef and pork by other workers[4,10]. Jay[11] found the ERV decrease in a straight line relationship with the increase in bacterial numbers.

In pork stored at 7°C until the microbial count reached 10^7/g, the ERV was significantly ($P < 0.01$) correlated with pH. No significant correlation was observed between period of storage, and ERV and pH.

The pH of refrigerated beef was reported to vary from 6.1 to 7.2 at the onset of organoleptic spoilage[12]. Price[13] reported that ERV of pork at off-odours varied between

TABLE 1. CHANGES IN ERV, pH AND TOTAL AEROBIC PLATE COUNT DURING SPOILAGE OF PORK AT 7°C

Pork	Period of storage (days)	ERV (ml) Mean±S.E.	pH	Total aerobic plate count (log)
Fresh	—	47.18±2.71	6.0±0.09	5.60±0.28
First sign of off-odours	14±2	26.00±4.30	6.11±0.10	7.35±0.15
Clear spoilage	17±3	6.60±2.20	6.87±0.40	9.09±0.51

TABLE 2. RELATIONSHIP BETWEEN ERV AND pH OF PORK AT FIRST SIGN OF OFF-ODOURS

Sample No.	pH of pork		Change in pH units from freshness to off-odours	% reduction in ERV
	Fresh	At off-odour		
1	6.2	6.2	0.0	57
2	5.4	5.5	0.1	18
3	6.2	6.6	0.4	76
4	5.7	6.2	0.5	66
5	5.7	6.3	0.6	64
6	6.0	6.6	0.6	89
7	6.4	6.3	–0.1	26
8	5.8	5.7	–0.1	30
9	6.1	5.9	–0.2	14
10	6.0	5.8	–0.2	50
11	6.5	6.1	–0.4	29

30 and 40 ml which could be due to variations in pH obtained at that stage. Reduction in ERV is more pronounced at higher pH than at lower pH values during storage (Table 1). Increase in pH from freshness to off-odour resulted in a greater reduction in ERV than those samples showing decreases in pH (Table 2). Reduction in ERV tended to be more when raw meat pH (ultimate pH) was high. With the same increase in pH units i.e. 0.6 units meat of low ultimate pH (5.7) showed less reduction in ERV than that of high ultimate pH (6.0) (Table 2). The results are in general agreement with that of Callow[14] who showed that an elevation in mean ultimate pH of 0.2 units was critical in effecting the spoilage of ham.

In meat samples showing decreases in pH during storage, hydration capacity of meat remained low as reflected by the high ERV. In such samples, the bacterial flora could be of the acid producing group. Riedel *et al.*[15] have shown that the ERV in ground pork and beef is influenced by the type of flora and change in pH with storage. Lactic acid bacteria have optimal growth between 5.5 and 6.0 and some of the bacterial enzymes which cause spoilage have pH optima which are different from those of the organism itself[16].

From these results, it is evident that hydration capacity of meat proteins during spoilage depends on the pH of raw meat and the extent of change in pH during storage. Both ERV and pH rather than ERV alone may have to be taken into consideration for detecting the onset of spoilage of meat.

Thanks are due to the Director, I.V.R.I., for providing the facilities.

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V. N. BACHHIL

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References

1. Hamm, R. and Deatherage, F. E., *Food Res.*, 1960, **25**, 587.
2. Jay, J. M., in *The Physiology and Biochemistry of Muscle as a Food*, by Brickey, E. J., Cassens, R. G. and Trautman, J. C. The University of Wisconsin Press, Maidson, 1966, 387.
3. Jay, J. M., *J. Milk Fd Technol.*, 1972, **35**, 467.
4. Jay, J. M. and Kontou, K. S., *Appl. Microbiol.*, 1964, **12**, 378.
5. Shelef, L. A. and Jay, J. M., *J. Fd Sci.*, 1971, **36**, 994.
6. Ingram, M. and Dainty, R. H., *J. Appl. Bacteriol.*, 1971, **34**, 21.
7. Shelef, L. A., *J. Appl. Bacteriol.*, 1974, **37**, 531.
8. *Method for Standard Plate Count of Bacteria in Food Stuffs*, IS: 5402 Indian Standards Institution, New Delhi.
9. Jay, J. M., *Food Technol., Champaign*, 1964, **18**, 1633.
10. Borton, R. J., Webb, N. B. and Bratzler, L. J., *Food Technol., Champaign* 1968, **22**, 94.
11. Jay, J. M., *Food Technol., Champaign*, 1964, **18**, 1637.
12. Shelef, L. A., and Jay, J. M., *Appl. Microbiol.*, 1970, **19**, 902.
13. Price, J. F., *Meat*, 1965, **31**, 37.
14. Callow, E. H., *Ann. Rep. Fd Invest. Bd Lond.*, 1937, **34**, 49.
15. Riedel, G. W., Burke, T. and Nordin, H. R., 13*th Europ. Meeting of Meat Res. Workers*, Rotterdam, Holland. 1967, A_3.
16. Lawrie, R. A., *Meat Science*, Pergamon Press, Oxford, 1974, 175.

BOOK REVIEWS

The Market for Culinary Herbs: by Peter Greenhalgh, Tropical Products Institute, London, 1979, Pp. 171; Price £ 3.75.

The hitherto published information on the culinary herbs deals mostly with the historical and medicinal aspects and very little on market and trade details. The Tropical Products Institute has brought out a report in line with those published earlier.

The book is divided into two parts. Part 1 deals with the general market considerations and Part 2 discusses fourteen individual herbs, viz. Basil, Bay, Celery, Chervil, Dill, Marjoram, Mint, Oregano, Parsley, Rosemary, Sage, Savory, Tarragon and Thyme with special reference to uses, qualities, production, prices, and trade prospects. The report also contains a list of 37 references, 60 tables and 4 appendices.

Much of the confusion in commerce regarding marjoram, oregano and thyme is caused by the fact that the essential oils from the various plants are often blended under different names. The report attempts to clarify this confusion by proper botanical identification.

According to this report, oleoresins of the herbs do not yet present significant competition for dry herbs except in the case of celery seeds, sage and marjoram, although one U.S. firm has recently started marketing oleoresin of Tarragon in a big way. The major areas of usage of herbs, according to the repor. is in flavouring, seasoning and medicinal preparations; use of herbs as food dyes, insecticides etc., is a field for future development.

The get up and printing of this report have been neatly brought out. In view of the reluctance of the commercial users to give out the necessary information, the tables have been compiled with caution, but give an insight into the trade. This is reflected in the data provided for thyme where France is shown as not only a major producer and exporter but also an importer. The report can be used as a source book by the trade for finding the market demand including quality requirements.

The data provided offer scope for new entrants capable of supplying the market at a different period of the year. In view of the excess capacity that has taken place in the spice oleoresin industry as pointed out by Adamson and the bulk volumes the herbs occupy in the transit, new market for the oleoresins derived from the herbs may also be explored.

V. KALYANARAMAN
FLAVOURS AND ESSENCES PVT. LTD., MYSORE.

Exotic Species in Mariculture: by Roger Mann, The MIT Press, 126, Buckingham Palace Road, London SW 1W 9SD, 1980, Pp.128,

The papers discussed at the symposium on Exotic Species in Mariculture: Case Histories of the Japanese Oyster, *Crassostrea gigas* (Thunberg), held at Woods Hole Oceanographic Institution, Massachusetts, during September 18-20, 1978 have been collectively brought out in this book.

This subject of introduction of species inherent to one region of the world to another to provide opportunity for increased productivity and economic gain, is important to persons concerned with fish culture and management. All the attendant problems in the introduction and nurturing of this exotic species of oyster to the east and west coasts of North America, the south Pacific, the United Kingdom and France have been discussed by contributors from these regions, from the point of view of disease organisms, ecology, biology, feasibility of selective breeding programmes, and economical to legal perspectives to be taken into account by the various regulatory organisations of the country contemplating introduction of an exotic species.

The two appendices, Code of Practice to reduce the risks of adverse effects arising from introduction of non-indigenous marine species and recommended procedure for introduction or transfers are interesting and important.

B. R. BALIGA
C.F.T.R.I., MYSORE.

Slaughter Facilities for Tropical Conditions: A guide to the selection and costing of appropriate systems, by D. Edwards, D. A. Hector, G. A. Norman and D. Silverside, Tropical Products Institute, 56/62, Gray's Inn Road, London, WC 1X 8LU., 1979, Pp. 63, Price: £1.52.

The book discusses the facilities required for setting up of slaughter houses under tropical conditions. The purpose of this publication is to assist the technical advisers in the planning and implementation of the livestock and meat marketing programmes.

Four different models in four different scales of throughput expressed as livestock units, have been dealt with in detail—The units are 15,60, 155, 275 livestock units, (cattle at 1 unit, small stock at 0.2, and pigs at 0.5 equivalents of livestock units). Each department

such as slaughter hall, chillers, offal room byproducts and effluent treatment is covered in terms of capital costs, operating costs, manpower requirements, services, and complete financial analysis. A number of practical problems and case studies have been illustrated to make the reader understand the various aspects of the meat industry.

The book is a very comprehensive ready-reckoner, probably the first of its kind to be published for the cause of the development of the meat industry. This publication will be a very useful source of information to both a financial analyst and a technical adviser associated with meat production/marketing management.

K. S. V. SAMPATH KUMAR,
BROOKE BOND INDIA LTD., AURANGABAD.

Composite Flour Technology Bibliography: Edited by D. A. V. Dendy and Ruth Kasasian, Tropical Products Institute 56/62 Gray's Inn Road, London WC 1X 8LU, 1979, Price: £ 2.00

The present supplement with 173 references brings the bibliography on composite flour technology updated to middle of 1978. The bibliography is conveniently classified according to products like leavened bread, unleavened bread, flour confectionery, biscuits etc., as well as on the non-wheat flour base used to make composite flours like cereals, tuber roots, protein supplementation etc.

The brief abstracts of the papers give adequate idea regarding contents and utility of the papers to the user research workers. This comprehensive updated bibliography will be useful to the food scientists and technologists in developing countries, where programmes of research and development work on replacement or substitution of imported wheat and wheat products by the locally available cereals and tubers for the preparation of bakery as well as traditional products are in progress.

S. R. SHURPALEKAR,
C.F.T.R.I., MYSORE.

Rice Report 1977: by S. Barber, H. Mitsuda, H. S. R. Desikachar and E. Tortosa (eds), Instituto de Agroquimica y Technologia de Alimentos, Valencia, Spain, 1978, Pp. 287+xxxv.

The Working Party on Rice Utilization of the International Union of Food Science and Technology (IUFST) publishes an annual report of world research and development work on the post-harvest utilisation of rice, called the 'Rice Report', funded and published by the IATA, Valencia. The present volume is the third in the above series. That the report has become very popular among contributors and readers alike is evident from the growth in its size (1976: pp. 167+xxiii). The present report covers 15 countries, 45 centres and 126 programmes. In keeping with its tradition, the present volume also maintains an impeccable standard in design, format and printing.

The value of the Report series is evident from its objectives. Here, in one volume, one gets at a glance the names and addresses of all researchers, list of all papers published in the previous year, a brief summary of all work accomplished and progress in the field. Further, when seen in sequence with the Reports of the previous years, they reveal the trend of work and the entry and drop-out of lines of work in it. However, this type of reports also tend to encourage excessive claims, particularly in a field like rice which now attracts active attention from many foundations and international organisations.

Despite its obvious value, the present volume has certain drawbacks. Firstly, there are a few glaring omissions—Bangladesh Rice Research Institute; Sri Lanka Rice Process Development Centre, Anuradhapur (in particular); National Food Research Institute (Tokyo), Kagawa University and Kyoto University from Japan; a number of institutions in India (Central Rice Research Institute, Indian Agricultural Research Institute, Central Institute of Agricultural Engineering); Russia and Eastern Rurope to name some. Secondly, some of the centres seem to have reported on too many programmes; in fact some of the programmes are nothing but subprogrammes. Thirdly, some of the reports (including some from business firms) are very meagre Fourthly, a few reports do not cite the names of all the authors. Lastly, a few reports, especially from the Philippines, follow a format which is different from others.

One might now make a few suggestions for improvement of this series:

The format could be profitably changed as follows: (*a*) The words "Centre", "Addresses" and "Authors" are jarring as headings and could be removed. (*b*) The centre names, both in the chapter headings and in the list of contents should be brief and not a duplication of their addresses. (*c*) The words "report from" do not look nice in the list of contents and could be removed. (*d*) In the list of contents as well as in the text, the programmes could be renumbered as: first number to represent the country, the second number to represent the centre, and the third number to represent the programme.

It is unnecessary to append separate lists of programmes and authors under each centre. The programme titles are in any case reproduced one after another. The authors can then be tagged to the programmes.

Separate sub-heads of 'introduction', 'objectives' and 'results to date and present position' under each programme do not seem to give any advantage, but only lead to much repetition. The entire report could be written as one piece. Or, at least, the introduction and objective could be combined, and the paragraph edited to save the reader from wading through a lot of vacuous verbosity. The above two suggestions will also save much space.

The report must appear in time (the present one is almost two years late). One must stick to a strict time schedule and omit those reports which come late.

Unless very relevant, one should omit trading and consultancy firms and include only R & D work and genuine works of innovation.

K. R. BHATTACHARYA
C.F.T.R.I., MYSORE.

"*Food Industries*"—1979: Published by the Chemical Engineering Development Centre, Indian Institute of Technology, Madras-600 036.

In most of the developing countries, food industry is basic,—in the sense that it is directed towards processing the staple foods for the kitchen. The agricultural produce is given the minimum processing effort,—drying in the field, cleaning and milling, and the produce comes to the market. The economy of most of the countries can ill afford any more primary or secondary processing. Till very recently Indian food industry was also very little, more than this. The major food industries were, the flour milling, bread or bakery products (mostly in the unorganized small-scale sector) and fruit processing. It is only during the past decade or a little earlier that the food industry in the country is getting established in a measurable way. We have now a very good export market for frozen marine foods, an organized baking and biscuit industry, fruit processing and beverage industry, well established baby food industry, confectionery and chocolate industry and snack foods.

The book under review is a compendium of essays written by well-known scientists. Out of the 17 topics covered, 12 are written by scientists from the Central Food Technological Research Institute, Mysore. Of the remaining five chapters, three are written by scientists one each from the Indian Institute of Technology, Madras; National Dairy Research Institute, Karnal; and the Institute of Catering Technology and Applied Nutrition, Madras. The chapter on "Baking of Biscuit Industry" is written by a senior executive from Britannia Industries and the chapter on "Cashew" is by two executives from the Cashew Export Promotion Council, Cochin. It is thus natural to expect in a volume of this nature a heavy emphasis on the scientific aspects of the processing of the commodities. Indeed the reader will not be disappointed in this expectation.

The coverage of the topics is fairly comprehensive. Almost all the agricultural products like the staple grains (rice, wheat and pulses), fruits and vegetables, plantation crops like cashewnut, coffee, tea and spices, dairy products, meat, fish and eggs are covered. In addition special food industries like bread and biscuits, confectionery, vegetable protein products, soft beverage industry, alcoholic beverages and starch industry are also covered. The last two chapters, i.e., infestation control and food preservation are of interest to the entire food industry. Possibly the notable exceptions which could also have found a place in this volume are the oilseeds and coconut. However, oilseeds are included as raw materials for the protein foods industry.

It is only natural that in a book of this nature, some topics are more fully dealt with than others. In some of the chapters, information is given regarding the volume of the trade, the import and export figures, but in others this is conspicuously absent. For example, a little more information regarding the trade in pulses or confectionery would have been useful. In a volume of this nature, whose object is to provide information to the industry, details regarding the project costing for small scale units is of immense use. Unfortunately this information is given only for bread and biscuits. Information of this nature would have been useful for most of the processes discussed.

The volume has provided an encyclopedic coverage of a large number of food products. The production processes are discussed in fair detail. The reference to ISI Standards covering most of the processes are given. A fairly comprehensive bibliography is included in each chapter.

A brief bio-data of the individual writers would have added to the value of the book.

This is one of the volumes published by the Chemical Engineering Education Development Centre of the Indian Institute of Technology, Madras. The Centre is doing a great service to the industry in publishing these volumes. This volume has provided an excellent link between agricultural production and processing.

The book is a welcome addition to the library of food scientists and technologists. Research institutes have a ready up-to-date reference in the volume for the latest

technologies in the field. The book is highly recommended to the research workers as well as for the use of students in food processing and technology.

M. R. CHANDRASEKHARA
PROTEIN FOODS AND NUTRITION DEVELOPMENT ASSOCIATION OF INDIA.

A History of Refrigeration Throughout the World: by Roger Thevenot and Translated from French by J. C. Fidler, Published by International Institute of Refrigeration, 177, Bd. Malesherbes, F-75017, Pp; 477, Price: 120FF.

No one else in the field of refrigeration could be in a better position to write such an authoritative book on refrigeration science than Mr. Roger Thevenot, Past Director of the International Institute of Refrigeration, Paris, since he has been in touch with such developments in different parts of the world.

The book traces the evolution of the science and technology of refrigeration from the early period to the present time. It elaborates the discoveries and inventions in various systems of refrigeration including the fundamentals viz. physics and thermo-dynamics. It also traces the developments in the application of refrigeration to food and agriculture, air-conditioning, cryology medicine, industrial applications including civil engineering.

The book is divided into three parts. The first part which surveys the history of refrigeration is dealt with in four epochs; (1) The first epoch gives the history of development of refrigeration for production of artificial cold before 1875. (2) The second epoch covers the period from 1875–1914 which is dealt with in 9 chapters. It traces the industrial application of refrigeration to areas like agriculture and food, brewing, meat and cold storages and cold chains in various countries for perishable products. It describes the development of the vapour compression system and various refrigerants, the vapour absorption system and the water-vapour system. (3) The third epoch covering the period between the first and the second World Wars which gave a spurt in the development of refrigeration science and technology, is dealt in 8 chapters, including the uses of refrigeration in daily life, development of refrigerated transport and conservation of food and agricultural produce by application of cold, introduction to air-conditioning, military cold chains, etc. (4) The fourth epoch which covers the period after 1945 traces further refinements in the development of sophisticated equipment using the refrigeration principle, viz., deep freezing, cryogenics, freeze drying, and airconditioning, This epoch is dealt in 9 chapters including non-food applications like chemical and pharmaceutical industries.

Each epoch also gives a survey of the corresponding developments in different countries of the world during that period. At the end of each epoch, the world-wide situation in the field of refrigeration equipment and facilities is given.

The second part of the book gives, in chronological order, significant events which were responsible for the important achievements in the development of refrigeration science and technology.

The third part gives brief biographies of persons—arranged in an alphabatical order—responsible for the developments and who were pioneers in the field of refrigeration science and technology.

For those interested in the field of development of the science of refrigeration and in general by all those who are interested in the history of science, this is a valuable book of reference and would be read by all such people. To teachers, engineers, research workers and all those who would like to have an idea of the significant events in the development of refrigeration as a science, it is a valuable work of reference.

S. K. LAKSHMINARAYANA
C.F.T.R.I., MYSORE

ASSOCIATION NEWS

Annual General Body Meeting

The Annual General Body Meeting of the Association was held on 29th May 1980 at the Central Food Technological Research Institute, Mysore, Dr. A. S. Aiyar, Vice-President, chaired the meeting. Sri J. D. Patel, Hon. Exec. Secretary, highlighted the various activities of the Association for the year 1979, which included the transactions carried out by the Central Executive Committee which met seven times during the year. Symposia were organised at different Chapters as well as at Head quarters. Topics of symposia were "Food needs of infants and pre-school children", "Post harvest technology of cassava", "Pineapple production and utilisation" and "By-products from food industries: utilisation and disposal".

Prof. V. Subrahmanyan Industrial Achievement Award: This award was not presented as no suitable person was selected by the Committee.

Best Student Award: This was presented to Sri Rajasekhara Melanta, a student of College of Fisheries, University of Agricultural Science, Mangalore. The second awardee was Mr. Subhash Chandra Bose, Research Scholar, Indian Institute of Technology, Kharagpur.

Gardner's Award: This was presented to the paper entitled "Pressure extrusion of Indian maize-legume composite flours" by B. Manohar Kumar, K. Seiler and P. Gostenkorn published in *Journal of Food Science and Technology*, 1978, **15**(5), 173-176. The award was received by Sri B. Manohar Kumar.

The Suman Food Consultants Travel Award: This was presented to Mr. S. S. Deshpande for his essay on "The role of food additives in food processing and public health". Mr. B. Srinivasan, M.Sc. (Food Technol) Student, CFTRI, Mysore, was given the award for 1979 for his essay on "Innovative methods of preservation of food."

During the discussion the topics covered included setting up of a building and welfare fund, mode of despatch of ballot papers, non-receipt of annual reports from chapters, and inadequate coverage of Association news in the Journal of Food Science and Technology.

The Treasurer presented his report for the year along with the Budget proposals for 1980. The Secretary's Report and the Treasurer's report were unanimously approved by the General Body.

The office-bearers of the Association for the year 1980 are as follows:

President	—	Dr. K. T. Achaya
President-Designate	—	Sri M. K. Panduranga Setty

Vice-Presidents

(*i*) Dr. Mrs. Rugmini Sankaran—	Headquarters
(*ii*) Dr. R. Jayaram	—Bombay Chapter
(*iii*) Dr. J. C. Anand	—Delhi Chapter
(*iv*) Sri B. S. Bhatia	—Ludhiana Chapter
(*v*) Mr. M. Srikrishna	—Madras Chapter
(*vi*) Shri B. S. Bhatia	—Ludhiana Chapter

Hon. Exec. Secretary	—Dr. K. R. Sreekantiah
Hon. Jt. Secretary	—Dr. P. Narasimham
Hon. Treasurer	—Sri P. Haridasa Rao

Bangalore Chapter

President	—Sri I. J. Puri
Vice-President	—Miss M. C. Madhura
Hon. Secretary	—Sri Varadu Seshamani
Hon. Jt. Secretary	—Dr. P. Muddappa Gowda
Hon. Treasurer	—Smt. N. Jayamani

Bombay Chapter

President	—Dr. R. Jayaram
Vice-President	—Dr. A. S. Aiyar
Secretary	—Dr. J. S. Pai
Hon. Jt. Secretary	—Sri A. P. Luhadiya
Hon. Treasurer	—Dr. P. R. Kulkarni

Calcutta Chapter

President	—Prof. M. M. Chakrabarty
Vice. President	—Sri B. N. Srimani
Hon. Secretary	—Sri Manas Das
Hon. Jt. Secretary	—Miss Madhusweta Das
Hon. Treasurer	—Dr. S. K. Mukherjee

Hyderabad Chapter

President	—Dr. G. V. Krishna Murthy
Vice-President	—Dr. Mrs. P. Geervani
Hon. Secretary	—Sri M. Venkateswara Rao
Hon. Jt. Secretary	—Sri Surendra Kumar Sood
Hon. Treasurer	—Sri N. Giridhar

Ludhiana Chapter

President	—Dr. A. P. Bhatnagar
Vice-President	—Dr. M. M. Kashyap
Hon. Secretary	—Sri O. P. Beerh
Hon. Jt. Secretary	—Sri Kuldip Singh
Hon. Treasurer	—Dr. H. P. S. Nagi

Madras Chapter

President	—Sri S. Rajagopalan
Vice-President	—Dr. R. N. Datta
Hon. Secretary	—Sri M. Srikrishna
Hon. Jt. Secretary	—Sri B. Raghuramaiah
Hon. Treasurer	—Dr. K. S. Murthy

Trivandrum Chapter

President	—Sri H. Sreemulanathan
Hon. Secretary	—Sri V. V. Nair
Hon. Jt. Secretary	—Sri K. C. M. Raja
Hon. Treasurer	—Mrs A. Jayalakshmi

The existing rules and regulations in regard to (*a*) Clause 1.5 and (*b*) Clause 3.7.3 were amended so as to enhance the subscription of members (resident abroad), and to alter election procedure of the Vice-Presidents. The clauses read as follows after amendment:

a) *Clause* 1.5

	Admission fee	*Fee*
Member (resident abroad)	$ 1	$ 10
Member, Life (-do-)	$ 1	$ 150

b) *Clause* 3.7.3

Four Vice-Presidents will be chosen from among all the representatives nominated, one from each Chapter, by all AFST members eligible to vote, by postal ballot. One Vice-President (Hq) will be chosen from among eligible AFST members resident at Headquarters.

The activities of the Bangalore, Delhi, Ludhiana and Trivandrum chapters were also presented.

The new office bearers were inducted and this was followed by a brief talk by the new President, Dr. K. T. Achaya.

The venue of the next General Body Meeting will be decided by the Central Executive Committee.

Dr. K. R. Sreekantiah, Hon. Jt. Secretary, proposed a vote of thanks to the outgoing office bearers for their services rendered to the Association during the year.

Bangalore Chapter

Late Sri B. N. Gupta, doyen of Journalism and Philanthropist has instituted "Food Science and Technology Utilisation Fellowship". The fellowship will be awarded to a graduate or postgraduate in food science, who has to stay for 8 to 12 weeks in a rural area and strive for the improvement of the village life by interacting with them. On completion the awardee has to submit a report. The awardee will be paid Rs. 250 honorarium per week with upto Rs. 5,000 as contingency expenses towards the project.

Trivandrum Chapter

A two-day seminar on Post Harvest Technology of Cassava was conducted at the College of Agriculture, Vellayani, Trivandrum on 22nd and 23rd February, 1980. The seminar was a joint effort of Trivandrum chapter, Central Tuber Crops Research Institute (ICAR), Trivandrum, Kerala Agricultural University Trichur and Regional Research Laboratory (CSIR), Trivandrum.

About 100 delegates from different parts of the country as well as from other countries participated. 30 papers were presented in three sessions. Session I was on storage of Cassava, session II was on Cassava starch and session III pertained to Cassava as Food.

In the concluding session, the following points emerged.

Although much progress has been made in the storage of fresh tuber, a pragmatic method for extending the life of the tuber substantially has yet to be evolved. There is need to study the deterioration of fresh tubers in depth.

In view of the high yield per unit area, and easy adaptability to different agroclimatic conditions, cassava has an excellent future as a food resource. There is need to upgrade the texture and cooking qualities of food products made from cassava flour to increase its off-take in place of cereal flours in traditional preparations.

Good quality cassava starch has an excellent potential in textile industry. However, the quality of starch made in small sector especially, the colour, is poor. The process technology in small sector has to be improved to bring about efficiency and better quality. There is also need to develop technology for small sector to make tailor made starches and hydrolysed products like glucose, dextrins and adhesives. In view of the serious energy shortage, viable technology for production of power alcohol from cassava has to be perfected.

Better utilization of the residue after starch extraction for uses like fermentation, growth of single cell protein and cattle feed is necessary.

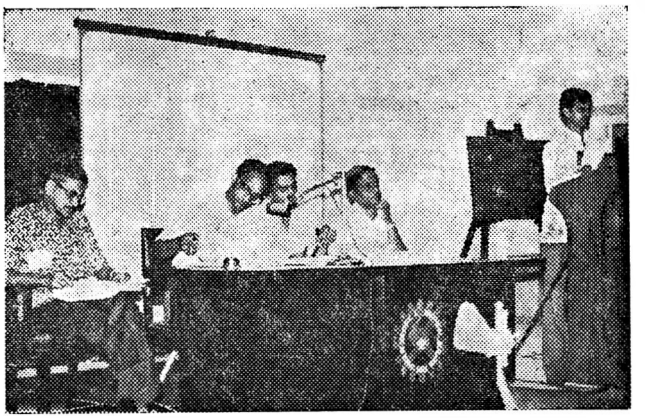
Microbial modification of starch, improved packaging for products, updating of standards, improvement of hygiene in factories and possibilities of pelletizing tapioca for export as animal feed are also considered important.

Symposium on "By-products from Food Industries: Utilisation and disposal"

This symposium was jointly sponsored by the Central Food Technological Research Institute and the Association of Food Scientists and Technologists (India) at Mysore on May 29-30, 1980. It was inaugurated by Prof. K. S. Hegde, Vice-Chancellor, University of Mysore. The salient features of the deliberations and the outcome of the symposium are as follows:

The six sessions of the symposium dealt with by-products and effluents from various types of food industries, ending with a plenary session at which trends and

recommendations were presented by the Chairman of each session, discussed and adopted by all the participants. Fairly accurate information was available on the magnitude of wastes in the starch, sugar and brewery industries, and even some technology for their utilisation was available indigenously. However, the economics of such treatment still needed to be worked out by various R & D organisations. Such bodies as the Sugar Manufacturers' Association of India and the All-India Distillers' Association should form working groups to pursue such specific subjects as recovery of oxalic acid from molasses, furfural from bagasse and wax from sugarcane press mud. In the area of fruits and vegetables, the technologies ready for utilisation are the extraction of fat from mango kernel and citrus oils from peel, and the preparation of feeds from citrus and grape seeds. Semi-processing of pomace to reduce bulk could be insisted upon. R & D work is called for in regard to natural food colours, improved citrus peel oil extraction, residues from cassava starch; utilisation of coffee husk, coffee waste, tea waste and oleoresin extraction residues all needed to be pursued. Regarding cereals, procedures for complete combustion of paddy husk with utilisation of the resultant ash should be integrated, and the economic feasibility of using paddy husk as a source of organic chemicals like furfural should be explored. Upgrading of rice bran by cleaning and stabilisation, and utilisation of solvent-extracted bran within the country as a component of animal feeds that can be given back to farmers in exchange for fresh bran, were stressed. Wheat germ recovery and stabilisation offered potential. Insecticidal and physiologically-active compounds present in certain non-edible



residues needed study. Regarding animal by-products, only by-products not used as human food should form the base of further exploitation or export. The nature of by-products available, and the sophistication of their further utilisation is strongly area-specific. Setting up of the proposed Meat Board should be expedited. Promising areas in regard to marine products are greater extraction of chitosan from squilla waste and of protein prawn waste, and production of fish meal from trash and waste fish. Use of urban food wastes for production of silage and microbial protein was suggested. Equipment is manufactured in the country for disposal of certain effluents, e.g. those derived from the meat and dairy industries, and for smoke abatement, and these should be more widely used—ISI limits for waste waters were a good guideline for factory management to follow. Whey was the major dairy by-product that needed better utilisation and small dairy-product manufacturers also had their own disposal problems that needed attention

National Workshop
on
FRUIT AND VEGETABLE INDUSTRY

Organisers:

Small Industry Extension Training Institute, Hyderabad

and

Association of Food Scientists and Technologists (Hyderabad Chapter)

It is proposed to hold the Conference in Hyderabad in Nov. 1980. The four sessions will deal with

(*i*) Raw materials-Production; procurement and distribution

(*ii*) Processing-with focus on appropriate technology

(*iii*) Packaging and Marketing

(*iv*) Research and Development, Consultancy and Training

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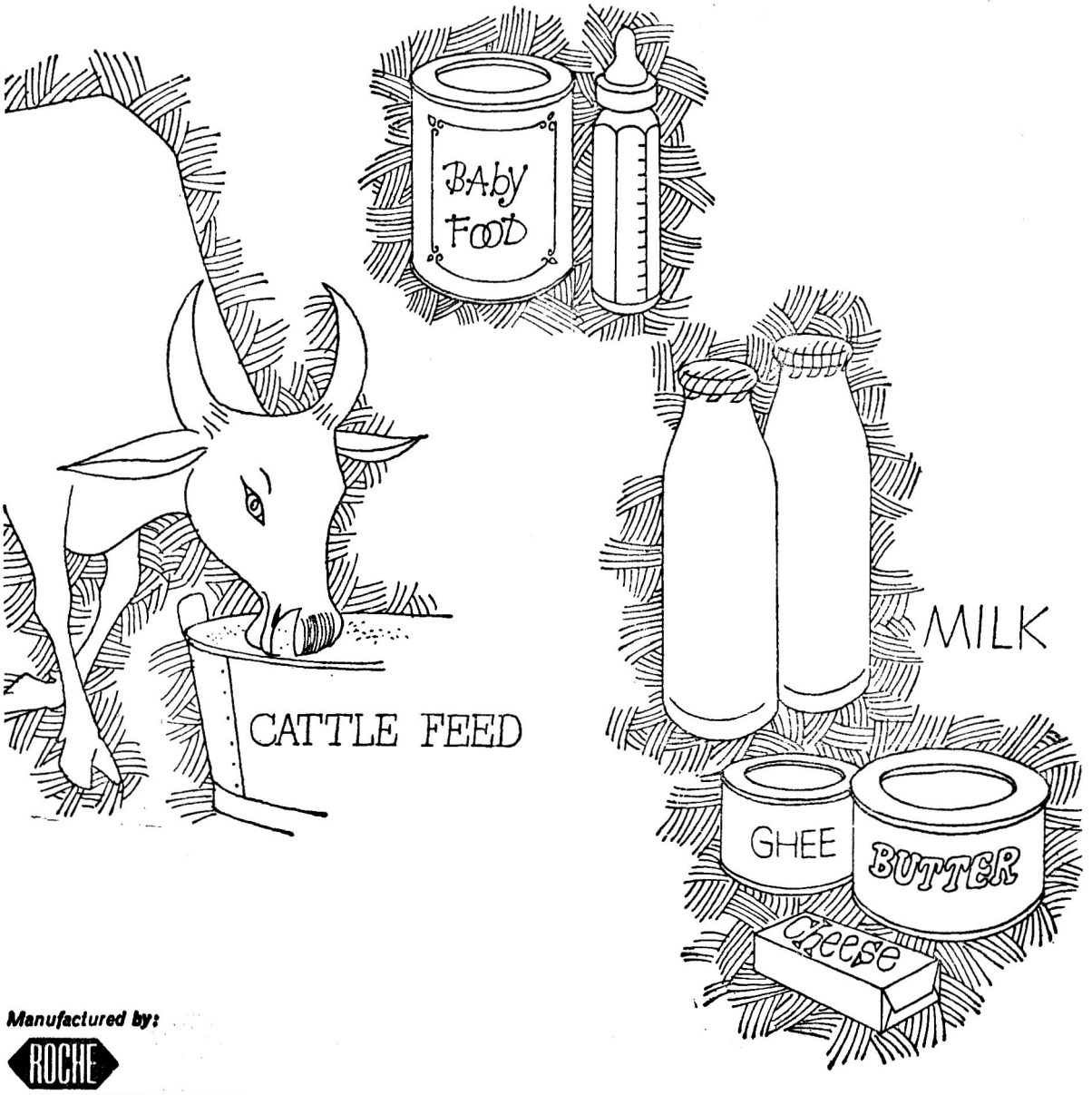

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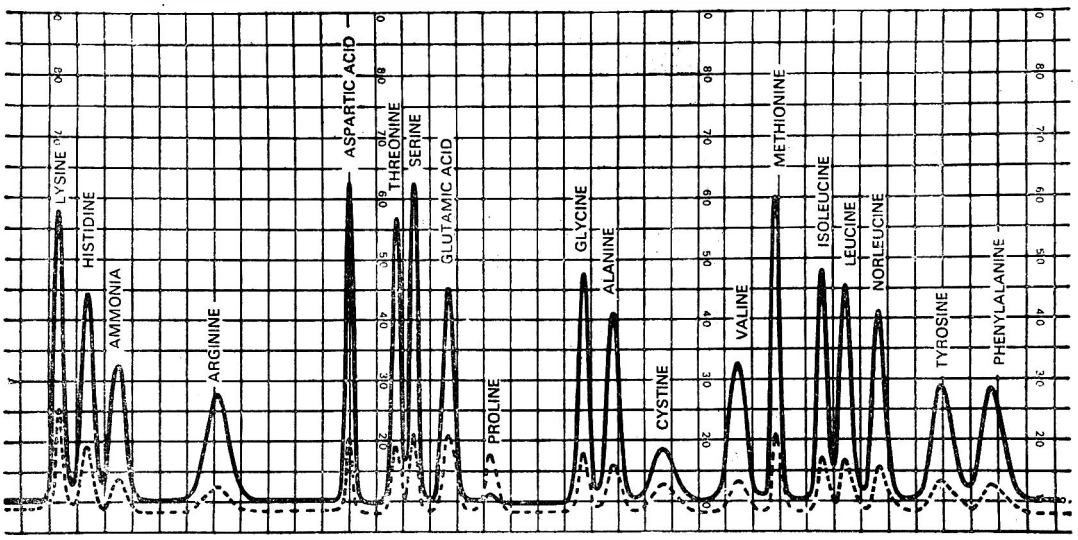

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