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ASSOCIATION OF FOOD SCIENTISTS AND TECHNOLOGISTS

(INDIA)

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Affiliated to the Institute of Food Technologists, USA

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2. To provide a forum for the exchange, discussion and dissemination of current developments in the field of Food Science and Technology.
3. To promote the profession of Food Science and Technology.

The ultimate object is to serve humanity through better food.

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3. Holding symposia on different aspects of Food Science and Technology.

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"The Printing of the Paper entitled 'SENSITIVITY OF STERILIZATION EFFECT FROM PROCESS PARAMETERS' by S. Akterian *et al.* H. Das has been delayed due to technical problems"

Professor Vaidyanatha Subrahmanyan
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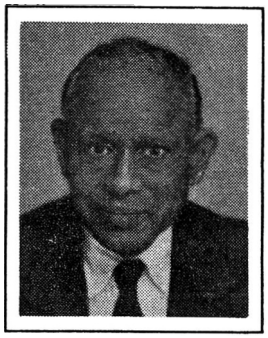
1902-1979



Born : October 29, 1902
Education : B.A., Madras University, 1922
D.Sc., London University, 1927

Positions held

1922-25 : Research Scholar, Biochemistry Department, Indian Institute of Science, Bangalore.
1925-27 : Research Scholar, London University,
1927 : Lecturer, Department of Biochemistry, Indian Institute of Science, Bangalore.
1929-48 : Professor & Head of the Department of Biochemistry, Indian Institute of Science, Bangalore.
1948 : Planning Officer, CSIR, New Delhi.
1950-63 : Director, Central Food Technological Research Institute, Mysore.
1963-66 : F.A.O., Expert in Food Technology, Philippines.
1967-69 : Adviser, Ministry of Food, Government of India.
1969-79 : Director, Paddy Processing Research Centre, Tiruvarur.

Followships

Fellow : Indian Academy of Science
Fellow : National Institute of Sciences of India.
Fellow : Current Science Association
Fellow : Royal Institute of Chemistry
President : Society of Biological Chemists
Founder-President : Association of Food Scientists and Technologists (India)
President : Chemistry Section, Indian Science Congress.
Member : Advisory Committee, ICAR, ICMR, CSIR.

Awards :
1. Research Medal of Royal Agricultural Society,
2. Rafi Ahmed Kidwai Award 1960-61
3. Padma Shri, Government of India, 1960
4. K.G. Naik Gold Medal, Baroda University, 1964
5. Sen Medal, Institute of Chemistry, 1960
6. Bobcock Hart Award, IFT, USA, 1962.
7. First Friesland Award, Netherland Dairy Science Association, 1965.
8. B.C. Guha, Memorial Lecturer.

His work at the Indian Institute of Science on soil nutrition, role of trace elements on crop yield, soil microflora and fauna, treatment of sewage, activated sludge process and composting of wastes is finding application to-day in environmental engineering and bio-mass production. As a war effort, he developed indigenous technology for production of many biological materials, enzyme products, supplements to Indian diet, vegetable milk from soya, preservation of food, prevention of pre-and post-harvest losses and safety of hydrogenated fats.

At the Central Food Technological Research Institute as its first Director in 1950, he identified national problems, assigned priorities and built an efficient infrastructure which enabled him and his fellow scientists to build a laboratory where all food science and technological problems could be referred to for solution and application. As a social scientist of the time, he worked on manpower development in different areas and nurtured them to face the problems and become self-reliant. His dedication to work was so complete that he had the rare opportunity to do research to the last day of his life (30th January 1979).

The major contributions were in finding new sources of vegetable proteins to supplement and combat under-nutrition and malnutrition in the country. Tuber starches were enriched with deoiled groundnut meal and vitamins. Some of these compositions have found greater use in school feeding programme and even been recognised by United Nation Agencies.

Another great achievement was the preparation of easily digestible baby foods using buffalo-milk which is available aplenty in the country.

The 'Amul' foods came into existence in cooperative sector in a bigway and the country became self reliant in this vital food.

He initiated studies on preservation of foodgrains by

insect control measures, processing optimally various foodgrains like rice, wheat and millets, enriching macaroni products, conservation of fruits and vegetables by refrigeration and adaptive processing, quality control of fruit products and food microbiology. Firm tie-up was established with Commodity Boards to work on plantation products which earn foreign exchange.

After 1963, he worked as an Expert in Philippines, where he developed food technology in National Institute of Food Science and Technology. His work on Coconut, which resulted in a technology to produce infection-free copra and a quality oil is well appreciated. After a short duration of assignment with Ministry of Food, he had opportunity to build a Paddy Processing Research Centre at Tiruvarur which has now become a full-fledged Institute at Thanjavur under the Government of India. His work here gave solutions to many problems in paddy processing.

The Journal now published as 'Journal of Food Science and Technology' by AFST was initiated by him replacing Food Science, a publication of CFTRI. He founded the Association and the AFST has established a prestigeous award 'Dr. Subrahmanyan Industrial Achievement Award' and has now decided to celebrate the "Founders day" every year in the country.

The edifice he built in Food Science and the seeds he sowed for R & D work in the nation should now be nurtured with dedication for the benefit of masses in the country.

"Lives of greatmen all remind us,
We can make our lives sublime,
And departing, leave behind us,
Foot prints on the sands of time".

(Long Fellow)

C.P. Natarajan

J. Fd. Sci. Technol., 1989, Vol. 26, No. 5, 239-241

Evaluation of Plastic Carton and Corrugated Fibre Board Carton vis-a-vis Conventional Wooden Box for Packaging and Transportation of Apple

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Received 26 August 1988; revised 13 June 1989

No damage was observed in the body of apple packed in 3 ply telescopic plastic carton and wooden box, whereas, in tray packed corrugated fibreboard (CFB) carton, some side rubbing and in CFB Kullu pack, pressing of corners were noticed during transportation by truck from Nauni (Dist. Solan) to Delhi market covering about 400 km distance. Quality of fruit retained during transportation in tray packed plastic carton and tray packed CFB carton was statistically at par though superior to the CFB Kullu pack and wooden box.

The continuous use of timber for the fabrication of packing cases has tremendously depleted our forest resources which have disturbed our eco-system adversely. The annual requirement of wood for conversion into packing cases for apple and other fruits at optimum production by the turn of the century will be around 6 lakh cubic meters which may outstrip its availability. Over last decade, trials have been conducted by various workers to forestall this condition and to find out appropriate substitute to wooden box. Use of telescopic corrugated fibreboard (CFB) carton with trays for packaging and transportation of apple has been suggested. However, 7 to 8 years of their use has not given confidence to the growers and other agencies involved in marketing of apples because of their susceptibility to moisture absorption especially in rainy season which coincides with apple harvesting. This is also due to the hilly terrains and poor roads through which the boxes are carried on human/mule back and in open trucks. In the present study, telescopic tray packed corrugated plastic board carton developed by M/S Caprihans Ltd. Bombay and Kullu pack of CFB received from Horticultural Produce Marketing and Processing Corporation of Himachal Pradesh (HPMC), Shimla have been field evaluated vis-a-vis tray packed CFB carton and conventional wooden box for packaging and transporation of apples to find out their suitability in the existing conditions of road transportation in Himachal Pradesh.

Materials and Methods

Medium size (70 mm ± 2.5 dia.) 'Red Delicious' apple fruits were procured from the University orchard located near Oachghat (Dist. Solan). Fruits were harvested at proper maturity and brought to packing house where they were sorted, graded and packed in the four types of packages like, telescopic corrugated fibre board carton with trays (A_1), telescopic corrugated plastic carton with trays (A_2), universal CFB Kullu pack (A_3) and conventional wooden box (A_4), with the inner dimensions 50.8 × 30.8 × 28.0 cm of A_1 and A_2 and 48.7 × 20.5 × 22.5 cm and 45.0 × 30.0 × 27.5 cm of A_3 and A_4 treatments respectively. Packed containers were transported by tractor to road head (4 km) and then to terminal market, Delhi by truck covering about 400 km distance. The damage to fruit was evaluated as number of fruits as well as extent of bruising, 'slight' when one minor touch, 'medium', when two touches and 'severe' when more than two marked bruising spots on individual fruit. Observations on change in the condition and weight of packing material including internal packing, net weight and gross weight losses of fruits, their firmness and chemical constituents were recorded at the time of packing and immediately on reaching Delhi. Loss of net weight of 10 fruits and gross

* Part of research work carried by the Ist author for the award of M.Sc. degree.

weight of box expressed as per cent of initial weight. Fruit firmness was measured on representative fruit samples in pound pressure with 'Effegi' fruit pressure tester having 7/16 in. plunger. Total soluble solids of fruits were determined with the help of hand refrectometer calibrated to 20°C and expressed as °Brix. The total titratable acidity of fruit was calculated and expressed as per cent anhydrous malic acid[1]. Starch content was recorded by starch iodine test as detailed by Phillips and Poapst[2]. Disappearance of starch in the fruits was compared with the chart prepared by assigning numerical value.

Results and Discussion

Condition of packaging material: Pressing of corners of two out of four of CFB Kullu packs was observed, which may be due to their poor stacking strength. The tray packed CFB carton and wooden box remained intact and sound during transportation to Delhi except side rubbing in the former and loosening of few nails in the latter. Safe arrival of CFB cartons with trays alongwith wooden boxes during transportation has been reported[3-5]. Among all treatments, tray packed plastic carton was found perfectly safe and sound without any rubbing impact and damage noticed on this carton which may be due to its good stacking and bursting strength. Plastic (foam) containers were found satisfactory in strength during transportation[6].

The tray packed CFB carton and CFB Kullu pack gained in empty weight by 0.5 and 0.66 per cent respectively during transportation with fruits which may be due to absorption of moisture from transpiring fruits or from atmosphere or both. In plastic carton in transit neither gain nor loss in empty weight was recorded due to non-hygroscopic nature of plastic. The wooden box showed 1.64 per cent loss in its empty weight which could possibly be due to the moisture loss from the fresh timber used for manufacturing wooden box. Minimum increase in weight of internal packing (newspaper pieces) in conventional wooden box may be due to subsequent loss of absorbed moisture from wrapping papers to the box and its further loss to atmosphere, whereas, the maximum gain in the weight of trays in plastic carton may be due to its greater water absorption nature and non-hygroscopic nature of plastic board.

Net and gross weight of fruits: It is clear from Table 1 that loss in the net weight of fruits during transportation was lowest in tray packed CFB carton (1.70 per cent), which was statistically at par with tray packed plastic carton, which may be due to the build up of higher humidity conditions inside the cartons resulting in lesser loss of net weight of fruits.

Minimum loss in gross weight of fruits was found in tray packed plastic carton (0.40 per cent) closely followed by tray packed CFB carton and CFB Kullu pack and was significantly lesser than the wooden box (1.64 per cent) which showed maximum loss in gross weight, possibly due to the moisture absorption by timber from the fruits and the subsequent loss of this moisture to atmosphere over and above the inherent moisture loss from the timber during transportation. Similar results have been reported earlier in CFB cartons[7].

There was a loss in fruit firmness in all the containers during transportation which was statistically at par with each other (Table 2). Loss of fruit firmness may be ascribed to the similar metabolic activities of the fruits in the containers, resulting in breakdown of insoluble protopectin to soluble pectin and pectic acid.

Bruising losses: Bruising damage to the fruit during transportation was found minimum (2.80 per cent) in tray packed plastic carton followed by tray packed CFB carton (3.80 per cent), whereas, it amounted to 19.2 per cent in wooden box (Table 2). Because of tight holding of fruits in cavities of trays in cartons, less bruising damage was noticed as compared to wooden box. Similar results have been reported by various workers[3,4,8,9].

Chemical changes in fruits: Data presented in the Table 3 indicate that there was a general increase in

TABLE 1. LOSS IN NET AND GROSS WEIGHTS OF FRUITS DURING TRANSPORTATION

Packaging type	Net wt. (kg)			Gross wt (kg)		
	Before despatch	After transport	Loss (%)	Before despatch	After transport	Loss (%)
A_1	1.47	1.45	1.70	21.11	20.93	0.84
A_2	1.48	1.45	1.89	21.45	21.86	0.40
A_3	1.56	1.52	2.50	11.90	11.79	0.90
A_4	1.52	1.48	2.69	21.38	21.03	1.64
C.D. (0.05)	—	—	0.59	—	—	0.71

TABLE 2. FRUIT FIRMNESS AND BRUISING DAMAGE OF FRUITS DURING TRANSPORTATION

Packaging type	Loss of firmness (lb)			Bruising damage (%)			
	Before despatch	After transport	Loss	Slight	Medium	Severe	Total
A_1	16.32	13.30	3.02	3.20	0.60	0.00	3.80
A_2	16.70	13.47	3.23	2.20	0.60	0.00	2.80
A_3	16.53	13.50	3.03	7.15	1.50	0.79	9.52
A_4	16.55	13.68	2.87	14.29	3.57	1.34	19.20
C.D. (0.05)	—	—	N.S.	1.56	0.60	—	2.05

N.S. = Non-significant.

TABLE 3. CHANGE IN TOTAL SOLUBLE SOLIDS, (T.S.S.) TITRATABLE ACIDITY AND STARCH INDEX NUMBER IN FRUITS DURING TRANSPORTATION

Packaging type	T.S.S. (°Brix)			Titratable acidity (%)			Starch index number (Out of 0-6)		
	Before despatch	After transport	Increase	Before despatch	After transport	Decrease	Before despatch	After transport	Increase
A_1	9.57	10.86	1.29,	0.265	0.246	0.019	1.80	3.20	1.40
A_2	10.05	11.39	1.34	0.274	0.251	0.023	1.78	3.28	1.50
A_3	9.47	10.94	1.47	0.287	0.257	0.030	1.82	3.25	1.43
A_4	9.97	11.49	1.52	0.279	0.246	0.033	1.79	3.33	1.54
C.D. (0.05)	—	—	N.S.	—	—	0.005	—	—	N.S.

N.S. = Non-significant.

total soluble solid contents and decrease in titratable acidity and starch content in fruits during their transportation to Delhi. However, increase in total soluble solid contents and decrease in acid value of fruits are relatively slower in tray packed cartons which may be due to the slower rate of ethylene production and better packing conditions inside cartons. This proves superiority of these cartons over conventional wooden box. Similar results were reported by other workers[3-5]

According to the present investigation, standard size telescopic plastic carton and CFB carton showed superiority over conventional wooden box, with respect to quality retention of apples during transportation. However, some modifications in CFB carton to make it moisture resistant is needed.

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Milling Characteristics of Wheat Straw*

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Received 1 August 1988; revised 10 April 1989

In batch grinding, the interrelation among the size reduction of wheat-straw, power consumption characteristics and time needed to get fine ground product is presented here. The power requirement of the mill in grinding successively decreased with time. In all the experiments, the power time curves tend to stabilize at the end of grinding period. Again, the plot of cumulative mass fraction with size showed that the ground product had almost a similar distribution trend in all cases.

Wheat straw is widely used as cattle feed through out the country. It becomes, to some extent, a governing factor in the economics of livestock farming in India. Because of the low bulk density and low nutritive value of wheat straw, the extent of its utilization is low. Both the problems could be solved by reducing the straw size. Size reduction increases the specific surface area of the material, thereby the efficiency of subsequent operations like chemical treatment, fortification and compaction, etc. can also be improved. Unfortunately, much emphasis has not been given towards increasing the efficiency of straw processing because of its low cost. But under the present circumstances, straw processing cannot be neglected.

Very few studies are there about the size reduction characteristics of straws. Power requirements increase rapidly at higher moisture contents and capacity is inversely related to moisture content. Also, as hammer tip speed increases, fineness modulus decreases. the fineness modulus reported for Alfalfa hay corresponding to coarse grinding, medium grinding, fine grinding and very fine grinding are 4.00, 3.10, 2.20 and 1.40 respectively.[1]

As speed of hammer increases, average consumption and capacity increase.[2,3]. Specific power consumption for grinding chopped straw decreases from 3.75 to 0.15 KWh/50 kg and capacity increases from 35 to 310 kg/hr, if size of sieve was varied from 3 to 24 mm[4]. Effect of particle size on bulk density of straw is that as average particle size of straw decreased from 4.80 to 0.25 mm the bulk density of material increased from 0.065 to 0.0951[5].

The present study deals with the performance of size reduction system, in respect of power consumption profile and the time needed to get fine ground product in batch grinding of wheat straw in a laboratory hammer mill.

Materials and Methods

Raw material: Commercial grade broken wheat straw of unknown variety was used for the study. Moisture content of straw (initial moisture 8.54 per cent) was determined by oven-drying method at a temperature-time combination of 95°C and 24 hr.

Experimental design: Independent variables selected for present study were; particle size of sample (five levels), grinding time, (five levels), moisture content of wheat straw and clearance between the hammer blades. The values of the parameters are shown in Table 1. The dependent variables which were measured at the time of experiment were: power consumed on no load, power consumed on load, and weight of the mass fractions retained on different sieves.

*Paper presented in the XXIV Annual Convention of Indian Society of Agricultural Engineers held at Punjab Rao Krishi Vidyapeeth, Akola, on January 21-23, 1988.

TABLE 1. INDEPENDENT VARIABLES

Variables	Levels (No.)	Values
Particle size of samples	Five	1.200, 1.700, 2.400 3.400, and 4.800 mm, average sieve size.
Grinding time	Five	60, 120, 180, 240, and 300 sec
Moisture content of wheat straw	One	8.54%
Clearance between the hammer blades	One	1.0 mm

Experimental set-up: A small size hammer mill was used for batch grinding of wheat straw in laboratory. The hammer mill used for grinding had a power rating of 1.8 kW. The main components of the hammer mill were: feed hopper, sliding gate, rotor, rotor blade, casing, stationary casing blade, frame and mill out-let. It had 4 blades/hammers on the rotor and six on casing, fixed at uniform distance. The diameter of the grinding chamber was 213 mm. The sieve area of the mill was blanked by metallic sheet to facilitate batch grinding tests. The details of consumption and specific features of the hammer mill are given in Fig. 1.

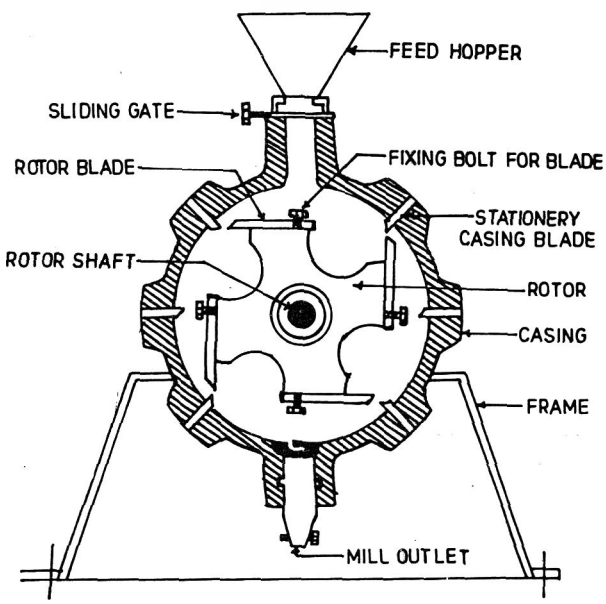

Fig. 1. Experimental hammer mill.

Sample preparation: Samples for grinding study were prepared by sieving wheat straw so as to have uniformity of size in the sample. Five sieve sizes having average size (arithmatic mean size) of 1.200 mm (1.4000/1.000 mm), 1.700 mm (2.000/1.4000 mm), 2.4 mm (2.800/2.000 mm), 3.400 mm (4.000/2.800 mm) and 4.800 mm (5.600/4.000 mm) were selected. The values correspond to the size of Indian Standard sieves. The samples of 40g were weighed and used for grinding. The weight of sample for grinding test was fixed after a number of preliminary trials.

Experimental procedure: The weighed 40g samples were kept in a high grade polyethylene bags. Before start of experiment, the sample was placed in the feed hopper by keeping the sliding gate in close position. The running of mill and feed of sample, by opening the sliding gate, was done simultaneously. Grinding was done for the specific time 60, 120, 180, 240 and 300 sec. The no load power and the power required for grinding were recorded with the help of a wattmeter. The power at test load was recorded at an interval of 15 seconds. After completion of the grinding, the mill was stopped and ground samples were collected cautiously. Same procedure was repeated for all set of experiments.

Ground straw samples were then analysed for particle size distribution. A rotap sieve shaker was used for this analysis. The Indian Standard sieves used for size analysis of the ground wheat straw were of size 2000, 1000, 500, 355, 300, 250, 212, 180, 125, 63, and 45 microns. A pan was also used. Sieving was continued up to the time, till the weights of sieves with samples became constant or unmeasurable.

Results and Discussion

Power consumption: From the data recorded plots of power consumption (Watts) *versus* time of grinding (sec) were drawn for different particle sizes of the sample. A sample plot of power watts *versus* time for 2.4 mm feed size is shown in Fig.2, which reveals that the power requirement of the mill in grinding successively decreases with time. This change reflects a decreasing rate of variation. Similar result was also reported by Davis *et al.*[5] In all the experiments, the power-time curve tended to stabilize at the end of grinding period.

Sieve analysis: Sieve analysis was done for all the ground samples and mass fractions retained on each sieve were recorded. Plots of cummulative mass fraction percent *versus* average size of ground straw (micron) were drawn for different particle size of straw. A sample plot for a feed size of 2.4 mm is shown in Fig.3, which clearly shows that the ground product had almost a similar distribution trend. Other samples also

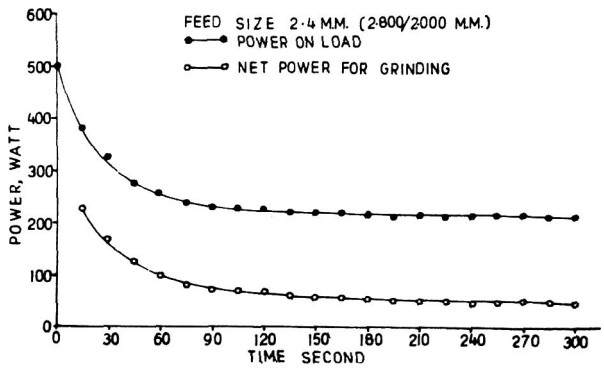

Fig. 2. Power variation in batch grinding of feed size 2.4 mm.

followed this trend. In batch grinding, all the particles going for the process seem to be highly interactive.

From the foregoing, it could be concluded that, power requirement of the mill in grinding successively decreases with time and the power time curve tends to stabilize at the end of grinding period. The plot of cumulative mass fraction with size showed almost a similar distribution trend and all the particles in the process of batch grinding seem to be highly interactive.

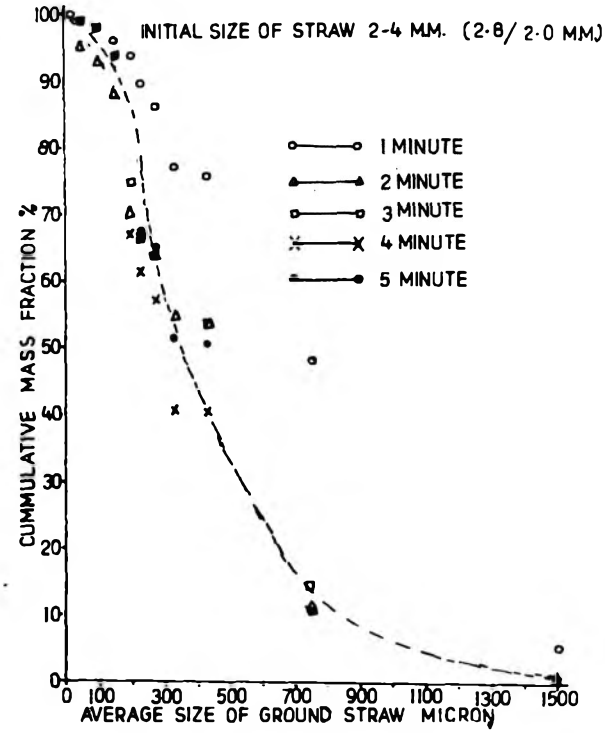

Fig. 3 Particle size distribution of ground straw.

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Effects of Degree of Parboiling on Some Quality Parameters of Rice

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The effects of soaking temperature and steaming period on some quality parameters of rice were studied for 'Os6' rice variety. These parameters include grain breakage, swelling capacity and test water absorption ratio. Steeping temperature was between 55 and 75°C while steaming period was from 60 to 120 min at atmospheric pressure. For a 16-hr steeped paddy, the results showed favourable parboiling conditions with an acceptable product at 65-75°C soaking temperature and steaming times between 90 and 110 min. The higher the soaking temperature the lower the breakage, swelling capacity and water absorption ratio. It was also found that a longer steaming period, lowers the breakage, swelling capacity and water absorption ratio.

Citizens of many third world countries have preference for imported rice from the developed countries. The reason for the preference is the characteristic odour of the locally processed rice. The odour is as a result of the fermentation which usually occurs when the paddy is soaked for about 4 days in the cold water steeping method of rice parboiling practised in certain parts of the countries. In most cases, proper cleaning of the paddy is not usually done before soaking. This practice according to Grist[1] encourages the dissolution of organic impurities in the soaking water causing fermentation. To improve the quality of the locally produced rice to the acceptance of the consumers, there is a need for an investigation into the parboiling process which mostly affects the quality of processed rice.

Materials and Methods

Samples of 'Os6' variety of paddy was used for the experiment. This was cleaned of foreign particles and made ready for the parboiling process. Six hundred g of the sample was soaked in water heated to 55°C in a metal can immersed in a parboiling tank for a period of 16 hr. The soaking time of 16 hr is the industrial practice of rice processing in the locality. The soaking water was drained after the 16 hr period through a tap at the bottom and the tank was refilled up to level just below the false bottom made of woven wire.

The soaked sample was divided into four equal portions in cans of enough capacity and arranged on the woven wire bottom. The base of each can was removed and wire mesh soldered so as to allow steam to rise through the column of rice samples in the open cans. Before arranging the samples in the parboiler, the water was raised to boiling point and after arranging the samples in the tank, the tank was covered with jute bags in order to maintain the temperature above the water column at about 100°C. The four samples were steamed for 60, 90, 105 and 120 min. Other samples were soaked at 60, 65, 70 and 75°C and the same steaming treatment as the first was applied.

The treated samples were dried to a moisture content of between 12 and 13 per cent in an oven set at 40°C. The moisture content was determined using the Dole moisture meter. A McGrill laboratory rice sheller was used for shelling the treated paddy. Treated samples were separately weighed and shelled. One hundred g. of each milled sample of the treated rice was randomly taken from various points in the containing vessel. Grains less than ¾ of whole grain size were separated manually. The breakage percentage is the weight of grain less than ¾ of whole grain per one hundred g of milled rice. The average of three replicates was obtained.

Five g of the milled sample was placed in 40 ml of distilled water in a beaker and covered with a watch glass. The beaker was placed in a bath of boiling water for 23 min[2] the content was poured into a Buchner on the surface of the grains. The sample was weighed and the water absorption calculated as the increase in weight per unit weight of sample.

Ten g of the sample was weighed into a 250 ml measuring cylinder containing 70 ml of distilled water. The initial height of the rice in the cylinder was noted. The sample was cooked to eating consistency in a boiling water bath. The final height was noted, hence the volume expansion was obtained. The swelling

capacity is the ratio of the volume expansion to the weight of raw rice.

Results and Discussion

Fig 1 shows the effect of the degree of parboiling on the swelling capacity of the rice samples. There is a general trend of decrease in swelling capacity for an increase in the steaming period. The sample soaked at 60°C but steamed for 60 and 120 min respectively have swelling capacities of 3.83 and 2.77 ml/g. Also the sample soaked at 70°C and steamed for 60 min has a higher swelling capacity of 3.81 ml/g than the same sample steamed for 120 min with a swelling capacity of 2.9 ml/g. These findings agree with the findings of Kurien *et al*[3]. The swelling of the rice samples results from the absorption of water. Failure of a sample to swell would be due to the inability of the sample to absorb water adequately. With increase in steaming period, certain structural changes occur in the cells of the endosperm that restrict water penetration hence the decrease in swelling capacity, using the method of Halick and Kelly[4]. The Amylography method was used to determine the gelatinization temperature[5]. The graph of viscosity runs parallel to the horizontal axis at lower temperatures, but at about 70°C started to rise, indicating a GT of 70°C.

It was also observed that the ability of the rice samples to retain their structure after cooking was dependent on the duration of steaming the sample. Samples soaked at 65°C and 70°C and steamed for 60 min were sticky while the same samples steamed for 120 min. were well separated. Statistical analysis (analysis of variance) reveals that the soaking temperature does not have a significant effect on the result. This may be due to the small temperature difference used for the tests. Using the t-distribution test however, there was a significance of mean values obtained for the effect of soaking temperature. This is at temperature of 65°C. This agrees

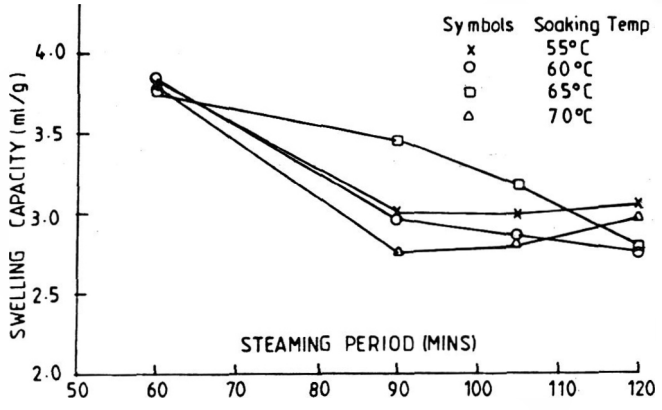

Fig. 1. Effect of steaming on Swelling Capacity

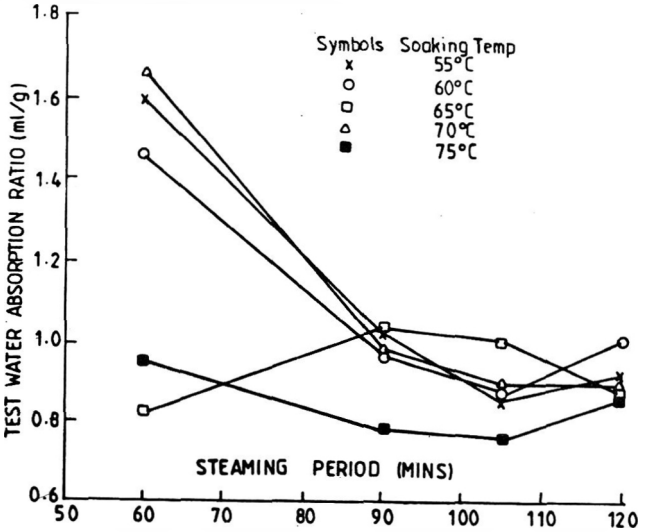

Fig. 2. Effect of steaming on test water absorption

with the finding of Bandyapadhya and Roy[6] that soaking at temperatures around 65°C gave considerable degree of parboiling and reduces the swelling quality of rice.

Fig 2 shows the plot of "test water absorption ratio" with steaming period at various levels of soaking temperatures. The graph shows a decrease in the test water absorption ratio with increasing steaming period resulting in the reduction of the quantity of water absorbed by the parboiled rice. This is in agreement with the findings of Kurien *et al*[3] that the absorption ratio for parboiled rice is lower than those of unparboiled rice. The fall in 'test water absorption ratio' with steaming period is consistent from 60 minutes of steaming to 105 min for soaking temperatures of 55, 60, 70, 75°C with subsequent rise in the absorption capacity beyond 105 min of steaming. The result obtained for 65°C soaking temperature is however different. A rise in the water absorption with steaming period is followed by a decrease in the water absorption.

Statistical analysis reveals that steaming time has significant effect on the water absorption while the soaking temperature has no significant effect on the water absorption. The non significance of temperature is possibly due to the fact that the temperature difference is small, about 5°C.

Fig 3 is a plot indicating the percentage breakage at varying steaming times. There is a general decrease in breakage as the steaming time decreases. The decrease changes from being rapid to gradual as the soaking temperature increases. It has been reported[7,8] that the higher the temperature and duration of parboiling, the harder the rice. The hardness of the sample with higher temperature of parboiling resulted in the lower breakage. It can be noted that a sample soaked at 55°C and steamed for 60 min has a breakage

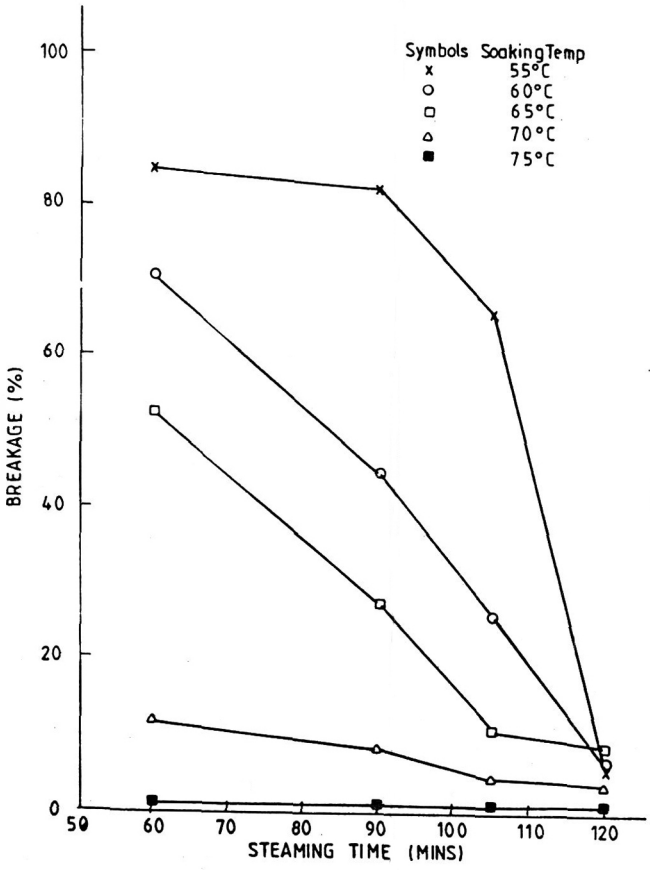

Fig. 3. Effect of steaming time on breakage

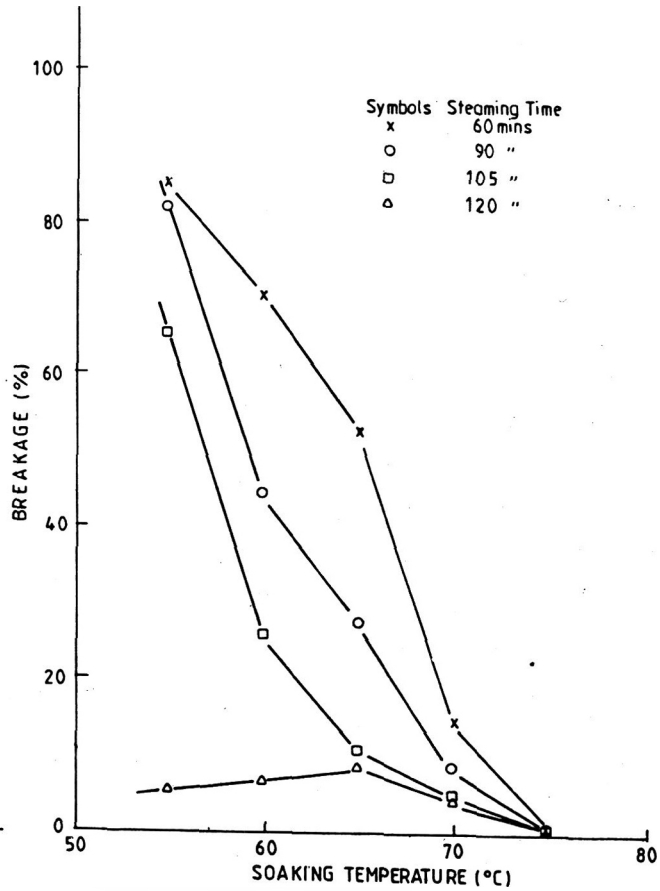

Fig. 4. Effect of soaking temperature on breakage

of 85 per cent while the same sample when steamed for 120 min has a breakage of 5.5 per cent.

Fig 4 shows the effect of soaking temperature on the breakage of the parboiled rice. For samples steamed for 60, 90 and 105 min, there is a rapid decrease in the breakage as the soaking temperature increases. Beyond 65°C soaking temperature however, the rate of fall in breakage became gradual. The behaviour of the sample steamed for 120 min is different from those steamed for other time periods. A slight increase in the breakage was recorded with a subsequent fall as the soaking temperature increases. For samples soaked beyond 65°C, the graph (Fig 3) is almost parallel to the x-axis and at 75°C soaking in particular the breakage is almost negligible.

The following conclusions may be drawn from the study.

Best swelling characteristics are obtained with a soaking temperature of 65°C and steaming period of between 90 and 110 minutes.

Soaking temperature and steaming time significantly affect breakage.

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Comparison of Methods for Enumeration of *Escherichia coli* in Raw Milk Samples

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The most probable number (MPN) method of Association of Official Analytical Chemists (AOAC), modified direct plate (MDP) method, violet red bile agar/violet red bile agar (VRBA/VRBA) and modified MPN (MMPN) methods were compared for the enumeration of *Escherichia coli* in naturally contaminated raw milk. Statistical analysis of data shows no significant difference among the counts obtained by these methods. Maximum counts of *E. coli* were obtained by the AOAC's MPN, MMPN and MDP methods.

Coliforms, particularly *Escherichia coli* are frequently used in the microbiological analysis food as indicator organisms of poor hygienic conditions and possible presence of Salmonella and other enteric pathogens[1,2]. At the same time, enterotoxigenic *E. coli* can cause infantile diarrhea, and also produce illness to a considerable extent in adults[1,3,4].

The enumeration of *E. coli* in foods is usually carried out by the conventional most probable number (MPN) procedure which requires many steps, multiple tubes of various media and the full test also requires at least 5 days for completion[4-8]. These are also subject to accuracies due to culture anamolies, such as anaerogenic or lactose-inactive strains and the errors innate in the statistical Tables from which the MPN is derived[6].

Recently, for this reason, some alternative methods based on direct-plating count have been developed[2,5,9,10]. Direct-plating methods are more rapid, inexpensive and less laborious. However, they are limited in accuracy by the failure of strains to ferment lactose and the errors could arise in selecting colonies for confirmation[6].

In the present study, an attempt has been made to compare different methods such as the Association of Official Analytical Chemists (AOAC) most probable number (MPN) method, modified direct plate (MDP) method, violet red bile agar/tryptic soy agar (VRBA/TSA) method, violet red bile agar/violet red bile agar (VRBA/VRBA) method, and modified MPN (MMPN) methods for *E. coli* enumeration in naturally contaminated raw milk samples.

Materials and Methods

Samples: Fifty raw milk samples were examined and 23 samples which had been found to be naturally contaminated with *E. coli* were selected for the tests.

Media: All media were obtained from Oxoid or Difco and prepared according to the manufacturer's instructions.

Cellulose acetate filter membranes: Cellulose acetate filter membranes (Pore size 450 nm, 85 diam.) which were used for MDP method were obtained from Oxoid[5,10].

UV lamp: In the MDP method, to fix colonies on the membrane and keep it for reference, ultra violet lamp (366 nm, Universal u.v. lamp-CAMAG) or direct sunlight were used[5,10].

Sample preparation: By using the naturally contaminated raw milk samples, 10^{-1} to 10^{-9} dilutions were made in buffered peptone water. These dilutions were used for following methods.

Enumeration methods: The AOAC 3-tube MPN method was followed by inoculating ten-fold dilutions of each sample into lauryl sulphate tryptose (LST) broth tubes. Cultures giving ++-- and -+-- IMViC patterns were considered as *E. coli* types I and II, respectively. Only these colonies were used to determine the MPN of *E. coli*.

Modified direct plate (MDP) method was performed according to the procedure of Anderson and Baird-Parker[5], and later modified by Holbrook *et al.*[10] using cellulose acetate filter membranes. Indole positive colonies appearing on the surface of the membrane were counted and multiplied by the dilution factor gave the number of *E. coli*/ml. milk.

Violet red bile agar/tryptic soy agar (VRBA/TSA) method of Powers and Latt[9] was used. Typical colonies (red, greater than 0.5 mm and surrounded by a halo) were counted and, selected colonies were tested for IMViC reactions for identifying *E. coli*[11].

A modification of the above method[9] known as violet red bile agar/violet red bile agar (VRBA/VRBA) was followed, wherein TSA was replaced by equal volume of VRBA.

In the modified MPN (MMPN), both gas production from lactose as well as indole production at 45.5°C were taken into consideration.

A series of 3-tube ten-fold dilutions for each sample was inoculated into preheated LST broth and incubated for 24 and 48 ± 2 hr at 35 ± 0.5°C in an air incubator. At 24 and 48 hr, transfers were made from the gas positive cultures to the tubes of EC broth medium. The tubes EC medium were incubated at 45 ± 0.2°C for 24 and 48 ± 2 hr. After incubation, Kovacs indole reagent was added to the gas positive EC tubes. Only those cultures yielding gas and indole positive were used in determining the MPN of *E. coli*.[11]

Statistical analyses: Linear regression-correlation analyses were applied to the logarithms of *E. coli* counts and methods were compared with by using the Bonferroni test.[11-14]

Results and Discussion

Counts of *E. coli* obtained from milk samples by the five methods varied from 36 to 42×10^6 cfu/ml. Statistical analyses of results obtained by the five methods on 23 naturally contaminated raw milk samples are shown in Tables 1 and 2. Using these data, linear regression-correlation analyses were studied and the results presented in Table 3 give a comparison among the different methods.

The relationship between the AOAC's MPN and MMPN was the best consistent (r=0.9872, Fig. 1) and there was a relatively weak correlation between AOAC's

TABLE 1. LOG *(E. COLI)* COUNTS OBTAINED BY THE FIVE METHODS ON NATURALLY CONTAMINATED RAW MILK SAMPLES

Sample	AOAC/EMS	MDP	VRBA/TSA	VRBA/VRBA	MEMS
1	3.4623	4.2430	3.4471	3.4712	3.4623
2	3.2222	4.3560	5.2922	4.8692	4.4623
3	2.4471	4.3138	3.0530	3.0740	2.5440
4	4.3222	4.3900	4.0813	4.0700	4.3222
5	5.3222	5.6384	5.7781	5.7958	5.3222
6	5.0413	3.9030	3.5563	3.5599	5.0413
7	4.3222	3.7520	3.5502	3.3074	4.3222
8	2.0413	2.6434	2.8573	1.8061	1.5563
9	7.3222	5.5051	5.6655	5.8034	7.6232
10	3.9637	4.2240	4.3117	4.3747	4.3010
11	4.1139	5.0293	5.1072	5.0743	4.7242
12	3.4471	3.1205	2.5477	2.9344	3.3802
13	4.6434	4.9420	4.2268	4.2624	4.5440
14	6.3010	4.9420	4.5797	4.6776	6.0413
15	5.4623	4.2253	4.1335	4.2988	4.7242
16	7.3222	5.3820	4.3552	4.5797	7.3222
17	4.4623	4.8893	3.6812	3.7371	4.3222
18	6.7244	5.0700	4.7403	4.7634	6.7242
19	6.6434	5.3636	4.8920	4.8573	6.6434
20	2.3010	2.6580	2.7075	2.6627	2.1760
21	3.0413	3.8481	3.9242	3.9319	3.0413
22	2.6232	2.6989	2.6989	2.7558	2.5440
23	3.4623	3.5682	3.0681	3.1172	3.4623

TABLE 2. STATISTICAL ANALYSES OF LOG *ESCHERICHIA COLI* COUNTS OBTAINED BY THE FIVE METHODS ON NATURALLY CONTAMINATED RAW MILK SAMPLES

Method*	No. of samples	Mean	Variance	Std deviation	Std error	Confidence limits (α:0.05) Lower	Upper
AOAC/MPN	23	4.4398	2.5655	1.6017	0.3339	3.7462	5.1333
MDP	23	4.2916	0.8390	0.9159	0.2003	3.8949	4.6882
VRBA/TSA	23	4.0189	0.9235	0.9610	0.2003	3.6028	4.4350
VRBA/VRBA	23	3.9906	1.0340	1.0168	0.2120	3.5503	4.4309
MMPN	23	4.4177	2.6825	1.6378	0.3415	3.7085	5.1268
Total	115	4.2317	0.5155	0.7179	0.0669	4.1005	4.3628

* Sex text for expansion of abbreviated words.

TABLE 3. CORRELATION COEFFICIENTS AMONG THE ENUMERATION METHODS

Method	MDP	VRBA/TSA	VRBA/VRBA	MMPN
AOAC/MPN	0.7940	0.6910	0.7470	0.9872
MDP		0.8592	0.8913	0.8293
VRBA/TSA			0.9654	0.7355
VRBA/VRBA				0.7819

MPN and VRBA/TSA methods (r=0.6910, Fig. 2). In the second step, the Bonferroni test using to compare of means of dependent samples was used.[11,12] The statistical analyses of data indicated that there was no significant difference among these methods when raw milk was used as a sample (α:0.05). Although there was no significant difference between the methods, the maximum counts of *E. coli* were obtained by the AOAC's MPN, MMPN, and MDP methods.

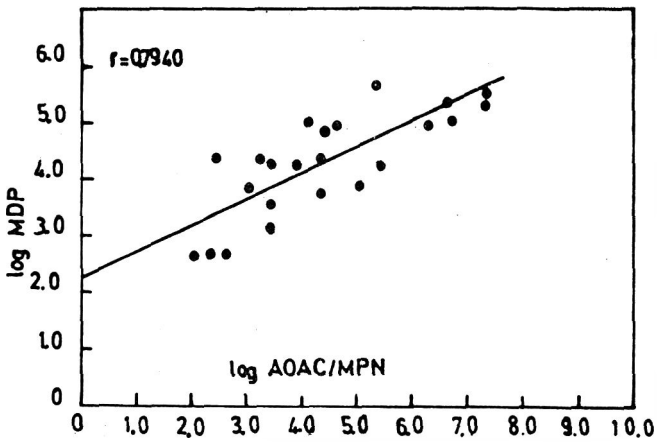

Fig. 1. Regression line showing the relationship between log AOAC/MPN of *E. coli* and log MDP of *E. coli* count. (log y = 2.2755+0.4540 log x)

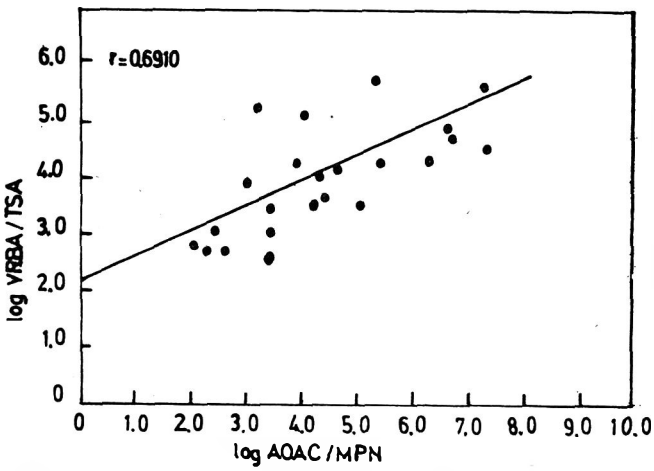

Fig 2. Regression line showing the relationship between log AOAC/MPN of *E. coli* and log VRBA/TSA of *E. coli* count. (log y=2.1782+0.4146 log x)

The high correlation between AOAC's MPN and MMPN methods can be explained by using the similar techniques and especially the same MPN Tables. However, the completion times are different in these two methods. Although AOAC's MPN method is completed in 192-240 hr[2], MMPN method is completed in only 48-96 hr[11]

In addition to this time-saving advantage of the MMPN method, an another advantage is its ability to detect both the gas production from lactose and the indole production. However, the anaerogenic and late lactose-fermenting strains of *E. coli* biotype I which comprise up to 10 per cent of *Escherichia* strains are missed by the MPN methods.[15] MDP method in this study gave higher counts in comparison with other plating methods, but as mentioned earlier there was no significant difference among the methods.

Although the MDP method does not enumerate *E. coli* biotype II which comprises about 1 per cent of strains and incorrectly indicates 3-5 per cent of other organisms as being *E. coli*[5], this method can detect anaerogenic and late lactose-fermenting strains of *E. coli*[15]. According to Holbrook *et al.*[10], the concentration of carbohydrate present in raw milk and ice-cream inhibits the production of indole by *E. coli* when the direct-plating method of Anderson and Baird-Parker[5] is used, but this can be overcome by use of the MDP method[10]. In the MDP method, results were obtained in 24-30 hr and there was the elimination of counting multiple tubes of media. However, it required expensive special membranes. VRBA/TSA procedure was evaluated as rapid, simple and inexpensive. The results were obtained in 72-76 h. *E. coli* colonies were typical but they were not as large as colonies on VRBA in VRBA/VRBA.

The present study showed that *E. coli* in raw milk samples could be accurately enumerated by VRBA/VRBA method. However, it was reported that VRBA at elevated temperature had the poor recovery achieved, particularly when cells are stressed.[9].

Isolates from the AOAC's MPN, VRBA/TSA and VRBA/VRBA methods were subjected to Gram staining procedure and IMViC tests[11]. It was found that, 198 (98.51 per cent) of the 201 isolates were Gram-negative, short, none spore-forming rods and 92.54 per cent of these were identified as *E. coli* biotype I (IMViC, ++--) and 3.98 per cent were identified as *E. coli* biotype II (IMViC, -+--).

Based on the present results and those of Anderson and Baird-Parker[5] and Rayman *et al.*[16], it was concluded that, the indole production is more often a character of *E. coli* strains than lactose fermentation. In MMPN method, all gas positive EC tubes tested for indole production gave positive results.

In conclusion, AOAC's MPN method is not recommended for enumerating *E. coli* in raw milk. The

MDP method is recommended, if there is a very short time to obtain the results. Although the MMPN has some MPN's disadvantages it can be recommended because of the lactose fermentation and the indole production is determined at the same time in a short period. Since the VRBA/TSA method is more rapid than VRBA/VRBA, it may be preferred to enumerate *E. coli* in raw milk samples.

Acknowledgement

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Studies on the Physico-chemical Parameters of Expanded Soybean

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The information available on processing of soybean was judiciously adopted to have expanded soybean dhal for use in snack foods. Longitudinal expansion was over by 50% of its length, but the increase in width and thickness was marginal. The bulk density reduced by 60% and the overall expansion was in the order of 30-40%. The recovery of the expanded dhal was 68-70% of the raw seeds. Most of the trypsin inhibitors were destroyed. The hardness was comparable to the hardness of roasted groundnut kernel.

Puffing of cereals and legumes is widely practised in India. Puffed cereals and legumes mixed with roasted oilseeds and desiccated coconut (salted and spiced) are the popular snack foods. Since the usual varieties of nuts are quite expensive relative to other snack food ingredients, there is always a constant search for cheaper substitutes.

Among the nuts, cashew, and groundnut are commonly used but are relatively costly. Therefore attempts are made to substitute them by soybean which is considerably low-priced and available in plenty.

The use of expanded soybean in fermented products like *Miso* and *Koji* has been reported[1]. For expansion, high temperature (250°C) and high pressure (6.5 kg/cm^2) for short time (5.6 sec) on soaked soybean was adopted.

The water uptake of soybean during soaking, the rate and maximum absorption showed little correlation with the protein content, density and size of the bean[2]. The influence of temperature and sodium bicarbonate treatment on the rate of water uptake was studied[3] and beyond 1 per cent concentration, the rate of water uptake was slow at lower temperature. Cooking for 90 min in water extracted 85 per cent of the oligosaccharides[4]. It was observed that soybean imbibed water in large proportion at higher temperature and retained its expanded structure during cooking[5].

Although soybean has some undesirable constituents, the information available on processing of soybean for food uses could be judiciously adopted to get rid of them and have good puffing of soy bean. This will provide ample scope for the direct utilisation of soy bean as a traditional nutritious snack food.

In the present paper, the data on standardisation of conditions for expansion, extent of trypsin inhibitor destruction, the bulk density, hardness of the expanded dhal with reference to raw dhal and material balance have been discussed.

Materials and Methods

Soybean varieties namely *'Kalitur'*, *'Bragg'*, *'Ankur'* and *'JS-2'*, grown and supplied by Jawaharlal Nehru Krishi Vishva Vidyalaya, Jabalpur (India) were used for water uptake studies. Physical (heat) and chemical (sodium bicarbonate, ammonium bicarbonate) treatments to remove the undesirable constituents such as trypsin inhibitor, haemagglutinin, urease activity, lypoxygenase activity have been used. These chemicals in combination with tartaric acid and sodium hydrogen phosphate (forming slow leaveners) were dissolved in hot water at different concentrations and combinations to study the water uptake in presence of chemicals. Because of general availability, the 'Bragg' variety was chosen for further studies on expansion qualities.

Water uptake: Twenty five g of each of the four varieties were taken in separate graduated cylinders. The initial volume occupied in each case was measured and 75 ml (1:3 w/w) of hot distilled water (80°C) was added and the temperature was maintained. At the end of 1 hr. the excess water was drained thoroughly and collected. The volume of the wet seed was measured. The volume of excess water thus collected was poured back into the corresponding cylinders for further extended periods of soaking. Similar readings were taken at the end of 2,4,6 and 8 hr.

Dry roasting: The commercial method of obtaining puffed Bengalgram described was adopted[6] as follows: Water was added at 5 per cent to wet the surface of soybean seeds kept for 20 min. and tempered over a sand bath at 170°-180°C for 1 min and kept in covered gunny bags for 20-30 min. The tempered seeds

were roasted over sand bath in a continuous gram roaster between 230-240°C for about 6 min. The final material temperature after separation from the sand by sieving ranged between 94 and 95°C.

Wet roasting: Blendford[7] process has been suitably modified for soybean as follows: Soybean was soaked for 1, 2 and 3 hr with thrice its volume of hot water (80°C) and the above chemical treatments (combined chemicals 1 per cent) were given maintaining the same temperature. At the end of 1, 2 and 3 hr of soaking, excess of water was drained off. The wet seeds were roasted over sand bath between 230 and 240°C for about 6 min. About two-thirds of the imbibed water get eliminated and the seed matrix is fixed in its expanded state by the dehydration resulting from the rapid diffusion of the water vapour out of it. The final temperature of material after separation from the sand by sieving ranged between 94 and 97°C. Further, a portion of the imbibed water, due to the potential heat developed steams off from the material. The expanded soybean was further dried in a through flow drier at 60°C to a constant moisture level (3 per cent).

Dehulling: Expanded soybean was dehulled in a plate mill keeping maximum clearance (5 mm) between the plates. The hulls and the dhal were separated by aspiration. The dhal and the brokens were separated over differential sieves.

Measurements: The length, width and thickness were measured using a micrometer calipers and the bulk density was determined by weight and volume ratio in a measuring cylinder (volume occupied by a known weight of the material after tapping it to a constant height). The hardness was measured at the yield point (the stress at which the grain cracks) using hardness tester instrument (Kiya Seisakutha Ltd., Japan).

Trypsin inhibitor: Trypsin inhibitor activity was determined by the method of Hamerstrand *et al.*,[8] using synthetic substrate.

The tryptic ativity of a crystalline preparation using benzoyl Dl-arginine paranitroanilide (BAPA) as substrate was measured with and without trypsin inhibitor extracted from processed and unprocessed soybean samples and the extent of trypsin inhibitors destroyed was reported in percentage. The extent of inhibition was in the range of 40-60 per cent in the assay.

Results and Discussion

The rate of water uptake of different varieties of soybean during hot water soaking over a period of 8 hr is shown in Fig. 1. The water uptake during 1st and 2nd hr was 100 and 150 per cent of original volume of seed and reached equilibrium conditions at the end of 3rd hr. Beyond 3 hr, there was marginal increase of hardly 5 per cent and reached maximum at the end of 8 hr. The influence of temperature and sodium bicarbonate on the rate of water uptake was studied[4]. The rate of water uptake was slow beyond 1 per cent concentration of sodium bicarbonate at lower temperatures.

The overall expansion of soybean dhal after the pretreatments (soaking, chemical treatments, roasting and dehulling) in terms of its dimensions are presented in Table 1. Soybean dhal expands longitudinally in the range 43-55 per cent of its original length and thickness increased in the range of 3-13 per cent. depending on the time of soaking. The width and thickness of the expanded dhal were comparable with the roasted groundnut kernel. The overall expansion values of soy dhal are in close agreement with the reported values of Bengalgram[6]. Further, the yield point of raw soybean dhal was 12.5 kg/sq.cm. whereas in the case of expanded dhal the yield points were 80-82 per cent lower than in both the chemical treatments. The yield point trends, suggest that longer the period of soaking, lesser the yield point. The hardness of the expanded soy dhal and the roasted groundnut kernel closely resembled each other in their yield points.

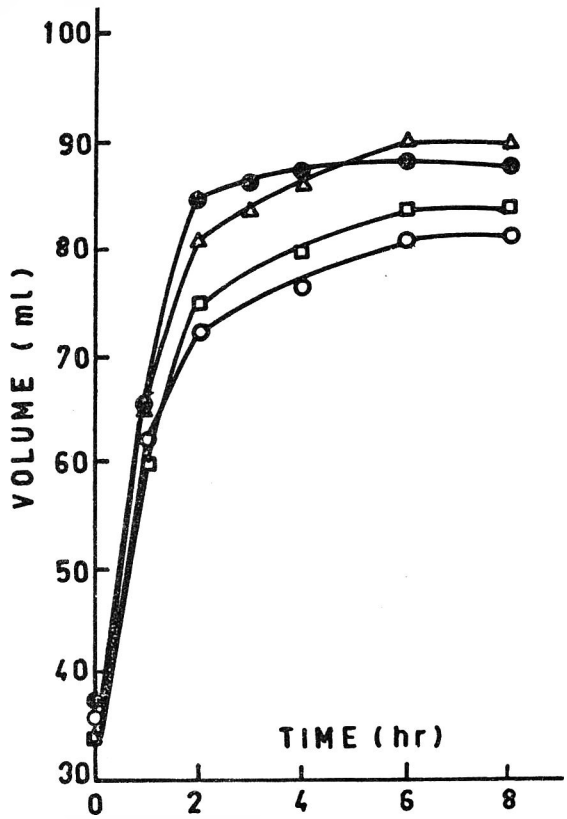

Fig. 1. Hot water uptake of different varieties of soybean.
●—● Bragg; ○—○ Kalitur
△—△ Ankur; □—□ JS-2

TABLE 1. OVERALL EXPANSION AND HARDNESS OF SOYADHAL/ROASTED GROUNDNUT KERNEL

Chemical treatments	1 hr Soaking				2 hr Soaking				3 hr Soaking			
	Length (mm)	Width (mm)	Thick-ness (m)	Hard-ness+ (kg/sq. cm)	Length (mm)	Width (mm)	Thick-ness (mm)	Hard-ness+ (kg/sq. cm)	Length (mm)	Width (mm)	Thick-ness (mm)	Hard-ness+ (kg/sq. cm)
Ammonium bicarbonate + sod. hydrogen phosphate	12.06[a]	6.26[a]	3.34[ab]	3.00	12.21[a]	6.06[a]	2.36[a]	2.30	12.67[a]	5.97[a]	3.35[a]	2.10
Sod. bicarbonate + sod. hydrogen phosphate + tartaric acid	12.11[a]	6.20[a]	3.53[a]	3.20	12.11[a]	5.89[a]	3.57[b]	2.50	13.04[b]	5.91[a]	3.38[a]	2.10
Soy dhal (raw)	8.40[b]	6.61[b]	3.16[b]	12.50	8.40[b]	6.61[b]	3.16[a]	12.50	8.40[c]	6.61[b]	3.16[b]	12.50
Groundnut kernel (roasted)	9.68[c]	7.50[c]	3.93[c]	2.10	9.68[c]	7.50[c]	3.93[c]	2.10	9.68[a]	7.50[c]	3.93[c]	2.10
SE_m (20 df)	± 0.11	± 0.10	± 0.07	--	± 0.11	± 0.10	± 0.06	--	± 0.10	± 0.07	± 0.06	--

Means of the same column followed by different superscripts differ significantly as per Duncan's New Multiple Range Test ($P > 0.06$)
*Combined chemicals is < 1% based on volume of water.
+ or yield point

The effect of chemical treatments on the destruction of trypsin inhibitor activity (TIA) indicates that the trypsin inhibitor destruction was in the range of 90-92 per cent and is independent of either the period of soaking or the chemical treatments. The effect of various acids and alkaline additives on inactivation of lypoxygenase, trypsin inhibitor and urease activity suggested that alkaline salts are better in inactivation[9,10]. Bianchi *et al.*[4] have studied the effect of different treatments such as soaking in water, cooking in autoclave with different soybean and water ratios on the oligosaccharide content, and concluded that cooking for 90 min. in water decreased the oligosaccharide content by 85 per cent. Wilken *et al.*[11] and Nelson *et al.*[12] have shown that boiling water or simmering water prevents the development of undesirable flavours in soybean.

The material balance data during the treatments and expansion of soy dhal are presented in Table 2. They suggest that beyond 2 hr soaking the recovery of dhal was affected adversely. Swelling increased with time but correspondingly there was an increase in the per

TABLE 2. MATERIAL BALANCE OF EXPANDED SOY DHAL

Chemical treatment	Soaking time (hr)	Moisture before splitting (%)	Bulk density (g/ml)	Brokens (%)	Hulls (%)	Dhal (%)
Amm. bicarbonate + Sod. hydrogen phosphate	1	7.0	0.5	4.0	8.0	72.0
	2	7.3	0.5	3.8	8.0	71.0
	3	7.1	0.47	3.0	10.0	70.0
Sod. bicarbonate + Sod. hydrogen phosphate + Tartaric acid	1	7.4	0.5	4.5	8.0	72.0
	2	7.4	0.5	4.0	8.0	68.0
	3	7.0	0.47	3.0	9.0	71.0

Note: Material balance for 1 kg soybean with initial moisture of 9.2%

cent shrinkage during sand roasting. Final expansion ratio and the bulk densities remained practically the same between 1st and 2nd hr. However, in the 3rd hr the expansion ratio and the bulk densities were slightly better than the other two. The combination of chemicals helps in the removal of bitter and undesirable active principles associated with soybean. The imbibed salts can liberate gases at high temperature and make them porous, which perhaps facilitate rapid water vapourisation resulting in low bulk density and high expansion ratio. It was also evident from the data that the two sets of chemical treatments did not have much effect on the recovery of expanded dhal. About 4-4.5 per cent of the soybean separates as brokens and the average yield of expanded dhal was about 70 per cent based on the whole bean. The hull fraction which is a by-product constitutes about 8 per cent. However, at 3 hr soaking there was an increase in the fraction containing hulls and a decrease in the per cent brokens. A fraction of the dhal was powdered during splitting because of low yield value, and the powdery material came along with the hulls during cyclonic separation. Thus, a soaking time of 2 hr. is optimum to obtain maximum recovery of expanded dhal.

In conclusion, soybean free from undesirable factors could be obtained as expanded dhal for direct consumption in traditional nutritious snack foods. The hardness of the expanded soy dhal is comparable with the hardness of the roasted groundnut kernel. About 70 per cent of the soybean is recovered as expanded dhal with minimum trypsin inhibitor activity.

Acknowledgement

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Induced Variation in Chemical Composition of Black Seeded Soybean Variety — Kalitur

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'Kalitur', a black seeded soybean variety was exposed to physical and chemical mutagens and subsequently studied for changes in electrophoretic and solubility behaviour of proteins, trypsin inhibitor activity and proximate analysis. Mutation induced changes in protein structure and lowered the fat percentage. Also, a mutant variety 'MACS 107' was found to be better than 'Kalitur' in having trypsin inhibitor activity lower by 15%.

Nuclear and chemical techniques are widely used to induce mutational changes in characters of cereal and pulse crops[1-3]. Sichkarv *et al.*[4] have reported a mutant variety from soybean 'Bukuriya' having low trypsin inhibitor activity. Mutation of γ - irradiation of 'Calland' and 'Hampton' varieties showed an increase in total lipids and carbohydrates and decrease in crude protein[5].

Nikolov[6] studied mutation of four soya varieties by γ - irradiation which yielded M_3 mutants having higher protein content than the source variety. γ -rays and thermal neutrons gave mutants which were 10 per cent richer in protein and higher in oil content[7].

Attempts have been made to induce desirable characters in 'Kalitur', a black seeded promising soybean variety, by exposing it to the physical and chemical mutagens. The derivatives were selected on the basis of seed coat colour and good yield of Kalitur and its nine mutants in M_9 generation[8,9].

In the present paper, studies were made for seed protein fractions by electrophoresis and solubility, assay for trypsin inhibitor and nutritive value by proximate analysis to understand the biochemical changes and nutritional performance of the mutants.

Materials and Methods

'Kalitur' and its nine mutants of M_9 generation were procured from the Department of Plant Breeding and Genetics, MACS. Samples were oven-dried at 60°C and ground to pass through 100 mesh sieve and stored in airtight plastic containers. These samples were analysed for studying electrophoretic[10] and solubility characteristics of proteins, trypsin inhibitor activity[12] and nutritive value by proximate analysis[13].

Gels were stained by 0.08 per cent coomassie G-250. The R_f values of the bands for all the samples were noted.

Results and Discussion

Electrophoretic pattern of proteins: The electrophoretic pattern is represented schematically in Fig. 1. 'Kalitur' gave 12 bands and 8 new bands can be said to be induced due to mutation. In order to study the total changes induced in 'Kalitur' proteins, an index as defined by Whitney *et al.*[4] was used

$$\text{Similarity index} = \frac{\text{no. of concurrent bands}}{\text{total number of bands}} \times 100$$

It was noted that mutants have shown similarity to Kalitur in the range 35 to 65 per cent indicating a considerable change in protein structure and variability within the mutants. Out of 20 bands, bands with R_f values .96, .90, .83, .46, .42, .26 were absent only in 2 out of 10 varieties and can be considered to be common bands, while band with R_f = .42 was absent in 'Kalitur' but present in all mutants.

Protein fractions based on solubility: Studies of protein fractions is of value since nutritional performance of the seed proteins is mainly dependent on per cent soluble proteins e.g. albumins[15]. Fig 2 shows the value of protein fractions in 'Kalitur' and its mutants. Statistical analysis indicated that there was variation in per cent albumin, prolamine and glutelins between varieties. Albumin content was 135 mg per g seed for 'Kalitur'. 'MACS 100', 'MACS 104', 'MACS 108', 'MACS 111' varieties showed values significantly lower ($P < .05$) than 'Kalitur' while albumin content for others was comparable. In the case of globulin fraction, 'MACS 104' showed a value which was significantly lower ($P < .05$) than Kalitur and other mutants. Prolamine and glutelin contents were significantly lower than 'Kalitur' in all mutants except 'MACS 108'. Gupta *et al*[10] have studied protein

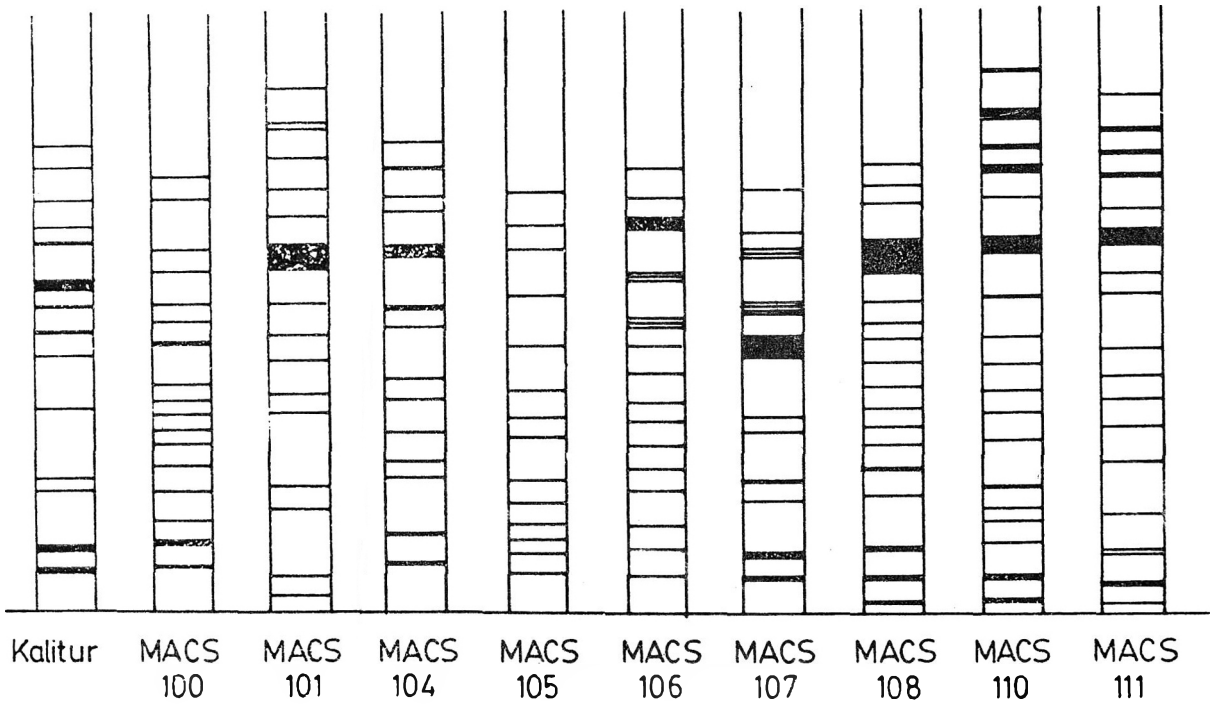

Fig. 1. Electrophoretic pattern of soybean protein.

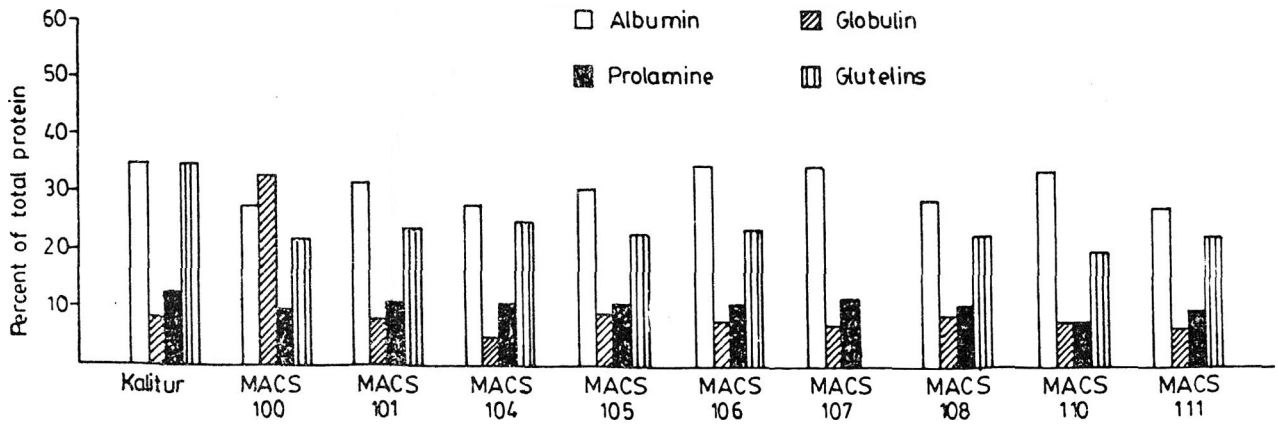

Fig. 2. Protein fractions of Kalitur and mutants depending upon solubility characteristics.

fractions in 7 soybean varieties. Results of the present studies for the per cent albumin and per cent globulin concur with their results. 'Kalitur' has shown higher per cent of prolamines and glutelins but the values for mutants are comparable to soybean varieties, Bragg', 'Ankur' and 'HM-1'.

Trypsin inhibitor assay: In Kalitur, it was of interest to find the effect of mutation on the trypsin inhibition activity. 't' test was used to compare performance of mutants for trypsin inhibition and was compared with 'Kalitur'. Trypsin inhibitor activity was significantly lower ($P < .01$) in 'MACS 107', by 15 per cent while 'MACS 101' showed significantly higher trypsin inhibition than 'Kalitur'. ($P < .01$) by 13 per cent. The performance of rest of the varieties was comparable.

Nutritive value: Energy value of 'Kalitur' and its mutants was estimated by analysis of per cent protein, per cent fat, per cent ash (Table 1). In general, it was seen that per cent fat is lower in most of the mutants whereas the per cent protein is higher than 'Kalitur' in 'MACS 106' 'MACS 107', 'MACS 108', 'MACS 110' and 'MACS 111' by 1 to 3 per cent. Energy content was lower than 'Kalitur' in 'MACS 104', 'MACS 105', 'MACS 106' and 'MACS 107' varieties.

The results indicate that mutation has introduced considerable changes in individual proteins as studied

TABLE 1. PROXIMATE COMPOSITION OF KALITUR AND ITS MUTANTS

Samples	Fat (%)	Crude protein (%)	Energy (kcal/100 g)
Kalitur	18.50	38.89	443
MACS 100	18.09	38.59	442
MACS 101	17.59	39.20	436
MACS 104	18.24	38.74	423
MACS 105	17.51	38.59	425
MACS 106	17.06	41.49	422
MACS 107	16.78	39.81	419
MACS 108	17.60	40.58	431
MACS 110	17.13	40.12	427
MACS 111	17.24	40.89	429
Mean	17.57	39.69	429.6
S.E.	0.55	0.63	8.41

by electrophoresis and solubility. A mutant variety 'MACS 107' has been generated having trypsin inhibitor activity lower by 15 per cent than 'Kalitur'.

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Studies on Utilization of Sweet Cream Buttermilk in the Manufacture of *Paneer*

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The possibilities of utilizing sweet cream buttermilk in the manufacture of *paneer* were studied. Buffalo milk was standardized to 5.9% fat by adding buttermilk and *paneer* prepared therefrom, referred to as buttermilk extended *paneer* (BEP), was compared with control *paneer* (CP). Addition of buttermilk significantly increased the moisture retention capacity of BEP, thereby increasing its yield by about 1 % over CP. The texture of CP made at 80°C was dry and hard which could be significantly improved by incorporating buttermilk solids. When coagulation of milk was done at 70°C, the recovery of total solids was significantly higher in BEP as compared with its counterpart CP whereas the other properties and keeping quality of two types of *paneer* did not differ appreciably. It was also possible to prepare good quality *paneer* from low fat milk (5.1%) by incorporating about 30% buttermilk solids to buffalo milk.

Buttermilk is an important dairy byproduct obtained during manufacture of creamery butter. It is estimated that approximately 200 million kg of buttermilk, containing more than 18 million kg milk solids, is produced in India every year. A scanty information on utilization of buttermilk [1–5] is probably not sufficient for its commercial adoption. Therefore, a major portion of buttermilk in our country is drained to the sewers. Only a small portion, which accounts nearly 8-10 per cent of total buttermilk production, is utilized by the organised dairies mainly for admixing with skim milk for spray drying. This may, however, alter the natural properties of skim milk powder[6], besides adversely affecting the keeping quality. However, spray drying is an expensive process and small scale buttermilk producing units cannot afford to adopt it. Therefore, there is a great need to explore a simple and economically viable method of utilizing buttermilk solids.

Paneer, an acid coagulated indigeneous milk product, is very popular in India particularly in the Northern parts. It is used as a base material for a variety of culinary dishes. For preparing good quality *paneer*, that conforms to the Prevention of Food Adulteration Act[7], buffalo milk is normally standardized to about 5.8 per cent fat [8-10]. Presently, skim milk is used for adjusting desired fat in buffalo milk. Since the gross chemical composition of sweet cream buttermilk closely resembles with skim milk, the former could also be used for standardization of buffalo milk for *paneer* manufacture. In this paper the effect of addition of different levels of sweet cream buttermilk on the physico-chemical characteristics, sensory quality, rheological properties and storage quality of *paneer* has been reported.

Materials and Methods

Buffalo milk: Buffalo whole milk, produced at the Institute's cattle yard and bulked after evening (stored overnight at 5°C) and morning milkings, was used in the present study. The average fat content of composite milk was 7.0 per cent.

Sweet cream buttermilk: The pasteurised (80°C for 16 sec) and overnight aged (8-10°C) buffalo cream of about 38 per cent fat was churned to obtain buttermilk. Dilution of cream and buttermilk was avoided at all stages of handling. The proximate composition of buttermilk was: fat, 0.5 per cent; solids-not-fat (SNF), 9.5 per cent and titratable acidity, 0.14 per cent.

Standardization of milk: Buffalo milk was standardized to two fat levels, i.e. (a) 5.9 (fat and SNF ratio, 1:1.66) and (b) 5.1 per cent (fat:SNF ratio, 1:1.85) by adding sweet cream buttermilk. About 18 per cent buttermilk (of the total quantity) was utilized in the former case and 30 per cent in the latter. For preparing control *paneer* (CP), buffalo milk was standardized to about 5.9 per cent fat (fat:SNF ratio, 1:1.67) by adding buffalo skim milk.

Preparation of paneer: The method suggested by Bhattacharya *et al.*[8] and subsequently modified by Sachdeva and Singh[9] was used for preparation of *paneer*. Coagulation of milk was achieved at two separate temperatures of 80°C and 70°C using

1 per cent hot citric acid solution (temperature of acid was equal to that of milk). After draining whey through a muslin cloth, the curd was filled in to a wooden hoop of 16 × 8 × 3 cm dimension (having holes on sides and bottom) lined with a clean cloth. Pressure was applied on the top of the hoop by putting 3 kg weight for 15 min. The pressed block of curd was removed from the hoop, cut into three pieces of equal size and immersed in chilled water (10-15°C) for 20 min followed by draining. The *paneer* samples were finally packaged in polyethylene bags (300 gauge) and stored in a refrigerator (7 ± 1°C). Three litres of milk was used for each batch.

Paneer prepared from buffalo milk standardized to 5.9 per cent fat using sweet cream buttermilk was referred to as Buttermilk Extended *Paneer* (BEP) and that prepared from 5.1 per cent fat referred to as Buttermilk Extended Low Fat *Paneer* (BELFP).

Chemical analysis of paneer *and whey*: The *paneer* samples were analysed for moisture, ash and titrable acidity as per the methods described in AOAC[11] for cheese. The fat content in *paneer* was determined by the Gerber method as recommended by ISI[12] and total protein (N × 6.38) by semi-micro-kjeldahl method suggested by Manefee and Overman[13]. The whey samples were analysed for total solids by AOAC method[11] and fat [14] and titratable acidity[15] by ISI methods. A digital pH meter was used for determining the pH of *paneer* slurry (10 g paneer plus 10 ml water) and whey samples.

Sensory evaluation of paneer: The fresh and stored samples of *paneer* were evaluated for flavour (aroma and taste), texture and appearance by a sensory panel consisting of 5 judges selected from the faculty of Dairy Technology Division. A 9-point Hedonic scale, wherin the descriptive terms were assigned numerical scores, as described by Amerine *et al.*[16] was used by the panelists.

Measurements of rheological properties: The texture profile analysis of *paneer* samples was done using an Universal Testing Machine (Instron, Model 4301) as per the method of Bourne[17]. The load cell of 100 Newtons (N) was used. The *paneer* samples of uniform size (2 × 2 × 2 cm dimension) were compressed to 20 per cent of thier original height using the cross head speed of 2 cm/min and the chart speed of 4 cm/min. All the measurements were done at 25°C.

Statistical analysis: The data on physico-chemical characteristics, yield, recovery and losses of solids, sensory evaluation and rheological properties were analysed for the Analysis of variance. The Duncan's New Multiple Range Test[18] was applied to separate the product means.

Results and Discussion

Chemical composition and yield of paneer: Table 1 shows the effect of addition of buttermilk and the temperature of coagulation on physico-chemical characteristics and yield of *paneer*. The moisture contents of control *paneer* (CP), buttermilk extended *paneer* (BEP) and buttermilk extended low fat *paneer* (BELFP) when manufactured at 80°C (HT) were 47.44, 50.85 and 53.15 per cent respectively. Such significant ($P < 0.05$) increase in moisture retention capacity of *paneer* by addition of buttermilk solids could be attributed to the presence of higher amount of lipoprotein materials, particularly the membrane proteins and phospholipids, which are considered to inherent much better water binding capacity than those of normal milk proteins[19]. The increase in water

TABLE 1. PHYSICO-CHEMICAL CHARACTERISTICS AND YIELD OF DIFFERENT TYPES OF *PANEER*

Type of *paneer*	Coagulation temp. (°C)	Moisture (%)	Fat (%)	FDM (%)	Protein (%)	Ash (%)	pH	Titrable acidity (%)	Yield (%)
Control	80(HT)	47.44^{e}	28.80^{c}	54.79^{a}	18.29^{a}	2.02^{a}	5.98^{a}	0.184^{b}	20.02^{a}
	70 (LT)	51.12^{bcd}	26.86^{a}	54.81^{a}	17.38^{bc}	2.00^{a}	5.96^{a}	0.192^{a}	21.00^{a}
Buttermilk extended	80 (HT)	50.85^{cd}	26.70^{a}	54.50^{a}	17.20^{cd}	1.87^{b}	6.07^{a}	0.182^{b}	21.27^{a}
	70 (LT)	51.99^{abc}	26.30^{a}	54.76^{a}	16.67^{d}	1.84^{b}	5.98^{a}	0.198^{a}	21.92^{a}
Buttermilk extended low fat	80 (HT)	53.15^{ab}	23.60^{b}	50.39^{b}	17.89^{ab}	1.84^{b}	6.05^{a}	0.182^{b}	21.07^{a}
	70 (LT)	53.84^{a}	23.34^{b}	50.54^{b}	17.61^{bc}	1.85^{b}	6.03^{a}	0.196^{a}	21.12^{a}
S Em (20 d.f.)		±0.75	±0.43	±0.41	±0.21	±0.04	±0.03	±0.003	±0.50

Mean values are based on five trials. HT = Higher temp of coagulation (80°C). LT = Lower temp of coagulation (70°C). The mean values with different superscript in each column differ significantly ($P < 0.05$) according to Duncan's New Multiple Range Test.

absorption capacity of breads by addition of buttermilk solids has been reported earlier[5]. CP had no buttermilk solids whereas BEP contained 18 per cent and BELFP 30 per cent. The decrease in coagulation temperature of milk to 70°C (LT) further improved the moisture retention capacity of *paneer*. The average moisture contents of CP (LT), BEP (LT) and BELFP (LT) were 51.12, 51.99 and 53.84 per cent respectively. The effect of temperature of coagulation was significant ($P<0.05$) on moisture retention in case of CP probably as a result of faster and more expulsion of whey from the curd at higher temperature resulting into decrease in moisture content. The effect was, however, not significant in case of BEP and BELFP. This further confirms that buttermilk solids have better water holding capacity.

A significantly ($P < 0.05$) low fat in BELFP was obvious because of the use of low fat milk (5.1 per cent) for its preparation in comparison with CP and BEP (5.9 per cent fat). The percentage fat of CP (HT) was significantly ($P < 0.05$) higher than CP (LT) and BEP mainly because of the difference in moisture levels otherwise on dry matter basis (FDM) there was no difference in their fat contents. As per the PFA rules[7], the FDM in *paneer* shall not be less than 50 per cent. CP and BEP easily met this legal requirement but BELFP was just a border case which contained 50.39 per cent (HT) and 50.54 per cent (LT) FDM. These results, corroborated with earlier report[10], indicate that buffalo milk intended for *paneer* manufacture shall not have less than 5.1 per cent fat or fat and SNF ratio not more than 1:1.85

The protein content of different types of *paneer* also varied slightly on as-is basis. The highest protein value (18.29 per cent) was observed in CP (HT) and the lowest (16.67 per cent) in BEP (LT). However, on dry basis the protein contents of CP and BEP were almost similar whereas of BELFP slightly higher probably because of less fat. A significantly ($P < 0.05$) low ash contents were noticed in BEP and BELFP in comparison with CP. Such a difference could be attributed to either less ash percentage in buttermilk than that of skim milk[6] or perhaps due to more acid solubilization of minerals during coagulation and their subsequent drainage into whey in the manufacture of BEP and BELFP. The ash contents of BEP and BELFP were of the same order. The temperature of coagulation did not have a significant effect on ash content. Neither pH nor acidity of BEP and BELFP differed significantly from that of CP. However, the acidity of *paneers* at 70°C (LT) was significantly ($P < 0.05$) higher than those prepared at 80°C (HT) which could perhaps be due to use of more amount of coagulant at lower temperature of coagulation.

The yield of CP (HT) was 20.02 per cent which increased by about 1 per cent by addition of buttermilk solids. The yields of all three types of *paneers* also increased by adopting lower temperature for coagulation of milk mainly because of retention of higher moisture. These results are in agreement with earlier workers[8,20].

Recovery and losses of solids: The percentage recovery of total solids and fat in *paneer* and their losses in whey are given in Table 2. The average recovery of total solids varied between 64.86 and 66.53 per cent, the maximum being in BEP (LT) and the minimum in CP (LT). The recovery of total solids was significantly ($P < 0.05$) higher in CP (HT) in comparison with CP (LT) which was in agreement with earlier findings[9,10]. These trends were, however, reversed by addition of buttermilk solids where the recovery of total solids was non-significantly ($P < 0.05$) higher at lower temperature of coagulation. There was no significant difference between the total solids recovery of CP (HT) and BEP (HT and LT). The recovery of fat in different types of *paneer* did not differ significantly and so also the losses of total solids in whey. The fat losses in whey was highest (4.32 per cent) in BELFP (HT) and the lowest (2.18 per cent) in

TABLE 2. PERCENTAGE RECOVERY AND LOSSES OF SOLIDS DURING MANUFACTURE OF DIFFERENT TYPES OF *PANEER*

Types of *paneer*	Coagulation temp. (°C)	Recovery of solids in paneer (%)		Losses of solids in whey (%)	
		Total solids	Fat	Total solids	Fat
Control	80	65.92^{ab}	95.80^{a}	32.32^{a}	3.30^{ab}
	70	64.86^{c}	96.10^{a}	33.23^{a}	2.57^{b}
Buttermilk extended	80	65.87^{abc}	95.43^{a}	32.54^{a}	3.42^{ab}
	70	66.53^{a}	96.35^{a}	32.04^{a}	2.18^{b}
Buttermilk extended low fat	80	64.98^{bc}	94.33^{a}	33.06^{a}	4.32^{a}
	70	65.35^{bc}	94.73^{a}	32.66^{a}	3.01^{ab}
SEm (20 d.f.)		±0.32	±0.59	±0.42	±0.47

Foot note as in Table 1.

TABLE 3. SENSORY SCORES OF DIFFERENT TYPES OF *PANEER*

Types of paneer	Coagulation temp (°C)	Flavour	Texture	Appearance
Control	80	7.73[a]	6.76[c]	7.92[a]
	70	7.61[ab]	7.68[a]	7.95[a]
Buttermilk extended	80	7.68[a]	7.46[b]	7.94[a]
	70	7.57[ab]	7.69[a]	8.00[a]
Buttermilk extended low fat	80	7.48[b]	7.68[a]	7.88[a]
	70	7.45[b]	7.72[a]	7.89[a]
SEm (20 d.f.)		±0.05	±0.05	±0.06

Foot note as in Table 1.

Key to scores: Like extremely 9; Like very much 8; Like moderately 7; Like slightly 6; Undecided 5; Dislike slightly 4; dislike very much 3; Dislike moderately 2 and Dislike extremely 1.

BEP (LT). In general, the losses of fat in whey decreased at lower temperature of coagulation.

Sensory evaluation: The mean flavour scores of CP and BEP did not differ significantly from each other at either temperature of coagulation, but BELFP got significantly ($P < 0.05$) lower score in comparison with CP (HT) and BEP (HT) (Table 3) which could be due to low fat percentage rather than the use of higher amounts of buttermilk solids. However, at coagulation temperature of 70°C (LT), there were no significant differences in flavour scores of CP, BEP and BELFP. On the basis of likings of penelists, the flavour of all *paneer* samples was liked moderately (mean scores ranged between 7.45 and 7.73).

The mean texture score of CP (HT) was 6.76 which was significantly ($P < 0.05$) lower than other types of *paneer* (Table 3). Such paneer was characterised with dry and hard texture which could be mainly due to low moisture content in this *paneer* (Table 1). Probably on this account, the texture score of BEP (HT) was also significantly ($P < 0.05$) lower than other types. There were however no significant differences in the mean texture scores of CP (LT), BEP (LT) and BELFP (HT and LT). Except CP (HT), the texture of all other *paneers* was liked moderately by all the panelists. The appearance of different types of *paneer* did not differ significantly. Sachdeva and Singh[9] also observed that good quality *paneer* could not be prepared by coagulating milk at higher temperature. These workers[21] suggested the use of hydrocolloids to improve the moisture retention capacity of *paneer* at higher temperature of coagulation. The present study reveals that the coagulation of milk can be done upto 80°C by just adding buttermilk to buffalo milk.

Rheological properties: The texture profile analysis data (Table 4) revealed that there were no significant differences in cohesiveness, springiness and chewiness properties of CP, BEP and BELFP. The effect of temperature of coagulation was also non-significant on these rheological properties. The hardness of CP (HT) was, however, significantly ($P < 0.05$) higher than all other types of *paneer*. This could mainly be because of very low moisture content in this *paneer*. There was no significant difference in the hardness of BEP (HT) and BELFP (HT). Coagulation of milk at 70°C (LT) significantly ($P < 0.05$) decreased the hardness

TABLE 4. RHEOLOGICAL PROPERTIES OF DIFFERENT TYPES OF *PANEER*

Types of *paneer*	Coagulation temp (°C)	Hardness (Newton)	Cohesiveness	Springiness (mm)	Gumminess (Newton)	Chewiness (Newton mm)
Control	80	12.56[c]	0.720[a]	10.32[a]	9.05[a]	93.56[a]
	70	9.72[ab]	0.699[a]	10.80[a]	6.82[b]	73.59[a]
Buttermilk extended	80	11.12[a]	0.718[a]	10.30[a]	8.00[ab]	82.92[a]
	70	9.59[b]	0.707[a]	10.92[a]	6.78[b]	74.10[a]
Buttermilk extended Low fat	80	10.62[ab]	0.715[a]	10.88[a]	7.61[b]	82.53[a]
	70	9.77[ab]	0.706[a]	11.20[a]	6.90[b]	77.62[a]
SEm (20 d.f.)		±0.46	±0.006	±0.50	±0.38	±4.69

Foot note as in Table 1.

in case of CP and BEP but there was no significant difference in the hardness of BELFP made at two different temperatures. These results could also be corroborated with the sensory scores on texture. The gumminess in CP (HT) was also significantly ($P < 0.05$) higher than all other *paneer*, with the exception of BEP (HT) which was non-significant. The gumminess in BEP (HT) and BELFP (HT) was of the same order. The temperature of coagulation had no significant effect on gumminess of BEP and BELFP but in case of CP it significantly ($P < 0.05$) decreased by lowering the temperature of coagulation.

Keeping quality: *Paneer* is invariably stored under refrigeration conditions. Hence, the storage studies on *paneer* in the present investigation were carried out at 7 ± 1°C (refrigerator). The changes observed in respect of pH. titratable acidity and organoleptic quality have been presented in Table 5. The average initial pH values of three types of *paneer*, ranging between 5.96 and 6.07, showed increasing trends in all the samples throughout the storage period. The titratable acidity of all the samples also increased during storage. The rate of increase in acidity appeared to be faster in BELFP as compared with CP and BEP probably because of higher moisture content. The proteolytic and lypolytic changes during storage were perhaps responsible for increase in pH and acidity of *paneer*. Sachdeva and Singh[9] with the help of electrophoretic studies have shown that breakdown of α-s and β-caseins into several fast moving components indicating a very high degree of proteolysis taking place in *paneer* during storage.

The flavour, texture and appearance scores of all the paneer samples showed a gradual decreasing trend up to 9 days of storage and there after an abrupt fall in scores of all the sensoric properties. All three types of

TABLE 5. CHANGES IN PH, ACIDITY AND SENSORY QUALITY OF DIFFERENT TYPES OF *PANEER* DURING STORAGE AT 7 ± 1°C

Storage period (days)	Control		Buttermilk extended		Buttermilk extended low fat	
	80°C	70°C	80°C	70°C	80°C	70°C
			PH			
0	5.98	5.96	6.07	5.98	6.05	6.03
4	6.02	5.98	6.08	6.01	6.07	6.06
7	6.05	6.04	6.13	6.09	6.11	6.10
9	6.11	6.08	6.18	6.16	6.16	6.17
11	6.14	6.13	6.21	6.19	6.18	6.20
			Acidity (% lactic acid)			
0	0.184	0.192	0.182	0.200	0.182	0.196
4	0.200	0.210	0.200	0.212	0.200	0.216
7	0.228	0.242	0.218	0.228	0.224	0.240
9	0.256	0.272	0.262	0.264	0.256	0.274
11	0.308	0.328	0.312	0.336	0.335	0.345
			Flavour scores			
0	7.73	7.61	7.68	7.57	7.49	7.45
4	7.54	7.48	7.50	7.48	7.25	7.25
7	7.10	7.04	7.06	6.98	6.82	6.70
9	6.57	6.12	6.14	6.10	6.04	6.00
11	4.90	4.60	4.60	4.40	4.40	4.40
			Texture scores			
0	6.76	7.68	7.46	7.69	7.68	7.74
4	6.50	7.45	7.20	7.20	7.40	7.25
7	6.40	7.10	7.04	6.95	6.80	6.50
9	6.10	6.55	6.40	6.25	6.30	6.27
11	5.40	5.80	5.60	5.80	5.80	5.70
			Appearance scores			
0	7.95	7.95	7.94	8.00	7.88	7.89
4	7.65	7.65	7.70	7.63	7.50	7.55
7	7.10	7.15	7.10	7.13	7.10	7.00
9	6.15	6.20	6.15	6.10	6.05	6.00
11	4.70	4.30	4.25	4.10	4.15	4.05

Values are average of five trials.
Key to the scores as in Table 3

paneer were fairly acceptable (average sensory score about 7) upto 7 days and slightly acceptable (average score about 6) upto 9 days of storage. The major symptoms of spoilage were the development of a putrefactive odour accompanied by surface spoilage. Initially, the surface became wet and greasy but with the advance of storage period, discolouration and formation of yellowish slime started. The interior of *paneer*, however, did not show any sign of spoilage throughout the storage. It indicates that the contamination of surface is the main starting point in spoilage of *paneer*. Some earlier workers[8,22] observed that *paneer* could be kept good for only 6 days at 10°C although it started loosing freshness on the 3rd day. A slightly better shelf life in the present case could be due to lower storage temperature and perhaps improved hygienic practices during handling of *paneer*.

It is concluded that the standardization of buffalo milk with sweet cream buttermilk and preparation of *paneer* therefrom offered many advantages. It improved the moisture retention capacity thereby increasing the yield by about one percent over the control *paneer*. It also helped in producing *paneer* of good texture at higher temperature of coagulation (80°C) which was not possible in conventional process. The storage quality of buttermilk extended *paneer* was not inferior to control *paneer*. Above all, it would make possible the economic utilization of buttermilk solids.

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Effect of Postmortem Chilling and Sheep Carcass Conditioning on Extractability and Fractions of Muscle Proteins

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Eleven Bannur ewes (age: 4-5 yr, live wt. 22.30 ± 2.0 kg) were sacrificed and carcasses slit vertically into two halves. The half-carcasses were subjected to either (i) Achilles tendon suspension at 2-3°C for 24 hr (direct chilling C_1), (ii) Pelvic suspension at 26 ± 2°C for 7 hr (7 hr, RT), (iii) Pelvic suspension at 26 ± 2°C for 7 hr followed by chilling at 2-3°C for 17 hr (delayed chilling, C_2) or (iv) left untreated (fresh, F). Semi-membranosus and semi-tendinosus (thigh) muscles of F-, 7 hr RT-, C_1 and C_2-carcasses as well as neck muscle held at 2-3°C were used for the study. The results revealed that during postmortem chilling the extractability of muscle proteins in buffer of ionic strength μ = 0.55 decreased initially upto 6 hr followed by slight increase at 25 hr postmortem and these changes were primarily due to changes in myofibrillar fraction. Contraction/stretching of muscles due to carcass conditioning treatments had a marginal ($P < 0.05$) effect on extractability in buffer of high ionic strength (μ = 0.55) as well as in alkali, whereas extraction in buffer of low ionic strength (μ = 0.05) was significantly ($P < 0.05$) lower in 7 hr RT and C_2-muscles due to partial denaturation of sarcoplasmic proteins.

Extractability of muscle proteins has been studied as an indicator of structural alterations in meat during postmortem aging and attempts have been made to correlate solubility and quantities of protein fractions to meat tenderness. Sayre[1] noticed that sarcoplasmic protein, non-protein nitrogen and stromal protein remained constant during 24 hr postmortem chilling of chicken muscle. On the other hand, Mahendrakar and Moorjani[2] reported that extractability was the same at 1 hr and 4 hr postmortem which markedly increased at 24 hr. Progressive loss of tensile strength of myofibrillar component of muscle (bovine) results into weakening and final dissolution of Z-band structures[5] and such disintegration leads to changes in extractabilities of myofibrillar proteins and meat tenderness[4,5]. Chaudhry *et al.*[6] suggested that the tenderization may be due, in part, to temperature dependent non-proteolytic alterations in the contractile apparatus. Postmortem conditioning treatments of ewe carcasses exert different restraining influence on thigh muscles, resulting into contraction or stretching of muscles and these changes have significant bearing on meat tenderness as reported recently[7,8]. The present investigation was designed to study the changes in extractability and fractions of muscle proteins during postmortem chilling and conditioning of sheep carcasses at ambient temperature prevalent in tropical regions so that they could be correlated to changes in meat texture.

Materials and Methods

The experiment was planned according to completely randomised design with unequal number of replicates. Eleven Bannur ewes (age: 4-5 yr, live wt. 22.3 ± 2.0 kg) were sacrificed and carcasses were slit vertically into two halves. Left halves of 5 carcasses were unconditioned (F) and right halves were subjected to C_1 treatment[8]. Left halves of remaining six carcasses were suspended by pelvis at RT (26 ± 2°C) for 7 hr (7 hr RT) and the right halves subjected to C_2-treatment[8]. Semi-membranosus (SM) and semitendinosus (ST) muscles (of thigh) from F-, 7 hr RT-, C_1- and C_2-carcasses were then minced separately. Neck cuts of 6 Bannur ewes (age: 4-5 yr), removed within 30 min postmortem, were procured from the local slaughter house. The cut in low density polythene pouch was stored at 2-3°C, sampled periodically and minced.

Extraction method: Muscle mince was blended with KCl-PO_4 buffer (μ = 0.55) and centrifuged[2]. The centrifugate was diluted (1:10) to μ = 0.05 to retain sarcoplasmic and non-protein nitrogen (NPN) in solution[9]. All fractions of muscle nitrogen except stroma were extracted in 0.1 N NaOH solution[10]. Nitrogen contents in muscle mince (TN) and in extracts and NPN[2] were estimated by Kjeldahl procedure. Fractions of sarcoplasmic, myofibrillar and stroma were calculated as:

Sarcoplasmic N = N in buffer (μ = 0.05) extract - NPN

Myofibrillar N = N in 0.1N NaOH extract-N in buffer (μ = 0.05 extract

Stromal N = Total N - N in 0.1N NaOH extract.

Statistical analyses: The results were analysed by using analyses of variance technique appropriate to the design[11] and Duncan's New Multiple Range test[12] was used to segregate the treatment means.

Results and Discussion

(i) Changes during postmortem chilling: The extraction in KCl-PO_4 buffer (pH 7.5), μ = 0.55, decreased initially upto 6 hr postmortem compared to pre-rigor value at 1 hr postmorten indicating the onset of rigor mortis. This value then slightly ($P > 0.05$) increased at 25 hr postmortem (Fig. 1). The extractions in buffer of lower ionic strength (μ = 0.05) and in 0.1N NaOH solution were found to be unaltered ($P > 0.05$) during chilling upto 25 hr. These findings indicate that mainly myofibrillar (contractile) proteins undergo some changes during 25 hr postmortem chilling of muscle.

The quantities of muscle N fractions, viz., sarcoplasmic, myofibrillar, stroma as well as NPN however, were found to be not significantly ($P > 0.05$) affected by postmortem chilling on account of greater animal to animal variations. The slight increase in myofibrillar fraction at 25 hr could be attributed to the concomitant decrease in other protein fractions (Sarcoplasmic and stroma) (Fig. 2).

Increased extractability of muscle N during postmortem chilling has been reported in chicken muscles[2]. This increase was primarily due to changes in myofibrillar fraction in chicken[1,13] as well as bovine muscles[14].

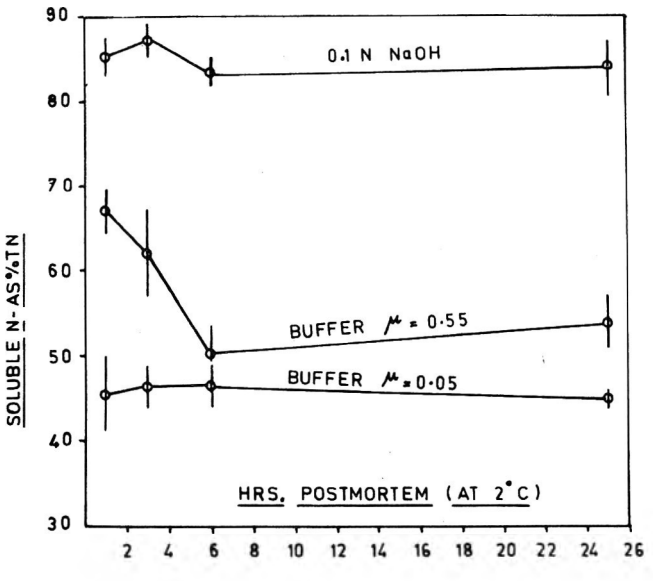

Fig. 1. Extractability of muscle proteins as a function of postmortem chilling hours (Neck Muscle of Bannur Ewe)
Vertical bar indicates standard deviation

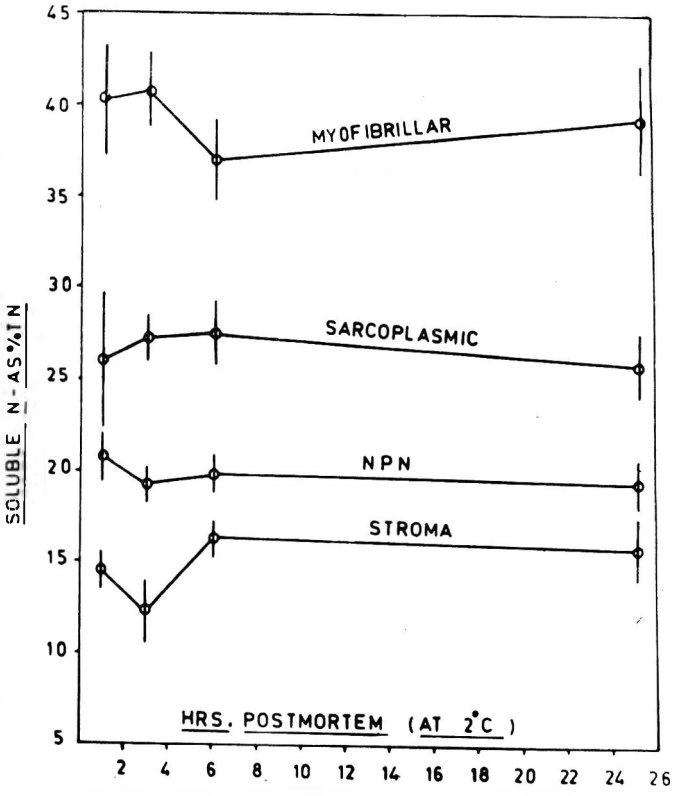

Fig. 2. Variations in muscle N-Fractions as a function of postmortem chilling hours.
(Neck muscle of Bannure Ewe)
Vertical bar indicates standard deviation

(ii) Effect of conditioning treatments: The extraction in buffer of μ = 0.55 was found to be marginally ($P > 0.05$) higher in conditioned (C_1 and C_2) and lower in 7 hr RT- muscles compared to pre-rigor (F) values (Table 1). This was due to greater animal to animal variation. Observation of results of each animal (not given) indicated that in each case the extraction was higher in C_1-muscles compared to (opposite side) F-muscles as also in C_2-muscles compared to counterpart muscles dissected out at 7 hr RT. These findings clearly indicate that the increase in extractability is due to postmortem storage period and not due to contraction or stretching of muscles affected by different methods of carcass suspension[8].

The extraction in buffer of low ionic strength (μ = 0.05) was significantly ($P < 0.05$) lower in C_2 and 7 hr RT-muscles compared to F- and C_1 muscles and no differences ($P>0.05$) were noticed among F- and C_1 muscles (Table 1). NPN fraction remained unaltered ($P < 0.05$) due to conditioning treatments (C_1, C_2 and 7 hr RT) (Table 2) indicating thereby that the sarcoplasmic proteins were partially denatured under the conditions of high temperature ($26 \pm 2°C$) and relatively lower pH values[7,8] making them insoluble. Among the muscles, the degree of denaturation was found to be greater in ST than in SM muscle.

TABLE 1. EXTRACTABILITY OF MUSCLE PROTEINS
(Soluble nitrogen as % TN)

		Extractability in KCl-PO_4 buffer, pH 7.5		0.1N NaOH
		μ = 0.55	μ = 0.05	
F	SM	69.30(5)^{abc}	46.67(5)^{a}	95.19(5)^{abc}
	ST	69.42(5)^{abc}	50.03(5)^{a}	94.07(5)^{bc}
7 hr RT	SM	66.07(5)^{c}	40.00(6)^{b}	95.24(6)^{abc}
	ST	67.79(4)^{bc}	35.73(6)^{b}	92.85(6)^{c}
C_1	SM	74.20(5)^{ab}	47.98(5)^{a}	98.13(5)^{a}
	ST	77.04(5)^{a15}	48.41(5)^{a}	96.98(5)^{ab}
C_2	SM	73.90(4)^{abc}	40.20(6)^{b}	96.58(6)^{ab}
	ST	75.30(4)^{ab}	36.05(6)^{b}	96.46(6)^{ab}
	SD	±5.34 (29 df)	±4.77 (36 df)	±2.43 (36 df)

Figures in parenthesis indicate the number of animals used. Means of the same column followed by different superscipts differ significantly (P < 0.05) according to Duncan's New Multiple Range Test.

In respect of extraction in 0.1N alkali, the marginal (P > 0.05) increase was noticed in conditioned (C_1 and C_2)-muscles compared to F-muscles. At 7 hr RT the extractability was lowest (P < 0.05) in ST muscle (Table 1).

These changes in extractabilities in buffer as well as alkali have resulted into quantitative differences in muscle N-fractions. The sarcoplasmic N-fraction was found to be significantly (P > 0.05) lower in C_2- and 7 hr RT-muscles compared to F-values but not affected (P > 0.05) by direct chilling (C_1) (Table 2). This is due to partial denaturation of sarcoplasmic proteins as indicated earlier. The denaturation of sarcoplasmic proteins at high temperature (37°C) and at pH below 6.0 has been reported by Scopes[15] in ox muscle.

The decrease (P < 0.05) in sarcoplasmic protein content has resulted into substantial (P < 0.05) increase in myofibrillar fraction in C_2 and 7 hr RT-muscles. Stroma fraction was in the range of 5-6 per cent of TN in pre-rigor (F) muscles which decreased to about 2 per cent in TN in chilled (C_1-) muscles (Table 2). The collagen content, the major protein of stroma fraction, in these muscles of aged ews, was in the range of 3-4 per cent of total protein[7,16] implying thereby that the weakening of fibrous protein linkages with stroma as well as the disintegration of stroma fraction itself have occurred in muscles during postmortem chilling[3].

In conclusion, extractability of muscle proteins in buffer of μ = 0.55 decreased during postmortem chilling upto 6 hr followed by slight increase at 25 hr postmortem and these changes were primarily due to changes in myofibrillar fraction. Contraction/stretching of muscles due to carcass conditioning treatments had marginal (P < 0.05) effect on extractability in buffer of high ionic strength (μ = 0.55) as well as in alkali whereas extraction in buffer of low ionic strength (μ = 0.05) was significantly (P < 0.05) lower in muscles from carcasses subjected to accelerated conditioning (7 hr RT and C_2) due to partial denaturation of sarcoplasmic proteins.

TABLE 2. EFFECT OF CARCASS CONDITIONING ON MUSCLE NITROGEN FRACTIONS

		Total N (g/100 g muscle)	NPN (% of TN)	Sarcoplasmic N (% of TN)	Myofibrillar N (% of TN)	Stromal N (% of TN)
F	SM	3.35(5)^{a}	13.23(5)^{a}	33.44(5)^{a}	48.56(5)^{ab}	5.44(4)^{abc}
	ST	3.19(5)^{a}	13.14(5)^{a}	36.64(5)^{a}	44.30(5)^{a}	6.34(5)^{ab}
7 hr RT	SM	3.24(6)^{a}	13.29(6)^{a}	26.71(6)^{b}	54.73(6)^{bcd}	4.76(6)^{abcd}
	ST	3.14(6)^{a}	12.98(6)^{a}	22.74(6)^{b}	57.81(5)^{cd}	4.61(6)^{a}
C_1	SM	3.32(5)^{a}	12.31(5)^{a}	33.61(4)^{a}	50.15(5)^{abc}	2.25(4)^{cd}
	ST	3.27(5)^{a}	12.38(5)^{a}	35.90(5)^{a}	47.49(5)^{ab}	1.99(5)^{d}
C_2	SM	3.24(6)^{a}	12.91(6)^{a}	27.30(6)^{b}	56.38(6)^{cd}	2.52(5)^{cd}
	ST	3.15(6)^{a}	13.11(6)^{a}	22.95(6)^{b}	60.40(6)^{d}	3.54(6)^{bcd}
SD		±0.14 (36 df)	±1.25 (36 df)	±4.99 (35 df)	±5.54 (35 df)	±2.16 (33 df)

Figures in parenthesis refer to the number of animals used.

Means in the same column followed by different superscripts differ significantly (P<0.05) according to Duncan's New Multiple Range Test.

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Effect of Accumulated Free Fatty Acids on Reduction of Salt Soluble Proteins of Pomfret and Seer Fish During Frozen Storage

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The effect of free fatty acids (FFA) released during frozen storage of pomfret and seer fish on the extractability of salt soluble proteins (SSP) was determined. The FFA content increased rapidly accompanied with marked decrease of phospholipids during frozen storage. There was a gradual decrease in the salt soluble protein throughout the period of storage, this decrease was faster during the first 30 days and gradual thereafter. SSP content appeared to level off beyond 150 days. Correlation between the decrease in SSP and increase in FFA showed that the FFA released during storage caused protein denaturation.

Dyer and Morton[1] were the first to report that FFA formed by the hydrolysis cause protein inextractability. Dyer *et al*[2]., Dyer and Fraser[3] and Ohshima *et al*[4]. pointed out that a large amount of free fatty acids released from phospholipids (PL) by the action of lipolytic enzyme were concerned with this protein denaturation. On the other hand, Olley *et al*[5]. and Olley and Duncan[6] reported that there was no distinct relationship between the rates of increase in the contents of FFA and of denaturation of fish protein, and that protein denaturation progressed at higher rate in the fish species with higher percentage of $C_{22:6}$ in the FFA liberated during frozen storage. It was shown that addition of small amount of linoleic and linolenic acids resulted in rapid insolubilization of cod actomyosin[7] and of sardine and prawn[8].

The present paper reports the effect of FFA released during frozen storage on protein solubility in seer fish and pomfret with varying amounts of total lipids.

Materials and Methods

Two species of marine fish *viz:* seer fish (*Scomberomorus guttatus*) and pomfret (*Pampus argenteus*) were purchased from Mangalore fish market in November 1984 and transported to the laboratory in iced condition. One inch thick steaks were made and immediately frozen in a coil freezer. Five hundred g of steaks were packed in polyethene bags and stored at -20 ± 2°C.

Total lipids (TL) were extracted from the minced meat sample according to the method of Bligh and Dyer[9]. To the total lipid (TL) extract, BHA at 0.1 per cent was added as an antioxidant and preserved at -18°C until further analysis. Separation of phospholipid (PL) and neutral lipid (NL) from TL was carried out by column chromatography using silicic acid (100-200 mesh Sisco. Lab.). PL was quantified according to Fiske and Subba Rao[10] and NL gravimetrically. Extraction, preservation and fractionation were done under an inert atmosphere of nitrogen.

FFA content was determined by the method of Takagi *et al*.[11]. Extraction of salt soluble proteins was according to Dyer *et al*.[12] Protein content in the extract was determined using the method of Gornoll *et al*.[13]

Correlation coefficients and respective regression equation were found out between FFA and SSP for seer fish and Pomfret using HCL - 80 I computer, Basic-II language and using 'REGGANAL' programme.

Results and Discussion

A decrease of PL (15.98 to 11.58 per cent) and a corresponding increase in NL (84.02 to 88.42 per cent) were seen in seer fish during 180 days in frozen storage whereas same trend in pomfret was from 7.03 to 3.40 per cent and 92.97 to 96.60 per cent respectively (Table 1).

The FFA content of seer fish and pomfret during 180 days of frozen storage is presented in Table 2. There was a steady increase in FFA content in both the species. In case of seer fish, the FFA increased by 127 per cent from an initial value of 2.55, while in pomfret the same increased to 269 per cent from the initial level.

In seer fish, the increase in FFA was quite apparent upto 60 days from the day of storage which was

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TABLE 1. CHANGES IN THE CONTENTS OF TOTAL LIPID (TL), PHOSPHOLIPID (PL) AND NEUTRAL LIPID (NL) OF SEER FISH AND POMFRET DURING FROZEN STORAGE AT -20°C

Storage period (days)	Seer fish				Pomfret			
	TL (g%)	PL (g%)	NL (g%)	NL (% of TL)	TL (g %)	PL (g %)	NL (g %)	NL (% of TL)
0	4.18	0.667	3.51	84.02	9.29	0.653	8.60	92.97
30	3.81	0.568	3.24	85.09	10.73	0.677	10.00	93.69
60	4.10	0.569	3.53	86.11	10.01	0.497	9.50	95.08
90	3.82	0.506	3.31	86.74	10.23	0.446	9.78	95.64
120	4.13	0.535	3.60	87.03	10.29	0.418	9.87	95.93
150	3.77	0.456	3.21	87.90	10.46	0.455	10.00	96.03
180	3.56	0.412	3.10	88.42	10.32	0.350	9.85	96.60

TABLE 2. CHANGES IN THE FREE FATTY ACID AND SALT SOLUBLE PROTEIN CONTENT OF SEER FISH AND POMFRET DURING FROZEN STORAGE AT 20°C

Storage period (days)	Seer fish		Pomfret	
	FFA %	SSP %	FFA %	SSP %
0	2.55	9.55	2.12	9.06
15	3.57	9.45	2.30	8.82
30	3.91	8.49	2.57	7.45
45	4.52	8.38	3.04	7.12
60	4.88	7.71	3.82	6.93
90	5.23	7.64	5.29	6.64
120	5.42	7.33	6.65	6.48
150	5.62	6.83	7.09	6.01
180	5.79	6.14	7.82	5.98

FFA : As of oleic acid/100 g lipid.
SSP : in g/100 g tissue.

91.35 per cent but after 90 days of storage the FFA appeared to level off. In the case of pomfret, there was a gradual increase in the FFA percentage till 60 days but later the increase was more pronounced and reached a level of 268.8 percent. Srikar and Hiremath[14] observed an increase in FFA level in oil sardine during 112 days in cold storage (-20°C) from an initial value of 1.4 to 4.4. Ohshima *et al*[15] demonstrated that in skipjack tuna, a lean fish with low content of TL (0.73 per cent) FFA were released by endogenous lipolytic enzymatic system. They attributed hydrolysis of lipids mainly due to phospholipase activity. Phosphotidyl choline (PC) being the major component hydrolysed during frozen storage Further, they observed an increase in FFA from 20 mg to 176.6 mg per cent during 112 days in cold storage (-20°C).

The initial SSP contents of 9.55 and 9.06 per cent in seer fish and pomfret respectively decreased to 6.14 and 5.98 per cent respectively (Table 2) during the frozen storage of 180 days. The decrease was faster during the first 30 days, gradual thereafter. But in pomfret SSP content appeared to level off beyond 150 days.

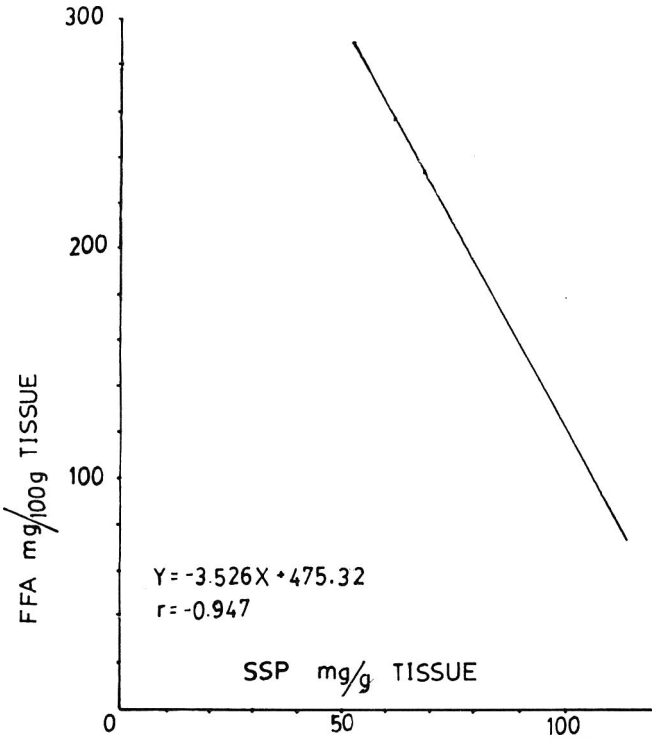

Fig. 1. Regression equation of FFA on SSP in seer fish during frozen storage.

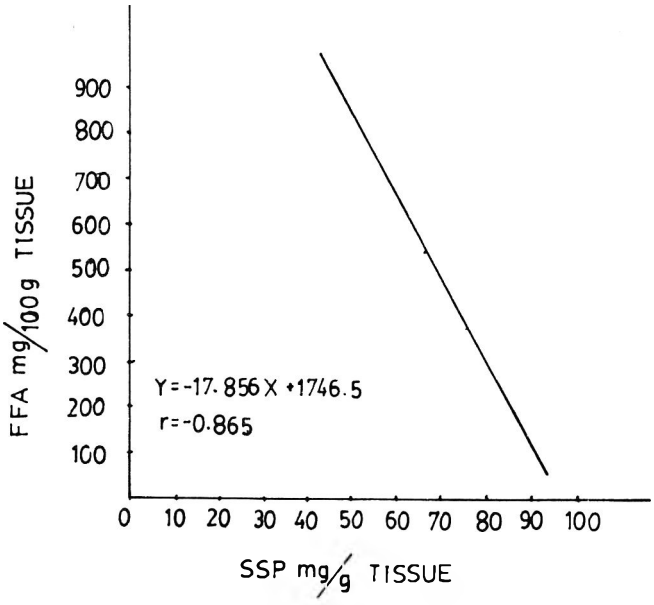

Fig. 2. Regression equation of FFA on SSP in pomfret during frozen storage.

In the present study, SSP decreased to the extent of 35.7 and 34.0 per cent of the initial value in seer fish and pomfret respectively, compared to these, the reported values 16-18 were on the higher side.

The results shown in Fig. 1 and 2 suggest the linear relationship between SSP and FFA of seer fish and

pomfret respectively, indicating high negative correlation between the two variables. This correlation was found to be significant at 5 per cent level. From the plot, an equation, Y = -3.526 × +475.32 for seer fish and Y = −17.856 × +1746.5 for pomfret was obtained. The correlation coefficient (r) for seer fish was −0.947 and for pomfret was −0.865. When these two plots are compared, it is observed that the rate of change of salt soluble protein value for a unit change in free fatty acid is approximately five times higher in pomfret than in seer fish. This indicates that in pomfret, a fatty fish, the accumulated FFA is more pronounced in bringing about the denaturation of proteins as compared with semi fatty seer fish. Ohshima *et al.*[4] observed a definite negative interrelation between the FFA content and the SSP extractability in cod. The results obtained in the present investigation strongly support the presumption that FFA accumulated enzymatically in the flesh during frozen storage plays a significant role in the denaturation of myofibrillar proteins.

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Quality Characteristics of Noodles Enriched with Salt Extracted Fish Protein

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Protein (fish protein isolate) enriched noodles prepared from wheat flour and pregelatinized tapioca starch in different compositions were assessed for cooking quality and compared with some commercially available noodles. Wheat flour noodle with 3% fish protein was found more acceptable in respect of overall quality. High cooking losses were observed for noodles containing pregelatinized tapioca starch.

Noodle is usually prepared from wheat flour and water as the main components[1]. In dough, the role of protein is critical even it may be only a small fraction of the food products[2]. Both protein content and its quality are important in determining the mechanical properties of dry pasta and the quality of cooked pasta[3]. Earlier studies carried out to estimate the quality of pasta using wheat flour of varying protein levels report that in all cases with varying wheat flour, the cooking quality is improved with higher protein content[4,5]. Compared to low protein noodles, high protein noodles are darker, stronger and internally firmer when cooked[5].

Besides wheat flour, others like tapioca flour, groundnut flour, rice flour etc., and various seasonal products like spinach, tomato can be added in noodle for fortification and/or improvement of its flavour[1,6-10]. Among the protein fortifying materials, egg is widely accepted and adopted since long. Among the various sources of proteins used, Matsuo *et al.*[4] reported that the most pronounced improvement in cooking quality was obtained with egg albumin. In noodle and pasta, incorporation of fish protein in the form of solvent extracted fish protein concentrate was reported by several workers[4,11,12]. Matsuo *et al.*[4] reported that fish protein concentrate when added to Semolina acts as inert filler in spaghetti and as a result cooking quality was impaired. On the other hand, Yang *et al.*[12] opined that in textural parameters (viz., hardness, cohesiveness and gumminess) of noodles, there were no marked differences between cooked noodles from wheat flour and composite flour containing 3 or 5 per cent file fish protein concentrate. In studying hydration[13], we have seen that extent of water binding per unit surface area of myosin isolated from fish by salt solution is of the same order of magnitude with that of egg albumin. Moreover, such myosin is found to bind with other globular and fibrous proteins as well as with long chain amphiphiles, the extent of which is determined by the factors such as pH, temperature, presence of salts etc[14]. The fact is generally accepted that free flour lipids mainly bind to flour protein during dough mixing[15]. Considering these functionalities, the purpose of the present work is to check the suitability of such protein isolated from fish as an enriching material for noodle. Noodles were made in laboratory incorporating fish protein isolate in wheat flour and wheat flour along with tapioca starch. For greater water imbibing properties, we used tapioca in the pregelatinized form. Quality of the noodles so prepared were assessed by cooking test and sensory evaluation[1,16-18]. Cooking quality of these noodles has also been compared with that of two commercial noodles.

Materials and Methods

The materials used for production of noodles in the laboratory were protein isolated from fish, wheat flour and tapioca starch.

Protein was isolated[13] from fresh water fish rahu (*Labio rohita*) of 250-300 g weight. The macerated muscle was extracted with phosphate buffer of pH 6.4 and ionic strength 0.1. The buffer contained 0.47 molar potassium chloride. The extractant was then centrifuged at 3000 g for 15 min and the supernatant diluted 10 times with water. After standing for overnight, the protein precipitated. The clear top layer was decanted and the protein was separated by centrifugation at 3000 g for 15 min. The isolated protein was in the form of gel like product. All the

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operations were done in cold. The protein content of the gel was determined by Kjeldahl method.

Wheat flour and tapioca starch were purchased from local market. For using in the noodle, the tapioca was converted to a gel by boiling with water with constant stirring. The gel was then allowed to cool to room temperature. While cooling, stirring was continued to prevent the formation of layer on the surface of the gel. Moisture contents of wheat flour and tapioca gel were estimated.

The proportions of the ingredients for the preparation of noodles were arbitrarily selected as shown below:

Sample 1 Water to wheat flour in the ratio of 1:1.2 (control)

Sample 2 Isolated protein gel: Wheat flour in 1:1 ratio

Sample 3 Isolated protein gel: Tapioca gel: wheat flour in the ratio of 1:1:1

Sample 4 Isolated protein gel: tapioca gel: wheat flour in 1:1.4:1 ratio

Sample 5 Market sample without egg

Sample 6 Market sample containing egg

Noodles were prepared by a simplified technique[1]. For each sample, the components were mixed thoroughly (10 min) and then kneaded (20 min) to form a homogeneous dough. These operations were done manually. The water content in the protein gel for sample 2 and in the protein gel and tapioca gel for sample nos. 3 and 4 were sufficient for required consistency. In case of noodle sample 1 (control), containing wheat flour only, additionally distilled water was added. In all cases, optimum absorption was detected by handling characteristics of the dough[5,17]. The dough was then passed through a traditional extruder, widely used in homes by house wives. In this way, round shaped noodles (3 mm diameter) were prepared on stainless steel trays and were dried at $50 \pm 1°C$ in an oven upto a final moisture content of 10-12 per cent on dry basis.

All noodle samples from 1-6 were subjected to cooking tests and samples 1-4 for sensory evaluation. The parameters examined in cooking tests were cooking time, the amount of water absorbed during cooking (i.e., cooked weight), the increase in volume due to cooking (i.e., swelling) and the material lost in water (i.e., cooking loss). All these cooking quality parameters were replicated five times.

The cooking time for each sample was determined by boiling with distilled water[16,17]. The ratio of noodle to water used for cooking test was 1:100. Noodles were added rapidly to boiling water. After each minute of cooking, a portion of noodles was removed and squeezed between two transparent plates. On complete cooking, no white core remained when squeezed between the plates. These tested noodles were discarded. The time taken for complete disappearence of white core was considered to be the cooking time. Cooked weight was the weight of wet mass after the cooked noodles were drained for 5 min at room temperature[19]. Cooking loss was determined by evaporation to dryness of the cooking water after separating the cooked noodles[17]. Swelling index was measured as the ratio of water displaced from cooked noodles to water displaced from an equivalent amount of uncooked noodles[16].

The sensory evaluation for samples 1-4 was done by ten semi-experienced panelists who were accustomed to eating noodles. The noodle samples were cooked in 2 per cent sodium chloride solution in distilled water for respective cooking time. After cooling and draining the cooking water, a serving (20 gm) was placed in a small cup and evaluated at room temperature. The panelists were asked to rank the samples for overall quality[17,18,20]. The amount of protein enrichment the of laboratory prepared samples 2-4 was estimated from the percentage of protein gel used with other raw materials. The percentage of enrichment was calculated[1] as follows. Let W_p W_f and W_t represent the dry weight of fish protein, flour and tapioca gel respectively in the mixture.

Then,

$$\text{protein enrichment (\%)} = \frac{W_p}{W_p + W_f + W_t} \times 100 \quad \ldots(1)$$

Results and Discussion

The desirable characteristics in noodles as food are a white appearance, minimum disintegration during cooking, short cooking time, minimum cooking loss and should not become sticky and soggy after cooking[17,21]. The colour of dry samples 1 and 2 was satisfactory compared to that of commercially available noodles. The colour of samples 3 and 4 with pregelatinized tapioca starch was slightly darker and translucent. In all dried samples 1-4, no visible fissure was observed. This may be due to low temperature and low convective current of air moving past the material[22,23]. This low temperature drying of protein enriched noodles also eliminates the possibility of undesirable browning by Maillard reaction[23]. Very low intensity of fishy smell was detected in the isolated protein gel. Moreover, when it was incorporated in different proportions during preparation of noodle samples as mentioned earlier, no undesirable smell of fish was detected in the dried samples.

All the parameters for cooking tests viz., cooking time, water absorbed, cooking loss and swelling index

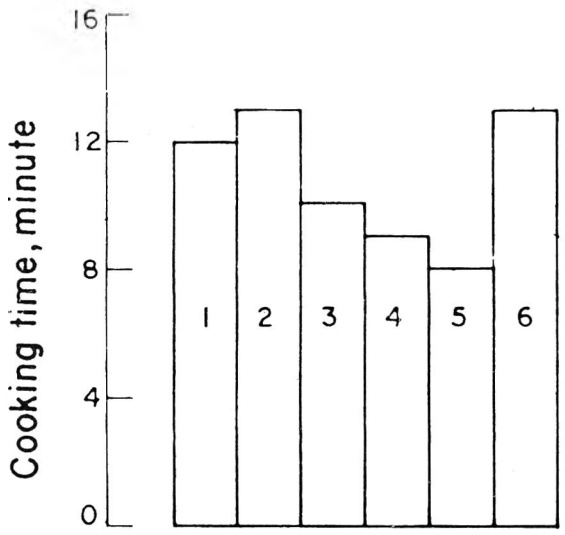

Fig. 1. Cooking time of different noodles
Samples 1,2,3,4,5, and 6 are as described in text.

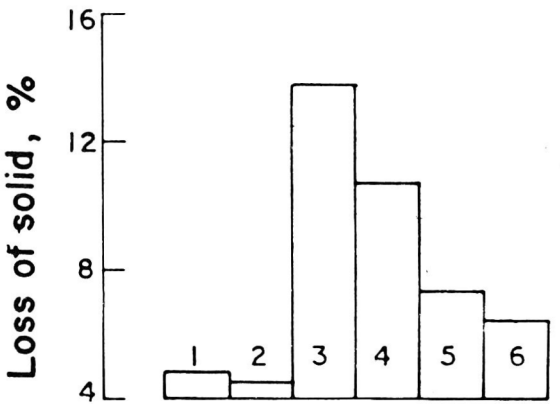

Fig. 2. Cooking loss from different noodles.
Legend as in Fig. 1.

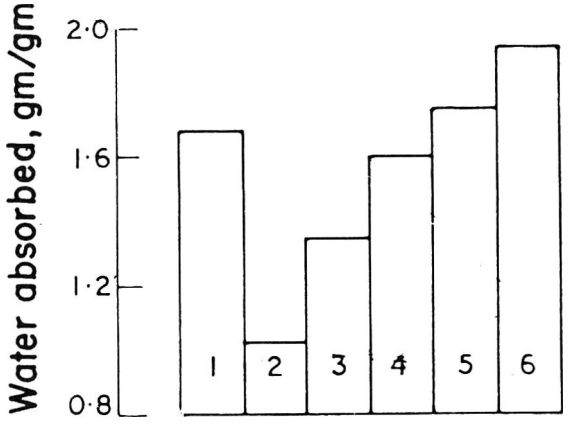

Fig. 3. Water absorbed by noodles after cooking.
Legend as in Fig. 1.

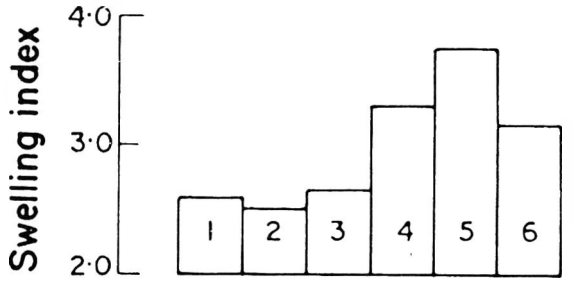

Fig. 4. Swelling index of different noodles.
Legend as in Fig. 1.

for different samples 1-6 are shown in Fig. 1-4. In these Figures, all the indicated values are means of five observations. The percentages of protein enrichment and sensory evaluation results for samples 1-4 are presented in Table 1.

From Fig. 1, the optimum cooking times for dry noodles in distilled water, as determined by visual disappearance of white noodle core were found to be 12, 13, 10, 9, 8 and 13 min for samples 1, 2, 3, 4, 5 and 6 respectively. The optimum cooking times were reproducible to the nearest minutes, since noodles could be lifted up and tested each minute during cooking. The cooking time of the laboratory made noodles was comparable to that of commercial noodles, and noodles made by other workers[17,21,23] The cooking time of sample 2 enriched with 3 per cent fish protein is greater than that of sample 1 containing no fish protein. Again the cooking time for sample 3 containing 2.64 per cent fish protein is greater than that of sample 1 containing 2.64 per cent fish protein is greater than that of sample 4 enriched with 2.36 per cent fish protein. Similar trend is obtained in case of commercial noodle sample 6 containing egg (per centage not known) which takes higher cooking time compared to that of sample without egg (sample 5). Thus, for these different types of noodle samples, namely noodle made from wheat flour, wheat flour and tapioca starch and commercial noodle, the above results reveal that cooking time of the noodle becomes longer with higher protein content. According to Oh *et al*[5], higher protein content may cause longer cooking time. Further, from their electron microscopic study,

TABLE 1. PROTEIN ENRICHMENT AND SENSORY EVALUATION OF DIFFERENT NOODLES

Panelists	Sample			
	1	2	3	4
	Overall quality rank at diff. protein enrichment of uncooked noodle (% db)			
	0.00	3.00	2.64	2.36
1	2	1	3	4
2	1	2	3	4
3	1	2	3	4
4	2	1	3	4
5	2	1	3	4
6	2	1	4	3
7	1	3	2	4
8	3	2	1	4
9	2	1	4	3
10	2	1	4	3
Rank sums	18	15	30	37

they reported that moisture had penetrated 40 per cent farther into low protein noodle than high protein noodle when both were cooked for the same period of time.

Fig. 2 shows the amount of water absorbed during cooking in gm per gm of uncooked noodle. The water absorbed in sample 2 is lower than that of sample 1. Similarly, the water absorbed in sample 3 is lower than that of sample 4. Considering the protein enrichment (Table 1) of these laboratory prepared noodle samples for both varieties i.e., with and without tapioca starch, the amount of water absorbed decreases with the protein enrichment. Yang *et al.*[12] reported that weight and volume of cooked noodles from wheat flour and composite flour (containing 3 or 5 per cent fish protein concentrate, FPC) were similar to wheat flour alone. But with increase of FPC (greater than 5 per cent) in the composite flour, the preceding parameters decreased slightly. However, in case of commercial noodle samples 5 and 6, the amount of water absorbed is higher for sample 6 containing egg.

The cooking loss based on weight of uncooked noodles is presented in Fig. 3. Noodle samples 1 and 2 show cooking losses of 4.8 and 4.5 per cent respectively. Similar kind of losses were reported by other workers[16]. Moreover, from the cooking losses for samples 1 and 2, it is apparent that percentage loss decreases with fish protein enrichment. Similar results were obtained for commercial noodles. Noodle containing egg shows less cooking loss compared to that of noodle without egg. According to Grzybowski and Donnelly[24], the cooking loss in noodle is closely related to protein content while Dexter *et al.*[25,26] reported that denaturation of a thin protein film during high temperature drying of pasta might have a role for improved surface stability (surface integrity) resulting in lower cooking loss. Since the major fraction of fish protein isolate is myosin, its low denaturation temperature as well as its interactive properties with other proteins and amphiphiles[14] might have contributed lower cooking loss for noodle sample 2 prepared with fish protein isolate. However, high cooking losses are observed in samples 3 and 4 which contradict the relations between cooking loss and protein content as mentioned above. This may probably be due to the presence of pregelatinized tapioca starch in these samples. Lanier[27] observed that addition of pregelatinized starch in Surimi (for fish gel preparation) disrupts the continuity of gel structure development resulting a loose coagulum which binds water tightly without any structural integrity.

The swelling indices of laboratory prepared and commercial noodle samples are shown in Fig. 4. It is evident that for laboratory prepared samples 1 and 2, 3 and 4 and also for commercial samples 5 and 6, swelling indices decrease with increase of protein enrichment. Dexter *et al.*[16] showed variation in swelling index of spaghetti with the protein content of the wheat flour. They obtained lower swelling index for higher protein content of wheat. On the contrary, Grzybowski and Donnelly[28] found that the degree of swelling during cooking of spaghetti was not related to protein content. However, in general, the swelling indices of laboratory made noodles were found to be lower than the two commercial noodles.

In Table 1, the ranks for individual sample 1-4 as given by the ten panelists for overall quality are presented along with the rank sum for each treatment. Applying Kramer's procedure[18] to the data (rank sums) in Table 1, for ten judges (replications) and four products (treatments), it is found that the two upper entries at the 5% level of significance when no treatment specified in advance are 17-33. Since the rank sum of sample 2 is less than 17 it is considered as the superior in terms of overall quality. Sample 4, however, has a rank sum greater than 33, so that it may be considered inferior. Since the rank sums for samples 1 and 3 are between 17 and 33, we can not conclude that any of these two samples are superior or inferior.

Noodles containing pregelatinized tapioca starch showed visual surface disintegration after cooking and subsequently gave high cooking losses as discussed earlier. Virtually negligible surface disintegration occurred in noodle samples made from wheat flour and wheat flour containing fish protein isolate. It has been reported by some workers[4] that the addition of fish protein concentrate (FPC) in noodles impairs the cooking quality. However in the present case, cooking quality of the noodles containing salt extracted fish

protein is comparable to that of commercially available noodles. From the overall quality rank sum, it is seen that the noodle sample made from wheat flour and 3 per cent fish protein is more acceptable among the other prepared samples.

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Studies on the Extraction and Evaluation of Raw Palm Oil for Edible Use

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Pilot plant trials were conducted to optimise unit operations for the extraction of edible raw palm oil. The raw palm oil thus produced had less than 1% free fatty acids, 0.2% moisture and impurities. Detailed analytical data supported the high quality of the oil. The raw palm oil contained 700 ppm carotenes and hence forms a good source of vitamin A. The acceptability trials conducted in the laboratory indicated the possibility for direct edible use. Based on the data, equipments for various unit operations were designed for fabrication. A demonstration plant based on this technology has been established at Palode, Trivandrum as a joint venture between Regional Research Laboratory (CSIR) and Central Plantation Crops Research Institute (ICAR). The plant with a capacity to process 0.7 tonnes fresh fruit bunches per hr is in operation to demonstrate the technology to produce edible raw palm oil.

India has imported 1.9 million tonnes of edible oil during 1987-88 out of which palm oil accounted for 1.1 million tonnes. In the Indian context, oil palm holds great promise to ease the acute edible oil shortage due to its incredible productivity[1] (4 to 5 tonnes/ha/yr). Currently, oil palm is cultivated in Kerala (3,700 ha) and in Andaman and Nicobar Islands (1,6000 ha). For further expansion, the working group has identified about 0.5 million ha in Southern India and North Eastern Region[2].

The palm fruit is a drupe with a fleshy outer mesocarp that encloses a hard nut. Two distinct types of oils are obtained from oil palm fruit. Palm oil is derived from the mesocarp which comprises 90 per cent of the oil yield. The nut yields the remaining 10 per cent called palm kernel oil which is chemically identical to coconut oil. The palm fruit contains an extremely active lipolytic enzyme which under favourable conditions releases free fatty acids (FFA) very rapidly[3]. If the fruit is bruised, the FFA in the damaged part of the fruit increases to 60 per cent within an hour[4]. The increase in FFA is also dependent on the time lapsed between harvesting and sterilization[5]. Production of edible quality palm oil, therefore demands strict process controls from harvesting onwards.

Our attempt has been to evolve a technology to produce edible raw palm oil to suit the local requirements, and to match the size of plantations particularly in the small sector. Raw palm oil assumes greater significance, being the richest natural source of β-carotenes, and can provide vitamin A, 430 to 760 I.U/g and vitamin E, 210 to 460 I.U/g[6]. Detailed reviews on different aspects of processing have been published[7,8]. The objectives of the present studies are (a) to collect design data for the fabrication of palm oil extraction equipments for the small scale sector and (b) to produce edible grade raw palm oil with a view to promoting the same as a nutritional oil.

Materials and Methods

Harvesting: The fresh fruit bunches (FFB) were harvested from Central Plantation Crops Research Institute (CPCRI) Research Centre at Palode. The harvesting was carried out under two sets of conditions (a) by following the pollination records of the Research Centre thereby ensuring actual maturity of the fruit bunch (180 ± 5 days) and (b) by following field practice i.e. a few loosened fruits from the apex of fruit bunch. The harvested bunches were transported to the pilot plant of Regional Research Laboratory (RRL). The time taken between harvesting and sterilization of FFB varied from 5 to 15 hr.

Bunch sterilization: Sterilization was carried out using steam and boiled water. For steam sterilization, a vertical autoclave of 0.25 cu.m. fitted with steam inlet, condensate and pressure release valves and pressure gauge was used. The autoclave had a capacity to hold 100 kg FFB. After charging FFB, steam was admitted. On reaching the desired working pressure, steam was vented off to remove air and recharged to the same pressure. Peak of pressures of 2 kg/sq.cm and

3 kg/sq.cm were maintained for 40 min. Steam was released slowly at the end. Total time taken for the process of sterilization was 60 min. Sterilizer condensate was collected and the quantity was recorded.

Sterilization using boiling water was also carried out in jacketted kettle of 100 litre capacity. FFB was steeped in boiling water for 60 minutes.

Bunch stripping: After sterilization the fruits were separated manually from the bunches.

Fruit digestion: Planetary mixer was employed for the purpose. The mixer consisted of a mixing vessel of 15 litre capacity, a sigma blade driven by motor of 0.5 HP at 25 r.p.m. The loose fruits were conditioned with boiling water and about 10 kg was transferred to the vessel. The fruits were agitated for 5 min at about 60 to 70°C and 70 to 80°C. About 20 per cent by weight of boiling water was added to facilitate digestion and to maintain the temperature.

Oil extraction: Separation of oil-water mixture from the digested mash was effected by hydraulic pressing. A 60 tonne capacity down-stroke hydraulic press was used for the purpose. The digested mash at about 60 to 75°C was charged into a perforated stainless steel cage of 30 cm diameter and 35 cm height with 0.6 cm wall thickness. The cage had 0.6 cm perforations at 1 cm triangular pitch. The pressure of 50 and 70 kg/sq.cm was applied from the top for 1 min. Oil-water mixture was expelled through the perforations leaving the press cake in the cage.

Clarification: Hundred litre capacity steam jacketted stainless steel kettle with tilting arrangement and with operating steam pressure of 3 kg/sq.cm was used for separating crude oil from the aqueous phase. The oil-water mixture obtained by hydraulic pressing was transferred to the kettle. The temperature was raised to 95°C to effect phase separation. The oil phase at the top was separated by decantation. Different oil-water ratio (1:1.5, 1:2.0; 1:2.5; 1:3.5, 1:4.5) was tried to obtain maximum recovery of oil.

Purification: The crude palm oil containing sludge impurities, moisture etc was subjected to high speed centrifugation in Westfalia Separator (Model TA 05-00-105). The centrifugation was carried out using a chamber type bowl of 300 ml capacity at 6,000; 8,000 and 10,000 r.p.m. The temperature of the oil was maintained at 80°C and the feed was adjusted between 100 and 200 litre per hr depending upon the bowl speed.

Analytical methods: Colour, moisture, free fatty acids, iodine value (IV), saponification value (SV) unsaponifiable matter, peroxide value (PV), melting point (MP) and carotenes were determined following PORIM test methods[9]. For tocopherol estimation, the unsaponifiable matter was first subjected to thin layer chromatographic separation. The bands corresponding to tocopherols were scraped off and estimated using Emmerie-Engel reagent[10]. Anisidine value was determined by the modified method of Jirousova[11]. Absorbance at 233 and 269 nm were recorded as measure of diene and triene values respectively[9]. Iron and copper were also estimated[9].

Fibre oil content was determined using soxhlet apparatus[12]. Sterilizer condensate and sludge oil were extracted with chloroform-methanol and estimated by gravimetry. Fatty acid methyl esters were prepared by using methanol-sulphuric acid reagent and the fatty acid composition was determined by gas liquid chromatography[12]. A Hewlett Packard 5840A model gas chromatograph with flame ionisation detector was used for the purpose. The methyl esters were separated on 10 per cent EGSS-X on chromosorb (WHP, 100-120) packed in stainless steel column (6 ft length and 1/8 inch I.D.). Injection and detector temperatures were 250°C and 300°C respectively. The column temperature was programmed from 160 to 190°C at the rate of 5°C/min. Nitrogen (20 ml/min) was used as carrier gas. Methyl esters were identified by using fatty acid standards (Sigma Chemical Co.) and the peaks were quantified by digital integration.

Development of free fatty acids: To follow the release of free fatty acids by the endogenous lipase, fresh and sound oil palm fruits were crushed using pestle and mortar. Samples from the crushed mash were taken at 5 min interval for 1 hr period for free fatty acid estimation.

To understand the stability of fruit bunches with respect to free fatty acid development on storage, the fruit bunches were stored after different treatments i.e. (a) FFB without sterilization (b) FFB sterilized in boiling water for 45 min and (c) FFB sterilized under 1 kg/sq.cm steam pressure.

The bunches after treatments were stored at ambient conditions for 15 days. Fruit samples were drawn at one day's interval and fat was extracted for FFA estimation.

Studies on fruit maturation: Three oil palm trees were selected for the purpose. One bunch from each tree was identified after consulting the pollination record of the Research Centre. The study was started from the 100th day after pollination. The fruits were extracted from these bunches separately at an interval of 10 days until 180th day of maturation. The mesocarp was separated and moisture and fat contents were determined for the three trees separately and mean values were reported.

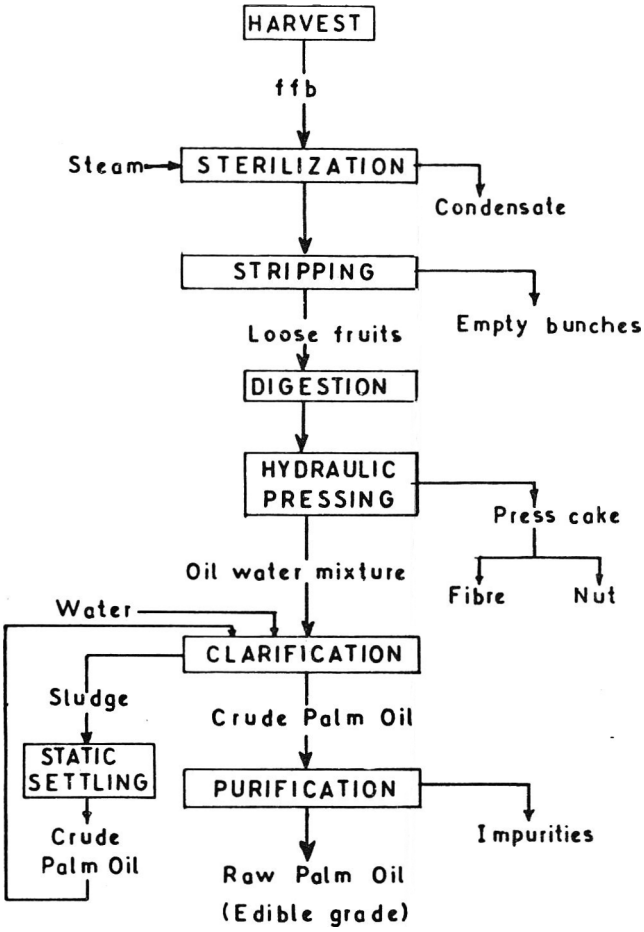

Fig. 1. Flow sheet for the production of edible grade raw palm oil.

Results and Discussion

pilot scale experiments conducted in the laboratory is presented in Fig.1. Production of raw palm oil comprises of two main stages: (1) harvesting and transport of FFB (field practices); and (2) extraction of raw palm oil (mill practices).

Harvesting: The oil palm produces fruit bunches throughout the year, although there are peak and lean periods. Harvesting can be broken down into a number of separate activities that can be broadly classified as under (i) finding and cutting ripe bunches, (ii) collection of bunches and loose fruit to the collection point, and (ii) loading into vehicle and transport to the mill.

The pattern of oil accumulation in the oil palm fruit mesocarp at different physiological maturity stages is presented in Fig.2. The results were obtained for 10 yr old oil palms of 'tenera' variety in the CPCRI Research Centre at Palode, Trivandrum. It is obvious from the results that nearly 70 per cent of the oil in the mesocarp was synthesised during 130 to 150 days after anthesis. The data further indicated that the oil content of mesocarp continued to increase till abscission though at slower rate following a sigmoidal curve pattern. Detachment of fruits from the bunches for the three palms studied here occurred around 180 days. Moisture content of the mesocarp exhibited a negative correlation with the oil content as expected. The quality of the oil in terms of FFA content at various stages of maturation varied only in narrow range from 0.2 to 0.5 per cent.

Various authors reported that the period of oil accumulation in the mesocarp ranged from 100 to 160 days depending on the variety, agro-climatic conditions and geographic location[13-15]. All these studies indicate that there is an active period of oil synthesis towards end of bunch maturation, corresponding to about 20 days and the rate of oil accumulation continues, though at a slower rate, till abscission. In the present study, the pattern of oil accumulation was found to be at a later period which is comparable with the results of Bafor and Osagie[15] reported for the 'Dura' variety. Considering the yield and the quality of the oil with respect to bunch maturation, a compromise may have to be worked out to determine the harvesting time to obtain the optimum yield without sacrificing the oil quality.

Sterilization: The primary objectives of this step are to inactivate the fruit enzyme, lipase and to loosen fruits from the bunch. The other functions of sterilization are softening the fruit tissue, coagulation of proteins and partial dehydration of nuts.

Development of FFA under different conditions is presented in Fig.3 when the fruits are crushed without sterilization, the FFA rose to 40 per cent within 10 min demonstrating the instant activity of the enzyme with the disintegration of the cell structure. This would explain the high FFA content of the palm oil extracted from damaged, over-ripened and stored fruits.

The results underscore the importance of sterilization of FFB after harvest preferably on the same day. Though the FFA release could be arrested using boiling water, the other functions i.e. loosening of fruits and softening of tissue could be achieved only when steam sterilization was adopted. In the present study, it was observed that sterilization of FFB under a steam pressure of 2 and 3 kg/sq.cm for 40 min facilitated the complete stripping of fruits from the bunches provided the bunches were well ripened.

The steam was admitted slowly to a pressure of 2 kg/sq.cm to expel air (venting) and subsequently maintained the desired pressure for 40 min. The recomended sterilization conditions of 3 kg/sq.cm for 60 to 75 min though seems to be on the higher side, it is necessary considering the non-uniformity of bunch ripening under field conditions of large plantations.

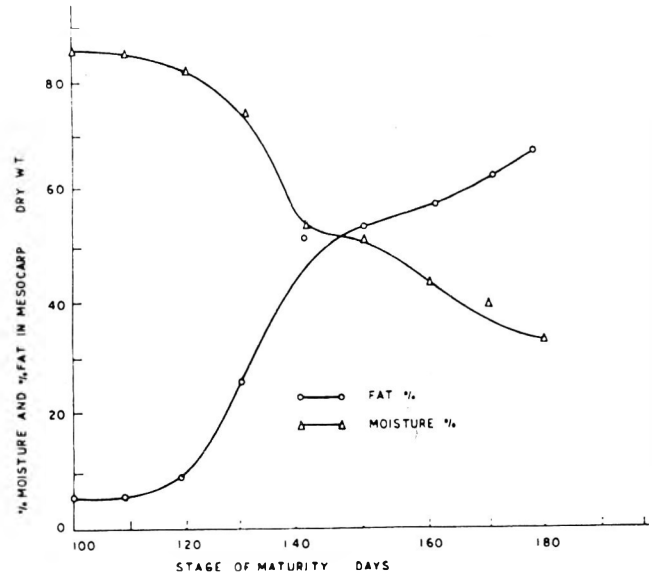

Fig. 2. Changes in fat and moisture contents of mesocarp during maturation

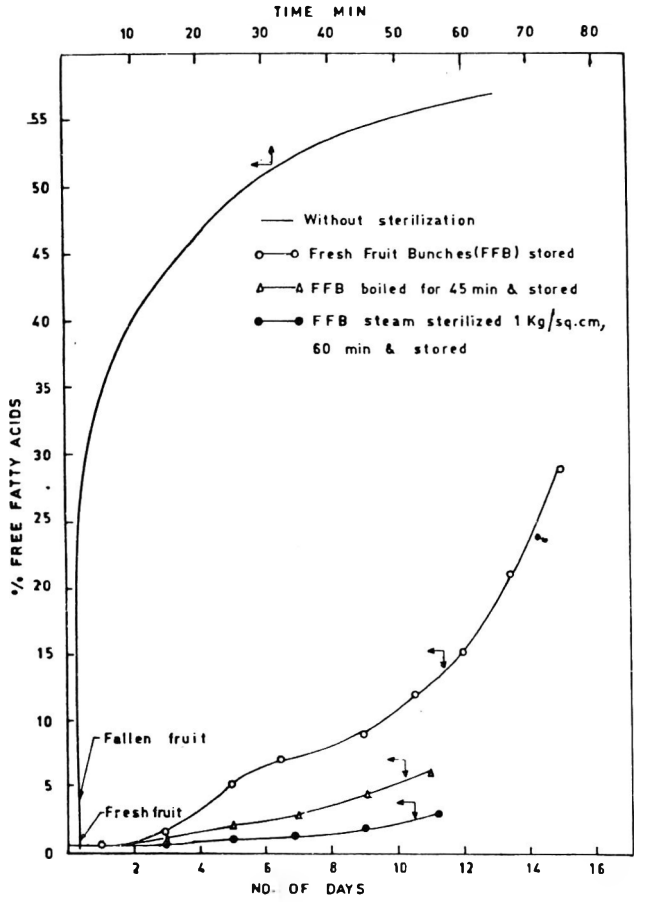

Fig. 3. Development of Free Fatty Acids (FFA)

Sterilization is a complex experimental situation which can be studied properly in a processing factory. The independent variables in sterilization technique which can be controlled within certain limits are steam pressure, the rate of increase of pressure, venting cycle time and air release. The dependent variables (oil loss, stripping efficiency, oil quality) will depend on age and type of fruit.

Stripping: The process involves the separation of the fruits and the calyx leaves from the bunch stalk. Bunch stripping was carried out manually for the pilot plant trials reported here. Bunch stripping is usually an efficient operation when standard mechanical strippers are employed. Rotary drum type is most commonly used in large mills.

Digestion: The purpose of digestion is to disrupt the mesocarp and to break up the oil bearing cells to facilitate oil release. The efficiency of digestion could be assessed only by monitoring the residual oil content of the press fibre. In the present study, the digestion seemed less efficient as revealed by the high residual oil content of the press fibre as the mash could be maintained only in the range of 70 to 80°C, unlike in the industry where it is kept at around 90°C.

Oil extraction: Hydraulic pressing, as described before was adopted here and the results obtained there from are presented in Table 1. Pressure and temperature of the mash were the major factors that affected pressing efficiency as indicated by the residual oil content. At 60°C, the pressure applied (50 and 70 kg/sq.cm) did not make appreciable difference in the residual oil content necessitating second stage pressing to bring down to 20 per cent oil in the press fibre. However, when the temperature of the mash was increased to 70 to 75°C, the residual oil content could be brought down to about 20 per cent, without further increasing the pressure. Increasing the pressure beyond 70 kg/sq.cm resulted in kernel breakage. Though further increase in the pressing efficiency could be attained by increasing the temperature of the mash, it could not be achieved due to the limitation of the digestion system adopted here. The other factors that favoured hydraulic press performance were ratio of nuts to mesocarp and presence of calyx leaves. Under ideal conditions of temperature and pressure, the efficiency could be enhanced to 98 per cent with 9 per cent residual oil content of press fibre.

TABLE 1. EFFECT OF PRESSURE AND TEMPERATURE ON OIL RECOVERY DURING HYDRAULIC PRESSING

No.	Mash temp. (°C)	Hydraulic pressure (Kg/sq.cm)	% Oil in fibre	
			Ist Press	IInd Press
1	60	50	38	20
2	60	70	35	20
3	70	70	22	-
4	75	70	20	-

Average of two trials

Clarification: The objective of this unit operation is to separate crude oil from the water, non-oily solubles and fibrous residues by taking advantage of the density gradient of oil and water at higher temperature.

The efficiency of clarification is determined by the residual oil content of the water phase, which depends on the oil-water ratio and temperature. Of the various oil-water ratios tried here, 1:2 was found to be the minimum dilution factor to achieve maximum recovery of the oil. The clarifier design based on simple over flow technique is employed for industrial purpose.

Purification: A final purification step was adopted using high speed centrifugation to remove the residual impurities (0.2 to 0.4 per cent) and excess moisture from the crude oil. In the present study, when the crude oil was fed at 80°C at a bowl speed of 8000 rpm, the impurities could be completely eliminated and moisture could be brought down to 0.2 to 0.25 per cent.

Material balance and oil recovery: The composition of FFB and yield of various constituents and palm oil recovery of selected trials are presented in Tables 2 and 3. Excepting the variation in the average bunch weight, the yield of loose fruits, empty bunches and weight loss during sterilisation are comparable to those earlier reported. The yield of palm oil around 15 per cent is significantly lower that could be attributed to higher oil loss through waste streams, variety and agro-climatic conditions. With appropriate equipments and process conditions, the recovery of palm oil could be enhanced to 90 to 95 per cent corresponding to 18 to 20 per cent on FFB. On the plant breeding side, improvement of the seed material would further enhance the oil yield.

Physico-chemical characteristics of raw palm oil: Data presented in Table 4 demonstrate the quality aspects of palm oil obtained during pilot plant trials as compared to the quality parameters prescribed by the Bureau of Indian Standards. Very low content of FFA indicates the high quality of the oil. Data for other quality parameters such as peroxide value, anisidine value, diene and triene values, iron and copper contents also reflect the soundness of raw palm oil. Of the quality parameters of palm oil, FFA is the most important one, the other parameters being consequence of initial FFA content. The palm oil extracted by the traditional African method is reported to contain as high as 50 per cent FFA and commonly around 10 to 20 per cent and possess very firm consistency[16]. However palm oil produced in the plantations of Malaysia contains FFA is the range of 2 to 5 percent[17,18]. The results reported here demonstrate the feasibility of palm oil production with very low level of FFA and other quality attributes conforming to standard specifications.

Raw palm oil owes its deep red colour to the presence of carotenoids. The raw palm oil produced in the pilot plant contained 700 p.p.m. carotenoids, of which 90 per cent was comprised of α-and β-carotenes and thus

TABLE 2. MATERIAL BALANCE OF PALM OIL EXTRACTION

Trial No.	FFB (kg)	Average bunch wt (kg)	Loose fruit wt (kg)	Empty bunch wt (kg)	Wt. loss in sterilization (kg)	% Fruit on FFA	% Raw palm oil on FFB	% Fibre (dry) on FFB	% Nut (dry) on FFB
1	100.0	12.5	60.0	26.5	13.5	60.0	14.0	4.1	8.4
2	120.0	11.0	83.0	25.3	11.7	68.0	15.0	6.9	13.5
3	90.0	18.2	56.5	23.5	10.0	57.0	14.5	6.6	13.1
4	290.0	16.5	180.0	68.0	40.0	62.0	14.7	9.0	12.5
5	280.0	28.0	176.0	60.0	42.0	62.0	15.3	8.2	14.0
6	290.0	9.0	190.0	60.0	38.0	65.0	15.0	7.0	14.5

TABLE 3. ANALYTICAL DATA ON OIL LOSS AND RECOVERY

Trial No.	Sterilizer condensate			Sludge			Fibre			Raw palm oil				
	Qnty. (kg)	% oil		Qnty. (kg)	% oil		Qnty. (kg)	% oil		Qnty. (kg)	% yield on FFB	% oil recovery	% FFB	% moisture & impurities
		On Condensate	On FFB		On sludge	On cond-FFB	Fibre	On filre	On FFB					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	25.0	1.5	0.30	85.0	3.2	2.2	8.3	28.0	2.0	17.5	15.0	80.0	1.0	0.30
2	18.0	1.2	0.23	30.0	3.6	1.0	6.2	20.0	1.3	13.5	14.5	83.0	0.6	0.20
3	40.0	2.0	0.30	152.0	4.0	2.0	27.0	30.0	2.8	40.0	14.7	73.0	0.7	0.15
4	32.0	2.6	0.30	100.0	7.0	2.5	25.5	23.0	2.0	43.0	15.3	77.0	0.8	0.24
5	150.0	1.2	0.60	123.0	3.3	1.4	20.3	21.6	1.5	43.2	15.0	81.0	0.9	0.23

$$\% \text{ oil recovery (12)} = \frac{\text{Column 11}}{\text{Columns 3+6+9+11}} \times 100$$

TABLE 4. CHEMICAL CHARACTERISTICS* OF EDIBLE GRADE RAW PALM OIL

Chemical characteristics	Raw palm oil RRL (T)+	Crude palm oil B.I.S@
Colour (lovibond unit 1")	28 R + 10 Y	
Free fatty acids (%)	0.9	5.0 (max)
Moisture & impurities (%)	0.22	0.25
Iodine value	52	45 to 56
Saponification value	195	195 to 205
Unsaponificable matter (%)	0.56	1.2 (max)
Carotenes (ppm)	700	-
Tocopherols (ppm)	800	-
Peroxide value	Nil	-
Anisidine value (O.D. at 400 nm)	0.14	-
Diene value (E_{233} 1%)	0.17	-
Triene value (E_{269} 1%)	0.15	-
Iron (ppm)	4.0	-
Copper (ppm)	0.5	-
Melting point (°C)	36	-

* Average of four trials
\+ Regional Research Laboratory, Trivandrum
@ Bureau of Indian Standards

qualifying raw palm oil as the richest natural source of carotenes. Raw palm oil is also rich source of tocopherols (800 ppm) with α- and γ-tocopherols predominating

In the modern processing as adopted in Malaysia and elsewhere, raw or the red palm oil is subjected to refining and fractionation to suit the requirements of international market. Nearly all carotenes and considerable amount of tocopherols are removed by refining. The fact that one gram of raw palm oil is equivalent to about 500 I.U. of vitamin A and about 300 I.U. of vitamin E, this oil can make valuable contributions from the nutritional angle, when consumed in the raw form[6]. Though palm oil is considered as a saturated fat, the fatty acid profile obtained here for the raw palm oil indicated that it has considerable amounts of unsaturated fatty acids (14.0, 1.22; 16:0, 42.44; 18:0, 5.17; 18:1, 37.01; 18:2, 11.71).

Limited trials with respect to the acceptability of raw palm oil conducted in the laboratory showed encouraging results. Detailed nutritional evaluation and consumer acceptability of raw palm oil produced in the laboratory are in progress with National Institute of Nutrition, Hyderabad. An expert panel has also been constituted by Indian Council of Medical Research for the purpose.

Data collected from the pilot plant trials were used to design appropriate equipments for the production of edible quality raw palm oil. A demonstration plant with an installed capacity of 0.7 tonnes FFB/hr that can meet the requirement of 200 ha. Oil palm plantation has been established at Central Plantation Crops Research Institute (CPCRI) Research Centre at Palode, Trivandrum as a collaborative venture between Council of Scientific & Industrial Research (CSIR) and Indian Council of Agricultural Research (ICAR) to demonstrate the technology and train personnel.

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FRACTIONATION OF EXTRACT FROM SEEDS OF *ADENANTHERA PAVONIA* AND EFFECT OF THESE FRACTIONS ON FISH SPOILAGE BACTERIA

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Crude extract of Indian red wood seeds (*Adenanthera pavonia*) was separated into 3 main fractions, *viz.* DC-IF, DC-IIF and DC-IIF by DEAE-cellulose chromatography. Only DC-IIF had protease inhibitor (PI) activity. DC-IF which contained ketones inhibited the ability of fish spoilage bacteria to reduce trimethylamine oxide and to produce H_2S from cysteine.

Spoilage of seafoods is mainly due to the activity of bacteria which produce off odour compounds like trimethylamine (TMA), volatile sulphur compounds and ammonia. Therefore, the main aspect in seafood preservation is to prevent or delay this spoilage activity of bacteria. Since proteases of endogenous origin as well as of bacterial origin also play an important role in fish spoilage, Gowda and Karunasagar[1] studied the effect of protease inhibitors on fish quality. They reported that crude extract of *Adenanthera pavonia* containing protease inhibitors (PI) brought about qualitative and quantitative changes in the microflora of fish and incidentally they noted that this crude extract also suppressed the production of TMA and volatile bases. This is a significant observation in as much as Connell[2] indicated that formation of TMA from TMA oxide is one of the most significant activities of spoilage bacteria and if reduction reaction could be stopped by enzyme inhibition, a way would be open for prevention of one of the key spoilage changes. But it is not clear whether the changes observed were due to suppression of proteases by protease inhibitors or whether some other component of the crude extract was bringing about inhibition of other metabolic activities of bacteria like TMA and H_2S production. So in this investigation, fractionation of the crude extract was attempted first to separate out the PI fraction. Since this fraction did not possess the ability to suppress spoilage potential like TMA production and H_2S production, the effect of other fractions on the metabolic activity of bacteria was studied.

Crude extract of Indian red wood seed was prepared and fractionated by DEAE-cellulose column chromatography as described by Prabhu and Pattabhiraman[3]. The fractions were pooled together to form 3 main fractions, namely DEAE-cellulose-I fraction (DC-IF), DEAE-cellulose-II (DC-IIF) and DEAE-cellulose-III fraction (DC-IIIF), based on their trypsin inhibitory activity and protein content. Caseinolytic assay of trypsin was performed by the method described by Sumathi and Pattabhiraman[4]. Protein content of the fractions was measured by the method of Lowry *et al.*[5]

Bacteria isolated from spoiling shrimp were identified up to generic level by the scheme described by Lechavelier *et al.*[6] The following bacteria were used for further studies: *Alteromonas, Moraxella, Proteus, Pseudomonas, Aeromonas, Micrococcus, Staphylococcus, Bacillus, Arthrobacter*. Ability of bacteria to reduce TMAO and to produce H_2S from cysteine were tested using Wood and Baird's broth[7] and cysteine broth[8] respectively. Effect of DEAE-cellulose fractions on TMAO reducing and H_2S producing abilities of bacteria was tested by adding suitable aliquots of the filtered fraction into the broth. Each aliquot was tested in triplicate.

DEAE-cellulose fraction which was effective in inhibiting the spoilage activity of bacteria was tested for the presence of organic functional groups as described by Singh *et al*[9]. Then the fraction was separated into two sub-fractions, *viz.* distillate and concentrate by separating out volatile fractions at 70°C using flash evaporator. Each of these sub-fraction was tested for inhibitory activity and the presence of functional groups, such as aldehydes, ketones, carboxylic, phenolic group, esters, anhydride and lactone.

After chromatographic separation of crude extract, fractions 4, 5, 6 and 7 which had highest trypsin inhibitory activity and protein content were pooled together and designated as DC-IIF. The fractions before DC-IIF, *i.e.* 1, 2 and 3 were pooled together to form DC-IF and the fractions 8 to 20 formed DC-IIIF.

Results in Table I indicate that out of the 3 fractions tested only DC-IF could inhibit the TMAO reduction by *Moraxella* and *Alteromonas* and H_2S production by *Moraxella*. Ability of *Alteromonas* to produce H_2S was only partially inhibited by DC-IF, and Table 2 indicates further that unheated DC-IF could inhibit TMAO reduction by all the bacteria tested, H_2S production by

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TABLE 1. SCREENING OF DEAE-CELLULOSE FRACTIONS FOR INHIBITION OF SPOILAGE POTENTIAL OF BACTERIA

Fraction	TMAO reduction		H_2S production	
	Moraxella	*Alteromonas*	*Moraxella*	*Alteromonas*
DC-IF	+	+	+	±
DC-IIF	-	-	-	-
DC-IIIF	-	-	-	-

+ = inhibition
- = no inhibition

TABLE 2. EFFECT OF DC-IF ON SPOILAGE POTENTIAL OF BACTERIA

Organisms	TMAO reduction		H_2S production	
	DC-IF	Heat treated DC-IF[1]	DC-IF	Heat treated DC-IF[1]
Aeromonas	+	-	(ND)	(ND)
Arthrobacter	(ND)	(ND)	+	-
Bacillus	+	-	+	-
Micrococcus	+	-	+	-
Proteus	(ND)	(ND)	+	-
Pseudo-monas	+	-	+	-
Staphylococcus	(ND)	(ND)	+	-

1 = at 100° C for 10 min + = inhibition
ND = Not done - = no inhibition

all the organisms except *Alteromonas* and *Proteus*, whereas, the heat treated (100°C for 10 min) DC-IF failed to be effective.

Characterisation of DC-IF by testing for organic functional groups showed that it contains ketones, esters and lactones. When the fraction was concentrated by flash evaporation at 70°C, it was noticed that distillate could inhibit spoilage activity of bacteria (Table 3) and this fraction contained ketones.

Contrary to earlier speculations[2,10], the protease inhibitor (PI) fraction of crude extract, DEAE-cellulose-II fraction (DC-IIF) did not have any effect on spoilage activity of bacteria. The earlier speculations were based on the observation that heat treated crude extract of PI which lost the trypsin inhibitory activity also lost the ability to inhibit spoilage activity of bacteria. But the present study shows that the active component of DC-IF has a low boiling point and therefore it evaporated when treated at 100°C for 10 min. However, even the earlier workers[1,2] also suggested that this inhibitory activity may be due to PI or some other heat labile compounds. So, the inhibitory activity of crude extract of Indian red wood seeds against spoilage activity of bacteria is perhaps due to components present in DC-IF of crude extract which contained ketones, esters and lactones. Further, since only the DC-IF distillate which contained only ketones brought about inhibition of spoilage activity, this fraction appears to be the most important.

TABLE 3. EFFECT OF DC-IF DISTILLATE AND CONCENTRATE ON SPOILAGE POTENTIAL OF BACTERIA

Fraction	H_2S production		TMAO production	
	Moraxella	*Alteromonas*	*Moraxella*	*Alteromonas*
DC-IF distillate	+	±	+	+
DC-IF conc	-	-	-	-

+ = inhibition
- = no inhibition

DC-IF could inhibit H_2S production and TMAO reduction by most of the organisms tested. The production of H_2S by bacteria is due to action of enzymes cysterine desulphydrase[11] and ketone reagents inhibit the action of this enzyme on cysteine. So, the ketones present in the DC-IF might be responsible for the inhibition of H_2S production by this fraction. Since TMAO reductase has been reported to be a membrane bound enzyme in bacteria[12,13] and uptake of amino acids like cysteine into bacteria is catalysed by functionally specific transport systems located in the cytoplasmic membrane[14] it is possible that the ketones might be interfering with these membrane proteins.

Since DC-IF of crude extract of protease inhibitors from *Adenanthera pavonia* inhibits activity of bacteria that are important in fish spoilage, it could be suggested that the DC-IF could be used for prolonging the shelf life of fishes. Prawns given dip treatment in this fraction had lower bacterial counts, TMA and volatile base levels as compared to controls[15].

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EFFECT OF PHOSPHATE AND CITRATE ON QUICK-COOKING OF RICE

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The effect of phosphate and citrate on cooking time of 'Pankaj' variety of raw and parboiled rice was studied. The process involved rinsing of the rice in sodium bicarbonate followed by cooking in disodium phosphate and calcium citrate solution and finally drying in a cabinet dryer. The treated rice cooked faster (3.7 times for raw rice and 1.2 times for parboiled rice) than the untreated rice. The process presumably caused loosening of the protein structure of raw rice thus increasing its rate of water uptake. The swelling, colour and appearance were slightly superior to those obtained from cooking untreated rice.

An instant rice that has intact full grains and swells on reconstitution to the same level as normal cooked rice, is yet to arrive in the Indian market. Depending on the variety and grain size, standard milled raw rice requires 20 to 35 min to cook to a satisfactory culinary acceptability when boiled according to usual recipe directions[1]. Apart from the long cooking time, sticky and pasty cooked rice sometimes makes them unacceptable.

A few instant rice manufacturing processes[2-4] with intact whole grain are available. However, these rices lack adequate swelling capacity. These processes involve mechanical or thermal methods that create stresses entailing grain rupture and also loss of texture. The cooking time is reduced by half for the quick-cooking rice obtained by ordinary plain water cooking followed by drying[5]. Further, the cooking time could be reduced by use of some food additives such as disodium phosphate and calcium citrate. It is believed that the alkali metal phosphates act principally to modify the starch of the rice for increasing its hydrophilic character, but may also modify the protein of the rice to reduce its protection of the starch from water absorption. Citrates are supposed to modify the protein structure by attenuation, disruption and/or disintegration[6].

The effect of these chemicals on reducing the cooking time is discussed in the present paper.

Preparation of the rice: Two hundred grams of 'Pankaj' variety of raw and parboiled rice were obtained from the Post Harvest Technology Centre of the Institute. The rice was initially rinsed for 20 min in a dilute solution (0.002 per cent) of sodium bicarbonate, then rinsed briefly in a mild (0.02 per cent) calcium chloride solution. It was then put in a boiling aqueous solution containing 0.3 per cent disodium phosphate and 0.2 per cent calcium citrate. Samples were taken out after 10 and 15 min of boiling. The cooked rice was rinsed briefly in calcium chloride solution. After draining the solution, the rice was dried in a cabinet dryer for 2-3 hr with a steady current of warm air (70°C) following which the moisture content reduced to 10-13 per cent.

Rehydration studies: The dried rice prepared above was rehydraded by keeping it in boiling water in an open pan. For the 'control', raw and parboiled rice were boiled in a similar manner. Samples were taken out at interval of one min and moisture content was determined by oven drying method[7].

Judgement of cooking time: The extent of cooking is normally judged by pressing a grain of rice between two fingers. Absence of 'hard centre', indicates full cooking. For the present experiment, the time when the moisture content reached to about 65 per cent (normally 65-70 per cent) was taken as the cooking time[5].

Reduction of cooking time: From Fig 1 it is observed that the chemical treatment and subsequent drying reduce the time of cooking. As the treatment time increases rehydration time decreases. For rehydration to 65 per cent moisture, the 'control' raw rice took about 7.0 min followed by the rice initially

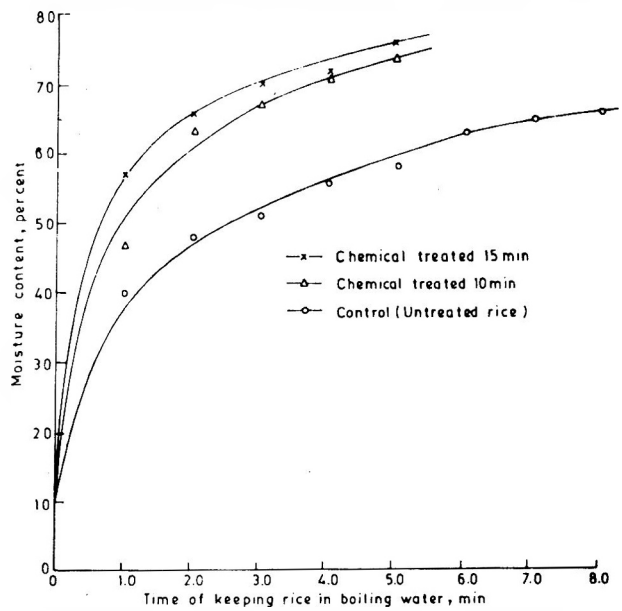

Fig. 1. Moisture absorption and cooking time relationship for raw rice

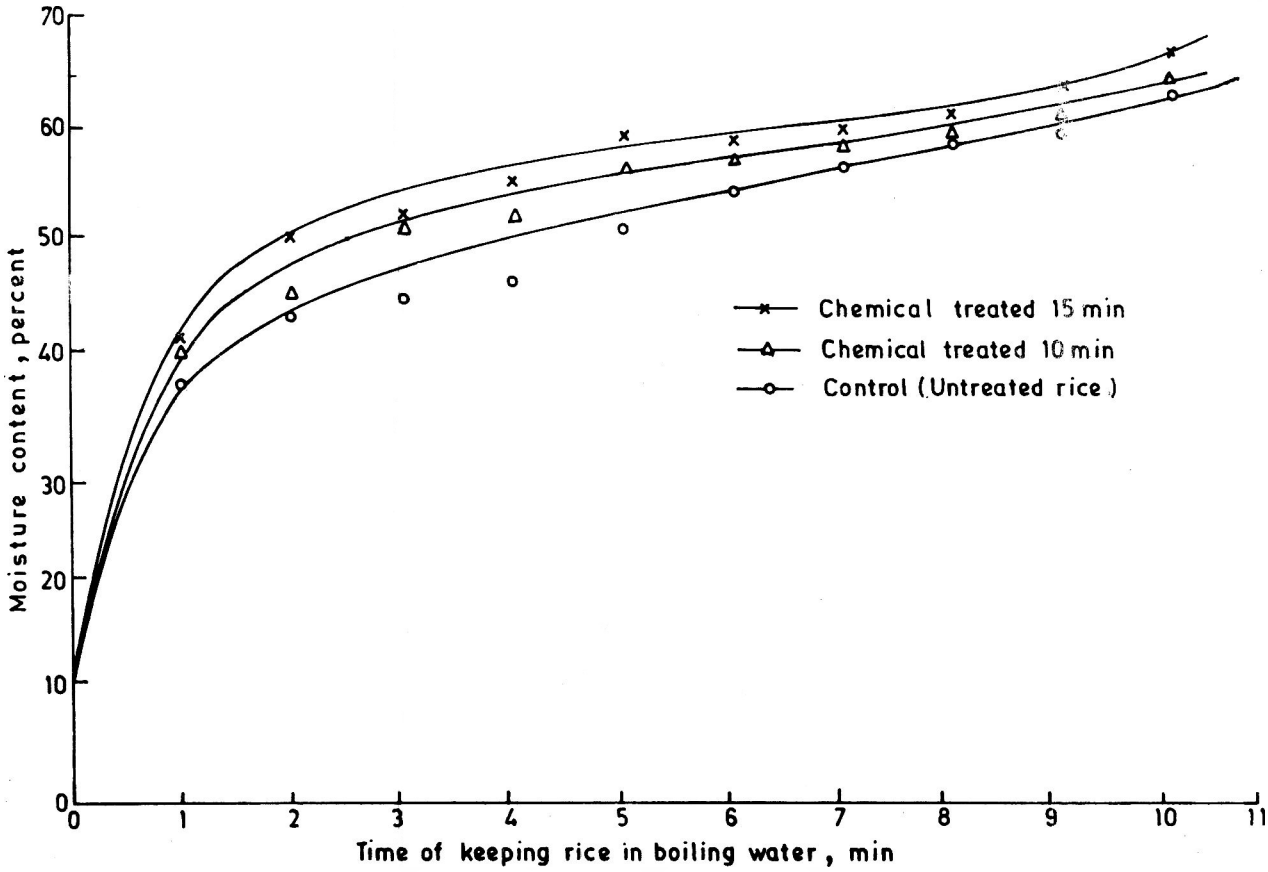

Fig. 2. Moisture absorption and cooking time relationship for parboiled rice

cooked in chemical solution for 10 min (cooking time 2.8 min) and 15 min (cooking time 1.9 min). For the 15 min chemically treated rice, the reduction in cooking time is therefore, 7.0/1.9 = 3.7.

In the case of parboiled rice, the rate of increase in moisture was less than the raw rice (Fig. 2). The parboiled rice cooked for 15 min in chemical solution took 9 min to attain 65 per cent moisture content whereas, the rice cooked for 10 min took 9.8 min. In case of control, the time was 10.5 min. The maximum reduction in cooking time is, therefore, 10.5/9 = 1.2. Slow rehydration in rate of parboiled rice as compared to raw rice is probably due to the changes in the starch and protein structures caused by gelatinization of starch during parboiling operation which restrict the chemicals of the cooking solution to bring further changes in the starch and protein structures. The use of chemical treatment would, therefore, be mainly applicable for reducing the cooking time of raw rice.

The whiteness of chemically treated raw rice and parboiled rice was slightly more than that of the 'control'. Chemically treated raw rice was found non-sticky. No difference in the stickiness of the 'control' and untreated parboiled rice was observed. Resistance against rupture during cooking was observed in the case of chemically treated rice. The reason for this might be the calcium chloride treatment of the rices before drying.

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SORPTION BEHAVIOUR OF MELON SEEDS

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Commercial samples of muskmelon, longmelon and watermelon seeds were analysed and found to be rich in fat and protein. Equilibrium relative humidities of muskmelon, longmelon and watermelon seeds were 50, 47 and 48% at initial moisture contents of 4.0, 4.0 and 4.3% respectively at room temperature (30 ± 5°C). The quality of the respective seeds during storage remained good upto an EMC of 7.50, 8.53 and 10.94% (RH 75%) beyond which the seeds were unacceptable and later became mouldy.

Melon seeds are rich sources of protein and fat and their kernels are used as dressing for bread, cake, confectionery, sweet meats and snack foods, often in place of almonds and pistachio. A refreshing beverage is also prepared from ground melon seed kernels which are considered beneficial in chronic or acute eczema and are reported to be diuretic[1]. Besides, these seeds are a good source of edible oil[2].

Melon seeds have been characterised for their chemical, nutritional and biological values[3]. The technological utilisation of these seeds has, however, not been explored except for some reports on seed extraction[4] and oil production from muskmelon[5] and processing of watermelon[6] seeds. Recently, physical characteristics of melon seeds were studied based on which a mechanical dehulling process was also developed[7,8]. Sorption behaviour of melon seed kernels also has been studied and reported[9]. However, prior to processing, the seeds are often required to be stored under proper conditions which should be determined. The knowledge of water sorption behaviour in this respect becomes necessary. The present studies were therefore, undertaken to assess the keeping quality of melon seeds under different humidity conditions.

Muskmelon, (*Cucumis melo* Linn) long melon (*Cucumis melo Var. Utilissimus)* and watermelon (*Citrullus vulgaris* Schrad.) seeds were procured from local market. Standard AOAC[10] methods were used for estimating chemical composition of duplicate samples of the respective seeds. Studies on sorption behaviour of melon seeds were carried out using weight equilibrium method[11]. Four grams of melon seeds were weighed and spread uniformly in petri dishes and were exposed to relative humidities ranging from 11 to 92 per cent in desiccators containing saturated salt solutions and kept at room temperature (30 ± 5°C). The changes in moisture content of the products were determined at intervals of 24 hr. Changes in colour, appearance, flow behaviour were also recorded.

The muskmelon, longmelon and watermelon seeds yielded 77, 66 and 43 per cent kernels respectively. The composition of seeds, kernels and hulls of melons is given in Table 1. The kernels of these seeds are rich in oil and protein ranging from 44.7 to 50.5 and 31.2 to 34.4 per cent respectively.

TABLE 1. CHEMICAL COMPOSITION OF SEEDS, KERNELS AND HULLS OF MELON SEEDS

Type of melon seeds	Seed part	Moisture (%)	Ash (%)	Crude fibre (%)	Crude fat (%)	Crude protein (%)	Carbo-hydrate (by diff.) (%)
Musk melon	Seed	5.5	3.5	20.8	33.8	25.5	10.9
	Kernel	4.3	4.1	3.2	44.7	34.4	9.3
	Hull	8.8	1.6	76.7	1.6	1.9	9.4
Long melon	Seed	5.4	3.7	23.5	33.8	22.6	11.0
	Kernel	4.2	4.5	2.8	47.5	31.2	10.8
	Hull	8.4	1.8	72.3	1.4	2.0	14.1
Water melon	Seed	6.8	2.8	38.3	21.1	15.6	15.4
	Kernel	3.8	4.0	1.8	50.5	32.0	7.9
	Hull	8.9	1.7	63.0	1.6	2.1	22.7

Analysed in duplicate

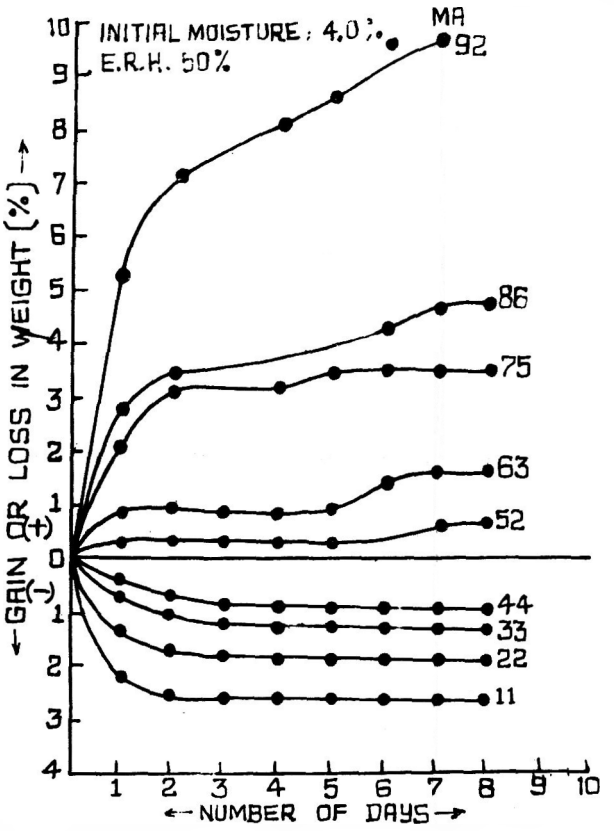

Fig. 1. Per cent change in weights of muskmelon seeds at different relative humidities.

The equilibrium relative humidities of muskmelon, longmelon and watermelon seeds were found to be 50, 47 and 48 per cent at initial moisture contents of 4.0, 4.0 and 4.3 per cent respectively. The changes in moisture content of muskmelon seeds equilibrated to different RH conditions at room temperature (30 ± 5°C) are given in Fig. 1. Longmelon and watermelon seeds also showed a similar trend in moisture changes under identical conditions. This may be attributed to the different moisture absorption capabilities of husks and kernels of the respective seeds. Further, the gain or loss of moisture by the husk is greater and quicker as compared to the kernels of the respective seeds.

All the samples remained in good and acceptable condition upto 75 per cent RH, beyond which they appeared sticky and were not acceptable. Mould growth was observed on 12th and 7th day of storage respectively at RH 86 and 92 per cent and corresponding moisture levels of 8.67 and 13.65 in muskmelon, 10.71 and 12.50 in longmelon and 11.05 and 18.50 per cent in water melon seeds (Table 2).

TABLE I. MOISTURE HUMIDITY RELATIONSHIP OF MELON SEEDS AT 30 ± 5°C

RH %	Equilibrium moisture content (%) Musk melon	Long melon	Water melon
11	1.46	1.58	1.85
22	2.50	1.80	2.03
33	3.12	3.01	3.30
44	3.58	3.69	4.02
52	4.53	4.78	4.75
63	5.69	6.00	5.65
75	7.50	8.53	10.94
86	8.67*	10.71*	11.05*
92	13.65**	12.50**	18.50**
	4.0(IM)	4.0(IM)	4.3(IM)
	50 ERH	47 (ERH)	48 (ERH)

*Mould appeared on these samples on 12th day
**Mould appeared on the samples on 7th day
IM: Initial moisture content (%)
ERH: Equilibrium relative humidity (%)

The moisture contents of 7.50, 8.53 and 10.94 per cent corresponding to 75 per cent RH were considered safe for the storage of respective seeds and the moisture above this critical level may lead to rapid deterioration.

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EFFECT OF DIFFERENT TREATMENTS AND DATE OF HARVESTING ON THE COLD STORAGE LIFE OF PATHARNAKH PEAR FRUITS

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Investigations were conducted to see the effect of chemicals and time of harvesting on the storage behaviour of 'Patharnakh' pear fruits at Amritsar, Punjab. None of the treatments improved all the characters of fruit quality at any stage. Ethephon 300 ppm and 3000 ppm at stage III and 2000 ppm at stages I and III exhibited higher physiological loss in weight (PLW) of the fruits over control. While the spoilage losses were minimised with its lower concentrations (300 and 400 ppm), ethephon at 400 ppm in stages II and III and its higher concentrations (2000 and 3000 ppm) gave fruits of good palatability rating. Calcium chloride treated fruits registered less PLW which were more firm at stage I and with 7.5 per cent at stage III over control but were of poor sensory quality and failed to effect physical characters including the spoilage of fruits. TSS and sugars, however, increased and acidity levels of fruits decreased during storage irrespective of the treatments. Ethephon at 300 ppm at stage I and 400 ppm at stage II and III proved most beneficial for the cold storage of 'Patharnakh'.

Patharnakh (*Pyrus pyrifolia* (Burm) Nakai) has become exceedingly popular in Punjab due to its adaptability to varying conditions of soil, climate and economic potentialities. The high post-harvest losses are great hindrance for establishing the fruit industry on a commercial scale. The marketing and storage of pear fruit need special attention to boost its production. Efforts are required to make the supply of pear fruit regular and also to protect the fruits from losses due to decay. The fruits shrink if picked earlier and will be of inferior sensory quality, whereas, over mature fruits are subjected to post-harvest losses[1]. The effect of chemicals to expedite or retard ripening, needs to be explored in depth so as to put the commercial production of pear fruit on sound footing. It is also essential to pick the fruits at proper stage of maturity and enhance its storability to increase net returns to the fruit growers.

Keeping the above objectives in mind, the present investigations to study the effect of different treatments and date of harvesting on the storage behaviour of 'Patharnakh' pear were conducted at Amritsar during 1986. The fruits harvested treated on three dates i.e. 21st July (Stage I), 31st July (Stage II) and 10th August (Stage III). The fruits were treated with ethephon at 300 and 400 ppm - 4 hr dip; ethephon 2000 and 3000 ppm - 2 min dip and calcium chloride 5 and 7.5 per cent - 30 min dip. Twenty fruits were packed in each polythene bag of 100 gauge thickness with 20 perforations (each of 0.4 cm diameter) and replicated thrice. The polythene bags were placed in ventillated wooden crates (40 × 18 × 16 cm size) and kept in the cold storage temperature of 0°C to 3.3°C having relative humidity 85-90 per cent for a period of 100, 90 and 80 days at stages I, II and III, respectively.

The loss in weight and spoilage of fruits were calculated and expressed in percentage. The fruit firmness was measured with the help of "Fruit - Tester" Penetrometre after removing skin by about one square inch. The palatibility rating was noted by a panel consisting of four judges, based on general appearance, taste and flavour (100 points). The total soluble solids were determined with hand refractometer. Total acids were estimated by titrating a known volume of juice with 0.1 N NaOH using phenolphthalein as an indicator. The results were expressed as per cent malic acid. Sugars were determined by the reported method[2].

Ethephon at 300 ppm and 3000 ppm in stage III and at 2000 ppm in stages I and III of fruit maturity exhibited higher physiological loss in weight (PLW) of fruits (Table 1). The lower concentrations have lowered spoilage losses at all the stages which were more at its highest concentration. The fruits treated with ethephon were less firm than control. Ethephon at higher concentrations in all the stages and at 400 ppm in stages II and III gave fruits of good organoleptic rating. In general, ethephon treatments lowered the acidity level of fruits (being minimum at 400 and 3000 ppm). These, however, improved total soluble solids (TSS), and reducing sugar contents at 300 ppm and higher concentrations and total sugars at 2000 ppm in stage I. Lack of firmness in fruit and improvement in fruit quality with ethephon treatments has also been reported[3].

Conversely, PLW on the fruits was less in calcium chloride treated fruits at all the stages of fruit maturity (Table 2). Similar observations were also recorded in 'Leconte' pear[6]. Although the fruits treated with calcium chloride at 5 and 7.5 per cent in stage I and with 7.5 per cent in stage III were more firm but failed to reduce spoilage losses over control. Moreover, the

TABLE 1. PHYSICO-CHEMICAL CHANGES AND SPOILAGE LOSSES IN THE ETHEPHON TREATED FRUITS AT DIFFERENT MATURITY LEVELS

Treatments								Sugars	
Chemical	Level (ppm)	PLW (%)	Spoilage (%)	Firmness (kg/in^2)	Palatibility rating (%)	T.S.S. (%)	Acidity (%)	Reducing (%)	Total (%)
				Maturity stage I					
Initial	-	-	-	9.83	43.33	9.47	0.53	5.18	6.23
Ethephon	300	9.30	2.50	7.08	63.33	12.33	0.22	5.77	7.55
Ethephon	400	10.86	4.17	6.92	63.33	11.93	0.20	5.59	7.11
Ethephon	2000	12.35	5.00	6.67	68.33	12.87	0.25	6.02	7.79
Ethephon	3000	11.20	10.00	6.83	70.00	12.87	0.22	6.03	7.45
Control	-	9.82	5.00	7.17	61.66	11.27	0.27	5.40	6.96
Mean	-	10.71	5.33	6.93	65.33	12.25	0.23	5.76	7.37
				Maturity stage II					
Initial	-	-	-	9.42	50.00	9.60	0.49	5.02	6.30
Ethephon	300	11.31	3.75	7.17	65.00	10.13	0.25	5.61	7.04
Ethephon	400	10.08	3.75	6.92	68.33	10.47	0.22	5.53	7.20
Ethephon	2000	11.23	5.42	7.33	65.00	10.47	0.27	5.84	7.76
Ethephon	3000	10.68	8.33	7.08	73.33	10.40	0.22	5.36	7.00
Control	-	9.44	7.08	8.26	63.33	10.07	0.30	5.40	7.96
Mean	-	10.55	5.67	7.35	67.00	10.31	0.25	5.55	7.39
				Maturity stage III					
Initial	-	-	-	9.17	53.33	9.67	0.41	4.63	6.53
Ethephon	300	12.65	4.17	6.58	63.33	10.32	0.22	5.47	7.50
Ethephon	400	10.62	2.50	6.33	68.33	10.06	0.18	5.10	7.47
Ethephon	2000	14.47	4.17	7.08	68.33	10.73	0.22	5.38	7.36
Ethephon	3000	13.23	7.08	7.17	68.00	10.80	0.20	5.25	7.59
Control	-	10.40	10.00	8.00	58.33	10.37	0.27	4.94	6.97
Mean	-	12.27	5.58	7.03	65.26	10.46	0.22	5.23	7.38
				C.D. at 5% level					
Maturity stage		NS	NS	NS	NS	0.46	0.02	0.23	0.13
Treatments		2.53	3.05	0.68	7.68	0.71	0.03	0.35	0.20
Interaction		NS	NS	NS	NS	NS	NS	NS	0.35

TABLE 2. PHYSICO-CHEMICAL CHANGES AND SPOILAGE LOSSES IN THE CALCIUM CHLORIDE TREATED FRUITS AT DIFFERENT MATURITY LEVELS

Treatments								Sugars	
Chemical	Level (%)	PLW (%)	Spoilage (%)	Firmness (kg/in^2)	Palatibility rating (%)	T.S.S. (%)	Acidity (%)	Reducing (%)	Total (%)
				Maturity stage I					
Initial	-	-	-	9.83	43.33	9.47	0.53	5.18	6.23
$CaCl_2$ 5	5	4.09	7.08	8.75	50.00	12.53	0.32	5.93	7.18
$CaCl_2$ 7.5	7.5	4.84	8.33	7.67	43.33	10.67	0.35	5.63	7.36
Control	-	9.82	5.00	7.17	61.66	11.27	0.27	5.40	6.96
Mean	-	6.25	6.80	7.86	51.66	11.49	0.31	5.65	7.17
				Maturity stage II					
Initial	-	-	-	9.42	50.00	9.60	0.49	5.09	6.30
$CaCl_2$	5	4.66	8.33	8.08	48.33	10.40	0.32	5.78	7.94
$CaCl_2$	7.5	5.09	10.00	7.50	46.67	10.13	0.37	5.36	7.42
Control	-	9.44	7.08	8.26	63.33	10.07	0.30	5.40	7.96
Mean	-	6.40	8.47	7.95	52.78	10.20	0.33	5.51	7.77
				Maturity stage III					
Initial	-	-	-	9.17	53.33	9.67	0.41	4.63	6.53
$CaCl_2$	5	4.97	10.00	7.33	40.00	9.93	0.22	5.39	7.98
$CaCl_2$	7.5	5.22	10.00	8.75	38.33	9.87	0.25	4.92	7.76
Control	-	10.40	10.00	8.00	58.33	10.37	0.27	4.94	6.97
Mean	-	6.86	10.00	8.03	45.55	10.06	0.22	5.08	7.57
				C.D. at 5% level					
Maturity stage		NS	NS	NS	NS	0.46	0.02	0.23	0.13
Treatments		2.53	3.05	0.68	0.68	0.71	0.03	0.35	0.20
Interaction		NS	NS	NS	NS	NS	NS	NS	0.35

fruits were of poor sensory quality. Increase in the firmness of fruits with the post-harvest application of calcium chloride has been reported[5].

TSS contents were more in stage I and reducing sugars at all the stages of fruit maturity with 5 per cent calcium chloride, while at 7.5 per cent treated fruits contained maximum level of acidity. Moreover, the fruits treated with 5 per cent calcium chloride gave higher level of total sugars than with 7.5 per cent in stages II and III and over control in stages I and III. Thus, lower concentration of calcium chloride proved better.

TSS and sugar contents increased and acidity decreased during storage (Tables 1 and 2). These results are in consistance with the earlier findings[4]. The date of harvesting failed to influence PLW, spoilage losses, firmness and palatability rating of the fruits significantly. Maximum TSS and minimum acidity levels were, however, observed in fruits harvested on July 21 (Stage I) and August 10 (stage III) respectively. In general, reducing sugars were higher in fruits of stage I and stage II (July 31 harvest) and total sugars in stage II and stage III (August 10 harvest).

Thus, the results of the study indicate that none of the treatments improved all the characters in the storage of 'Patharnakh' at any stage of harvesting. Ethephon treatments, however, proved better over calcium chloride treatments. Ethephon at 300 ppm in stage I and 400 ppm in stages II and III gave overall better performance than other treatments.

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CHEMICAL ANALYSIS OF SOME CULTIVARS OF *CURCUMA LONGA* LINN

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Chemical analysis of eleven cultivars of turmeric (*Curcuma longa*) was carried out to select the best variety for cultivation. The relative proportion of the three colouring pigments curcumin, demethoxycurcumin and bis-demethoxycurcumin was also determined by TLC separation followed by spectrophotometry. Results of analysis showed that the hybrid variety 'PCT-10' is promising for cultivation and trade. The two monoterpenes α-pinene and β-pinene are identified for the first time in the essential oils.

Turmeric, the dried rhizome of *Curcuma longa* Linn (Family: Zingiberaceae) is commercially important and exclusively used as a spice and condiment. Though some early analyses[1] were carried out, little information is available on the chemical composition of different cultivars of *Curcuma longa*. Turmeric is principally valued for its yellow colour which is due to the pigments, curcumin, demethoxycurcumin and bis-demethoxycurcumin present in it. According to Verghese *et al.*[2], the three TLC pure curcumins have EOA colour values of 14916, 15130 and 12036 respectively. The relative curcuminoid content is thus important for the total colour and hence a study of the composition of the curcuminoids in different cultivars has been undertaken to see whether it is cultivar specific.

Authentic samples of eleven cultivars of *Curcuma longa*, 'Amalapuram', 'Daragauhati', 'Thachanttykara', 'Pathanapuram,' 'Erode', 'Wynad' and the hybrid varieties 'PCT-2', 'PCT-5', 'PCT-10', 'PCT-15' and 'PCT-18' cultivated at the CPCRI Regional Centre (ICAR), Palode were used in this study. The fingers were sliced and dried in a cross flow dryer on perforated plates at 50°C (± 2°C) until the samples were crisp. The samples were powdered to 40 mesh size and used for analysis. The solvents used were of chemically pure grade and the chemicals used for the preparation of standard solutions were of analytical reagent grade. The moisture content was determined by toluene distillation method using dean stark apparatus[3,4]. Ash and acid insoluble ash[4] were determined by AOAC method. The volatile oil content was determined by clevanger distillation method[4]. Gas chromatographic analysis of the volatile oils was performed on a Hewlett Packard Model 5840 instrument: 6 ft Column 10 per cent OV-17, temperature programming 80-5-200°C and the run was continued for another 10 min at 200°C. The components were identified by comparison with retention times of authentic samples under identical conditions and by peak enhancement on co-injection with authentic sample.

The curcumin content was determined by ISI method[5]. Thin-layer chromatography was carried out on silica gel G plates using benzene-methanol mixture (80:6) as developing solvent. The three spots were scrapped out and eluted with ethyl alcohol. The relative concentration of each spot was determined from the optical density measurement at 425 nm[9].

UV/visible absorption measurements were made on a Hitachi-220 microprocessor controlled double beam spectrophotometer. The minerals sodium, potassium, and calcium present in the ash were determined using flame photometry[6]; iron[7], manganese[7] and phosphorus[8] by absorption spectrophotometry.

The ash content is a measure of the quality of the sample and acid insoluble, a measure of sandly matter in the sample. The ash content was minimum (4.49 per cent) in 'Daragauhati' (Table I). It has, however, shown the highest content of acid insoluble ash. The cultivar 'Thachanttykara' has shown minimum insoluble ash (0.14 per cent) and it has ash content of 4.79 per cent which is very close to that of 'Daragauhati'. The mineral content was determined in two representative samples 'Erode' and 'Pathanapuram'. Both the cultivars have shown similar sodium (0.025 and 0.021 per cent), potassium (27.25 and 27.19 per cent) and calcium (2.49 and 2.22 per cent) contents. The 'Erode' cultivar has high iron content (5.27 per cent) compared with 'Pathanapuram' (2.75 per cent).

The yield of the volatile oil in different cultivars ranged from 4.5 to 6.22 per cent on dry weight basis. The physical characteristics, refractive index and specific gravity are given in Table I. The values are quite comparable. The UV spectra of the oils from all the cultivars showed maximum absorption at 235 nm. Krishnamurthy *et al*[9] reported a maximum volatile oil content of 7.2 per cent for the cultivar 'Waigon' and of 4 per cent for the Erode variety. In the present study, the 'Erode' cultivar has shown 5.2 per cent volatile oil content. This may be due to the differences in the collection, maturity time and curing of the sample.

TABLE 1. ANALYSIS OF DIFFERENT CULTIVARS OF *CURCUMA LONGA*

Cultivar	Moisture (%)	Ash*	Acid insoluble ash*(%)	Volatile Oil				Curcuminoid content		
				%	Refr index at 20°C	Sp. gr. at 20°C	Total (%)	Relative proportion % Cur-cumin	Demetho-xycurcumin	Bis- deme-thoxy-curcumin
Amalapuram	10.87	4.81	0.27	5.58	1.4999	0.9010	4.21	42.05	34.75	23.20
Daragauhati	10.49	4.49	0.40	5.68	1.501	0.9173	4.71	50.50	28.60	20.90
Thackanttykara	10.00	4.79	0.14	4.99	1.501	0.9520	3.50	53.00	39.80	7.20
Pathanapuram	9.06	4.84	0.15	5.19	1.506	0.9490	5.48	56.70	24.80	18.50
Erode	9.31	4.75	0.33	5.20	1.509	0.9570	2.19	31.00	35.50	33.50
Wynad	11.10	5.24	0.33	6.06	1.504	0.9720	4.54	46.47	27.52	26.01
PCT-2	11.56	4.79	0.37	5.38	1.501	0.9500	4.50	50.80	27.80	21.40
PCT-5	10.31	8.05	0.23	4.56	1.502	0.9590	3.70	46.30	35.20	18.50
PCT-10	10.31	6.15	0.21	5.55	1.511	0.9320	7.74	45.70	22.00	32.30
PCT-15	11.59	5.29	0.24	5.08	1.500	0.9445	4.11	47.18	31.52	21.30
PCT-18	11.64	4.57	0.17	6.22	1.504	-	4.61	43.40	35.20	21.40

*Average values from duplicate measurements

TABLE 2. GAS CHROMATOGRAPHIC ANALYSIS OF VOLATILE OILS

Cultivar	α-pinene (%)	β-pinene (%)	1,8-cineole (%)	Zingiberene ar-curcumene (%)	ar-turme-rone (%)	Tumerone (%)	Unknown sesquiter-pene (%)	Total ses-quiterpene (%)
1	-	-	0.78	9.78	7.68	3.78	8.35	29.59
2	0.07	0.08	0.54	8.81	9.64	7.02	14.31	39.78
3	0.04	0.08	1.53	3.73	19.66	11.61	19.55	54.55
4	0.10	0.13	1.87	5.50	16.66	11.84	19.14	53.14
5	0.09	0.12	2.28	2.51	18.58	11.60	18.65	51.34
6	0.03	0.01	1.11	12.53	13.62	4.63	6.48	37.26
7	0.08	0.09	1.37	7.77	10.05	4.67	9.65	34.14
8	0.13	0.13	1.45	16.47	10.43	4.00	6.42	37.32
9	-	-	0.42	4.59	20.30	12.21	23.28	60.48
10	0.06	0.07	1.14	6.88	11.27	7.42	11.17	36.74
11	-	-	-	-	-	-	-	-

The chemical composition of the volatile oils is given in Table 2. Earlier work on the turmeric oil indicated about 40-50 per cent of turmerones. However, there appears to be some confusion about the presence of another sesquiterpene in the same region of the chromatogram while some other workers consider this as dihydroturmerone. We are unable to conclude whether this sesquiterpene is identical with dihydroturmerone and further work is in progress to isolate and identify this sesquiterpene. All the volatile oils also showed the presence of α-pinene and β-pinene except 'Amalapuram' and 'PCT-10'. The presence of α-pinene and β-pinene has been reported to *C. aromatica* and *C. zesoaria*. The presence of these two monoterpenes is observed for the first time in the cultivars of *C. longa*.

Turmeric is valued principally for its orange-yellow colour which is determined by the total curcuminoid content. Among the cultivars examined, the hybrid variety 'PCT-10' has the highest curcumin content of 7.74 per cent (Table 1). There is no significant variation in the relative proportions of curcumin and demethoxycurcumin while significant variation is obsrved in the relative composition of bis-demethoxycurcumin. For example 'Thachanttykara' cultivar contains only 7.20 per cent bis-demethoxycurcumin of total curcuminoids. The relative proportion of the curcumins does not seems to follow any fixed pattern with respect to total curcumin content among the cultivars studied.

Turmeric oil is at present a byproduct in the oleoresin industry and is a rich source of turmerones. Recently, attempts have been made to convert turmerones into value added products such as juvabione[10], nuciferal[11] and some new aroma chemicals[12]. It is likely that turmeric oil will be the futuristic raw material for such value added products. The volatile oil content (5.55 per cent) of the hybrid variety 'PCT-10' is only next to that

of the highest (6.22 per cent, 'PCT-18') and has the highest curcumin content of 7.74 per cent. Hence this variety is recommended for further cultivation and commercial exploitation.

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EFFECT OF STORAGE ON MICROBIAL QUALITY OF DRESSED CHICKEN HELD AT —18°C

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Eviscerated, whole broiler carcasses were aged at 5°C for 4,8 and 24 hr and subsequently frozen stored at - 18°C. They were microbiologically examined at one month intervals upto 6 months. The aging process carried out prior to freezing resulted in an increase in microbial load on the carcasses. A gradual reduction was however, recorded in different microbial counts during frozen storage. After six months of frozen storage, the chicken carcasses were found to be acceptable. No *Salmonella* was isolated from any of the samples.

Tropical conditions as prevailing in our country necessitates the use of different methods for extending shelf life of highly nutritious but perishable foods like chicken meat. Freezing and subsequent storage at -18°C is one of such a process which minimises microbiological and physico-chemical changes in the food. Once in vogue, the frozen stored chicken meat would require a code for shelf life and standards for its quality control. Hence, it is essential to understand various changes which might occur in these products during frozen storage. The present study was conducted to collect data on the microbiological changes on chicken carcasses during post-mortem aging and subsequent frozen storage at - 18°C as the degree of bacterial contamination can serve as an indicator of microbial quality[1]. This study describes the microbial quality of dressed chicken during frozen storage.

Eight week old broilers were processed at the dressing plant of the Institute. One group containing 14 carcasses was frozen within 15 min of slaughter, while the rest of the 42 birds were divided into three equal groups and subjected to post mortem ageing at 5°C for 4,8 and 24 hr respectively to facilitate a more tender product. They were also frozen subsequently by holding at - 18°C for 24 hrs and all the four groups were stored at - 18°C for 6 months.

Microbiological examination was conducted at monthly intervals upto 6 months by selecting carcasses in duplicates from each group. The frozen birds were thawed at 7°C for 12 hr prior to analysis[2]. Sampling was done by macerating one gram neck skin flaps with sterile sand. A 1 per cent sodium citrate solution was used as a diluent[3]. Appropriate serial dilutions were made for aerobic plate counts on plate count agar and for the presence of *staphylococci* on Baird-Parker agar, coliforms on violet red bile agar, *streptococci* on KF - *streptococcal* agar, yeast and moulds on acidify potato dextrose agar and *salmonellae* on brilliant green, and bismuth sulphite agar after enrichment in selenite cystine, and tetrathionate broth using standard procedures[4]. The data obtained were subjected to analysis of variance[5] and where significant differences were found, pair wise comparison of means was done following Duncan's multiple range test[6].

In general, counts of all groups of bacteria were found to reduce the length of frozen storage (Tables 1 and 2). the overall total counts decreased from $\log_{10}$ 4.1 to 2.9 in 6 months of frozen storage. A decrease in *enterobacteriaceae* and total counts in broiler parts frozen stored at - 12°C for 9 months was earlier reported by Bolder *et al.*[2] Contrary to this, no significant change in total counts, as well as, faecal

TABLE 1. MICROBIAL COUNTS (LOG_{10}) OF BROILER CARCASSES DURING FROZEN STORAGE

Storage period (days)	(Ageing time before freezing				Overall counts ± SE*
	15 min	4 hr	8 hr	24 hr	
Staphylococcal counts					
0	3.3	3.6	3.6	3.6	$3.6^{a} \pm 0.06$
120	3.0	3.0	3.3	3.4	$3.2^{b} \pm 0.07$
150	2.8	3.1	3.0	3.1	$3.0^{c} \pm 0.07$
180	2.6	2.9	2.8	3.0	$2.9^{c} \pm 0.06$
Coliform counts					
0	3.6	3.4	3.6	3.8	$3.6^{a} \pm 0.08$
120	2.8	2.8	2.9	2.9	$2.9^{b} \pm 0.02$
150	2.4	2.6	2.7	2.9	$2.7^{c} \pm 0.06$
180	2.2	2.6	2.6	2.7	$2.5^{d} \pm 0.10$
KF - Streptococcal counts					
0.	2.7	2.7	2.8	2.9	$2.9^{a} \pm 0.2$
120	0.9	1.8	2.1	2.2	$1.8^{b} \pm 0.3$
150	0	0	1.8	1.9	$0.9^{c} \pm 0.3$
180	0	0	1.2	1.6	$0.8^{c} \pm 0.3$
Yeast and moulds					
0	2.8	2.8	2.8	2.9	$2.8^{a} \pm 0.1$
120	0.9	1.7	1.9	2.1	$1.7^{b} \pm 0.2$
150	0	1.0	1.8	1.8	$1.2^{c} \pm 0.3$
180	0	0.4	1.2	1.5	$0.8^{c} \pm 0.2$

*Overall counts carrying similar superscripts do not differ significantly ($P < 0.05$) among themselves.

TABLE 2. ANALYSIS OF VARIANCE FOR DIFFERENT MICROBIAL COUNTS

Source	D.f.	Mean sum square				
		Total plate counts	Staphylo-cocci	Coli-forms	Strepto-cocci	Yeast moulds
Aging time (a)	3	0.46**	0.25**	0.31**	0.27**	1.63**
Frozen storages (b)	6	1.33**	0.38**	1.01**	3.69**	3.74**
a × b	18	0.09**	0.06**	0.09**	0.86**	0.53**
Error	28	0.01	0.02	0.03	0.12	0.20

** $P<0.01$

coliforms, *E. coli* and *S. aureus* was observed by Koburger *et al.*[7] during storage of smoked broilers at - 18°C for 12 months. Although frozen storage had significant effect in reducing the number of coliforms throughout the storage, the counts of *staphylococci*, *streptococci* and yeast and moulds did not decrease significantly after 150 days of frozen storage. Incidence of *staphylococci* is of great importance as the earlier work conducted in our laboratory has revealed that *S. aureus* isolates obtained from frozen chicken at different intervals retained their enterotoxigenicity[8].

Ageing of birds at 5°C for three different periods resulted in multiplication of microflora (Tables 1 and 2). Statistical analysis indicated a significant increas in the counts of different groups of bacteria especially during 8 and 24 hr of aging. This increase in counts also affected the final quality of carcass during frozen storage. The overall counts obtained after 6 months of storage showed that in general no significant difference was there in the microbial count of carcassses held for 15 min and 4 hr prior to frozen storage. However, further aging upto 8 and 24 hr resulted in higher bacterial counts in stored samples also. On the basis of these findings, it is recommended that birds may not be exposed to more than 4 hr of ageing prior to freezing. This would help in restricting bacterial growth on the carcasses and eventually produce a better product, in terms of microbial quality.

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BOOK REVIEWS

Dense gases for extraction and refining: E. Stahl, K-W-Quirin and D. Gerard, Springer - Verlag; Pp: 240; 1988; Price: DM 156.

The book under review is the English translation of the original work by the authors. The major emphasis has been laid on the possibilities of applying dense gases for obtaining and refining naturally occurring materials. In fact, the chapter dealing with various applications occupies more than half of the book and is fairly exhaustive and comprehensive - covering probably the entire range from extraction of oil seeds, waxes, etc. to extraction of wood, peat and lignite. Important up-to-date data on the yields, solubility isotherms, analytical results of actual extracts and the experimental conditions have been given. These data should prove valuable to those who would like to evaluate the use of dense gas extraction in any of these applications.

Apart from the extensive coverage of applications, the book also devotes the initial chapters to highlight the special physico-chemical principles involved in dense gas extraction *vis-a-vis* the other methods of extraction such as steam distillation the thermodynamic principles involved and the application of phase rule. However, the details in these chapters are kept to bare minimum without jeopardising the conceptual clarity.

The book as a whole, should interest any reader who works in the area of dense gas extraction specially the process development efforts towards applications. The book will definitely be a worthwhile addition to any library.

G.D. SURENDER
RRL, TRIVANDRUM

Food irradiation - A technology for preserving and improving the safety of food: World Health Organization, Geneva, Price: SW. fr 16 or US$ 12.80 pp:84; 1988;

The benefits of using ionizing radiation for extension of shelf-life disinfestation and microbial decontamination of agricultural and horticultural produce have been long recognized by the scientific world. The technology has been accepted and even commercialized in countries where the governments and public are convinced about its utility and safety.

However, skeptics have criticized the process by citing results of some ill-conceived experiments. They have been supported by confused members of public having impressions of the past atomic destruction and recent nuclear accidents firmly etched in thier minds.

The major challenge to food irradiation technology, therefore, lies in its acceptance by the general consumer without qualms. Though the individual governments and international organizations have done their best in identifying areas of application of the technology, wholesomeness and even legislative aspects, efforts in consumer's education are far from adequate. This book is a welcome attempt on the part of two major international organizations, WHO and FAO, in this direction.

Besides an introduction and a useful bibliography, the book contains six chapters covering established methods of food processing, the process of food irradiation, effects of food irradiation, practical applications of food irradiation, legislation and control of food irradiation and consumer acceptance. It also contains three very useful and handy annexures for everyone, including technical staff, providing information on list of countries that have cleared irradiated food for human consumption, Codex General Standards for Irradiated Foods and Recommended International Code of Practice for the Operation of Irradiation Facilities Used for the Treatment of Food.

The perusal of the book indicates that it has succeeded in its aim of providing basic information for general readers, students, policy makers, consumers and media regarding the benefits and safety of the technology and allay fears and apprehensions about the process. The contributions of eminent scientists edited by a highly experienced editiorial board have gone into the making of the book. The science behind the technology has been conveyed in simple and lucid manner without loosing the impact. The book does not suffer from any flaw but at a few places some statements do warrant clarity. The quality of pictures in the book could have been better. The price of the book should have been kept low to make it popular. Nevertheless, this does not diminish the value and usefulness of the book to the cause.

P.M. NAIR
B.A.R.C., BOMBAY

Low calorie products: Edited by B.G. Birch and M.C. Lindley, Elsevier Applied Publishers, Crown House, Linton Road, England; 1988; pp: 287; Price: $40.

Birch and Lindley have edited the papers presented at a symposium organised under the auspices of the National College of Food Technology (Department of

Food Science and Technology), University of Reading from 25-26 March 1987. The papers have brought an update of current literature on divergent fields like the importance of reduced diets in the management of diabetes, consequences of obesity, markets for low calorie foods, artificial sweeteners and appetite in man, use of Acesulfame-K in calorie reduced and low calorie products, methodology in the measurement of calorie availability, calorie value of fibre and guar gum, and legislation and low-calorie products. The book is precise and distinct in expression and is an easily readable document of valuable scientific and technical information and the publication of the book on "Low calorie products" fills in the long felt need. The term "low calorie" is used to cover three distinct types of food products: i.e. (1) products designed to aid in weight loss; (2) reduced calorie version of normal foods and (3) foods that are inherently low in calories. The general reduced calorie products including ready meals, soft drinks, low fat spread, skimmed milk, low fat yoghurt, CALO fats and oils. Each presentation has been adequately supported by extensive bibliography, graphs and tables.

In many countries, the reduced and low calorie food and beverage markets are now showing very exciting growth. Closely related to fat and cholesterol is obesity. Obesity can affect both quality of life and also longivity. It is often difficult to disentangle the causes and effects of obesity. Metabolism and cardiovascular, respiratory, and endocrine physiology are altered in the obese. It is well discussed that the energy-reduced diets as the means of achieving weight loss amongst obese individuals tend to emphasize the benefits of weight loss. The importance of therapeutic application of an energy modified food plan to both diabetics and their professional advisers to achieve the continued short term benefits of blood glucose content and ultimately with significant improvements in body weight, beneficial changes in the blood lipids as well.

A wide variety of sweeteners has been explained in detail. Artificial sweeteners constitute an important class of food additives which are being used in progressively increasing quantities. The sweeteners currently in use are saccharin, acesulfdeme -K, cyclamates and aspertones. Acesulfame -K, is approximately 200 times sweeter than sucrose. Due to its good stability, taste characteristics and safety acesulfame-K can be used as a single sweetener or in combination with other in terms or bulk sweeteners in a variety of foods and beverages. The methods used to determine calorie availability can be categorised as partial methods, indirect methods and direct methods. Palatinil (Isomalt) is a hydrogenated isomer of sucrose which provides the bulk, texture and bland taste. Polydextrose is a unique low-calorie (1 kg cal/g) bulking agent made from glucose.

The other part of the book deals with the calorie value of fibre and guar gum. Fibre is often considered to help subjects lose body fat or maintaain lowered fat stores. Fibres may affect body fat retention in three ways i.e., (1) it does so by effecting hunger, (2) by diluting dietary calories and (3) by modifying the efficiency of metabolism. Increasing intakes of fibre and guar gum have been considered casual their effects of lowering body weight and body fat in man. The role that food and food additives regulation plays in the development of new low calorie products is to ensure that both the food and the food additives are permitted only when genuine commercial and consumers needs exist for them.

Consumer taste is shifting from specific slimming foods to a generally healthier diet - more fibre, less fat and sugar, and therefore a net reduction in calorie intake.

This book provides a very useful information to food scientists, technologists, nutritionists, food manufacturers, food marketing managers, psychologists, sociologists, sensory evaluation experts and chemists. This book on the whole is well written and is worthy of possession in institutional libraries.

VIJAY KHADER
A.P. AGRIL. UNIVERSITY, HYDERABAD

AFST (I) news

Annual General Body Meeting 1988

The Annual General Body Meeting of the Association for the year 1988 was held on 5th May 1989 at CFTRI, Mysore. The following are the office bearers for the year 1989-90.

President	: Dr. L.V. Venkataraman
President-designate	: Dr. V. Sreenivasa Murthy
Vice-President HQ	: Dr. S.P. Manjrekar
Vice-Presidents	: Dr. P.G. Adsule
(Chapters)	*Dr. C.L. Nagarsekar*
	Dr. A.S. Bawa
	Mr. S.K. Sood
Hony. Exec. Secretary	: Dr. P. Haridas Rao
Hon. Joint Secretary	: Mr. P. Ramakrishna
Hon. Treasurer	: *Mr. N.S. Singh*

Nagpur Chapter

The Annual General Body Meeting was held on 30th June 1989. The following office bearers were elected for 1989-90

President	: Mr. A.M. Pande
Vice-Presidents	: Dr. S.D. Bhalerao and
	Dr. C.L. Adinarayanaiah
Hon. Secretary	: Mr. D.K. Kawadkar
Jt. Secretary	: Mr. S.V. Joshi
Hon. Treasurer	: Dr. G.V. Mulmuley

Hyderabad Chapter

In the Annual General Body Meeting following office bearers were unanimously elected for 1989-90

President	: Mr. G.V. Krishnamurthy
Vice-President	: Dr. Y. Sitarama Shastri
Hony. Secretary	: Mr. H.K. Guru Raj Rao
Jt. Secretary	: Mr. A. Satyanarayana
Hon. Treasurer	: Mr. K.A. Madhava

Bombay Chapter

The Annual General Body Meeting was held on 23rd June 1989.

The following office bearers were elected for 1989-90

President	: Dr. S.R. Padwal-Desai
Vice-Presidents	: Dr. D.R. Bongirwar and
	Dr. (Mrs) G. Subbulakshmi
Hon. Secretary	: Dr. S.M. Gaonkar
Hon. Jt. Secretary	: Dr. S.B.K. Warrier
Hon. Treasurer	: Dr. A.S. Gholap

A lecture on 'Making food processing a relevant Industry' by Mr. H.S. Gurudas, Executive Director, Protein Foods and Nutrition Development Association of India was arranged.

Pune Chapter

The Annual General Body Meeting was held on 17th March 1989. The following office bearers were elected for 1989-90.

President	: Dr (Mrs) P.P. Kanekar
Vice-President	: Mrs. Lalita Pradhan
Hony. Secretary	: Mrs. N.R. Joshi
Hony. Jt. Secretary	: Mrs. K.S. Reddy
Hony. Treasurer	: Mrs. S.S. Sarnaik

ASSOCIATION OF FOOD SCIENTISTS & TECHNOLOGISTS (INDIA)
CFTRI Campus, Mysore — 570 013, India

NOMINATIONS FOR AFST (I) AWARDS FOR 1989

Nominations for the following awards of the AFST (I) for the year 1989 are invited. All nominations should be sent by Registered post, so as to reach Honorary, Executive Secretary, Association of Food Scientists and Technologists (India), CFTRI Campus, Mysore — 570 013, before 31 January 1990.

PROF. V. SUBRAHMANYAN INDUSTRIAL ACHIEVEMENT AWARD

The guidelines for the award are:

(i) Only Indian nationals with outstanding achievement in the field of Food Science and Technology will be considered for the award.
(ii) The nominee should have contributed significantly to the enrichment of Food Science and Technology, and the development of agro-based food and allied industries in India.
(iii) The nomination duly proposed by a member of the Association must be accompanied by the biodata of the candidate highlighting the work done by him for which he is to be considered for the award.
(iv) The awardee will be selected by an expert panel constituted by the Central Executive Committee of the Association.

The envelope containing the nominations along with biodata and contributions (five copies) should be superscribed "Nomination for Prof. V. Subrahmanyan Industrial Achievement Award — 1989".

LALJEE GODHOO SMARAK NIDHI AWARD

The guidelines for the award are;

(i) The R & D group/person eligible for the award should have contributed significantly in the area of Food Science and Technology in recent years with a good standing in his/her field of specialisation.
(ii) The nominee(s) should be duly sponsored by the Head of the respective Scientific Institution and the application for this award should highlight complete details of the contributions made by the candidates and their significance.
(iii) The awardee(s) will be selected by an expert panel constituted by the Central Executive Committee of the Association.

The envelope containing the nominations (five copies) should be superscribed "Nomination for Laljee Godhoo Smarak Nidhi Award 1989".

BEST STUDENT AWARD

The award is to be given to a student having a distinguished academic record and undergoing the final year course in Food Science and Technology in any recognised University in India. The aim of the award is to recognise the best talent in the field and to encourage excellence amongst the student community.

The guidelines for the Award are:

(i) The applicant must be an Indian national
(ii) He/she must be a student of one of the following courses:
(a) M.Sc. (Food Science)/(Food Technology)
(b) B. Tech., B.Sc. (Tech), B.Sc. (Chem. Tech) with Food Technology specialisation.
(iii) He/she should not have completed 25 years of age on 31st December 1989.

Heads of the Department of Food Science and Technology in various Universities may sponsor the name of one student from each institution supported by the candidate's biodata, details starting from high school onwards, including date of birth and post-graduate performance to date (five copies).

The envelope containing the nomination should be superscribed "Nomination for Best Student Award — 1989".

YOUNG SCIENTIST AWARD

This award is aimed at stimulating distinguished scientific and technological research in the field of Food Science and Technology amongst young scientists in their early life.

The guidelines for the Award are:

1. The candidate should be an Indian national below the age of 35 years on 31st December 1989, working in the area of Food Science and Technology.

(i) The Candidate should furnish evidence of either:
(a) Original scientific research of high quality, primarily by way of published research papers and (especially if the papers are under joint authorship) the candidate's own contribution to the work.

OR

(b) Technological contributions of a high order, as reflected by accomplishments in process design etc., substantiated with documentary evidence.

The application along with details of contributions of biodata (five copies) may be sent by registered post with the envelope superscribed: "Nomination for Young Scientists Award 1989".

ANNOUNCING FELLOWSHIPS

ASSOCIATION OF FOOD SCIENTISTS AND TECHNOLOGISTS (INDIA)

Central Technological Research Institute Campus, Mysore - 570 013

Subject:- FELLOWSHIPS OF AFST(I)

The Association has pleasure in announcing conferring of Fellowships of AFST(I) entitled "Fellow of Association of Food Scientists and Technologists (India)" (FAFST) to honour persons who have contributed significantly to the progress of Food Science and Technology.

The following are the highlights of the Fellowships:

General:-

1. The awardee will be called as Fellow of Association of Food Scientists and Technologists (India) and in an abbreviated form will be termed as FAFST.
2. The total Fellowships of the Association will not exceed 5% of total membership including regular and life members of the Association in any given year or 100, whichever is lower.

Fellowships have been awarded to 20 AFST(I) members and 2 non-members who have contributed to the progress of Food Science and Technology.

Eligibility:-

1. The fellowship is to honour persons of outstanding merit who have contributed significantly in the field of Food Science and Technology including R&D, Product/Project Development, Industry, Transfer of Technology and Marketing. The merit of Contribution should be the main criterion.
2. Among the Fellows to be nominated every year 70% will be from ASFST(I) and remaining 30% may be from non-members who have contributed significantly for the development of Food Science and Technology.

Nominations:-

1. The nominee for Fellowship should be proposed by five AFST(I) members of good standing for a minimum of 5 years or by 2 fellows of the Association. This is applicable to AFST(I) members as well as non-members.
2. Any regular or life member of AFST(I) who has been continuously a member of the Association can sponsor the nomination for only one Fellowship in a particular year.
3. The nomination shall be accompanied by acceptance of the person proposed.
4. The nomination shall be in the format given. A brief biodata of the nominee with highlights of Scientific or Technological achievements in the area of Food Science and Technology supported by list of publication not exceeding 10 important research papers or other supporting documents not exceeding 20 pages must accompany the nominations.
5. The nomination duly proposed and accepted by the nominees's consent shall be sent to the Hony. Executive Secretary of AFST(I) by December 31, of each year.

Selection of Fellows:-

The nominations received will be placed before an expert committee appointed by CEC for suitable recommendations to CEC each year. CEC by majority decision will finalise Fellowships for each year. The decision of the CEC in this matter will be final.

Privileges of a Fellow:-

The following shall be entitled to the following rights:-

1. The awardee will be entitled to add FAFST after his name as short title.
2. To be present and vote at all general body meetings.
3. To propose and recommend the candidates for fellowship of the Association.
4. To receive gratis copies of one of the publications of AFST(I)
5. To fill any office of the AFST(I) duly elected.
6. To be nominated to any committee of AFST(I).
7. To offer papers and communications to be presented before the meeting of the Association.

Cessation of Fellowship:-

1. Any Fellow may withdraw from the Fellowship of the Association by signifying his wish to do so by a letter addressed to the Hony. Executive Secretary, AFST(I), which will be placed before CEC for acceptance.
2. Fellowship will be for life time of the member.
3. If the Association comes to know of any activity prejudicial to the interest and well being of the Association, the CEC will have the right to withdraw the Fellowship.

Conferring of Fellows:-

The Fellowship will be conferred with a Citation at the time of AGBM or at any other suitable function of the Association.

The Association may invite some fellows nominated each year to deliver special lectures in the area of their specialisation either at the AGBM or any other function arranged by AFST(I).

Please write to Hony. Executive Secretary, Association of Food Scientists & Technologists (India), CFTRI Campus, Mysore - 570 013, India for application forms for nominations.

Last date for receiving the nominations is 28th February 1990.

(Dr. P. Haridasa Rao)
Hon. Exec. Secretary.

ASSOCIATION OF FOOD SCIENTISTS & TECHNOLOGISTS (INDIA)
CFTRI CAMPUS, MYSORE — 570 013.

Nomination Form

We, the following members of AFST(I) wish to propose

Full name and academic distinction

FULL NAME :

ACADEMIC QUALIFICATION :

Date of Birth

Areas of specialization

for election of the Fellowship of AFST(I). We append below the statement of his/her claims for election as Fellow and certify that in our opinion he/she is fully qualified for that distinction. We also certify that he/she has been informed of the obligations attaching the fellowships of the AFST(I) and agreeble, if elected to abide by them.

Statement of the proposer (not to exceed 100 words) setting out the discovery, invention or other contribution to newer or process/products or the industrial development of the knowledge made by the candidate.

Seconder's name & Signature
Date :
Station :

Proposer's name & signature
Date :
Station :

(Signature of supporters from personal/general knowledge)

(1) (2) (3)

I agree for the above nomination

(name & signature)

Note: (1) Five copies of the candidate's bio data and list of important scientific publications not exceeding 10 pages and one set of reprints or supporting documents not exceeding 20 pages shall be attached to this form.

(2) Additional information that would be of assistance in considering the nomination may be supplied in separate sheet.

(3) Last date for receipt of nomination at the office is 31st December 1989.

INSTRUCTIONS TO AUTHORS

1. Manuscripts of papers (in triplicate) should be typewritten in double space on one side of bond paper. They should be complete and in final form. The paper should not have been published or communicated for publication anywhere else. Research Notes should clearly indicate the scope of the investigation and the salient features of the results. Only *invited* review papers will be published.

2. The typescript should be arranged in the following order: Title (to be typed in capital and small letters for Research Papers and all capitals for Research Notes), Authors' names (all capitals) and Affiliation (capitals and small letters). Also give a short running title not exceeding 10 words as a footnote.

3. **Abstract:** The abstract should indicate the principal findings of the paper and typed in single space. It should not be more than 200 words and in such a form that abstracting periodicals can readily use it.

4. Use names of chemical compounds and not their formulae in the text. Methods of sampling, number of replications and relevant statistical analyses should be indicated. Footnotes especially for text should be avoided as far as possible.

5. **Tables:** Tables as well as graphs, both representing the same set of data, should be avoided. Tables should be typed on *separate* sheets. Nil results should be indicated and distinguished clearly from absence of data, which is indicated by '——' sign. Tables should not have more than *nine* columns.

6. **Illustrations:** Graphs and other line drawings should be drawn in Indian ink on tracing paper or white drawing paper preferably art paper not bigger than 20 cm (OY axis) × 16 cm (OX axis). The lettering should be twice the size of the printed letter. Photographs must be on glossy paper and must have good contrast; **three copies** should be sent.

7. **References:** Names of all the authors along with title of the paper should be cited. Abbreviations such as *et al.*, *ibid*, *idem* should be avoided. References should be serially numbered as superscripts in the order they are cited in the text and the same order should be maintained in the reference list. The titles of all scientific periodicals should be abbreviated in conformity with the World List of Scientific Periodicals, Butterworths Scientific Publication, London, 1962.

   Citation should be as follows (note the underlines also):

   (*a*) *Research Paper*: Jadhav S S and Kulkarni P R, Presser amines in foods, J Fd Sci Technol, 1981, 18, 156.

   (*b*) *Book*: Venkataraman K, The Chemistry of Synthetic Dyes, Academic Press, Inc, New York, 1952, Vol. II, 966.

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

   (*d*) *Proceedings, Conferences and Symposia Papers*: Nambudiri E S and Lewis Y S, Cocoa in confectionery, Proceedings of the Symposium on the Status and Prospects of the Confectionery Industry in India, Mysore, May 1979, 27.

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

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

8. Consult the latest issue of the *Journal* for guidance. For "Additional Instructions for Reporting Results of Sensory Analysis" see **issue No. 1** of the Journal.

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Research Papers

Research Notes

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