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Research Notes

Evaluation of the Stability of Sausage Emulsion by the Canning of Mutton Sausages*

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Manuscript Received: 15 June 1973

Mutton sausages containing 40, 45, 50 and 55 per cent of lean, added mutton fat, vegetables and green curry stuff were prepared and their stability to canning was evaluated. The processing condition used was satisfactory and obtained commercial sterility. The integrity of each sausage was maintained well at 55 per cent lean. Fat separation to varying extents was observed and was least at 45 per cent lean. Similarly, the water absorption was highest at 45 per cent lean. Taking all the observations into consideration, sausages containing 50 per cent lean mutton are the most suitable for canning.

Stability of an emulsion is usually described in terms of time required for an apparently stable emulsion to break down into the two immiscible phases from the homogenous state of the continuous and discontinuous phase in the emulsion. The stabilization of the emulsion of two immiscible phases requires the presence of an emulsifier in the continuous phase. In the field of meat technology, emulsification of two immiscible phases of water and fat is achieved by the meat proteins, particularly the salt soluble fibrillar fraction[1, 2] which is used in the preparation of sausages and meat loaves of the fine ground type like frankfurters and bologna. The empirical classification of sausage meats into three classes with good, medium and poor binding quality, can now be substantiated on the basis of the proportion of characteristic groups of meat proteins like sarcoplasmic, fibrillar and stroma in the different sausage meats[3, 4].

In western countries, comminuted meat products like sausage is a by-product industry based on the trims and meat from such primal cuts like chuck, plates and flanks. In countries where an elaborate cutting system is not in vogue, sausages are prepared out of whole meat. It was shown in previous studies[5] that when mutton obtained by deboning a whole carcass was used, the proportion of meat in the sausage formulation could be reduced without sacrificing the firmness of the sausage. Preparation of mutton sausages incorporating vegetables and dried bread, was also reported in an earlier publication[6].

The stability of mutton sausage emulsion after the prepared sausages were canned, processed and stored under different conditions was investigated and the results are presented in this communication.

Materials and Methods

The whole dressed carcass of sheep was obtained from the local market, deboned and lean and fat separated. The lean mutton and fat were composited separately by grinding through a plate with 1/8 in. holes. The other ingredients used in the formulation were salt, chemicals ($NaNO_3$, $NaNO_2$ and sodium tripolyphosphate), spices (cumin, cinnamon, pepper and cloves), pre-cooked vegetables (carrot and tomatoes), green curry stuff (green ginger, green chillies, coriander leaves, garlic and onion) and binder. The compositions of the mutton sausage are given in Table 1. It was necessary to precook the vegetables to destroy the bacteria carried by them. Water was added to Batch I whereas partial removal of the water separated during pre-cooking of vegetables was necessary in the case of Batches II, III and IV.

The sausage emulsion was prepared in the following order using Stefan's machine, in which cutting knives rotate horizontally while a manual, vertically rotatable mixing attachment feeds the material on the sides to the cutting blades. The lean mutton, salt and chemicals were chopped first for two minutes followed by the addition of fat and the chopping was continued for two more minutes to emulsify

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TABLE 1. COMPOSITION OF THE MUTTON SAUSAGE FORMULATIONS

Ingredient%	Batch I	Batch II	Batch III	Batch IV
Lean mutton	40.0	45.0	50.0	55.0
Mutton fat[1]	13.3	15.0	16.7	18.3
Added water[2]	6.35	−0.35	−7.05	−13.65
Salt	1.50	1.50	1.50	1.50
Binder	3.00	3.00	3.00	3.00
Chemicals[3]	0.46	0.52	0.58	0.63
Spice mixture	0.35	0.35	0.35	0.35
Vegetables	17.5	17.5	17.5	17.5
Green curry stuff	17.5	17.5	17.5	17.5

[1] Mutton fat added was 1/3 of the lean meat.

[2] Water separated during pre-cooking was removed as necessary

[3] The amount of sodium tripolyphosphate added was 1 per cent of the lean meat.

the fat. The precooked vegetables, curry stuff, spices and binder were mixed with the manual mixing attachment and chopped for one minute. The total mix was 11 kg in each batch. All the ingredients were precooled to 4°C to minimise the rise of temperature during chopping. The rise in temperature during chopping was from 4 to 18°C. Rise in temperature beyond 18-20°C is detrimental to the stability of the emulsion[7].

The emulsion was stuffed into natural sausage casings (18-20 mm) using a hand stuffer and linked by twisting manually into 2½ in. long individual sausages. The string of sausages looped on an aluminium rod was placed in a hot air oven at 120°C for 45 min to cook the sausages to a central temperature of 71°C. The temperature during cooking was measured by a thermistor probe located at the centre of the sausage. The cooked sausages were cooled in a draught of air. The individual pieces were separated and stored at 0-1°C packed in polythene bags till canning.

Ten sausages were filled into each can (301 × 309 MPJ laquer, 30 cans per batch) manually. The interspaces were filled with hot (simmering) brine (1.5 per cent), containing spices to the same extent as the sausage formulation leaving a head space of ½ in. The cans were exhausted in an autoclave with flowing steam for 15 min and double seamed immediately. The sealed cans were processed for 45 min a 10 lb/sq inch steam pressure. After processing the cans were cooled in running water.

Each batch of 20 cans was divided into three lots of 10, 5 and 5 and incubated as follows. The lots of 10 were held at room temperature (25-27°C) while the other two were held at 35 and 55°C. The lots incubated at 35 and 55°C were removed at the end of 15 days and held at room temperature for further analysis. Cans held at room temperature were opened after 28-30 days. The incubated cans were opened 13-15 days after incubation. Five cans from each batch held at room temperature were opened after one year's storage.

The following observations were made on the cans: (i) vacuum, (ii) head space, (iii) drained weight[8], (iv) separated fat, (v) condition of individual sausages, (vi) consistency and (vii) pH of brine. From the data maintained on weight of the can (*a*) empty, (*b*) filled with sausages, (*c*) after topping up with brine, and (*d*) after processing (gross weight), the weight of sausages filled in each can and the loss during exhausting and seaming was calculated. After draining out the brine on standard seive for measuring the drained weight, the separated fat particles in the material were picked out and weighed. Particles of fat and disintegrated sausage material that have passed through the seive contribute to the cloudiness of the filling medium. The difference between weight of drained material and the sausages filled in each can was attributed to absorption of water.

Discussion

Material handling data upto the stage of cooked, cooled and packed sausages is given in Table 2. Total processing loss has been between 20-25 per cent. Among the four levels of lean mutton used for preparing the different batches, sausages containing 50 per cent lean mutton have shown the least

TABLE 2. MATERIAL BALANCE DATA

Observation	Batch I	Batch II	Batch III	Batch IV
Total ingredients (kg)	11.0	11.0	11.0	11.0
Sausage emulsion (kg)	10.7	10.5	10.4	10.7
Filled sausages (kg)	9.5	9.5	9.6	9.9
Cooked sausages (kg)	8.2	8.5	8.8	8.8
Processing loss (kg)	2.8	2.5	2.2	2.2
,, (%)	25.5	22.7	20.0	20.0
Cooking loss (kg)	1.3	1.0	0.8	1.1
,, (%)	11.8	9.1	7.3	10.0
Exper. cooking loss (kg)	0.95	0.89	0.67	0.78
,, (%)	8.6	8.1	6.1	7.1
Handling and evaporation loss (kg)	1.85	1.61	1.53	1.42
,, (%)	16.8	14.6	13.9	12.9
Post-cooking handling and evap. loss (kg)	0.35	0.11	0.13	0.32
,, (%)	3.2	1.0	1.2	2.9
Pre-cooking handling and evap. loss (kg)	1.5	1.5	1.4	1.1
,, (%)	13.6	13.6	12.7	10.0

All losses have been calculated on the basis of total weight of ingredients.

cooking loss, total as well as experimental. Apart from cooking loss, the sausages are subject to other handling and evaporative losses during processing. The difference between total processing loss and experimental cooking loss represents total handling and evaporation loss. The variation of this has been from 16.8 to 12.9 per cent. The difference between total cooking loss and experimental cooking loss represents post cooking handling and evaporation loss which varies from 1 to 3.2 per cent. Similarly the pre-cooking handling and evaporation loss ranges from 13.6 to 10 per cent.

Changes in distribution of sausage and brine due to processing and storage are given in Table 3. Since the sausages were filled into the cans by number and the sausages were not graded according to thickness, the weight filled into cans showed a difference of 40 to 55g in any one batch and a variation of 162 to 200 g between different batches. The amount of brine used to fill up the interspaces and to the desired head space also showed a similar variation of 125 to 160 g. The variation in filled weight was from 310 to 330g. Due to losses during exhausting and processing these variations ranged from 302 to 320g for net weight, 191 to 233g for drained weight and 73 to 115g for filling brine.

Post processing and storage characteristics of the canned sausages are given in Table 4. The purpose of incubating processed cans from each batch at ambient temperature (25°C) and 35 and 55°C is for the purpose of finding out whether the processing was adequate to achieve commercial sterility. Neutralisation of the vacuum, bulging and unpleasant odour after incubation would indicate gaseous spoilage. Decrease of pH would indicate thermophilic spoilage. The condition of sausage and brine would indicate any spoilage other than gaseous or thermophilic. These changes are judged in comparison with the cans at ambient temperature. In the present experiment it was observed that incubation did not give rise to neutralisation of vacuum. The variation in vacuum in the cans incubated and stored at different temperatures is 7 to 13 in. for ambient temperature, 8-15 in. for 35°C and 8 to 13 in. for 55°C. The variation observed was probably due to the influence of differences in head space and were probably caused by loss due to evaporation and spilling during exhausting and seaming. The difference in weight of the cans before exhausting and seaming and the gross weight of the can after processing, incubation and storage was taken to represent the loss due to evaporation and spilling. This loss ranged from 2.3 to 6.8 per cent.

The pH of the filling medium did not show any change on incubation at the different temperatures. The other observation on the filling medium showed no change in the odour, clarity or consistency. The brine in all cases tended to be cloudy to different extents depending on the extent of fat separation and splitting and/or disintegration of the side and/or end of the sausage. Splitting and disintegration was present in the sausages of Batch I containing 40 per cent lean muttor.. There was no splitting in Batch IV containing 55 per cent lean mutton in the cans stored at ambient temperature. In the other two batches the tendency was intermediate. Comparing the different incubation conditions within any batch

TABLE 3. CHANGES IN DISTRIBUTION OF SAUSAGE AND BRINE TO PROCESSING AND STORAGE

Batch No.	Incubation		Storage at RT	Pre-processing		Brine (g)	Post-processing		Brine (g)
	Temp °C	Days	days	Sausage (g)	Sausage+ brine (g)		Net wt (g)	Drained wt (g)	
I	25	28	...	166.7	309.7	142.9	302.0	190.8	111.2
	35	15	13	178.0	315.8	137.8	307.6	203.8	103.6
	55	15	13	180.0	318.4	138.4	310.4	195.4	115.0
	25	...	1 yr	174.2	314.8	140.6	307.6	194.8	112.8
II	25	28	...	169.2	330.4	161.2	314.2	200.0	114.0
	35	15	13	176.0	327.4	157.2	308.2	215.6	90.6
	55	15	13	161.6	318.8	150.8	302.6	200.6	102.4
	25	...	1 yr.	171.4	320.2	150.8	306.6	201.6	105.0
III	25	28	...	200.0	326.5	126.5	319.9	217.5	101.4
	35	15	19	185.0	323.4	138.4	301.0	228.4	72.6
	55	15	19	193.2	318.6	125.4	310.6	219.4	91.2
	25	...	1 yr.	200.0	326.2	126.2	314.4	233.0	79.4
IV	25	28	...	186.4	319.8	133.4	309.8	197.0	114.8
	35	15	15	187.2	325.0	137.8	303.4	196.8	106.6
	55	15	15	191.6	321.6	130.0	309.0	199.8	109.3
	25	...	1 yr.	186.2	320.0	133.8	309.6	197.0	112.6

TABLE 4. POST-PROCESSING AND STORAGE CHARACTERISTICS OF THE CANNED SAUSAGES

Batch No.	Incubation		Storage at RT days	Vacuum (in)	Head space xi/16 in.	Condition of sausage		pH
	Temp °C	Days				End	Side	
I	25	28	...	10.5	10.7	S+D	S	6.10
	35	15	13	9.0	9.6	S+D	S	6.10
	55	15	13	9.2	10.0	S+D	S	6.10
	25	...	1 yr.	10.4	10.6	S+D	S	6.09
II	25	28	...	11.2	9.5	S+D	S+D	6.05
	35	15	13	13.0	11.2	S	S+D	6.05
	55	15	13	12.2	11.6	S	S+D	6.05
	25	...	1 yr.	12.2	9.2	S	S	6.03
III	25	28	...	10.0	9.2	S	...	6.10
	35	15	19	13.0	12.2	S	...	6.10
	55	15	19	11.4	10.2	S+D	S	6.10
	25	...	1 yr.	9.4	9.2	S	...	6.09
IV	25	28	...	12.1	10.6	...	...	6.10
	35	15	15	11.8	12.0	S	...	6.10
	55	15	15	11.6	10.2	S	...	6.14
	25	...	1 yr.	11.0	10.4	...	...	6.10

S = Splitting D = Disintegration

In all cases the brine odour was fresh with cloudy nature and non-ropy consistency

TABLE 5. CHANGES IN SAUSAGES DUE TO PROCESSING AND STORAGE

Batch No.	Incubation		Storage at RT days	Exhausting and seaming loss		Drained wt. net wt. %	Fat separated		Water absorbed	
	Temp °C	Days		g.	%		g	%	g	%
I	25	28	...	7.6	2.5	63.1	6.0	3.1	18.1	10.9
	35	15	13	8.2	2.7	66.5	8.0	3.9	17.8	9.9
	55	15	13	8.0	2.5	63.1	9.4	4.8	6.0	3.5
	25	...	1 yr	7.2	2.3	63.3	5.8	2.9	14.8	11.5
II	25	28	...	16.2	4.9	63.7	0.2	0.1	30.6	18.3
	35	15	13	19.2	5.0	69.9	0	0	39.6	32.6
	55	15	13	16.2	5.1	66.2	0	0	38.8	22.3
	25	...	1 yr	15.6	4.8	65.8	0.2	0.1	30.0	17.4
III	25	28	...	8.2	4.9	68.1	2.4	1.1	15.1	7.6
	35	15	19	22.2	6.8	75.8	4.4	1.9	39.0	16.2
	55	15	19	8.0	2.5	70.6	7.8	3.6	18.4	9.6
	25	...	1 yr	16.8	4.8	74.4	2.4	1.0	28.6	14.5
IV	25	28	...	10.0	3.0	62.9	2.0	1.0	8.6	4.8
	35	15	15	21.8	6.7	65.0	5.8	2.9	3.0	1.6
	55	15	15	12.6	3.9	63.4	8.8	4.4	3.8	1.9
	25	...	1 yr	10.4	3.2	63.6	2.0	1.0	8.8	4.8

the tendency for splitting was more in the cans incubated at temperature higher than ambient; the highest being in cans incubated at 55°C.

The susceptibility to separation of fat from the sausages during canning was highest in Batch I containing 40 per cent lean and minimum in Batch II containing 45 per cent lean. Separation of fat in the case of the other two batches was intermediate. From the data on hand it is not possible to arrive at a valid conclusion on fat separation because the ratio of added fat to lean was equal in the four batches. The susceptibility to fat separation was more in cans incubated at the temperatures higher than ambient, the highest being in cans incubated at 55°C.

The differences in drained weight in the different batches and different incubation treatments were due only to the variation of the weight of the sausages filled into the cans. The water absorbed during

processing and storage also is involved in the drained weight. This absorption was highest in Batch II. Even though the absorption in Batch III was only 7.6 per cent, at the end of 28 days, this increased to 14.5 per cent on storage of the cans for 1 yr at ambient temperature. Incubation of the can at temperatures higher than ambient has resulted in less absorption in Batch I and IV but higher absorption in Batch II and III. From the available data, it is not possible to conclude whether there is any relation between susceptibility to fat separation and water absorption.

Considering all the observations together, Batch III containing 50 per cent of lean was the most suitable among the different levels investigated. The quality of the casing used to prepare the sausages also influences the stability of the resultant sausages.

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Microbiological Quality of *Pedha*

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***Pedha* samples purchased from the local market have been examined for their total microbial profile in terms of psychrophilic, mesophilic, thermophilic counts, coliforms and for the presence of coagulase-positive *Staphylococci*. The mesophilic count was the highest followed by psychrophilic and thermophilic counts. Coliforms, surprisingly, could not be detected in any of the samples examined. *Staphylococci* were detected in 14 of the 16 samples of which four were coagulase-positive and 64.3 per cent of the strains isolated haemolysed human red blood cells. Other characteristics of the Staphylococcal strains such as horse and rabbit blood haemolyses, gelatin liquefaction, aerobic and anaerobic mannitol fermentation and chromogenesis have been studied. The need to establish microbiological quality standards to protect the consumer has been stressed.**

Khoa obtained by partial dehydration of cow's milk or buffalo milk, is a major constituent of a variety of Indian sweets such as *Pedha*, *Burfi*, and *Gulabjamun*[1]. *Khoa* has a poor keeping quality[2] and attempts to extend its shelf life have not been very successful[3].

Sporadic incidences of food poisoning resulting from the consumption of milk products have been reported[4-6]. The high incidence of staphylococcal mastitis in Indian dairy herds[7-9] coupled with poor sanitary practices in the collection, handling, processing and storage of milk and milk products in the country provide ample opportunities for the proliferation of micro-organisms including pathogens in such products. Recently, Ghosh and Laxminarayana[10] reported the presence of enterotoxigenic *Staphylococci* in milk and milk products such as ice-cream, *kulfi* and cheddar cheese. Systematic investigations on the general microbiological profile of Indian dairy products, the levels of potential pathogens, and nature of toxins produced if any, are urgently needed so that microbiological standards could be laid down to protect the consumer.

The present work was started with a view to study the microbiological quality of market samples of *pedhas* with particular reference to the occurrence of enterotoxigenic strains of *Staphylococci*.

Materials and Methods

Samples of *pedhas* were collected from different sweet-meat shops in Bombay. Ten grams of the sample was emulsified in 90 ml of 1.25 per cent sodium citrate[11,12] solution by shaking with glass-beads on a rotatory shaker for 45 min which was found to be adequate for getting a homogeneous mixture. The emulsified sample was serially diluted and plated on modified total plate count agar[13]. Bromocresol purple (0.004 per cent) was added to the medium to distinguish the acid producing colonies from the non-acid producers. The petri-plates were incubated at 20, 35 and 55°C for 48 hr to get the psychrophilic, mesophilic and thermophilic counts.

Staphylococci were enumerated by plating on Baird-Parker's medium[14]. Plates were incubated at 37°C for 48 hr and typical black, shining, convex colonies, 1-3 mm in diameter, with either a surrounding zone, or no zone of clearance or those exhibiting a zone of opacity were counted. A number of atypical colonies (black, no egg yolk clearance) may be found on Baird-Parker's medium. These atypical colonies could be due to *Staphylococcus epidermis*, Lancefield group D, *Streptococci* (mainly *Streptococcus faecalis*), *Micrococci*, *Corynebacteriaceae*, *Enterobacteriaceae* (mainly *Citrobacter* and *Proteus* spp.) and *Pseudomonads*[15,16]. Typical colonies were confirmed as *Staphylococci* by microscopic examination, gram-staining and differentiated from the *Micrococci* on the basis of anaerobic fermentation of glucose[17].

Haemolytic activity of typical isolates was studied on plates containing nutrient agar overlaid with blood agar (10 per cent sterile defibrinated blood added to molten nutrient agar at 55°C).

The plasma-coagulase test was carried out as described by Evans and Niven[18]. Gelatin liquefaction and carbohydrate fermentation tests were

done according to Cruickshank[19]. Anaerobiosis was maintained by covering the medium in test tubes with 1-1.5 in. layer of sterile paraffin oil. Chromogenesis was observed by incubating the isolates on nutrient agar slants for 24 hr at 37°C and then transferring to room temperature for 24 hr[20].

Presence of coliforms were detected by the MPN method using brilliant green lactose bile broth and incubation for 48 hr at 37°C. Tubes showing acid and gas production were confirmed on Eosin-Methylene Blue (EMB) agar plates by incubating for 48 hours[21]. Three types of colonies are known to develop on EMB agar: (*a*) typical nucleated with or without metallic sheen; (*b*) atypical, opaque, unnucleated, pink; and (*c*) negative, all others[22]. Typical colonies of *Escherichia coli* show dark centres possessing a greenish metallic sheen, while typical colonies of *Aerobacter aerogenes* show brown centres and rarely possess a metallic sheen[23].

Results and Discussion

Table 1 depicts the total microbiological profile of each sample and also the average of the 16 samples screened. The average mesophilic count was the highest followed in decreasing order by the psychrophiles and thermophiles. The mesophiles were generally in larger numbers than the cold-tolerant organisms in 9 out of the 16 samples examined. The remaining samples showed a greater number of cold-tolerant organisms than true mesophilic types. Thermophilic organisms could not be detected in 3 of the samples although their number was generally lower in most cases. Sample 11 was exceptional in containing a higher number of thermophiles than either mesophiles or psychrophiles.

The mesophilic flora as represented by determination of total count during routine microbiological examination of food products serves as an index of the quality of the final product[24]. The mesophilic flora not being very much heat-resistant, are usually destroyed following the rigorous heat processing given to raw milk during manufacture of *khoa*. Freshly prepared *khoa* should thus be fairly low in mesophilic count. High mesophilic count in *pedhas* could be attributed to carry over from other ingredients like sugar, insanitary equipment and practices during manufacture, poor quality *khoa* or due to post-processing contamination.

The thermoduric and thermophilic bacteria including the spore-formers are generally found to be growing on the surfaces of ineffectively washed or improperly sanitized farm utensils and equipment especially when held at warm temperatures[21]. Since many of these form spores which can withstand the temperatures employed in *khoa* processing, these may survive in the product. A high thermophilic count indicates ineffective plant sanitation and/or aerial contamination of product.

The psychrophilic or cold-tolerant bacteria are mainly a problem in the refrigerated storage of such dairy products. Psychrophilic bacteria belonging to the genera *Pseudomonas*, *Achromobacter*, *Flavobacterium* and *Alcaligenes* have the undesirable effect of causing slime formation in dairy products held at low temperatures[21]. They also cause fruity, putrid, rancid flavours and odours. Since most of these are killed during the processing of milk to obtain *khoa*, their presence in *pedhas* could originate from water supplies used in rinsing utensils and

TABLE 1. MICRO ORGANISMS (PER G) OF PEDHA SAMPLES

Sample No.	Mesophilic	Thermophilic	Psychrophiles	Acid producers	*Staphylococci*
1.	1.00×10^{7}	2.10×10^{3}	1.90×10^{5}	...	1.50×10^{4}
2.	2.16×10^{5}	1.30×10^{3}	1.00×10^{5}	...	3.50×10^{3}
3.	6.00×10^{3}	Absent	3.20×10^{3}	...	4.60×10^{3}
4.	1.46×10^{4}	,,	5.00×10^{3}	...	Absent
5.	2.80×10^{4}	,,	1.10×10^{2}	1.30×10^{4}	2.30×10^{3}
6.	2.70×10^{4}	5.00×10^{2}	5.00×10^{3}	1.40×10^{4}	9.00×10^{3}
7.	2.20×10^{3}	1.40×10^{2}	5.90×10^{6}	2.20×10^{6}	2.79×10^{4}
8.	3.24×10^{5}	1.60×10^{2}	5.20×10^{5}	4.50×10^{4}	4.30×10^{4}
9.	4.00×10^{4}	2.20×10^{3}	3.70×10^{3}	1.50×10^{3}	Absent
10.	9.00×10^{3}	9.00×10^{2}	2.35×10^{5}	4.00×10^{3}	3.00×10^{3}
11.	4.00×10^{4}	1.19×10^{5}	1.62×10^{4}	1.40×10^{4}	6.70×10^{4}
12.	1.25×10^{5}	2.80×10^{3}	3.15×10^{5}	Absent	4.00×10^{2}
13.	4.60×10^{4}	4.40×10^{3}	2.81×10^{4}	,,	1.30×10^{4}
14.	3.30×10^{3}	4.00×10^{3}	3.16×10^{5}	,,	8.10×10^{3}
15.	4.16×10^{4}	4.00×10^{3}	1.07×10^{5}	1.10×10^{4}	7.20×10^{2}
16.	2.10×10^{4}	7.00×10^{3}	7.70×10^{3}	8.00×10^{3}	8.00×10^{1}
Av.	8.33×10^{5}	9.28×10^{3}	4.85×10^{5}	1.93×10^{5}	8.97×10^{3}

(...) indicates that samples were not examined for acid producing organisms.
No coliforms were detected in any of the samples.

equipment, ressdues on improperly cleaned equipment and splashings from the floor, etc[21]. A high count of cold-tolerant organisms could indicate that either the *khoa* used in the manufacture of *pedhas* or the *pedhas* themselves were held at temperatures permitting the growth of such organisms.

The average mesophilic count of the samples was considerably higher than the limits specified by the Indian Standards Institution for condensed milk[25] (500/g) and dry milk powder[26] (50,000/g). Acid producing micro-organisms were accounted for in 56 per cent of samples.

Curiously, coliforms were not detected in any of the samples examined. In view of the general lack of sanitation in most sweet-meat shops one would have reason to expect a high incidence of coliforms in *pedha* samples. The absence of coliforms in *pedhas* could probably be due to low available moisture and high sugar content in the environment which could inhibit their growth. Tanner has reported the total absence of coliforms in several samples of candies[27]. Addition of 10 per cent sucrose was shown to enhance the lethality of *Escherichia coli* in carbonated beverages[28]. Thus it seems likely that coliforms do not survive the high sugar concentration present in *pedhas*. Hence the mesophilic count is high in spite of the absence of coliforms. Studies on the survival of coliforms in experimentally inoculated packs of *pedhas* are in progress.

Staphylococci were detected in 14 out of the 16 samples examined and ranged between 80-15,000/g. The different characteristics of the isolated *Staphylococci* have been presented in Table 2.

The most widely used index of Staphylococcal enterotoxigenicity is the coagulase reaction based on the ability of culture filtrates to clot citrated or oxalated rabbit or human blood plasma[29-31]. Coagulase-positive *Staphylococci* are expected to produce a zone of clearing in Baird-Parker's medium within 24-30 hr at 35°C.[32] Prolonged incubation may lead to the zones becoming opaque due to lipase activity[33]. While most enterotoxic strains are coagulase-positive even coagulase negative strains have been involved in Staphylococcal food poisoning[34,35]. Typical black colonies exhibiting either zone of clearance (or opacity) or no zone of clearance were carefully examined for the other criteria such as pigment production, haemolysis of rabbit, horse and human blood, coagulase activity, anaerobic and aerobic mannitol fermentation and gelatin liquefaction. Twenty-eight per cent of the isolates produced golden yellow pigment, an equal number of isolates produced pale yellow pigment and the rest were colourless colonies. Seventy-five per cent of the golden yellow colonies gave a positive coagulase reaction, with the exception of a single isolate (No. 15). Out of the 14 isolates examined 4 showed haemolysis with rabbit blood, 7 with horse blood and 9 with human blood. Very good correlation was obtained between coagulase activity and haemolysis of rabbit blood, while some of the coagulase-negative strains also showed haemolysis with horse or human blood. No detailed investigation on the nature of the haemolysins produced was attempted at this stage. The alpha-haemolysin which is the best studied of all the exotoxins produced by virulent human strains of *Staphylococci* is known to haemolyse red blood cells of the rabbit, sheep, cow

TABLE 2. CHARACTERISTICS OF STAPHYLOCOCCI ISOLATED FROM PEDHA SAMPLES

Isolate number	ETGPA medium[1]	Chromogenesis[2]	Haemolysis of blood			Coagulase activity	Mannitol fermentation		Gelatin liquefaction
			Rabbit	Horse	Human		Aerobic	Anaerobic	
1.	+	GY	+	—	+	+	+	+	+
2.	+	GY	+	—	+	+	—	+	—
3.	—	W	—	+	+	—	—	—	+
5.	—	W	—	—	—	—	—	+	—
6.	—	W	—	+	—	—	—	+	—
7.	+	GY	+	—	—	+	+	+	+
8.	—	W	—	—	—	—	—	—	+
10.	—	W	—	+	+	—	—	+	+
11.	—	PY	—	+	+	—	—	+	+
12.	—	W	—	+	+	—	—	—	+
13.	—	PY	—	+	+	—	—	+	+
15A.	—	PY	—	—	+	—	—	—	+
15.	+	GY	—	—	—	—	—	—	—
16.	+	PY	+	+	+	+	—	+	—

[1] Zone of clearance or precipitation [2] On nutrient agar slants.
GY, Golden Yellow; PY, Pale Yellow; W, White

and goat but not those of man[20]. However, some of the isolates did haemolyse human red blood cells. The hamoolysin production has been attributed to be an outstanding character of several coagulase-positive strains, although coagulase-negative strains may also produce haemolysin[36,37]. All the coagulase-positive isolates showed positive anaerobic mannitol fermentation, confirming the earlier observation of Joshi and Dale[38]. North[39] however, reported no correlation between haemolysin formation and enterotoxigenicity. Several coagulase-negative strains were found to ferment mannitol anaerobically. Only 2 out of the 4 coagulase-positive strains exhibited gelatin liquefaction. No correlation was observed between gelatin liquefaction, coagulase and haemolysin production. Further work on phage typing of these isolates to ascertain their origin (human or saprophytic), study of the nature of the enterotoxins produced and methods of control are in progress.

The present study indicates the poor microbiological quality of our market samples of *pedhas*. The very high total count could be due to the use of poor quality raw material such as *khoa* or lack of proper plant sanitation or to post-processing contamination. The very high microbial load, in spite of the absence of coliforms, combined with the reported occurrence of coagulase-positive *Staphylococci* highlights the need to ensure reasonably safe standards for this popular commodity by the Governmental regulatory agencies. Establishment of minimum quality control procedures at various stages of processing would enable the processor to meet these specified standards.

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Studies on Groundnut Protein Concentrates Prepared by Alcohol and Acid Washing of the Defatted Flour

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Defatted groundnut flour was extracted with 80 per cent ethanol, 80 per cent isopropanol and 0.05N HCl with a view to obtaining bland protein concentrate. The total soluble solids extracted were about 15 per cent with the alcohols and about 22 per cent with acid. The acid-extracted residue contained about 67 per cent protein and showed a very low trypsin inhibitor activity. All the three extracted samples had aflatoxin levels below detectable limits while the original sample had 39 ppb. The nutritional value of the protein measured as PER remained unaffected in the extracted residues.

A large amount of work has been done on the processing of groundnut into edible grade flour for use in the development of protein-enriched foods[1-3]. One of the problems encountered in the use of the flour is its characteristic nutty flavour. Occasionally, there is also some bitter after taste in the product. These drawbacks can be overcome to some extent by suitable processing of the flour with added ingredients, spices, and flavours, but are not eliminated completely. Studies on soybean have indicated that a number of minor constituents present both in the lipid and non-lipid fractions are responsible for the characteristic beany flavour and that extraction procedures using aqueous alcoholic solvents offer promise of producing bland protein products and isolates[4-6]. Investigations on groundnut have also shown that some of the minor constituents present are bitter tasting and that many of the precursors to flavour factors are concentrated in the alcohol soluble fraction of defatted flour[6,7].

The presence of trypsin inhibitors, hemagglutinins, saponins, etc. in oilseeds also adversely affect the nutritional value[7]. These are believed to be eliminated in the whey fraction during protein isolation, or inactivated by heat processing[8]. A trypsin inhibitor manifesting approximately half the activity of soybean inhibitor and showing growth depressing effects in rats has been reported in groundnut[9,10]. A bitter-tasting and foam-producing glycoside has been isolated from the 80 per cent ethanol extract of groundnut hearts[11]. Four sapogenins have been isolated from the saponins of groundnut[12]. Further, use of aqueous alcoholic solvents has been reported to be effective in reducing aflatoxin levels in oilseed meals[13]. It was of interest therefore, to examine the extraction of edible defatted groundnut flour with solvents such as ethanol, isopropanol and hydrochloric acid with a view to obtaining bland protein concentrates for wider application in processed foods. The quality characteristics and nutritive value of such extracted flours are discussed in the present paper.

Materials and Methods

Defatted groundnut flour (*A*): Edible-grade expeller pressed groundnut cake obtained from an oil mill was coarsely ground (20-30 mesh) and solvent-extracted with hexane. The defatted meal was desolventized in a rotary vacuum drier at 50°C, cooled and ground to pass through a 60 mesh (BSS) sieve.

Alcohol-extracted flours (*B*, *C*): One hundred gram lots of the defatted flour were used for extraction with ethanol and isopropanol. The alcohol concentration was maintained at 80 per cent and three successive extractions were done with a meal-to-solvent ratio of 1:2, 1:1 and 1:1 respectively. The dispersion was kept stirred for 1 hr each time to ensure proper extraction of the solubles. After each extraction the dispersion was centrifuged and the supernatant collected. An aliquot of the extract was analysed for solid content. The extracted residues were spread in trays and dried in a current of warm air (50°C). The material was cooled, weighed and ground to pass through a 60 mesh sieve. Ethanol washed and isopropanol washed materials were designated B and C respectively.

Acid-extracted groundnut flour (*D*): Hundred grams of defatted groundnut flour was added to 800 ml of 0.05 N HCl and the dispersion was kept

stirred for 1 hr; the pH was around 4.5, the isoelectric point of groundnut proteins. The dispersion was centrifuged and the residue similarly extracted for a second time with 400 ml of the acid. A third extraction was done with 400 ml of distilled water, there being little change in the pH of the dispersion. The combined extract was analysed for total soluble solids. The extracted residue was dried in a shelf-drier (50°C), cooled, weighed and ground to 60 mesh.

Analysis of samples: The defatted groundnut flour and the samples of alcohol and acid extracted residues were analysed for moisture, protein and fat contents by standard procedures.[14] Aflatoxin content of the samples was determined by the method of Pons *et al*[15]. Trypsin inhibitor activity was determined by a modified method of Kunitz[16] using 1.0 per cent solution of Merck soluble casein in 0.1M phosphate buffer of pH 7.6 as substrate and 0.1 per cent solution of Merck trypsin (2000 E/g) as enzyme source. The inhibitor solution was prepared by extracting the test material with 0.05 N HCl (10 per cent w/v). Trypsin inhibitor activity was expressed in terms of amount of trypsin inhibited and measured by comparing the trypsin activity of two samples of trypsin, one containing a known amount of inhibitor and the other without any inhibitor. The difference in activity was expressed as trypsin inhibitor units per milligram protein used.

Protein solubility: The protein solubility of the samples was carried out in the pH range 1-11, by dispersing 1.0 g of the sample in 40.0 ml water and adjusting to the desired pH using acid or alkali. The dispersions were stirred in a magnetic stirrer for 30 min, centrifuged at 3000 rpm for 15 min and an aliquot of the supernatant analysed for nitrogen content. The percentage of soluble nitrogen was calculated[17]. The results are plotted in Fig. 1.

Bench scale preparation of the concentrate: After conducting the preliminary studies with 100 g lots of groundnut flour, larger batches of 2500 g of the raw material were extracted with the three different solvents. The conditions were similar to those described earlier except that clarification of the dispersions was done in a Westfalia (LWA-205) multi-purpose laboratory centrifuge with a clarifier attachment for continuous settling of solids. The dried residues were used for nutritional assay.

Nutritional studies: The protein efficiency ratios (PER) of the protein in the defatted groundnut flour (A), the alcohol washed flours (B and C), and the acid washed flour (D) were determined at 10 per cent protein level according to the standard procedure[18], with skim milk powder (E) as control.

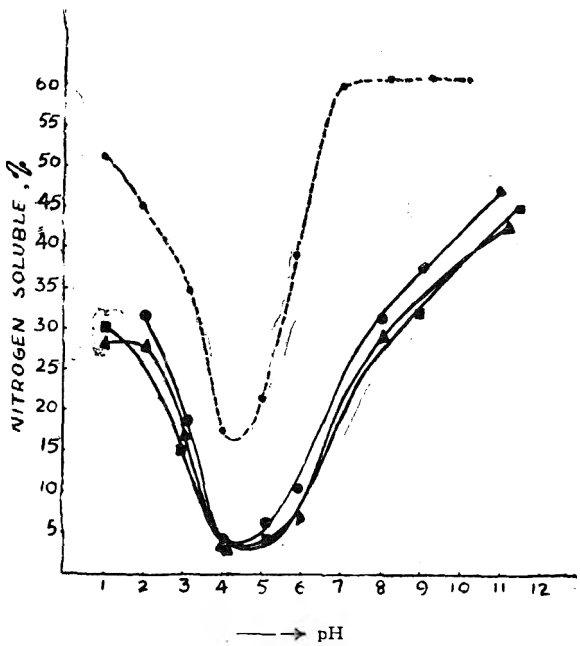

FIG. 1. Nitrogen solubility of groundnut flour and concentrates at different pH values

---●---●--- defatted flour; —□—□— ethanol extracted flour; —△—△— isopropanol extracted flour; —●—●— acid extracted flour

Results and Discussion

Data presented in Table 1 show that the total solids extracted by 80 per cent ethanol and 80 per cent isopropanol were comparable and amount to about 15 per cent on the defatted flour. More than 50 per cent of the extractable solids came in the first extraction and there was a progressive decrease in the subsequent two extractions. The extraction with 0.05N HCl on the other hand yielded 22 per cent total soluble solids, and nearly 70 per cent was obtained in the first extraction. The difference in the behaviour between the aclohols and acid could be due to the solubilization by acid of low-molecular weight peptides and proteins such as trypsin inhibitors, etc. as shown in Table 2 by the higher protein content of the extracted residue. The protein content of the alcohol washed samples is about 62 per cent and that of the acid washed sample is 67 per cent, compared

TABLE 1. EXTRACTION OF SOLUBLE SOLIDS FROM GROUNDNUT FLOUR WITH ALCOHOLS AND ACID

Solvent	% Soluble solids extracted			Total solids extracted %
	1st extn.	2nd extn.	3rd extn.	
Ethanol 80%	8.61	4.62	2.03	15.26
Isopropanol 80%	8.13	4.46	2.48	15.07
HCl 0.05N	15.70	4.32	2.14	22.16

TABLE 2. CHEMICAL CHARACTERISTICS OF PROCESSED GROUNDNUT PROTEIN CONCENTRATES

Material	Protein (dry basis) %	Petroleum ether extractives %	TIU* × 10^{-3} per mg protein	Aflatoxin ppb
Defatted groundnut flour	56.1	0.79	3.66	39
Ethanol extracted flour	62.6	0.35	2.56	N.D.
Isopropanol extracted flour	61.6	0.44	2.88	,,
Acid extracted flour	67.4	0.76	0.54	,,

*Trypsin inhibitor units
N.D. Not detectable

TABLE 3. PROTEIN EFFICIENCY RATIO OF GROUNDNUT PROTEIN CONCENTRATES OBTAINED FROM DEFATTED FLOUR

	Material	Protein level %	Protein intake g	Wt. gain g	P.E.R.
A.	Original sample	10.3	24.8	50.5	2.12
B.	Ethanol extracted flour	10.1	24.0†	47.9†	1.95*
C.	Isopropanol extracted flour	10.1	23.6‡	50.1‡	2.15*
D.	Acid extracted flour	11.3	26.8	51.0	1.91
E.	Skim milk powder (control)	9.5	23.5	67.8	2.85

*Value for one rat was estimated by the missing plot technique
†Average of 6 observations
‡Average of 7 observations

R. B. Design: 5 groups of 8 rats each; 21 day weanling rats of initial body weight around 32 g.

Test of significance

B~C	0.17*	C~D	0.20*
B~D	0.03‡	D~E	0.24†
B~E	0.21*	C~E	0.04‡

*Significant at 5 per cent level; †Significant at 1 per cent level; ‡Not significant

to 56 per cent in the defatted flour used. Thus acid extraction appears to give a product of higher protein content which could be considered a protein concentrate. There was a reduction in the fat content in the alcohol-extracted samples from 0.79 to about 0.4 per cent while the acid extracted flour had the same fat content (0.76 per cent) as the original. The trypsin inhibitor activity of the acid washed samples was the lowest (0.54 units) while the alcohol extracted samples retained 70-80 per cent of the activity of the original sample. Aflatoxin was below detectable limits in all the extracted samples, while the original sample had a content of 39 ppb.

The protein peptization curves for the different samples in the pH range 1-11 are given in Fig. 1. The original sample gave a pattern similar to that observed by other workers[19] but with the maximum solubility around 61 per cent. The iso-electric point was around pH 4.4 where the per cent solubility was about 16. The three extracted samples show solubility curves different from that of the original sample but similar among themselves. The maximum solubility for the three extracted materials, occurring at pH 11, ranged from 42-47 per cent, while the minimum solubility at the iso-electric point was about 3 per cent. The difference in behaviour between the original and the extracted samples could be due to the removal by extraction of most of the soluble non-protein nitrogenous constituents, as also to protein denaturation occurring during such extraction, as with the soybean[20,21].

Data on the gain in weight and protein intake of weanling rats fed on the different materials at about 10 per cent protein level are given in Table 3. The original flour caused an average gain in weight of 50.5 g in 4 weeks yielding a PER of 2.12. The samples extracted with ethanol, isopropanol and acid gave gains in weight of 47.9, 50.1 and 51.0 g respectively with corresponding PER values of 1.95, 2.15 and 1.91. Thus there appears to be no marked alteration in the nutritive value of the protein as a result of acid or alcohol extraction.

Extraction of groundnut flour with aqueous alcoholic solvents or dilute acid offers scope for obtaining bland protein concentrates without change in nutritional value, while aflatoxin present is also mostly eliminated.

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Development of Quick Cooking Dehydrated Curried Spinach-Dehusked Red Gram

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Spinach has been dehydrated by the method of deep fat frying without impairing its green colour. The optimum conditions of blanching with or without calcium chloride treatment and partial drying before frying and subsequent deep fat frying of spinach have been determined based on leaching of oxalic acid and green colour into the blanching water and frying oil respectively, minimum percentage of conversion of chlorophyll to pheophytin and organoleptic quality of the processed material. The deep fat fried spinach has been curried along with precooked dehydrated red gram. The curried product is found to be stable upto one year both at ambient temperature (24-30°C) and at 37°C.

Spinach is one of the popular green leafy vegetables used in various culinary preparations. Large quantities of this vegetable are consumed in the canned form by our Armed Forces. Canning of spinach has got the disadvantages of weight and bulk. Therefore work was taken up to develop dehydrated curried spinach. Hot air dried spinach was found to be too fibrous and dull in colour which took more than 15 min for reconstitution in boiling water. Work done to improve colour, flavour and reconstitution properties of spinach by deep fat frying and formulation of a curried mix in combination with dehusked pre-cooked dehydrated red gram is reported in this communication.

Materials and Methods

Fresh spinach leaves as procured from local market were trimmed and washed well in running water to remove grits and other impurities. It was blanched in tap water at 95°C with and without the addition of calcium chloride (0.25-1 per cent) for different periods of time (1-10 min). After blanching, thoroughly drained spinach was dried in cross flow cabinet drier at 70°C for different periods, air velocity being 180 meters/min. After partial dehydration spinach leaves were fried in hydrogenated vegetable oil, keeping ratio of the blanched material to oil 1:4. Source of heat and other frying conditions were kept similar in all the cases. In order to determine optimum frying conditions put-in temperature and subsequent frying temperature of the frying medium were varied.

Conversion of chlorophyll to pheophytin was determined by the method reported by Dietrich, *et al.*[1] The percentage of oxalic acid leached into blanching water was determined by titration against standard permanganate solution after washing precipitates

of calcium oxalate with distilled water free from reducing substance and dissolving them in dilute sulphuric acid. When tap water was used, oxalic acid was precipitated by adding excess of calcium chloride. Calcium content in blanched spinach was determined by AOAC[2] method. The colour leaching into frying oil was determined by comparing transmitted light with standard colour disc using Lovibond Tintometer.

Spice mixture was prepared by powdering the locally available coriander seeds, turmeric and red chillies to 60 mesh, mixing them in the ratio of 10:7:3 by weight and roasting on hot plate at 150-200°C till roasted flavour developed (5-10 min depending upon batch size).

Ginger-starch was prepared as follows:

Locally available fresh ginger was soaked in 0.1 per cent potassium permanganate solution for 15 min and it was peeled using potato-peeler and minced using meat mincer. The corn starch was roasted to low moisture (1-2 per cent) at 150-200°C on a hot plate. It was mixed with minced ginger in the ratio of 1:1 by weight and dried to low moisture in fluidised bed drier for 1 hr at 60°C.

Tomato-starch was prepared by drying 2 kg tomato puree of 16° Brix after mixing with 1 kg of roasted corn starch in fluidised bed drier. Tomato puree was mixed in four instalments of 660, 550, 400 and 390g respectively and dried for 30 min after mixing each instalment. This was finally dried for 60 min at 60°C after the last mixing.

The recipe formulated contained 54, 27, 5, 6.5, 1.5 and 6g each of fried spinach, dehydrated red gram *dal*, spice mixture, tomato-starch, ginger-starch and salt respectively. Pre-cooked dehydrated dehusked red gram was prepared by the method reported by Bhatia *et al*[3].

The ingredients prepared as above were mixed with tomato starch or in its place roasted corn starch and packed with or without compression, first in MST cellophane (300 grade) and then in kraft paper (60 BC) aluminium foil (.02 mm) polythene (150 gauge) laminate. Pressure of 1,000 psi and dwell period of 30 sec were given for compression. For determining the degree of browning and overall colour change during storage mixing was done separately for individual packets i.e. in batches of 100 g to avoid batch to batch variation due to improper mixing.

All the above packs were stored under ambient conditions (20 to 31°C) and at 37°C, while control samples were kept in deep freeze. They were per odically analysed for general acceptability i.e. flavour, consistency and colour of the reconstituted sample. Reconstitution was done by adding sample to three times its weight of boiling water and simmering till cooked. Degree of browning was determined by the method reported by Hendel *et al*[4].

Results and Discussion

Table 1 shows the amount of oxalic acid leached out into blanching water and calcium absorbed by the blanched spinach. It was observed that the oxalic acid leached out decreases in the increasing order of calcium chloride in blanching water. When calcium chloride is not used in blanching water, blanching time has to be restricted to 3 min beyond this spinach leaves become too mashy and subsequent handling was difficult. When blanched in 0.25 per cent calcium chloride for 5 to 7 min, the leaching of oxalic acid is slightly less but there is threefold increase in calcium content. When concentration of calcium chloride is further increased, calcium absorption is too much so as to impart bitter taste to the fried product. Increase in blanching time is advantageous from the point of view of removal of nitrate salts which, on processing, are converted into toxic nitrite salts[5]. There was marginal increase in reconstitution time when spinach was blanched in 25 per cent calcium chloride for 5 to 7 min but this was nullified when converted into curry mix. Curry mix could be reconstituted in four minutes. Water uptake was three times.

It was found that although there was minimum conversion of chlorophyll to pheophytin, (Tables 2 and 3)

TABLE 1. DETERMINATION OF OPTIMUM CONDITIONS OF BLANCHING

% $CaCl_2$ in blanching water	Blanching time (min)	% Oxalic acid leached into blanching water	% Calcium in blanched spinach	Reconstitution time (min)
0.0	1	0.39	—	4
	2	0.50	—	4
	3	0.55	0.08	4
0.25	3	0.27	0.11	4.5
	5	0.37	0.21	5
	7	0.40	0.23	6
	10	0.55	0.33	7
0.5	3	0.15	0.41	8
	5	0.16	0.42	8
	7	0.17	0.43	9
	10	0.21	0.46	9
1.0	3	0.13	0.50	10
	5	0.14	0.52	10
	7	0.14	0.58	11
	10	0.15	0.62	12

TABLE 2. DETERMINATION OF OPTIMUM DRYING CONDITIONS BEFORE FRYING

Drying time (min)	Moisture %	% Conversion of chlorophyll into pheophytin		Frying time (min)	Tintometer readings		Reconstitution time (min)	Organoleptic quality
		Before frying	After frying		Blue units	Yellow units		
0	92.1	18.2	46.6	15	2.0	97.9	5	Poor
15	90.6	24.4	77.7	10	1.6	76.5	5	Fair
25	89.3	30.8	69.8	7	0.9	71.0	5	,,
35	86.0	42.0	63.3	3.5	0.2	20.4	5	Good
45	84.8	46.4	52.9	2.8	Nil	7.7	5	,,
55	80.7	48.2	49.9	2.5	Nil	6.9	5	Very good
65	78.8	58.4	63.0	2	Nil	6.5	6	Good
75	75.8	61.4	64.8	1.5	Nil	5.5	7	Fair
90	—	63.0	64.4	1.5	Nil	3.5	8	Poor
105	—	63.3	65.3	1.25	Nil	2.4	10	,,

there was significant loss of chlorophyll, carotene and possibly flavouring principles. This made the resultant curried spinach of inferior quality. Partial dehydration of spinach before frying decreased the frying time and hence leaching of colour into frying medium. Although, there was more conversion of chlorophyll to pheophytin on partial dehydration, this was compensated by less conversion during subsequent frying when spinach was dehydrated for 55 min and moisture level reduced to 80.7 per cent from initial level of 92 per cent. This stage of partial dehydration can be considered to be optimum. Also at this level, organoleptic quality was found to be good because of decrease in leaching losses and if frying time was further reduced by further dehydrating spinach, it was not possible to detect the end point of frying correctly and therefore conversion of chlorophyll to pheophytin increased and flavour was adversely affected due to development of slight charred smell although leaching losses further decreased. There was increase in reconstitution time on further partially dehydrating before frying the spinach, possibly due to case hardening.

Tomato puree and minced ginger could be dehydrated by using fluidised bed drier, by using corn starch as dehydrating aid which helped in the locking of fresh ginger and tomato flavours. These items along with roasted spice mixture improved the colour and flavour of the curry mix. Corn starch also improved the consistency of the reconstituted product. Pre-cooked, dehydrated, dehusked red gram not only blended the taste to the desired level but increased the protein content of the product to 13.5 per cent. Other components were: moisture, 3; fat, 34.2; ash, 9.95; crude fibre, 3.3 per cent; and carbohydrates by difference, 36.1 per cent. Proximate composition shows that the developed curry mix can be good adjunct to a meal provided other components are low in fat.

TABLE 3. DETERMINATION OF OPTIMUM FRYING CONDITION

Put in temp. C	Frying temp. C	Frying time (min.)	Tintometer reading (Yellow units)	Organoleptic quality
	160	2	6.1	Fair
200	150	3	6.9	Good
	140	4	9.5	,,
	160	2.5	7.0	Very good
180	150	3	7.8	Good
	140	3.5	8.1	,,
170	150	3.5	8.5	Fair
	140	6	16.0	,,

On storage of samples under ambient conditions and at 37°C it was found by taste panel that samples were acceptable organoleptically up to one year even at 37°C and there was no change in reconstitution properties. There was also no significant increase in browning. Optical density at 420 mμ increased from 0.115 and 0.110 for curry mix with or without tomato starch and compressed bar increased to 0.13 under ambient conditions and 0.14 and 0.135 respectively when stored at 37°C.

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Development of Quick Cooking Dehydrated Curried Vegetables Using Fried Potatoes, Peas, Cabbage and French Beans

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Conditions for frying of cabbage and French beans to low moisture contents were standardised for formulation of dehydrated curry mixes. Curry mixes based on cabbage-potato, French beans-potato and peas-potato combinations had good acceptability as regards flavour, colour and reconstitution properties both initially and after storage for one year under ambient conditions and at 37°C.

It has been reported by Bhatia[1] that deep fat frying improves the reconstitution properties, but all vegetables could not be fried to low moisture content. Cabbage and French beans were chosen as two representative vegetables for improving the frying technique to achieve low moisture content since the former turned brown and lost all its green colour when fried to low moisture content. The present communication reports the results of work on the determination of optimum frying conditions of cabbage and French beans of improved colour and reconstitution property and their conversion into curry mixes having a reasonable shelf life.

Materials and Methods

Firm green cabbages procured from local market were washed thoroughly and good leaves separated and cut into strips of about 1.5 cm width, after removing central thick veins. These were then blanched in boiling water containing 0.1 per cent calcium chloride for 5 min, drained thoroughly and dried in a cross flow cabinet drier at 70°C for different periods. The air velocity was 180 metres/min and tray load was 3.6 kg/sq m. Blanched as well as partially dehydrated cabbage were deep fat fried keeping the ratio of material (blanched and drained) to hydrogenated oil 1:4. Optimum conditions for frying were arrived at after several frying trials varying the put-in temperature, frying temperature and time and the moisture content of the material before frying. The colour leaching into frying oil was determined by comparing transmitted light with standard colour discs using Lovibond tintometer.

Tender flat type French beans (*Phaseolus vulgaris* L) procured from the local market were washed, trimmed and cut into transverse segments of 1 cm thickness. These were then treated to fix green colour as reported by Gururaja Rao *et al.*[2] Final blanching was done for six minutes. Blanched French beans segments were fried with or without partial dehydration and optimum conditions were determined as in the case of cabbage. Conversion of chlorophyll to pheophytin was determined by the method reported by Dietrich *et al.*[3] Potatoes and green peas were fried by the method reported by Jayaraman *et al.*[4] Instead of cutting potatoes into strips, cubes of 0.5 cm were made. Onions were dehydrated by the method reported by Gururaja Rao *et al.*[2] Tomato-starch, ginger-starch and spice mixture were prepared as in the case of curry mixes based on fried spinach and dehusked red gram[5]. For the preparation of minced cabbage, veins removed in the preparation of fried cabbage were utilised and mince was prepared using 3 mm diameter hole disc after steaming at atmospheric pressure till cooked and steeping for 10 min in 0.125 per cent potassium meta-bisulphite and dehydrated at 60°C in a fluidised bed drier, to less than 6 per cent moisture.

Suitable recipes as given in Table 1 were formulated for curry mixes from three combinations, cabbage-potatoes, beans-potatoes and peas-potatoes. Minimum spices were used to suit all tastes and the recipes were evaluated by a taste panel selected from staff members. Curry mixes from combinations of fried cabbage-potatoes and fried French beans-potatoes were packed in kraft paper (30 B.C.)/polythene (150 gauge)/aluminium foil (0.02 mm) laminate after pre-packing in MST cellophane (300 grade) with or without compression, using a pressure of 100 psi and dwell period of 30 sec, which was found to be optimum.

TABLE 1. RECIPES OF CURRY MIXES

Ingredient %	Potato-cabbage	Potato-beans	Potato-beans
Fried cabbage	30.0	—	—
Dehydrated cabbage mince	7.5	—	—
Fried potato	37.5	37.5	55.0
Fried peas	—	—	28.0
Fried beans	—	37.5	—
Dehydrated onion	—	7.5	—
Spice mixture*	10.0	4.0	4.0
Tomato-starch	5.0†	5.0	4.0
Ginger-starch	4.0	2.5	3.0
Salt	6.0	6.0	6.0

*This consisted of roasted coriander, turmeric and red chillies powder in the ratio of 10:7:3.

†In samples without tomato-starch, this was substituted by roasted corn starch containing 0.2 ml lemon essence.

All the above packed dehydrated curry mixes were stored under ambient conditions, 37°C and at —10°C. They were periodically subjected to same taste panel which was used for developmental work and compared with the samples stored in deep freeze. Taste panel was asked to give overall acceptability with regard to flavour, texture and consistency of the reconstituted samples. Reconstitution was done by adding required amount of boiling water and simmering till cooked (Table 6). Flavour of the reconstituted sample was also evaluated by threshold dilution method as reported by Tilgner[6]. Proximate composition of the curry mixes was determined by AOAC[7] methods.

Results and Discussion

Results of frying with or without calcium chloride treatment after partial dehydration are given in Table 2. As reported by Patton[8] in case of fried potato chips, this treatment considerably reduced the degree of browning in fried cabbage. Addition of 0.5 per cent calcium chloride in blanching water was optimum (calcium absorption 55.3mg/100 g blanched material) as blanching in higher concentrations of calcium chloride though reduced the browning further imparted undesirable bitter taste and increased reconstitution time.

Partial dehydration before frying improved the flavour of the fried cabbage and French beans (Table 3 and 4). In case of cabbage it also prevented leaching of yellow colour into frying oil possibly due to less contact time with frying oil. In cabbage partial dehydration for about 60 min, when its moisture content reduced from 93 to 85 per cent, was considered optimum. There was no leaching of colour into frying oil when French beans were fried

TABLE 2. EFFECT OF BLANCHING IN WATER CONTAINING CALCIUM CHLORIDE ON DEGREE OF BROWNING IN FRIED CABBAGE

$\%CaCl_2$ (anhydrous)	Reconstitution time (min.)	Browning Opt. density 420 mμ	Ca in blanched cabbage mg/100 g
0	4	0.40	17.04
0.10	4	0.16	19.27
0.25	4	0.10	29.31
0.50	5	0.07	55.30
0.75	5.5	0.03*	78.29
1.00	6.5	0.01*	109.26
1.50	9.0	0.01*	176.61

*Bitter taste in fried products.

TABLE 3. EFFECT OF PARTIAL DRYING BEFORE FRYING ON THE COLOUR AND FRYING TIME OF CABBAGE

Moisture %	Drying time (min)	Frying time (min)	Tintometer reading (yellow units)	Reconstitution time (min)	Organoleptic quality
93.4	0	13.5	1.4	5	Fair
92.8	15	10.5	1.0	5	,,
91.9	30	9	0.9	5	,,
90.9	40	8	0.8	6	Good
87.8	50	6	0.6	6	,,
84.9	60	5	0.6	6	Very good
79.9	75	2	0.6	7	Poor
74.3	90	1	0.6	7	,,
68.5	105	1	0.6	7.5	,,
61.3	120	0.5	0.6	8.5	,,

TABLE 4. EFFECT OF PARTIAL DRYING OF FRENCH BEANS ON ITS FRYING QUALITY

Moisture (%)	Drying time (min)	Frying time (min)	Conversion of chlorophyll to pheophytin After drying	Conversion of chlorophyll to pheophytin After frying	Reconstitution time (min)	Organoleptic quality
92.0	0	5	13.4	28.6	4.0	Good
90.9	15	4	14.0	33.3	4.5	,,
88.6	30	2	20.0	37.5	5.0	Very good
87.6	40	1'50"	22.2	44.2	5.0	Fair
85.9	50	1'40"	24.0	66.6	6.0	Poor
83.6	60	1	30.8	66.0	7.0	,,
82.8	75	—	33.4	—	—	—

even without partial dehydration. However, flavour was found to improve when dehydrated for 30 min (moisture content reduced from 92 to 88.6 per cent). Although there was more conversion of chlorophyll to pheophytin when fried after partial dehydration, dehydration to this stage can be considered to be advantageous from flavour point of view. In the case of both the vegetables, there was increase in

TABLE 5. DETERMINATION OF DEGREE OF BROWNING ON STORAGE (OPTICAL DENSITY—420 mμ)

Product	Moisture (fat free basis)	Initial	3 months		6 months		8 months		10 months		1 year	
			Amb	37°C	Amb	37°C	Amb	37°C	Amb	37°C	Amb	37°C
Potato-cabbage												
Without tomato-starch		0.41 (15.50)	0.41 (15.50)	0.42 (15.50)	0.44 (15.50)	0.5 (14)	0.48 (15)	0.56 (13)	0.52 (14.50)	0.58 (12.5)	0.54 (14.50)	0.60 (12)
With tomato-starch	4.2	0.255 (18)	0.255 (18)	0.30 (18)	0.31 (18)	0.33 (17.50)	0.32 (17.50)	0.36 (17)	0.34 (17)	0.38 (16)	0.36 (16.50)	0.40 (15.50)
Compressed bar with tomato-starch		0.24 (18)	0.26 (17.50)	0.265 (17)	0.29 (17)	0.32 (16)	0.30 (17)	0.34 (15.50)	0.34 (16)	0.38 (14.50)	0.36 (15.50)	0.42 (14)
Potato-beans												
Without tomato starch		0.24 (11)	0.26 (11)	0.32 (10)	0.28 (10.50)	0.45 (9)	0.30 (10.50)	0.48 (10.5)	0.32 (10.00)	0.50 (8)	0.33 (9.50)	0.52 (7)
With tomato-starch	7.9	0.25 (11)	0.26 (11)	0.28 (11)	0.28 (10.50)	0.40 (9.50)	0.29 (10)	0.29 (10)	0.30 (10)	0.44 (8.50)	0.30 (9.50)	0.45 (7.50)
Compressed bar with tomato-starch		0.26 (11)	0.28 (11)	0.31 (10)	0.34 (10)	0.49 (9)	0.35 (9.50)	0.35 (9.50)	0.36 (9.50)	0.53 (8)	0.37 (9)	0.54 (7)

Reflectance meter readings are given within the brackets. Amb: Ambient

TABLE 6. CHANGES IN THE RECONSTITUTION TIME AND ORGANOLEPTIC QUALITY OF CURRIED MIXES FROM FRIED VEGETABLES

		Potato-cabbage					Potato-beans				
		Initial	6 months		12 months		Initial	6 months		12 months	
			Ambient	37°C	Ambient	37°C		Ambient	37°C	Ambient	37°C
Reconstitution time (min.)		6	6	6	6.5	7	6	6	6.5	6.5	7
Water uptake (ml/100 mg)		400	400	400	400	350	350	350	325	325	300
Organoleptic quality		Good	Good	Good	Good	Fair	Good	Good	Good*	Good*	Good
Threshold dilution	Flavour	1:275	1:250	1:225	1:225	1:250	1:225	1:200	1:200	1:200	1:250
index	Odour	1:175	1:175	1:150	1:150	1:150	1:150	1:150	1:150	1:175	1:175

*little fibrous

reconstitution time when partially dehydrated and fried which might be due to case hardening because of initial hot air dehydration.

It was found that for both the vegetables, put-in temperature of 180°C and a frying temperature of 130 and 150°C were optimum for getting fried product of good flavour in the case of cabbage and French beans respectively. At higher put-in temperatures it was difficult to determine end point and slight charring took place. At lower frying temperatures frying time increased and there was loss of flavour.

Dehydrated curried vegetables, based on fried cabbage, beans or green peas with fried potatoes, incorporating ginger-starch, tomato-starch and spice mixture were found to have good flavour, appearance and reconstitution properties. Ginger-starch and tomato-starch not only imparted fresh ginger flavour or tomato flavour and colour to the reconstituted product, but also improved the consistency of the product.

Curried fried vegetable mixes had good reconstitution properties. Reconstitution time of 6 min of fried French beans and fried cabbage in boiling water is much less as compared to corresponding dehydrated vegetables for which reconstitution time is reported[9] to be 12 to 15 and 20 to 25 min respectively. This may be because of prevention of case hardening or puffing due to sudden increase in temperature.

The drawback of frying vegetables like cabbage, to low moisture content is that in final stage of frying (dehydration), temperature cannot be kept low enough to avoid flavour loss. In order to make up this loss of fresh vegetable flavour, 7.5 per cent dehydrated minced cabbage was added to the curry mix. This improved the flavour and the consistency of the reconstituted product. Compressed samples had better reconstitution property but reconstituted product was inferior in appearance.

Storage studies showed that curry mixes based on fried vegetables at 37°C were acceptable for one

TABLE 7. PROXIMATE COMPOSITION OF THE CURRIED MIXES

Product	Moisture %	Fat %	Protein %	Ash %	Crude fibre %	Carbo-hydrate by diff.
Potato-cabbage	2.6	36.8	5.6	7.4	2.8	45.0
Potato-beans	4.9	38.0	4.9	6.5	2.8	42.9
Potato-peas	2.6	22.5	8.8	9.2	8.2	48.7

year with regard to flavour but there was change in texture and reconstitution properties with little browning (Tables 5 and 6). French beans became slightly fibrous even under ambient conditions of storage. There was increase in reconstitution time by one minute in both the cases.

Proximate analysis is given in Table 7 which shows that curry mixes developed can form part of a combat ration provided other items in ration are not rich in fat.

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Residues and Persistence of Endosulfan (Thiodan) in the Head and Leaves of Cauliflower

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Residues of endosulfan, sprayed at 0.05 and 0.1 per cent, in the head and leaves of cauliflower, was estimated by a spectrophotometric method. There was a rapid degradation of endosulfan in the head and leaves, as indicated by half-life of about 3 and 4 days respectively. In five days, endosulfan residues reached below the permissible level of 2 ppm, in the head when sprayed with recommended dose of 0.05 per cent, but slightly more time was needed when sprayed with 0.1 per cent. No residues were found on leaves 30 days after application.

Cauliflower (*Brassica oleracea* var. *botrytis*) is one of the favoured vegetables and is consumed extensively throughout India. Even to meet the demands of the city dwellers, this vegetable is grown largely in the adjoining villages also. Unfortunately this vegetable is attacked by a variety of insect pests from seedling to harvest and therefore, needs constant protection. However, from consumers safety, only those insecticides which have broad effectiveness but shorter residual life and low mammalian toxicity, like malathion[1-5], carbaryl[5-7] and lindane[8] are recommended for application on cauliflower, but these insecticides do not spare the parasites and predators of cauliflower pests. Sarup *et al.*[9] suggested that endosulfan could be usefully incorporated in any spray schedule because of higher safety margin to predators, parasites and pollinators. Studies conducted in our own laboratory have shown that a schedule consisting of three applications of endosulfan was second best for the cauliflower pests. The best schedule comprising one application of endrin three weeks after transplanting and two subsequent applications of dimethoate showed toxicity to parasites and predators, whereas endosulfan was least toxic[10].

Endosulfan, which is a broad spectrum, economic and persistent insecticide, has not been preferred on cauliflower because of lack of information on its residues. The result presented in this paper gives the magnitude of residues of endosulfan and its persistence in both the head and leaves of cauliflower.

Materials and Methods

Seedlings of cauliflower variety 'Snowball' were transplanted in October, 1972 on the farm of the College of Agriculture, Udaipur. There were in all 9 sub-plots including control. All agronomic operations were done as and when necessary. A protective spray application of 0.05 per cent endosulfan was given to all plots except control 27 days after transplanting.

Two doses of endosulfan, one recommended (0.05 per cent) and the other higher (0.1 per cent) were sprayed twice, first 33 days after the protective spray (60 days after transplanting) and second 25 days after first application (85 days after transplanting). Each treatment was randomised and replicated three times. First and second applications of each dose were given at the rate of about 1300 and 2340 l/ha respectively.

Samples of cauliflower head and leaves were collected at definite intervals and analysed for endosulfan contents. Samples of head were drawn only when they were of marketable size. The samples were first chopped into smaller pieces, 2-3 mm and then extracted with acetonitrile (3 ml/g sample) by tumbling for 30-45 min. The supernatent extract was filtered through a layer of sodium sulphate anhydrous held over a pad of glasswool in a funnel. The clean-up of extract involved washing with 5 per cent sodium sulphate solution and transferring endosulfan from acetonitrile to hexane. To ten ml concentrated hexane fraction, which also contained chlorophyll and other plant pigments, were added 2.5 ml distilled acetone (giving hexane-acetone ratio of 4:1) and 0.5 g activated charcoal. It was shaken for 5-7 min and the clear colourless extract was filtered through a thick, 2 cm layer of sodium sulphate anhydrous, to hold any charcoal particle on the surface, into a clean, dry reaction tube. Charcoal and sodium sulphate anhydrous layers were washed 3-4 times to remove the traces of endosulfan left and all such washings were also collected into the same reaction tube. The filtrate was analysed according to modified spectrophotometric method.[12,13].

Recoveries of endosulfan from cauliflower head and leaves were also worked out (Table 1) and are approximately 71 and 90 per cent respectively. In order to calculate the rate of dissipation, half-life was also estimated.[14]

TABLE 1. RECOVERIES OF ENDOSULFAN IN CAULIFLOWER HEAD AND LEAVES

Cauliflower head				Cauliflower leaves			
Added μg	Recovered μg	Recovery %	Average %	Added μg	Recovered μg	Recovery %	Average %
150	101.00	67.33	—	100	84.15	84.15	—
200	174.99	87.50	—	150	136.50	91.00	—
200	144.72	72.36	70.83	200	184.50	92.25	89.13
150	84.18	56.12					

Results and Discussion

Results presented in Table 2 show the residues of endosulfan on the leaves of cauliflower. Average deposits of 13.652 and 43.413 ppm were found from the first application of 0.05 and 0.1 per cent endosulfan. The insecticide dissipated completely in 25 days, when the second application was given. Higher initial deposits of 20.219 and 59.518 ppm resulting from the second application probably because of higher application rate, also degraded rapidly as is evident from their half-lives of less than 5 days. In 20 days, hundred per cent loss occurred in case of 0.05 per cent spray, but on an average 0.605 ppm (with a range of 0.218 to 1.258 ppm) was found from 0.1 per cent application. No insecticide was, however, detected after 30 days in any of the application.

An entirely different picture was noticed in case of cauliflower heads. At the time of first application, no head was formed and, therefore, the residue of endosulfan was not determined. As a result of second application, however, 5.705 and 11.549 ppm average deposit was estimated in the head from 0.05 and 0.1 per cent application respectively. Ten days later, the content of endosulfan reached undetectable level in lower application dose (0.05 per cent) while it was about 1.35 ppm in case of higher dose (0.1 per cent). The half lives of about 3 days indicated that residue dissipated more rapidly in case of head than the leaves. Similar observations were also recorded[15] which says that after spraying cauliflower with 0.75 lb/acre endosulfan several weeks before the harvest, the insecticide was mainly found in the leaves and to a lesser extent on the flower (head). Two weeks after the last of eight sprayings, the endosulfan content of the cauliflower leaves was still 3.8 ppm and flower contained less than 0.05 ppm.

From the point of view of the consumer safety, it could be suggested that endosulfan, when sprayed with a recommended dose of 0.05 per cent, reaches below the tolerance level of 2.0 ppm[16] in 5 days on head and about 10 days on leaves of cauliflower

TABLE 2. RESIDUES OF ENDOSULFAN ON CAULIFLOWER LEAVES AND HEAD

Days after application	Residue (ppm) Leaves	Residue (ppm) Head	0.05% Application Average Residue (ppm) Leaves	0.05% Application Average Residue (ppm) Head	0.10% Application Average Residue (ppm) Leaves	0.10% Application Average Residue (ppm) Head	0.10% Application Average Residue (ppm) Leaves	0.10% Application Average Residue (ppm) Head
First application 5-12-1972								
	15.772	...	...	...	50.000	...	...	...
0	13.325	...	13.652	...	47.733	...	43.413	...
	11.858	...	...	...	32.413	...	...	...
	...	...	...	...	...	...	...	...
25	...	...	...	...	...	...	...	...
	...	...	...	...	...	...	...	...
Second application 30-12-1972								
	19.508	6.635	...	...	52.994	19.302	...	...
0	25.544	6.170	20.219	5.705	55.654	10.774	59.518	11.549
	14.605	4.310	...	...	79.906	4.571	...	...
	9.374	2.661	...	...	23.785	7.413	...	...
5‡	6.702	2.024	7.639	1.965	18.541	5.123	20.844	5.025
	6.241	1.210	...	...	20.208	2.541	...	...
	2.482	...	...	...	3.320	1.462	...	...
10†	2.237	...	2.155	...	4.543	1.202	3.456	1.353
	1.748	...	...	...	2.505	1.395	...	...
	...	...	...	...	0.341	...	...	...
20	...	...	...	..	1.258	...	...	...
	...	...	...	...	0.218	...	...	...
	...	...	...	...	...	...	...	...
30	...	...	...	...	...	...	...	...
	...	...	...	...	...	...	...	...

†*Leaves:* Half life (days) and anticipated days when residue reaches 2 ppm tolerance level are 4.63 and 15.43 respectively at 0.05% application and 4.75 and 23.26 at 0.10% application.

‡*Head:* Half life (days) and anticipated days when residue reaches 2ppm tolerance level are 3.98 and 6.01 respectively at 0.05% level of application and 3.22 and 8.17 at 0.10% application.

There should be no cause of alarm to the consumers, even in case of unwarranted higher application dose of 0.1 per cent endosulfan, because of its rapid degradation in case of the head. However, care ought to be taken in feeding treated leaves to cattle and these should not be fed to them up to 15 days after the application of 0.1 per cent endosulfan.

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Kinetics of Thermal Precipitation of Leaf Proteins from Lucerne (*Medicago sativa*)*

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The kinetics of thermal denaturation of leaf proteins from lucerne (*Medicago sativa*) has been studied. Four kinetically distinguishable protein fractions are found to be present in the leaf extract. Both the Q_{10} values as well as the reaction rate constants gave low values characteristic of proteins of particulate nature. From these studies, 70°C appears to be optimum for fractional heat coagulation of chloroplastic proteins from lucerne leaf, in order to get a non-green cytoplasmic protein fraction. Heat coagulation studies by adjustment of pH suggests the possibility of fractional precipitation at lower temperature.
A method has been devised to purify leaf protein from substances which interfere in the biuret method of protein estimation.

The protein in leaves is an extremely heterogeneous system from which it is difficult to isolate characteristic homogeneous proteins[1]. Proteins occur in the protoplasm of the leaf cells, 30 to 40 per cent of which may be found in the chloroplasts, 5 to 10 per cent in the mitochondria and the rest in other particulate structures and the protoplasmic fluid. Most of the proteins in the leaf are enzymic in nature and, therefore, different from the reserve proteins of the storage tissues in seeds.

The use of leaf proteins as a possible source for human consumption has been extensively advocated[2]. The precipitated leaf protein has an unacceptable dark green colour due to the chloroplastic fraction[3-5]. Some work has been done to differentially precipitate these fractions but the colour problem has not been completely overcome but for removal with acetone. Thus a careful study of the precipitation characteristics of leaf protein is of considerable importance.

In this paper is reported the investigations carried out on the thermal precipitation characteristics of a protein extract from lucerne leaves over a temperature range between 40 and 80°C, as also at different pH values. The kinetic aspects of thermal denaturation of this protein at 60 and 70°C were studied and from the data, energies of activation and Q_{10} values for the different fractions were calculated.

Materials and Methods

Fresh leaves of lucerne were chilled, crushed and the juice pressed out. The temperature was always kept below 5°C. The juice was centrifuged at 1000**g** for 7 min and the supernatant fluid taken for the studies.

A portion of this extract was also centrifuged in a refrigerated centrifuge at 11,000 **g** for 30 min. The supernatant fluid (hereafter called cytoplasmic fraction) had a pale greenish-yellow colour.

Protein estimation by the Biuret method[6]: The leaf extract could not be used directly for the estimation of protein by the Biuret method due to interfering substances which masked and inhibited the colour development. Initial purification of the leaf extract was therefore needed and the following method was adopted for the purpose.

Half to one ml of the sample (containing not more than 3.5 mg protein N) was taken in a graduated centrifuge tube, and made up to 2 ml with distilled water, 8 ml acetone was added, mixed and the tube allowed to stand for 5 min. The mixture was centrifuged at 2,000 **g** for 10 min and the supernatant fluid discarded. To the precipitate 5 ml 0.1N NaOH was added, the tube shaken vigorously to dissolve the precipitate, and centrifuged at 3000 **g** for 30 min. The clear supernatant was collected in another centrifuge tube. To the former tube another 3 ml 0.1 N NaOH was added and the residual precipitate dispersed to dissolve as much as possible and centrifuged as above. The combined alkali extract gave a protein recovery of over 95 per cent. Three ml of 20 per cent trichloroacetic acid was then added to the extract and mixed. The mixture was allowed to stand for

*This was submitted by the senior author as a part of the course work leading to M.Sc. (Food Technology) degree of the Mysore University.

10 min, centrifuged at 2000 **g** for 15 min and the supernatant discarded. To the precipitate, 0.1N NaOH was added to make the volume to 1 ml. To this 5 ml of the Biuret reagent was added, mixed to dissolve the precipitate and allowed to stand for 30 min. The colour density was compared in a Klett-Summerson photoelectric colorimeter using No. 54 filter against a blank containing 1 ml of 0.1N NaOH and 5 ml of the Biuret reagent.

Heat precipitation methods: Five ml of the extract was taken in thin-walled (thickness: 0.5 mm) glass tube (10 mm × 100 mm) and brought to room temperature just before subjecting to heat. The samples, under constant stirring were kept in a water bath at temperatures of 40, 50, 60, 70, 80, 90 and 100°C for exactly 60 sec. For heat denaturation studies at selected temperatures, the samples were heated at 60, 65 and 70°C with time intervals of 5 sec. The effect of pH on heat precipitation at 60°C was studied over a range of 5.0 to 8.0. Even though autolysis of proteins in leaf extracts is reported[7], this is not taken into account in these experiments as the time of heating was very short even at lower temperatures.

Subsequent to heat denaturation of the proteins, the tubes were removed and immediately cooled in ice-water and centrifuged at 2000 **g** for 15 min. The residual protein content in the supernatant was determined by the Biuret method.

Results and Discussion

(*a*) *Protein precipitation at various temperatures:* From Fig. 1 it can be seen that above 80°C almost complete precipitation takes place within 60 sec, at 80°C more than 90 per cent of the protein is precipitated, whereas, below 50°C the precipitation is insignificant. From the preliminary observations the temperature range of 60 to 70°C was considered optimum for a detailed study of the heat precipitation characteristics of these proteins.

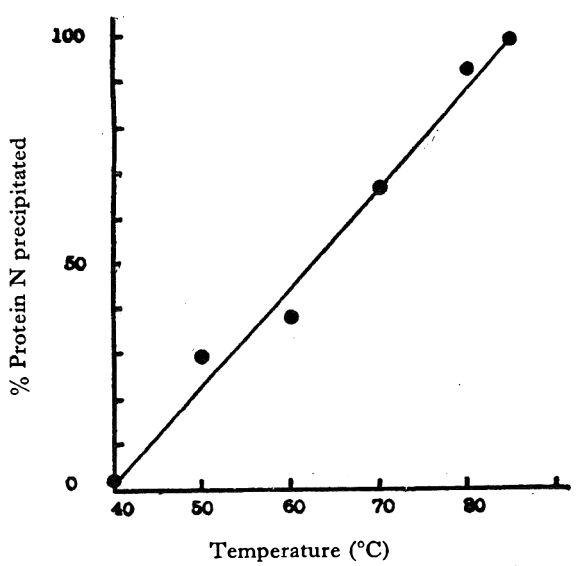

FIG. 1. The extent of precipitation of protein from leaf extract at temperature between 40-80°C in one minute

(*b*) *Kinetics of precipitation between 60 and 70°C:* Table 1 shows the relationship between time and the amount of the protein precipitated at three temperatures, viz., 60, 65, and 70°C respectively. The colour of the residual solutions after different time intervals of heating at these three temperatures are also given. A semilog plot of the residual protein (a-x) against time at various temperatures shows excellent correlation with the theoretical expectations of first order reaction kinetics for heat precipitation of proteins according to the equation

$$K = \frac{2.3}{t} \log \frac{a}{(a-x)}$$

where a=Initial protein concentration

(a-x)=Protein concentration after time 't'

K=Reaction rate constant

These are presented in Fig. 2. The data presented suggest that:

TABLE 1. HEAT PRECIPITATION OF LEAF PROTEINS FROM WHOLE LEAF EXTRACT AT 60, 65 AND 70°C

Time (sec.)	Protein N (mg.) left in the supernatant fluid (a-x) 60°	65°	70°	% Protein N precipitated 60°	65°	70°
0	3.62 (G)	3.6 (G)	3.61 (G)	0	0	0
10	3.22 (G)	2.94 (G)	2.34 (GY)	11.1	17.8	35.2
20	2.82 (G)	2.38 (GY)	2.06 (Y)	22.2	32.0	42.8
30	2.51 (G)	2.26 (Y)	1.82	30.7	36.0	49.6
40	2.34 (GY)	2.16	1.62	35.4	38.9	55.1
60	2.34 (Y)	2.02	1.22	38.1	42.7	66.2
120	1.92	1.50	0.50	47.0	58.1	86.2
180	1.70	1.16	0.18	53.0	66.0	95.0
240	1.48	0.86	—	59.1	75.1	—
300	1.32	0.54	—	63.5	82.7	—
360	1.16	0.24	—	68.0	86.5	—
420	0.98	—	—	72.9	—	—
480	0.86	0.18	—	76.3	92.4	—
540	0.72	0.17	—	77.4	92.7	—
600	0.45	—	—	87.6	—	—
660	0.27	—	—	92.5	—	—
720	0.23	—	—	93.9	—	—
780	0.22	—	—	93.9	—	—
840	0.21	—	—	94.2	—	—
900	0.19	—	—	94.8	—	—

G=Green GY=Greenish Yellow Y=Yellow

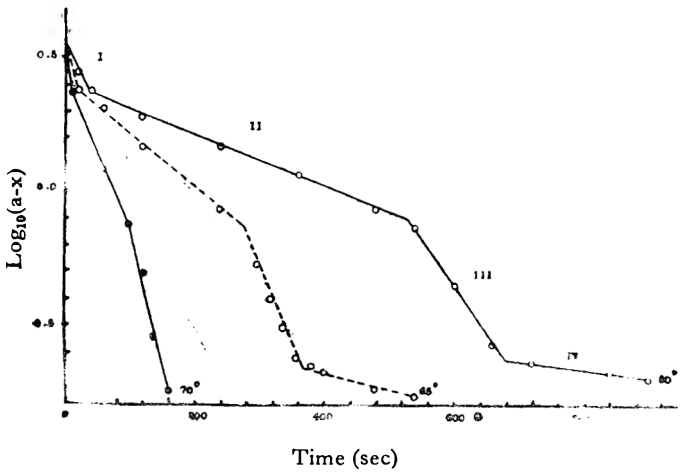

FIG. 2. Precipitation of leaf protein at 60, 65, 70°C, and pH 6.5
I, II, III and IV are the fractions

1. Heat precipitation at 60 and 65°C reveals four distinct protein fractions. At 70°C, however, only three are distinctly noticeable, the fourth fraction probably having co-precipitated along with the third.

2. Quantitative estimates show that the first fraction (I) accounts for about 35 per cent of the total proteins, the second (II) for about 42 per cent, the third fraction (III) for about 15 per cent and the last fraction (IV) for about 8 per cent. This last fraction is precipitated extremely slowly at 60 and 65°C, but faster at 70°C.

3. With the precipitation of the first fraction (I) there is a concurrent removal of green colour leaving a pale yellow (supernatant) extract. The former is perhaps the chloroplastic fraction along with some mitochondrial proteins. Microscopic observations support this view.

4. The second group is likely to be constituted of the rest of the mitochondria and a greater part of larger microsomes The latter, depending on their size, would obviously be distributed between the second and the third fractions. The fourth fraction most probably consists of non-particulate matter, possibly consisting of soluble proteins.

From the slopes of the curves on the semi-log plot the first order reaction rate constants (K) were calculated. Table 2 gives these and Q_{10} values (between 60 and 70°C) for the various fractions. An Arrhenius plot of these observations is shown in Fig. 3, from which the activation energies (E_{Act}) for thermal denaturation of the individual fractions calculated. These are listed in Table 3.

TABLE 2. FIRST ORDER REACTION CONSTANTS OF THE FRACTIONS AT 60, 65 AND 70°C

Absolute temp. T°	First order reaction constant K_1	K_2	K_3	K_4
333	0.01265	0.002415	0.0078	0.000767
338	0.02128	0.00469	0.0138	0.0013
343	0.0414	0.01265	0.0245	—
Q_{10}	3.3	5.2	3.2	—

(between 60° and 70°C)

TABLE 3. ACTIVATION ENERGIES OF THE PRECIPITATION OF THE FOUR LEAF PROTEIN FRACTIONS

	Part of the curves of log (a-x) *vs* time I	II	III	IV
Slope E(act) / K × 2.3	6×10^3	8.02×10^3	5.6×10^3	3.0×10^3
Energy of activation E(act) cal/mole	27,690	37,010	25,840	13,850

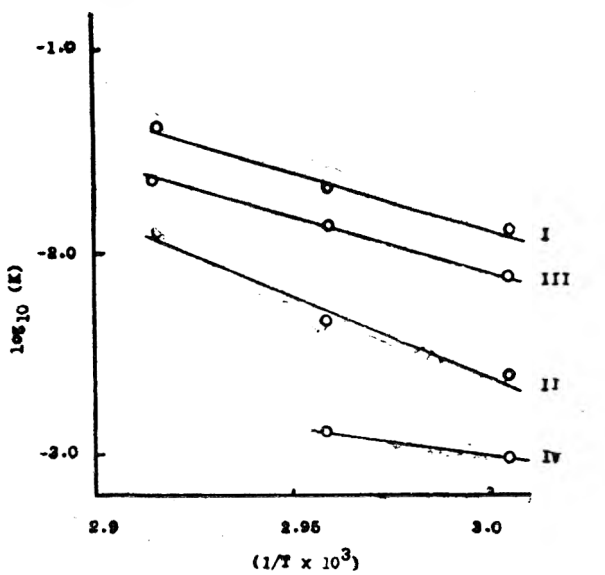

FIG. 3. Precipitation of leaf proteins: temperature variation of Kr
I, II, III and IV are 1st, 2nd, 3rd and 4th deflections respectively

5. The Q_{10} values for precipitation of the three fractions (I, II and III) are 3.5, 5.2 and 3.2 respectively, which are apparently low for protein denaturation. The particulate nature of these proteins may provide an explanation for this anomaly.

The E_{Act} values for the first three fractions are low as expected of proteins of particulate nature as against very high values of the order of 35,000 to

1,30,000 for others[8]. However, the E_{Act} value even for fraction IV, which is assumed to be more soluble, is surprisingly low.

(*c*) *Thermal stability of the cytoplasmic fraction:* Table 4 gives the kinetics of protein precipitation at 60°C. Fig. 4 shows a plot of log (a-x) against time for the whole leaf extract and the cytoplasmic fraction. It can be seen that the cytoplasmic fraction behaves almost exactly like the whole leaf extract, except in the initial stages. The slight deviation from the second part of the curve may be due to sedimentation of a small fraction of this protein at 11,000 **g**.

(*d*) *Effect of pH on heat precipitation characteristics of the protein:* Table 5 shows the heat precipitation characteristics at 60°C in the pH range 5 to 8.

TABLE 4. HEAT PRECIPITATION OF PROTEIN FROM CYTOPLASMIC FRACTION AT 60°C

Time sec	Protein N in the supernatant mg.	%Protein N precipitated
0	2.76	0
10	2.44	11.3
20	2.34	15.2
30	2.28	17.4
40	2.24	18.8
60	2.14	22.5
120	1.91	30.8
180	1.72	37.7
240	1.48	46.0
300	1.32	52.3
360	1.15	58.3
420	0.97	64.9
480	0.86	68.9
540	0.73	73.6
600	0.45	84.5
660	0.28	90.0
720	0.23	91.4
780	0.22	92.0
840	0.21	92.5
900	0.19	93.1

TABLE 5. EFFECT OF PH ON HEAT PRECIPITATIONS OF LEAF PROTEINS AT 60°C

Heating time sec.	% Protein precipitated at pH value of 8.0	7.0	6.5	6.0	5.5	5.0
10	9.4 (G)	9.1 (G)	10.4 (G)	19.3 (G)	31.3 (G)	90.6 (Y)
15	16.7 (G)	15.5 (G)	17.4 (G)	17.3 (G)	35.8 (G)	93.9 (Y)
20	20.3 (G)	19.3 (G)	21.9 (G)	32.9 (GY)	41.4 (Y)	96.5 (Y)
25	25.4 (G)	24.9 (G)	26.5 (G)	35.8 (Y)	44.1 (Y)	96.6 (Y)
30	29.4 (G)	27.8 (G)	31.8 (GY)	37.2 (Y)	54.5 (Y)	98.2 (Y)

G = Green GY = Greenish Yellow Y = Yellow

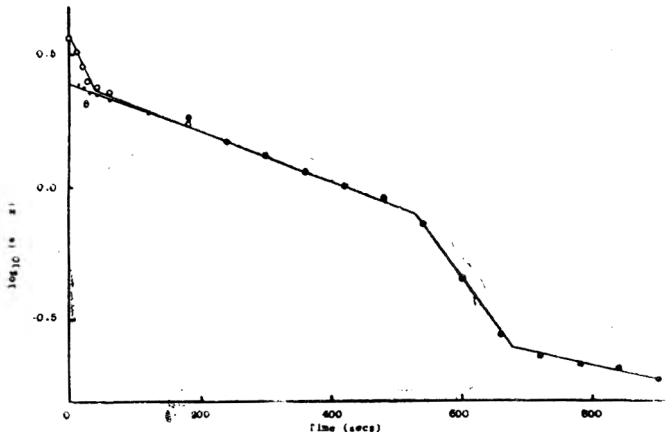

FIG. 4. Precipitation of leaf protein at 60°C, pH 6.5
A, Whole leaf extract; B, Cytoplasmic fraction

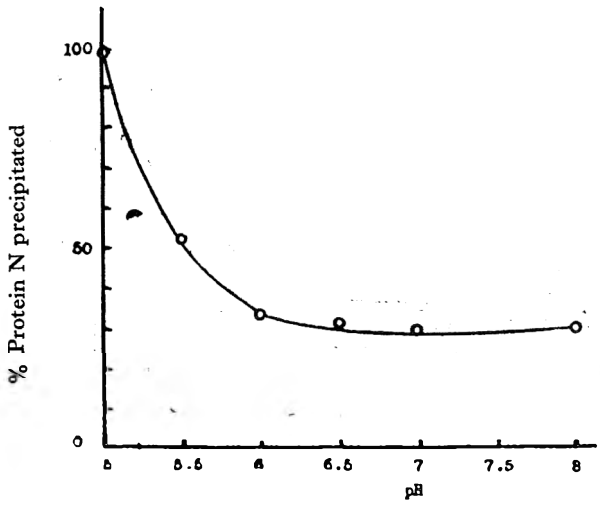

FIG. 5. Effect of pH on the precipitation of leaf protein. Time, 30 sec; Temp, 60°C

The pH of the leaf extract was around 6.5. Fig. 5 shows a relationship between pH and protein precipitation in 30 sec.

Below pH 5.5, precipitation is noticed even at room temperature. From the colour of the supernatant fluid and the amount of protein precipitated it appears that at pH 5.5, a co-precipitation of the cytoplasmic protein occurs along with the chloroplasmic proteins.

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Effect of Different Salts and Chemical Additives upon the Quality of Curd *(Dahi)*

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Calcium and magnesium chloride greatly reduces the curd tension, whereas sodium chloride, sodium acetate and sodium citrate do not affect the tension significantly. Additives like pectin and gelatin increase the curd tension whereas glycerine monostearate and lecithin decrease the tension slightly. Formation of total acid does not change appreciably by the additions of salts and additives, but sodium chloride, sodium citrate and lecithin were found to increase the volatile acid content of the final curd.

Curd (*Dahi*) is a thick, sour, fermented milk product having a close resemblance to *Yoghurt*. It is one of the most popular amongst milk products consumed in India. The production of milk in India is estimated to be about 23.0 million tons[1] and 9.1 per cent of the total milk production is utilised for curd preparation[2].

The desirable organoleptic properties of curd are firm body with clean acid taste and aroma, without bitterness, saltiness or other off-flavours. The flavour compounds of greater importance are lactic acid, volatile acid and diacetyl[3-4]. The diacetyl content of market samples is negligible[5].

The chemical and microbiological quality of *dahi* samples from different parts of India vary widely and there is hardly any process control in its preparation. The most common organisms are *Streptococci* and *Lactobacilli* and common contaminants are yeasts and molds which give bitterness and other off-flavours to curd after 72 hr of storage. Yeasts are known to synthesise B-complex vitamins[6,7].

Chandrasekhara *et al.*[8] devised a simple curd tension meter for determining the curd tension in milk. The effect of heat and addition of phosphates and citrates on the curd tension of buffalo milk were studied and it was found that the curd tension of buffalo milk was reduced to a very low figure as a result of these treatments.

Sufficient work has also been done on the factors affecting the curd tension of cow's milk[9]. The available data indicate that the ingredients of milk directly affecting the curd tension are casein[10,11] and ionised calcium[12,13]. Doan and Welch[10] showed that the curd tension was a linear function of the casein content when there was sufficient ionised calcium. Lyman *et al.*[12,13] reported the removal of the ionised calcium present in milk by base exchange process reduced considerably the curd tension of milk. The curd tension of milk can also be lowered by various other treatments such as boiling[10,14,15], acidification and homogenisation[16,17], addition of phosphates and citrates[8,9].

All these reports, however, are on rennet clotted curd but the structural difference is significant between rennet and lactic fermented curd (*dahi*).

It is also well-known that the flavour of the fermented milk is improved by the addition of citrates, cream, lecithin, sodium chloride[18], etc. But no data are available regarding their effect on *dahi*. The present study was, therefore, undertaken to investigate the effect of various chemical salts and additives upon the quality of *dahi*.

Materials and Methods

Preparation of curd: Milk (prepared from spray dried whole milk powder maintaining 12 per cent total solid) was heated in conical flasks at 85°C for 30 min with frequent shaking and then cooled immediately to room temperature. Pure and active culture of *S. thermophillus* (containing 0.80 to 0.85 per cent lactic acid) grown on milk sterilized at 5 psig for 30 min and cooled, was inoculated at the rate of 5 per cent (v/v) and incubated for 16 hr at 40°C. Curd tension knives were placed in the beaker after inoculation.

Titratable acidity was estimated by titrating 5 g of the sample against standard alkali using phenolphthalein as indicator. Results were expressed as per cent lactic acid. Volatile acidity was determined according to the method of Hammer and Bailey[19]. The result was expressed as ml of standard alkali (N/100 NaOH) required to neutralise the 150 ml condensate collected from 10 g of sample curd. Curd tension was determined according to the method suggested by Curd Tension Committee of the American Dairy Science Association, and as described by Chandrasekhara *et al*[8].

All salts were added to milk after heat treatment and in 0.2M concentration. Pectin, GMS and lecithin were added during heating of milk to solubilise them and the entire mixture was then homogenised.

Results and Discussion

The effect of salts upon curd tension is presented in Fig. 1. In all cases curd tension was reduced with the addition of salts. Calcium and magnesium chloride reduced curd tension more sharply than corresponding additions of sodium salts (0.2M). The effect of salts upon titratable acidity and volatile acidity of curd has been represented in Fig. 2 and 3 respectively. The addition of these salts to milk increased the titratable acidity at a lower dose. Volatile acidity was very sharply increased in case of sodium chloride and sodium citrate. The addition of salt in higher amount again reduced the volatile acid content of curd. Calcium and magnesium chloride, however, did not improve the flavour of the final curd.

The effect of additives upon the curd tension is shown in Fig. 4. Curd tension is increased by the addition of pectin and gelatin but decreased to a little extent by the additions of GMS and lecithin. The effect of these additives upon titratable acidity and upon volatile acidity is shown in Fig. 5 and 6

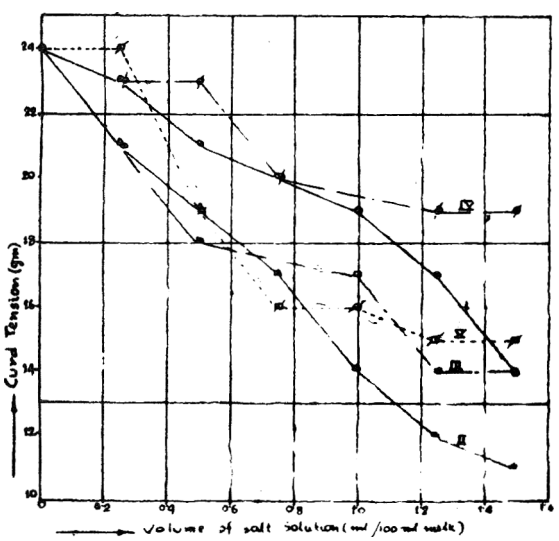

FIG. 1. Effect of salts upon curd tension
I, $CaCl_2$; II, $MgCl_2$; III NaCl; IV, Na acetate; V, Na Citrate

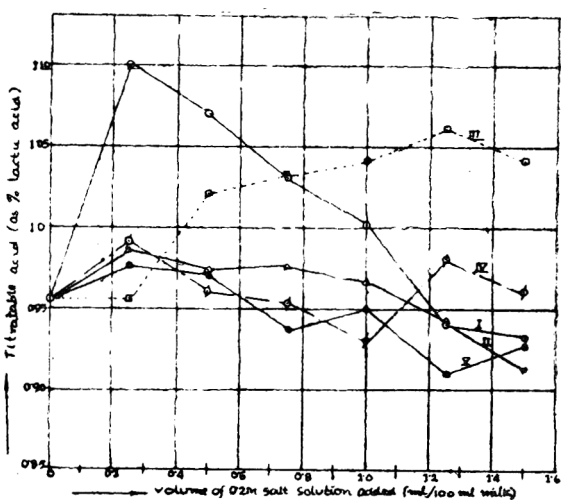

FIG. 2. Effect of salt upon total acid of curd
Legend same as in Fig. 1.

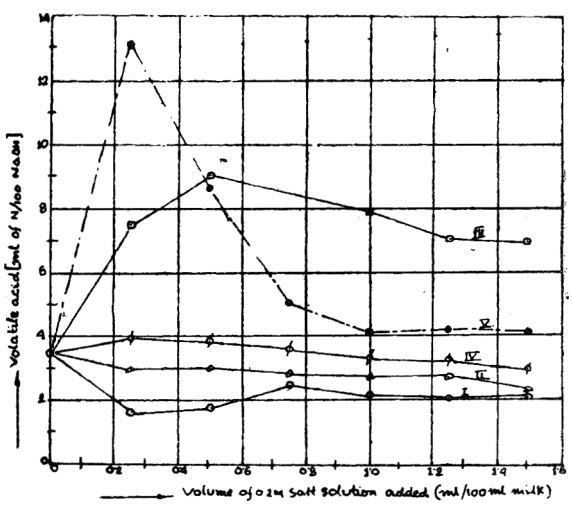

FIG. 3. Effect of salt upon volatile acid of curd
Legend same as in Fig. 1.

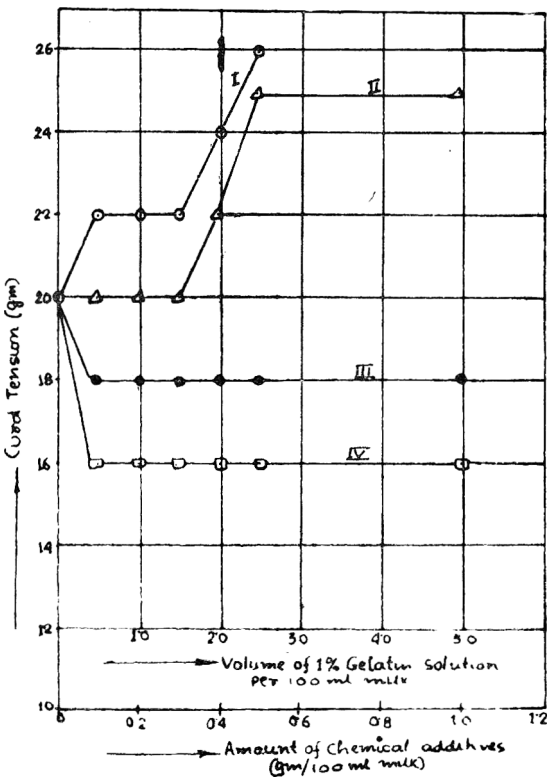

FIG. 4. Effect of chemical additives upon curd tension
I, Pectin; II, Gelatin; III, Glycerine monostearate; IV, Lecithin

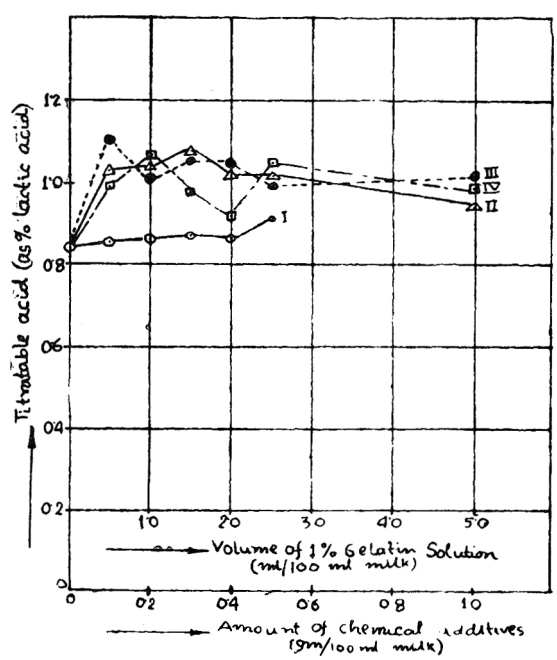

FIG. 5. Effect of chemical additives upon total acid of curd
Legend same as in Fig. 4.

respectively. The titratable acidity did not change with the addition of these additives but the volatile acidity was highly increased by the additions of lecithin and GMS but not by pectin and gelatin.

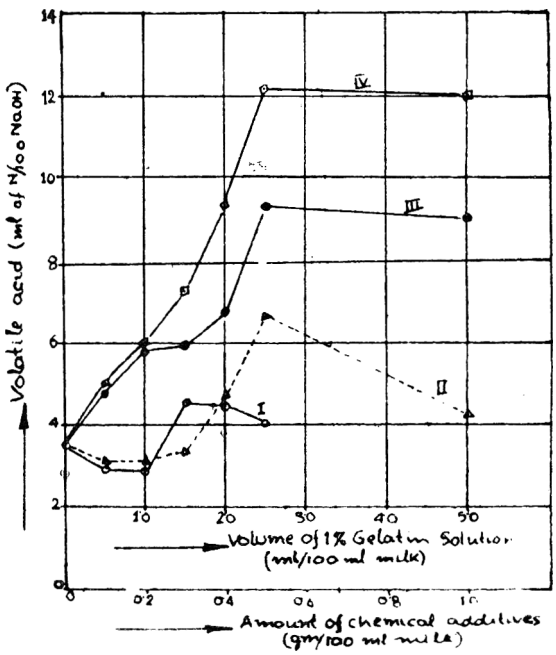

FIG. 6. Effect of chemical additives upon volatile acid of curd
Legend same as in Fig. 4.

Lecithin and GMS also retain the texture of the curd better, because of their colloid stabilising action. The curd tension was increased by pectin and gelatin probably due to their gelling action. The increase in volatile acidity of the curd due to the addition of sodium chloride was presumably because it acts by 'bringing out the flavour', a well recognised property of salt in foods. The action of lecithin as flavour improver in fermented milk is well known[1].

Acknowledgement

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Chemical and Nutritive Changes in Refined Groundnut Oil during Deep Fat Frying

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Extent of polymerisation and resulting losses in polyunsaturated fatty acids, iodine value and *in vitro* digestibility that take place in refined groundnut oil during frying of purees at 180, 220 and 260°C have been investigated. The monomers, dimers and polymers were separated by liquid-liquid partition chromatography on silicic acid. The concentrations of dimeric and polymeric fractions ranged from 11.8—18.6 per cent and 10.0—12.2 per cent respectively during six hours of frying under the conditions used. The percentage decreases in the rates of hydrolysis by pancreatin were 36 at 180°C, 38 at 220°C and 52 at 260°C. Possible causes for decreased enzymic hydrolysis of heated fats are discussed.

A major portion of the vegetable oils produced in this country is utilized for deep or shallow frying of foods, either in the form of raw oil or after refining and hydrogenation. Of these, groundnut oil is the major edible oil, utilized by the largest segment of population. During frying, vegetable oils are subjected to temperatures ranging from 180-250°C and questions arise regarding the wholesomeness of fats/oils used repeatedly for frying purposes. During the course of heating in presence of air, fats and oils are partially converted into volatile chain-scission products, non-volatile oxidised derivatives and dimeric, polymeric or cyclic substances. The nature and extent of these changes depend very much on the kind of fat and the way it is heated. In continuous deep fat frying, large quantities of fat/oil are absorbed by the foodstuff and thus continuously removed, and this has to be replenished with fresh fat. Through such removal and replenishment, fat reaches a steady state condition and is perhaps unlikely to deteriorate beyond a certain point. In intermittent frying, the fats remain hot for quite long periods and also undergo many heating and cooling cycles before they are used up during successive frying operations. Probably fats receive maximum oxidative and thermal abuse in this sort of operation.

The chemical and nutritive properties of fats heated both under laboratory and commercial conditions have been extensively investigated[1]. Raju *et al*[2] reported that groundnut oil heated for 8 hr at 270°C produced growth depression, fatty livers and elevated blood glucose and cholesterol values in rats; the nature and extent of chemical changes that occurred during the heating process were not studied. In a previous communication[3] from this laboratory the comparative chemical changes that take place during frying of purees in refined groundnut oil and vanaspati were reported. The present communication reports the dimer and polymer contents, *in vitro* digestibility and polyunsaturated fatty acid (PUFA) contents of refined groundnut oil before and after frying at three temperatures.

Materials and Methods

Frying conditions: Commercially refined groundnut oil was heated in batches of 1 kg each time in a circular concave iron pan (diameter 14 in., depth,

4 in.) at 180, 220 and 260°C respectively. Purees, rolled from 5 g of a dough itself made by mixing 1200 g *atta* with 750 ml water, were fried at each of the three temperatures at the rate of 65 purees per hour. After 3 and 6 hr, samples of heated oil (100 g) were removed for measurement of monomer, dimer and polymer contents, *in vitro* digestibility to pancreatic lipase and PUFA content. The heated samples were stored in glass bottles in a refrigerator prior to analysis.

Chromatographic separation: The column chromatographic method was essentially that of Frankel *et al.*[4] Dry silicic acid 150g, heated at 120°C for 15 hr was well mixed with 40 ml of immobile solvent (20 per cent methanol in benzene). The mixture was slurried by adding 100 ml of mobile solvent (2 per cent methanol in benzene) with rapid mixing and the slurry transferred to a column (2.5 × 40 cm) fitted with a sintered glass disc at the lower end. Air pressure was applied at the top of the column to get a uniform bed. The oil sample was saponified, and the fatty acids liberated with dilute HCl and extracted with ethyl ether. The extract was repeatedly washed with distilled water and moisture removed over anhydrous sodium sulphate. The ether was removed under vacuum and a known weight (0.2 g) of fatty acid was dissolved in 2 ml of mobile solvent and applied to the top of the column. The sides were washed with another 5 ml of mobile solvent. The column was eluted first with 320 ml of mobile solvent and then with 250 ml ethyl ether at a uniform rate of 3 ml/min. Aliquots (10 ml) were collected and the quantity of fatty acid in each was determined by titrating with potassium hydroxide (0.02N) solution to thymol blue.

In vitro digestibility by pancreatic lipase: The procedure of Fiore and Nord[5] was followed with slight modifications. Carbowax-400 (2.5g) was dissolved in 100 ml water and the solution neutralized to pH 7 with dilute NaOH solution. To this 8.2 g of oil sample was added and the mixture emulsified in a Waring blender. Ten ml of the freshly prepared emulsion and 10 ml of pancreatin solution in phosphate buffer (pH, 7.2) were shaken at 37°C for 4 hr on a magnetic stirrer. After this period 30 ml of alcohol-acetone (1:1 v/v) mixture was added to break the emulsion and the solution was titrated against 0.05N NaOH solution to phenolphthalein. A blank using heat-inactivated enzyme solution was run simultaneously.

Polyunsaturatrd fatty acids: The PUFA content was determined by the AOCS method[6] using 6.5 per cent potassium hydroxide and 15 min for isomerisation.

Results and Discussion

Proportions of monomers and polymers: Fig. 1 shows the results of chromatographic separation of monomers, dimers and polymers on silicic acid. Refined groundnut oil contains mostly monomeric material and a very small quantity of polymers but no dimers. As the oil is heated, monomers decrease, polymers increase and dimers appear in increasing amounts. The peroxide value of the heated samples are low, below 10 meq of oxygen per kg of fat. Frankel *et al.*[4] reported a linear relationship between peroxide value and the oxidative dimer content of vegetable oils, which must therefore be low in the present instance. Barrett *et al.*[7] found during frying in cottonseed oil that the polymeric materials carry mostly carbon-carbon rather than carbon-oxygen linkages. Dimers and polymers present in heated groundnut oil are also likely to have carbon-carbon linkages.

Table 1 shows that after 6 hr of frying at 180°C, the content of dimers was 11.8 per cent and that of polymers 10.0 per cent. At 220°C the figures were 12.5 and 10.0 per cent and at 260°C dimers constituted 18.6 per cent and polymers 12.2 per cent.

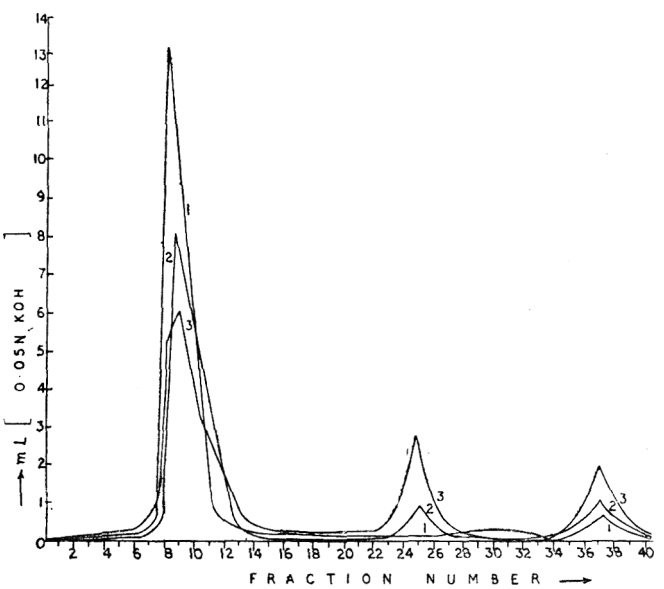

FIG. 1. Chromatographic separation of monomers, dimers and polymers on silicic acid column.
1. Refined groundnut oil; 2 and 3. Refined groundnut oil heated for 3hr and 6 hr respectively during frying

TABLE 1. PERCENTAGE OF MONOMERS, DIMERS AND PLOYMERS IN REFINED GROUNDNUT OIL HEATED AT 180, 220 AND 260°C FOR FRYING PUREES

Temp. of frying °C	Period hr	Monomers %	Dimers %	Polymers %
	0	96.7	0.0	3.3
180	3	90.7	4.5	4.9
	6	79.2	11.8	10.0
220	3	84.2	9.8	6.0
	6	77.5	12.5	10.0
260	3	81.4	11.0	7.2
	6	69.2	18.6	12.2

In vitro digestibility: Table 2 shows the pancreatic digestibility of the original and heated oils. The percentage decrease in the rate of digestibility was 36 per cent at 180°C, 38 per cent at 220°C and 52 per cent at 260°C. If the total frying time is considered in terms of two periods of 3 hr each, the decrease in rate of digestibility at 180°C was the same for both periods, but at 220 and 260°C, the decrease was greater in the first period than in the second.

Formation of several products on heating could account for the observed depression in lipase activity. The presence of short chain carbonyl compounds like malonaldehyde, propionaldehyde, formaldehyde etc., and of fat hydroperoxides, have both been reported to inhibit lipolysis [9,10]. However, the peroxide values in the present work were all low, pointing to low concentrations of oxygenated fat derivatives. Cyclised glycerides formed by thermal polymerisation and Diels-Alder condensation products, such as are known to be present in heated vegetable oils[11], are both likely to offer steric resistance to lipolytic attack on the ester linkage.

Changes in PUFA: Table 3 shows the PUFA contents and the iodine values of the heated fats.

Groundnut oil itself after isomerisation exhibits an absorption maximum at 233 nm for diene conjugation, showing that linoleic acid (27 per cent) is the sole PUFA present. Losses of linoleic acid after 6 hr at 180, 220 and 260°C were as high as 53, 81 and 95 per cent respectively. Fleischman *et al.*[12] reported PUFA losses of 15 to 47 per cent during commercial and home cooking of corn and cottonseed oils at temperatures ranging from 375 to 495°F (190-260°C).

Losses in iodine value by heating varied in the present work from 18 to 33 per cent, whereas in the previous study[3], where five times the quantity of oil was taken the losses were only from 5 to 12 per cent. Clearly the quantity of oil and the surface area in contact with air during heating are relevant to the degree of deterioration. In designing equipment for deep fat frying, attention must be paid to such conditions as time, temperature, shape of equipment and fat turnover so as to minimise the extent of deterioration, as judged by loss of PUFA and development of non-absorbable dimers and polymers which resist lipolytic attack. Though triglycerides can be absorbed in part even without prior hydrolysis, formation of free fatty acids and diglycerides by pancreatic lipase promotes emulsification of fat and thus raises the degree of its absorption.

TABLE 2. CHANGES IN *in vitro* DIGESTIBILITY OF REFINED GROUNDNUT OIL DURING DEEP FAT FRYING AT 180, 220 AND 260°C

Temperature °C	Heating period hr	*In vitro* digestibility*
—	0	132.8
180	3	109.9
	6	84.5
220	3	92.0
	6	82.8
260	3	78.8
	6	63.7

*Millilitres of 0.05N NaOH required for the fatty acids liberated from 8.8 g of refined groundnut oil by pancreatin during 4 hr at 37 ± 0.05°C.

TABLE 3. CHANGES IN POLYUNSATURATED FATTY ACIDS CONTENT AND IODINE VALUE OF REFINED GROUNDNUT OIL DURING DEEP FAT FRYING AT 180, 220 AND 260°C

Frying temp. °C	Heating period hr	Linoleic acid %	Iodine value
	0	27.1	91.3
180	3	19.6	83.5
	6	11.7	75.4
220	3	13.3	81.0
	6	5.3	—
260	3	11.5	78.7
	6	1.4	65.9

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Suitability of Raw and Steamed Cereal Grains for Making Deep Fried Preparations

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Bajra (*Pennisetum typhoides*), was found to give a highly crisp, deep fried product while wheat and refined wheat flour gave extremely hard products, maize, sorghum and rice coming in between. When the grains were steamed for about 30 minutes after washing in water the pattern of suitability was markedly altered. Although all the steam treated cereals were better than untreated controls with respect to the crispness of the deep fried products, the improvement was phenomenal in the case of wheat as compared with other grains. The addition of shortening reduced the hardness of the deep fried product while the addition of black gram *dhal* flour had the reverse effect although the latter gave adhesion to the dough and improved its extrudibility. Steaming of cereals, particularly wheat and bajra, could be used as a method of reducing the requirement of shortening while in preparing deep fried crisp products and for making prepared mixes for them.

Deep fried products are valued for their crisp and crunchy texture and are prepared from cereals and cereal pulse mixtures. Rice and *maida* (refined wheat flour) have been the normal cereal components used for making these preparations. In attempts to produce a ready mix flour for producing the *Chakli* using rice and black gram flours it was found that the amount of shortening needed for producing a crisp texture in the finished product was so high as to affect the cost of the mix. It could also affect its shelf life. When rice was substituted by *maida* the dough could not be easily extruded through the household hand press. In preliminary studies to reduce the need for shortening and facilitate extrusion, steam treatment was found to improve the crispness of the deep fried product and facilitate extrusion in the case of *maida* and wheat. The above warranted a detailed systematic study of the suitability of different cereal grains for making crisp deep fried products and the effect of steam treatment on the same. Results reported here relate to such a study.

Materials and Methods

Rice, wheat, maize, sorghum, bajra (*Pennisetum typhoides*) and varagu (*Paspalum scrobiculatum*) seeds were obtained from the Agricultural Farm or standard suppliers and cleaned of impurities, and ground in a plate grinder mill to pass through BSS 44 mesh sieve. The whole meal flour including the bran (except in the case of rice) was used in these studies. Dehusked bajra and unpolished brown rice were also used for comparison. For steam treatment, the grains were washed in running water and after draining the water, spread in $\frac{1}{2}$ in. layer in trays and steamed for about 30 min and then dried to about 12 per cent moisture. *Maida* was steamed for 30 min without any wetting. The varagu grain used in the study had been parboiled by soaking in hot water at 60°C for 3 hr followed by steaming and drying. The steam treated products were also ground to pass through 44 mesh sieve.

The relative ease of extrusion of the dough through a standard die fitted to a hand-vermicelli press was reckoned in terms of the time needed for extruding the dough between 2 markings (1.5 cm apart) on the inner socket of the extruder at constant pressure by applying a known weight (5 kg) on the balance pan in an improvised pressure extruder system (Fig. 1). The amount of water needed for making the dough was also determined.

The dough from the raw and steam processed flours was extruded and fried in hot oil (150°C to start with and ending at 175-180°C) and the crisp eating quality of the *Chakli* curls was measured by means of a Kiya type hardness tester which measured the force needed for crushing the *Chakli* pieces. However these meter readings were found to be less sensitive than organoleptic panel tests. Hence further comparative tests were done organoleptically

the hardness being expressed in an improvised scale varying from 0.2 to 8 as indicated in Table 1. The data on extrusion time and hardness index are averages of several replications.

The effect of adding black gram flour or shortening along with the cereal or millet flour on the crispness quality of *Chakli* was also studied. The amount of shortening necessary for imparting an acceptable crispness (hardness scale 0.2-0.5) to the *Chakli* was determined for the various mixes. The fat content in the deep fried product was also determined as per standard method (AOAC, 1970, Eleventh Edn., p. 224).

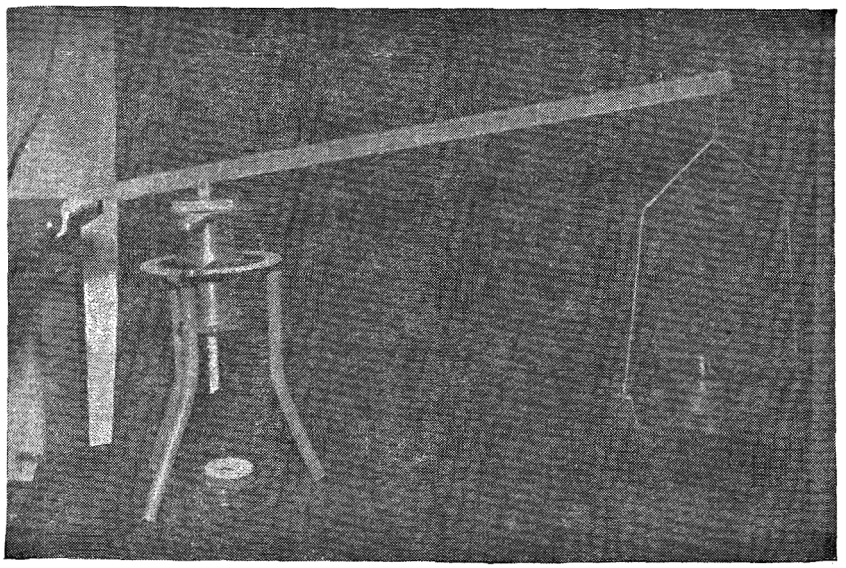

FIG. 1. Improvised dough extruder

TABLE 1. ORGANOLEPTIC HARDNESS SCALE RATING FOR *chakli*

Terms of crispness	Acceptability	Hardness (rating)
1. Extremely crisp amounting to slight softness	Highly acceptable	0.2
2. Optimally crisp	-do-	0.5
3. Quite crisp	Quite acceptable	0.8
4. Crisp	-do-	1.0
5. Tending to be hard	Tending to be non-acceptable	2.0
6. Perceptibly hard	-do-	3.0
7. Definitely hard	Not acceptable	4.0
8. Very hard	-do-	5.0
9. Extremely hard	-do-	6.0
10. Extremely hard (with case hardened exterior and uncooked core)	-do-	7.0 and above

Results and Discussion

Data presented in Table 2 show that the steam processed flours required slightly more water for making of the dough. These differences were relatively smaller for bajra and maize than for others. The dough from wheat and *Maida* could not be extruded; by normal hand pressure the extrusion times being very high (more than 50 sec). The dough from the other flours could be easily extruded. The extrusion times varied from about 2 to 20 secs. Steam treatment generally reduced the extrusion time and facilitated ease of extrusion, the effect being remarkable in the case of wheat and *Maida*. With rice and sorghum, however, the dough consistency became somewhat sticky and extrusion time was actually increased.

Wheat and *Maida* gave the hardest of the deep fried products (hardness rating 7-8). Rice and maize also gave quite hard *Chaklis* (hardness rating 4-5). Whole meal bajra flour gave a highly crunchy product (hardness rating 1) although somewhat darkish in colour. The silky soft porous bran/glume of the bajra probably contributes to this texture. Its removal by pearling increased the hardness rating to 3-5.

There was a consistent improvement in the crispness quality of the deep fried products when the cereals were steam processed. Here again, the beneficial effect was specially noteworthy in the case of wheat and *Maida*. The treated wheat and *Maida* gave *Chakli* with hardness index of 0.4 and 0.8 respectively. Best crispness was noticed in *Chakli* from steamed bajra. Among the products from steamed cereals rice crispy was the hardest with an index of 2.

While the crispness of the fried product was improved by steaming, the extruded dough lacked sufficient adhesiveness particularly with maize and sorghum which could not be extruded continuously and shaped into the round strands. This was possible by introducing black gram flour but only at the cost of making the product hard. Even at 10 per cent level the hardening effect was pronounced in all cases (Table 2).

The level of shortening (hydrogenated vegetable oil) which was needed to be added to the cereal pulse mix to give a deep fried product with crispness in the acceptable range of 0.2-0.5 has been worked out for the various cereals. The mixes that gave hard products required a high level of shortening to give an acceptable product. Wheat and bajra mixes required only 2 per cent addition of shortening while the rice mix required 15 per cent addition.

TABLE 2. EFFECT OF STEAM PROCESSING ON DOUGH CHARACTERISTICS AND CRISPNESS QUALITY OF DEEP FRIED PRODUCTS FROM CEREAL GRAINS

Cereals	Extrusion time		Hardness index of crispie			Shortening requirements for optimal crispness in *Chakli*			Hardness index of *Chakli* with 10% shortening & 10% BGF (meter readings)	
	Raw sec	Processed sec	Raw	Processed	Processed flour with 10% BGF	Shortening %	Hardness index (organoleptic)	Ether extractives in fried *Chakli* %	Raw	Processed
Wheat	55 (70)	4 (120)	7 (13.2)	0.4 (48)	0.7	2.0	0.4	40.0	2.9	1.6
Maida	52 (64)	12 (80)	8 (N.D.)	0.8 (38)	2.5	5.0	0.2	41.5	2.5	6.8
Rice (8 % polish)	22 (70)	32 (120)	5 (17.3)	2.0 (31)	4.0	13.0	0.2	35.1	3.1	3.0
Brown rice	—	—	4.5	3.0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Maize	1.5 (116)	21 (126)	4 (26.8)	0.8 (40.5)	2.0	9.0	0.4	40.2	3.3	2.3
Sorghum	4 (90)	20 (120)	2 (32.1)	0.5 (38.2)	1.5	9.0	0.2	43.2	2.8	2.3
Ragi	12 (90)	7 (130)	3 (25.3)	1 (29.6)	1.5	9.0	0.5	33.5	N.D.	N.D.
Bajra	8 (100)	2 (120)	1 (36.8)	0.2 (47)	0.5	2.0	0.2	36.5	N.D.	N.D.
Bajra (dehusked)	N.D.	N.D.	3.5	0.75	N.D.	3.0	0.5	N.D.	N.D.	N.D.
Varagu (parboiled)	N.D.	N.D.	3 (N.D.)	2 (26.2)	N.D.	9.0	0.4	34.5	N.D.	N.D.

Under 'Extrusion time' the figures in brackets indicate the water needed to make dough from 100 g of flour.
Under 'Hardness index of crispie', the figures in brackets indicate the fat content in finished product (ether extracts).
BGF: Black gram flour; N.D.: Not done.

About 10 per cent was required in the case of the other cereals.

With regard to the oil content of deep fried products, it was found, in general, that the greater the crispness, the greater was the oil content of the fried *Chakli*. This was so irrespective of the level of shortening added to the mixes prior to frying. There was, however, no indication of proportionality between the crispness and the oil content of the *Chakli*. The bajra *Chakli* had the lowest oil content with maximum crispness. This point has however, to be checked further by more controlled studies.

The effects of black gram flour at various levels on the crispness quality of *Chakli* from rice, wheat and jowar are presented in Fig. 2. Increasing levels of black gram flour increased the hardness of the *Chakli*. In contrast to this, at fixed level of black gram flour, increasing proportion of shortening reduced the hardness contributing to an agreeable texture of the product.

Chaklis are made traditionally by using a mixture of black gram flour and rice. The present studies have shown that products much crisper than that from rice, could be made using other processed cereals and millets and with much less shortening which is a great advantage in the formulation of stable ready-mix flours for crisp products. The observation has been made use of for developing mixes for *Chakli* and *Muchorai* in this Institute.

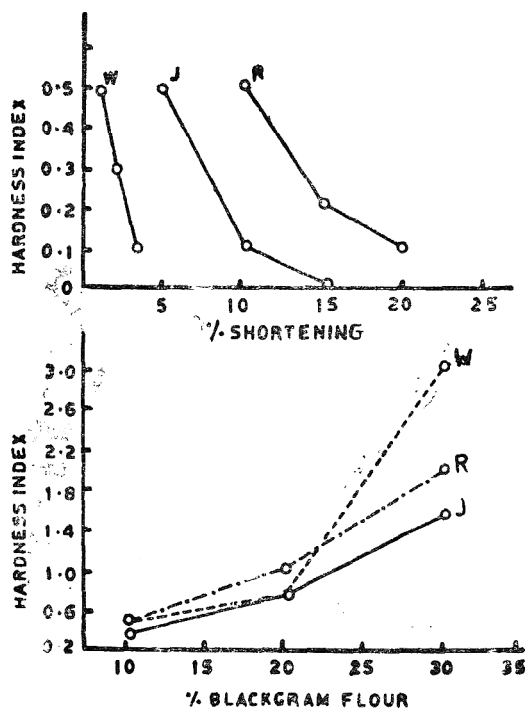

FIG. 2. Effect of shortening and blackgram flour on hardness index of *chakli*
W, Wheat; R, Rice; J, Jowar

CHANGES IN COLOUR AND ACIDITY OF BLACK GRAM (*PHASEOLUS MUNGO*) *PAPADS* DURING STORAGE

Results obtained in the present study have indicated significant changes in pH values and colour in *papads* stored at 92 per cent RH and 38°C. Possibly, temperature dependent chemical reactions similar to that of Maillard type non-enzymatic browning are responsible for such changes.

The moisture sorption behaviour of black gram (*Phaseolus mungo*) *papads* under different humidities and packaging of *papads* in different films have been studied earlier[1]. In these investigations, some discolouration in *papads* was observed during storage. Studies on the physico-chemical characteristics of commercial *papads* had also indicated wide differences in the acidity (pH) of the samples[2]. Since colour and acidity are important factors contributing to the overall acceptability of *papads* stored for different periods, a study was undertaken to assess these changes in *papads*, when stored in different flexible packaging materials.

Two batches of black gram *papads* used in this investigation were prepared according to the procedure described earlier[3]. The recipe consisted of 45 parts of water, 7 parts of common salt and one part of sodium carbonate per 100 parts of black gram flour. *Papads* of 8 cm diameter and 0.6 mm thickness made out of above recipe were dried to approximately 14 and 16 per cent moisture. Twenty *papads* each were packed in 10 cm × 12 cm bags made of 400 gauge low density polyethylene (LDPE) and 200 gauge high density polyethylene (HDPE) and aluminium foil laminate (AFL) consisting of paper/Al foil 0.009 mm/150 gauge polyethylene respectively. The samples were stored under three conditions, viz. refrigerator (about 4°C and 40-50 per cent RH); 65 per cent RH at 27°C and 92 per cent RH at 38°C. Periodical changes in colour and pH of *papads* were estimated.

For estimation of colour of *papads*, Lovibond tintometer and Photovolt photoelectric reflectionmeter with different filters were tried. As measurement in reflectionmeter using green filter was found to be more reliable, the same was taken as an index of the colour of *papads*. Changes in colour were visually observed periodically. When significant colour change was noticed in samples stored for 140 days under accelerated conditions, the colour was measured. Reflection measurements were made at 6 different places on each *papad* and percentage reflectance noted for 10 samples in each set. The maximum, minimum and average values of the same are reported in the Table 1.

For estimation of acidity (pH), 5 g of sample was dispersed in 50 ml of distilled water and pH was recorded using Beckman pH meter.

As indicated in Table 1, the colour of *papads* changed from a reflectance value of 26.5 to 16 per

TABLE 1. CHANGES IN MOISTURE, pH AND COLOUR OF PAPADS IN DIFFERENT PACKAGING MATERIALS AT THE END OF 140 DAYS OF STORAGE

	Initial values	At 92%RH and 38°C			At 65%RH and 27°C			In refrigerator		
		LDPE	HDPE	AFL	LDPE	HDPE	AFL	LDPE	HDPE	AFL
		Papads containing 14% moisture								
Moisture‡ (%)	13.5	19.1	18.5	13.5	13.7	13.8	13.5	13.9	13.9	13.5
pH	7.6	5.7	5.9	5.9	6.9	6.9	6.9	7.6	7.6	7.6
Colour (% reflectance)										
Range	24-29	14-19	14-19	14-19	24-29	24-29	24-29	23-28	23-28	23-28
Average†	26.5	16	16	17	26	27	26	27	26	26
		Papads containing 16% moisture								
Moisture (%)	15.9	20.1	20	16.4	16.2	15.9	16.2	15.9	15.8	15.9
pH	7.2	5.6	5.7	5.7	6.5	6.5	6.4	7.2	7.2	7.2
Colour (% reflectance)										
Range	29-31	14-18	14-18	14-18	25-30	25-30	25-30	28-32	28-32	28-32
Average†	29.5	16,6.5	16.5	16.5	28	28	27	29	29	29.5

‡On fresh weight basis †Of about 50 values

cent under accelerated storage conditions of 92 per cent RH at 38°C during a storage period of 140 days. This change was uniform in *papads* packed in all the three packaging materials used. It is interesting to note that irrespective of the final moisture content of *papads*, the colour change was the same, indicating thereby, that humidity as well as moisture content have negligible effect on the colour change. For example, even though the *papads* packed in LDPE and HDPE attained a moisture content of 18-20 per cent during storage, the reflectance values were the same as those observed in AFL, wherein the moisture contents were 14 and 16 per cent respectively. It may, therefore, be concluded that the colour change in *papads* is predominently temperature dependent. Neither packaging material nor humidity variation affects colour appreciably.

In contrast, there was practically no discolouration in the samples packed in different films and stored at 65 per cent RH and 27°C and under refrigerated conditions.

With respect to *papads* stored for the same period at 92 per cent RH and 38°C, sharp falls in the pH values from 7.6 to 5.7 and from 7.2 to 5.6 were observed, when their initial moisture contents were 14 and 16 per cent respectively. The slight sour taste observed in *papads* containing 16 per cent moisture is well reflected by their low pH values. In contrast, a fall of only 0.7 was observed in samples stored at 65 per cent RH and 27°C. Under refrigerated conditions of storage (at about 4°C and 40-50 per cent RH), no decrease in pH values was observed. Results obtained in the present study have indicated significant changes in pH values and colour in *papads* stored at 92 per cent RH and 38°C. Possibly, temperature dependent chemical reactions similar to that of Maillard type non-enzymatic browning are responsible for such changes.

Acceptability studies were carried out on *papads* with 14 per cent moisture and stored at 65 per cent RH and 27°C at the end of a storage period of 300 days. These results have indicated that, as compared to control samples stored in refrigerator, all the samples packed in LDPE, HDPE and AFL retained a bright and fairly uniform colour and pleasing appearance. There was practically no blister formation on frying. All the fried samples were crisp and brittle and had an acceptable taste. As against this the samples with 16 per cent moisture had developed slight sour taste and somewhat unpleasant odour when stored at 65 per cent RH and 27°C.

The present studies have clearly indicated that colour change in *papads* is mainly temperature-dependent and can be conveniently measured in a photovolt photoelectric reflectionmeter using a green filter. This colour change is not affected by humidity or moisture. Completely moisture and gas proof aluminium foil laminate has no advantage over LDPE or HDPE as indicated by pH and colour measurements of stored *papads*. As such, 400 gauge LDPE or 200 gauge HDPE appears to be a suitable packaging material. It can also be concluded that *papads* containing 14 per cent moisture (as is basis) will have a shelf-life of more than 300 days under normal conditions of storage. A pH value of 8.0, suggested in Indian Standards Specification and a moisture content of 14 per cent are desirable to avoid positively the undesirable changes in colour and pH during storage.

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FURTHER STUDIES ON THE CONTROL OF INTERNAL FUNGI OF SORGHUM BY FUMIGATION

Earlier studies on the control of internal fungi of grain sorghum by fumigation have revealed the fungicidal properties of ethylene oxide, methyl bromide and sulphur dioxide. Further studies were conducted with eight more fumigants and the results are reported here. The method of fumigation, the estimation of internal fungi as well as the viability of grains were the same as described in the previous study[1]. The fungicidal characters of the fumigants are given in Table 1. The grain sorghum contained internal fungi of the genera *Fusarium*, *Helminthosporium* and *Alternaria*.

Methyl iodide at 64 mg/l gave hundred per cent control of internal fungi in sorghum. The fungicidal action of other fumigants at 96 mg/l dosage could

TABLE 1. EFFECT OF FUMIGANTS ON THE CONTROL OF INTERNAL FUNGI AND VIABILITY OF SORGHUM GRAINS

Fumigants	32 mg/l		64 mg/l.		96 mg/l	
	%Control	Viability %	%Control	Viability %	%Control	Viability %
Trichloroethylene	10	98	10	98	13	100
Tribromopropene	24	94	88	92	69	88
Crotyl bromide	29	76	69	74	88	78
Acetonitrile	0	94	0	98	13	96
Methyl iodide	95	86	100	74	100	56
Formaldehyde	33	94	63	68	94	18
Hydrogen cyanide	50	100	78	92	55	96
Ethyl formate	53	92	48	96	50	98

Exposure: 48 hr. Temperature during fumigation: 27±1°C.

Note: The percentages given in the table were calculated by Abbott's formula which represents the corrected figures over control.

be arranged in the descending order as follows: formaldehyde (94 per cent), crotyl bromide (88 per cent), tribromopropene (69 per cent), hydrogen cyanide (55 per cent), ethyl formate (50 per cent), acetonitrile (13 per cent) and trichloroethylene (13 per cent). When the grains were fumigated with methyl iodide (64 mg/l), the viability was lost to an extent of 26 per cent. The other fumigants used in this study seem to have very little deleterious effect on the viability of grains at lower dosages.

Among the fumigants used in this study, methyl iodide was found to be superior in controling internal fungi like *Fusarium*, *Helminthosporium* and *Alternaria* with minimum loss in viability of grains. The fungicidal action of crotyl bromide, formaldehyde and ethyl formate on the external fungi of grains were known previously[2]. However, the value of methyl iodide as a fungicide is concluded only from this study.

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COLORIMETRIC ESTIMATION OF FENITROTHION RESIDUES ON VEGETABLES AND FRUITS

The insecticide was extracted with methyl cyanide. After filtration partitioning was done with 100 ml mixture of petroleum ether and diethyl ether in the presence of distilled water. After concentrating the upper layer to 10 ml, it was passed through 'Florisil' column. Elution was done with 50 ml of eluting mixture. Suitable extract was taken in small beaker and the solvent was evaporated after adding diethylene glycol as keeper. Hydrogen peroxide was added and conditioning was done at 35°C for 15 min. Hydrolysis of the insecticide was done by adding alkali, and keeping the beaker at 35° C for 20 min. Intensity of the yellow colour developed was measured at 400 mμ.

Fenitrothion, (0,0-dimethyl 0-4-nitro -3- methyl phenyl thiophosphate), which is also known as sumithion, accothion, folithion, Bayer 41831 or methyl nitrophos has been determined by colorimetry or spectrophotometry by many workers[1]. Deshmukh and Joia[8] have employed the methods of partitioning and clean up for chlorinated insecticides of Mills *et al.*[9] to fenitrothion from maize. However, inconsistent recoveries were got, when the methods were employed for estimation of fenitrothion residues from fruits and vegetables. The modified procedure and the results of analysis of the insecticide are described in this note.

Extraction and clean-up: A 25 g sample of the commodity was homogenised with acetonitrile in the ratio of 1:2 in a blender. The extract was

filtered through sintered funnel and washed twice with acetonitrile. The combined filtrate was used for partitioning in a separatory funnel with 100 ml mixture of petroleum ether and diethyl ether, in the ratio of 80:20, in presence of 300 ml distilled water and 5 ml saturated sodium chloride solution. The contents were shaken for 2 min and lower aqueous layer was rejected. Upper organic layer containing the insecticide was concentrated to 10 ml under a current of air at room temperature. The concentrated extract was passed through florisil column. Ten to twelve grams of florisil activated at 110°C for 4 hr was employed. The column was eluted with 10 ml of elution mixture containing petroleum ether, diethyl ether and dioxon in the ratio of 29:20:1. The flow rate was 4 to 5 drops per min.

Estimation: Volume of the preserved effluent was diluted to 50 ml with petroleum ether. Suitable aliquots were taken in 10 ml beakers and 2 drops of diethylene glycol was added to act as keeper. The solvent was evaporated with the help of fan. To the residue 0.05 ml of H_2O_2 was added and the beakers were kept at 35°C in constant temperature water bath for about 15 min. Four ml of 0.5 N KOH was added and the beakers were again held at 35°C for 20 min[10]. Almost equal weight of each commodity was employed as control. The acetonitrile extracts were similarly treated and employed as blanks. The intensity of the yellow colour was measured at 400 mμ with spectrophotometer against control as blank.

This method was tried for 9 substrates and it was found to work very well with 8 of them. The sensitivity of the method was calculated by the method given by Bates[11] which was found to be 0.03 ppm. Perusal of the Tables 1 and 2 clearly shows that the recoveries were quantitative in all the substrates except one.

When 100 ml of petroleum ether was used for partitioning of fenitrothion from acetonitrile-water phase, the recovery was low. To increase the recovery admixture of petroleum ether and diethyl ether was tried for partitioning which resulted in good recovery. The quantity of diethyl ether in eluting mixture was also changed due to same difficulty. However, interference with sumioxon was encountered in the method.

The authors are thankful to Dr O. S. Bindra, Dept. of Entomology for providing of necessary facilities.

TABLE 1. RECOVERIES OF FENITROTHION FROM FORTIFIED SAMPLES OF DIFFERENT SUBSTRATES

Substrate	Added (ppm)	Fenitrothion recovered (ppm)	Recovery %	Av. recovery %
Cabbage	6.4	6.400	100	
	1.28	1.220	95.31	94.00
	0.256	0.222	86.71	
Brinjal	6.4	5.85	91.40	
	1.28	1.108	86.56	90.83
	0.256	0.242	94.53	
Tomato	6.4	6.25	97.65	
	1.28	1.254	97.96	94.10
	0.256	0.222	86.71	
Potato	6.4	5.66	88.43	
	1.28	1.108	86.56	84.53
	0.256	0.201	78.51	
Okra	6.4	5.97	93.28	
	1.28	1.16	90.62	90.04
	0.256	0.222	86.71	
Carrot	6.4	6.11	95.46	
	1.28	1.25	97.65	96.35
	0.256	0.246	96.00	
Radish	6.4	6.27	97.96	
	1.28	1.94	93.28	95.20
	0.256	0.242	94.53	
Peach	6.4	5.999	93.73	
	1.28	1.132	88.43	92.24
	0.256	0.241	94.53	
Spinach	6.4	3.2	50.00	46.68
	0.256	0.111	43.35	

TABLE 2. BLANK VALUES OF DIFFERENT SUBSTRATES

Substrate	R_1	R_2
Bhindi	0.050	0.055
(Okra)	0.085	0.075
	0.100	0.095
Brinjal	0.120	0.115
	0.100	0.090
	0.090	0.095
Radish	0.085	0.080
	0.095	0.095
	0.095	0.090
Cabbage	0.075	0.070
	0.080	0.070
	0.095	0.095
Potato	0.090	0.085
	0.100	0.090
	0.110	0.100
Peach	0.090	0.110
	0.100	0.100
	0.100	0.090
Tomato	0.120	0.115
	0.100	0.100
	0.090	0.095
Carrot	0.075	0.085
	0.110	0.090
	0.100	0.110

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REMOVAL OF BRAN AND ALEURONE LAYERS AT DIFFERENT POINTS ON THE SURFACE OF RICE GRAIN DURING PROGRESSIVE POLISHING

Histological study has revealed that at all stages of polish studied (1-6 per cent), the abrasion is more severe on the protruding ridges than on the grooves and greater on the ventral region than on the dorsal. Similarly, bran (pericarp and tegmen) and aleurone removal was greater in the median portion than in the corresponding portions at the tapering distal end of the grain. Residual bran and aleurone layers are present in the grooves and dorsal pit even at 6 per cent of polish.

It is well known that bran and aleurone layers get removed from the rice grain during polishing. The pattern and extent of removal at different stages of polishing does not, however, seem to have been studied and understood in detail although Rabechault[1] made a study of the progressive removal of the bran and aleurone layers in rice samples collected from successive cone polishers using the histological technique and observed that bran was removed first on the ridges and that residual bran layers could be found in the grooves in the early stages of polishing. Aleurone layers were removed later than the bran layers.

The rice grain is a cono-elliptical cylinder[2] and has longitudinal ridges and grooves alternately arranged on the surface. For these reasons, the extent of bran removal is expected to be uneven at different points on the surface of the grain. The object of the study reported here is to investigate the differences in the pattern of bran and aleurone layers removed during progressive polishing in rice at different points on the grain.

'Bangara Sanna' (S-1092) variety of paddy was shelled in a McGill sheller to obtain brown rice. The cleaned pure brown rice was polished from 1-6 per cent in a McGill polisher No. 3[3].

Transverse hand sections, ten at the median portion and five at the distal end of each of ten softened[4] rice grains were prepared, stained with Sudan IV and examined microscopically. In order to eliminate the interfering effect of germ, only the sections at the distal end have been used for comparison with median sections. Presence or absence of the bran (pericarp and tegmen) and aleurone layers on eight locations (ridges, grooves and dorsal and ventral surfaces as explained in 'C' in Fig. 1) was recorded.

Histograms in 'A' in Fig. 1 show that the most prominent ridge 1 suffers the greatest abrasion resulting in a greater proportion of loss of bran and aleurone layers than at the other points on the grain. Ridge 2 comes next in this regard. The grooves in between ridges exhibit lower proportion of bran and aleurone removal than the ridges on either side. Similarly, the dorsal region suffers comparatively much less abrasion than the ventral portion. Differences enumerated above are statistically significant as can be seen from data presented in Table 1. The median portion exhibits greater bran damage than the corresponding points of the distal end ('B' in Fig. 1).

TABLE 1. PERCENTAGE OF SECTIONS WITH DENUDED BRAN AND ALEURONE LAYERS AT DIFFERENT DEGREES OF POLISH IN RICE

Portion of grain	Degree of polish 1%	2%	3%	4%	5%	6%
Dorsal	0	32	46	53	74	74
	(0)	(14)	(13)	(24)	(36)	(36)
Ventral	24	52	77	94	96	100
	(5)	(42)	(52)	(73)	(86)	(98)
Ridges †	52	76	87	92	98	99
	(41)	(63)	(69)	(82)	(93)	(98)
Grooves †	25	47	69	79	87	92
	(13)	(29)	(40)	(46)	(58)	(69)
X^2 test						
Dorsal *vs* ventral	—	**	*	*	*	*
	—	(*)	(*)	(*)	(*)	(*)
Ridges *vs* grooves	*	*	*	*	*	*
	(*)	(*)	(*)	(*)	(*)	(*)

Significant at:* 5 per cent level; ** 1 per cent level.

† Data represent averages of all ridges and grooves on both sides in each transverse section. Original total observations on ridges and grooves were used in statistical analysis.

Figures in parenthesis pertain to aleurone layer

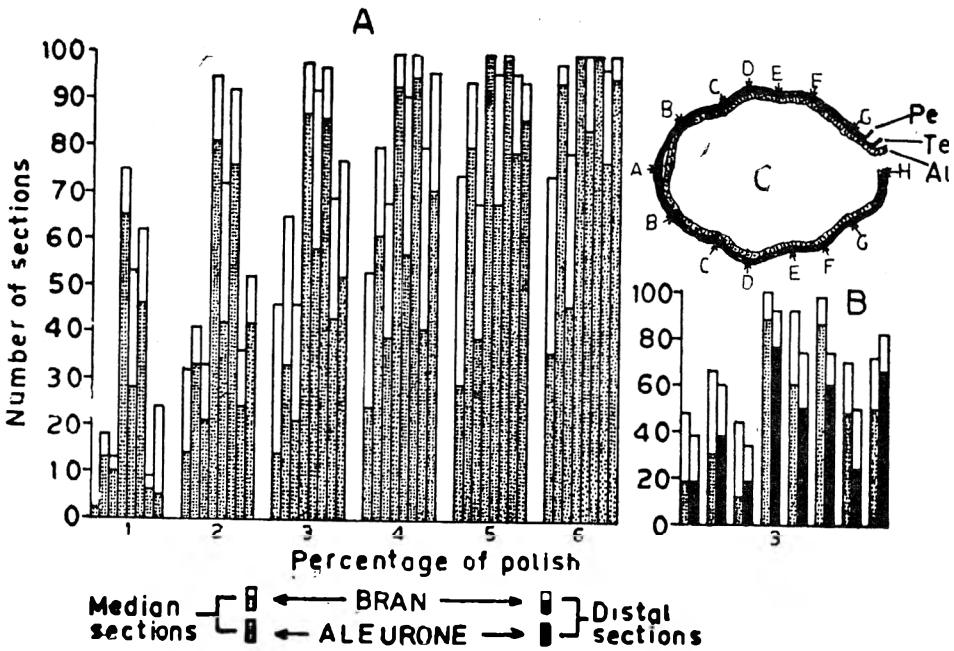

FIG. 1. Histogram represen ing percentage of sections with denuded bran and aleurone layers at different degrees of polish

A: Median section. The eight bars from left to right in each group pertain respectively to dorsal, dorsilateral, groove-1, ridge-1, groove-2, ridge-2, ventrilateral and ventral portions as described in 'C'.

B: Distal and median sections compared.

C: Transverse section of rice grain showing different sites at which romoval of bran and aleurone layers was studied. A=dorsal, B=dorsilateral, C=groove-1, D=ridge-1, E=groove-2, F=ridge-2, G=ventrilateral, H=Ventral, Pe=pericarp, Te=tegmen, Al=aleurone layer.

The peripheral bran layers were removed faster and earlier than the aleurone at all stages of polish as described earlier by Rabechault[1]. Even a low degree of polish was enough to remove the outer bran layers, while much greater polish was required for effecting removal of the aleurone. It is, however, to be noted that even at the maximum degree of polish of 6 per cent, residual bran and aleurone could be seen in the grooves and also in the dorsal portion. The reason for the lower damage at the dorsal point as compared with the ventral is, perhaps, to be attributed to its being located in a pit and also to the fact that the thickness of the aleurone is greater at this point[5]. The small amount of oil and vitamins that are still present in polished rice samples is, therefore, at least partly contributed by the residual bran and aleurone layers present in the grooves and depressions present in the rice grain.

The present studies indicate that differences in chemical composition arising from different degrees of polish are an average effect of different degrees of bran removal not only amidst grains[6], but also amidst different points in the same grain caused by its peculiar cono-elliptical shape.

The authors wish to thank (Miss) D. Rajalakshmi for kind advice in the statistical analysis of the data.

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AMINO ACID COMPOSITION OF BARLEY VARIETIES

Amino acid spectra of six recently released barley varieties and Hiproly were prepared. On the basis of chemical score it was observed that except for variety Jyoti, the most limiting amino acid was threonine followed by isoleucine and lysine. Leucine/ isoleucine ratio was much lower than those for sorghum and maize.

In India, barley grains are utilized for human food as well as for animal feed. In addition, a small quantity is utilized for preparation of malt for infant food and brewing purposes. It is, therefore, essential that the established genotypes of this cereal be screened for their nutritional quality. This report evaluates some barley varieties, recently released for commercial cultivation, on the basis of their amino acid composition and chemical score[1], and comparison with those of the high-protein high-lysine selection of Munck[2].

Representative samples of seven varieties of barley, including *Hiproly*, were ground to 60 mesh size in a Wiley mill and defatted. Nitrogen was determined on these by the micro-Kjeldahl method and the protein percentage computed by using the factor, 6.25.[3] Amino acid analyses were made on acid hydrolysates of the samples[4,5]. Hydrolyses were carried out on samples containing an equivalent of 5 ± 0.5 mg of protein (Kjeldahl N $\times$6.25) with 5 ml of distilled 6 N hydrochloric acid for 24 hr at $110\pm1^{\circ}$C in evacuated sealed tubes. Excess acid was removed by repeated washing with double distilled water and it was subsequently evaporated under reduced pressure at 50°C on a rotary flash evaporator. The residue was taken up in citrate buffer (pH 2.0) and an aliquot used for estimating the amino acid content with the help of a Technicon Sequential Multisample Amino Acid Analyser.

It was observed that lysine, generally considered to be the most limiting amino acid in cereals[6], varied from 2.77 to 3.16 (g/16 g N) (Table 1). In *Hiproly*,

TABLE 1. AMINO ACID CONTENT* AND CHEMICAL SCORE OF GRAINS OF SOME BARLEY VARIETIES

Amino acid	Amino acid (g/16 gN) content in indicated varieties						
	Ratna	Jyoti	RS6	Hiproly	LSB2	NP109	K572/11
Lysine	2.91 (0.380)	3.00 (0.413)	2.94 (0.380)	4.04 (0.816)	3.16 (0.403)	3.12 (0.283)	2.77 (0.266)
Histidine	2.04 (0.266)	2.34 (0.322)	1.96 (0.253)	2.75 (0.556)	2.33 (0.298)	2.20 (0.200)	2.19 (0.211)
Arginine	4.19 (0.548)	5.19 (0.713)	4.50 (0.582)	6.29 (1.271)	4.96 (0.634)	4.82 (0.438)	4.81 (0.463)
Aspartic acid	4.15 (0.542)	4.42 (0.608)	3.83 (0.495)	5.75 (1.163)	3.92 (0.501)	3.78 (0.343)	3.68 (0.354)
Threonine	1.99 (0.260)	2.67 (0.367)	2.05 (0.265)	2.47 (0.499)	2.03 (0.260)	1.97 (0.179)	1.89 (0.182)
Serine	3.41 (0.446)	3.91 (0.537)	3.16 (0.408)	4.16 (0.841)	3.53 (0.451)	3.28 (0.298)	3.19 (0.307)
Glutamic acid	17.15 (2.241)	20.67 (2.842)	18.61 (2.404)	20.18 (4.079)	16.50 (2.109)	18.37 (1.668)	15.73 (1.513)
Proline	9.67 (1.264)	11.48 (1.578)	8.79 (1.136)	8.91 (1.800)	9.47 (1.210)	8.00 (0.726)	8.36 (0.804)
Glycine	3.12 (0.408)	3.01 (0.414)	3.11 (0.406)	3.90 (0.789)	3.42 (0.437)	3.40 (0.309)	2.95 (0.284)
Alanine	3.71 (0.485)	4.38 (0.602)	3.66 (0.473)	5.47 (1.106)	4.50 (0.575)	4.10 (0.372)	3.68 (0.354)
Cystine	2.79 (0.364)	2.12 (0.291)	2.15 (0.278)	1.66 (0.335)	2.35 (0.299)	2.54 (0.231)	2.86 (0.275)
Valine	3.76 (0.491)	4.47 (0.615)	3.65 (0.471)	4.74 (0.958)	3.98 (0.509)	3.47 (0.315)	3.17 (0.305)
Methionine	1.51 (0.197)	1.74 (0.239)	1.38 (0.178)	2.35 (0.475)	1.81 (0.231)	1.34 (0.122)	1.33 (0.128)
Isoleucine	2.69 (0.350)	3.62 (0.497)	2.74 (0.354)	3.17 (0.641)	3.16 (0.403)	2.85 (0.259)	2.73 (0.263)
Leucine	5.72 (0.748)	6.73 (0.925)	6.15 (0.794)	6.71 (0.357)	5.97 (0.762)	6.47 (0.587)	5.69 (0.547)
Phenylalanine	4.25 (0.556)	5.04 (0.693)	4.30 (0.555)	5.01 (1.012)	4.11 (0.526)	3.95 (0.359)	4.07 (0.392)
Tyrosine	2.85 (0.372)	3.05 (0.420)	2.90 (0.375)	2.83 (0.572)	3.13 (0.400)	2.58 (0.234)	3.20 (0.308)
Protein (%)	13.07	13.75	12.92	20.21	12.78	9.08	9.62
Chemical score (%)	40	45	41	49	41	39	38

*Values are based on actual recoveries; figures in parenthesis give amount in g/100g of sample.

†Based on the chemical score of hen's egg (whole) taken as 100 per cent.

the percentage was 4.04. On the basis of the chemical score,[1] however, it was observed that, except for the variety *Jyoti*, the most limiting amino acid appeared to be threonine, followed by isoleucine (Table 1). Improvement in the lysine content of *Hiproly* resulted in the enhancement of chemical score value for lysine to 61. Thus, the limiting amino acids for *Hiproly*, as well, were isoleucine and threonine, their chemical scores being 48 and 49, respectively.

In sorghum and maize, various authors have reported that high leucine/isoleucine ratio is responsible for the incidence of pellagara disease[7,8]. In the varieties presently examined it was observed that the ratio varied from 1.86 to 2.27. These ratios are considerably lower than those reported for sorghum and maize, viz. 3.39 and 3.40 (calculated on the basis of FAO values[9] for the amino acid contents). The glycine content varied from 2.95 to 3.90 (g/16 g N). Its importance has been stressed in the feeding of chicks[10].

However, it needs to be mentioned that assessment of protein by chemical methods gives only the potential food value since processing may affect the availability of some essential amino acids especially in view of the large amount of carbohydrates present, or there may be an improvement in its quality because of the destruction of protease inhibitors inherently present in the grains[1,11,13].

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2 August 1973

BOOK REVIEWS

Symposium: Vertical Coordination in the Pork Industry, Edited by R. E. Schneidatt and L. L. Duewer, AVI Publishing Company, Westport, Conn., 1972, pp. 277. Price: $ 20.50.

The book is an outcome of the papers presented at a Symposium held at Perdue University. It critically examines the present status of the hog industry in leading hog producing countries of the West, with special reference to vertical coordination in the industry and its possible future role. The book tries to avoid the more common term vertical integration which has assumed a much narrower meaning of combining various stages of economic activity under one ownership and defines vertical coordination as an agreement between two parties, one an input supplier to the other, resulting in the transfer from one party to the other, part or all of management control, assets or function. The *per capita* consumption of beef and poultry has been steadily increasing while the demand for pork has remained constant. The challenge before the pork industry as stated by Erikson in the introductory section is to raise demand for pork and lower its cost of production in order to compete with beef or broiler production enterprise. The second section contains articles expressing the views of the producer, packer and retailer on how they look at the challenge faced by the pork industry. As they put it, in decades to come, the industry will adopt more rigid standards for product. The product development will have to be in conformity with likely changes in consumer preferences for more uniform and convenient product. The producers will need feed-back from retailers and packers so that they could make necessary changes in production technique to suit the needs of retailers and consumers. The feed manufacturer can play a very useful role in bringing about vertical coordination in various operations from producer to retailer.

The next section deals with systems and techniques of coordination in different pork producing areas in U.S.A. and in Danish and Canadian swine industry. By linking the various stages in production with feed manufacturer and packer a more highly industrialised system as has been achieved for poultry and beef business can be developed for future. Broadbent has listed these measures for future development of pork industry. They include: (1) large scale swine production and direct selling to packer buying organisation; (2) contract growing of pigs for regular supply of quality feeders to pork producers; (3) sow leasing programmes by feed companies and packers to provide seed stocks to producers; and (4) integrated marketing and credit facilities to the industry. These conclusions apply more or less to different pork producing centres in U.S.A. Edmondson has dealt about Danish system of pork industry which is mostly controlled by swine farmers. The Danish swine industry has to compete in the international market. The producing farm units are effectively coordinated and integrated by a comprehensive network of farmers cooperatives which supply all requirements of swine farmers and undertake marketing of their products at home and abroad. The geographical proximity of Canada with U.S.A. has helped its swine industry to a considerable extent in maintaining its efficiency in production methods and marketing.

The effect of technological changes on future of swine industry has been stated in the next section. Advances in knowledge regarding feed nutrients, the dietary inter-relationship among them and more precise knowledge about quantitative requirement of nutrient energy during different life phases, will help in feed formulations for improving production efficiency. Quantifying nutrient energy ratio will improve the capabilities of the nutritionist to maximize the utilization of dietary protein and energy for lean meat production. New feed ingredients such as unicellular protein sources and high lysine corn are likely to be tried in feeding. The possible use of hormones in altering the metabolic response as measured by growth, feed utilization and carcass quality would provide a new line of approach in swine production. The application of modern techniques of production like artificial insemination and oestrous control are likely to be used extensively in breeding programmes. The problems of water pollution caused by swine wastes under intensive flock management conditions are discussed by Muehline and Day. The role of management technique in bringing about increased coordination is also touched upon in an article by Kadlac. The section on Agribusiness and vertical coordination contains a series of articles on vertical coordinations while the next two sections deal with financial issues, marketing system, and implication of government regulation in coordination.

In the last chapter a conclusion is drawn that increased coordination and vertical integration in the pork industry will occur in future and will exist side by side with privately owned and controlled production and open market. The general consensus of all the chapters is that increased coordination is 'good' as long as it lowers costs and increases efficiency and product quality, while increased integration is questionable. The intensive pig raising is hardly ever practised in India. However, one cannot escape a conclusion that systematic raising of pigs cannot be feasible without a well coordinated processing sector as requirement of heavy inputs and competition from traditional unorganized swine raising practices will make it unremunerative.

N. P. DANI

Food Dehydration: Vol. I. Drying Methods and Phenomena by van Arsdel, AVI Publishing Co. Inc., West Port, Conn., Second Edition, 1973, pp. 347, Price: $ 20.

This volume covers the basic scientific principles of Food Dehydration. The book consists of 8 chapters, all written by specialists conversant with the equipment and methods. This is a major change that has been brought in, when compared to the earlier Edition.

The chapters are: (1) Introduction, (2) Dehydrated foods in United States, (3) Drying phenomena, (4) Properties of water, water vapour and air, (5) Air drying and drum drying, (6) Freeze drying, (7) Drying rates and estimation of drier capacity and (8) Dehydration plant operations. A separate chapter on freeze drying is brought in, considering the importance of the freeze drying process.

The first chapter, covers the history and present status of dehydration industry, listing the commodities that were dehydrated during the war time. The second chapter covers the commodities that are dehydrated in USA, giving statistical data. The chapter on drying phenomena is very well written and covers the basic theoretical concepts for dehydration process, clearly explaining all the changes that a material undergoes during dehydration.

The 4th chapter covers the basic concepts for the construction of psychrometric charts as the title implies.

The next chapter considers the requirements of drier like, the type and selections of fans, air heating methods and instrumentation. All the types of air heated dryers are listed and explained. Drum and foam-mat drying methods are also outlined.

The chapter on freeze drying covers the basic concepts and equipment used in freeze drying.

The chapter on drying rates covers the experimental aspects that are needed for estimating drying time and capacity. Aspects like size, shape, tray loading, air velocity and temperature changes are well explained.

The last chapter on 'Plant Operations' outlines the aspects of plant layout, raw material requirements, predrying operations, quality control and sanitation, and waste disposal, for a dehydration factory. Many layouts are indicated. These aspects were not covered in the earlier edition.

To sum up, the revised edition serves the needs of a university student, studying Food Engineering and Technology and also the needs of people who are in the dehydration industry, requiring a thorough understanding of the dehydration process. Each chapter lists many important references.

B. S. RAMACHANDRA

Food Consumption of Households, U.S. Department of Agriculture, U.S.A., 1973, pp. 215.

The reports under review are in three volumes:

1. Food consumption of the households in the North East: Seasons and Year 1965-66.

2. Food consumption of the households in the West: Seasons and Year 1965-66.

3. Food consumption of the households in the South: Seasons and Year 1965-66.

They are based on a survey conducted by the U.S. Department of Agriculture, Agricultural Research Service. They present findings on quantity and money value of food used by households in a week in each season and the average for the year. The survey covers various income groups, and also cities of various sizes, rural farm and non-farm areas. Since the food actually consumed by an individual family during a week is likely to differ from the quantity purchased, food consumption was measured at the level at which the foods come into the kitchen. The food items covered include breakfast foods, meat, fish, milk, cream, cheese, vegetables, fruits, fruit juices, cereals, bakery products, etc. It is expected that such 'nationwide consumption surveys supply bench marks to appraise trends, measure current variations and identify needs for new changes in policies and new programmes that will benefit the consumer'.

Each volume pertaining to the North East, the West or the South of U.S.A. runs into 215 printed pages and contains numerous tables. Each table refers to one food item or a group of similar food items and covers the various income groups and the various seasons of the year namely spring, summer, fall and winter. The seasonal variability of household averages for quantities of major food items and the money value are summarized in a table in each volume. Although in each region a seasonal variability was noticed in the way the food dollar was divided, this did not differ from region to region.

In the United States where a large volume of canned and cooked foods is purchased even by the average households such surveys of foods consumed have a significance. The data can 'bring the processing and marketing of food closer to the needs and wants of consumers'. The reports under review are at best of only national interest to USA and we, in this country, are not likely to find these useful in planning our food industries.

M. S. NARASINGA RAO

Advances in Biochemical Engineering—2. Edited by T. K. GHOSE, A. FIECHTER AND N. BLAKEBROUGH, Springer-Verlag, Berlin, Heidelberg, New York, 1972, pp. 215. Price: $ 17.20.

The book deals with recent avdances in Biochemical Engineering. It contains six chapters.

Lemuel B. Wingard, Jr.'s chapter on 'Enzyme Engineering' is very well written giving more emphasis on various procedures for the isolation of crude mixtures of enzymes and their purifications, enzyme immobilization. It also deals with various kinetic properties to be taken care of and the design of reactors.

The second chapter is on 'Application of Computers in Biochemical Engineering' by L. K. Nyiri. Application of computers in fermentation processes, programming and languages, process control oriented use of computers and future trends in its application are thoroughly discussed.

The next chapter on 'Mixed Microbial Populations' by Anthony F. Gaudy, Jr. and Elizabeth T. Gaudy stresses the importance of substrate removal and growth, kinetic equations for continuous culture with recycle, treatment of protein deficient waste, various methods for sludge removal and response to changes in environment.

The chapter on 'Scale-up of Biological Waste Water Treatment Reactors' deals with the general concepts of biological waste water treatment, mathematical models and design examples, evaluation of laboratory, bench scale and pilot plant data for design and application of model to available data. The authors W. Wesley Ecknfelder, Jr., Brain L. Goodman, and A. J. Englande have presented useful data to practising biochemical engineers.

The fifth chapter on 'Cellulose as a Novel Energy Source' by E. T. Reese, Mary Mandels, and Alvin H. Weiss deals with the possibilities of direct conversion of cellulose into microbial protein or other products apart from the conventional use of cellulose as a useful heat energy source. The future potential for acid and enzymatic hydrolysis processes for glucose and other sugars from waste cellulose was also discussed. With the available scanty source of information the economic viable unit was also suggested.

The last chapter on 'the Culture of Plant Cells' by Mary Mandels emphasises the future use of culture products for the production of costly drugs from rare or inaccessible plants even though as a bio-engineering science this has not achieved any major break through, due to the slow growth of plant cells and problems regarding stabilization.

Every chapter at the end gives the research needs and future trends in applications. The book is very well documented with figures, flow-sheets, designs, etc. It will be a good addition to libraries and useful to practising biochemical engineers.

M. M. KRISHNAIAH

Hygiene in Food Manufacturing and Handling: by Barry Graham—Rack and Raymond Binstead, Food Trade Press Ltd., England, 1973, Second Edition, Pp. viii+185.

Offering advice on improving hygiene in food factories and other food premises is the theme of this completely revised, enlarged and profusely illustrated new edition. The book concentrates more on the effective design of food processing premises and equipment than on medical connotations.

The effective cleaning and maintenance of food processing premises and equipment are the main theme of this book.

The explanation of the formulation and application of the products of the industrial chemist, which allows the food handler to work correctly without causing hazard is the edifice of modern food hygiene. The book not only adequately discusses this but also

gives information on engineering details on food machinery, knowledge of which is essential for practising food hygiene.

The entire subject matter is discussed in 13 chapters as follows:

Chapter-I on 'Introduction to the Problems of Food Poisoning', discusses how hygiene is the science of sanitation and cleanliness in relation to health. If food hygiene is neglected, the food may be spoiled or cause food poisoning or reduce its shelf-life. Statistics regarding food poisoning are discussed in detail. Community feeding increases the risk of widespread food poisoning.

Chapter-II on 'Bacteria and Moulds' describes the size, appearance, multiplication, growth, and factors influencing it (temperature, oxygen, pH, sporulation, heat, toxins, etc) of bacteria and moulds. Since these micro-organisms play an important role in spoilage of foods and plant hygiene the inclusion of this chapter in the book is quite appropriate.

To understand the importance of hygiene in the manufacture and handling of foods it is necessary to have a basic knowledge of the working of the human digestive system that is briefly described in *Chapter III*.

Chapter-IV on 'Bacterial Food Poisoning'—before discussing in detail the specific types of bacterial food poisoning, explains the differences between food infection and intoxication. Typhoid fever, Salmonella and Shigella infections, Staphylococci and Streptococci spoilage, botulism and other food borne infections are discussed in brief.

Chapter-V is a continuation of Chapter IV dealing with the incidence of various food poisonings and their etiology in different foods.

'Non-bacterial Food Poisoning' in *Chapter IV* deals in fairly good detail with chemical, vegetable and animal food poisonings. The incidence of different types of non-bacterial food poisoning has been surveyed. The discussion illustrates that while bacterial food poisoning is most common, other types are also prevalent.

Chapter-VII on 'Food Spoilage' deals elaborately with various types of microbial food spoilage, including canned products. Hygiene and careful handling are essential to reduce the amount of spoilage.

In *Chapter-VIII* on 'Protection of Food', the author describes the source of contamination in (*a*) naturally contaminated raw material, (*b*) naturally wholesome raw material contaminated by internal processes, (*c*) naturally wholesome raw material externally contaminated before consumption. A detailed discussion on personal hygiene consisting of hand washing facility, personal tidiness and cleanliness, first aid facilities, equipment and education find a prominent place. The role of visual aid in the education of plant operation is stressed.

Chapter-IX deals with 'Construction and Layout of Plant and Equipment.' In this, the author discusses the lay out and construction of the different parts of food plants, viz., floors, walls, ceilings, lighting, ventilation, aeration, dust collectors, canteens and cloak rooms. Production processes, fittings like tables and benches, chopping blocks and cutting boards, containers, construction materials and location of equipment, pipe-lines, tanks, valves, pumps, rotary conveyers, mixers, bearings and electrical equipment have been detailed.

Chapter-X on 'Cleaning Methods' deals with water, its chlorination, water hardness and softening treatments, detergents (alkali, acids, water conditioners, surfectants), sterilisation, product and plant cleaning procedures with equipment for cleaning.

'Pest Control and Hygiene' is the subject matter of *Chapter-XI* occupies a very important place in this. The write-up of this chapter with useful guidelines in pest control, is excellent. Information on habitats and regular procedures of control/eradication of mice and rats (food industry's No. 1 pest), flying insects, crawling insects, pest birds and pest control precautions are very elaborate.

Chapter-XII on 'Hygiene Contact Services' emphasises the need for scrupulous cleanliness on food production and food preparation areas and catering equipment, and toilets and their associated plumbing fixtures.

Chapter-XIII on 'Statutory Regulations' deals with different statutory regulations laid down to protect the quality of the food. These include requirements for processing premises, processing of foods, handling, storage, sanitary facilities, etc. The mode and scope of some of the enactments have been described in detail.

An added attraction of the book is the exhaustive illustrations of plant and equipment and the reading list of books and booklets provided.

The book will be a valuable addition to the current literature on the subject. It will be useful to students, research workers, and food plant operators. The get-up and the binding of the book are good.

M. A. KRISHNASWAMY

NOTES AND NEWS

Food Technology and Asia

The Australian Institute of Food Science and Technology, Brisbane, is arranging a technical programme for its 8th Annual Convention to be held at the Wentworth Hotel in Sydney from 23rd to 27th June 1974. The main theme chosen is 'Food Technology and Asia'.

Seminar on Activated Carbons

A Seminar on the Role of Activated Carbon in the Economic and Industrial Development of India will be held at Bombay from 15th to 17th, July 1974. Communications should be addressed to Chairman, Sychem, No. 150, V Block, Jayanagar, Bangalore-11.

Third All-India Poultry Science Symposium

The 3rd All-India Poultry Science Symposium was held at the Indian Veterinary Research Institute, Izatnagar, between 21st to 24th December 1973. A number of Scientists, Poultry Farmers and representatives from commercial hatcheries, drawn from all over the country, attended the conference. Dr Hans Abplanalp, a renowned poultry geneticist inaugurated the Symposium. Dr C. M. Singh, Director, Indian Veterinary Research Institute, presided over the function and Dr G. L. Sharma, Joint Director cum Principal, postgraduate studies of IVRI welcomed the delegates.

A beautiful souvenir was brought out to mark the occasion which contained articles on poultry science from leading scientists working in the area of poultry science, in the country.

One hundred and fourteen research papers were presented in the conference, which was divided into seven different sessions such as poultry nutrition, poultry genetics, poultry products technology, poultry physiology, poultry diseases and poultry science education. The deliberations were interesting and thought-provoking.

Quality of Indian Wheats

Analytical, physical, chemical, and baking studies were performed on 43 samples, representing 30 spring wheat varieties harvested in India. Some high-yielding wheats and wheats recently introduced from Mexico were excellent bread wheats compared with a typical composite bread flour (RBS-70A) from wheats grown in the U.S. Water absorptions of India's wheats averaged materially above those of U. S. grown varieties. Water absorptions of some of the semi-dwarf Mexican varieties were as high as 75 to 78 per cent, and many indigenous Indian varieties had water absorption above those of average U. S. wheats. Bread-baking quality of both Mexican and Indian varieties varied from excellent to poor; however, the Mexican varieties generally were better bread wheats. (Finney, Bains, G. S., Hoseney and Lineback, *Cereal Science Today*, 1973, **18** (12), 394.)

Spectra of Dyes, Pigments and Stains

Sadtler Research Laboratories, Inc. of Philadelphia, has published six volumes of infrared and two volumes of ultraviolet visible reference spectra of dyes, pigments and stains. They also announce the publication of 1000 IR Spectra of surface active agents and a new IR spectra collection of minerals. A continuing collection of U.V. spectra of nonpolar solvents is also announced.

Introducing the Sugarbeet

Indian agronomists are busy in growing sugarbeet, once an exclusive European preserve, in north-west India. Systematic investigation on sugarbeet, a succulent root, by the Indian Institute of Sugarcane Research, Lucknow, and Coordinated Centres have revealed that the yield per hectare in India compares favourably with that of Europe. In fact, Pusa in Bihar recorded double the average best yields in Europe. Under a centrally sponsored scheme, 23 factories in Punjab, Haryana and Uttar Pradesh will manufacture beet sugar at the end of the Fifth Five Year Plan. There will be 54,620 hectares under sugarbeet at the end of the plan. The annual production of beet sugar is expected to be 1.88 lakh tonnes by the end of the Fifth Five Year Plan.

Indian Standards Institution

The following standards have been published:

IS:6894-1973 Malting Barley, Rs. 3.00

IS:6795-1972 Acacia (Arabic) Gum, Food Grade, Rs. 4.00

IS:6853-1973 Peptone, Microbiological Grade, Rs. 4.00

IS:6695-1972 Code for Conservation and Maintenance of Honey Bees, Rs. 9.50

IS:1158-1973 Corn Flakes, Rs. 5.50

Seminars and Lecture

Under the joint auspices of the Association of Food Scientists and Technologists (India) and the Technical Seminar, CFTRI, Mysore, a Seminar was arranged on Biosynthesis and Synthesis of Indol-alkaloids with Isoprenoic Side-Chains, by Prof. H. Plieninger, Prof. of Organic Chemistry, University of Heidelberg, Federal Republic of Germany on Monday, 31st December, 1973.

Under the joint auspices of the Association of Food Scientists and Technologists (India), Eastern Regional Branch, and Institute of Standards Engineers, Calcutta, a talk on 'Sanitation with special reference to fermentation Industry' by Shri R. N. Ghatak, Director, Indian Yeast Co. Ltd. (Shaw Wallace and Co. Ltd.) was held on Saturday, 22 December 1973 at National Test House.

The Seminar on Food Processing Machinery was successfully held under the auspices of the Western Regional Branch of AFST on 19th and 20th January, 1974. There was enthusiastic participation from both Industry and Research Institutions.

Symposium on Development and Prospects of Spice Industry in India

The Symposium on Development and Prospects of Spice Industry in India was held at CFTRI, Mysore, from 28th Feb. to 2nd March 1974. The Symposium was jointly sponsored by the Association and Central Food Technological Research Institute, Mysore. A total of 125 delegates representing manufacturing units, trading business houses, government agencies, technological research centres, agricultural research centres, quality control agencies planters and ancillary industries took part in the Symposium. The delegates came from different corners of India as well as from U.S., U.K., Indonesia, Japan and Holland.

There was an interesting exhibition of spices, spice products and packaging materials. A Souvenir containing information on spices was also released by the organizers.

Shri K. H. Patil, Chairman, Advisory Committee and Hon. Minister for Food and Forests, Karnataka State, presided over the inaugural function on the morning of 28th Feb. 74. The inaugural address was delivered by Dr H. Nath, President, of the Association and Director, Defence Food Research Laboratory, Mysore. Mr C. P. Natarajan, Chairman Programme Committee and Dy. Director of CFTRI highlighted the objectives of the Symposium. The distinguished gathering was welcomed by Mr F. K. Irani, Chairman Reception Committee and Managing Director, Ideal Jawa Ltd, Mysore, and the vote of thanks was proposed by Dr A. G. Mathew, Hon Exe. Secretary of the Association and Scientist CFTRI, Mysore.

The technical discussion was divided into 6 Sessions spread over 3 days. Session I, chaired by Mr Ahmed Bavappa, Director, Central Plantation Crops Research Institute, Kasargod and Co-chaired by Mr T. T. Paulose, Director, Directorate of Arecanut and Spices Development, Calicut, was on Spice Production. The production aspects of major spices were described by different experts.

The Session II on Spice Processing and Packaging was chaired by Mr J. M. Gandhi of Gandhi and Sons, Bombay and Co-chaired by Mr R. N. Gray, Chief Executive of Brooke Bond India Ltd, Cochin. The different aspects of processing of raw spices was the subject matter of a lively discussion.

On 1st March '74 the opening Session was on Quality Control and Standards. This was chaired by Mr C. P. Natarajan, and Co-chaired by Mr T. V. Mathew, Director, Central Agmark Laboratory, Nagpur. The microbial, quality, chemical and physical aspects of spice and spice products were discussed.

Session IV was chaired by Mr K. R. Sandelin, Vice President, Kalamazoo Spice Extraction Co. Inc., Kalamazoo, U.S.A. and Co-chaired by Mr M. Ram Mohan, Managing Director, Synthite Industrial Chemicals Ltd, Cochin. The Session was on Spice Flavours and Products, where the different aspects of oleoresin, oil and curry powder were covered in an interesting discussion.

The Marketing Aspects of Spice and Spice Products was the subject matter of Session V which was chaired by Mr T. V. Swaminathan, Chairman, Cardamom Board, Cochin and Co-chaired by Mr L. R. Madhusudhan, P. Mittulaul Lalah and Sons, Madras. Both the export and internal marketing aspects as well as the criteria for the selection of oleoresin plant site were discussed by eminent speakers.

On 2nd March, Session VI on Future Needs of Spice Industry was held under the Chairmanship of Dr B. L. Amla, Director, CFTRI, Mysore and Co-chairmanship of Mr P. B. Kurup, Managing Director of Techno Chemical Industries Pvt. Ltd., Calicut. The raw material, equipment and packaging requirements as well as use of spice in dietary and food were reviewed.

The concluding Session for Recommendations which was chaired by Dr Nath, and Co-chaired by Dr T. N. Ramachandra Rao, President-elect of the Association and Chairman Food Microbiology, CFTRI.

It has been proposed to print and publish the proceedings of the Symposium.

Proceedings of the General Body Meeting of the Association

The meeting was held at CFTRI, Mysore, on 2nd March, 1974 at 2.30 p.m. It was attended by 75 members which included all Executive Council members in Headquarters as well as Secretaries from Western and Eastern Regions. The meeting opened with the presidential address by Dr Nath who traced the history of the AFST from its inception to the present status. He emphasized the contribution by the previous presidents, particularly those of Dr V. Subrahmanian and Dr H. A. B. Parpia. The assistance and support given by the industry was also stressed.

Hon. Exec. Secretary, Dr A. G. Mathew presented the annual report highlighting the activities during the year. The report was proposed for adoption by Shri Bhavani Shanker Rao, seconded by Dr T. N. Ramachandra Rao and unanimously accepted by the GB. The Treasurer's report as well as the Balance Sheet for the year were then presented by Mr M. V. Sastry, the Hon. Treasurer. This was proposed for adoption by Mr J. C. Anand, seconded by Shri Bhavani Shanker Rao, and unanimously accepted by the GB. The budget proposal for 1974 presented by the Hon. Treasurer, was proposed for adoption by Mr V. S. Govindarajan, seconded by Dr J. S. Pruthi and unanimously accepted by the GB.

Two resolutions were taken up for discussion and decision by GB. The first concerning the formation of Chapters, officially moved by the Executive Council of the Association was accepted unanimously. The second resolution concerning the formation of Association of Alcoholic Beverage Technologists under the auspices of AFST, proposed by Dr B. K. Jha, and seconded by Shri M. S. Subba Rao, was not accepted on the plea that there is technical difficulty for introduction of such a resolution although the idea itself was commendable. The President assured the house that he would advise the new Executive Council about the possibilities of setting up panels for specialised important subjects including Alcoholic Beverage Technology.

The Gardners Award was presented *in absentia* to M/s. O. S. Bindra and T. S. Sidhu of Punjab Agricultural University for their paper entitled 'Dissipation of Malathion Residues on Maize Grain in Relation to Dosage, Storage Conditions and Baking' which appeared in Journal of Food Science and Technology in the January-March issue of 1972.

The new office-bearers announced by the President are as given below:

President: Dr T. N. Ramachandra Rao, Chairman, Food Microbiology Discipline, CFTRI, Mysore.

President-elect: Dr P. K. Kymal, Executive Director, Food and Nutrition Board, Krishi Bhavan, New Delhi-1.

Vice Presidents

Headquarters: Dr T. R. Sharma, Principal Scientific Officer, DFRL, Mysore.

Eastern Zone: Mr K. C. De, The Metal Box Co. Ltd., 92/1, Alipore Road, Calcutta-27.

Northern Zone: Dr S. V. Pingale, Manager, Food Corporation of India, New Delhi.

Western Zone: Dr B. P. Baliga, Tata Oil Mills Limited, Bombay House, Bombay-19.

Central Zone: Dr. S. Neelakantan, IVRI, Izatnagar, Uttar Pradesh.

Hon. Exe. Secretary: Dr V. H. Potty, Scientist, CFTRI, Mysore.

Hon. Treasurer: Mr E. S. Nambudiri, Scientist, CFTRI, Mysore.

Hon. Jt. Secretary: Mr M. V. Sastry, Scientist, CFTRI, Mysore.

Councillors

Headquarters: Mr C. S. Viraktamath, Scientist, CFTRI, Mysore.

Eastern Zone: Mr P. K. Bose, Indian Oxygen Limited, P-34, Taratala Road, Calcutta-53.

Northern Zone: Mr J. C. Anand, Division of Horticulture, I.A.R.I., New Delhi-12.

Western Zone: Dr G. A. Sulebele, Food Technology Section, University of Bombay, Matunga, Bombay-19.

Many of the members stressed the need for the Association to advise the Government regarding the food policies and to point out the shortcomings of the government in its economic policy. After a very healthy discussion in which several members took part, it was felt that the subject could be an ideal topic for a seminar, or some study group can be formed by the Association to take up this issue in future. The possibility of sending comments through NCST also was discussed.

The outgoing President, Dr Nath then inducted the new President Dr T. N. Ramachandra Rao. The President-elect assured the house that he would continue to implement the suggestions of the outgoing President and try his best to make the Association stronger.

The meeting ended with a vote of thanks by Dr V. Sreenivasamurthy, Vice-President, Headquarters.

Welcome Address by Dr H. Nath, President of the Association

It is a matter of great pleasure for me to welcome you all to the Annual General Body Meeting of the Association of Food Scientists and Technologists.

More than two decades ago, an organisation named as 'Fruit Technology Students' Association' was established in 1950-51, possibly at a meeting of the CFTRI, perhaps in this very hall—the venue of the present meeting. As the very name suggests, one of the important objectives of this new Association which the founders had in mind was the projection of major contributions to the profession and to the advancement of the food industry as related to the educational training of the food technologists.

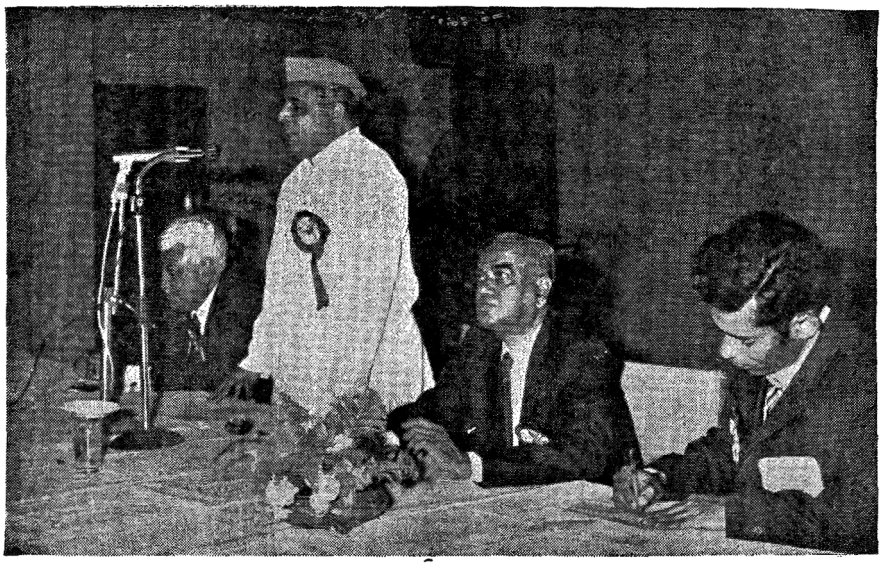
The name of the Association was changed to Fruit Technology Association in 1954 and later to Association of Food Technologists in 1956. The gradual metamorphosis of the name suggests a constant search, on the part of the early organizers, for a reorientation in their endeavours to make the organisation as broad based as possible. It was, however, in 1969 that the Association was renamed as AFST, encompassing a multiplicity of related disciplines and interests and became a broad based forum with a wide perspective. The Association, thereafter, had an almost exponential growth and in a matter of only a couple of years acquired a national standing. The activities were intensified to generate a wider response in the scientific community and the progress towards that objective has indeed been heartening.

I also take this opportunity of giving tributes to my predecessors who had the vision to see the need for an organisation at the national level for food scientists and technologists, and particularly to Dr V. Subrahmanian, who took the first step in forming the Association, Dr Parpia whose wisdom conceived the Association in its present form, and Dr Amla and Dr Bose who enthusiastically pledged their unstinted support for the growth and development of the Association. We all owe a tremendous debt of gratitude to all these leaders, among others, who have carried out the idea of this Association and contributed to its growth and development.

I would also fail in my duty if I do not mention about the increasing interest evinced by the Food Industry in the development of the Association as seen by its participation in the various seminars/symposia organised by the Association as also by the gradual increase in the number of corporate members or membership by individual professionals serving the industry. The impact of the Association on the industry in establishment of a desirable rapport between the food scientists and the manufacturers can perhaps be better judged by the fact that almost all of our annual seminars have been progressively becoming self-sustaining, thanks to the excellent cooperation by the food Industry. In my opinion this kind of a barometer is more reliable than any other statistics.

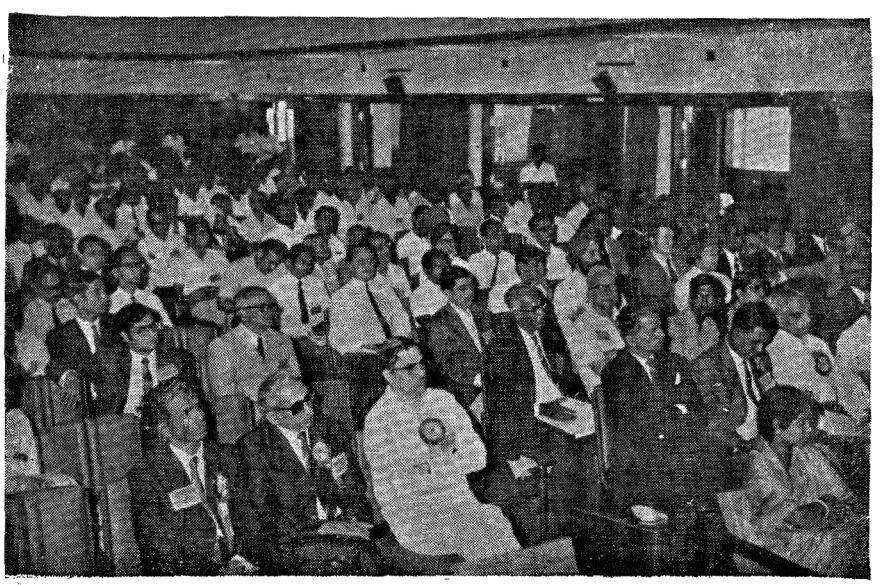
Coming to the over-all growth of the Association, during the past three years the total membership in 1971 was 677. It jumped to 738 in 1972 and 815 in 1973. During the past two years we, therefore, had a growth rate of about 9-10 per cent—a feat which national planners are still striving to achieve for our G.N.P. It is indeed gratifying to note that a fair percentage of the increase in membership is also due to the increasing representation from the industry. The generation of interest by the industry in the Association is important because it is not possible to build a balanced professional body just by grouping together of individuals who have similar jobs. It is only with an assured availability of a abundant cooperation from the industry that the AFST provides an ideal forum not only for propagating the potential of development of the food industry in the country but also in highlighting and projecting the bottlenecks involved in such development. The Association has been faithfully doing this over the past few years.

The Association in its present form is thus five years old, though its forerunner, AFT is fifteen years old. Whatever might be its present growth rate as indicated above, there is no reason to take it for granted that this growth rate will be maintained in

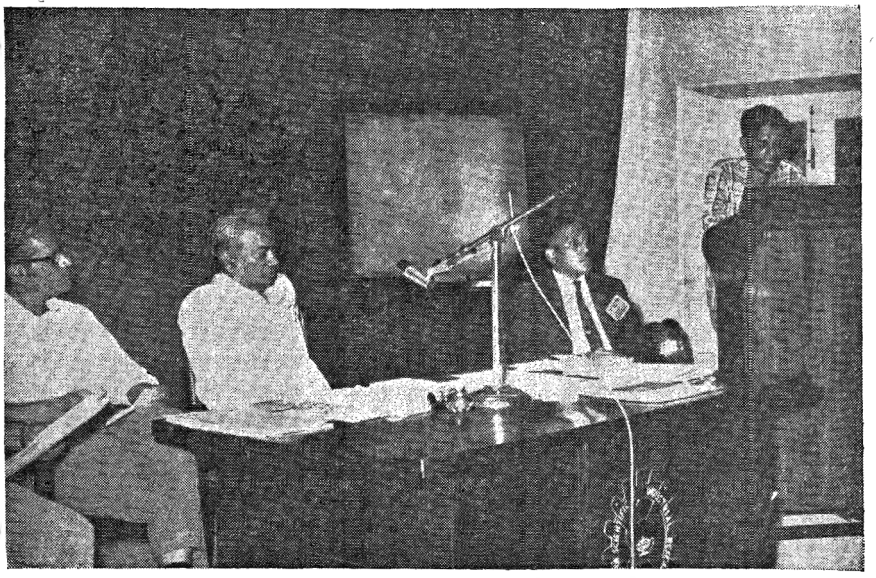


Shri K. H. Patil, Hon. Minister for Food, Karnataka State delivering the Presidential address. Others from left are Shri F. K. Irani, Dr H. Nath and Dr A. G. Mathew.

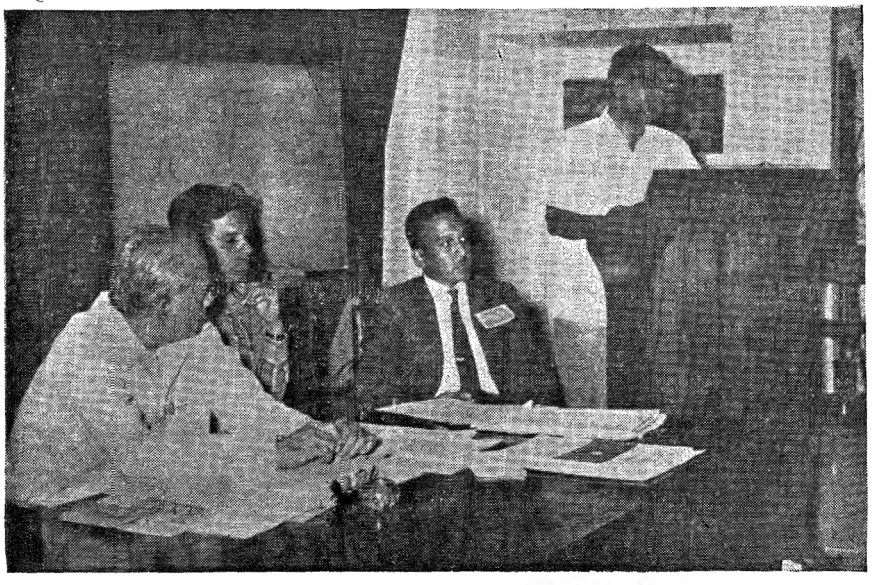
Shri Irani welcoming the gathering at the inaugural function of the Symposium. To his right is Shri C. P. Natarajan, and to his left is Hon. Minister, Shri K. H. Patil.



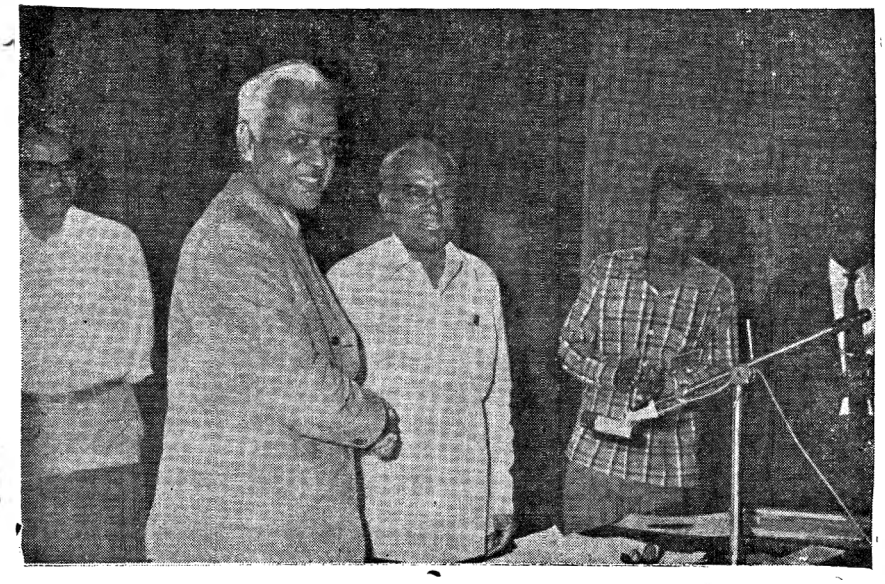
A view of the gathering.



Hon. Secretary, AFST (Dr A. G. Mathew) presenting the report.



Hon. Treasurer, AFST (Sri M. V. Sastry) presenting his report.



Dr H. Nath inducting the new President of the AFST, Dr T. N. Ramachandra Rao.

the coming years also. It is true, that in terms of human developmental growth rate, the chances of infant mortality may not be there, but this is also the phase when utmost care has to be taken for providing optimum nourishment and care in all possible ways. It is therefore of extreme importance to all of us to pledge for the maintenance of the growth rate and to see that the Association flourishes in all possible ways.

One of the most important activities of the AFST is the publication of the quarterly 'Journal of Food Science and Technology'. This Journal has been playing a very effective role in disseminating scientific information and technological developments in food science and technology. The response from scientific fraternity for publication of their researches has been increasing over the years and I am now informed by the Editor that it is overwhelming in fact. The rate of receipt of manuscripts is almost one per day. It is, however, a matter of great satisfaction that due to the untiring efforts of our editor and his Publication Committee, the time lag between receipt of a manuscript and its publication is much less than when compared to many Indian journals of similar status. In order to attain a quicker turnover of scientific thought, it has been decided to increase the frequency of your Journal to that of a bimonthly from this year. While I am sure this will be welcomed by the scientists and the technologists, this will necessarily involve additional table work for the Editor as also an increased cost of production. I therefore feel that there will be a pressing need for providing for one or two Asst. Editors to cope with the increased frequency of publication. The present Publication Committee has acted only in an advisory capacity and has not participated in day to day functions and as such there is a real need of extra hands to help the Editor in an effective manner. As regards the increase in cost of production it has been decided to increase the rate of subscription by 50 per cent but this will not make the Journal self sustaining because of the increased cost of stationery, printing, etc. I would therefore like to utilise this opportunity of requesting representatives of the Industry to help us by increasingly advertising their goods and wares in the JFST. I am sure the past performance of the Association deserves this encouragement and it will be forthcoming spontaneously.

Another way in which industries can help the cause which AFST has stood for is by ploughing back by them certain portion of funds for R and D activity. It was most gratifying to note that Metal Box, UK are spending additional £ 8¾ million in developing new technology. We do hope that Indian industries will also not lag behind in this respect.

Disseminating information has been acknowledged as one of the most important objectives of the Association and as will appear from Secretary's report being presented shortly, AFST has organised a number of lectures at the headquarter and the regional centres also have arranged seminars, etc. at their respective places. There is however one aspect which I would specifically mention under the same objectives and that is regarding formation of panels in specialised important topics related to the subject of food science and technology. The terms of reference of the panels would be to prepare reports on subjects of vital concern to the nation giving the views of the AFST and specific recommendations and to draw the attention of appropriate authorities/agencies for implementation of the recommendations. I understand this is one of the most important activities of IFT, USA, and though they have formed so far only one Panel, viz., Expert Panel on Food Safety and Nutrition, they have in view a number of other proposals also for formation of expert panels. I suggest the new AFST Executive Committee may give a serious thought to this aspect which I would consider as one of our social responsibilities.

Your Association is in a sound financial position. The Secretary's report as well as the Treasurer's report will be with you shortly.

I take pleasure in looking back on my tenure during the last year and take this opportunity of expressing my deep thanks for the unceasing interest, co-operation and understanding to the Executive Committee Members, Dr Amla, Shri Natarajan, Dr. Ramachandra Rao and above all our most competent Secretary Dr Mathew, and also the members of the AFST for their unstinted confidence in me throughout.

I also cannot express the pleasure which I feel turning over the Presidentship of AFST to Dr Ramachandra Rao, my most esteemed friend, and I do hope that during his tenure, the Association will prosper and fulfil the task left incomplete by the present committee.

Extract from the Annual Report of the Association Presented by Dr A. G. Mathew, Hon. Exec. Secretary

Mr President and fellow members,

I have great pleasure in presenting the Annual Report for the year 1973. The year just concluded

has been one of many activities. At the Headquarters 15 technical Seminars by eminent international personalities on the various aspects of food technology have been conducted. The most important event has been the Symposium on Development and Prospects of Spice Industry in India at C.F.T.R.I., from 28th February to 2nd March 1974.

The year was also one of great activities in all the three Regional Sections. Besides several lectures, the Regional Sections also conducted highly successful national seminars, viz., 'Frozen Food for Meeting Social Objectives' during May 1973 at New Delhi by Northern Region and 'Food Processing Machinery' during January '74 at Bombay by Western Region.

At the request of some active members from Hyderabad and Bangalore, local Chapters were organized in these centres after getting tentative approval of Executive Council subject to ratification by the general body. Dr M. Muralikrishna and Mr M. R. Chandrasekhara who have given dynamic leadership in each of these centres, were nominated as *Ad-hoc* Conveners for Hyderabad and Bangalore Chapters respectively. *Ad-hoc* Committees were formed and much useful work by way of technical discussions and seminars is being carried out. A draft resolution for formation of Chapters for introduction in this meeting has been prepared after consulting with the Regional Sections. Spade work has already been done for the formation of Chapters in centres like Kanpur and Izatnagar for the coming year. It is hoped that Regional Sections would also give lead in forming Chapters in cities under their jurisdiction in the coming years.

The present membership position is as follows:
(as on 22nd Feb. '74)

Life members	35
Ordinary members	735
(including 143 members who joined in 1973)	

Increased activity has naturally resulted in increased membership. However, the number of cases of arrears and consequent drop out of membership continues to be significant. While to some extent 'floating' membership is unavoidable, it is hoped that by supplying live lists to Regional Sections and Chapters periodically and enlisting their help, it would be possible to improve the situation in the coming years. To this effect indexing of Membership, region-wise and arrear-wise has just been completed. A similar indexing, country-wise has also been completed for subscribers to the Journal.

'Journal of Food Science and Technology' continues to receive original articles in great numbers and due to the limited periodicity of the publication the time gap between receipt and publication is increasing. In this context it has been decided to convert it from a Quarterly to a Bimonthly one (6 issues per year). Consequently the annual subscription rate of Rs. 40 in India and $ 10 abroad has been increased by 50 per cent. A vigorous drive to increase the number of subscribers to the Journal by contacting 300 libraries of food technology centres has been completed. The advertisement rate and cost of back volumes have been doubled. With a view to get postal concession for the Journal we have applied for registration with Registrar of Newspapers. The printed proceedings of the Symposium held in 1971 and 1972 have been published.

Headquarters propose to pursue its drive to make the Association activities spread all over India by holding General Body Meetings in different centres. Approach has already been made to New Delhi to hold the next meeting there. Chapter centres should also be invited to hold General Body Meetings and Seminars. However, Indian Railways have turned down our request to give concessional travel facility to Members to attend annual conventions. AFST has decided to assist the Seminar on Refrigeration and Air Conditioning to be held at CFTRI during July 1974.

On the basis of an appeal from the President of International Union of Food Scientists and Technologists and offer of concessional affiliation charges, AFST has reaffiliated with IUFoST. Rs 100 annually has been suggested as the affiliation charges instead of $ 100 so far. It must be remembered that earlier IUFoST had offered the hosting of 1978 International Congress of IUFoST to AFST and India.

As per the requirement of Registrar of Societies the accounts have been audited by a Chartered Accountant and Balance Sheet prepared. On the advice of Finance Sub-committee, it has been decided to discontinue the practice of taking the subscriptions of CFTRI and DFRL Members in instalments. To have a better watch over financial situation, it has been decided to have the statement of accounts prepared quarterly, besides the annual auditing.

The Committee consisting of Prof. A. N. Bose, Calcutta (Chairman), Dr G. S. Siddappa, Gonicoppal and Dr N. J. Contractor, New Delhi, has nominated Dr O. S. Bindra and Dr T. S. Sidhu for their paper 'Dissipation of Malathion Residues on Maize Grain in Relation to Dosage, Storage Condi-

tions and Baking' as the best paper of the 'Journal of Food Science and Technology' for Gardner's Award for 1972. It is regretted that the national committee set up for the Training and Education could not even meet once. It is hoped that at a future date a Seminar will be conducted on this important subject so as to give necessary attention to it.

The lead given by Dr H. Nath, the President and tireless efforts of the Regional Secretaries have been instrumental in making this year a particularly successful year. To Dr B. L. Amla, Director, and other staff members of the CFTRI, the Association owes a great deal. The successful conducting of the Symposium has been to a large measure due to tireless efforts Mr C. P. Natarajan as the Chairman of Programme Committee. Whatever little success that has been possible is due to the team work by many devoted members, I owe a lot to my colleagues in the Executive Council and particularly to the support and devoted efforts of the Joint Secretary, Dr V. H. Potty. My thanks are also due to the Supervising Committee for the conduct of elections and the sincere dedication of the staff of AFST Office.

With active secretariats at Regional Sections and Chapters and a good band of Office bearers in the new Executive Council, I am confident that the Association can look forward to more successful year ahead.

New Members

Mr. B. C. Adavappa, C/o Kissan Products Ltd., Old Madras Road, Bangalore-16.

Mr. S. M. Anantha Krishna, Sensory Evaluation Unit, C.F.T.R.I., Mysore-13.

Mr. Bhadsavle, Chandrasekhar H. Valley Fresh Inc., 7th and D Streets, Turlock, Calif, 95380, U.S.A.

Mr. Jogesh Chandra Deb, Shibnagar East, P.O. Agarthala College, College Road, Tripura-799001.

Mr. S. Dhananjaya, Instructor, College of Fisheries, Technology Wing, Hoige Bazaar, Mangalore-575001.

Mr. Velpur Eswarayya, Community Canning and Preservation Centre, 2-2-2 University Road, Hyderabad-500007.

Mr. M. Gopalakrishnan, C.F.T.R.I. Experiment Station, Krishnadas Niwas, Shornaur Road, Thiruvambadi, Trichur, Kerala State.

Mr. A. Govindan, Deputy Director, Indian Standards Institution, 54, G. P. Road, Madras-2.

Mr. G. G. Hiremath, Asstt. Professor of Freezing, College of Fisheries, Technology Wing, Hoige Bazaar, Mangalore-575001.

Mr. Devendra Kumar, Senior Scientific Officer, D.F.R.L., P. B. No. 45, Mysore-10.

Mr. N. Krishna Murthy, PPFT, C.F.T.R.I., Mysore.

Mr. Devesh Kumar, S/o Sri S. S. Saxena, 126, Katra Shamshur Khan, Etwah, U.P.

Mr. Shiam Behari Lal, C/o M/s Gupta and Co., Perfumers, Sadar Bazaar, Delhi-110006.

Mr. D. S. Malpekar, M/s. Kissan Products Ltd., Old Madras Road, Bangalore-16.

Miss M. C. Madhura, No. 8, Govinda Rao St., Sheshadripuram, Bangalore-5600020.

Mr. V. Muthu Krishna, A.B.T. Agency, Virudhu Nagar Road, Near Fire Service Station, Shivakasi, Tamil Nadu.

Mr. P. N. Melinmath, M/s Rajpal Fruit Products, 64/B, Opp. Police Head Qrs., Dharwar-8, Karnataka State.

Mr. M. H. Naik, Naik's Bungalow, Opp. S.T. Office, Shiwaji Nagar, Ratnagiri-415612.

Mr. S. P. Nandedkar, M/s. The Tata Oils Mills Co. Ltd., Mohan Nagar, Ghaziabad, U.P.

Dr S. V. Pingale, Manager (QC and PR) Food Corporation of India, Link House, B. S. Zafar Marg, New Delhi.

Mr. S. G. Patwardhan, C.F.T.R.I. Experiment Station, Bhavan College Campus, Andheri West, Bombay-58, AS.

Mr. M. Ramachandra Rao, Agents, Vulcan Laval Ltd., IA/S, Palace Road, Bangalore-5600052.

Mr. Ramanathan, V. K., M/s Kissan Products Ltd. Bangalore-16.

Mr. V. Sree Ram, 2/2D, Vignana Puri, Hyderabad-500044, Andhra Pradesh.

Smt. Saroja Pitchmuthu, 21, (Upstairs), New Mission Compound, Lalbagh Road, Bangalore-27.

Mr. Gopal Sarup, 45, Prag Narian Road, Lucknow-226001.

Prof. T. R. Sarkari, Head, R and D Division, Wanson (India) Pvt. Ltd., Village Akudi, Chunichwad, Poona-19.

Mr. A. Somasunder, C/o Kissan Products Ltd., Bangalore-16.

Dr K. S. V. Sampath Kumar, Research and Development Centre, Brooke Bond India Ltd., Whitefield, Bangalore-562/136.

Mr. C. V. Srinivasa Kumar, 210/A, 2nd Block, Jayanagar, Bangalore-560011.

Mr. S. Srinivasa Murthy, Senior Research Fellow, Refrigeration and Airconditioning Laboratory, Dept. of Chemical Engg., Indian Institute of Technology, Madras-600036.

Mr. K. Srinivasa Rao, Managing Director, Nandi Hotels Pvt. Ltd., Bangalore-25.

Mr. D. K. Srivatsava, S/o B. Pd. Srivatsava, Singapore, Suklagunj, Jaunpur (U.P.)

Mr. C. H. Subba Rao, Box No. 5188, Mississippi State, Ms. 39762, U.S.A.

Mr. Bhagwan Das Tripathi, 1/37,-12, Nagla Deena, Fatehgarh-209601, U.P.

Mr. Aditya K. Vasitha, Tata Oil Mills Co. Ltd., Research Labs., Haybunder Road, Bombay-33.

Mr. L. Venkataratna, Chief Agricultural Development Officer, Nigerian Agricultural Development Industry, Gombe P. O. 93, North East State, Nigeria.

Mr. Prabodh S. Vishnoi, (S) Student of M.S.C., H.B.T.I., Kanpur-2.

Mr. S. M. M. Zunnithu, C/o Ratnagar Canning Industries, Industrial Estate, 415612. Ratnagiri, Maharashtra.

Mr. Vibhakar Pathak, Department of Agricultural Chemistry, Bihar Agricultural College, Sabour (Bhagalpur), Bihar.

Mr. Fazalulla Khan, S.L.A., PPFT, C.F.T.R.I., Mysore.

Mr. G. Ramachandra Rao, Hyderabad Bottling Co. Pvt. Ltd., 8-3-949/1, Punjagutta, Hyderabad-500016, A.P.

Miss R. Sarda, 3-4-376/17/1, Lingampalli Hyderabad-500027, A.P.

Mr. K. S. T. Shaye, Chief Chemist, Shri Krishna Bottlers (P) Ltd., Tank Bund Road, Secundrabad-3, A.P.

Mr. Arora, Kanwa Kumar, Production Manager, Shri Krishna Bottlers (P) Ltd., Tank Bund Road, Secundrabad-3, A.P.

Mr. Prahladbhai Bhikhabhai Patel, AT: Vanesha P. O. Venesa Pisad VIA: Gangadhara Dist: Surat, Gujarat State, India.

Mr. Katsusuke Arai, 2-10, Kiba-5, Koto-ku, Tokyo, Japan 135.

Mr. B. Raghavan, PPFT., C.F.T.R.I., Mysore.

Mr. N. B. Shankaracharya, PPFT, C.F.T.R.I., Mysore-13.

Major (Dr) V. A. Narayanan, Defence Food Res. Lab., Jyothinagar, Mysore-10.

Smt. Shantha Krishnamurthy, Scientist, PPFT, C.F.T.R.I., Mysore.

Mr. G. Krishnappa, Defence Food Research Lab., Jyothinagar, Mysore-10.

Dr. M. L. Shankaranarayana, PPFT, C.F.T.R.I., Mysore-13.

Mr. S. Shivashanker, S.S.A., PPFT., C.F.T.R.I., Mysore-13.

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Annual subscription	**Rs 30.00**	**£ 3.50**	**$ 10.00**
Single copy	**4.00**	**0.30**	**1.50**

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Single copy	**7.00**	**0.50**	**2.75**

INDIAN JOURNAL OF RADIO AND SPACE PHYSICS (quarterly)

This journal, which is being published beginning from March 1972, is intended to serve as a medium for the publication of the growing research output in various areas of radio and space physics, such as ionospheric propagation, magnetosphere, radio and radar astronomy, physics and chemistry of the ionosphere; neutral atmosphere; airglow, winds and motion in the upper atmosphere; stratosphere-mesosphere coupling; ionosphere-magnetosphere coupling; solar-terrestrial relationship, etc.

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Single copy	**10.00**	**0.80**	**4.00**

INDIAN JOURNAL OF BIOCHEMISTRY AND BIOPHYSICS (quarterly)

This journal, published in association with the Society of Biological Chemists (India), Bangalore, is the only research journal in India devoted exclusively to original research communications in biochemistry and biophysics.

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Single copy	**12.00**	**0.90**	**4.50**

INDIAN JOURNAL OF MARINE SCIENCES (half-yearly)

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