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Quality Characteristics of Some Promising Triticale Strains of India

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Manuscript received 20 *November* 1981; *revised* 21 *January* 1982

Data on some physico-chemical characteristics, rheological, bread and chapati making properties and amino acid compositon of six promising triticale strains are reported. The results showed higher grain weight, grain protein, grain ash, flour protein, flour ash and diastatic activity for triticale as compared with wheat. But all triticale strains had lower Pelshenke and sedimentation values and gave poor flour recoveries. The mixographic characteristics revealed poor resistance to mixing and alveographic characteristics showed poor baking strength of triticale flours. Bread produced from triticale flours had lower loaf volumes and specific volumes. The chapaties produced from triticale were reddish in colour and harder in texture. The mean lysine content (g/100 g protein) was 3.13 for triticale as against 2.56 for wheat.

One of the major objectives of producing triticale by crossing wheat with rye was to combine the desirable characteristics of wheat like, high grain yield, disease resistance, good bread making properties, etc. with better nutritional quality of rye. A number of reports indicated triticale to be actually high in protein content and superior in protein quality [1-5]. However, the earlier triticales were reported to have lower test weights and comparatively lower yields.

Efforts were therefore, initiated at many places in the world to improve upon the test weights, the colour and plumpness of grains. Triticale improvement programme was also taken up at Punjab Agricultural University, Ludhiana. As a result, triticale strains are now available with better grain colour and high grain weights. The present paper describes the quality characteristics of six triticale strains which are in the advanced stage of testing at Punjab Agricultural University, Ludhiana.

Material and Methods

Representative samples of six triticale strains ('TL 17', 'TL 22', 'TL 32', 'TL 38', 'TL 41', 'TL 54') along with the wheat variety 'Kalyan Sona' were obtained in duplicate from the crop grown at Punjab Agricultural University Farm, Ludhiana. The crop was raised under recommended package of practices.

The samples were cleaned and conditioned to 14 per cent moisture. The flour was extracted through a Brabender Quadrumatic Junior Mill. Protein content, sedimentation value, Pelshenke value, ash content, and diastatic activity were determined according to the approved methods of AACC[6]. The rheological properties were determined through Brabender Mixograph and chopin Alveograph. Bread test was conducted by straight dough method of AACC[6] using 100 g flour on 14 per cent moisture basis. The chapati test was conducted as described earlier[7]. The amino acid composition was determined by using Beckman amino acid analyzer Model 120C after acid hydrolysis of samples. All tests were conducted in duplicate.

Results and Discussion

The data on some physico-chemical characteristics of triticale strains along with wheat variety, 'Kalyan Sona' are given in Table 1. All the triticale strains had higher grain weights, grain protein, grain ash, flour protein, flour ash and diastatic activity. On an average, the triticale showed 1.4 per cent more protein in the grains, but the difference was only 0.5 per cent in flours. This showed that a large part of the grain protein of triticale is lost with the bran. Such high differences in grain protein and flour protein of triticale have been reported earlier also.[8-11]

But all the triticale strains had lower Pelshenke values and sedimentation values and gave poorer flour recoveries than 'Kalyan Sona'. The triticale gave on an average, 3.7 per cent lesser flour recovery than the wheat variety. However, 'TL 52' and 'TL 38' showed fairly good flour recoveries. Higher diastatic activity and

TABLE 1. PHYSICO-CHEMICAL CHARACTERISTICS OF TRITICALE STRAINS

Characteristics	TL 17	TL 22	TL 32	TL 38	TL 41	TL 54	Mean	Kalyan Sona
1000 grain wt(g)	51.7	50.1	48.6	37.6	41.9	43.3	44.5	37.3
Grain protein (%)	13.0	12.8	13.2	12.6	12.5	12.6	13.0	11.6
Grain ash (%)	1.92	2.00	1.88	1.97	1.84	1.86	1.91	1.40
Pelshenke value (min)	78.0	69.0	70	71	67	69	70	94.0
Flour recovery (%)	61.0	61.5	65.0	63.5	60.0	63.0	62.3	66.0
Sedimentation value (ml)	23.5	20.0	20.0	25.0	20.0	25	22.2	30.0
Flour protein (%)	11.5	11.2	11.6	11.4	11.5	11.7	11.5	11.0
Flour ash (%)	0.80	0.70	0.84	0.75	0.75	0.83	0.78	0.50
Diastatic activity (Maltose units/10 g flour)	195	187	201	241	259	236	219	175

TABLE 2. RHEOLOGICAL CHARACTERISTICS OF TRITICALE STRAINS

Strains	Mixographic characteristics		Alveographic characteristics		
	Mixing time (min)	Area under the curve (cm^2)	Stability (mm)	Extensibility (mm)	Baking strength (cm^2)
TL 17	1.3	14	70	25	12
TL 22	1.6	16	47	28	12
TL 32	1.8	17	82	23	11
TL 38	2.2	18	82	40	17
TL 41	2.0	17	92	35	16
TL 54	2.2	14	66	43	18
Mean	1.9	16	75	32	14
Kalyan Sona	2.5	20.4	62.7	53	40

TABLE 3. BREAD MAKING CHARACTERISTICS OF TRITICALE STRAINS

Strain	Loaf volume (cc)	Loaf wt. (g)	Sp. vol. (cc)
TL 17	400	140	2.86
TL 22	385	134	2.87
TL 32	420	140	3.00
TL 38	410	138	2.95
TL 41	420	136	3.08
TL 54	395	139	2.84
Mean	405	138	2.93
Kalyan Sona	465	141	3.30

lower Pelshenke and sedimentation values for triticale than wheat have been reported earlier also[2, 5, 12, 13].

Mixographic characteristics showed smaller mixing time and area under the curve for all the triticale strains as compared with wheat (Table 2). This showed poor resistance to mixing of triticale flours. The alveographic characteristics also showed poor stability, extensibility and area under the curve for all the triticale strains. Thus, the triticale strains had poorer baking strength than the wheat variety 'Kalyan Sona.'

The baking test revealed poor loaf volume and specific volume of the triticale bread in comparison to that of wheat (Table 3). On an average, triticale gave a loaf volume of 405 cc against 465 cc of wheat. Lower loaf volumes of triticale flours were reported by earlier workers also.[2,12,14,15] However, highly acceptable breads can be produced from triticale flours with slight adjustments in water absorption and mixing time, etc.[9]

The chapati making properties (Table 4) revealed that the triticale strains produced reddish chapaties with harder texture as compared with wheat variety, 'Kalyan Sona.' However, 'TL 54' 'TL 41' and 'TL 38' produced better chapaties among the triticale strains. Earlier report also indicated that triticale produced reddish chapaties[5]. Some strains of triticale having desirable properties for chapati making have been reported.[16,17]

The amino acid composition of triticale strains (Table 5) revealed higher values for lysine as compared with wheat. Several earlier workers[1,2,10,18] have also reported triticale to be higher in lysine content than wheat. The other amino acids in triticale are identical in content to that reported by earlier workers.

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TABLE 4. CHAPATI MAKING PROPERTIES OF TRITICALE STRAINS

Variety	Water absorption (%)	Colour of dough	Dough handling	Colour of chapati	Puffing	Texture	Taste	Loss of moisture during baking	Score
TL 17	64	Reddish	Sticky	Reddish	Nil	Hard	Less Sweet	24.0	20
TL 22	64	Reddish	Sticky	Reddish	Partial	Hard	Less Sweet	23.0	24
TL 32	64	Reddish	Sticky	Reddish	Partial	Hard	Sweet	23.5	22
TL 38	64	Reddish	Less-sticky	Reddish	Full	Hard	Sweet	23.1	28
TL 41	64	Reddish	Sticky	Reddish white	Full	Hard	Sweet	23.0	29
TL 54	64	Reddish	Less-sticky	Reddish	Full	Soft	Sweet	23.1	30
Mean	64							23.2	26
Kalyan Sona	68	Creamish	Non-sticky	Creamish	Full	Soft	Sweet	16.7	37

All possessed a pleasing flavour

TABLE 5. AMINO ACID COMPOSITION (G/100 G OF PROTEIN) OF TRITICALE STRAINS

	TL 17	TL 22	TL 32	TL 38	TL 41	TL 54	Mean	Kalyan Sona
Lysine	3.40	3.03	3.17	2.85	3.06	3.27	3.13	2.56
Histidine	2.43	2.54	2.11	2.16	2.03	2.51	2.30	2.50
Ammonia	3.24	3.17	3.35	3.02	2.87	3.53	3.03	3.50
Arginine	3.96	5.14	5.13	4.30	4.14	3.91	4.59	4.56
Aspartic Acid	7.25	6.07	6.65	5.20	5.70	5.01	5.98	5.78
Threonine	2.61	2.28	3.14	2.24	2.27	2.50	2.50	2.50
Serine	4.10	3.59	4.60	3.53	3.57	4.57	4.17	3.18
Glutamic acid	37.6	31.0	35.6	29.8	33.5	36.2	34.0	35.5
Proline	9.90	8.80	8.20	8.05	7.95	10.47	8.89	10.78
Glycine	4.17	3.89	4.79	3.52	3.43	3.76	3.92	3.83
Alanine	3.55	3.63	3.83	3.44	3.44	3.55	3.05	4.13
Valine	5.07	5.43	4.86	4.42	4.76	4.63	4.78	5.67
Methionine	1.53	1.21	1.44	1.32	1.30	1.40	1.33	1.31
Isoleucine	4.27	4.02	4.26	3.42	3.78	3.65	3.85	3.95
Leucine	6.25	6.98	7.48	6.70	6.05	7.40	6.81	6.94
Tyrosine	3.00	2.18	2.78	2.15	2.42	2.17	2.44	2.01
Phenylalanine	4.92	4.11	5.17	3.92	3.80	4.72	4.44	4.25

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Food Value of Dehydrated Root tubers of Selected Genotypes of Winged Bean (*Psophocarpus tetragonolobus* (L) DC)

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Fourteen genotypes of winged bean tubers were evaluated for tuber waste during processing, yield of gratings and 3 genotypes assessed for reconstitution ratio. Tuber waste ranged from 26.9 – 64.1 per cent and the yield of dried gratings was 15.1 — 37.9%. The reconstitution ratio after cooking was from 1 : 4.73 to 1 : 9.12. The tubers contained fairly high amounts of protein (13.06%), but were lacking in fat content. The mean carbohydrate content was 70.14 per cent and fibre content was 2.7 per cent in the dried processed tuber flour; this could replace upto 25% of wheat grits in Kesaribath (a sweet preparation) and 25% of wheat flour in cookies. At higher level of substitution, the rooty flavour of the tuber was present.

Winged bean is cultivated mostly for its green pods and dried beans. The mature tuber of this crop containing high percentage of protein can also become an edible tropical root crop. Being a plant containing high percentage of protein in all its parts, confirmation is needed regarding its edibility and economics as a processed food item[1]. In the present study, a brief report of dehydration and rehydration studies, nutritional composition of root tubers of selected genotypes of winged bean as well as evaluation of two snacks prepared by substitution of winged bean root flour are presented.

Materials and Methods

Out of 64 genotypes of winged bean which were grown in an 8 × 8 lattice design with 3 replications during summer 1981 in the experimental plots of division of Agricultural Botany, U. A. S. Bangalore, only 30 genotypes were found to produce healthy tubers (Fig. 1) without any nematode galls on their surface. Of these, 14 genotypes which were found superior in their physical characteristics were selected for the present study.

Dehydration / rehydration studies: The tubers obtained in all the three replications were pooled variety-wise and a known weight of cleaned fresh tubers was taken and their outer skin was peeled out. The tubers were then grated in steel graters. The hard fibrous middle portion of the tubers together with outer peeled skin formed the tuber waste and their weight was expressed as percentage of total tuber weight. The soft grated portion was air dried for two days inside the laboratory and their weight was expressed as percentage of total tuber weight. Rehydration value, which is a ratio

*Dept. of Home Science, **Dept. of Agril. Botany.

Fig. 1. Root tubers of winged bean

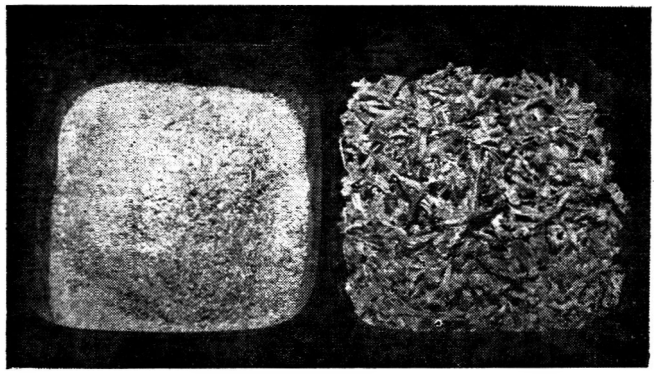

Fig. 2. Flour and dried gratings of winged bean root tubers

between mass of reconsituted dehydrated product after cooking (MR) and mass of dehydrated material before cooking (MD) was calculated for a randomly selected 3 genotypes only following ISI method.[2]

Proximate nutrient analyses: The air dried gratings of only 12 genotypes with more than 20 per cent recovery were ground into flour and passed through 40 mesh sieve. The final product was analysed for moisture, protein, ash, fat, fibre and carbohydrate by standard methods.[3] The percentage of reducing and non-reducing sugars was also estimated following the methods of Nelson.[4]

Sensory evaluation of the snacks: Two snacks, viz., *Kesaribath*, and cookies prepared with 25 and 50% substitution with winged bean tuber flour for wheat soji (grits) and wheat flour (*maida*) respectively, were evaluated by a panel of eight judges. The flour of six genotypes of winged bean which yielded higher amounts of dried gratings were pooled together for substitution in the above snacks, because of similarity in samples and insufficient quantity of the flour for single genotype study.

Results and Discussion

The application of dehydration technology to any tuber depends upon the percentage of dehydrated product that can be obtained from raw tubers and also on its rehydration capacity. The results of dehydration studies carried out in tubers of 14 genotypes as well as rehydration value of randomly selected three genotypes of winged bean are presented in Table 1. It is observed that the genotypes which gave high recovery of dried gratings had low percentage of tuber waste (Fig. 2). The rehydration studies also indicated acceptable rehydration value for winged bean tuber flour.

TABLE 1. RESULTS OF DEHYDRATION AND REHYDRATION STUDIES IN ROOT TUBERS OF SELECTED GENOTYPES OF WINGED BEAN

Genotypes	Tuber waste (%)	Dried gratings (%)	MR:MD* Value
IC.26940-A	36.6	29.6	—
LBNC-1	46.4	16.3	—
AC-13368-B_2-1	28.8	21.4	4.73:1
IHR-2-1	49.8	21.8	—
CFTRI-1	41.2	21.9	6.49:1
UPS-121	34.3	26.3	—
IHR-13	36.2	23.7	—
EC-38821-P_4-A	29.5	27.0	—
EC-27886	26.9	37.9	—
EC-27886-A	46.2	30.6	—
TPT-1B	64.1	15.1	—
IC-26940-B	41.4	27.1	—
EC-26942-B	45.2	25.1	—
IC-15018-A	47.0	21.5	9.12:1
Mean	40.9	25.3	—

*Analysed for only three genotypes.

MR: Mass of reconstituted dehydrated product-after cooking.

MD: Mass of dehydrated material before cooking.

The results of proximate nutrient analyses of tubers (on air dried basis) of 12 genotypes of winged bean which had acceptable percentage of dried gratings have been presented in Table 2. The average protein content of the tubers is 13.06 per cent which is about 6.94 per cent lower than the reported value.[5] It must be noted that neither potato (*Solanum tuberosum*) nor cassava (*Manihot esculenta*) contain as much protein as is found

TALBE 2. NUTRITIONAL VALUE OF DEHYDRATED ROOT TUBERS OF SELECTED GENOTYPES** OF WINGED BEAN

Genotype	Moisture (%)	Protein* (%)	Ash (%)	Fibre (%)	Carbohydrates (%)	Sugars (mg/100g)	
						Reducing	Non-reducing
IC.26940-A	10.3	12.9	1.6	2.3	70.4	—	—
AC.13368-B_2-1	9.5	14.2	2.3	3.0	68.3	114	26
IHR-2-1	9.3	16.2	2.3	3.5	66.5	56	104
CFTRI-1	9.5	9.0	2.1	2.8	74.9	140	80
UPS-121	9.1	14.2	2.3	2.6	69.1	130	94
IHR-13	10.2	10.3	1.9	3.5	72.2	116	24
EC-38821-P_4-A	9.8	14.2	2.2	3.2	68.0	122	78
EC-27886	9.3	10.3	2.1	2.3	74.1	—	—
EC-27886-A	9.5	12.9	2.2	2.7	70.4	64	176
IC-26940-B	9.0	14.2	2.0	2.3	69.8	84	92
IC-15018-A	9.6	10.3	1.6	1.9	74.6	116	20
EC-26942-B	10.0	17.4	2.2	2.5	64.6	114	16
Mean	9.6	13.1	2.0	2.7	70.1	108.6	71.0
Range	9.0-10.3	9.0-17.4	1.6-2.3	1.9-3.5	64.6-74.9	56-144	16-176

**Chemical analysis revealed absence of any type of fat in all these genotypes.

*N × 5.30.

in winged bean tuber, since the former two crops do not exceed 5-6 per cent protein in their tubers. This is also true when compared to sweet potato and yam.[3] The chemical analysis revealed absence of any type of fat in the tuber flour. The average carbohydrate content of 70.14 per cent, and mean fibre content of 2.7 per cent in the dehydrated, processed winged bean root tuber flour with high content of protein appears to be very much acceptable for mixing in animal feed concentrates. The proportion of reducing sugars to non-reducing sugars was more in case of FC-26942-B(9 : 1), followed by IC-15018-A (6 : 1) and IHR-13(5 : 1) which is desirable even though the total sugar content was less in all three genotypes.

Processed tuber flour had sweetish taste. Perhaps, this may be the reason for some people to eat the raw tubers. Two snacks viz., *Kesaribath* and cookies prepared by substituting dehydrated tuber flour for wheat soji and wheat-flour (*maida*) in respective snacks, when subjected to sensory evaluation indicated that, *Kesaribath* is slightly liked at 25 per cent substitution and totally disliked at 50 per cent substitution level by the panel members. On the other hand, cookies were acceptable and liked at 25 per cent substitution level and disliked at 50 per cent level by majority of the panel members. Several reports on edibility of winged bean root tuber have indicated, the method of cooking these tubers in hot ashes.[3] Thus, baking method of preparation of cookies had better acceptance in this study also. The panel felt a highly tuberous, 'rooty' or 'root-like' odour which was thought to be a repulsive factor for the better acceptance of the above snacks. Further, investigations in this line are essential for possible cereal substitution in the food products.

As this tuber is to be newly introduced in India, dietary flour needs are to be carefully studied before recommending this as a root tuber crop. Since processing can be successfully applied to get a good dehydrated product, as its protein value is good, further work in its utilisation aspect in food and feed is valuable for future agricultural considerations.

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Evaluation of Tofu and its Products Prepared from Soymilk and Combination with Sunflower Seed Milk and Skimmilk*

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Tofus from soymilk and combinations with sunflower seed milk and skimmilk were developed as a ready-to-use and prepare base for various Indian dishes. It was adjudged by the panel of sensory evaluation that Tofus of soy 100% and soy + skimmilk (60 + 40) were acceptable where as Tofus of soy + sunflower seed milk (60 + 40) and soy + sunflower seed milk + skimmilk (60 + 20 + 20) were unacceptable. Two snack items, namely "Burfi" and "Pakoda" prepared from the accepted Tofus were both acceptable with no significant difference ($P < 0.05$) among the products. It is desirable to popularise soy 100% and soy + skimmilk (60 + 40) Tofus as they are nutritious food products at a low cost.

Tofu, a preparation similar to that of the cow's milk product Paneer, is the soybean curd prepared by precipitating the protein from soybean milk either with an acid or alkali salt[1]. It has the consistency of cream cheese and is tasteless, but is used as the base for many preparations. Tofu is specially rich in protein, fat and minerals as Chinese proverb says "Tofu is meat without bones". Soy milk Tofu can form a protein source of low cost for millions of people suffering from under-nutrition and malnutrition[2]. But , many of the vegetable protein foods are deficient in the amino acid-methionine. The purpose of this study was to prepare an acceptable Tofu using soymilk, sunflower seed milk and skim milk to improve the nutritional quality by this supplementary effect.

Materials and Methods

'Hardee' variety of soybean and 'EC. 68415' variety of sunflower seeds were procured from the All India Coordinated Research Project and the skim milk from the Dairy Science Department of UAS, Bangalore. The milk from soybean and sunflower seeds was extracted as per the method outlined by Smith and Beckel[3], with slight modification. One kg of soybean was soaked in 3 kg of water containing 0.5 per cent sodium bicarbonate. Water was drained and the soaked beans were dehulled manually by rubbing between the hands and the hulls were removed by water flotation. The dehulled beans were ground for 8 to 10 min using 8 kg of water. The blended slurry was filtered through a muslin cloth to get soy milk. The quantity of milk extracted was 8.2 kg. One kg of dehulled sunflower seed kernels were ground with 5 kg of water and the blended slurry was filtered through a muslin cloth and the milk obtained was 5.1 kg.

Coagulants: Citric acid, magnesium sulphate and sea salt (Nigari) were used for the curdling of milk and the highest yield giving coagulant, namely 20% magnesium sulphate solution was used in the preparation of Tofu throughout the study.

Preparation of Tofu: The cow's milk Paneer commercially obtained from Nilgiris Dairy Farm, Bangalore, was used as the control for sensory evaluation. The different combinations of Tofus (T_2 to T_5) tested in this study were as follows: commercial Paneer (T_1); soy 100%(T_2); soy + skim milk (60 + 40) (T_3); soy + sunflower seed milk (60 + 40) (T_4); and soy + sunflower seed milk + skim milk (60 + 20 + 20)T_5). One kg of soymilk was boiled for 15 min at 110°C and a freshly prepared 20% magnesium sulphate solution was added in a thin continuous stream till complete coagulation was observed. The coagulated mass was allowed to settle for 10 min and then transferred by a ladle to a wooden Tofu box having perforated sides

*Part of M. HSC (Food and Nutrition) thesis submitted by the first author to University of Agricultural Sciences, Bangalore.

lined inside with a muslin cloth. The ends of the cloth were folded over and 10 kg of weight was placed on it overnight for the whey to drip out. The pressed Tofu was then removed from the box and was wrapped in butter paper and kept in a refrigerator for use in 2-3 day's time. The same method with slight modification was followed for preparation of other Tofus (T_3, T_4 and T_5). For T_3, skim milk was added after the soy milk was boiled for 10 min at 110°C. In T_4 and T_5, sunflower seed milk was added just prior to the addition of the coagulant as the sunflower seed milk gets coagulated even at temperature below 100°C.

Product development from Tofu: *Burfi* and *Pakoda* were prepared with Tofus of T_1, T_2 and T_3. Ingredients used in Tofu *Burfi* were:

Tofu and sugar	100g each.
Cardamon powder	½ tea spoon.
Cashewnuts	1 table spoon
Green colour	1 drop.

Method: Sugar and Tofu were mixed well and kept on a low fire for 10 min stirring continously till it reached 112 to 116°C and thereafter powdered cardamom, cashewnut and colour were added. The above mixture was poured on to a greased plate and flattened to an even thickness of half an inch. It was cut into squares of 1 × 1 in when cooled.

Pakoda was prepared with the following ingredients:

Tofu	100 g.
Bengalgram flour	10 g.
Chopped onions	½ cup.
Chopped coriander and curry leaves	1 table spoon.
Chopped green chillies	1 tea spoon.
Salt	sufficient to taste
Pinch of cooking Soda	
Oil for frying	

Method: Chopped onions, green chillies, coriander and curry leaves, and salt were mixed with Tofu well, to a drop batter consistency and a heaped tea spoon of batter was dropped in the form of *Pakoda* into the heated oil and fried till golden brown colour.

Sensory evaluation of Tofus and products prepared from acceptable Tofus: Sensory evaluation was conducted on the different combinations of Tofu and its products by a panel of 8 judges. A few of the panelists were drawn from the post-graduate student population who were undergoing training in flavour analysis course and others were employees of UAS who have repeatedly examined products for organoleptic studies of this department. On the first day, the selected panelists were given detailed instructions regarding the method of scoring and the significance of their judgement of the coded samples of Tofus and their products for the appearance, texture, flavour and overall acceptability using 5-point scale. The index for the score point being 1, unacceptable; 2, slightly unacceptable; 3, acceptable; 4, moderately acceptable; and 5, highly acceptable; score sheet had overall acceptability to be scored separately apart from the quality characteristics to be scored.

The scores recorded on the first 2 days were ignored and the subsequent scores only were considered. Analysis of variance was used to test differences among the treatments. Differences existing were subjected to least significant difference (L.S.D.) test as per the methods outlined by Sundararaj *et al.*[4]

Cost evaluation: The cost of different Tofus were evaluated based upon the raw materials used in the preparation.

Results and Discussion

Coagulants: The effect of three coagulants on the curdling of soy milk is given in Table 1. Magnesium sulphate solution gave the highest recovery (210 g) of Tofu at pH 5.6. Jagannath Rao[5] reported that increase of soy milk from 60 to 80% in the modified milk Paneer prepared with citric acid, had a pronounced beany flavour with a poor body and texture. The coagulant magnesium sulphate used in this study might have resulted in a better body and texture of Tofu and also decreased the beany flavour.

Yield of Tofu: It was observed (Table 2) that soy milk 100%(T_2) gave the highest recovery of Tofu (15.4%)

TABLE 1. COAGULANTS FOR CURDLING OF SOY MILK

Coagulant used (20% w/v)	Quantity (ml)	Tofu obtained (g)	Whey obtained (ml)	Whey (pH)
Citric acid	100	50	895	2.1
Magnesium sulphate	100	210	775	5.6
Sea salt	100	160	835	5.7

Soy milk used is 1 Kg. for each best.

TABLE 2. YIELD OF DIFFERENT TYPES OF PANEER

Source of milk	Quantity of milk taken (g)	Coagulant used (ml)	Wt of Tofu (g)	Whey (ml)	Yield of Tofu (%)
Soymilk, 100%	1333	150	206	1005	15.4
Soy + skimmilk (60 + 40)	800 + 533	150	193	1065	14.4
Soy + sunflower seed milk (60 + 40)	800 + 533	150	157	1096	11.7
Soy + sunflower seed milk + skim milk (60 + 20 + 20)	800 + 267 + 267	150	126	1275	9.4

with crumbled and broken texture. Soy + skim milk (60 + 40)(T_3) Tofu had a recovery of 14.4% and the texture of Tofu was quite compact and firm. The recovery of soy + sunflower (60 + 40) (T_4) Tofu was 11.7% with soft texture and kneadable consistency. The soy + sunflower + skim milk (60 + 20 + 20)(T_5) Tofu had a yield of 9.4% with undesirable soggy appearance and texture.

Smith[6] *et al.* and Altschul[2] reported an yield of 4 to 5 times of Tofu from soybean with a moisture content of 86 to 90%. The yield of Tofu in the present study when calculated for 86 to 90% moisture levels, is in conformity with yield reported in the above studies. Perhaps, the low level of 60 per cent moisture content of Tofu in this study may help in increasing the shelf-life.

Sensory evaluation of Tofus and their products: It was observed that commercial Paneer T_1 scored as highly acceptable. Soy 100% (T_2) and soy + skim milk (60 + 40)(T_3) were moderately acceptable to acceptable and T_4 and T_5 were unacceptable. The unacceptable Tofus were not used for further study of product development. The results of the taste panel scores for the characteristics of different Tofus are shown in Table 3 and the least significant difference at 5% level of significance is shown in Table 4.

TABLE 3. ANALYSIS OF VARIANCE OF THE TASTE PANEL SCORES FOR THE CHARACTERISTICS OF DIFFERENT TOFUS

Characteristics/source	DF	Mean sum of squares			
		Appearance	Texture	Flavour	Overall acceptability
Treatments	4	9.16**	8.46**	4.50**	11.36**
Judges	7	0.74*	0.74*	3.02*	1.93*
Error	28	0.31	0.45	0.54	0.48
Total	39	—	—	—	—

*Significant at 5% level. **Significant at 1% level.

TABLE 4. MEAN SCORES OF THE SENSORY PANEL JUDGES FOR THE CHARACTERISTICS OF TOFU

Characteristics	T_1	T_2	T_3	T_4	T_5	Least significant difference
Appearance	5.0	3.6	3.0	2.5	2.3	0.48*
Texture	4.7	3.8	3.6	2.5	2.2	0.56*
Flavour	4.0	3.0	3.0	2.2	2.1	0.64*
Ovrall acceptability	4.5	3.5	3.3	2.1	1.6	0.59*

There is no significant difference between the means underlined at $P < 0.05$.

The *Burfi* and *Pakoda* prepared from acceptable Tofus (T_1, T_2 and T_3) revealed no significant differences (Table 5).

Soy milk preparations received fairly high scores for organoleptic evaluation and were almost on par with standard (cow's milk) preparations[7]. The products developed with the acceptable Tofus of this study agreed with the above findings.

Cost evaluation: The cost of Tofu and the Paneer were evaluated and is given in Table 6.

It is assumed that an acre of soybean would yield nearly 10 times as much protein as a cow produces from an acre of pasture. Soy Tofu which is highly rich in proteins, fats and minerals proved to be cheaper than that of cow's milk Paneer. This agrees with the studies of Mittal *et al.*[8] and Parihar *et al.*[7] who reported that the use of soy milk in various recipes affected a savings of upto 50% in the cost of preparation compared to standard recipes using cow's milk. Hence, it is feasible to popularise soy 100% and soy + skim milk (60 + 40) Tofus as they are more nutritious and can be made available at a low cost.

TABLE 5. ANALYSIS OF VARIANCE OF THE TASTE PANEL SCORES FOR THE CHARACTERISTICS OF TOFU PRODUCTS, *BURFI & PAKODA*

Characteristics	DF	Mean sum of squares			
		Appearance	Texture	Flavour	Overall acceptability
Treatments	5	0.03	1.48	0.87	0.87
Judges	7	3.50	1.30	2.47	1.33
Error	35	0.68	0.83	0.46	0.88

Non-significant at 5% level of significance.

TABLE 6. COST EVALUATION OF TOFU

	Cost *Rs. P.*
*Commercial Paneer**	
Milk 4.5 l @ Rs. 2/l	9.00
Citric acid 9 g @ Rs. 60/500 g	1.08
Total cost/kg	10.08
Soy 100% Tofu	
Soy milk 6 l. @ Rs. 2/l	1.50
Mag. sulphate 120 g @ Rs. 12.60/500 g.	2.90
Total cost/kg	4.40
Soy + skim milk Tofu (60 + 40)	
Soy milk 3.6 l @ Rs. 2/l	0.90
Skim milk 2.4 l @ Re. 1.00/l	2.40
Mag. sulphate 120 g @ Rs. 12.60/500 g	2.90
Total Cost/kg	6.20

*Obtained from the Manager, Nilgiris Dairy Farm, Bangalore.

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Determination of Dimethoate and its Residues in Foods and Formulations by Gel Electrophoresis

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The water soluble Organophosphorus pesticide, dimethoate (solubility 2%) can be identified by running the hydrolysed product in polyacrylamide gel using citrate buffer (pH 2.4) as chamber buffer. The electrophoresed product is visualised as a band with 1% copper sulphate solution as a staining agent. Though the sensitivity of the method is not very low, it is specific for dimethoate. The quantitation can also be done with use of densitometer. The method is simple and quick.

Gel electrophoretic method is widely used for separation of proteins[1-3] which appear as bands after staining with the appropriate dye. Separation of dyes have also recently been done.[4,5] In the present note, the separation and identification along with the quantitation of dimethoate have been done in polyacrylamide gel.

Materials and Methods

Preparation of 7.5% polyacrylamide gel:

Buffer for gel (solution A): 24 ml of 1(N) HCI and trisbase [tris (hydroxymethyl) - aminomethane, $C_4H_{11}NO_3$] 18.15g and NNN-N-tetramethyl ethylene-diamine 0.23 g in a total volume of 100 ml are made up with distilled water.

Monomer solution (solution B): 30.0g of acrylamide and 0.8 g of bisacrylamide in 100 ml are prepared.

Ammonium persulphate, $[(NH_4)_2S_2O_8]$, is added at the rate of 1 mg/ml of total mixture just before the experiment. Solution B (3 ml) and solution A (4 ml) (3 : 4) are taken and mixed and the solution is poured to the gel tubes (8 cm × 0.5 cm I.D.); the bottom ends of the tubes are closed by parafilm secured with a rubber band. Layer the top of the solution with distilled water. It is allowed to polymerise in the presence of fluorescent lamp, which takes 15 min.

Preparation of the chamber buffer: 10 ml IM citric acid was mixed with 1.51 ml IM NaOH solution and the volume was made upto 100 ml with distilled water. The pH 2.4 of the citrate buffer was maintained at 2.4.

Determination of dimethoate residue: The residue

obtained after extraction[6–7] from foods and formulations is collected and dissolved in a minimum quantity of distilled water. To the residual dimethoate solution is added twice the equivalent quantity of N/10 NaOH solution for hydrolysis (alkali remaining in excess). The flask is then fitted with an air condenser and placed in a water bath for 30 min for complete hydrolysis. The excess alkali is neutralised with acetic acid. About 0.87 g/ml sucrose is added to make the solution thicker.

The above solution is applied on the top of gel by a micropipette. The sample size is 10-20 μl.

A drop of 0.1% bromophenol blue dye in alcohol is added along with the sample to indicate the run of the sample in the gel tube. Electrophoresis is carried out for 30 min using a current 45mA per gel tube. After completion of the run, the gel is taken out from the tube by forcing water gently using injection syringe. The gel is put in the test tube containing 1% copper sulphate solution (acidified) for staining. Lastly, the colour of copper sulphate absorbed by gel is removed by washing the gel for several times with distilled water.

Results and Discussion

FIG. 1 The band obtained for dimethoate in polyacrylamide gel.

A dark brown band at a distance of 6.5 cm from the spotting point is obtained as shown in the Fig. 1. The minimum detectable limit is found to be 100μg. The densitometric scanning of the band as obtained in the gel has been presented in Fig. 2; the scan is obtained from Photo-Volt Densitometer. Thus, quantitation can be done first by having a standard graph (obtained by plotting peak area against concentration) with known concentration of the pesticide. Natural colours or the co-extractives do not interfere in this method[5]. The relatively high detectable limit makes the method more convenient in case of analysis or quality control of formulations or technical grade dimethoate. However, 100 g food containing 1 ppm or more of dimethoate (or its hydrolysed residue) can be estimated by this method.

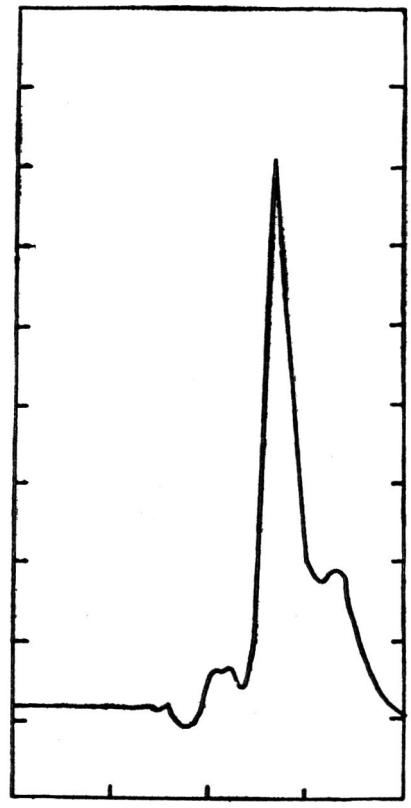

FIG. 2. Densitometer scan of gel chromatograph

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A Comparative study on the effect of Gibberellic Acid, Ethrel and Ethylene Chloride on Potato (*Solanum tuberosum* Linn.) Sprouting

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In a study to assess the relative efficacies of Gibberellic acid (GA), Ethrel (E) and Ethylene Chloride (EC) to induce sprouting and sprout growth, potatoes dipped for 10 min in each of GA, E and EC solutions at 10, 100 and 1000 ppm concentrations, were observed during 4 weeks of storage at ambient conditions. The results revealed that significant sprouting was induced with E at 10 ppm and GA at 100 and 1000 ppm concentrtaions. Further, Ethrel at 10 ppm and GA at 100 ppm were equally effective in inducing maximum number of sprouts per tuber, while the former did not affect the length of the sprout. Sprout yield at the end of 4 weeks, was significantly more than control at 100 and 1000 ppm of GA, 10 ppm of Ethrel and 100 ppm of EC.

Potato tubers remain dormant for about 6 to 8 weeks after harvest, depending on the variety at Mysore weather conditions, where temperature ranges from 22–30°C[1]. At the end of the dormant period, all the buds in a tuber do not sprout at the same time, because of the 'apical dominance'[2]. Activation of all the buds in a tuber is necessary when heat treatement is to be employed to control sprouting, which is a serious problem in potato storage, as active buds can be suppressed with milder heat treatment, avoiding side effects like browning of the tubers (as found by our preliminary studies). Many chemicals have been used to activate the dormant bud[3]. Ethylene chloride (EC) vapour at a concentration of 1-2 ml / 17.5 l atmosphere is known to break dormancy[3]. Gibberellic Acid (GA) when applied as foliar spray or as dip treatment to whole potato tubers shortens the rest period and promotes sprout elongation[4]. Effect of Ethrel on growth response of 'Russet burbank' and 'Kennebec' potatoes has been reported[5]. Though GA and EC are known to break dormancy, their relative effectiveness in inducing number of sprouts/tuber, sprout length and such other characteristics are not known. Hence, a comparative study was made to know the efficacy of GA, E and EC on (a) number of tubers sprouted/week, (b) number of sprouts/tuber, (c) mean length of the sprout and (d) sprout weight.

Materials and Methods

Potatoes collected from the local market were washed and tubers without any visible damage were selected for the study. These tubers were about 5 weeks old after harvest. They were separated into 1 kg lots and dipped for 10 min in each of Gibberellic Acid (GA), Ethrel (2-chloroethyl phosphonic acid) and Ethylene chloride (1-2 dichloroethane) and 10, 100 and 1000 ppm concentration. They were surface dried and stored in 0.2% ventilated, 200 gauge polyethylene bags at ambient temperature (22-30°C) and 60-80 per cent relative humidity. Tubers dipped in water served as control. Each treatment was triplicated (with 1 kg tuber in each replicate). The results are the means of the 3 replicates.

Results and Discussion

Effect on number of tubers sprouted: The effect of GA, E and EC on the number of tubers sprouted at the end of each week is given in Table 1. Only GA and E induced early sprouting, while EC was not effective. At the end of 1 week, the number of tubers sprouted with GA was 69.9, 76.5, 86.2 per cent at 10, 100 and 1000 ppm respectively, as against 48.3% in control. Although, the number of tubers sprouted at the end of 1 week increased with increase in concentration, 100% sprouting was achieved at the end of 4 weeks in all the concentrations as in the control. Ethrel treated tubers showed 80.9, 74.7 and 75.2 per cent sprouting at the end of 1 week after treatment at 10, 100 and 1000 ppm respectively. Ethrel at 10 and 100 ppm showed 100% sprouting at the end of 4 weeks. There was 68.4, 61.0, 73.4% sprouting at 10, 100 and 1000 ppm

TABLE 1. EFFECT OF GA, E AND EC ON NUMBER OF TUBERS SPROUTED AT THE END OF EACH WEEK

Treatment	Concn. (ppm)	Tubers sprouted (%) at the end of indicated periods			
		1st week	2nd week	3rd week	4th week
Gibberellic acid	10	69.9 ± 1.9	89.4 ±2.7	95.9	100.0
	100	76.5 ± 7.1@	95.8 ±2.0@	97.9	100.0
	1000	86.2 ± 7.07*	96.0 ±2.0@	95.9	100.0
Ethrel	10	80.9 ± 4.7*	92.83±0.3	100.0	100.0
	100	74.7 ± 8.5	83.1 ±2.4	100.0	100.0
	1000	75.2 ± 10.0	93.5 ±3.8	98.0	100.0
Ethylene chloride	10	68.4 ± 12.3	73.4 ±3.5	93.6	100.0
	100	61.0 ± 3.0	81.0 ±7.1	100.1	100.0
	1000	73.4 ± 14.4	100.0	100.0	100.0
Control		48.3 ± 10.06	75.91 ± 8.2	94.1	100.0

Test of significance by student's 't' test (compared with the control).

*—Significant at 5% level; @ —Significant at 10% level. Figures without superscript in column 3 and 4 are not significant.

EC at the end of 1 week and were not significantly more than the control, but 100% sprouting was reached at the end of 4, 3 and 2 weeks in 10, 100 and 1000 ppm respectively.

Though EC could induce 100% sprouting at the end of 2 weeks itself, the concentration required was 1000 ppm. But, Ethrel showed 100% sprouting at the end of 3 weeks at 10 ppm only. Hence Ethrel could be preferred to GA and EC.

Effect on number of sprouts/tuber: The number of sprouts tuber is given in Table 2. The number of sprouts/tuber with GA at 100 and 1000 ppm were

TABLE 2. EFFECT OF GA, E AND EC ON NUMBER OF SPROUTS/TUBER/WEEK

Treatment (groups)	Concn (ppm.)	Av. number of sprouts/week/tuber at the end of the indicated periods			
		1st week	2nd week	3rd week	4th week
Gibberellic Acid	10	2.06 xyz	3.18 xy	3.26 x	4.14 x
	100	3.06 pq	4.34 zp	4.87 z	5.87 p
	1000	3.26 q	3.96 yzp	5.09 z	5.41 zp
Ethrel	10	3.34 q	3.95 yzp	4.39 yz	5.39 yzp
	100	2.23 xyzp	2.74 x	3.77 xy	4.17 x
	1000	2.40 yzpq	3.28 xy	3.87 xy	4.51 xyz
Ethylene chloride	10	2.38 yzpq	2.69 x	3.56 xy	4.06 x
	100	1.71 xyz	3.41 xy	3.51 xy	4.55 xyz
	1000	2.78 zpq	4.60 p	4.44 yz	4.42 xy
Control		1.31 x	2.89 x	3.26	4.02 x
Standard deviation		±2.16 (464 df)	±2.19 (464 df)	±2.05 (464 df)	±2.11 (464 df)

Means of the same column followed by different letters differ significantly according to Duncan's New Multiple Range Test ($P < 0.05$)

NOTE: Number of sprouts of each tuber was counted and total sprout number was divided by total number of tubers under each treatment to get mean number of sprouts/tuber.

significantly more than the control at the end of 4 weeks. It was 5.9 at 100 ppm and 5.4 at 1000 ppm of GA as against 4.0 in control. With Ethrel, the number of sprouts/tuber was 5.4 at 10 ppm, while it was 4.17 at 100 ppm and 4.5 at 1000 ppm at the end of 4 weeks. EC was not effective even at 1000 ppm in increasing the number of sprouts/tuber, when compared to control.

Of all the 9 treatments, GA at 100 ppm induced maximum number of sprouts/tuber. However Ethrel at 10 ppm and GA at 1000 ppm were equally effective.

Effect on sprout length: The mean length of sprouts is represented in Fig. 1. The sprout length at the end of 4 weeks was significantly more than the control, at 100 and 1000 ppm GA and it was 6.2 mm and 11.8 mm as against 3.5 in control. The sprout lengths with ethrel and EC at the end of 4 weeks at 10, 100 and 1000 ppm were 4.3, 4.4, 4,4 and 3.5, 3.2, 4.1 mm respectively. However, the sprout length was not significantly more than control. Of the three chemicals, GA appears to stimulate sprout length more vigorously than Ethrel and EC.

Effect on sprout yield: Sprout yield/100 tubers at the end of 4 weeks is given in Fig. 2. The sprout yield with GA was 22.1, 33.1, 35.4g and with Ethrel was 25.0, 20.1 and 20.8g at 10, 100 and 1000 ppm levels respectively, as against 14.3g obtained with control. Sprout yield was significantly more at all concentrations of GA and at 10 ppm of Ethrel. With GA, the sprout yield increased with increase in concentration. The sprout yield was 19, 20 and 19 g with EC at 10, 100 and 1000 ppm level respectively. Only at 100 ppm of EC, the sprout yield was significantly more than that of control.

Only GA at all concentrations resulted in more sprout yield than control while, Ethrel and EC were effective at 10, and 100 ppm respectively.

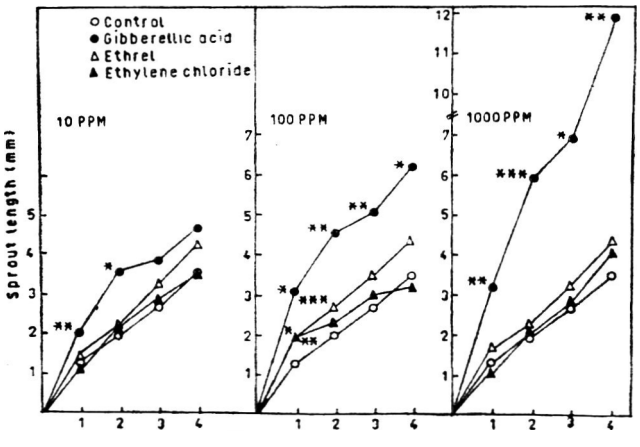

FIG. 1. Effect of Gibberellic acid, Ethrel and Ethylene chloride on the sprout length of potatoes during 4 weeks storage at ambient conditions (test of significance over control * at 5%, ** at 1% and *** at 0.1% level)

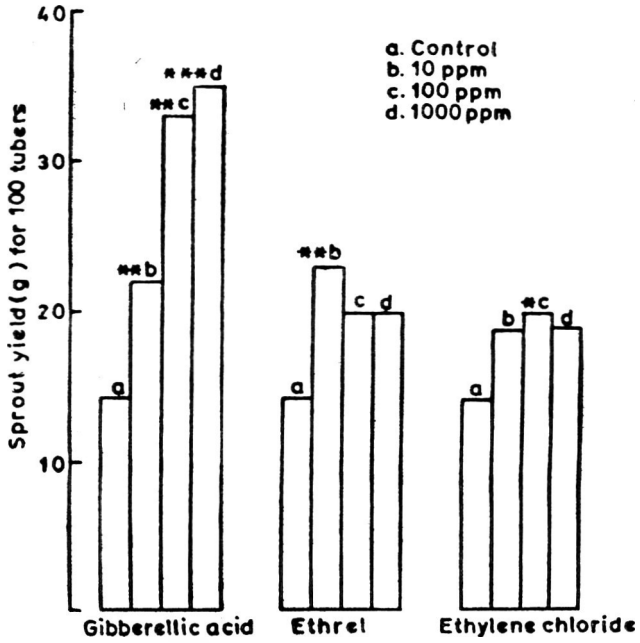

FIG. 2. Effect of Gibberellic acid, ethrel and ethylene chloride on sprout yield of potatoes at the end of storage at ambient conditions for 4 weeks (test of significance over control * at 5%, ** at 1% and *** at 0.1% level).

Among the 3 chemicals, GA stimulated sprout growth more vigorously followed by Ethrel and EC. GA and EC, with the increase in concentration had promotary effect on all the parameters observed, while promotary effect of Ethrel was not commensurate with increase in its concentration. This action of Ethrel can be compared to the dual effect of ethylene treatment on potato sprouting. Ethylene is known to shorten the duration of dormancy, but prolonged treatments inhibit sprout elongation[6]. GA at 100 ppm brought about maximum number of sprouts into physiologically active state, when compared to other treatments, but resulted in an undesirable increase in length of the sprouts, which may break easily. Ethrel treatment at 10 ppm is advantageous over GA at 100 ppm, as it is equally effective to induce more number of buds to sprout with less lengthy sprouts. Ethrel can also be used to treat seed potatoes, where dormancy is to be broken, prior to planting in the field to ensure better sprouting.

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Studies on Niger (*Guizotia abyssinica*) Seed Oil

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Nine niger seed samples collected from different parts of Maharashtra and Gujarat were analysed for physico-chemical characteristics and fatty acid composition. Oil content ranged from 30.0 to 32.4%, crude protein from 26.0 to 30.6 per cent and moisture from 1.7 to 3.0%. Ranges for iodine value, saponification value, free fatty acid percent, butyro-refractometer reading, refractive index, Bellier turbidity temperature and unsaponifiable matter per cent were: 112.8 to 129.0, 187.0 to 195.0, 0.2 to 2.0%, 59.5 to 62.2, 1.4655 to 1.4673, 24.5 to 27.8 C and 0.5 to 1.0% respectively. Oil samples were *trans*-esterified and fatty acid composition determined by gas liquid chromatography. Among saturated fatty acids, palmitic (5.8 to 13.0), stearic (5.0 to 7.5) and arachidic (0.2 to 1.0%) were present, whereas oleic (13.4 to 39.3) and linoleic (45.4 to 65.8%) constituted the major portion of total fatty acids. Ultra-violet spectrum of methanol solution of niger seed oils have also been noted.

Niger (*Guizotia abyssinica* Cass.) is extensively grown in Madhya Pradesh, Andhra Pradesh, Orissa, Maharashtra and Karnataka and to some extent in Bihar as mixed crop with ragi, horsegram, cotton and groundnut. The better grade niger seed oil is used for edible purposes, whereas the lower grade is used as adulterant, particularly, for sesame and mustard oils. Physico-chemical characteristics and fatty acid composition of niger seed oils from different origin have been reported by various workers[1-4]. Among fatty acids, myristic, palmitic, stearic, arachidic, oleic, linoleic and linolenic were reported to be present.

Published literature showed a wide variation in quality parameters of niger seed oil especially, iodine value and Bellier turbidity temperature. A systematic study has therefore, been undertaken to find out the various physico-chemical parameters and fatty acid composition of niger seed oil.

Materials and Methods

Nine seed samples of niger seed were collected from different parts of Maharshtra and Gujarat. They were cleaned, crushed and solvent extracted using hexane in Soxhlet apparatus. The hexane extract was filtered and solvent was removed under vacuum. The glyceride oil obtained was utilised for physico-chemical studies and spectroscopic analysis. Iodine value, saponification value, free fatty acids, butyro-refractometer reading, refractive index, Bellier turbidity temperature, unsaponifiable matter of oil and moisture content of whole seeds were determined employing A.O.C.S. methods[5]. Oil content was determined on the sample weight basis, whereas protein content of moisture free defatted seeds was esimated by Kjeldahl procedure[6]. Methyl esters for gas-liquid chromatographic (GLC) analyses were prepared[7] by using 1% sodium methoxide direct from the glyceride oils. Fatty acid composition of mixed methyl esters was determined on gas chromatograph (CIC, Baroda model) equipped with flame ionization detector and stainless steel column (60" × 1/8" dia) packed with diethylene glycol succinate, 15% as stationary phase adsorbed on chromosorb W, nitrogen (60 ml/min) was used as carrier gas, whereas hydrogen (40 ml/min) served as a fuel gas. GLC analysis was done on isothermal conditions maintaining the oven temperature at 190°C and injection port at 230°C. Internal reference standards were run alongside for comparison of relative retention time and equivalent

chain length determinations. Relative percentage of fatty acids was calculated by following triangulation method. Ultra-violet spectrum of the 1% methanol solution of the oils were taken on Perkin Elmer (Model-Coleman 575) U.V. Visible spectrophotometer.

Results and Discussion

Crude protein content was 26.0 to 30.6% in defatted seed samples, whereas moisture content of whole seeds was between 1.7 and 3.0% (Table 1). Niger seeds contained oil between 30.0 and 32.4%. Most of the oil samples were light yellow in colour. Iodine value ranged from 112.8 to 129.0 compared to 125 to 135 stipulated under P.F.A. specifications (Table 2). Rao and Swaminathan[2] have reported a lower iodine value of 90 in certain varieties of niger seed oil. The Wealth of India[8] compilation has quoted the range to be 120.5 to 135.44. Our findings have further been supported by the workers at Bombay and Pune Laboratories (unpublished work, Table 2).

Saponification value was between 187.0 and 195.0 which has been found by others[2,4,8] as well as by data from Bombay and Pune laboratories. Free fatty acid content ranged from 0.2 to 2.0% which is quite within the permissible levels. Butyrorefractometer reading and refractive index of the samples (Table 2) ranged between 59.5/1.4655 and 62.2/1.4673. Unsaponifiable matter was between 0.5 and 1.0% which confirmed the previous findings[2,9,10] as well as the PFA specification. Bellier turbidity temperature, has ranged between 24.5 and 27.8°C.

Niger seed oil may be categorised among linoleic-rich oils, the content of which ranges from 50 to 73%. Ranges for fatty acid distribution, tentatively adopted by Food and Agriculture Organization and World Health Organization Committee for Fats and Oils[11] for sunflower, corn and safflower oils showed great similarity with nigerseed oil especially of oleic and linoleic acid content. Barker and Hilditch[9] have concluded that environment is the main cause for difference in fatty acid composition and the predominant factor is apparently the rate of development or ripening of the newly formed seeds in the flower-heads.

TABLE 1. OIL AND PROTEIN CONTENT OF NIGER SEED SAMPLES

Place of collection	Moisture (%)	Oil (%)	Protein Nx6.25(%)
Nandubar	3.0	30.6	26.5
Dabhadi	2.5	31.3	26.6
Dindori	1.8	31.2	29.4
Ghoti	2.8	31.0	26.0
Surgana	1.7	32.4	29.8
Kalvan	2.5	30.0	28.9
Peth	2.0	31.2	30.6
Lathur	2.5	30.0	29.5
Nasik	2.0	30.5	27.3

Except Dabhadi sample which is from Gujarat, all others are from Maharashtra.

TABLE 2. ANALYTICAL DATA ON NIGER SEED OILS

Place of collection	Iodine value		Sapon. value	FFA %	Butyro-refractometer reading (at 40°C)	Refr. index (at 40°C)	Bellier turbidity temp (°C)	Unsapon. matter (%)
	Detd	Calcd						
Nandubar	118.0	117.8	188.0	1.5	59.5	1.4655	26.0	0.9
Dabhadi	112.8	112.5	187.0	1.5	51.0	1.4665	26.5	0.7
Dindori	129.0	128.9	189.4	1.7	62.0	1.4672	26.5	0.5
Ghoti	127.5	127.4	193.0	1.0	62.0	1.4672	26.0	0.8
Surgana	118.0	117.6	189.8	0.4	62.2	1.4673	24.5	0.7
Kalvan	118.0	117.8	192.0	2.0	62.0	1.4672	25.0	1.0
Peth	119.0	118.7	195.0	1.5	60.3	1.4673	26.5	1.0
Lathur	126.0	127.6	187.6	0.2	60.0	1.4659	27.8	0.9
Nasik	125.0	125.4	193.1	0.6	60.0	1.4659	27.5	0.5
*PFA standard	125-135		188-193	< 3.0	61.0-65.0	1.4665-1.5691	25.0-26.0	< 1.0
Report from Bombay Municipal laboratory	111.1-130.3		188.4-194.5	0.34-1.02	58.4-61.8	1.4648-1.4671	25.5-31.0	
Report from State Health Laboratory Pune	111.2-131.5		188.18-194.48	0.588-1.977	59.4-62.6	1.4654-1.4676	26.0-29.6	

*The Prevention of Food Adulteration Act, 1954, Eastern Book Company, Law Publishers & Booksellers, 34, Lalbagh, Lucknow, 1980.

TABLE 3. FATTY ACID COMPOSITION OF NIGER SEED OILS (% BY WEIGHT)

Place of collection	$C_{16:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{20:0}$
Nandubar	9.4	7.2	30.2	53.0	0·2
Dabhadi	6.8	7.5	39.3	45.4	1.0
Dindori	5.8	6.0	25.8	61.6	0.8
Ghoti	7.3	5.0	27.3	60.0	0.4
Surgana	8.5	7.5	31.0	52.5	0.5
Kalvan	9.4	7.2	29.4	53.4	0.6
Peth	8.1	7.1	31.9	52.7	0.2
Lathur	6.0	5.7	27.5	60.0	0.8
Nasik	13.0	7.0	13.4	65.8	0.8

Myristic, palmitic, stearic, arachidic, oleic, linoleic and linolenic acids are reported to be present in niger seed oil[8,4], but in the present study (Table 3) only palmitic (5.8 to 13.0), stearic (5.0 to 7.5), arachidic (0.2 to 1.0), oleic (13.4 to 39.3), and linoleic (45.4 to 65.8%) were observed.

Saturated fatty acids: Saturated fatty acid contents are usually low in niger seed oils particularly in South Rodhesian varieties[11], where saturates contained upto a maximum of 13.8%. In the present investigation, total saturates; (palmitic, stearic and arachidic) ranged from 12.5 to 20.8%. Palmitic acid dominated stearic acid in some samples (Table 3), whereas stearic acid was found dominating in two samples. Traces of arachidic acid was observed in all the samples.

Unsaturated fatty acids: Oleic and linoleic acids ranged between 79.2 and 87.5%. Linoleic acid, however dominated in all the samples comprising more than 50% of the fatty acid composition except in one sample. It was found ranging between 45.4 to 65.8%, thereby showing the semi-drying nature of the oil. Oleic acid fell within the level of 13.4 to 39.3% (Table 3).

UV–analysis of niger seed oils: Presence of conjugated systems in glyceride was checked by ultra-violet spectral analysis of 1% methanol solution of the oil samples. Three maxima were observed in all the samples at λ max. 256, 260 and 267 nm, which cannot be assigned to any specific pattern of conjugation[12] in glyceride oils. UV-spectrum of methyl esters of the oil samples did not show any maximum thereby confirming the absence of conjugation. However, possibility of absorption by unsaponifiable matters at observed wave lengths may be considered.

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Effect of Feeding a Commonly Used Nonpermitted Food Colour Orange II on the Haematological Values of *Mus musculus*

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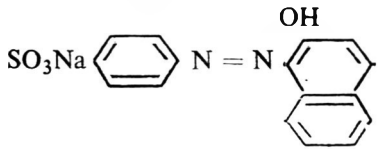
Haematological studies have been carried out to investigate the effect of Orange II on male and female mice after feeding for 90 days at levels of 0.0, 0.1, 0.5 and 3.0 g/kg body weight. There was no change in total erythrocyte count, total leucocyte count, platelet count, haemoglobin, haematocrit value, erythrocyte sedimentation rate, bleeding time, coagulation time and absolute values (MCV, MCH, MCHC). However, differential leucocyte count showed decrease in the percentage of polymorphs and eosinophils and increase in the percentage of lymphocytes and monocytes suggesting the occurrence of lymphocytosis or lymphatic form of leukaemia. Heinz bodies were not observed.

The use of colours in foodstuffs has become a general phenomenon and has been known for centuries. Most commonly used nonpermitted food colours in the market are metanil yellow and orange II.

Orange II [(Monoazo; C. I. Acid Orange 7 (15510)] is the sodium salt of p-[2-hydroxy-1-naphthyl)azo] benzene sulphonic acid:



Orange II

Prevention of Food Adulteration Act, India, does not include Orange II in the list of permitted food dyes. It has been toxicologically classified under the category C II by the Joint FAO/WHO Expert Committee on Food Additives which indicates that virtually no information on long-term toxicity of this colour is available. U.S. Food and Drug Administration has kept this colour in the subhead Ext. D & C Orange-4 "the colours provisionally and presently subject to certification by the FDA and provisionally tested for use in externally applied drugs and cosmetics and, at present it is allowed to be used in U.K. and U.S.A. However, a survey conducted by Indian Toxicological Research Centre, Lucknow, revealed that as many as 11% of the foodstuffs are coloured with Orange II It is most commonly used in bakery, beverages, ice-candy, confectionery, dairy products, sausages, pet foods, snacks and medicinal tablets.

Kinetic response of testes[1] to Orange II toxicity of Orange G[2,3] Metanil yellow[4], Orange PN[5] and tumorigenecity of acridine Orange[6] are known, but effects of Orange II on the haematological values are lacking. So, the present study was carried out.

Materials and Methods

Eighty ICR/Swiss mice *Mus musculus* (4-6 weeks old, average weight 20-25 g) were used. Forty male and forty female mice were divided into four groups and each group was fed with 0.0, 0.1, 0.5 and 3.0 g/kg body weight Orange II (Superior quality, procured from M/s Dadajee Dhakjee & Co. Ltd., Vugadi, Bombay, India) mixed in Lever's pelleted lab chow, for 90 days. Water was given *ad libitum*. Tney were maintained at a temperature of 28 ± 1°C under ideal hygienic condition[5].

Tail blood was used for total erythrocyte count, total leucocyte count, platelet count and differential leucocyte count[7]. Heinz bodies were observed by staining with methylene blue[8].

For other haematological tests, cardiac blood was used for the estimation of haemoglobin,[9] erythrocyte sedimentation rate and haematocrit value[10]. From the above data, "Absolute Values" like mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration were determined.

Bleeding time was determined by puncturing the pinna. The blots were recorded in series along a strip of blotting paper and subsequently counted. Coagulation time was determined according to the method of Lee and White[11]. Mean values of the

haematological data with standard error are given in Tables 1, 2 and 3.

Results

Various haematological values from control and treated male and female mice fed with different concentrations of Orange II are shown in Tables 1, 2 and 3.

No change was observed in total erythrocyte count, total leucocyte count, platelet count, haemoglobin percentage haematocrit value, erythrocyte sedimentation rate and bleeding time. Absolute values viz. mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration also did not show any marked difference from the controls. Coagulation time also did not show any appreciable difference. Heinz bodies were not at all observed.

Differential leucocyte count showed a marked increase in the percentage of lymphocytes from 34 to 54 per cent and monocytes from 1 to 6 per cent, while there was a decrease in polymorphs from 62 to 40 per cent and eosinophils from 3 to 0 percent in 3.0 g/kg body wt. fed male mice. In female mice also there was an increase in the percentage of lymphocytes from 35 to 52 per cent

TABLE 1. MEAN VALUES OF TOTAL LEUCOCYTE COUNT AND DIFFERENTIAL LEUCOCYTE COUNT IN CONTROL AND TREATED MALE AND FEMALE MICE

Sex	Dose (g/body wt.)	Total leucocyte count (x 10^3/mm^3) Mean±S.E.	Differential leucocyte counts (%)				
			Polymorphs Mean±S.E.	Lymphocytes Mean±S.E.	Monocytes Mean±S.E.	Eosinophils Mean±S.E.	Easophils Mean±S.E.
Male	0.0	13.50±0.60	62.00±1.00	34.00±2.00	1.00±0.00	3.00±1.00	0.00±0.00
	0.1	14.81±0.50	64.50±1.50	33.00±2.00	1.50±1.50	1.00±0.00	0.00±0.00
	0.5	13.30±0.40	62.00±2.00	31.00±4.00	3.00±1.00	4.00±0.00	0.00±0.00
	3.0	12.85±0.30	40.00±3.00	54.00±2.00	6.00±1.00	0.00±0.00	0.00±0.00
Female	0.0	13.65±0.40	61.50±2.50	35.00±3.00	1.50±0.00	2.00±0.00	1.00±0.00
	0.1	14.48±0.35	64.00±2.00	32.00±2.00	2.00±0.00	2.00±1.00	0.00±0.00
	0.5	13.12±0.65	63.00±2.00	33.00±3.00	3.00±1.00	1.00±0.00	0.00±0.00
	3.0	12.89±0.35	42.00±2.00	52.00±4.00	5.00±1.00	1.00±0.00	0.00±0.00

TABLE 2. MEAN VALUES OF TOTAL ERYTHROCYTE COUNTS, PLATELET COUNTS, HAEMOGLOBIN PERCENTAGE, ERYTHROCYTE SEDIMENTATION RATE AND HAEMATOCRIT VALUE IN CONTROL AND TREATED MALE AND FEMALE AND MICE

Sex	Dose (g/body wt.)	Total erythrocyte counts (TEC) (x 10^6/mm^3) Mean±S.E.	Platelet counts (x 10^5/mm^3) Mean±S.E.	Haemoglobin (g/100 ml) Mean±S.E.	Erythrocyte sedimentation (ESR) rate mm Mean±S.E.	Haematocrit value Mean±S.E.
Male	0.0	6.69±0.23	6.20±0.20	12.50±0.20	1.20±0.00	43.00±0.00
	0.1	6.35±0.12	6.15±0.10	12.55±0.10	1.19±0.02	43.50±3.00
	0.5	6.10±0.29	6.17±0.05	12.35±0.10	1.22±0.01	44.50±1.00
	3.0	5.36±0.18	6.20±0.20	12.50±0.00	1.23±0.02	42.50±1.00
Female	0.0	6.20±0.22	6.02±0.05	12.45±0.10	1.21±0.01	44.00±0.00
	0.1	6.48±0.21	6.10±0.10	12.35±0.10	1.22±0.04	44.00±0.00
	0.5	6.21±0.09	6.02±0.05	12.50±0.00	1.22±0.04	43.50±2.00
	3.0	6.53±0.15	6.02±0.05	12.35±0.10	1.22±0.02	44.50±1.00

TABLE 3. MEAN VALUES OF ABSOLUTE VALUES, HEINZ BODIES, BLEEDING TIME AND COAGULATION TIME IN CONTROL AND TREATED MALE AND FEMALE MICE

Sex	Dose (g/body wt.)	Corpuscular Vol (μm^3) Mean ± S.E.	Corpuscular haemoglobin (10^{-12}g) Mean ± S.E.	Corpuscular haemoglobin concnt (%) Mean ± S.E.	Heinz bodies (% of RBC) Mean	Bleeding time (sec) Mean ± S.E.	Coagulation time (sec) Mean ± S.E.
Male	0.0	6.42 ± 0.00	1.86 ± 0.08	29.07 ± 0.20	0.00	97.50 ± 15.00	337.00 ± 15.00
	0.1	6.77 ± 0.25	1.97 ± 0.08	28.84 ± 0.33	0.00	95.00 ± 30.00	322.50 ± 45.00
	0.5	7.29 ± 0.33	2.02 ± 0.03	28.22 ± 0.10	0.00	90.00 ± 40.00	330.00 ± 30.00
	3.0	6.68 ± 0.55	1.96 ± 0.00	29.48 ± 0.00	0.00	90.00 ± 40.00	345.00 ± 30.00
Female	0.0	7.09 ± 0.00	2.00 ± 0.04	28.29 ± 0.10	0.00	90.00 ± 00.00	300.00 ± 0.00
	0.1	6.79 ± 0.00	1.90 ± 0.04	22.06 ± 0.16	0.00	90.00 ± 00.00	333.00 ± 60.00
	0.5	7.00 ± 0.22	2.01 ± 0.00	22.73 ± 0.00	0.00	95.00 ± 30.00	345.00 ± 30.00
	3.0	6.87 ± 0.66	1.89 ± 0.06	27.75 ± 0.10	0.00	95.00 ± 30.00	377.50 ± 75.00

and monocytes from 1.50 to 5 per cent and decrease in polymorphs from 61.5 to 42 percent and eosinophils from 2 to 1 per cent.

General blood picture showed marked lymphocytosis. All the lymphocytes were of the mature variety in 3.0 g/kg body wt. fed mice, while in controls both immature and mature lymphocytes were observed. Red blood cells didnot show any abnormality (Fig. 1).

Discussion

Although Singh and Khanna[1] have shown the appearance of degenerative changes in the testes of rats after giving an intratesticular injection of Orange II, no haematological studies have been done with this food colour as yet. Gaunt[2] in his haematological study with Orange RN, reported the production of Heinz bodies, development of methemoglobinemia, anaemia and reticulocytosis in rats. In India, Chandra and Singh[12] have done a haematological study injecting benzanthrone, an intermediate dye. No haematological work on short term feeding or injecting Orange II has been done in India.

The present haematological study revealed no change in total erythrocyte count, total leucocyte count, platelet count, haemoglobin, haematocrit value, erythrocyte sedimentation rate, bleeding time, coagulation time and "Absolute Values". No Heinz body was observed in either group. Differential leucocyte count, however, decreased in the percentage of polymorphs and eosinophils which were significant in the group fed 3.0 g/kg body weight of Orange II. It is possible that either Orange II suppressed the development of polymorphs and eosinophils or arrested their maturation at a later stage. The increase in lymphocytes and monocytes might be due to the stimulation of the

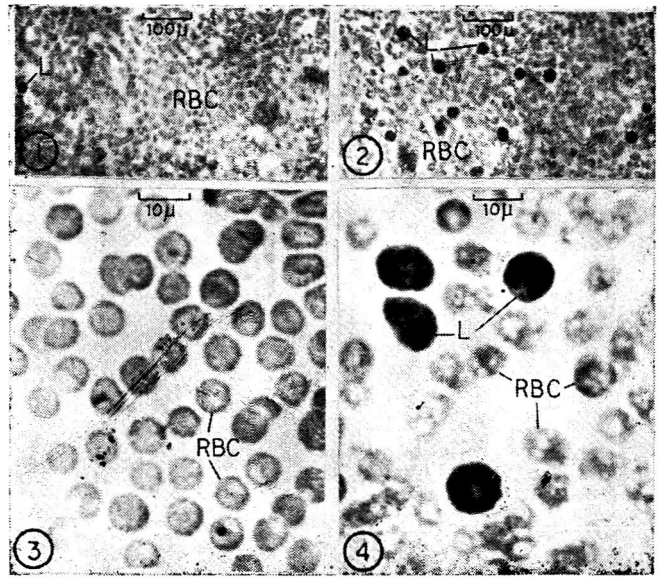


FIG. 1. Blood film picture of control and treated mouse.

1. Blood film of a contral mouse.
2. Blood film of a mouse fed with 3.0 g/kg body wt. mouse showing lymphatic form of leukaemia. Note increased number of 'mature' lymyhocytes. Red cells are normal in appearancnce.
3. Blood film of a control mouse at higher magnification. Note normal red blood cells.
4. Blood film of a mouse fed with 3.0 g/kg body wt. showing 'mature' lymphocytes. Red cells are normal in appearance.

haemopoietic system suggesting the occurrence of lymphatic form of leukaemia. Studies in other haematopoietic organs like bone marrow, lymph modes and spleen have also confirmed this observation.

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Equilibrium Moisture Content of Some Flours

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Equilibrium moisture content of defatted soyflour, full-fat uncooked soyflour, Bengal gram flour, semolina (*suji*), and wheat flour was studied at 20, 30, 40 and 50°C temperature and in the relative humidity range of 30 to 90%. At a given temperature and relative humidity, products having a higher starch content had higher equilibrium moisture. Latent heat of vapourization of the adsorbed moisture was about the same for all products. Amongst the standard isotherm equations tested, Henderson's equation gave the best fit to the data. To provide more compact representation of equilibrium moisture data, a relationship of the form M = F (ln(rh)/ln(ps/δ)) has been proposed which gave lower prediction errors than those obtained using the Henderson's equation.

The moisture content that a food material attains in equilibrium with a given atmosphere is of fundamental importance in handling, storage, and processing operations. For proper storage of all food products, the humidity and temperature to be prescribed is so selected, as to have the corresponding equilibrium moisture contents within the safe range from the stand point of quailty deterioration. Apart from the curation involved, the criticalness of the exposure is largely governed by the product moisture content that would be in equilibrium with the prevailing environment. In certain operations, it may be desirable to moisten the product under controlled environment, when the information on corresponding equilibrium moisture content would be essential. Therefore, a study of equilibrium moisture content of foods as a function of temperature and relative humidity is of considerable practical utility. Products such as wheat flour, semolina (*suji*), Bengal gram flour full-fat and defatted soy flour are important food items, as also raw materials for many processed foods. Equilibrium moisture content of wheat flour has been studied by many workers[1–6]. However, no published information is available on equilibrium moisture content profiles of the other flours.

This paper describes equilibrium moisture content of the above flours under different temperature and humidity conditions. Applicability of some isotherm equations available for biological materials has been examined. An attempt has also been made to develop a more compact representation of the equilibrium moisture content data.

Materials and Methods

The food products used in this investigation were: defatted soy flour, full-fat uncooked soyflour, semolina (farina or *suji*), Bengal gram flour and wheat flour. Soy flours and semolina were of standard commerical grade purchased from the local market. Wheat flour and Bengal gram flour were, prepared from wheat variety 'RR-21' and commercially dehulled Bengal gram, respectively. Individual samples each weighing 25 g, were sealed in polyethylene bags and stored at room temperature. Physical properties and the gross composition are given in Table 1.

The experiments were conducted at approximately equally spaced seven relative humidity levels in the range of 30 to 90% and at temperatures of 20, 30, 40 and 50°C. Static desiccator method and appropriate salt solutions were used to measure the equilibrium moisture content. Triplicate samples each weighing 2 g were equilibriated with the different atmospheres. Approximately, 75 to 100 hr were required to establish the moisture equilibrium. Hot air oven with a regulation of $\pm$0.5°C was used as a temperature control chamber. Initial moisture content of the samples was measured using standard hot air oven method. To ensure moisture absorption in each case, the samples were first dried to less than 3% moisture. This drying was done at room temperature using activated silica gel. It took about 25 to 36 hr for this drying. Details of the experimental procedure, the salt solutions used and the equipments have been described by Vijay Pratap.[7]

Table 1. PHYSICAL PROPERTIES AND CHEMICAL COMPOSITION OF THE FLOUR MATERIALS

Properties and composition	Defatted soyflour	Full-fat uncooked soyflour	Wheat flour	*Suji* (farina)	Bengal gram flour
Initial moisture content (%)	9.57	10.19	13.75	17.62	11.33
Bulk density (g/cc)	0.57	0.47	0.59	0.71	0.46
Particle density (g/cc)	1.45	1.30	1.45	1.46	1.87
Porosity (%)	60.6	63.7	60.0	49.5	75.2
Particle size (mm)	—	—	0.50	0.60	0.50
Protein (%)	55.0	40.0	13.2	10.4	20.2
Fat (%)	0.50	20.00	2.10	0.80	4.40
Carbohydrate(%)	37.5	33.5	68.2	74.8	58.8
Ash (%)	7.00	6.50	1.70	2.20	2.50

Results and Discussion

Equilibrium moisture content values for the different flours are given in Tables 2 and 3. Caking was observed

Table 2. EQUILIBRIUM MOISTURE CONTENT OF FLOURS AT DIFFERENT RELATIVE HUMIDITIES AND TEMPERATURES

Temp. (°C)	R.H. (%)	Equilibrium moisture content (% d.b.)			
		Defatted soyflour	Full-fat soyflour	Bengal gram flour	*Suji* (farina)
20	33.0	8.66	7.90	10.43	13.39
	39.0	9.85	—	—	14.35
	43.9	—	9.22	12.09	—
	54.2	13.11	11.75	14.62	16.75
	59.6	14.90	13.07	15.90	17.83
	68.4	17.51	15.35	19.66	19.71
	79.2	22.09	21.53	21.84	22.03
	90.7	30.78	30.36	30.61	28.73
30	32.4	7.68	6.32	8.77	12.98
	43.5	9.04	8.50	11.23	14.63
	51.3	11.06	9.66	12.65	16.03
	63.2	13.42	12.36	17.82	18.25
	69.4	16.15	14.94	17.92	19.36
	78.2	20.50	18.42	20.42	21.24
	89.9	28.06	26.91	28.10	27.44
40	31.8	6.55	5.85	7.47	12.08
	41.0	7.48	7.11	9.22	13.08
	48.4	8.85	7.93	10.73	13.76
	61.5	11.90	10.90	14.17	16.91
	71.5	15.18	12.25	16.48	17.88
	79.1	—	16.05	19.38	20.11
	81.7	19.05	—	—	—
	89.1	24.78	24.80	26.81	25.92
50	31.2	5.56	5.29	7.17	10.75
	38.2	6.41	6.15	7.95	11.91
	45.5	7.59	6.87	9.61	12.35
	63.2	11.82	9.64	12.37	15.34
	68.6	12.39	10.72	13.73	16.30
	78.4	—	15.09	17.33	18.11
	79.1	16.17	—	—	—
	88.3	22.28	22.08	23.95	24.49

TABLE 3. EQUILIBRIUM MOISTURE CONTENT OF WHEAT FLOUR AT DIFFERENT RELATIVE HUMIDITIES AND TEMPERATURES

Temp. (°C)	R.H. (%)	Equilibrium moisture content (% d.b.)
20	33.00	12.26
	43.90	14.12
	55.00	16.85
	65.35	18.98
	75.20	21.46
	85.00	23.57
	90.70	25.54
30	29.25	10.53
	43.80	12.59
	51.35	15.60
	63.20	17.30
	74.40	19.56
	83.40	20.92
	89.90	23.68
40	31.80	8.75
	43.90	10.21
	49.65	11.90
	61.55	13.95
	71.59	16.00
	81.70	18.85
	89.10	21.60
50	31.20	6.70
	38.20	8.71
	46.95	10.30
	59.80	12.79
	68.60	14.63
	80.20	17.33
	88.30	20.83

in all materials at 80 to 90% R.H. At 20 and 30°C and at 90% R.H., mold growth was observed on all samples except semolina. Equilibrium moisture content values obtained with wheat flour are very close to those reported by Bailey[1], Fairbrother[2], Anderson[3], Anker *et al*[4], Morey *et al*[5] and Bushuk and Winkler.[6]

As could be seen from Tables 2 and 3, defatted soyflour adsorbed more moisture than full-fat soy flour at the same temperature and R.H. The full-fat flour contains 20% oil. Only the non-oil portion of the flour absorbs moisture. If the moisture content of full-fat flour is converted to moisture content of the non-oil portion then, the resulting values are higher than those for defatted soy flour. Before defatted flour is produced, the solvent extracted flakes are toasted for removal of residual solvent. The resulting heat treatment must be causing some denaturation of the proteins, thus lowering their sorptive capacity. It is because of this that on oil free basis the defatted flour has lower equilibrium moisture content than the full-fat flour

A comparison of the equilibrium moisture content data of the different flours reveals that semolina has the highest sorptive capacity followed by wheat flour, Bengal gram flour and soy flours in that order The starch content of the flours also follows the same order. Therefore, it appears that the starch component of the flour plays a dominent role in determining its capacity for water vapour sorption Bushuk and Winkler[6] also found that the sorptive capacity of starch is higher compared to other flour fractions.

Isotherm equations: Isotherm equations of Harkins and Jura[8], Smith[9], Henderson[10] and Chung and Pfost[11] were examined for applicability to the present data. Each equation was tested for goodness of fit. For data analysis, the equations were used in their linearized form. Henderson's equation gave the best fit over the entire range of R.H. and temperature for all the products. The equation could satisfy the experimental data within an error of ± 0.03, ± 0.026, ± 0.06, ± 0.04, and ± 0.04 percent for the defatted soy flour, wheat flour, full-fat soy flour, semolina and Bengal gram flour respectively The values of constants of the Henderson's equation were also evaluated and are given in Table 4.

Development of a new relationship: Because of the temperature dependence of the constants of Henderson's equation their values should be available for various temperatures, if the equation is to be used for prediction purposes. Extrapolation beyond the temperature range over which the values of constant are known is particularly difficult. All these make use of the Henderson's equation which is rather cumbersome. Collection of equilibrium moisture content data over an extensive temperature range is a laborious process. In many practical applications, situations arise where equilibrium moisture content values at various temperatures need to be estimated from rather meager data. Therefore, development of relationship expressing equilibrium moisture content as a function of a single composite variable, which in turn is some simple function of relative humidity and temperature is of considerable practical value.

The starting point for the present development is the Othmer plot[12] of the equilibrium moisture content data. The plot relates the partial pressure p of water vapour is surrounding atmosphere which is in equilibrium with the product at moisture content M. For a given equilibrium moisture content, Othmer's equation is

$$\ln p = \lambda \ln p_s + \text{Constant} \quad \ldots \quad (1)$$

TABLE 4. VALUES OF CONSTANTS C AND n OF THE HENDERSON'S EQUATION

Material	Temp °C	C×10-5	n
Defatted	20	6.8097	1.4074
soyflour	30	9.6651	1.3225
	40	12.6389	1.2706
	50	14.0303	1.2627
Full-fat uncooked	20	10.7818	1.2856
soyflour	30	14.0398	1.2270
	40	14.4824	1.2630
	50	15.6880	1.2612
Bengal gram flour	20	3.1313	1.6431
	30	4.6532	1.5425
	40	7.3640	1.4164
	50	6.7873	1.4814
Suji (Farina)	20	0.2797	2.4148
	30	0.2764	2.4281
	40	0.3868	2.3626
	50	0.5571	2.2843
Wheat flour	20	0.3437	2.3791
	30	0.4488	2.3387
	40	1.9051	1.9315
	50	4.8719	1.6104

Where, λ is the ratio of the latent heat of vaporization of the moisture adsorbed on the product to the latent heat of free water at that temperature. Both λ and the constant are functions of product moisture content.

Using the approach of Strohman *et al.*[13] it could be shown that eq. (1) leads to the relationship

$$\text{In (rh)} = (\lambda - 1)\ \text{In}\ (p_s/\delta) \quad \ldots\ (2)$$

where, δ is a material parameter and rh stands for relative humidity.

The equilibrium moisture content data of all the flours at various temperatures and relative humidities agreed with Othmer's equation. For each value of M, the value of λ could always be determined through eq. (1). Knowing the values of λ for different M corresponding to various values of rh and p_s the unknown parameter δ could be easily found through the expression

$$\delta = p_s(\text{rh})^{-\left(\frac{1}{\lambda - 1}\right)} \quad \ldots\ (3)$$

From eq. (2)

$$\lambda - 1 = \frac{\ln(\text{rh})}{\ln(p_s/\delta)} \quad \ldots\ (4)$$

The quantity $(\lambda - 1)$ being a function of moisture content alone, the following relationship is implicit in eq. (4)

$$M = F(X) \quad \ldots\ (5)$$

Where,

$$X = \frac{\ln(\text{rh})}{\ln(p_s/\delta)}$$

Eq. (5) implies that if M is plotted against the composite variable X, a single curve would result for all the combinations of R.H. and temperature.

On physical grounds, λ must always remain finite even as moisture content tends to zero. Therefore, in eq. (2), δ must become infinitely large as zero relative humidity is approached. This implies that δ must be a function of moisture content. In the present case, the value of δ was found almost equal to unity for all the materials. Thus, it is obvious that moisture dependence of δ is of significance only at very low moisture content. Generally speaking, a R.H. of 30% is low enough value for most practical applications. Therefore, for all purposes moisture dependence of δ could be neglected.

The equilibrium moisture content data have been plotted in terms of the ratio $\text{In}\ \frac{\ln(\text{rh})}{\ln(p_s)}$, where the relative humidity in decimal and p_s, the vapour pressure in atmosphere. The resulting curves are shown in Fig. 1 to 5. From these figures, it is evident

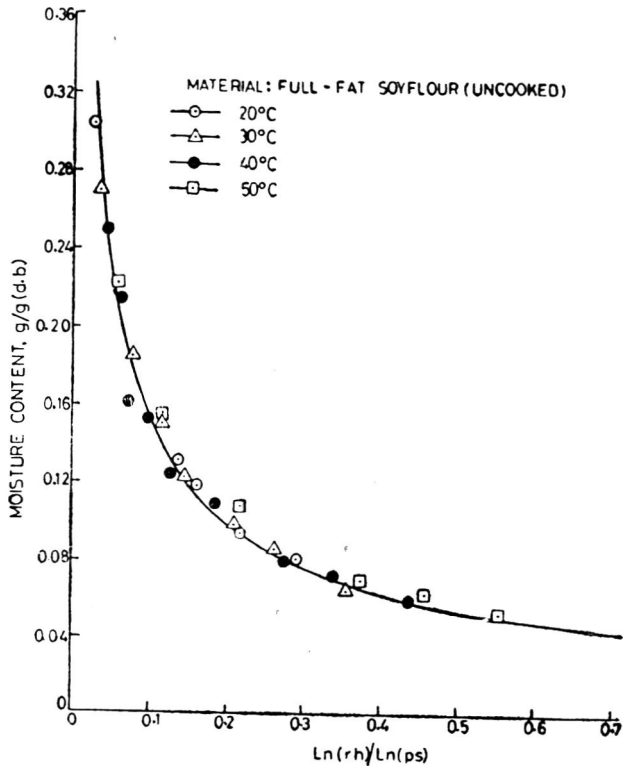

Fig. 1. Effect of temperature and relative humidity on equilibrium moisture content

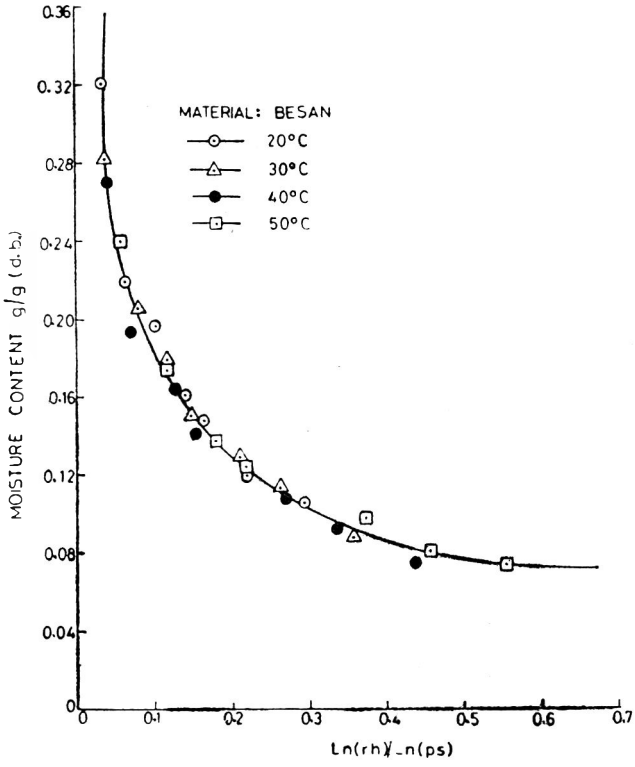

Fig. 2. Effect of temperature and relative humidity on equilibrium moisture content

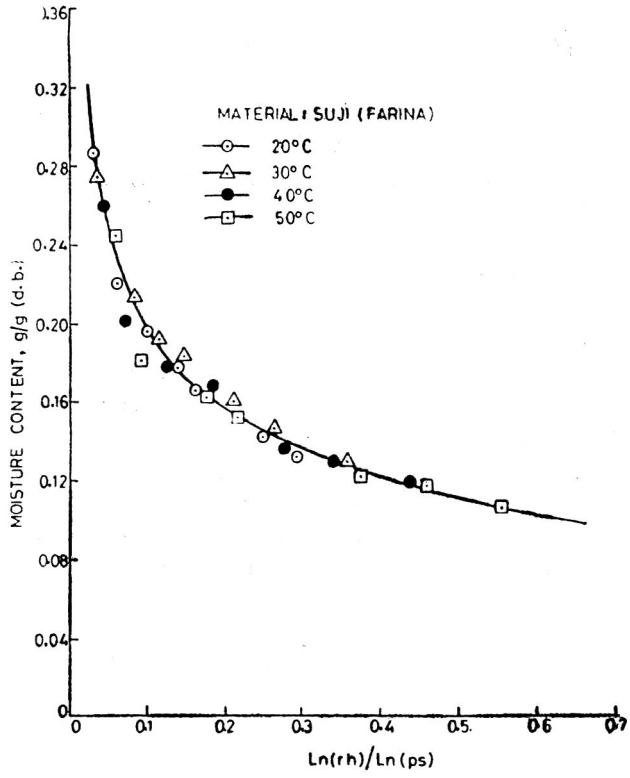

Fig. 4. Effect of temperature and relative humidity on equilibrium moisture content

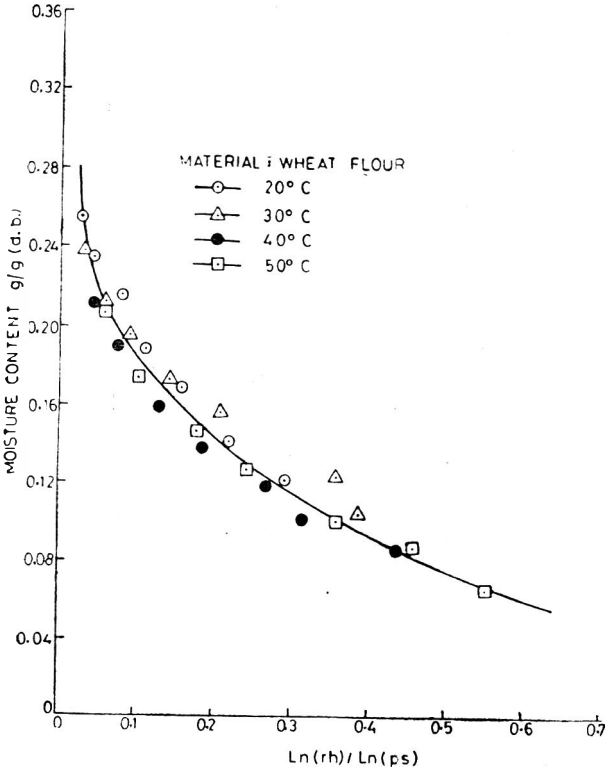

Fig. 3. Effect of temperature and relative humidity on equilibrium moisture content

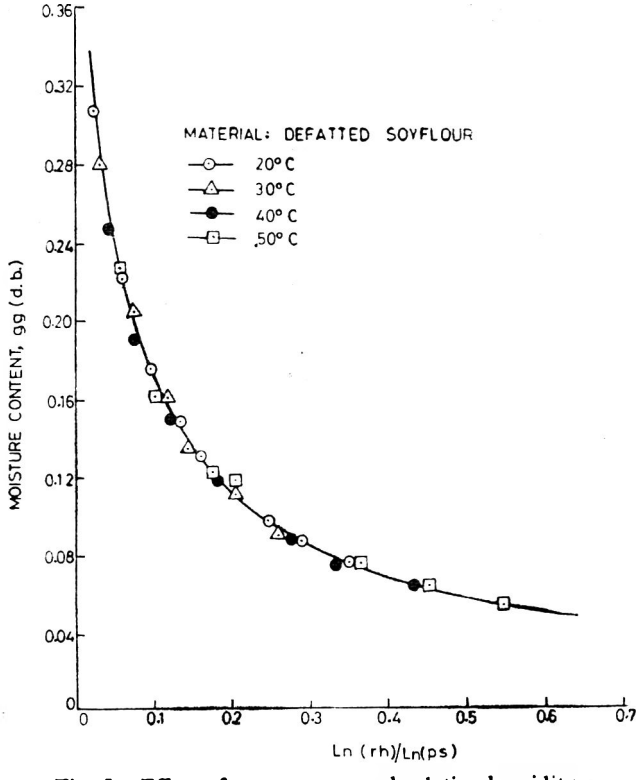

Fig. 5. Effect of temperature and relative humidity on equilibrium moisture content

that eq. (5) applies to all the products of the study. using M vs X curves, maximum prediction error was found to be less than the prediction error given by the Henderson's equation. Thus, eq. (5) is a better way to represent equilibrium moisture content data than usual isotherm plots. Further, it permits evaluation of M values at various R.H. and temperatures even from a limited set of equilibrium moisture content data. As evident from Fig. 1 to 5, the relationsnip of eq. (5) must be quite smooth and it should be possible to establish its mathematical representation. Constants involved in such a representation would be pure constants independent of both relative humidity and temperature.

Latent heat of vapourization: From eq. (4), it follows that M vs X plots, apart from being representation of equilibrium moisture content, temperature and R.H. relationship, can also be used for direct estimation of λ. Once λ is known the latent heat of vaporization of adsorbed moisture could be easily determined. Calculated values of λ are given in Table 5. As expected λ tends to one as flour moisture content increases. At a moisture content of about 20%, the latent heat of vaporization of the adsorbed moisture almost becomes the same as that of free water. The quantity $(\lambda - 1)$ represents the ratio of excess heat over and above the latent heat of free water at a moisture content and temperature to the latent heat of free water at that temperature. Therefore, it can be taken to indicate the strength of molecular interactions which bind adsorbed moisture. These interactions in all the five products of the study are almost the same. This also indicates that the nature of active sites on which water molecules are adsorbed, are essentially the same in all cases.

TABLE 5. VALUES OF λ FOR DIFFERENT FLOURS

Flours	Moisture content (%) (d.b.)	λ
Defatted soy	6	1.4818
	8	1.3219
	10	1.2401
	12	1.1850
	14	1.1420
	16	1.1150
	20	1.0769
Full-fat uncooked soy	6	1.4319
	8	1.2751
	10	1.1901
	12	1.1700
	14	1.1350
	16	1.0900
	20	1.0600
Bengal gram	8	1.4198
	10	1.3000
	12	1.2250
	14	1.2250
	16	1.1700
	20	1.0750
	22	1.0600
Farina (*Suji*)	12	1.4251
	14	1.2870
	16	1.1901
	18	1.1280
	20	1.0949
	22	1.0720
	24	1.0550
Wheat	10	1.3800
	12	1.2900
	14	1.2170
	16	1.1550
	18	1.1050
	20	1.0700

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RESEARCH NOTES

PREPARATION AND KEEPING QUALITY OF PICKLED QUAIL MEAT

Dressed quail carcasses were pickled in four different pickling solutions and stored in glass jars at room (26°C) and refrigeration (5 ± 1°C) temperatures for two months to study their keeping quality. Changes in some chemical, microbiological and sensory parameters during storage of the pickle were also studied. It was concluded that dressed quails could be pickled in solution containing 50% vinegar in water, either 8 or 10% common salt and 2% each of spice mixture, garlic and ginger. It can be stored for 2 months.

Pickling of food has been known for centuries as a means of preservation. However, information on pickling of meat is very limited[1,2]. Besides its preservative effect, pickling is also considered to be a means of imparting desirable characteristics such as flavour and taste to the food. Because of its smaller body size, quail can be pickled as whole carcass. The present note deals with the preparation of the pickled quail meat and the effect of different levels of pickling ingredients on the keeping quality and sensory attributes of the product during storage.

Japanese quails (*Coturnix coturnix japonica*) aged 4 months of either sex and weighing about 169g were slaughtered, dressed and the whole carcasses were cooked at 14.4 lb/in^2 pressure for 10 min. Based on preliminary experiments, four pickle solutions were made containing 50 and 75% synthetic vinegar and common salt at 8 and 10% levels. Peeled and minced garlic, ginger and spices mixture[3] each at the rate of 2% were added to each solution. The solutions were boiled for 10 min., cooled to room temperature, filtered through muslin cloth and poured in presterilised glass jars containing cooked quails, capped and stored at mean room (26°C) and refrigeration (5 ± 1°C) temperatures. The ratio of meat to pickle solution was 1 : 1.5(w/v).

pH changes in pickle solution and pickled meat were determined in a Beckman pH meter at 0, 2, 4, 6, 8, 10 and 12 hr. followed daily upto 7 days and after wards at 14, 21, 28, 45 and 60 days of storage both at room and refrigeration temperatures. In case of meat, 10 g samples blended with 100 ml water were used. Moisture, crude protein, ether extract, total ash and sodium chloride contents of the raw, cooked and pickled quail meats were estimated after 0, 1, 3, 5 and 7 weeks of storage according to A.O.A.C. methods.[4] Total plate count, coliform, anaerobic and fungal counts were determined[5] after 0, 8, 15, 30 and 60 days of room and refrigerated storage. The pickled quails were subjected to sensory evaluation by a 8-member taste panel for colour, flavour, tenderness, juiciness, saltiness, sourness and overall acceptability using 7-point hedonic scale after 7, 15, 30, 45 and 60 days of storage. Sample scoring 5 or more on hedonic scale was considered acceptable.

For the sake of brevity, only representative data are presented in Tables pertaining to different parameters pH changes in pickle solution, leg and breast muscles are presented in Table 1. Irrespective of levels of vinegar, and salt and storage conditions, the pH of all the pickle solutions increased rapidly during first 6 hr of storage, but the increase was rapid during first 2 hr than in subsequent 4 hr of storage with corresponding decline in pH of pickled meat; the decline being more rapid in leg than in breast muscle. The equilibrium pH was observed on the 4th day of pickling in all the

TABLE 1. PH VALUE OF PICKLE SOLUTION, LEG AND BREAST MUSCLE OF PICKLED QUAIL MEAT STORED AT ROOM TEMPERATURE (26°C)

Storage period	Pickle with vinegar 50%, salt 8%			Pickle with vinegar 75%, salt 8%		
	Pickle soln.	Leg	Breast	Pickle soln.	Leg	Breast
Initial	3.05	6.10	6.15	2.70	6.10	6.15
6 hr	4.25	4.40	4.55	4.00	4.15	4.35
12 hr	4.30	4.40	4.50	4.05	4.15	4.35
1 day	4.35	4.35	4.45	4.10	4.10	4.25
3 days	4.35	4.35	4.40	4.10	4.10	4.20
5 ,,	4.35	4.30	4.40	4.10	4.10	4.15
28 ,,	4.40	4.40	4.35	4.10	4.05	4.15
60 ,,	4.30	4.35	4.40	4.15	4.10	4.10

TABLE 2. MEAN MICROBIAL PROFILE OF PICKLED QUAIL MEAT STORED AT ROOM (26°C) AND REFRIGERATION TEMPERATURES (5 ± 1°C)

Quail meat	Storage period (days)	Total plate Count (org./g)		Anaerobic count (org./g)		Coliform count (org./g)		Fungal count (org./g)	
		26°C	5 ± 1°C	26°C	5 ± 1°C	26°C	5 ± 1°C	26°C	5 ± 1°C
Fresh	Initial	67.5×10^5	—	32×10^4	—	24×10^4	—	19×10^2	—
Pickled	Initial	8×10^1	3.8×10^1	Nil	Nil	Nil	Nil	Nil	Nil
-do-	8	16.8×10^1	5.5×10^1						
-do-	15	205×10^2	Nil						

Microbes were nil at 30 days and after in pickled samples.

treatments and the final pH value ranged from 4.10 to 4.35 depending upon the initial acid strength of the pickling solutions.

Raw quail meat had 72.93 per cent moisture which came down to 58.59 per cent on cooking. Pickling of cooked meat increased the moisture content by 0.36 to 0.85% on 7th day of storage and showed no appreciable changes during remaining storage period.

Crude protein content in pickled meat ranged from 25.3 to 26.3 per cent during storage. Crude protein in pickle solutions increased from 0.62 to 1.02 per cent during storage presumably due to diffusion of soluble components from meat to pickle solution. Per cent ether extract in different samples varied from 5.05 to 4.73 during storage.

Total ash and salt contents in different samples after 7th day of storage averaged 4.66 and 4.17 per cent repectively. Pickled quails stored at room temperature had slightly higher total ash and salt contents than similarly treated quails stored at refrigeration temperature due to the rapid diffusion of salt at higher temperature[6]. The values did not change much during subsequent storage.

The microbiological profile of pickled quails is presented in Table 2. There was drastic reduction in total viable count on pickling. Mean viable count in pickled quail meat remained fairly low irrespective of storage conditions and storage periods which might be due to low pH of the product and inhibitory effect of spices. Pickled quails were free of coliforms, anaerobes and mould throughout storage period.

Sensory analysis scores indicated that quails pickled in solution containing 50% vinegar with either 8 or 10 der cent salt were more acceptable (6.2) than those pickled in 75% vinegar solution (5.9). Refrigerated pickles scored a little more than those held at room temperature. As the age of the product advanced, the score gradually declined from 6.1 to 5.6 under both storage conditions.

It may be concluded from this study, that dressed quails could be pickled as whole carcasses in a pickling solution consisting 50% vinegar (v/v) in water, either with 8 or 10 percent common salt (w/v) and 2% (w/v) each of spices mixture, garlic and ginger. The product could be consumed from 4th day of pickling and could remain organoleptically acceptable upto a period of two months when stored either at room temperature (26°C) or refrigeration temperature (5 ± 1°C).

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USE OF RICE GERM IN THE COMMON FOOD PREPARATIONS

Rice germ, after converting into stable milk was incorporated into coffee and tea. Rice germ (whole or defatted) as also flour was used in sweet preparations like sweet *pongal*, sweet ball, sweet cake and *dosa*. The milk could be used in tea but in coffee rice flavour was perceptible. All the above sweet proparations made from germ were of acceptable quality. Rice germ could be added upto 20% of rice flour in *dosa* preparation.

The rice germ in rice grain is a rich source of oil, protein and vitamins[1]. The rice germ could be separated without powdering from the brown rice in a specially designed equipment[1]. Considering the high nutritive value of the rice germ, use of germ in food preparations was tested. Different types of commonly known food dishes were prepared using whole rice germ and also after powdering and defatting it; these preparations were also assessed for flavour and taste.

Germ was prepared from clean 'IR 20' brown rice using the PPRC degermer[1]. The germ was placed in an airtight bottle and stored at 10°C in the refrigerator to arrest enzymic and microbial changes. It was defatted in laboratory Soxhlet extractor, after macerating in a porcelain mortar to facilitate fat extraction. The defatted germ was powdered in a mechanical grinder after drying and desolventising in the hot air oven at 75–80°C for 1 hr. Milk was prepared by washing 50 g of rice germ in water and then blending it in the mixer with 200 ml of water for 15 min. Analysis of germ milk for specific gravity, pH, fat, protein etc., were carried out by standard methods[2]. The germ milk was tested for use in coffee and tea. Sweet *Pongal* was prepared by adding raw germ in boiling jaggery or sugar solution and stirring continuously to a thick consistency. For the preparation of sweet ball, raw germ was roasted with a little ghee over a pan and added to boiling sugar or jaggery syrup. The mixture was stirred continuously, taken out of the pan, cooled for sometime and made into small balls. Cardamom was added to the balls. For making cakes, powdered raw or defatted germ was added to sugar or jaggery syrup and after stirring it till it attained semi solid state, it was transferred into a plate and spread. In the *dosa* preparation, the defatted germ flour was added to the rice dough during grinding and then mixed with the blackgram dough as usual. The dough was kept overnight and *dosa* was prepared as usual.

Various food preparations made, their ingredients and the taste panel results are given in Table 1. Only raw germ yielded a thick and stable milk due to its rich fat content. From 50 g of rice germ, 250 ml of milk was obtained. The composition of the germ milk (Table 2) indicates that in its quality, it is equivalent to cow's milk. The quality can be further improved by increasing the germ content of milk. The milk will also be rich in thiamine content since germ is one of the richest sources of thiamine[3]. The milk, having a good colour and appearance, possessed the flavour of rice. But the rice flavour subsided when this milk was mixed with buffalo milk at either 50 : 50 or 75 : 25 proportion. Though coffee and tea could be prepared from this milk, it was tea which suited best and the taste and flavour were comparable to tea prepared from buffalo milk. In coffee, slight rice flavour was perceptible which affected the coffee flavour. Addition of tea extract or flavourings like almond, cardamom, etc. to the germ milk was readily acceptable. The other preparations like sweet *Pongal*, sweet ball and sweet cake were all judged to be of good and acceptable taste and flavour. These preparations are all commonly

TABLE 1. COMMON FOOD PREPARATIONS FROM RICE GERM AND THEIR EDIBILITY

Preparation	Ingredients	Judges' remarks
Germ milk	Raw germ and water	Acceptable taste.Light yellow colour and noticeable rice flavour
Coffee	Germ milk, coffee decoction and sugar	Acceptable taste and coffee flavour. Slight rice flavour
Tea	Germ milk, tea decoction and sugar	Acceptable taste and tea flavour. Absence of rice flavour
Sweet *pongal*	Raw germ, sugar or jaggery and water	Delicious taste and acceptable flavour
Sweet ball	Raw germ, jaggery and cardamom	Delicious taste and acceptable flavour
Sweet cake	Raw germ or deoiled germ, sugar or jaggery and cardamom	Delicious taste and acceptable flavour
Dosa	Deoiled germ flour, rice, blackgram and salt.	Normal taste and flavour.

TABLE 2. COMPOSITON OF RICE GERM MILK

Specific gravity	1.004
pH	6.0
Total solids (%)	9.67
Fat (%)	3.95
Protein (N × 6.38)	2.99
Titratable acidity (as % lactic acid)	0.00542

made in the households using groundnut, gingelly or coconut. Addition of germ also did not interfere with the preparation of these dishes. *Dosa* prepared with defatted germ flour up to 20% on the weight of rice was of acceptable quality. When used in excess of this, severe browning was noticed in *dosa* probabaly due to the higher amounts of free sugars present in the germ. The browning of the germ was noticed in all the food preparations listed in Table 1 except milk. The use of raw or defatted germ either as such or as flour did not make any significant difference in taste, flavour and appearance of these food preparations. However, unless the germ is stabilised, the oil content and enzyme activity in raw germ[1] is likely to affect the preparations. Hence, it is better to use defatted germ in the preparations. Sweet cake and *dosa* could be better prepared with germ in powdered form. It is envisaged that these preparations can be used in feeding of pre-school and school children, as these can be prepared at a low cost.

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BIOCHEMICAL CHANGES DUE TO WEEVIL (*CYLAS FORMICARIUS* FAB.) FEEDING ON SWEET POTATO

The biochemical changes in sweet potato tuber due to feeding by the adults and larvae of the weevil, *Cylas formicarius* Fab. (Curculionidae: Coleoptera) were investigated. Considerable increase in the total phenols was noticed in the adult fed (0.68%) and larval fed (0.70%) tubers when compared to the non fed tubers (0.43%) after 7 days of feeding while these were much higher for the 14-day fed sample, the values being 1.88%, 2.43% and 0.95% in the (adult + larve) fed, larva fed and non fed tubers respectively. Rapid increase in the total proteins could be observed in the tubers fed for 14 days. The implications of the various changes consequent to weevil feeding have been discussed.

Sweet potato weevil, *Cylas formicarius* Fab. is the most serious pest of sweet potato (*Ipomoea batatas* Lam.) which causes extensive damage both in the field and in storage. Studies on the biology of the weevil have shown that after laying eggs in small pockets[1], weevils plug the entrance of each pocket with faecal matter which gets oxidised to a brownish black substance[2]. The adult weevil and the larva feed on the fleshy tubers and on the infested tubers lose their normal texture and appearance. It has been reported that the feeding of sweet potato by the larvae of the two weevils *C. formicarius* and *E. postfasciatus* results in the induced synthesis of furanoterpenes[3]. *C. formicarius* infested tubers were found to posses a typical aroma and a bitter taste. With a view to understand the nature of the aroma producing component and also to understand the biochemical changes in the tuber consequent to weevil feeding, a study of this type was undertaken.

Tubers of a local variety ('Kanjangad local') of sweet potato which were free from any weevil infestation were selected for the study. Tubers were divided into three groups; adult weevils alone were allowed to feed on one group and larvae alone were allowed to feed on a second group. Third group served as the non-fed control to eliminate the error due to biochemical changes occurring during the normal storage of the tubers.

Tubers were fed for periods of 7, 14 and 21 days and samples for analyses were drawn during these intervals. Dry matter content was determined by the oven drying method. The phenols were estimated by the cold methanol extraction procedure of Swain and Hillis[4]. Total proteins were determined by Lowry's method[5] and total free sugars by the phenol-sulphuric acid method[6]. Starch content was estimated by the titrimetric ferricyanide method[7]. Total lipids were determined by evaporating in weighed dishes, the extracts obtained by digesting the tissue with alcohol: ether (3 : 1) at 60 °C for 2 hr followed by chloroform: methanol (2 : 1) for 1 hr.

Biochemical changes occurring due to weevil feeding on sweet potato are given in Table 1. After 7 days of feeding, the dry matter content of the adult weevil fed tuber is significantly higher as compared to the larva fed and non fed tubers. This is due to the increased loss of water through the cavities made in the tuber by the adult weevils. After 21 days of feeding, the dry matter content of the tubers increases rapidly resulting in the shrinking of the tubers. Significantly high phenol values could be obtained in the adult and larval fed tubers after 7 and 14 days of feeding. Sweet Potato slices have been reported to synthesise phenols like chlorogenic acid and caffeic acid on inoculation with the fungus, *Ceratocystis fimbriata*[8,9]. The typical aroma of the tuber develops during the second week of feeding. The starch content of the larval fed tuber is significantly reduced as compared to the non fed tubers

TABLE 1. BIOCHEMICAL CHANGES DUE TO WEEVIL FEEDING ON SWEET POTATO

Constituents	7-day fed sample by			14-day fed sample by			21-day fed sample by		
	Adult	Larva	Control	Adult larva	Larva	Control	Adult larva	Larva	Control
Dry matter (%)	31.8 ± 0.17**	25.8 ± 0.16*	26.8 ± 0.26	37.5 ± 0.18**	29.3 ± 0.54*	33.1 ± 0.98	51.6 ± 0.21**	42.6 ± 0.23**	39.4 ± 0.25
Total phenols (%)	0.68 ± 0.01**	0.70 ± 0.0**	0.43 ± 0.01	1.88 ± 0.01**	2.43 ± 0.06**	0.95 ± 0.02	0.49 ± 0.0 **	0.72 ± 0.01**	0.38 ± 0.01
Total proteins (%)	1.07 ± 0.01^{NS}	1.14 ± 0.02*	1.03 ± 0.01	6.43 ± 0.24**	4.9 ± 0.32**	1.41 ± 0.09	1.51 ± 0.01**	1.89 ± 0.01**	1.71 ± 0.02
Starch (%)	86.8 ± 1.2 **	56.1 ± 0.36**	60.06 ± 0.35	76.0 ± 0.91**	52.9 ± 0.66**	58.9 ± 0.67	46.4 ± 1.7 **	30.2 ± 0.31**	42.9 ± 0.27
Total sugars (%)	0.94 ± 0.02^{NS}	1.06 ± 0.04^{NS}	1.00 ± 0.03	4.4 ± 0.07^{NS}	4.4 ± 0.10^{NS}	4.44 ± 0.15	0.93 ± 0.06**	0.80 ± 0.05**	1.99 ± 0.09
Total lipids (%)	10.5 ± 0.66*	10.3 ± 0.44**	8.2 ± 0.40	12.8 ± 0.28**	15.3 ± 0.73**	8.9 ± 0.61	14.0 ± 0.05**	16.6 ± 0.18**	9.11 ± 0.11

**Significant at $p < 0.01$; *significant at $p < 0.05$; NS — not significant
Dry matter is expressed as fresh wt and all others are on dry wt basis. Values are mean of observations ± S.E.

after the first week of feeding. Hcwever, in the 7 days' and 14 days' adult weevil fed and (adult + larva) fed samples, starch degradation seems to be inhibited. The phenolic compounds formed in the tubers during these days may be inhibitory to the starch degrading enzymes of the tuber. However, as the larva consumes more starch than the adult weevil, this inhibition is not so conspicuous in the larval fed tissues. The decreasing trend observed in the phenols and proteins during the third week of feeding may be possibly due to the metabolic breakdown of these compounds. After 21 days of feeding, starch content also decreases significantly due to the combined effect of feeding as well as release of inhibition of the amylolytic enzymes. Since the rise in phenolic values coincides well with the development of aroma of the tuber, there is possibility that some phenolic compound which is either synthesised by the host tissue or which may be an excretory product/a pheromone like product of the weevil is responsible for the aroma of the tubers which are attacked by the sweet potato weevil.

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EFFECT OF N, P AND K ON THE PHYSICO-CHEMICAL CHARACTERISTICS OF SAPOTA (*ACHRAS SAPOTA* LINN.)

The N, P and K showed significant interaction for increasing fruit weight. Potash application showed favourable effect on peel and seed weight, and reducing and total sugars.

In commercial fruit production, judicious fertilization not only affects the vigour and cropping but also the quality of fruits. The research efforts on the sapota nutrition have been scanty and recommendation based on the experimental evidence is not available. There is hardly any reference on the effect of N, P and K on the composition of sapota fruits. Hence, a systematic study was made to assess the effect of these nutrients on the physico-chemical characteristics of sapota fruits.

Studies were made on 'Kali Patti' variety of sapota grown at the Horiculture Department, Marathwada Agricultural University, Parbhani. The investigations were made on the uniformly grown selected trees planted in July, 1972 at a spacing of 12m × 12m, on medium black vertisol. The soil contained 45 per cent clay and 0.04, 0.03 and 0.44 per cent N, P and K respectively.

The experiment was laid out in 3^3 partially confounded design comprising of 27 treatments, with 3 levels each of N, P and K. The treatments were replicated twice, each replication having 27 trees. During July 1978, the trees were treated with 3 levels each of N (0,200 and 400 g/tree), P_2O_5(0,100 and 200 g/tree) and K_2O (0,100 and 200 g/tree) for the first time. In the fruit trees fertilizers are applied taking their age into consideration. These N, P and K levels were increased proportionately with age and vigour i.e. doubled when applied in July 1979. The nutrients were applied in single dose. Nitrogen was applied through urea (45 per cent N), phosphorus through single super phosphate (16 per cent P_2O_5) and potash through muriate of potash (60 per cent). Harvesting was done each year during February-March. The physo-chemical studies of sapota fruits were made in March 1980. Sugars were estimated by the method of Lane and Eynon[2]. The mean data on the weight of pulp, peel and seed of fruit are presented in Table 1.

Table 1 shows that the average weight of fruit was significantly increased by increasing the levels of N, P and K. The N_2 produced significantly heavier fruits over N_0 treatment while N_1 was similar to N_2. The P_1 treatment produced significantly heavier fruit over P_0. There was no significant difference between P_0 and P_2. Significant linear response was evident with the increasing level of K. The interaction effect of NP was not significant, but those of PK and NK were significant.

The interaction of PK revealed that any selected level of P along with higher level of K gave significantly heavier fruit. Under P_0 levels, heavier fruit was obtained for every increment of the K level. Both higher levels of K in combination with P_1 produced significantly superior result over K_0. Under P_2 level, the highest level of K showed significantly superior performance over the remaining K levels.

On perusal of the data of NK interaction, it may be seen that both the higher levels of N showed significantly superior results in respect of increase in fruit weight. Both the higher levels of K alone and in the presence N_1 showed significantly superior response, while the highest level of N could only show significantly superior response for fruit and pulp weight only in presence of the highest level of K. The second order interaction of NPK was significant.

A significant NPK interaction observed in average weight of fruit indicated the need for inclusion of P and K along with the N in the nutrition of sapota trees.

Data on pulp, indicated that the weight of pulp of sapota fruit was not significantly influenced by various levels of N. P and K and their interactions. The weight of peel was significantly more under higher levels of K.

TABLE 1. EFFECT OF LEVELS OF N, P AND K ON THE AVERAGE WEIGHT OF FRUIT, PULP, PEEL AND SEED

Treatment	Fruit wt. (g)	Pulp wt. (g)	Peel wt. (g)	Seed wt. (g)
N_0	43.79	65.98	29.36	3.00
N_1	53.79	64.38	32.45	3.24
N_2	55.77	64.97	31.29	2.76
P_0	49.62	62.62	32.04	2.69
P_1	52.72	66.08	31.58	3.00
P_2	51.01	66.64	29.49	3.31
K_0	46.27	64.83	28.53	3.51
K_1	51.77	65.33	32.72	2.26
K_2	55.31	65.18	31.86	3.22
N*,P*,K*	N,P,K.	N,P,K*.		N,P,K*.
S.E.±0.824	S.E.±2.98	S.E.±0.942		S.E.±0.174
C.D. 2.416	N.S.	C.D. 2.763		C.D. 0.432
NP,PK*,NK*.	NP,PK,NK.	NP*,PK,NK*.		NP,PK,NK.
S.E.±1.428	S.E.±5.17	S.E.±1.632		S.E.±0.30
C.D. 4.189	N.S.	C.D. 4.789		N.S.
NPK*	NPK	NPK*		NPK
S.E.±2.473	S.E.±8.945	S.E.±2.828		S.E.±0.520
C.D. 7.255	N.S.	C.D. 8.295		N.S.

* = Significant at 5% level.
NS = Not significant

TABLE 2. FFFECT OF N, P AND K ON THE TOTAL SUGARS AND REDUCING SUGARS

Treatment	Total sugars (%)	Reducing sugars (%)
N_0	12.04	9.09
N_1	11.94	9.61
N_2	11.59	8.81
P_0	11.47	8.80
P_1	12.16	8.86
P_2	11.94	9.93
K_0	11.37	8.90
K_1	12.12	8.67
K_2	12.09	10.01
	N*,P*,K*.	N*,P*,K*
	S.E. $\pm$0.034	S.E. $\pm$0.081
	C.D. 0.100	C.D. 0.237
	NP*,PK,*NK*	NP*, PK*,NK*
	S.E. $\pm$0.059	S.E. $\pm$0.141
	C.D. 0.173	C.D. 0.134
	NPK*	NPK*
	S.E. $\pm$0.102	S.E. $\pm$0.244
	C.D. 0.300	C.D. 0.718

*Significant at 5% level

Highest peel weight was observed under N_1K_1 treatment. The per cent seed weight was not significantly influenced by various N and P levels. However, application of potash observed to have significant effect and K_1 level produced the fruit with significantly lowest seed weight. None of the interactions were significant.

The mean data on the total sugars and reducing sugars of sapota fruit are presented in Table 2.

It is evident from the data (Table 2) that N, P and K significantly influenced the total sugars in the fruit. There was significant reduction in the total sugars content with increasing N levels. P_1 gave the fruit with significantly highest total sugars. Highest total sugars were observed at K_1 level and this was significantly superior to K_2.

In the absence of nitrogen, P_1 produced highest total sugars and this treatment combination was followed by N_1P_2 and N_1P_1, respectively. In the case of PK interaction, P_1K_2 gave the higher total sugars. Significantly, lowest total sugars were observed in the absence of P and K.

The NK interaction revealed that N_1K_2 was the best in inducing significantly highest total sugars.

Table 2 indicates that the N_2 treatment decreased the reducing sugars significantly over N_2 and N_1 treatment. N_1 gave highest reducing sugars. The P_2 treatment produced significantly highest percentage of reducing sugars over P_0 and P_1. Further, K_2 also produced significantly highest reducing sugars over K_0 and K_1, which were similar among themselves.

Under the N_2 level, the reducing sugars significantly increased with increase in the P level. N_1P_2 produced the fruit of significantly highest reducing sugars, followed by N_0P_2 and N_2P_2.

The PK interaction revealed that the highest level of K with either P levels produced fruit having higher reducing sugars. N_2P_2 gave fruit with significantly, higher reducing sugars. Significant second order interaction (NPK) was present.

Although research work on sapota has been meagre, different workers studied the effect of N, P and K on the physico-chemical composition of mango. Singh[3] reported that N and P either alone or in combination were found to have significant effect on the weight and chemical constituents of Langra mango. Jagirdar and Sheikh[1] found that NK treatment increased the pulp percentage, in Alphanso mango which support the present findings. The present investigation indicated the need of N, P and K in the sapota nutrition (800 g N, 200 g P_2O_2, and 200 g K_2O/tree/year) for superior size fruit with higher pulp and total and reducing sugars.

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COTTON SEED OIL AND GROUNDNUT OIL MIXTURES AS COOKING MEDIA

Bhajji and _murukku_ fried in pure cotton seed oil were acceptable in colour, flavour and crispness and tasted better than those prepared in groundnut oil. _Vadai_ fried in a mixture of 75% groundnut oil and 25% cotton seed oil was the most acceptable. It is concluded that groundnut oil can be mixed with refined cotton seed oil for frying purposes to give satisfactory results.

For building a national food security system, Swaminathan[1] has emphasised the necessity of building up food reserves and their efficient utilisation. Cotton seed oil (C) is extensively used in Egypt, Sudan and other countries. But inspite of large production, its use as an edible oil is still limited in our country though upto 50% of the total requirement of oil is contributed by cotton seed oil for the manufacture of Vanaspati. In view of the present shortage of groundnut (G) and other edible oils, an attempt was made to find out how far mixtures of cotton seed oil and groundnut oil in different proportions could be satisfactorily used for cooking purposes.

Edible refined cotton seed oil (C) and non-refined groundnut oil (G) were mixed in the following proportions and used for preparing tried savoury snacks like *Bhajji*, *Vadai* and *Murukku*: (*i*) groundnut oil 100%, (*ii*) 75% groundnut oil + 25% cotton seed oil, (*iii*) 50% cotton seed oil + 50% groundnut oil, (*iv*) 75% cotton seed oil + 25% groundnut oil, and (*v*) 100% cotton seed oil.

For these trials, common flour mixture and ingredients were used. The time of frying was equal for all the items. Ten persons (6 males and 4 females) from among the staff evaluated these preparations. In the first experiment, the opinion on (1) not good, (2) normal, and (3) good under characters such as odour, flavour, crispness, taste, after taste and ranking of the items in decreasing order of preference were obtained. Based on the results of the first experiment, a second experiment was conducted with (*i*) 100% cotton seed oil, (*ii*) 75%G + 25%C, (*iii*) 50%C + 50%G, (*iv*) 100% G. *Murukku* and *Sevai* were prepared with similar type of flour and other ingredients used were also same. Observations were made on the following: 1. colour of the samples (*a*) slightly brown, (*b*) moderately brown, (*c*) brown, (*d*) deep brown; 2. adherence of oil to the samples, (*a*) too much, (*b*) moderate, (*c*) least, (*d*) dry; 3. flavour, (*a*) excellent, (*b*) good, (*c*) satisfactory, (*d*) fair, (*e*) poor; 4. first bite; 5. chewability, (*a*) very tender, (*b*) moderately tender, (*c*) neither tender nor tough, (*d*) slightly tough, (*e*) tough; 6. flavour, (*a*) agreeable, (*b*) disagreeable; 7. after taste, (*a*) oily, (*b*) neither oily nor dry, (*c*) dry; and 8. rank (ranking was done in decreasing order of acceptability).

Physico-chemical analysis of oils was carried out

TABLE 1. EVALUATION SCORE FOR DIFFERENT PREPARATIONS FRIED IN MIXTURE OF OILS

Character	Preparation	100% G	75% G+ 25% C	50% C+ 50% G	75% C+ 25% G	100% C	Mean±S.E.
Odour	*Bhajji*	18	22	19	19	23	20.2±1.0
	Vadai	17	23	20	18	22	20.0±1.1
	Muruku	18	22	18	18	23	19.8±1.1
Flavour	*Bhajji*	15	20	18	17	21	18.2±1.1
	Vadai	15	20	17	16	20	17.6±1.0
	Muruku	14	20	18	15	20	17.4±1.3
Crispness	*Bhajji*	16	24	20	16	23	19.8±1.7
	Vadai	14	22	20	17	24	19.4±1.8
	Muruku	15	23	20	17	23	19.6±1.6
Taste	*Bhajji*	19	23	18	18	24	20.4±1.3
	Vadai	20	23	18	18	23	20.4±1.1
	Muruku	18	24	18	17	23	20.0±1.5
After taste	*Bhajji*	15	22	20	15	22	19.8±1.6
	Vadai	14	23	21	15	23	19.2±2.0
	Muruku	15	22	21	15	22	19.0±1.6

G = Groundnut oil C = Cotton seed oil (refined)

TABLE 2. EVALUATION SCORE FOR *MURUKKU* AND *SEVAI* PREPARATIONS FRIED IN OIL MIXTURES

Character	Preparation	100% C	75% G+ 25% C	50% C+ 50% G	100% G	Mean±S.E.
Colour	M	33	23	41	17	28.5 ± 5.3
	S	43	26	35	25	32.3 ± 4.2
Adherence of the oil	M	34	26	31	31	30.5 ± 1.7
	S	38	34	38	33	35.8 ± 1.3
Flavour	M	40	34	35	32	35.3 ± 1.7
	S	41	33	34	34	35.5 ± 1.9
Crispness	M	35	42	29	40	36.5 ± 2.9
	S	39	44	33	41	39.3 ± 2.3
Chewability	M	40	34	38	35	36.8 ± 1.4
	S	39	32	34	31	34.0 ± 1.8
Taste	M	24	27	30	30	27.8 ± 1.4
	S	28	31	36	31	31.5 ± 1.7
After Taste	M	25	25	22	26	24.5 ± 0.9
	S	29	26	24	28	26.8 ± 1.1

M = *Murukku* S = *Sevai*

according to standard procedures. The ranking of five oils was done as per the procedure described by Kramer and Twigg[2].

It is clear that *Bhajji* fried in cotton seed oil alone gave comparatively better odour and taste than those fried in other oils (Table 1). *Vadai* fried in 75% G + 25% C was better than in other mixtures. Based upon these traits 75%G+25% C was better for frying *Bhajji*, followed by 100% C. Pure cotton seed seed oil was also considered superior for preparing *Vadai* and *Murukku* followed by 75% G + 25% C mixture.

In the second experiment, *Murukku* fried in pure cotton seed oil possessed good flavour, least adherence of oil to the sample and munching feel was moderately tender. It was ranked highest (Table 2). But *Murukku* fried in 50% mixture was highly acceptable with slightly brown colour. Other characters were nearly the same. *Sevai* fried in pure cotton seed oil was brown coloured, least adherence of the oil to the sample, excellent flavour, moderately tender munching, no after taste and was acceptable. It got the highest ranking. Similarly *Sevai* fried in 50% mixture also showed the same trait as that fried with pure cotton seed oil.

In the first experiment, 5 types of oils based upon their performance were ranked by ten panelists. According to Kramer's scheme of analysis, G, 100%, C 75% and C 50% are significantly superior than C 100% and C 25% (Table 3). Similarly, in the second experiment

TABLE 3. RANK TOTALS FOR OILS AND THEIR MIXTURES

	G 100%	G 25% + C 75%	G 50% + C 50%	C 100%	G 75% + C 25%
1st Exp	43	41	31	19	16
2nd Exp.	22	—	28	21	29

1st and 2nd Exp. refer to Table 1 and 2 respectively.

there was no significant difference in the preparations made from these oils.

The chemical analysis of the oils showed that free fatty acid content varied with the quantity of groundnut oil used in the mixture (Table 4). The saponification value increased with the addition of cotton seed oil. The specific gravity and refractive indices were practically the same. There were no changes in these values even after these oil mixtures were stored at room temperature for over a month. Yousuf Alikhan *et al*[3] have shown that groundnut oil under storage is stable hydrolytically and oxidatively for a very long period.

Achaya[4] reported that in India about 13 to 15 g of visible fat per head is available in the daily diet, consisting of 10 g of vegetable oil, half of which is groundnut oil, the rest being in the form of vanaspati and/or ghee or butter. Of these about, 0.5 to 0.7 g is derived from imported oils. The importance of groundnut oil can thus be realised.

TABLE 4. PHYSICO-CHEMICAL CHARACTERS OF OILS AND THEIR MIXTURES

Oils	Free fatty acid %	Sapon. value	Specific gravity	Refractive index
Groundnut(100%)	2.85	181.3	0.889	1.465
Groundnut(75%)+ Cotton seed(25%)	1.84	188.1	0.898	1.468
Cotton seed(50%)+ Groundnut(50%)	1.55	189.5	0.889	1.468
Cotton seed(75%)+ Groundnut(25%)	1.27	192.0	0.889	1.470
Cotton seed(100%)	0.35	191.0	0.894	1.473

The preparations fried in cotton seed oil possessed acceptable colour, good flavour, and are crisp and tasted better than those fried in groundnut oil. Due to non-adherence of the oil to the preparations, after-taste was quite satisfactory. Further, groundnut oil can be mixed with refined cotton seed oil in equal proportions for frying purposes, where there is preference for groundnut oil flavour. This has the same advantage as using pure cotton seed oil. In view of the shortage of edible oils, especially groundnut oil which is consumed in large quantities, it will be advantageous to use a mixture containing 50% groundnut oil and 50% cotton seed oil. Since large quantities of cotton seeds are available in the country, this approach may considerably ease the present situation on the demand for edible oils.

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STUDIES ON THE PREPARATION, QUALITY AND STORAGE OF INTERMEDIATE MOISTURE (IM) CARROT PRESERVE

Intermediate moisture (IM) carrot slices were prepared using a solution containing sugar, glycerol, water, acid and preservatives. The product had good colour, flavour and texture and could be consumed as such without any further rehydration or preparation. The slices treated with 500 ppm SO_2 and 0.45% potassium sorbate remained free from microbiological spoilage at 39.2% moisture level (water activity, 0.85). Glass container showed better retention of β-carotene. Samples of IM carrot slices packed in glass retained about 45% β-carotene both at room and high temperatures when stored for 2 months, but developed a slightly off flavour at 37°C. At low temperature, the product remained acceptable for 6 months in glass container with a β-carotene retention of 40.0 per cent.

Among vegetables, carrot is one of the richest source of carotene (precursor of Vitamin A). The popularity of carrots in the form of its preserve may be due to its nutritive role for supply of β-carotene. Intermediate moisture (IM) foods have been attracting widespread attention in recent times. These foods are dry enough to be shelf stable without additional needs for refrigeration or thermal processing. The technique of IM foods preparation by immersion equilibration procedure has been applied with success to guava[1], pineapple[2], mango[3], carrots[4] and banana[5] with satisfactory results. The earlier workers prepared IM carrot by soaking the blanched carrot in a solution containing salt, sucrose, glycerol, water and preservatives, followed by drying at 65-70°C in a cross flow cabinet drier to a final moisture content of 50% and storing the finished product at various temperatures in SR lacquered cans in nitrogen headspace, in laminated and high density polythene pouches. Coating of IM carrot slices with BHA combined with mild compression was reported to result in a better shelf life of the material at room and high temperature in respect of loss of carotene and development of off flavour. The present study relates to the preparation of low sugar concentration semi-dry (IM) carrot preserve of acceptable quality and changes occurring in it during storage in glass and plastic pouches

Fresh tender carrots of 'Desi' variety purchased from the local market were scrapped, blanched in boiling water for 5 min, cooled, and cut into slices of 8-10 mm thickness. The prepared slices were added to the soak solution[1] heated to 95°C, in the ratio of 1 : 2, held at 90°C for 3 min with constant stirring, cooled to room temperature and allowed to equilibrate at 2 ± 1°C for 2 days,

drained thoroughly over a stainless steel wire mesh. Citric acid (0 1%) was also added to the soak solution. The product was packed in glass (1 lb) and HDPE bottles (350 ml), 150 gauges polyprophylene pouches (20 × 17 cm) and 200 gauge polyethylene pouches (22 × 20 cm) and stored at 1-3°C, room temperature (25-35°C) and at 37-40°C for six months.

Total soluble solids (°Brix) were determined by a hand refractometer (the values were corrected to 20°C moisture), acidity, pH and protein by the A.O.A.C[6]. methods, sugars by Lane and Eynon's method[7], ascorbic acid by the method of Association of Vitamin Chemists[8], carotene was estimated as total carotenoid[9] pigments by measuring O. D. at 450 nm, total SO_2 by modified Ripper's titration method[10], potassium sorbate by the method of Nury and Bolin[11], water activity by the graphical interpolation method[12] and non-enzymatic browning by the method of Thorat *et al.*[13] Organoleptic evaluation was carried out by a panel of seven judges using 9-point Hedonic scale[14].

The contaminating moulds at various relative humidities during study of equilibrium relative humidity (ERH) were isolated and identified at the Division of Mycology and Plant Pathology, IARI, New Delhi.

As seen from Table 1 IM carrot contained 39.2% moisture and 54% T.S.S. The product retained 12.18 mg/100 g of β-carotene. Leaching losses from the product into the soak solution were negligible. No loss or gain in moisture was observed at 85% R.H. (Fig. 1). *Aspergillus niger* and *A. flavus* were seen in the product after 16 days at 100% R.H and 17 days at 97% R.H. Slight bleaching of red colour of carrot at 92% R.H. was observed on 13th day which may be ascribed to decreased lipid oxidation at high water activity.

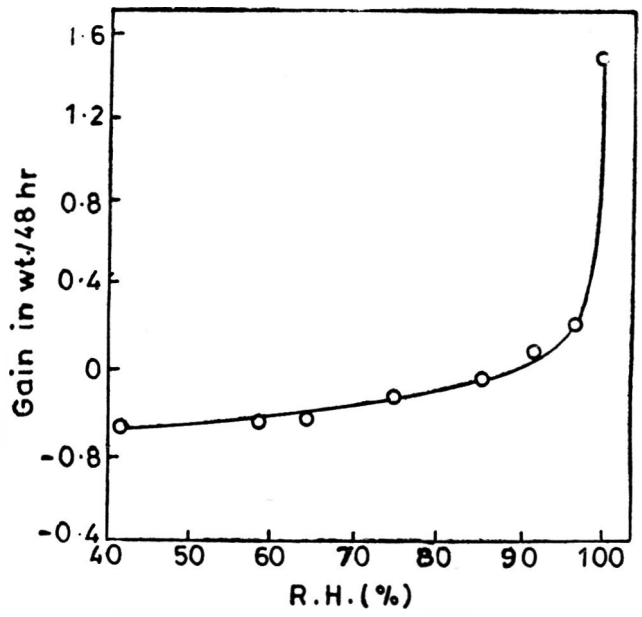

Fig. 1. ERH curve for IM Carrot at room temperature (30-35°) Gain in weight is in grams.

Table 1. Composition of intermediate moisture (IM) carrot preserve

Particulars	Fresh blanched carrot	IM carrot product	Soak sol. after equilibration (carrot: solution–1:2)
Moisture (%)	90.1	39.20	37.90
°Brix (20°C)	7.80	54.00	54.30
Total acidity (% anhydrous citric acid, W/W)	0.072	0.17	0.35
pH	5.98	4.70	5.00
Reducing sugars (%, W/W)	2.79	1.34	Nil
Total sugars (%, invert)	5.23	28.71	30.47
Crude protein (%)	0.49	1.09	—
Ascorbic acid (mg/100 g)	5.74	4.67	2.66
β-carotene (mg/100 g)	11.67	12.18	0.15
NEB (O.D. at 420 nm × dil factor)	—	0.0265	Nil
Total SO_2 (ppm)	—	231.28	274.40
Potassium sorbate (%)	—	0.162	0.243
Yield (%)			
Raw wt. basis	90.13	—	—
Finished wt. basis	—	82.00	—
ERH (%)	—	85.0	—

Data on the chemical changes in IM carrot preserve during storage, when packed in different containers, are given in Table 2. Moisture and sugar content in carrot increased and acidity decreased with simultaneous rise in pH in all the samples during storage at different temperatures. At 1-3°C, IM carrot preserve retained fair proportions of β-carotene content for 6 months in all the containers. There was a complete loss of β-carotene after 4 months at high temperature which caused bleaching of the product from red to yellowish colour. The maximum retention of β-carotene during storage was observed in glass bottles followed by polypropylene, polyethylene and HDPE containers respectively. The product retained 24.4 to 45.60%, 15.6 to 44.0% and 57.3 to 80.6% of β-carotene at 37°C, room temperature and low temperature respectively after 2 months of storage. The retention of β-carotene after this period was negligble both at room and high temperatures. The product retained 39.9 to 52.5% and 25.6 to 39.9% of β-carotene at 4 months and 6 months of storage respectively at low temperature. The greater loss in β-carotene, SO_2 and increased non-enzymatic browning in containers other than glass may be attributed to the permeability differences in the

TABLE 2. CHEMICAL CHANGES IN IM CARROT PRESERVE IN DIFFERENT PACKAGINGS DURING STORAGE

Storage temp. (°C)	Storage period (months)	Containers	β-carotene (mg/100 g)	Total SO_2 (ppm)	NEB (O.D. x dil. factor
25–35	0	—	12.18	231.28	0.0265
(Room temp.)	2	Glass bottles	5.56	180.70	0.0630
		HDPE bottles	4.76	175.00	0.0446
		Polyethylene	2.98	86.64	0.0176
		Polypropylene	3.90	165.88	0.0676
	4	Glass bottles	0.80	99.98	0.1010
		HDPE bottles	0.62	73.28	0.1124
		Polyethylene	0.29	70.21	0.2000
		Polypropylene	0.40	78.09	0.1200
	6	Glass bottles	0.19	79.35	0.3114
		HDPE bottles	0.09	66.98	0.3164
		Polyethylene	nil	69.79	0.4387
		Polypropylene	nil	68.49	0.3214
37–40	0	—	12.18	231.28	0.0265
(High temp.)	2	Glass bottles	5.48	153.07	0.1412
		HDPE bottles	4.83	86.86	0.1210
		Polyethylene	1.91	87.70	0.1160
		Polypropylene	3.90	76.10	0.1210
	4	Glass bottles	0.34	90.92	0.1797
		HDPE bottles	0.29	73.21	0.2080
		Polyethylene	0.10	73.39	0.1997
		Polypropylene	0.20	70.00	0.2084
	6	Glass bottles	nil	74.45	0.3804
		HDPE bottles	nil	65.14	0.7963
		Polyethylene	nil	69.26	0.6425
		Polypropylene	nil	66.79	1.0634
1–3	0	—	12.18	231.28	0.0265
(Low temp.)	2	Glass bottles	8.13	213.94	0.0266
		HDPE bottles	6.98	183.30	0.0298
		Polyethylene	8.84	124.88	0.0310
		Polypropylene	9.82	183.18	0.0268
	4	Glass bottles	6.40	140.73	0.0864
		HDPE bottles	4.87	118.62	0.1027
		Polyethylene	4.90	116.78	0.1913
		Polypropylene	5.21	120.10	0.1029
	6	Glass bottles	4.87	125.03	0.2544
		HDPE bottles	3.12	110.96	0.3028
		Polyethylene	3.43	109.18	0.3839
		Polypropylene	4.42	121.10	0.3050

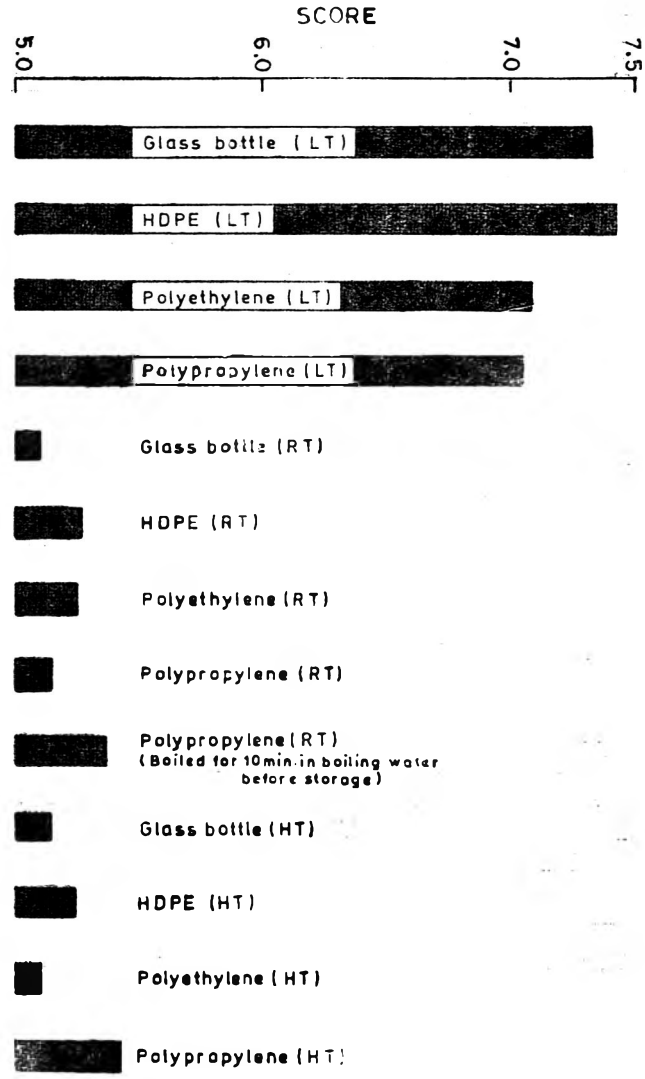

Fig. 2. Organoleptic scores of IM carrot after 6 months' storage.

oxygen and water vapour barriers in the materials used for packaging. The plastic containers were found to be as good as glass so far the taste and flavour of the product was concerned (Fig. 2). Microbiologically, the product remained sound upto six months, but there was discolouration of the product even after 2 months at room temperature and at high temperature. The product showed no discolouration after six months of storage at low temperature.

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ERRATUM

I. In the article "Characteristics of an intermediary strain obtained by crossing *Streptomyces fradiae* SCF_5 and *Streptomyces exfoliatus* MC_1" by H. K. Sreenath and Richard Joseph, this journal 1982, Vol. 19, No. 1, page 19:

The abstract should read:

The mixed cultivation of *S. fradiae* SCF_5 and *S. exfoliatus* MC_1 yielded a number of apparently intermediary strains. Among these, one isolate, FE-16 which was stable over a number of transfers was subjected to detailed studies. The strain resembled exclusively SCF_5 in 4 of the traits and MC_1 in others. It shared common traits of both the parents in 6 characteristics. It, however, did not resemble either of the parents in 10 characteristics. Of particular importance was the integration of glucose isomerase (EC 5.3.1.5) and xylan hydrolase (E.C. 3.2.1.8) of MC_1 in the intermediary strain FE-16.

BOOK REVIEWS

Post Harvest Technology of Cereals and Pulses: by Drs. A. Chakraverty and D. S. De, Indian Institute of Technology, Kharagpur, Oxford and IB Publishing Co., 1981, pp. 333, Price: Rs. 36.

Post Harvest Technology is a new terminology used frequently in recent times both by the agricultural engineer and the food technologist alike. Although each one gives his own emphasis, definition and scope to the subject, it is an emerging area of thrust in the context of a 'systems approach' to grain processing and utilisation.

The book 'Post Harvest Technology of Cereals and Pulses' has been written, as indicated by the authors, to serve as a text or source book to students of crop processing and agricultural engineering. From this point of view, it largely meets the syllabus requirements of the course. It covers the areas of drying, parboiling, milling and by product utilisation with special emphasis on rice, the main cereal crop of India. Wheat, maize and pulses are covered but in a less exhaustive manner. Many a book on cereal technology written by western authors places most emphasis on wheat, the nonwheat grains being given a secondary treatment. Obviously, the authors have viewed the field from the point of view of Asian requirements particularly with reference to the Indian situation and should be welcome to the Indian student in this field. The title of the book could have been suitably modified to emphasise this special coverage of rice.

Engineering principles involved in grain drying, milling practices and machinery and in construction of grain driers using paddy husk fired furnace are explained in simple terms to be useful and intelligible to the engineering student. This is particularly true with regard to working out the engineering parameters in designing and operation of furnaces and driers.

The book is well illustrated with diagrams and many worked examples to explain principles of construction and operation and to arrive at design specifications which are very valuable. Tables on physical properties of cereal grains are also useful to the design engineer.

Future editions of the book would do well to cover, in somewhat greater detail, the threshing and harvest operations in relation to milling quality, other factors affecting milling breakage of paddy and grain quality parameters to put the subject in true perspective to the student. A better coverage of wheat milling both for 'white flour' and 'Atta' production also appears desirable. A small chapter on utilisation of grains and grain products may also be thought of. The inevitable printer's devils that have inadvertently crept in have, of course, to be eliminated.

The present treatise deserves praise and encouragement as it is a first attempt to compile related information in a simple, direct manner and intelligible to the Indian student.

H. S. R. DESIKACHAR
C.F.T.R.I., MYSORE

Beverages: Carbonated & non-Carbonated by J. G. Woodroof and G. F. Phillips, AVI Technical Books Inc. USA, 1981, pp. 415, Price: $ 26.50.

Beverages can be broadly classified into two groups, viz., alcoholic and non-alcoholic. The second group comprises carbonated and non-carbonated beverages, commonly referred to as 'soft drinks.' This book deals with all the important aspects of the soft drinks and the soft drink industry. The book is divided into 16 chapters. The first two chapters trace the historical development and the growth of the soft drink industry including the fruit/vegetable based beverages in the United States. The authors deal at length with the development of the soft drink manufacturing companies like Coca Cola, Crush International, Dr. Pepper, Pepsico, Seven-up, etc., with a brief mention of beverages in Europe. The various problems in the fruit juice manufacture, like elimination of sediment, pasteurization, concentration, blending, freezing, canning, bottling, etc., have been briefly discussed with reference to individual fruit juices.

The main ingredients which go into a soft drink are water, sweeteners, flavours, acids, colors, emulsifiers, carbon dioxide clouding agents and preservatives. Chapters 3 to 6 give a fairly adequate account of the above ingredients. Chapter 3 deals with sweeteners- (1) nutritive-sugars like sucrose, fructose, high fructose corn syrup, liquid sugar, etc., and (2) non-nutritive-synthetic sweeteners like saccharin, chalcones, cyclamates, peptides and others. In the next chapter, the requirements of the beverage water and the necessary treatments are described. These data will be very useful to bottlers of soft drinks in deciding upon the right type of treatment depending on the source of water. The acceptability of a beverage mainly depends on its taste, aroma and eye-appeal. Chapter 5 is devoted to the discussion on the different constituents contributing to the above sensations. Useful information has been

compiled on different acids, gum., clouding agents food colours, essential oils and certain flavour formulations. Carbon dioxide and carbonation form the topic of the next chapter. The various aspects like sources of carbondioxide, properties, specifications, purification, carbonation techniques and gas volume testing have been discussed.

Packages for carbonated beverages include individual units, packs, cartons, cases and pallets of varying sizes, materials, shape, color, etc. The important packaging materials are glass, steel, plastic, aluminium, fibre board, polystyrene foam, waxed paper etc. Chapter 7 deals in some detail, with the developments in the packaging technology. Beverage production, equipment and plant layout form the topics of discussion in the next chapter. These include bottle washing machines, water treatment plants, syrup mixing tanks, refrigeration and carbonation equipments, case packers, etc., with a brief note on soft drink plant design.

Soft drink industry is becoming more and more competitive in recent years. This has resulted in greater emphasis on quality control procedures, both for the raw materials and for the finished beverage. The various parameters like sampling and testing procedures, equipments, specifications, etc , are detailed in chapter 9.

New product development is an important feature of any dynamic industry. The various stages of new product evolution, such as exploration, screening, business analysis, development, testing and commercialization are discussed in chapter 10. Chapter 11 deals with certain aspects of marketing and shelf life of beverages. Mention is made of powdered beverages and different types of vending practices and microbial spoilage. A brief discussion on different types of carbonated beverages, such as beer, champagne, mead, soft drinks, frozen soft drinks, modified and protein enriched soft drinks is given in chapter 12; whereas chapter 13 deals with non-carbonated beverages. These include fruit and vegetable beverages, fruitmilk drinks, instant solid mixes, coffee, tea, cocoa, chocolate and protein beverages.

In Chapter 14, the author deals with some of the recent developments in fruit juice beverages, viz. electrolyte drinks, fortified drinks, canned non-carbonated beverages etc. Chapter 15 deals with the very important problem of disposal of waste. The various aspects such as recycling of containers including reprocessing of glass, plastic, metal and paper, pollution control and waste water treatment have been adequately covered. The book ends with summary and the authors's view on the future outlook of the industry.

This book is a revised edition. The topics have been covered quite adequeately both from the scientific and technological angles. This book is a welcome addition to the literature on beverages, which is scarce at the moment.

K. O. ABRAHAM
C.F.T.R.I., MYSORE

Pearson's Chemical Analysis of Foods, Eighth Edition, by Harold Egan, Ronald S. Kirk and Ronald Sawyer, Churchill Livingstone, Edinburgh, London, Melbourne & New York, 1981 pp 591: Price $ 17.

The book deals in detail with the analysis of food which plays an important role in the assessment and maintenance of food quality, both in industry and enforcement authoritics at the national and international levels. The book has 17 chapters dealing with general chemical instrumental methods which have been dealt with very exhaustively for readers who are interested in different fields in food analysis. The other chapters deal with analytical details of food additives, contaminants, sugars and preserves, fruit and vegetable products, cereals and flour, starch products; baking powders, eggs, salad cream, beverages and chocolate, herbs and spices, fermentation products, flesh foods, dairy products, oils and fats and the last one on miscellaneous items of food including table jellies.

The eighth edition has got revised sections of the book bearing in mind the international requirements such as those of Codex Alimentarius Commission as well as taking into account the revised standards which have been published by British Standards Institution and International organisation for Standardisation. Methods recommended by the Analytical Methods Committee of the Analytical Division of the Royal Society of Chemistry have also been taken note of in this latest edition. The text has been amplified by references for more detailed as well as specialised interest.

In addition to the 17 Chapters, seven appendices have also been given indicating the various organisations dealing with analytical methods for food commodities, EEC directives and regulations, UK reports and regulations on food composition, labelling, food additives and contaminants as well as food additives permitted in U.K.

A broad cross section of methods of interest, both to students, and industrial and enforcement laboratories have been dealt with in exhaustive detail. The latest edition will act as a good guideline for students and food analytical chemists.

O. P. KAPUR
C.F.T.R.I., MYSORE

Meat and Meat Products: Factors Affecting Quality Control Ed. By Wilson, N. R. P., Applied Science Publishers, London and New Jersey, 1981, pp. 207, Price £ 16.

Quality control, either aesthetic or hygienic is a prerequisite in food industries to compete for viability of their products in the market. This problem is acute specially with highly nutritious and sensitive or perishable foods such as meat and meat products.

A standard product can be achieved starting only from a standard raw material. Even otherwise, food materials being prone to attack by microorganisms and deteriorative changes can not only lead to economic loss, but also to human health hazards. Steps need be taken, therefore, to control these forces right from the time the food materials begin to exist to the time they reach the consumer.

This book brings together, in a nut shell, in ten chapters extending through 199 pages, vast information on the subject of quality control–a topic widely distributed in literature and rarely found in one compilation.

Practical guidelines and solutions are outlined to various factors involved in the problem of quality control in meat and meat products at different stages of the production line such as, from animal health through transportation, live stock handling, hygiene in abattoir, meat handling, microbiological problems and standards, processing, curing to plant sanitation. The coverage given to each chapter under consideration is appreciably wide and is of practical worth to technologists and related workers. Relevant standards and legal aspects are also discussed wherever necessary.

The language is simple and concise with background where necessary to make the subject clear, interesting and useful to the experts and novice alike. The book contains an excellent bibliography after each chapter for supplementary reading.

This book can be a valuable asset to libraries catering to the needs of food scientists and technologists.

T. R. SHARMA
DEFENCE FOOD RESEARCH LABORATORY, MYSORE

Progress in Food and Nutrition Science–Quality of Pig Meat for Fresh Consumption: by M. Jul and P. Zeuthen: Vol. 4, Number 6, Pergamon Press, Great Britain, 1980, pp. 132, price: $ 5.

The book is an outcome of the study report regarding quality aspect of pig meat for the Commission of the European Communities. The information is divided into ten chapters and six appendices which elaborates the factors affecting quality of pig meat at production, handling, processing and marketing channels with recommendations for production of good quality and select grade of pig meat.

The first two chapters describe the concept of food quality and consumer's attitude towards quality of pig meat. Information regarding composition, grading and consumption of pork in the EEC countries have been compiled to give an insight into consumer's attitudes. The third chapter is on objective and subjective methods of examination for fat, pH, PSE, DFD, tenderness, trichinella, colour, firmness and odour to be carried out on a large scale production and are expected to give reasonable reliable results for assessment of quality of pig meat.

In chapters 4 and 5, the authors have reviewed series of recommendations by various researchers in respect of production, processing, handling and distribution of pig meat. Authors have advocated improvement in transport and lairage condition for control of PSE and DFD condition in pig carcasses. Stunning, sticking, dressing, chilling, freezing and packaging may affect pH, water holding capacity, colour juiciness and tenderness and ultimately the quality of the meat. The recommendations for good production practices are summerised in Annex. I of the book. In the next chapter, specifications for good production practices for improving quality of pig meat have been listed. It appears, however that there is some duplication of information already covered under preceeding chapters.

Next three chapters, describe the methods for producing pig meat of select quality and offer detailed suggestions for organisational set-up, producers and consumer's education regarding quality of certified pig meat.

In the last chapter, authors have summarised conclusions and recommendations with reference to quality of pig meat. One of the salient features of the book, is that a supplement section has been provided summarising some of the most recent results, which are likely to influence profoundly the future pig production, processing and the methods for assesment of pig meat quality. It also indicates the areas where further work needs to be done. Though the recommendations contained in the book are meant for the Europian communities, the information mentioned there-in will certainly be of help in implementing good practices in production, processing and marketing of pork in any swine industry. The text is properly provided with line diagrams and tables summarising important information. The book is useful for teachers, researchers, personnel of pork processing factories and also for those engaged in formulation of specification and standards on pork.

N. SHARMA
DIVISION OF LIVESTOCK PRODUCTS TECHNOLOGY, IVRI., IZATNAGAR

Ahara 82

The International Food Conference, Ahara 82 organised by AFST (I) was held between 23-26 May 1982. The Conference was inaugurated by Sri N. Sanjeeva Reddy, President of India. The Chief Minister of Karnataka, Sri R. Gundu Rao released the first issue of the journal "Indian Food Industry". Dr. M. S. Swaminathan, Director General, Rice Research Institute, Manila, delivered the keynote address. On the evening of 23rd May, the Food Expo exhibition and Silver Jubilee celebrations of AFST (I) were inaugurated by Sri Mallikarjun Kharge, Revenue Minister of Karnataka, deputising for the Chief Minister.

In the Food Expo, many food industries of India and a few foreign firms participated. The displays covered the latest developments in food science and technology and associated areas. Processed foods, processing machinery, ingredients and additives, packaging, technical books, kitchen appliances etc., were displayed.

The Conference proceedings were held during 24-26 at the Ashoka Hotel. Each day started with a plenary lecture. This was followed by symposia, poster presentations and slide presentations. There were special lectures in the evenings. On the last day three panel discussions were held. A valedictory function was held on the evening of 26th.

Lucknow Chapter

The Annual General Body Meeting was held on June 11, 1982 and the following Office bearers were elected: President—Dr. S. K. Kalra, Vice-Presidents—Drs. Surjit Singh, S. K. Khanna, Secretary—Dr. D. K. Tandon, Jt. Secretary—Mr. M. C. Tomar, and Treasurer Mr. M. D. Agarwal.

Bombay Chapter

The Annual General Body Meeting was held on May 6, 1982 and the following Office bearers were elected: President—Dr. A. S. Aiyar, Vice-Presidents—Drs. P. J. Dubash, S. R. Padwal-Desai, Secretary—Dr. R. R. Mallya, Jt. Secretary—Dr. B. L. Sathyanarayana and Treasurer—Dr. G. S. Sabnis.

Calcutta Chapter

The Annual General Body Meeting was held on April 19, 1982 and the following Office bearers were elected: President—Prof. M. M. Chakraborty, Vice-President—Mr. K. R. Narasimhan, Secretary—Mr. Hiranmay Gangopadhyay, Jt. Secretary—Mr. Amit Ghosh and Treasurer—Dr. Sankar Mukherjee.

Palayamkottai Chapter

A new Chapter of the AFST (I) was inaugurated on 17-2-1982 in Palayamkottai with Prof. T. Thirumalai as the President, Sri N. Jayaprakasam as Vice-President, Sri V. Theetharappan as Secretary and Prof. S. Narasimhan as Treasurer.

Statement about ownership and other particulars about the periodical entitled JOURNAL OF FOOD SCIENCE AND TECHNOLOGY as required to be published under Rule 8 of the Registration of Newspapers (Central) Rules 1956.

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I, Dr. L. V. Venkataraman, hereby declare that the particulars given above are true to the best of my knowledge and belief.

L. V. Venkataraman

Signature of the Publisher

YOUNG SCIENTIST AWARD FOR THE YEAR 1982

Association of Food Scientists and Technologists (India), announces with pleasure the institution of the YOUNG SCIENTIST AWARD for distinguished scientific research and technological contributions to the field of Food Science and Technology.

The award consists of a cash prize of Rs. 1,000/-, a plaque and a citation.

Nomination for the Award is open to aspirants fulfilling the following conditions:

1. The candidate should be an Indian National below the age of 35 years on the date of application, working in the area of food science and technology.

2. The candidate should furnish evidence of either,

   (*a*) Original scientific research of high quality, primarily by way of published research papers and (especially if the papers are under joint authorship) the candidates own contribution to the work.

   OR

   (*b*) Technological contributions of a high order, for example in product development, process design etc., substantiated with documentary evidence.

The application along with details of contributions and biodata (in triplicate) may be sent by Registered Post, (the envelope should be superscribed as 'Nomination for Young' Scientist Award') so as to reach Dr. L. V. VENKATARAMAN, Hony. Exec. Secretary, Association of Food Scientists and Technologists (India), CFTRI Campus, Mysore-570 013 before 31 January 1983.

SUMAN FOOD CONSULTANTS TRAVEL AWARD 1982

The Association of Food Scientists and Technologists (India) has instituted a Travel Award in the name of "Suman Food Consultants" to Post-graduate Degree/Diploma students in Food Science/Technology. The Award will be of Rs. 500/- which will enable the awardee to attend the Annual General Body Meeting and the Technical Seminar/Symposium of the AFST(I) in that year.

The selection of the Award will be based on an essay competition. The subject will be announced later.

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FOOD INDUSTRY DEVELOPMENTS
REVIEW ARTICLES ON FOOD INDUSTRIES
NEWS FROM FOOD INDUSTRIES
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BEST STUDENT AWARD

The Association of Food Scientists and Technologists (India) has instituted a BEST STUDENT AWARD to be given every year to two students with distinguished academic record and undergoing Final Year Course in Food Science and Technology. The aim of the award is to recognise the best talent in the field and to ensure wider recognition of food science and technology as professional discipline.

There are two awards each comprising a cash award of Rs. 500/- and a certificate.

The candidates to be considered for the awards should fulfill the following conditions:

1. They must be Indian nationals

2. They must be students of one of the following:

   (*a*) M.Sc. (Food Science)/(Food Technology)

   (*b*) B.Tech., B.Sc. Tech., B.Sc., Chem. Tech. in Food Technology.

   (c) B.Tech., in food sciences

3. They should not have completed 25 years of age on 31st December of the year preceding the announcement when their names are sponsored.

Heads of Post-graduate Departments in Food Science and Technology may sponsor the name of *one* student from each institution supported by the candidate's biodata, details starting from High School onwards, including date of birth and his post graduate performance to date.

Nominations for the year 1982 may be sent by Registered Post, (the envelope should be superscribed as 'Nomination for Best Student Award) so as to reach Dr. L. V. VENKATARAMAN, Hony. Exec., Secretary, AFST (I), Central Food Technological Research Institute Campus, Mysore-570 013 before 31 January 1983.

PROF. V. SUBRAHMANYAN INDUSTRIAL ACHIEVEMENT AWARD FOR THE YEAR 1982

The Association of Food Scientists and Technologists (I) has instituted this Award. Nominations for this award for the year 1982 are invited. The quidelines for the award are as folliws:

1. Indian Nationals engaged in the field of Food Science and Technology will be considered for the award.

2. The Nominee should have contributed to the field of Food Science and Technology, for the development of Agro-based food and allied industries or to basic food science and technology with immediate prospect and or future potential for industrial application.

3. The nomination should be proposed by a member of the Association. The bio-data of the, candidate together with his consent should be given in detail including the work done by him and for which he is to be considered for the award.

4. The Awardee will be selected (from the names thus sponsored) by an Expert panel constituted for the above purpose by the Executive Committee.

Nominations along with bio-data and contributions should be sent by Registered Post, so as to reach Dr. L. V. VENKATARAMAN, Honarary Executive Secretary, Association of Food Scientists and Technologists (India), Central Food Technological Research Institute Campus, Mysore-570 013 before 31st January 1983. The envelope should be superscribed as 'Nomination for Prof. V. Subrahmanyan Industrial Achievement Award'.

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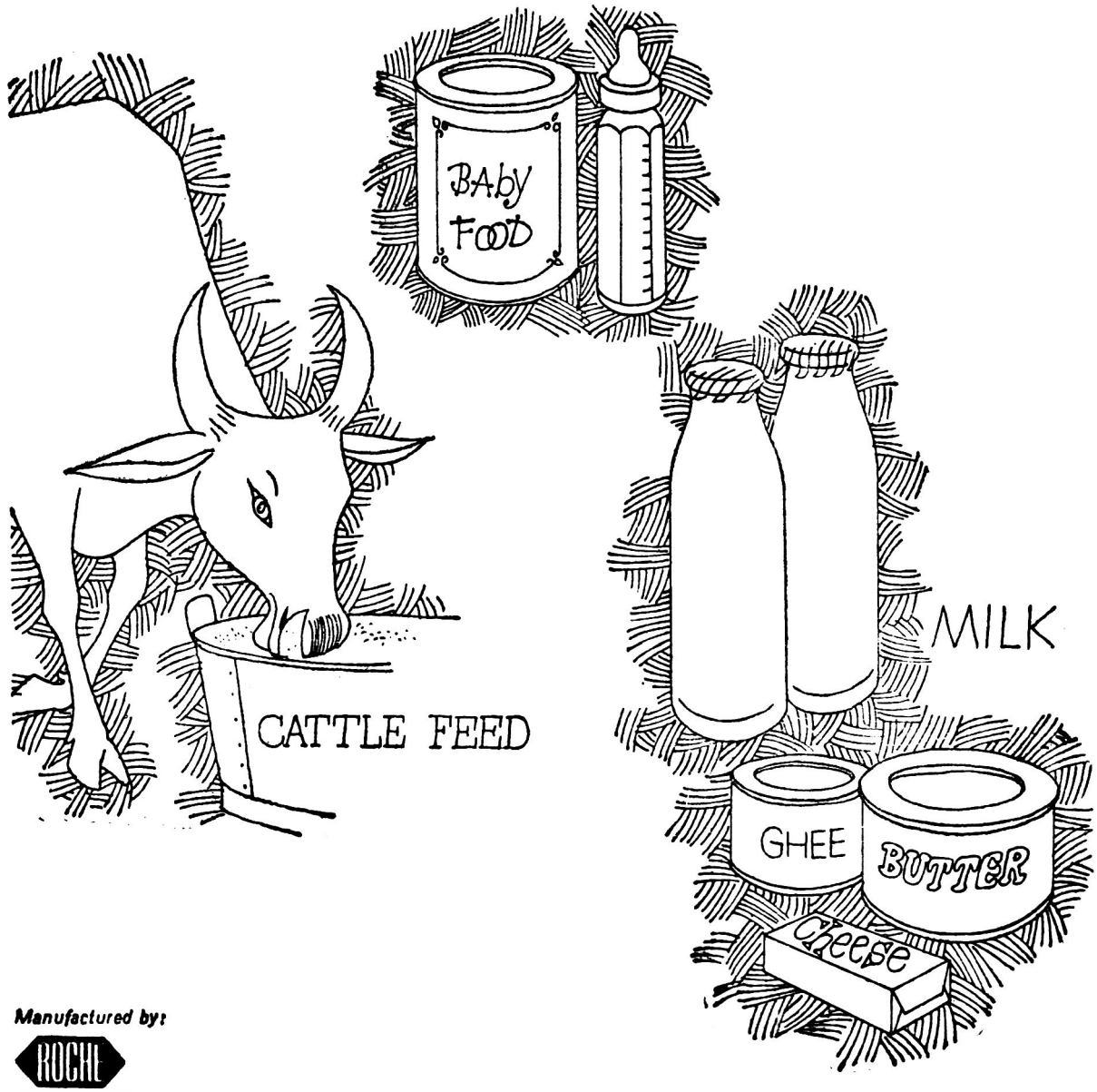

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INSTRUCTIONS TO AUTHORS

1. Manuscripts of papers (*in triplicate*) should be typewritten in double space on one side of bond paper. The manuscripts should be complete and in final form, since only minor corrections are allowed at the proof stage. The paper submitted should not have been published or data communicated for publication anywhere else. Review papers are also accepted.

2. Short communications in the nature of Research Notes should clearly indicate the scope of the investigation and the salient features of the results.

3. Names of chemical compounds and not their formulae should be used in the text. Superscripts and subscripts should be legibly and carefully placed. Foot notes especially for text should be avoided as far as possible.

4. **Abstract:** The abstract should indicate the principal findings of the paper. It should be about 200 words. It should be in such a form that abstracting periodicals can readily use it.

5. **Tables:** Tables as well as graphs, both representing the same set of data, should be avoided. Tables and figures should be numbered consecutively in Arabic numerals and should have brief titles. They should be typed on separate paper. Nil results should be indicated and distinguished clearly from absence of data, which is indicated by '—' sign. Tables should not have more than nine columns.

6. **Illustrations:** Graphs and other line drawings should be drawn in *Indian ink* on tracing paper or white drawing paper preferably art paper. The lettering should be in double the size of printed letters. For satisfactory reproduction, graphs and line drawings should be at least twice the printed size 16cms (ox axis) × 20cms (oy axis); photographs must be on glossy paper and must have good contrast; *three copies* should be sent.

7. Abbreviations of the titles of all scientific periodicals should strictly conform to those cited in the World List of Scientific Periodicals, Butterworths Scientific Publication, London, 1962.

8. **References:** Names of all the authors along with title of the paper should be cited completely in each reference. Abbreviations such as *et al.*, *ibid. idem*, should be avoided.

   The list of references should be included at the end of the article in serial order and the respective serial number should be indicated in the text as superscript.

   Citation of references in the list should be in the following manner:

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

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

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

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

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

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

9. Consult the latest copy of the *Journal* for guidance.

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JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

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Review Paper

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