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(INDIA)

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POSTPONEMENT OF BIOTECHNOLOGY CONVENTION OF AFST(I) MYSORE

The proposed IX Convention on 'Application of Biotechnology in the Develcpment of Food Processing Industries' scheduled to be held on 15-17th May 1991 has been postponed to 10-12th June 1991 due to general elections. In view of this, the last dates for receipts of Poster Abstracts and Registration of Delegates have been extended upto May 10, and May 15, 1991 respectively without any late fee.

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Dehydrated Coconut Chutney*

T.S. SATYANARAYANA RAO, N.M. KAVERAPPA AND T. HEMA PRAKASH REDDY
Defence Food Research Laboratory, Mysore-570 011, India

Received 4 October 1989; revised 2 April 1990

Dehydrated coconut chutney was developed by using simple hot air drying technique. Dehydrated chutney reconstitutes well in cold water and had all the characteristics of fresh chutney. The product had a shelf life of 3 months at 37°C and 6 months at ambient temperature when packed in flexible pouches.

Chutney and pickles used daily as side dishes in meals are prepared at home and also commercially. Chutney is good as long as it has colour appeal, texture, taste and an appetising quality. Several chutneys made from apple, chilli, bamboo, tomato are known[1].

Chutney is preserved in vinegar, acetic acid, common salt, sugar, mustard oil, with or without benzoic acid and packed in glass bottles for domestic and export markets. The cost of package and transportation works out higher than the cost of the product and hence it is not widely commercialized.

Coconut chutney is an important item served along with breakfast items like dosa, idli, chapathi, etc.. Under commercial condition, its preparation takes too much of time.

The major ingredients used at home in the preparation of coconut chutney are fresh grated coconut, salt, chillies, curry leaves, coriander leaves, etc., but it has short shelf life unless preserved under refrigeration.

As very little work was reported on dehydration of coconut chutney, this paper presents the method of preparation, dehydration, preservation and reconstitution of coconut chutney and their storage behaviour (physical and chemical changes) at different temperatures.

Materials and Methods

Fully matured fresh coconut, green chillies, salt, tamarind pulp (brown), fresh ginger, coriander leaves, curry leaves, hydrogenated oil (vanaspathi) and mustard seeds were procured from the local market.

Preparation of instant chutney: Coconut were first soaked in bleaching powder solution for 30 min, washed thoroughly, broken into two pieces and grated in an electrical grater leaving behind the brown thick shell of coconut. Stalk of green chillies, roots of coriander leaves and outer skin of ginger were first removed. Tamarind was soaked 15 min in water (1:2) and the extract was added to the mix. All these ingredients including salt were first ground in an electrical blender for 15 min by adding extra water and to get uniform slurry. The chutney was seasoned (garnished) with mustard seeds and curry leaves which were fried in oil hydro for 5 min. The ground chutney was then spread uniformly on aluminium trays of size 40×80×3 cm at the rate 1 kg/tray. Five to six such trays were loaded in a Kilburn cross flow drier and dried at a temperature 50-60°C at an air velocity of 600 linear ft/hr for 5 to 6 hr.

One hundred and fifty grams of dehydrated chutney was packed in paper aluminium foil (0.02 mm) polyethylene laminate pouches and stored at 37°C, at ambient temperature (19-26°C) at 4°C (control) to study the physico-chemical and organoleptic changes during storage.

Moisture, free fatty acids, peroxide value, total acidity, total ash, acid insoluble ash, total fat and crude fibre were determined as per AOAC methods[2]. pH was determined by reconstituting 10g of chutney in 100 ml of distilled water by using Elico digital pH meter having combined electrode. Non-enzymatic browning was determined as per the method of Ranganna[3]. TBA value was determined as per Kwon *et al.*[4] by distillation method. The overall acceptability of the product was determined on a 9-point Hedonic scale. Moisture sorption isotherm characteristic was determined at ambient temperature by exposing weighed quantities of the samples in the petri dishes to relative humidity ranging from 0 to 90 per cent using appropriate saturated salt solutions[5]. The samples were periodically weighed till they attained a constant weight or showed signs of fungal growth.

Reconstitution of dehydrated chutney: Cold water (50 ml) was added (2:1) to 25 g of dehydrated chutney and mixed well with a spoon to get the desired consistency of fresh coconut chutney.

Results and Discussion

Standardization of recipe: Several recipes containing different quantities of fresh coconut, chillies, tamarind

*Adjudged as best paper in VIII IFCOST, 1990.

TABLE 1. RECIPE USED FOR THE PREPARATION OF COCONUT CHUTNEY

Ingredients	(%)
Fresh grated coconut	72.5
Salt	3.5
Tamarind whole	6.0
Green chillies	6.5
Ginger	3.0
Coriander leaves	3.0
Oil hydro	4.0
Mustard seeds	0.9
Curry leaves	1.0

extract, coriander leaves, salt were investigated and standardised through a panel of judges. Table 1 gives the recipe which scored maximum in sensory quality testing.

Moisture-isotherm characteristic of dehydrated coconut chutney is presented in Fig 1. The dried chutney had a initial moisture content 2.0 per cent which equilibrates at 27 per cent relative humidity (RH) (a_w 0.27). It is seen that the product picks up moisture rapidly above 65 per cent RH which indicates that it is highly hygroscopic and requires immediate packing.

Table 2 indicates the physico-chemical and organoleptic changes of dehydrated instant coconut chutney during storage at different temperatures. The dehydrated chutney had an initial moisture content 1.99 per cent and the values did not change during storage at all the temperatures upto 6 months. The initial peroxide value (2.72 per cent) was increased to 7.8 and 5.6 at 37°C and at ambient temperature at 3 months and 6 months storage period respectively. The free fatty acids (FFA) content, expressed as lauric acid, was 0.24 per cent initially and increased to 0.33 per cent at 37°C in 3 months and at ambient temperature in 6 months respectively. The samples were rated very good (8) and good (7) with respect of colour, texture and flavour. The thiobarbituric acid (TBA) values were 68 μ g/kg sample at 37°C for 3 months and 73 μg/kg sample at ambient temperature for 6 months. An

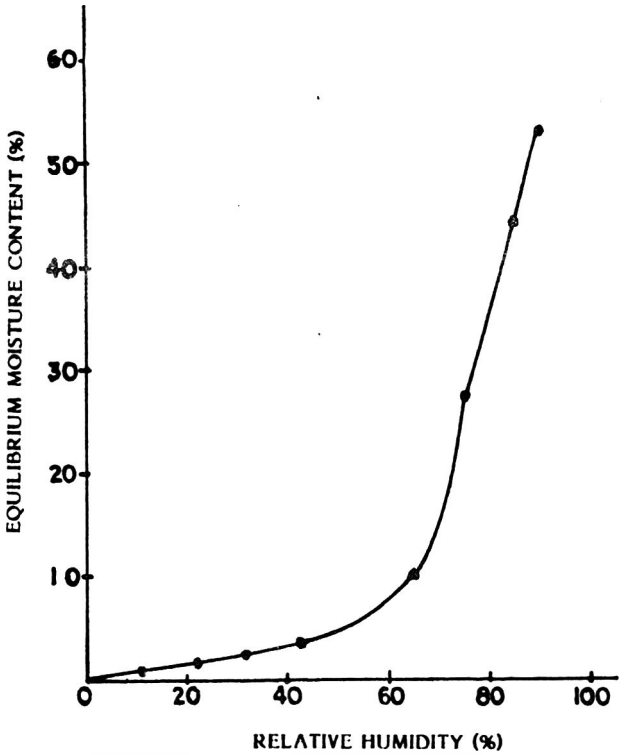

Fig.1 Sorption isotherm for instant dehydrated coconut chutney.

increase of 20-30 μg in TBA value seems to have no effect on sensory quality of the product. The total acidity and pH values did not show much difference during storage. There was no significant change in O.D. (0.16) due to non-enzymatic browning of the samples during storage at all the temperatures studied.

It is seen from Table 3 that the dehydrated coconut chutney is a good source of fat, fibre and it also gives calorific value of 635 Kcal/100g.

Acknowledgement

We thank Dr. (Mrs.) R. Sankaran, Director, Dr. K.S. Jayaraman, Project Coordinator, Fruits, Vegetables and Pulses

TABLE 2. PHYSICO-CHEMICAL AND ORGANOLEPTIC CHANGES IN DEHYDRATED INSTANT COCONUT CHUTNEY MIX DURING STORAGE AT DIFFERENT TEMPERATURES

Storage period (months)	Storage temp. (°C)	Moisture (%)	PV (milli eq of O_2/kg fat)	FFA (% lauric acid on fat basis)	TBA (μg. malon-aldehyde/ kg sample)	pH	Acidity (% tartaric acid)	NEB (OD at 420 nm)	Organo-leptic score
Initial	—	1.99	2.72	0.24	43	4.36	1.05	0.160	8
1	37	1.81	5.89	0.29	56	4.35	1.06	0.165	8
2	37	1.84	6.15	0.31	56	4.40	1.08	0.170	7
3	37	1.91	7.77	0.33	68	4.43	1.05	0.180	7
2	RT	1.97	4.56	0.28	53	4.40	1.10	0.165	8
4	RT	1.88	5.42	0.31	60	4.44	1.11	0.165	7
6	RT	2.98	5.55	0.33	73	4.45	1.08	0.170	7
2	0	1.83	2.94	0.24	44	4.35	1.08	0.160	8
4	0	1.94	2.92	0.24	43	4.47	1.07	0.160	8
6	0	2.01	3.22	0.23	53	4.41	1.02	0.160	8

Discipline of the laboratory for their valuable suggestions while carrying out the work and also to Dr. K. Santhanam for going through this manuscript.

TABLE 3. CHEMICAL COMPOSITION OF DEHYDRATED COCONUT CHUTNEY

Parameters	(%)
Moisture	1.99
Total lipids	58.22
Total protein (N × 6.25)	8.70
Total ash	3.70
Acid insoluble ash	0.79
Crude fibre	7.60
Carbohydrates (by diff)	19.00
Energy (Kcal)	635

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Effect of Presoaking on Cooking Time and Texture of Raw and Parboiled Rice

C.M. SOWBHAGYA AND S. ZAKIUDDIN ALI
Discipline of Cereal Science and Technology,
Central Food Technological Research Institute, Mysore, India

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Milled raw rice ('IR 20', 2 year old) needed about 15 min to cook in excess boiling water. Parboiled rice (normal-, pressure-, roasted-parboiled) required longer time (21 to 32 min) for cooking depending upon parboiling condition. Cooked parboiled rice was however shorter (2-10%) in length, but thicker (15-20%), more firm (about 5%) and considerably more elastic (15-20%) than cooked raw rice. Presoaking at room temperature for 15 min of raw and 2 to 3 hr of parboiled rice reduced the cooking time by 50% for raw and 25-40% for parboiled rices as compared to unsoaked controls. Presoaking of raw rice caused an increase in the length (about 20%) of cooked raw rice but a reduction in thickness (about 5%), firmness (about 10%) and elasticity (about 25%) as compared to unsoaked cooked control. Presoaking of parboiled rice did not significantly change these parameters.

Rice generally takes about 15 min in boiling water to cook to normal soft consistency, while parboiled rice takes longer (about 1.5 times or more). This has been attributed to its reduced hydration ability[1-5]. Parboiled rice produced by 'pressure parboiling' process[6,7] requires still longer time to cook to the same softness. Its hydration ability was shown to be further reduced[8]. Dry-heat parboiling (by roasting) has recently been developed as yet another new process[9] but cooking characteristics of rice produced by this method have not been studied.

During an earlier study[2], presoaking was shown to cause an increase in cooked grain length but textural changes and comparison of different types of parboiled rices in this regard have not been studied. The present study was, therefore, directed towards these objectives and results are reported in this paper.

Materials and Methods

Materials and processing: 'IR 20' variety of paddy stored at room temperature (25-30°C) for 2.5 years after harvest, obtained from a nearby Agricultural Research Station was used. As profound textural changes in cooked rice are known to exist between 'fresh' and 'aged' rice[10], paddy stored for long period where maximum changes due to ageing would have taken place, was therefore preferred.

Parboiling: About 2 kg paddy was used for the preparation of each sample of parboiled rice. Normal parboiled rice (NPB) was prepared according to the method described by Bhattacharya and Indudhara Swamy[11]. Pressure parboiled (PPB) rice and roasted-parboiled (dry-heat parboiled R-PB) rice were prepared as described by Ali and Bhattacharya[9].

Milling: Paddy was shelled in a Satake laboratory test husker and milled in a McGill Miller No.1 under standard conditions to a fairly high (about 7-8 per cent) degree of milling. Broken grains were removed and only sound whole grains were used for different studies.

Analyses: Grain length was determined as cumulative average by keeping 10 grains end-to-end and noting the total length (mm). Thickness for uncooked grains was measured using a dial caliper (marked in 1/100 mm division), and that of cooked grains as the height (mm) of laterally placed grains in the 'Viscoelastograph'[12]. Moisture content (w.b) was determined from loss in weight by drying about 10 g sample at 105°C for 20 hr. Cooking time of raw rice was determined as described by Desikachar and Subrahmanyan[2]. Cooked rice was transferred to a stainless steel wire-mesh strainer, jerked to remove the excess water, transferred to a double layer of filter paper and surface water removed by spreading and turning the grains for 1 min with a spatula. The moisture content of cooked rice was then determined. All samples were cooked till they attained the moisture level of 72-73 per cent that was shown by the cooked raw rice, to eliminate possibilities of variation of results due to moisture differences. Initially, the parboiled rices were cooked to a texture close to that of cooked raw rice as judged by the sensory method of testing the firmness by pressing cooked grains between thumb and forefinger, and its moisture determined. This lay in the range of 72-75 per cent (w.b.). The cooking time was then increased or decreased to yield cooked rice with moisture of 72-73 per cent and the time taken, as cooking time. All other parameters were studied using this rice. Pre-soaking at room temperature was also done in excess water. Soaked rice was strained and transferred to boiling water for cooking. For measurement of textural properties (firmness and elasticity) the cooked rice (excess and surface water removed) was transferred to a petri dish, covered and kept at room

temperature for at least one hour before measurement. The textural parameters, using Chopin-INRA Viscoelastograph, were carried out as described by Sowbhagya and Bhattacharya[12] with 350 g test load. At least 10 replicates of 3-grain set were run with fresh set of grains each time and average taken. The entire test was also repeated wherever it was necessary. The firmness (F) and elastic recovery (ER) were calculated as described[12].

Results and Discussion

Effect of parboiling: Table 1 shows the effect of parboiling on various properties of uncooked and cooked rices. There was a slight but apparent change in the grain dimension of the milled rice due to parboiling and its method. Whereas the pressure parboiled rice had dimensions similar to those of raw rice, normal parboiled rice showed a marginal decrease in length alone. Roasted parboiled rice showed an increase in length and breadth but its thickness decreased. This result confirms the earlier observations on roasted parboiled rice by Ali and Bhattacharya[9] that the grains appear to undergo a lateral shrinkage due to escape of moisture simultaneously, during gelatinization by roasting, resulting in decrease of thickness. Due to decreased moisture at the end of processing (about 20 per cent, w.b.) with drying, the lateral sides of the grain possess deep ridges. Fig 1 shows that lateral view of individual grains produced by different parboiling methods as compared to raw. Rounding of the tips as well as smooth and uniform surface could be seen in normal parboiled rice in contrast to the pronounced and deep ridges in the case of pressure parboiled as well as roasted-parboiled rices. It may be noted that in the case of pressure parboiling too, the moisture content at the end of processing is normally around 20-22 per cent (w.b.). Fig 1 also shows another interesting difference between raw and parboiled rices. Whereas the raw rice grain shows numerous small cracks on the surface, none of the parboiled rices bears any. The cracks in raw rice have developed due to the heat of illuminating source used during photography. Under the same conditions, parboiled rice (by any method) tolerates the heat stress without development of cracks.

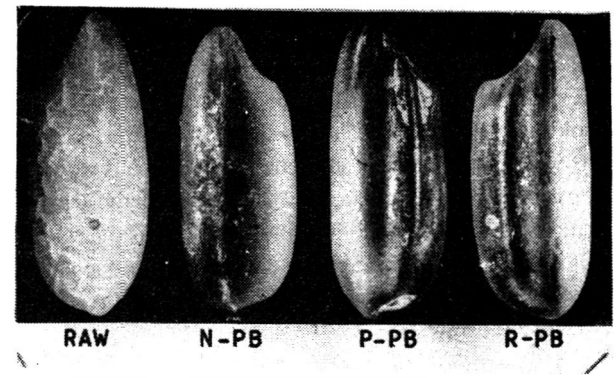

Fig.1. Appearance of milled raw and parboiled rice grains. N-PB, P-PB and R-PB stand for normal-, pressure- and roasted- parboiled rice, respectively.

The cooking time increased from raw (15 min=100 per cent) to roasted parboiled (135 per cent), to normal parboiled (160 per cent) to pressure parboiled rice (210 per cent) indicating the advantage of roasted parboiled rice in comparison to other types (Table 1). Increase in grain length due to cooking was highest (60 per cent) for raw rice as compared to parboiled rices (53-55 per cent). However, cooked parboiled rices

TABLE 1. EFFECT OF PARBOILING ON GRAIN DIMENSIONS AND COOKED RICE PROPERTIES

Rice property	Raw	Parboiled		
		Normal[a]	Pressure[b]	Roasted[c]
Uncooked				
Length, (mm)	5.7 ± 0.06[d]	5.3 ± 0.06	5.7 ± 0.02	5.9 ± 0.09
Breadth, (mm)	2.18 ± 0.02	2.00 ± 0.10	2.18 ± 0.03	2.35 ± 0.03
Thickness, (mm)	1.60 ± 0.02	1.62 ± 0.01	1.62 ± 0.01	1.48 ± 0.05
Cooked rice				
Cooking time (min)	15.0 ± 0.5	24.0 ± 0.5	32.0 ± 1.0	20.5 ± 0.5
Moisture (%) (w.b.)	72.9	72.1	72.2	72.1
Length, (mm)	9.2 ± 0.10	8.2 ± 0.06	8.7 ± 0.06	9.0 ± 0.07
Thickness, (mm)	1.88 ± 0.10	2.21 ± 0.07	2.16 ± 0.07	2.18 ± 0.05
Firmness, (%)	65.7	69.5	67.5	68.4
Elastic recovery, (%)	54.2	68.0	68.4	61.6

[a]Paddy soaked in warm water overnight, drained and steamed at atmospheric pressure for 20 min.

[b]Paddy soaked for 0.5 hr at room temp, drained and steamed at 2.5 kg/cm^2 for 20 min.

[c]Paddy soaked as in (a) above and roastec with sand at 250°C for 1.5 min.

[d]SD, n = 10.

showed more thickness than cooked raw rice. Suprisingly, the roasted parboiled rice, which in the uncooked condition had 20 per cent less thickness as compared to other parboiled rices, also reached thickness values similar to other types after cooking. As regards the texture of cooked rice, normal and pressure parboiled rices showed higher elasticity as compared to roasted parboiled rice. Raw rice showed the least. Their firmness was more or less similar.

It is apparent from the above that in many of the properties, roasted parboiled rice tends to be in between normal parboiled rice and the raw rice.

Effect of presoaking:

(i) *Hydration:* Milled raw and par-boiled rice absorbed water to various extents during pre-soaking. Thus, raw rice absorbed the least and reached an equilibrium in about 1 hr (about 29 per cent, w.b.) parboiled rice absorbed more water and at a higher rate, reaching values of 41.5, 55.0 and 56.4 per cent for normal, roasted, and pressure parboiled rice, respectively, in 3 hr (Fig. 2). The fact that parboiled rice absorbs water at a faster rate and to a higher extent at low temperatures, proportional to the severity of heat treatment, has already been reported[4,13]. The higher hydration power of roasted parboiled rice, though being only mildly parboiled, has been ascribed to reduced reassociation of starch due to simultaneous drying during roasting[4,5,9]. The data thus show that the soaked rice had different moisture contents at the time of transferring to boiling water for cooking.

(ii) *Cooking time:* Increased moisture content of soaked rice appears to cause quick heat transfer and thereby reduce the cooking time (Fig. 3). Presoaking raw rice even for 15 min reduced its cooking time to about half, which did not decrease further upon prolonged presoaking time - even up to 3 hr. It was observed that the cooked rice from 15 min

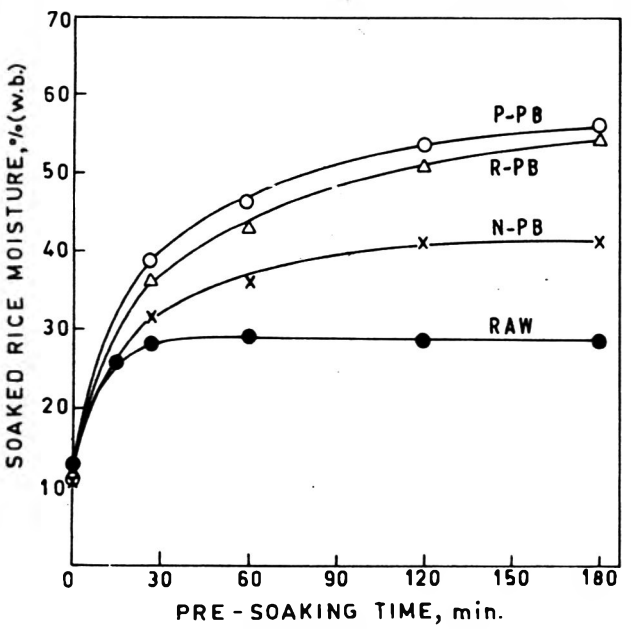

Fig.2. Hydration of raw and parboiled rice during soaking at room temperature. Legend as in Fig.1

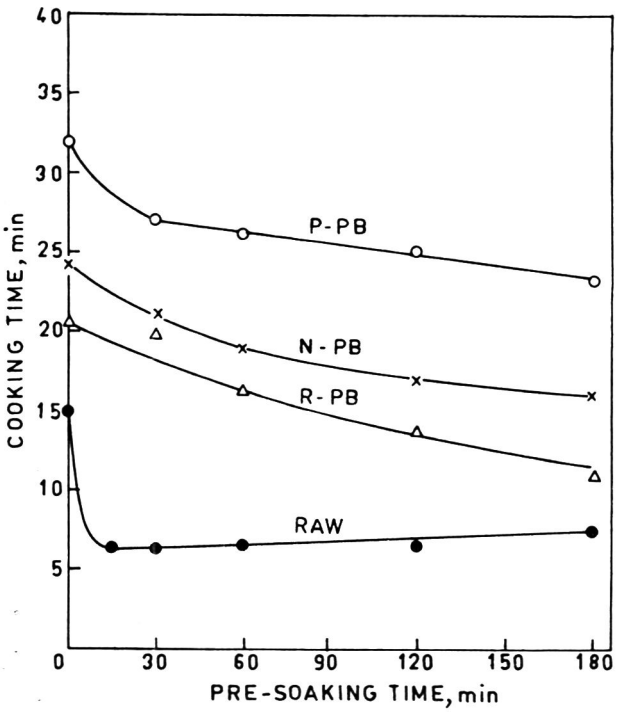

Fig.3. Effect of presoaking on cooking time of raw and parboiled rice. Legend as in Fig.1.

presoaking was more prone to disintegration during handling after cooking than the rice presoaked progressively for longer periods. The rates of decreases in the cooking time due to presoaking of parboiled rices on the other hand, were not as sharp (Fig. 3). They showed a slower rate and thereby required longer presoaking periods (about 3 hr) to effect a reduction of 7-8 min (observed for raw rice) in their cooking time. The individual relative differences in the cooking time among them were, however, maintained. Further, in contrast to raw rice, the cooked parboiled rices, after shorter presoaking periods, did not show any tendency of disintegration during handling. Thus, it is apparent from the figure that though there was a decrease in the cooking time due to presoaking of parboiled rices, the maximum was rather a fixed quantum of about 7-8 min and required much longer presoaking period. It is rather difficult to explain as to why this maximum decrease is rather more or less similar in all the samples, whether raw or parboiled, and irrespective of the severity of parboiling. Due to this fact, the reduction in cooking time was high for raw rice (about 50 per cent) and low for parboiled rices (25 to 40 per cent) as compared to the unsoaked controls.

(iii) *Grain dimensions:* Changes in grain length and thickness of cooked rices due to presoaking (Fig. 4) are in agreement with the trend already reported[2]. The changes were more pronounced in raw than in parboiled rices, thus enhancing the visual differences that existed among them when cooked without presoaking (Fig. 5). The elongated and thin appearance of presoaked and cooked raw rice stands out in comparison to all the parboiled rices. The increase in length

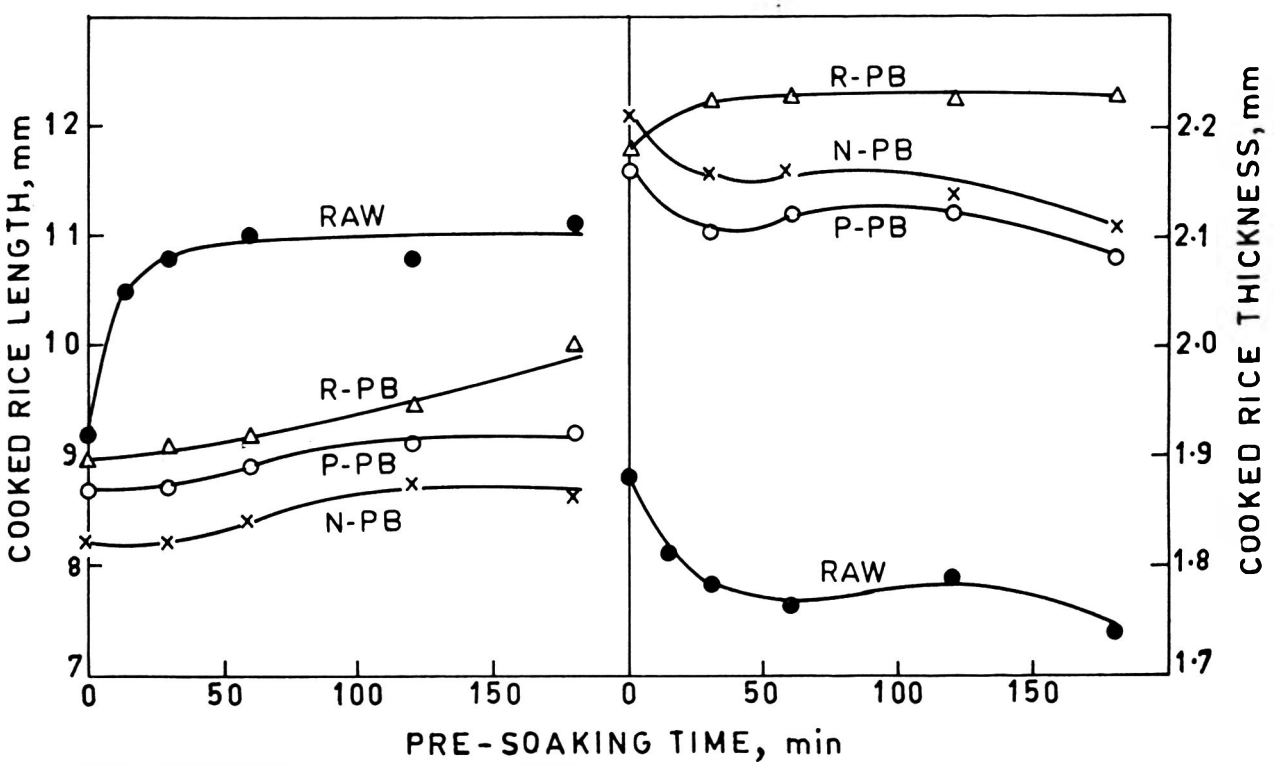

Fig.4. Effect of presoaking on grain length and thickness of cooked raw and parboiled rice. Legend as in Fig.1.

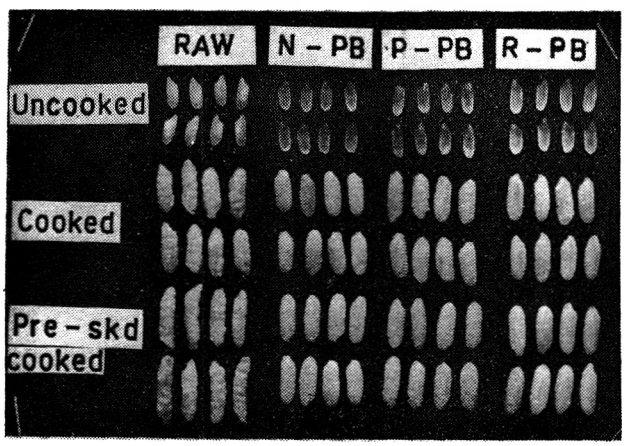

Fig.5. Appearance of uncooked, cooked and presoaked and cooked raw and parboiled rices (presoaking time - 1 hr for raw and 3 hr for parboiled rice).

upon presoaking has been attributed to the formation of transverse cracks upon wetting[2]. Raw rice develops these cracks at a very fast rate and to a higher magnitude than does parboiled rice. These cracks presumably permit rapid entry of water along them effecting elongation during cooking[2]. The cooked rice grain length with 3 hr presoaking treatment was thus, maximum for raw rice, about 120 per cent of rice cooked without presoaking and about 195 per cent as compared to the uncooked. It was least, about 105 and 160 per cent, for both normal and pressure parboiled rices as against uncooked and cooked control samples without presoaking respectively. The roasted parboiled rice fell in between, with corresponding values of about 110 and 175 per cent. There was more or less uniform decrease upon presoaking in grain thickness, and cooked raw as well as parboiled rices (except roasted parboiled) had 93-96 per cent thickness as compared to the respective unsoaked cooked controls. Roasted parboiled rice behaved differently in this respect and it showed slightly higher thickness (104 per cent) than its unsoaked control. This is also evident from Fig. 5.

(iv) *Texture:* Raw rice showed marked decrease in its textural properties upon presoaking and cooking as compared to the parboiled rices (Fig. 6). Thus, raw rice presoaked for 0.5 to 1 hr had the least firmness and showed poor elastic recovery. However, with longer presoaking times, the values increased slightly. Normal parboiled rice behaved similarly, but to a much reduced level. Pressure- and roasted-parboiled rices showed more or less stable textural properties, i.e., the firmness and elastic recovery remained more or less the same with or without presoaking.

It can be seen from above data, therefore, that the roasted parboiled rice when presoaked and cooked, would require cooking time similar to or less than that of raw rice. In view of this, the advantages of roasted parboiled rice in cooking are also established.

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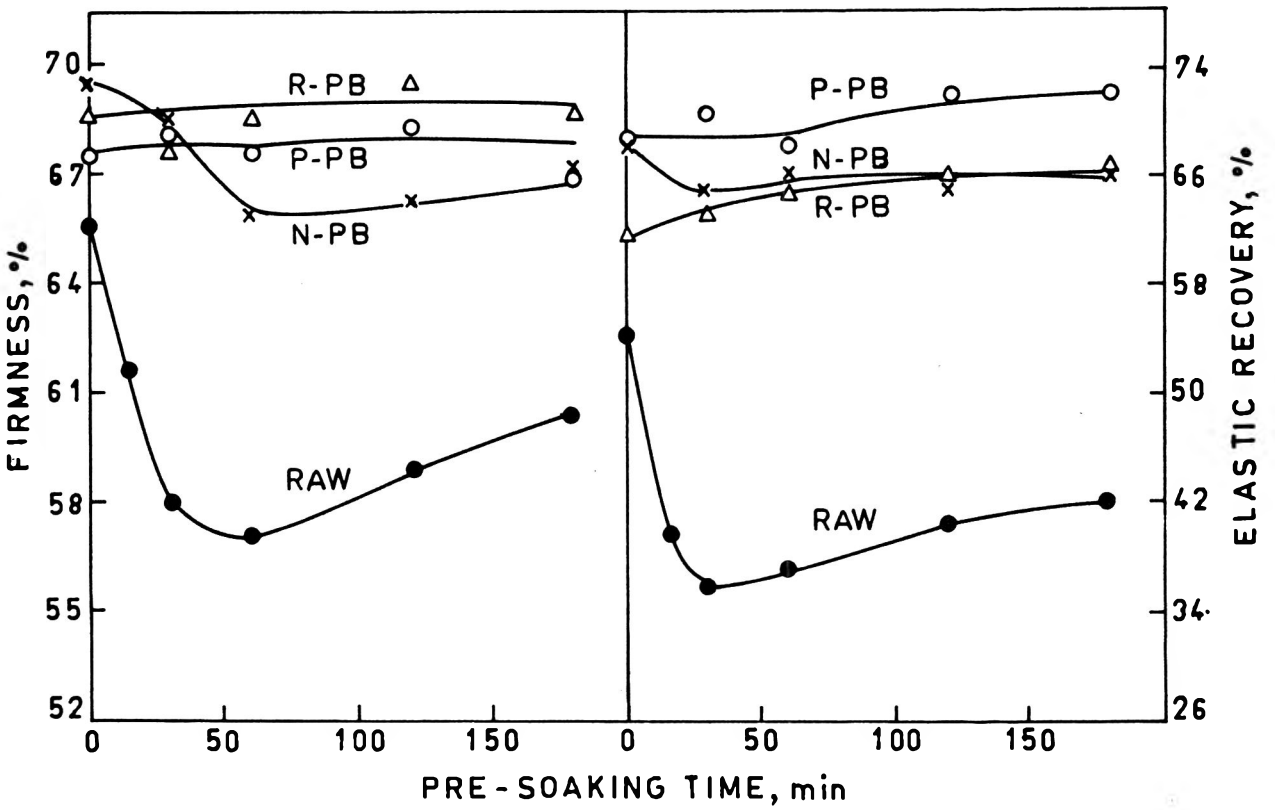

Fig.6. Effect of presoaking on firmness and elasticity of cooked raw and parboiled rice. Legend as in Fig.1.

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Studies on Beer Production from Nigerian Millet

REGINALD C. AGU
Department of Applied Microbiology and Brewing
Anambra State University of Technology, Awka Campus, Nigeria
AND
ZAK A. OBANU
Department of Food Science and Technology
University of Nigeria, Nsukka.

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All malt lager beer was brewed from Nigerian millet using the upward infusion method for wort production. The beer produced from millet compared favourably with the commercial beers brewed from barley malt except sparkling colour as confirmed by sensory evaluations.

The beer industry depends to a great extent on agricultural products in which barley malt with or without adjuncts predominates as the chief raw material. A considerable work has been done on the properties of barley and methods of analyses ranging from sampling to the spent grains[1-4] are available.

In Nigeria, efforts have been made to cultivate barley but the yield was poor due to climatic factors. The need to conserve foreign exchange in Nigeria has necessitated research into local substitute for barley. Aniche and Okafor[5] have produced beer from Nigerian sorghum. Skinner[6] also produced "tropical lager" from sorghum and reported that it was acceptable to tasters. The aim of this paper is to investigate the acceptability of the beer produced from Nigerian millet.

Materials and Methods

A local Nigerian variety of millet (*Pennisetum maiwa*) was malted for 5 days at 28°C which was optimum for the millet malt. The upward infusion mashing method was used. About 2.5 kg of millet malt was milled using Thomas-Wiley mill to produce grist of different particle sizes. Prior to mashing the grist was divided into two equal samples (1.2 kg each). These were mixed separately in 4.8 l of tap water (43°C) contained in aluminium pots. The temperature in one of the mashes as raised to 53°C and then to 63°C in 15 min. The mash was allowed to rest at this temperature for 10 min after which it was raised to 100°C in 10 min. Subsequently, the mash was transferred to the initial mash held at 43°C, with a resultant increase in temperature to 63°C. The combined mash was held at this temperature for 30 min and then it was raised to 73°C and held for 25 min. The mash was run-off at 78°C.

Six litres of wort (specific gravity 1039) was obtained and boiled with 16.25 g of hops for 2½ hr as per the method[7]. The wort produced was analysed for total soluble nitrogen, permanent soluble nitrogen, index of modification, specific gravity, pH, colour, fermentables[8] and attenuation[9].

Saccharomyces uvarum (supplied by Premier Breweries Limited, Onitsha) propagated in yeast extract dextrose broth[10] was used as inoculum. About 3 g fresh weight of yeast was used as inoculum per litre of wort and was pitched at a temperature of 11°C at pH 5.4.

The green beer was allowed to stay for three weeks at 5°C in a thermostated refrigerator for maturation after a 5-day primary fermentation. The beer was analysed[2] for pH, colour, specific gravity, alcohol, acidity, bitterness and sensory qualities. For sensory evaluation, 20 tasters evaluated the beer and compared it with three commercial beers in the market. The parameters used were colour, foam, bitterness and flavour, and the scores based on a scale of 5.

Results and Discussion

The data in Table 1 show values obtained for the millet wort and were compared with those from two local breweries using barley malt as extract. Although the values compared favourably, the extract (°P) and specific gravity obtained from millet wort were significantly lower than the other two worts. The liquor/grist ratio of 4:1 which was used during mashing was probably responsible for the dilution of the wort. Furthermore, the diastatic power, 33.5° 10B, which is low when compared with malts from American barley varieties which ranged from 94-163°L (≃°10B), could also account for low extracts leached into the wort.

From the work of Aniche and Okafor[5] high values for the specific gravity and extract were obtained when their liquor/grist ratio was lower than 4:1.

TABLE 1. PROPERTIES OF MILLET WORT COMPARED WITH THOSE OF TWO LOCAL BREWERIES

Wort type	Sp. gr. (26°C/20°C)	Extract (°P)	Wort pH	Iodine reaction	Wort colour (EBC)
Millet wort	1039	9.75	5.4	Yellowish	10.5**
Brewery wort I	1048	12.00	5.2—5.8*	-do-	8—14*
Brewery wort II	1047	11.6±0.2	5.2±0.1*	-do-	7.5*

*Acceptable range for the brewery operation
**Mean value of two readings

The changs in some properties of the wort during fermentation are shown in Table 2. The values were compared with those from a local brewery. Those of millet wort followed a pattern similar to those from barley wort fermentation. The specific gravity dropped from 1039 to 1012 after five days of fermentation while the pH was 4.4. The gradual drop in the extract is indicative of the utilization of the wort by the yeast.

Table 3 shows the properties of the beer brewed from millet. These values are in agreement with those obtained by Schneider[11] for barley malt except that for millet beer in which the alcohol (2.39 per cent by weight), was lower when compared with 3.10-3.90 per cent obtained by Schneider[11]. The lower alcohol was due to the low extract value and probably from the yeast metabolism of the wort.

The sensory evaluation (Table 4) shows that millet beer was acceptable by the panelists, although the flavour score was slightly low. The low score for the flavour was not due to deterioration from micro-organisms, but probably a property of the cereal.

Skinner[6], in his tropical lager beer brewed from sorghum observed that the beer might not have the colour and flavour characteristics required for a conventional barley lager beers, but could nevertheless be a satisfying beverage especially for some barley importing countries. For brewing such novel types of beers, more flexibility could be allowed with regard to colour and flavour. Nigerian sorghum beer has been brewed[5] and other alcoholic liquors have been brewed from cereals other than barley malt. These beers have their problems and one should not expect them to be accepted like the barley beer. It would seem more appropriate to use millet malt for brewing of tropical lager beers, which would have somewhat darker colour and a different flavour to the conventional type of barley lager beer. This tropical lager beer would be completely accepted when barley lager beer is no longer in existence in barley malt importing countries.

In conclusion, it is possible to produce a lager beer from millet although extensive work is needed to improve the flavour and colour of the beer.

TABLE 2. CHANGES IN SOME PARAMETERS OF MILLET WORT DURING FERMENTATION

Days of fermentation	Specific gravity		pH		Extract	
0	1039	1044*	5.4	5.4*	9.75	11.0*
1	1030	1036*	4.9	5.3*	7.50	9.10*
2	1023	1028*	4.7	5.1*	5.75	7.00*
3	1018	1021*	4.6	4.9*	4.50	5.40*
4	1015	1016*	4.5	4.5*	3.75	4.0*
5	1012	1014*	4.4	4.3*	2.25	3.50*

*Values from one of the local breweries
Each value is average of two readings.

TABLE 3. PROPERTIES OF MILLET BEER

Specific gravity (20°C/20°C)	1.009
pH	4.4
Total acidity (% as lactic acid)	0.18
Alcohol (% wt)	2.39*
Colour (EBC)	10.5
Iodine reaction	Yellowish
Extract (°P)	2.23

*Each value is the average of two readings.

TABLE 4. ANALYSIS OF TASTE SCORES

Variable tested	No of tasters	Rank total	Average rank
Commercial barley beer			
Colour	19	68	3.6 (97.1%)
Foam	20	70	3.5 (92.9%)
Bitterness	19	64	3.4 (96.9%)
Flavour	20	69	3.5 (98.6%)
Millet beer			
Colour	20	51	2.6 (63.7%)
Foam	20	64	3.2 (75.0 %)
Bitterness	20	46	2.3 (57.0%)
Flavour	20	39	2.0 (44.0 %)

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A Study on Instantisation of Redgram Dhal

B.W. BHUIBHAR, B.P. SAWANT, V.K. ANDHARE[1] AND A.B. KADU[2]
College of Agricultural Engineering MAU., Parbhani,
Maharastra, India

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Drying time of cooked dhal was found to be decreasing with increase in drying air temperatures. Rehydration percentage of dehydrated dhal, dried at 80°C was found to be higher than that dried at 60 and 70°C. Percentage reduction in cooking time for instant dhal was 80 to 84%, when recooked in boiling water. Instant dhal dried at 60°C was found to be most acceptable with respect to colour, texture, taste and odour.

Pulses are among the most demanded proteinous foods of the people all over the world. In India, among pulses, redgram (*Cajanus cajan*) is most commonly used in most of States. The dehusked legumes, commonly called as 'dal' or 'dhal', requires a longer cooking time than any other food material. Particularly, the redgram dhal requires about 40 to 50 min to cook[1]. People, especially in urban areas, cannot devote their time and full attention to the lengthy cooking procedures. Hence, use of ready foods and food material like bread, buns, instant food etc. is gaining increasing popularity among the masses. Results of studies on dehydration of cooked dhal and its rehydration are presented in this paper.

Materials and Methods

Drying was done in the present study, by a fluidised bed dryer, designed and fabricated to suit for laboratory scale operation.

Redgram was cooked till the whitish chalky portion at the centre of the grain disappeared and the duration of cooking was noted. One hundred fifty g of samples of cooked dhal were dried in fluidised bed dryer at temperatures of 60, 70 and 80°C[2,3]. Time required to dry the individual sample was taken as the time for which the blower was on. Samples were taken out at 5 min interval for moisture determination during drying which was done by oven drying method.

Dried samples were packed in polythene bags after cooling to room temperature. True density and bulk density of raw and dehydrated dhals were also determined. Rehydration of one month stored dried samples was done by soaking for 10 min in normal water at 35°C and hot water at 70°C and soaking for 5 min in boiling water. Also, the samples were fully cooked separately.

Fully cooked dehydrated dhal samples were evaluated by a taste panel of five members with respect to colour, texture, taste and odour. Statistical analysis of sensory evaluation was done using chi-square test.

Results and Discussion

From Table 1, it is observed that time of dehydration for precooked dhal decreases as the drying air temperature increases. Total time required to reduce initial moisture content of 170 per cent (d.b.) to 6 per cent (d.b.) at 60, 70 and 80°C drying temperatures was 50, 40 and 30 min respectively.

True density and bulk density of dehydrated dhal were reduced remarkably compared to raw dhal. True density of dehydrated dhal was found to be 1403.5 kg/m^3 as compared to 1428.6 kg/m^3 of raw dhal, whereas bulk densities of dehydrated and raw dhals were found to be 540 and 829.2 kg/m^3, respectively.

Rehydration percentages of dehydrated dhal were worked out and presented in Table 2. The rehydration percentage was

TABLE 1. MOISTURE CONTENT AT DIFFERENT DRYING TEMPERATURES

Time (min)	Moisture content at indicated temp (%) (d.b.)		
	60°C	70°C	80°C
0	170.00	170.00	170.00
5	77.60	68.07	63.50
10	44.06	32.01	25.60
15	21.20	16.99	13.09
20	14.50	11.30	8.20
25	10.77	9.10	7.14
30	9.17	7.92	6.02
35	8.37	6.50	5.05
40	7.60	5.07	4.31
45	6.85	3.67	3.61
50	6.11	3.30	3.00

Present address: 1. CADA, Nagpur, 2. PKV, Akola.

TABLE 2. REHYDRATION PERCENTAGE (d.b.) FOR DIFFERENT WATER CONDITIONS AND DRYING TEMPERATURES

Water treatment method	Temp °C	Time (min.)	Rehydration % (d.b.) at different drying temp		
			60°C	70°C	80°C
Soaking	35°C	10	171.0	179.0	195.0
Soaking	70°C	10	179.5	191.0	201.5
Cooking	boiling water	5	206	208.8	222.0

highest (222 d.b.) in dhal dried at 80°C and when rehydrated in boiling water and rehydration percentages were also more for the same dhal, when soaked in normal and hot water as compared to dhals dried at 60 and 70°C. This is due to fact that higher temperature of drying air, causes more sudden diffusion stresses, developing more cracks throughout the grain, which ultimately helps in absorbing and holding more water during rehydration. Among the three temperatures of water used for soaking for same dehydrated dhal, water uptake was highest in boiling water. From Table 3, it is observed that percentage reduction in cooking time for instant dhal with respect to raw dhal cooking time (35 min), was 80 to 84 per cent, when cooked in boiling water, as compared to 34 to 42 and 57 to 64 per cent reduction in normal and hot water soaking, respectively. The reconstitution time for instant dhal dried at 80°C, is less for all the three temperatures of soaking water.

The probability analysis using chi-square distribution (Table 4) shows that instant dhal dried at 60°C is more acceptable.

TABLE 3. PERCENTAGE REDUCTION IN COOKING TIME OF INSTANT DHAL FOR DIFFERENT WATER CONDITIONS

Drying temp (°C)	Reduction (%) in time at indicated treatments		
	Soaked in water at 35°C	Soaked in water at 70°C	Cooked in boiling water
60	34.2	57.1	80.0
70	40.0	60.0	81.5
80	41.5	64.3	83.5

TABLE 4. STATISTICAL ANALYSIS OF TEST SCORES ON RECONSTITUTED DHAL IN BOILING WATER

Drying temp. (°C)	Average score	X^2	D.F.	Probability
60	44.9	0.950	4	0.916
70	43.5	2.676	4	0.618
80	41.0	7.460	4	0.120

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Application of Osmosis-Osmo-Canning of Apple Rings

R.C. SHARMA, V.K. JOSHI, S.K. CHAUHAN, S.K. CHOPRA AND B.B. LAL
Department of Post-harvest Technology,
Dr Y.S. Parmar University of Horticulture & Forestry,
Nauni, Solan 173 230 (HP), India

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Different dip treatments before canning for various periods of time in hypertonic solution of sugar (70%) resulted in weight loss, sugar penetration and increase in shrinkage of the apple rings. Cut-out analysis for various parameters of the canned rings revealed that the pre-treatment in 70% sugar solution at 50°C for half an hour prior to canning was adjudged to be the best treatment from physico-chemical, sensory and economic points of view, among the treatments tried. The application of this technique resulted in the products of desired drained weight, colour and appearance, texture and sugar-acid-blend compared to those canned as per conventional canning technology. The pre-treatment technique being simple, cheap without involving extra equipment is commercially feasible.

Canning of the fruits like peach, pear, plum, pineapple and apricot is practised commercially and it has become an integral part of the fruit processing industry. Apple is produced extensively in northern States of India including Himachal Pradesh. Although, a few popular products from apple like single strength juice, concentrate, jam, jelly, chutney, preserve and dried products are prepared commercially, canning of apple is not practised commercially due to some inherited problems like presence of high volume of gases (29.5 per cent) in the fruit tissues, difficulty of their removal during exhausting, less drained weight, mushy texture etc. There are a few reports pertaining to canning of apple slices in which the firming agents like calcium chloride for the improvement of texture have been tried only on laboratory scale[1]. The problems encountered during canning of apple are many and, therefore, need a thorough investigation so that canning of apple could also become commercially popular like other canned fruits and vegetables.

Application of partial osmotic dehydration of fruits and vegetables has already been applied in the production of quality dried products[2,3], and alcoholic beverages[4]. However, there is no published information on its use in canning technology. It was, therefore, thought to use this technique to overcome the drawbacks, stated earlier in apple canning process. The results of the various treatments tried and their effect on the osmo-canned apple slices are reported in this paper.

Materials and Methods

'Golden Delicious' variety of apple was used in this experiment. The fruits were washed, peeled manually with S.S. knives and were cut into rings of 13 mm thickness with the help of pineapple slicer. The cores were removed with a punching machine. The rings were dipped in 100 p.p.m. solution of commercial ascorbic acid to prevent enzymatic browning. The prepared rings were submerged in the hypertonic 70 per cent sugar solution and were held at 50°C as per standard methods[2,3] for varying periods of times i.e. for 0 hr (control) (T_0), ½ hr ($T_{½}$), 1 hr (T_1), 2 hr (T_2) and 3 hr (T_3). The ratio of rings to the solution was kept at 1:3 and osmosis was carried out in static condition and 3.36 kg of prepared rings were used for each treatment. The rings after the dip were taken out from the osmotic bath, drained followed by washing in warm water to remove adhering sugar syrup. Rings of each treatment (420 g) were canned with syrup of 35°B, in A 2½ cans. Apple rings without any pretreatment were canned as control (T_0). Conventionally, practised process for canning was followed[5] except that 22 min of processing time was given.

The apple fruits were tested for pressure with Magnus Pressure Tester and T.S.S. by Refractometer. Observations on recovery (per cent) of the rings and wastage of trimmings and cores (per cent) were also recorded. During osmosis, loss in weight, sugar penetration and the shrinkage were recorded as per the prescribed methods[2]. Shrinkage was measured with Vernier callipers. Loss in weight was calculated as per cent loss $= \frac{M-M_1}{M} \times 100$, where M is the initial weight, M_1 is the weight after osmosis. Sugar penetration was measured as sugar penetration $= \frac{M_1 \times S_1 - M \times S}{M_1} \times 100$, where S_1 = T S.S. of fruit after osmosis, S = T.S.S. of the fruit before treatment, M and M_1 are the initial and final weights after osmosis, respectively.

Cut-out analysis: The cans were incubated for a week at a temperature of 37° ± 1°C., and opened for analysis of various physico-chemical characteristics like vacuum or pressure, volume, drained weight, T.S.S. acid, pH, of rings and syrup as per the standard methods[6].

Sensory analysis: Canned rings of all the treatments were evaluated for sensory characteristics viz., colour and appearance, texture, sugar-acid-blend, flavour and over-all acceptability (total score). Each attribute was given a separate score. The panel for sensory evaluation was comprised of 10 trained judges selected after initial screening. Coded samples were presented to the judges in the separate booth/rooms The scores awarded were statistically analysed according to the prescribed methods[7].

Results and Discussion

Initial characteristics of the apple fruits given in Table 1, show that the fruits used for this investigation were of optimum maturity. The per cent losses in terms of cores and peels were normal, but cutting and trimming losses were slightly more as the rings were made manually. Mechanically these losses could be minimised. It is evident from Table 2 that per cent weight loss, penetration of sugar and shrinkage of apple rings increased with the increase of dipping time, while gas volume decreased as the dipping time was increased.

Samples of osmo-canned as well as control apple rings, incubated at 37°C for 7 days did not show any sign of puffing/ swelling and showed 0.5 kg/cm^2 of vacuum, indicating the absence of any spoilage (Table 3).

Cut-out analysis of the canned apple rings after 2 months is shown in Table 3. As was expected, the per cent drained weight and T.S.S. of apple rings increased considerably from $T_{\frac{1}{2}}$ to T_1, compared to that of control (T_0). There was a continuous decrease in the volume of the syrup from T_0 to T_1. The increase in the drained weight and decrease in the volume of the syrup could be attributed to the reconstitution of the osmotically pretreated rings in canned sugar syrup during storage. A reference to the F.P.O. 1955, indicates that the canned fruit should not contain drained weight less than 50 per cent of the net weight of the fruit canned[8]. All the osmotically treated canned apple rings fulfilled the minimum specifications unlike that of control. Under similar conditions of canning, more losses of syrup and rings were observed in control samples, as during exhausting with the application of heat, expansion and escape of intercellular gases may have initiated cell separation and rupturing, which was not observed in the osmotically treated samples. It has been reported that the most obvious changes in histology of apple tissues during osmosis are elongation, shrinkage of the parenchyma cells and escape of intercellular gases[5]. The syrup of control sample in contrast to treated samples was comparatively more cloudy, which may be due to sloughing-off the cells during exhausting and processing. The acidities of all the treatments were comparable. The visual colour of all the treated rings was found to be better than the control.

The data of the sensory analysis scores of the canned apple slices are given in Table 4. There were no significant differences among the various treatments for colour and appearance, texture and aroma, which indicate that the preliminary treatment has not altered these parameters. But there were significant differences between all the treatments for taste and over-all quality (total score) of the products. The

TABLE 1. INITIAL CHARACTERISTICS OF APPLE FRUITS

	Mean ± S.D.
Pressure (kg)	6.5 ± 0.21
Size (dia. in mm)	64.0 ± 0.70
T.S.S. (°B)	12.5 ± 0.21
Gas content within the fruit (vol. %)	29.5 ± 1.41
Fruit utilized for rings making (%)	60.0 ± 3.53
Cores (%)	5.1 ± 0.14
Peels (%)	12.4 ± 0.36
Cutting & trimmings	21.9 ± 0.84

TABLE 2. EFFECT OF TIME AND TREATMENT ON SOME PHYSICAL PARAMETERS* OF APPLE RINGS

Treatment	Wt loss (%)	Sugar penetration (%)	Shrinkage of rings (%)	Decrease in gas content (% by vol)
$T_{\frac{1}{2}}$	14.5 ± 0.30	5.5 ± 0.28	12.1 ± 0.30	6.2 ± 0.24
T_1	23.1 ± 0.32	8.2 ± 0.44	20.6 ± 0.25	10.9 ± 0.24
T_2	35.6 ± 0.43	9.4 ± 0.25	30.2 ± 0.21	18.3 ± 0.12
T_3	40.2 ± 0.12	10.3 ± 0.30	31.6 ± 0.25	23.4 ± 0.32

*The results are means of four replicates ± S.D.

TABLE 3. CUT-OUT ANALYSIS OF CANNED APPLE RINGS OF DIFFERENT TREATMENTS*

Treatment	Vacuum (kg/cm^2)	Drained wt. (%)	Volume (ml)	T.S.S. of Cut-out rings	° Brix syrup	Acidity (% M.A.)	Syrup clarity	Appearance of rings
T_0	0.5 ± 0.01	46.04 ± 0.70	390 ± 9.35	22.5 ± 0.93	34.0 ± 0.93	0.11 ± 0.03	+	Yellow
$T_{\frac{1}{2}}$	0.5 ± 0.00	62.78 ± 0.76	300 ± 9.35	23.5 ± 0.35	23.2 ± 0.57	0.12 ± 0.02	++	Whitish yellow
T_1	0.5 ± 0.02	63.33 ± 0.94	250 ± 9.35	27.8 ± 0.49	27.4 ± 0.25	0.11 ± 0.07	++	Whitish yellow
T_2	0.5 ± 0.01	66.81 ± 0.71	205 ± 3.55	32.5 ± 0.31	29.8 ± 0.56	0.10 ± 0.01	++	Slightly yellow
T_3	0.5 ± 0.02	68.20 ± 1.55	200 ± 15.41	33.0 ± 1.22	31.0 ± 0.93	0.10 ± 0.07	++	Slightly yellow

*Cut-out analysis means of four replicates ± S.D. + = Extent of clarity.

TABLE 4. SENSORY ANALYSIS OF OSMO-CANNED APPLE RINGS OF VARIOUS TREATMENTS*

Treatments	Colour and appearance (20)	Texture (20)	Attributes aroma (20)	Taste (40)	Total score (100)
T_0	14.60	11.90	13.40	13.10	63.00
T_1	17.10	16.70	16.00	32.90	82.70
T_2	15.20	14.50	14.90	29.00	73.60
T_3	14.80	13.90	14.50	28.40	71.60
T_4	14.60	14.20	14.20	27.40	70.80
C.D.= (P=0.05)	N.S.	N.S.	N.S.	4.48	4.48

Figures in the parenthesis indicate max. score N.S.: Not significant.

product of the best quality was T_1 as is also evident from the scoring pattern.

Feasibility of the process: In conventional canning of apple rings, hardening agents such as calcium chloride are added for maintaining their texture and clinching operation before exhausting is followed up. With the application of this new technology known as 'Osmo-canning', firm texture, better quality and desired drained weight (50 to 68 per cent) were obtained. This process was successfully practised on commercial basis. The trimmings, cores as well as the deformed rings were used for the extraction of juice, and the left over syrup could also be reused 4-5 times for osmotic treatments and also as a covering media in the canning of apple rings which could be considered as economically feasible.

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Soy - Wheat Flour Blends: Chemical, Rheological and Baking Characteristics*

PRATIMA MISRA, M.S. USHA AND SURJAN SINGH**
Department of Foods and Nutrition, College of Home Science,
G.B. Pant University of Agricultural Technology,
Pantnagar, 263 145, U.P., India

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Blending with defatted soyflour at levels of 2,4,6,8 and 10% in two wheat varieties ('UP-319' and RR-21') was studied for its effect on bread making qualities. The protein, total ash, calcium and phosphorus contents increased in the blends and sedimentation values decreased marginally at higher levels of blending. Mixing time increased as the level of defatted soyflour increased upto 10%. In the alveograms, the height of curve (tenacity) increased with blending level. The extensibility of dough decreased inversely with defatted soyflour level. Loaf volume of bread decreased when soyflour level increased beyond two per cent.

Soyflour is already in use as an ingredient in bread making[1]. Chiefly, full fat soyflour is used at the rate of 0.906 to 1.359 kg per sack for bleaching the flour and producing white bread[2]. Some studies have also reported the successful use of defatted and enzyme-active soyflour in bread making[3,4]. The present production of solvent-extracted soyflour in India is 5-6 lakh tonnes per year[5]. If the solvent-extracted soyflour is of edible grade and untoasted, it could profitably be used in bread making in small bakery units also. In addition to producing whiter bread, soyflour would also add to the protein content of the bread. This study investigated the effect of solvent-extracted soyflour on the rheological characteristics of dough and the loaf volume of bread.

Materials and Methods

Wheat varieties 'UP-319' and 'RR-21', obtained from the Crop Research Centre of the G.B. - Pant University of Agriculture and Technology, Pantnagar, were cleaned, graded and milled on a Brabender Quadrumat Junior mill. The flours were sifted in the Brabender sieve shaker using a 100-mesh sieve. Solvent extracted soyflakes, obtained from M/s Mahadeo Sahara and Bros., Indore, M.P., were ground on the pin mill to 100-mesh size. Samples were prepared by blending defatted soyflour with wheat flour of each variety separately at the rate of 0, 2, 4, 6, 8 and 10 per cent by weight. The samples thus prepared were analysed for moisture, ash, crude protein, ether extractives and crude fibre contents[6], and the minerals calcium[7] and phosphorus[8]. The gluten content and maltose figure were also estimated. The sedimentation test was carried out according to AACC procedure[6]. The rheological properties were recorded on the mixograph (National Manufacturing Company, U.S.A.) and on the alveograph (Chopin Extensimeter) using the procedures described by Kent Jones and Amos[1] and Pal[9]. Pup loaves were made from each of the soy-wheat flour blends using the straight dough method and the loaf volume was measured by rapeseed displacement method.

Results and Discussion

Defatted soyflour contained 57.53 per cent protein, 1.04 per cent ether extractives, 0.5 per cent crude fibre, 6 per cent ash and 8.5 per cent moisture. The contents of calcium and phosphorus were 280 and 650 mg/100 g respectively. There was a definite increase in protein, crude fibre, total ash and minerals (Ca and P) as a result of soyflour incorporation in samples of both varieties of wheat flour under study, whereas the ether extractives decreased with increasing levels of soyflour incorporation (Table 1).

Table 2 presents data on gluten content, maltose value and sedimentation value in wheat flour and soy-wheat blends. The gluten contents of 'UP-319' and 'RR-21', were 10.41 and 8.52 g/100 g, respectively and decreased in the soy-wheat flour blends of both varieties of wheat. Tsen[10] has shown that wheat protein, particularly gluten, has visco-elastic properties unique for bread making and any other protein or food component added at a high level can damage the unique gluten properties through dilution or interaction which may result in impaired properties and bread quality. Maltose value, a measure of amylase activity, decreased as the level of defatted soyflour increased (Table 2). Sedimentation value remained almost unchanged upon incorporation of defatted soyflour. Higher sedimentation values in blends of 'UP-319' are primarily due to the higher protein and gluten contents in this wheat variety.

*Research Paper No. 6237, Directorate of Experiment Station, Pantnagar.
Present address: **USAID, New Delhi.

TABLE 1. PROXIMATE COMPOSITION AND MINERAL CONTENT OF WHEAT FLOUR AND SOY BLENDS

Soyflour level in blends (%)	Variety	Moisture (%)	Total ash (%)	Crude fibre (%)	Protein (%)	Ether extractives (%)	Calcium (mg/100 g)	Phosphorus (mg/100 g)
0	UP-319	10.90	0.49	0.25	11.50	1.26	42.00	175.00
(Control)	RR-21	11.10	0.59	0.35	10.00	1.70	68.00	210.00
2	UP-319	10.80	0.61	0.26	12.45	1.23	46.80	184.50
	RR-21	11.00	0.70	0.36	10.95	1.68	72.50	219.50
4	UP-319	10.76	0.73	0.26	13.33	1.21	51.60	194.00
	RR-21	11.00	0.82	0.36	12.00	1.65	77.50	229.00
6	UP-319	10.70	0.85	0.27	14.29	1.20	56.40	203.50
	RR-21	10.90	0.95	0.37	12.95	1.61	81.20	238.50
8	UP-319	10.60	0.94	0.28	15.22	1.18	61.20	213.50
	RR-21	10.90	1.10	0.38	13.90	1.60	85.90	248.50
10	UP-319	10.60	1.06	0.30	16.17	1.15	65.90	223.00
	RR-21	10.80	1.22	0.40	14.90	1.57	90.50	258.00
Mean ± S.D.		0.158	0.050	0.054	1.851	0.228	15.48	25.84

*Values are the mean of three replicates.
Calcium and Phosphorus contents of defatted soyflour are 280 and 650 mg/100g respectively.

TABLE 2. GLUTEN CONTENT, MALTOSE FIGURE AND SEDIMENTATION VALUE OF SOY-WHEAT FLOUR BLENDS*

Soyflour level in blends (%)	Variety	Gluten (g/100 g)	Maltose figure	Sedimentation value (CC)
0	UP-319	10.41	1.64	26.25
(Control)	RR-21	8.52	1.72	22.00
2	UP-319	10.20	1.56	26.25
	RR-21	8.35	1.69	22.00
4	UP-319	10.00	1.50	26.00
	RR-21	8.15	1.66	22.00
6	UP-319	9.80	1.46	26.00
	RR-21	8.01	1.61	22.00
8	UP-319	9.62	1.38	26.00
	RR-21	7.73	1.56	21.50
10	UP-319	9.42	1.32	26.00
	RR-21	7.61	1.52	21.50
Mean ± S.D.		0.981	0.116	2.15

*Values are mean of three replicates.

TABLE 3. MIXOGRAPH AND ALVEOGRAPH VALUES OF SOY-WHEAT FLOUR BLENDS

Soyflour level in blends (%)	Variety	Mixograph mixing time (min)	Alveograph values	
			W-value	P/G ratio
0	UP-319	2.24	205.19	0.57
(Control)	RR-21	2.40	53.99	0.49
2	UP-319	2.24	155.92	0.68
	RR-21	2.40	58.27	0.61
4	UP-319	2.24	154.27	0.93
	RR-21	2.40	89.93	0.81
6	UP-319	2.24	162.47	1.10
	RR-21	2.40	96.51	0.73
8	UP-319	2.48	138.71	1.13
	RR-21	3.20	98.15	0.95
10	UP-319	3.18	129.89	1.21
	RR-21	3.40	100.32	1.00
Mean ± S.D.		0.428	45.21	0.283

*Values are the mean of three replicates.

Mixograph data show that addition of soyflour upto 6 per cent did not affect the mixing time of either of the wheat flours. Mixing time increased as the level of soyflour increased from 6 to 10 per cent (Table 3). The mixing time of 'UP-319' was shorter than that of "RR-21' which was possibly due to the higher gluten content of 'UP-319'.

The data on alveograph value indicate that W-values (work of deformation) in the case of 'UP-319' and its blends were in decreasing order whereas there was a reverse trend in the case of "RR-21' and its blends. This might be attributed to the variation in the type and amount of gluten in these two

varieties. 'UP-319' is known to have a balanced type of gluten while 'RR-21' has a weak gluten. The W - value of 205.19 in 'UP-319' decreased to 129.89 at 10 per cent level of blending. The very high W - values of 'UP-319' indicate the presence of strong and balanced gluten which appears to get weakened and destabilized by the incorporation of soy proteins. The gluten of 'RR-21', however, had the W - value of only 53.99; this increased to 100.32 with the incorporation of soy proteins at 10 per cent level of blending. The gluten from 'RR-21' being weak and unbalanced, appears to get stabilized with the incorporation of soy proteins, resulting in an almost 100 per cent increase in the W - value at 10 per cent level of blending. The P/G ratio in both the wheat varieties was in increasing order. No correlation between P/G and W - value could be established.

Data on loaf volume are presented in Table 4. Loaf volume of commercial maida (refined wheat flour) - soyflour bread decreased from 300 to 240 cc as the level of soyflour increased from 0 to 10 per cent. The loaf volume of bread of 'UP-319' - soyflour decreased from 290 to 240 cc, and the loaf volume of "RR 21' - soyflour bread decreased from 270 to 220 cc, as the level of soyflour incorporation increased. It is seen that the loaf volume of bread made from commercial maida was slightly larger than the loaf volume of each of the two experimental wheat breads. However, there was a decrease in loaf volume of all the wheat flour breads when soyflour incorporation increased beyond two per cent.

TABLE 4. LOAF VOLUME OF BREAD MADE FROM COMMERCIAL MAIDA AND TWO WHEAT VARIETIES BLENDED WITH SOYFLOUR

Soyflour level in blends (%)	Loaf vol. from wheats		
	Maida	UP-319	RR-21
0	300	290	300
2	300	290	270
4	280	270	260
6	270	260	260
8	250	240	230
10	240	240	220

The results show that the addition of defatted soyflour to wheat flour increased the protein, total ash, calcium and phosphorus contents of the blends in both wheat varieties. Mixing time of the blends as recorded by the mixograph increased as the level of blending with defatted soyflour increased up to 10 per cent. Alveograms revealed that with increase in blending level with defatted soyflour, the tenacity (height of the curve) increased in all the blends and the extensibility of dough (length of the curve) decreased upto 10 per cent level. Loaf volume of bread decreased when soyflour incorporation exceeded two per cent.

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Effect of Incorporating Wheat Bran on the Rheological Characteristics and Bread Making Quality of Flour

P. HARIDAS RAO AND HEMA MALINI RAO
Baking Technology, Central Food Technological Research Institute,
Mysore - 570 013, India

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Water absorption capacity determined in farinograph increased from 59 to 67% with increase in the bran level upto 20% while further increase in its level gradually decreased the water absorption capacity to 63%. However, when determined in mixograph or 'Research' water absorption meter, the same increased gradually upto 40% level of bran incorporation, but the extent of increase was much higher in the mixograph. The water absorption capacity of flour containing 40% bran indicated in mixograph and 'Research' water absorption meter were 79.6% and 62%, respectively. The water absorption capacity determined in mixograph was nearer to the bakery water absorption. Incorporation of bran adversely affected the texture, grain and loaf volume of bread but improved the aroma depending on the level used. The maximum level of bran that could be used to obtain the acceptable quality high-fibre bread was found to be 30%. The quality was improved by using the following additives: 0.5% guar gum; 0.5% sodium stearoyl lactylate; 3.0% gluten; 15 p.p.m. potassium bromate and 60 p.p.m. ascorbic acid. Sponge and dough method of bread making was found to be better than the straight dough method. The volume of bread thus made increased to 510 ml from 415 ml observed for control.

Bakery products particularly bread are considered as the best sources to increase the dietary fibre content. Some of the fibre sources used to increase the fibre content of bread were guar gum[1], coconut residues[2], alpha-cellulose[3] and bran from cereals such as wheat[4], triticale[5] and oats[6]. Pomeranz *et al.*,[4] in their studies, have found 7 per cent as the optimum level of wheat bran that could be incorporated to get the acceptable quality bread comparable to conventional white bread. The present study aims at finding out the possibility of increasing the level of bran in bread as the same could be consumed as a therapeutic food containing sufficient quantity of dietary fibre. Wheat bran was selected in preference to other fibre sources to avoid foreign taste in bread. In addition, it has a good amount of protein of high biological value and also a rich source of B-group vitamins and minerals[4]. The results of studies relating to the rheological characteristics and bread making quality of flour as affected by incorporation of wheat bran and possibility of improving the quality are presented in this paper.

Materials and Methods

Commercially available hard wheat was milled in a laboratory Buhler mill (Model MLU-202) after conditioning it overnight at 15.5 per cent moisture. The straight run flour thus obtained was used for different studies. Coarse bran obtained from the commercial roller flour mill was toasted at 160°C for half an hour to stabilize. The toasted bran was then powdered in a hammer mill using 0.8 mm sieve. The powdered bran was sieved through 80 mesh sieve and the overtailing was again powdered so that all the material passed through the sieve. Gluten was separated from the wheat flour by preparing the dough using optimum quantity of water and washing it under running water to obtain wet gluten free of starch and was used directly in bread making.

Sieve analysis: Sieve analysis of bran flour was carried out using Buhler plan sifter using sieves of different mesh sizes. The overtailing on each sieve were weighed after running the sifter for 5 min and the percentages calculated.

Chemical analysis: Moisture, gluten, ether extractives were determined according to the standard methods[7]. Micro-kjeldhal method was used to estimate the nitrogen.

Rheological characteristics: Farinograph, extensograph, mixograph and amylograph characteristics of flour containing different levels of bran were determined according to AACC methods[7]. Texturometer characteristics of the dough were determined using General Foods Texturometer (Model GTX) as per the method reported earlier[8]. The water absorption capacity of flour containing different levels of bran was also determined using 'Research' water absorption meter (RWAM) according to the method described in the manual for yeasted doughs[9].

Preparation and evaluation of bread: Test baking of bread was carried out using the procedure of Irvine and McMullan[10]. Breads were also made by varying the levels of water and by using additives such as gluten, potassium bromate, ascorbic acid and sodium stearoyl-lactylate. Bakery water absorption was determined by preparing bread at different water levels and the water required to obtain

maximum volume of bread was taken as the bakery water absorption. Bread volume was measured by the rapeseed displacement procedure. The other quality parameters were evaluated as per the method of Pyler[11] by a panel of 10 judges giving scores to different quality attributes such as specific volume, crust colour, symmetry of form, texture, crumb grain, aroma and taste. Statistical analysis of the data was carried out by Duncan New Multiple Range test. All these experiments were carried out in four replicates.

Results and Discussion

Quality characteristics of wheat and bran flour: Some of the quality characteristics of wheat flour used (Table 1) indicated the suitability of the flour for bread making as seen from the level of gluten and sedimentation value. The values for protein and ether extractives for bran were similar to those reported in literature[12]. Sieve analysis of the bran flour showed that 84.5 per cent passed through 7XX sieve (193 μ).

Rheological characteristics: Farinograph water absorption increased with increase in the level of incorporation of bran upto 20 per cent and further increase in the level decreased the water absorption capacity (Fig. 1). Pomeranz *et al.*[4] and Lorenz[5] also observed increase in the water absorption of flour when bran from wheat, triticale or rye was incorporated. Since levels higher than 15 per cent were not used in those studies, no decreasing trend in the water absorption capacity was observed. This decrease in the water absorption at higher levels was due to interference of bran in the formation of gluten thereby making the dough less cohesive and elastic. Such doughs naturally offer less resistance to the mixing blades of the farinograph and hence indicate lower consistency though theoretically water absorption should increase in view of the higher levels of pentosans present in bran[13].

The dough development time gradually increased from 1.5 to 15 min with the addition of 40 per cent bran (Fig. 1). The other significant difference observed particularly at higher level of bran incorporation was the band width which was

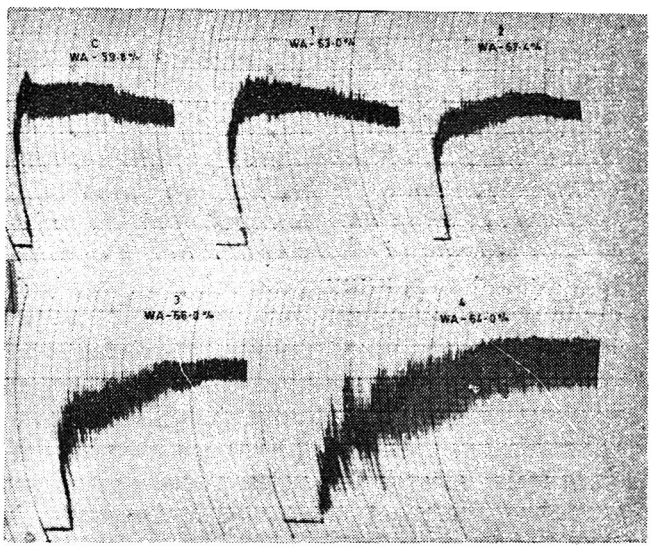

Fig.1. Farinograms of flour containing varying levels of bran.

noticeably much greater at 30 and 40 per cent level of incorporation possibly due to non-uniformity of dough phase. Though the farinograph consistency of the doughs containing different levels of bran was the same (500 BU) in all the cases, the doughs containing 30 or 40 per cent bran were stiffer than other doughs as indicated by subjective evaluation.

To confirm the above, the dough characteristics were evaluated in mixograph using the farinograph water absorption and it showed that the water added for dough containing higher levels of bran (more than 20 per cent) was insufficient to get the optimum consistency, as the curve had greater peak height and excessively wider streaks as compared to wheat flour dough (Fig. 2). Hence, experiments carried out a higher levels of water to adjust the peak height (4.5 cm) comparable to control, confirmed that the dough containing bran 20 per cent and above required more water than indicated in the farinograph. This variation in the water absorption could be

TABLE 1. QUALITY CHARACTERISTICS* OF WHEAT FLOUR AND WHEAT BRAN

Constituent	Level (%)	
	Wheat flour	Bran
Total ash	0.49	5.60
Acid insoluble ash	0.04	0.11
Crude gluten (d.b.)	10.80	—
Sedimentation value (ml)	31.10	—
Protein (N × 6.25)	11.04	14.45
Ether extractives	1.51	4.12
Total dietary fibre**	1.21	46.20
Flour passing through 7XX sieve+	100.00	84.50

*All values are expressed on 14% moisture basis
**Data obtained from Dong Babcock 1987[15] (1)
+Sieve opening - 193 microns

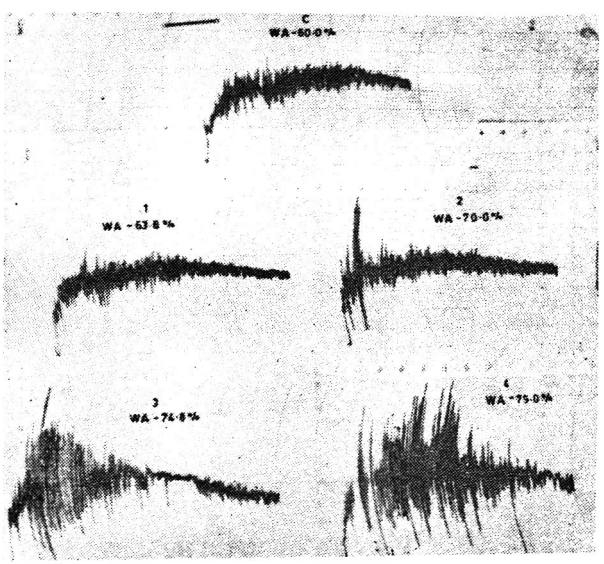

Fig.2. Mixograms of flour containing different levels of bran.

attributed to differences in the intensities and type of mixing in these instruments. The farinograph water absorption of dough containing 40 per cent bran was only 63 per cent as compared to 74 per cent observed in mixograph. Also in the case of mixograph, water absorption of flour increased with increase in the level of bran used.

The hardness values of doughs mixed in both farinograph and mixograph were measured in General Foods texturometer. The results showed that the hardness values for farinograph mixed doughs containing more than 20 per cent bran were higher than for other doughs, containing lower levels of bran though all these doughs were mixed to the same farinograph consistency of 500 BU. The hardness values were reported to be positively correlated[8] to farinograph consistency in a normal wheat flour dough. But the hardness values were almost similar in doughs mixed in the mixograph (Fig. 3).

This further indicated that farinograph when used for flours containing high levels of wheat bran may not give the correct consistency as it may behave more like a non-wheat flour dough offering little resistance to mixing though it is stiff and hence recording lower consistency.

The water absorption capacity determined by using 'Research' water absorption meter also showed gradual increase in the water absorption with increase in the levels of bran, but the extent of increase was less as compared to that observed in mixograph (Fig. 4). The water absorption of flour containing 40 per cent bran indicated by 'Research' water absorption meter was only 62 per cent as compared to 79.6 per cent observed in mixograph and 64 per cent observed in farinograph. In all these instruments, values of water absorption capacity were similar only for control wheat flour dough. Hence, it can be inferred that many of these instruments, give correct picture of the water absorption capacity only with wheat flour.

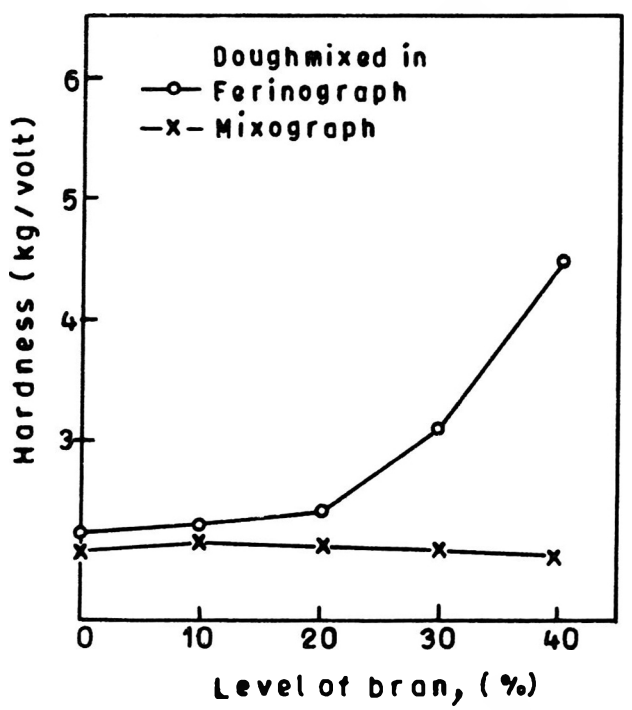

Fig.3. Texturometer hardness of dough mixed in farinograph and mixograph.

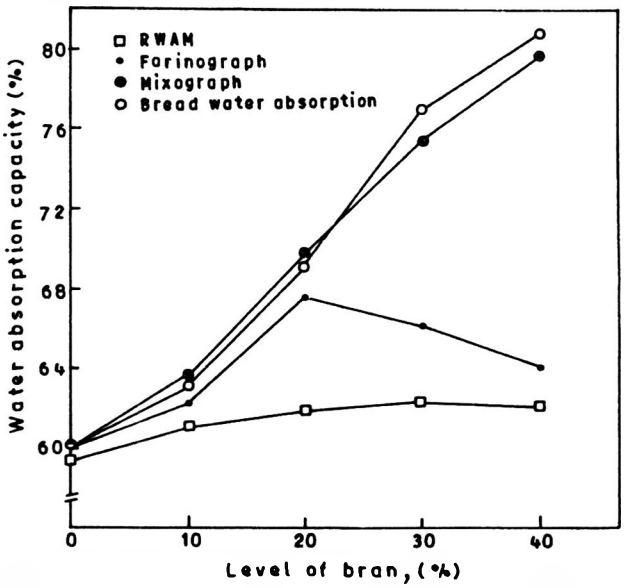

Fig.4. Water absorption capacity of flour containing varying levels of bran as determined in different instruments.

The texturometer characteristics of the dough containing increasing levels of bran showed, as expected, decrease in the cohesiveness as well as adhesiveness of the dough (Fig. 5).

The extensograph characteristics indicated (Table 2) that the resistance to extension as well as the extensibility gradually decreased with increase in the level of bran. The dough naturally became stiffer with incorporation of bran as indicated by increase in the ratio figure (Table 2).

Amylograph peak viscosity gradually decreased from 2320 to 1020 AU when 50 per cent bran was incorporated, possibly due to decrease in the total starch content as suggested by Lorenz[5].

Bread making trials: The quality of bread made using different levels of bran (Table 3) showed that loaf volume decreased gradually upto 30 per cent level of incorporation while at 40 per cent level, the reduction in volume was substantial. The gradual increase in the loaf weight indicated greater water retention capacity of bran. Though the crust and crumb characteristics were adversely affected with incorporation of bran as indicated by the lower score, the aroma of bread was not significantly affected. The bread made

TABLE 2. EXTENSOGRAPH CHARACTERISTICS OF FLOUR CONTAINING DIFFERENT LEVELS OF BRAN

Level of bran used (%)	Resistance to extension, R (B.U.)	Extensibility, E (mm)	Ratio figure (R/E)	Area (cm^2)
0	980	145	6.76	122.8
10	840	122	6.89	91.7
20	700	92	7.61	84.3
30	570	64	9.00	71.8

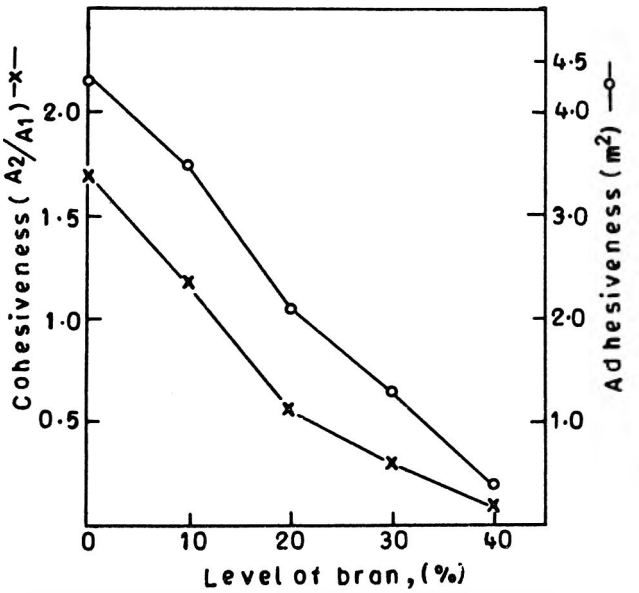

Fig.5. Texturometer characteristics of flour containing varying levels of bran.

with 30 per cent, bran, had pleasant wheaty aroma, but had slightly branny taste. However, the overall quality of bread containing 30 per cent bran was acceptable considering its therapeutic value. But, the bread made at 40 per cent level had pronounced branny taste and was found to be unacceptable. Lorenz[5] and Pomeranz *et al.*,[6] in their studies on the use of different bran sources, found the maximum amount of 15 per cent that could be incorporated to get an acceptable quality bread. However, the maximum level was arrived at, after taking into consideration the staple nature of bread in several parts of the world.

Improvement in the quality of bread: Since the bread doughs containing different levels of bran made by using farinograph water absorption were hard, breads were made at higher levels. The results showed (Fig. 6) that the specific volume increased considerably with increase in water particularly in those containing higher levels of bran (above 20 per cent). In the extra requirement of water, the differences between bread water absorption and farinograph water absorption increased with the level of bran. This was illustrated by the fact that the difference was only 1.6 per cent in case of dough containing 10 per cent bran while in dough containing 30 per cent bran, it was as high as 9.5 per cent.

It is clear from Fig 4 that bread water absorption and mixograph water absorption were almost similar. However, in the present case mixograph water absorption was determined by maintaining the consistency or peak height to about 4.5 cm comparable to that of control wheat flour dough.

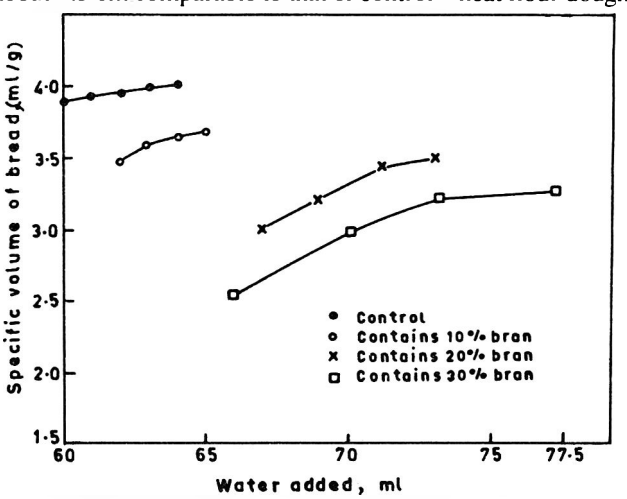

Fig.6. Specific volume of bread containing varying levels of bran as affected by different water levels.

TABLE 3. EFFECT OF USING DIFFERENT LEVELS OF BRAN ON THE QUALITY OF BREAD*

Level of bran (%)	Loaf vol (ml)	Wt of bread (g)	Sp. vol** (cc/g)	Crust colour (10+)***	Symmetry of form (5)	Texture (20)	Crumb colour (10)	Grain (10)	Aroma (10)	Taste (25)	Total score (100)
0	550^a	142	3.88 (7.8)	8.5^a	4.5^a	15.3^a	9.2^a	8.4^a	8.0^a	18.1^a	79.8^a
10	515^b	148	3.49 (7.0)	7.4^a	4.5^a	13.4^a	7.5^a	8.1^a	8.0^a	16.3^b	72.2^b
20	450^c	150	3.00 (6.0)	6.3^b	4.0^b	11.3^b	6.3^b	6.9^b	8.8^b	15.2^c	64.8^c
30	410^d	153	2.68 (5.3)	4.5^c	3.0^c	9.8^b	4.4^c	6.0^b	9.1^b	12.8^d	54.9^d
40	320^e	155	2.06 (4.1)	3.1^d	2.0^d	7.4^c	2.9^d	5.3^c	8.8^b	8.7^e	42.3^e
SEm (df 27)	± 4.1		± 0.03	± 0.71	± 0.04	± 0.04	± 0.05	± 0.06	± 0.06	± 0.07	± 0.78

*Bread made using farinograph water absorption; **Values given in parenthesis are the mean scores out of maximum 10; ***Maximum scores; Mean followed by the same superscript in each row did not differ significantly at P = 0.01.

TABLE 4. EFFECT OF ADDITIVES AND PROCESSING CONDITIONS ON THE QUALITY OF BREAD CONTAINING 30.0% BRAN

Serial No.	Processing method/additives used	Loaf vol (ml)	Specific vol (ml/g)	Texture (20)*	Grain characteristics (10)*	Total score (100)*
1	Nil	415^{a}	2.71	10.2	5.8	54.1^{a}
2	Fermentation time (90 min)	430^{a}	2.82	11.7	6.2	56.9^{a}
3	Gluten (30%)	470^{b}	3.10	12.5	7.1	62.1^{c}
4	Potassium bromate (45 ppm)	435^{a}	2.84	2.2	5.9	56.4^{b}
5	Potassium bromate (15 ppm) + ascorbic acid (60 ppm)	445^{ab}	2.90	12.0	5.9	58.3^{d}
6	Xanthan gum (0.5%)	435^{a}	2.84	12.2	6.3	59.2^{d}
7	Guar gum (0.5%)	455^{ab}	3.04	13.7	6.8	61.9^{c}
8	SSL (0.5%)	450^{ab}	2.96	12.3	6.3	60.8^{c}
9	Gluten, (3.0%) + guar gum (0.5%) + SSL (0.5%)	490^{c}	3.25	14.1	7.0	64.1^{e}
10	Sponge and dough method** (additives as in 9)	510^{d}	3.31	14.7	7.4	66.8^{e}
	SEm (df 15)	± 0.89				± 0.64

*Maximum score: 100.
**Flour taken: Sponge - 50%, dough flour 10%, bran 30% fermentation time - 60 min. Floor time - 30 min.
Means followed by the same letter in rows showed no significant difference at p = 0.01; SSL : Sodium stearoyl lactylate.

Processing conditions: Bread making trials were carried out at lower fermentation time since use of bran dilutes the gluten. The results indicated that 60 min fermentation as optimum for bread containing 30 per cent bran. The bread thus made had higher specific volume and total score as compared to control bread (Table 4).

Use of additives: Some of the additives used were found to improve the quality of bread containing 30 per cent bran (Table 4). Potassium bromate or the mixture of potassium bromate and ascorbic acid improved the loaf volume and the overall quality. Since gums have been used to produce gluten-free bread[14], the same when used, improves significantly the quality of high fibre bread. Guar gum was found to be more effective as compared to xanthan gum. Use of 3 per cent gluten as expected, improved the bread quality significantly as indicated by the increase in the loaf volume from 415 to 470 ml and overall quality score from 54.1 to 63.8. The surfactant sodium stearoyl lactylate (SSL) also significantly improved the volume, texture and overall quality of bread. Similar observation was also made earlier in bread containing 15 per cent bran[2]. The bread quality was further improved by adopting the optimized condition of fermentation time (90 min) and using mixtures of additives such as gluten 3 per cent, guar gum 0.5 per cent and sodium stearoyl lactylate 0.5 per cent. The loaf volume improved significantly from 415 to 495 ml and total score from 54.1 to 68.3.

Maximum improvement in the quality of high fibre bread was observed by adopting sponge and dough method of bread making using 60 per cent flour in the sponge and using all the bran and remaining flour at the dough stage. The loaf volume and overall quality score of bread made by the method improved respectively from 415 to 510 ml of 54.1 to 66.8 as compared to control bread containing 30 per cent bran made using the normal procedure and recipe.

Results of the present studies indicate that at lower levels of bran incorporation of flour (20 per cent and below) the farinograph water absorption increased with increase in the level of bran, but at higher levels, the reverse trend was observed. In case of mixograph, the water absorption continuously increased with increase in the level of bran and it was well related to the bread water absorption. An acceptable quality high fibre bread containing 30 per cent wheat bran could be prepared by using sponge and dough method of bread making and incorporating 3.0 per cent gluten, 0.5 per cent guar gum, 0.5 per cent sodium stearoyl lactylate, 15 p.p.m. potassium bromate and 60 p.p.m. ascorbic acid in the formulation.

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Influence of Casein/Fat Ratio of Milk on Baking, Rheological and Sensory Characteristics of Buffalo Milk Mozzarella Cheese

M. Ravi Sundar and K.G. Upadhyay
Dairy Technology Department, Sheth M.C. College of Dairy Science,
Gujarat Agricultural University, Anand Campus, Anand 388 110, India

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The melting and fat leakage properties of Mozzarella cheeses were significantly influenced by C/F ratios. The cheese made from low C/F ratio showed the highest melting and fat leakage. These characteristics declined progressively with increase in C/F ratio of milks. The rheological characteristics of cheeses were significantly influenced by C/F ratio of cheese milk. The cheese made using the lowest C/F ratio had the least hardness, cohesiveness, springiness, chewiness and gumminess than its counterpart made from higher C/F ratio. The value of each rheological character increased progressively with increase in C/F ratio of milk. Organoleptically, the cheese made from 0.7 C/F ratio milk had the highest total score, whereas least was observed for 0.9 C/F ratio cheese. The cheese from 0.5 C/F ratio was ranked significantly high for flavour, whereas 0.7 C/F ratio milk cheese had the best score (though non-significant) for body and texture; but flavour wise it was at par with the former. The cheeses were ranked based on C/F ratio in the order 0.7>0.6>0.8>0.5>0.9 for their suitability as toppings on pizza pie.

Mozzarella cheese is a variety which is traditionally made from buffalo milk. For this variety of cheese, standardization of milk is usually done for fat only and not for casein/fat (C/F) ratio. In our earlier paper[1] we have described the effects of C/F ratio of milk on Mozzarella cheese composition and cheese making efficiency. The present paper deals with effects of C/F ratio on baking, rheological and sensory characteristics of buffalo milk Mozzarella cheese.

Materials and Methods

Fresh buffalo raw milk was standardized to five levels of C/F ratios, viz. 0.5, 0.6, 0.7, 0.8 and 0.9 by appropriate addition of skim milk, separated from the same milk. The standardized milks were flash pasteurized at 72°C, immediately cooled to 37°C and utilized for cheese manufacture. In all, 15 batches of Mozzarella cheese (3 for each C/F ratio) were prepared using the starter culture method of Upadhyay *et al.*[2]

Moisture, fat, protein and salt contents of cheese were determined by standard methods described previously[1]. The baking characteristics of experimental cheeses were objectively ascertained in terms of meltability[3,4] and fat leakage[3] characteristics.

The hardness, cohesiveness, springiness, gumminess and chewiness of cheese were objectively studied by compression testing of samples on Instron Universal Testing Machine, Model-1000 (M/s. Instron Ltd., England), using a 0 to 5 kg chart reading range at cross head speed of 20 mm/min and chart speed of 100 mm/min. Cubic samples of Mozzarella cheese, previously tempered at 23 ± 1°C for about 1 hr, with edges 1 ± 0.06 cm, were placed on the compression support plate in a way that fibres oriented perpendicular to the cylindrical compression anvil. The samples were compressed upto 70 per cent of the initial size. For each cheese, five cubic samples were used and mean value was reported. The rheological behaviour of the cheese was ascertained from its respective force distance compression curve. The area of compression curve was measured using a Licor portable area meter, model LI-3000 (M/s. Licor, Nebraska, USA).

Fresh Mozzarella cheese samples, tempered at 23 ± 1°C were evaluated for sensory characteristics by a panel of six judges, selected on the basis of triangle test. The score card of Duthie *et al.*[5] was used.

Preparation of pizza and toppings was done as described by Dubey[6]. Pizza prepared using experimental cheeses were subjected to sensory evaluation by the judges who knew the characteristics of Mozzarella cheese required for pizza. The judges were asked to grade pizza in order of their preference.

Statistical analysis of data was carried out according to completely randomized design with equal replication as suggested by Steel and Torrie[7].

Results and Discussion

Cheese composition: Average composition of cheeses made with different C/F ratio is shown in Table 1. The C/F ratio studied had significant effect on fat, fat-on-dry matter (FDM) and protein contents of cheeses, whereas the moisture, moisture-on-fat-free substances (MFFS) and salt contents of all cheeses were statistically alike.

Baking characteristics: The mean values of two important baking attributes viz. meltability and fat leakage presented

TABLE 1. AVERAGE COMPOSITION OF BUFFALO MILK MOZZARELLA CHEESES MADE USING DIFFERENT CASEIN/FAT RATIOS IN MILK

Casein/ fat ratio	Moisture (%)	Moisture (%) on fat free substances	Fat* (%)	Fat* in dry matter (%)	Protein* (%)	Salt (NaCl) (%)
0.5	48.5	67.3	28.0	54.3	20.4	1.0
0.6	49.8	66.2	26.0	51.7	21.4	1.1
0.7	49.6	65.3	24.2	47.9	22.9	1.0
0.8	49.3	65.0	23.3	46.1	24.1	1.1
0.9	50.8	65.0	21.8	44.2	25.0	1.0

*These components of Mozzarella cheese were significantly ($P<0.05$) affected by the casein/fat ratios studied.

in Table 2 indicate that these properties significantly declined progressively with increase in the C/F ratio of cheese milk. In general, cheeses having high fat, high MFFS, low protein and lower hardness were more meltable and had greater fat leakage. The trend of changes in meltability and fat leakage characteristics observed in the present study is in conformity with other reports.[3,8,9] Breene *et al.*[3] suggested that for obtaining satisfactory fat leakage on pizza, the cheese should give a minimum fat leakage area of 4.0 cm^2, and accordingly cheese made from milks having C/F ratio of 0.5 and 0.6 could only meet the suggested value for fat leakage.

Rheological characteristics: The textural characteristics of Mozzarella cheese show best correlation between instrumental and sensory data at compression ratios in 45-65 per cent range using a cross head speed of 20 mm/min. But in the present study, Mozzarella cheese did not show yield point in the above range and therefore 70 per cent compression was used for testing. A typical two-bite force distance compression curve as shown in Fig 1 was obtained for Mozzarella cheese and numerical values from the graph were calculated as suggested by Larmond[10].

The mean values of different rheological characteristics of experimental cheeses are collated in Table 3. The C/F ratio had significant effect on all the rheological attributes studied.

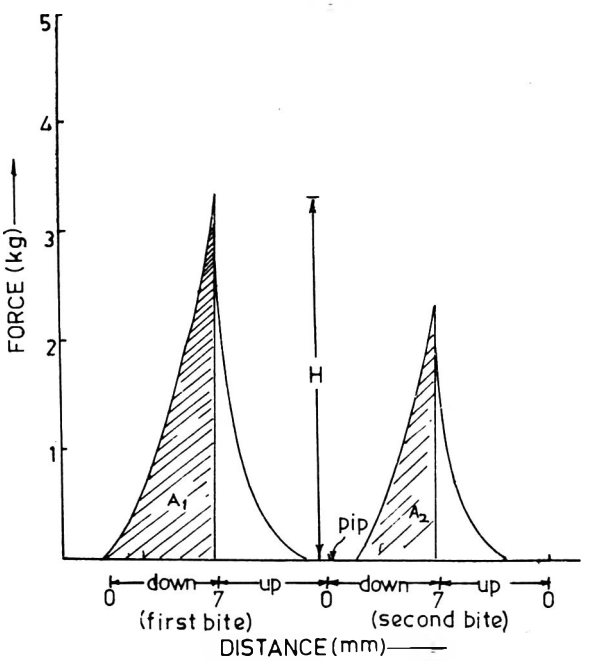

Fig.1. A typical two-bite force-distance compression curve for Mozzarella cheese.

There was a progressive increase in the mean values of each characteristic with increase in the C/F ratio of milk. All the cheeses differed significantly with each other in their hardness, gumminess, chewiness and cohesiveness (except cheeses made from 0.8 and 0.9 C/F ratio milk, which were alike). Cheeses made from 0.5 and 0.6 C/F ratio were alike in their springiness, but differed significantly from the rest which were also statistically alike.

The increase in hardness, cohesiveness, springiness and gumminess with the increase in C/F ratio of milk used for experimental cheeses could be ascribed to compositional (i.e. fat, protein, minerals, MFFS, salt and pH) and structural (protein matrix) differences among the cheeses. A cheese made with high fat, high MFFS and low protein (i.e. low C/F ratio) in the present study is likely to give formation of weak α_s-casein framework of the cheese structure and thus rendering it less hard, less cohesive and in turn less gummy.

TABLE 2. EFFECT OF CASEIN/FAT RATIO OF CHEESE MILK ON MELTABILITY AND FAT LEAKAGE CHARACTERISTICS OF MOZZARELLA CHEESE

Casein/fat ratio	Meltability (%)		Fat leakage (sq. cm.)
	Horizontal	Vertical	
0.5	118.8	32.2	6.3
0.6	102.1	29.8	4.7
0.7	90.5	25.3	2.8
0.8	78.8	24.1	2.3
0.9	66.6	22.3	1.9
S.Em.	9.3	2.1	0.7
C.D. (0.05)	29.2	6.8	2.3
C.V. (%)	17.5	13.9	34.8

TABLE 3. INFLUENCE OF CASEIN/FAT RATIO OF CHEESE MILK ON THE RHEOLOGICAL PROPERTIES OF MOZZARELLA CHEESE

Casein/fat ratio	Rheological property				
	Hardness	Cohesiveness	Springiness	Gumminess	Chewiness
0.5	1.3	0.27	3.7	33.7	1.4
0.6	1.9	0.32	4.3	59.9	2.6
0.7	2.2	0.37	5.1	81.1	4.1
0.8	2.7	0.46	5.3	112.1	6.0
0.9	3.1	0.44	5.7	139.4	7.9
S.Em.	0.1	0.01	0.2	4.9	0.2
C.D. (0.05)	0.3	0.04	0.7	15.5	0.8
C.V. (%)	7.9	5.52	8.3	10.0	10.0

The trend of changes in hardness, cohesiveness and gumminess observed in present study is in agreement with the reports of Patel[9], Emmons *et al.*[11] and Chen *et al.*[12] respectively. The presence of fat reduces the number of elastically effective cross links and thus a cheese with low C/F ratio (high fat) showed less springiness which is substantiated by the findings of Patel[9].

Sensory characteristics: Except flavour, other sensory attributes of Mozzarella cheese were not significantly influenced by the C/F ratio of milks studied (Table 4). The cheeses made from milks having 0.5, 0.6 and 0.7 C/F ratios were scored significantly higher but were statistically alike. The lower flavour scores of cheeses from 0.8 and 0.9 C/F ratio milk could be ascribed to lower levels of fat in these cheeses. Contribution of fat to richness of flavour of cheese is well documented.[13,14] From body and texture points of view, cheese from 0.7 C/F ratio ranked the highest, which also reflected on total score, the latter being also highest for this cheese. The cheese obtained with low C/F ratio was criticised as soft and weak, whereas one made using high C/F ratio was found to be hard, coarse and chewy. These observations of the panelists are also supported instrumentally (Table 3). Cheese made with high C/F ratio had rough surface and thus scored low.

Suitability for pizza making: All the experimental Mozzarella cheeses were evaluated for their suitability as topping on pizza pie. The ranking preference of judges revealed that cheeses made from 0.5 and 0.6 C/F ratios were best with respect to flavour but had excessive meltdown and fat leakage on pizza. The cheeses made from 0.8 and 0.9 C/F ratio milks were too chewy and had relatively low intensity of characteristic cheesy flavour. The cheese made from 0.7 C/F ratio, when topped on pizza pie gave good flavour, showed moderate chewiness, stringiness and fat leakage and accordingly was ranked the best among all the cheeses evaluated. The cheeses made from different C/F ratio milks were ranked in the following order: 0.7>0.6>0.8>0.5>0.9.

The superiority of 0.7 C/F ratio milk (having 4.27 per cent fat and 3.18 per cent casein) cheese, observed in the present study is supported by the findings of Ghosh and Singh,[15] who also found Mozzarella cheese made from 4 per cent fat milk to be highly suitable for pizza making. Further, it is important to note that the lower fat leakage ability of 0.7 C/F ratio milk cheese, as observed objectively (Table 3) did not reflect adversely on its fat leakage behaviour when used as a topping on pizza pie.

TABLE 4. INFLUENCE OF CASEIN/FAT RATIO OF CHEESE MILK ON SENSORY QUALITY OF MOZZARELLA CHEESE

Casein/fat ratio	Sensory score			
	Flavour (10)	Body and texture (5)	Appearance (3)	Total score (18)
0.5	9.3	3.2	2.9	15.4
0.6	9.1	3.4	2.6	15.5
0.7	9.2	4.2	2.6	16.4
0.8	7.6	3.5	2.6	14.0
0.9	8.1	3.5	2.2	14.3
S.Em.	0.4	0.6	0.2	0.8
C.D. (0.05)	1.2	NS	NS	NS
C.V. (%)	7.7	31.2	14.8	9.8

Figures in the parentheses indicate max. score.

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Effect of Ice Storage on Protein and Related Changes in Pink Perch (*Nemipterus japonicus*)

G. VIDYA SAGAR REDDY AND L.N. SRIKAR
Department of Biochemistry, College of Fisheries,
University of Agricultural Sciences, Mangalore - 575 002, India

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Significant ($P<0.05$) decreases in total nitrogen, non-protein nitrogen, salt soluble proteins, water soluble proteins and total proteins were observed during the ice storage of Pink Perch (*Nemipterus japonicus*). Total plate count showed a gradual increase throughout the ice storage period. The increase in alpha- amino nitrogen content was significant ($P<0.05$) up to 5 days storage. Electrophoretic studies indicated alterations in sarcoplasmic and myofibrillar proteins during storage. Significant correlations ($P<0.05$) existed between the mean sensory scores for texture and the protein changes. The product was found acceptable up to 12.5 days storage.

Fresh fish is susceptible to rapid spoilage in tropical countries owing to the prevalence of high ambient temperature. Even though, the shelf life of tropical fish held in ice varies from species to species, many tropical fish have longer shelf life when stored in ice compared to fish from temperate waters[1]. One of the marked changes occurring during post mortem storage is the development of rigor mortis. Ice storage is usually employed to fresh fish to prevent and retard the lowering of freshness, especially degradation of muscle proteins which is a major reaction of spoilage process in fish. Chemical changes in Indian marine fish during ice storage have been reported by many investigators[2-7]

In the present study, attention is focussed on utilising one of the important species *viz.*, pink perch also known as the "thread fin bream" (*Nemipterus japonicus*), an important catch of Indian shrimp fishery which forms an excellent source of white flesh with low fat content. Protein and related changes during ice storage of this fish and its shelf life have been described in this paper.

Materials and Methods

Pink perch (*Nemipterus japonicus*) caught off Mangalore coast was iced on board the vessel in the ratio of 1:1. Fish were washed in the processing hall thoroughly in ice cold water and kept well iced in an insulated box, the temperature being maintained near 0°C throughout the period of study. Samples were drawn on 'zero' day (fresh), 4th, 6th, 9th, 12th and 15th day of storage for analysis for total proteins, soluble proteins, non-protein nitrogen, Alpha amino nitrogen and electrophoretograms depicting changes in protein bands.

Moisture and ash were estimated by the AOAC[8] procedure. Total lipids (TL) were extracted with chloroform-methanol[9]. Total nitrogen (TN) and non-protein nitrogen (NPN) were determined by the method reported by Srikar and Chandru[10]. The water soluble and salt soluble proteins in the respective extracts were determined by the methods of Gornall *et al.*[11]. Alpha- amino nitrogen (AAN) determination was done according to Pope and Stevens[12]. Disc electrophoresis of water soluble protein (WSP) and salt soluble protein (SSP) extracts were carried out on polyacrylamide gel and sodium dodecyl sulphate polyacrylamide gels (SDS-PAGE), respectively[13]. Total plate counts were determined by the method given in ISI specification[14]

Sensory analyses: Ice stored fish was steam cooked with 2 per cent brine for 10 min and assessed for texture by eight trained panelists using a ten point Hedonic scale ranging from 'excellent' (9.5-10.0), 'good' (6.5-9.4), 'fair' (5.5-6.4), 'acceptable' (3.5-5.4), borderline of acceptance (2.5-3.4) and 'not acceptable' (0-2.4).

The data from the chemical analyses were subjected to ANOVA and students 't' test to determine the differences between experimental periods of storage. The mean sensory scores for texture of the product were correlated with the protein changes and storage time. The shelf life of ice stored pink perch was calculated using a linear regression plot.

Results and Discussion

Proximate composition of the fresh pink perch mince is given in Table 1. Changes in the total proteins, WSP and SSP in pink perch stored in ice for 14 days are presented in Table 2. Total proteins showed a significant decrease over the period of storage ($P<0.05$). Protein content was highest in the fish sample analysed immediately after catch (16.2 per cent), which decreased to 13.54 per cent at the end of 14 days of ice storage. The decrease is mainly due to the loss of soluble protein components.

The WSP content decreased significantly ($P<0.05$) during ice storage, with a maximum solubility in the 3 day ice stored sample. WSP forming 2.91 per cent initially, reduced to 2.01 per cent at the end of 14 day storage in ice. This decrease

TABLE 1. PROXIMATE COMPOSITION OF FRESH FISH MINCE

Parameter	Mean ± S.D.
Moisture (%)	82.34 ± 0.34 (4)
Lipid (%)	0.74 ± 0.04 (4)
Total protein (%)	16.18 ± 0.68 (3)
Ash* (%)	5.26 ± 0.49 (3)
Non-protein N (mg %)	104.20 ± 0.40 (3)
Alpha-amino N (mg %)	11.16 ± 0.13 (3)

* - On dry weight basis
Figures in parenthesis indicate the number of observations.

TABLE 2. CHANGES IN TOTAL PROTEIN, SALT SOLUBLE PROTEIN AND WATER SOLUBLE PROTEIN DURING ICE STORAGE

Period of ice storage (days)	Total protein+	SSP	WSP
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.
0	16.20^{a} ± 0.69	9.31^{a} ± 0.52 (3)	2.95^{a} ± 0.21 (4)
3	15.15^{a} ± 0.57	8.95^{ab} ± 0.43 (4)	3.02^{a} ± 0.15 (3)
5	15.32^{ab} ± 0.19	8.71^{bc} ± 0.21 (4)	2.48^{ab} ± 0.06 (4)
8	14.31^{ab} ± 0.44	8.06^{cd} ± 0.08 (4)	2.31^{b} ± 0.03 (4)
11	13.64^{b} ± 1.22	7.40^{d} ± 0.15 (4)	2.14^{b} ± 0.09 (3)
14	13.54^{b} ± 0.13	8.02^{cd} ± 0.14 (4)	2.01^{b} ± 0.06 (3)
'r' with texture scores	0.9201167**	0.81346*	0.953186**

Means followed by different superscript within a column differ significantly (P>0.05); Figures in parenthesis indicate the number of observations; + Average of 3 estimates; * Significant at 95%; ** significant at 99%; r = correlation coefficient.

could be due to leaching out of WSP in the melted ice. The SSP which constituted 57.5 per cent of total proteins in the fresh meat, decreased significantly during ice storage. The SSP with an initial value of 9.3 per cent decreased to 8.02 per cent (P 0.05) at the end of 14 days of storage. A similar decrease in SSP of perch and croaker during ice storage has been observed by Solanki *et al.*[2] and Srikar[3], respectively. Decreases in SSP values can be attributed to the aggregation, leading to the insolubilisation of myofibrillar protein fractions and are dependent on the initial quality of fish. The insolubilisation of proteins has been explained to be due to the oxidised and hydrolysed products of lipids through hydrophobic association.

Fig. 1 shows the changes in total nitrogen (TN), NPN and AAN of pink perch during ice storage. The total nitrogen decreased from an initial value of 2.69 to 2.25 per cent at the end of 14 days ice storage. Non-protein nitrogenous components showed a gradual decrease during ice storage. The NPN constituting 104.2 mg/100 g tissue initially, decreased at the end of 14 days storage in ice to 83.3 mg/100 g tissue. Significant relationship (P<0.001) existed between NPN values and the texture scores (r = 0.97827). The decrease in total nitrogen and NPN may be due to the loss of water soluble nitrogen components due to leaching, or utilisation of free amino acids by the bacterial flora.

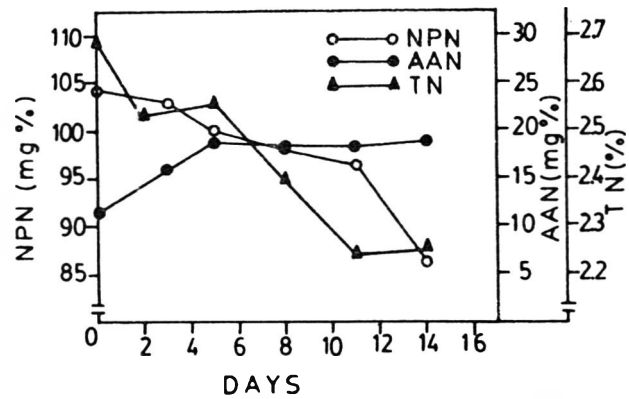

Fig.1. Changes in the NPN, AAN and TN contents of ice stored pink perch.

The alpha-amino nitrogen in pink perch meat which was initially 11.6 mg per cent increased to 18.75 mg per cent (P<0.05) at the end of 6 days ice storage, which upon further storage remained unchanged (Fig. 1). Generally, increase in AAN is attributed to both muscle enzymes as well as microbial enzymes. However, in spite of its continuous production, constant values of AAN can be attributed to the utilisation of free amino acids by the bacteria as well as to the leaching of amino nitrogen along with ice melt. Water soluble proteins are the main proteins contributing to the non-protein nitrogenous fractions especially free amino acids[15]. A steady increase in TPC was also observed during ice storage (Table 3). An initial TPC of 4.7 × 10^{4}/g of meat was recorded, which upon 14 days of storage increased to 3.63 × 10^{6}/g of meat.

Fig. 2 shows the changes in electrophoretograms of WSP. Initially 8 bands of proteins were seen. During ice storage, there was disappearance of a few bands and appearance of new bands with different relative mobility (RM) values. Protein band with RM of 23.8 in the fresh fish disappeared during further ice storage. Protein band with RM of 40.4 disappeared after 3 days of ice storage and appeared later on the 14th day of ice storage. Protein band with RM value of 62.3 was formed after 5 days storage in ice. On the other hand,

TABLE 3. TOTAL BACTERIAL COUNTS AND THE TEXTURE SCORES OF PINK PERCH DURING ICE STORAGE

Period of ice storage (days)	Total plate count+	Texture scores*
0	4.70 × 10^{4} (4.67)	9.0^{a}
3	6.10 × 10^{5} (5.79)	8.4^{a}
5	9.53 × 10^{5} (5.98)	7.0^{b}
8	2.12 × 10^{6} (6.32)	5.9^{bc}
11	2.16 × 10^{6} (6.34)	4.8^{c}
14	3.63 × 10^{6} (6.56)	2.5

Means followed by different superscript within a column differ significantly (P<0.05); * - Values represents the mean of Hedonic scores as assessed by 8 panelists; + - Figures in parenthesis indicate log. bacterial counts.

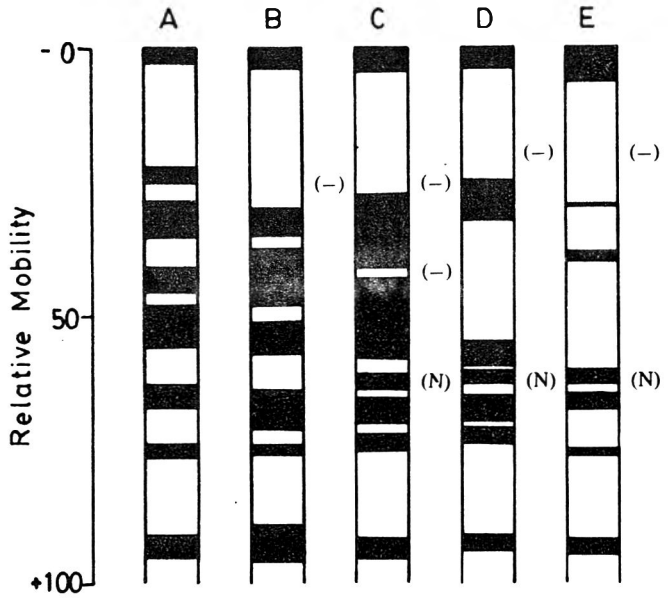

Fig.2. Disc electrophoretograms of WSP of pink perch meat during ice storage (A) Zero day; (B) 3 days; (C) 5 days; (D) 11 days and (E) 14 days. (−) denotes missing of protein band; (N) denotes new protein band.

protein bands with 1.2, 30.3, 51.9, 65.3, 75.2 and 92.8 RM values remained unaltered.

Changes in the electrophoretograms of SSP in SDS - PAGE are shown in Fig. 3. Initially 7 protein bands were present of which some disappeared, while new bands appeared during ice storage giving 8 protein bands at the end of 14 days ice storage. However, protein bands with RM values of 1.5, 46, 72.7, and 96.7 did not show any change in their relative mobility. Disappearance of original RM value protein bands and appearance of protein bands with new RM values are

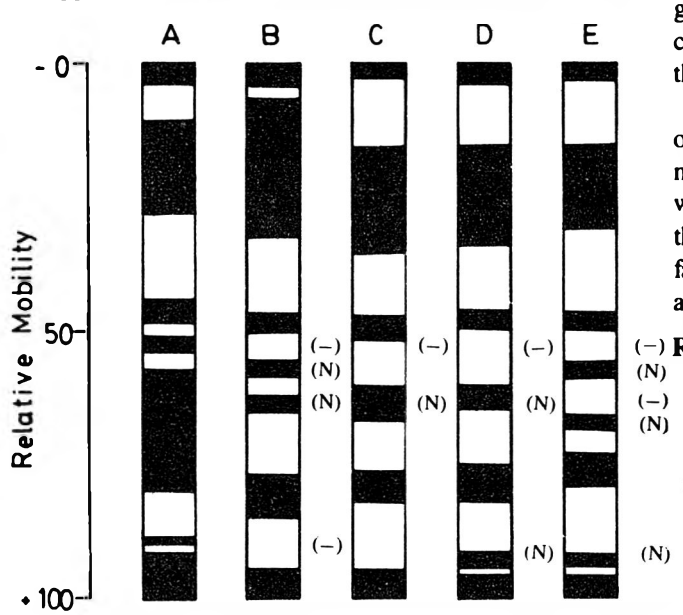

Fig.3. SDS - PAGE patterns of SSP of pink perch meat during ice storage (A) Zero day; (B) 3 days; (C) 5 days; (D) 11 days and (E) 14 days. (−) denotes missing of protein band: (N) denotes new protein band.

mainly due to the degradation of proteins into simpler compounds, as well as loss of some soluble proteins due to leaching effect.

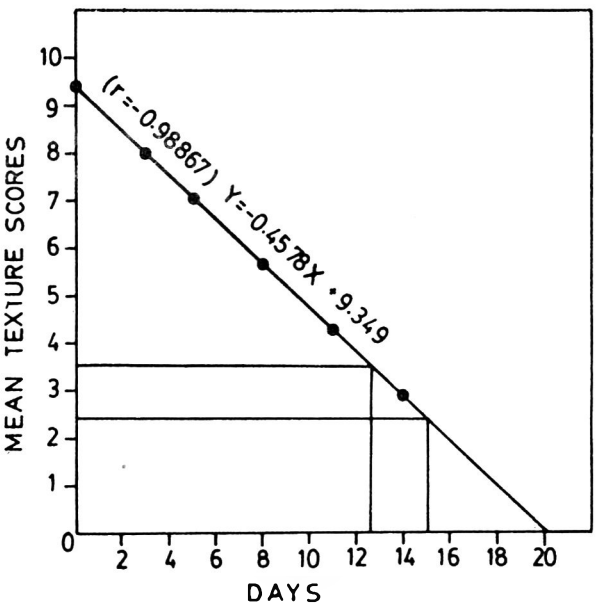

Fig.4. Sensory evaluation of pink perch stored in ice based on texture scores. Plot of linear regression with time.

Mean sensory scores for the texture of ice stored pink perch are given in Table 3. A significant ($P<0.05$) decrease in the scores was obtained with the increased duration of ice storage. Textural changes among seafood products are associated with toughening events, in myotomal tissue[16]. Deterioration of textural quality of muscle foods has been related to changes resulting from denaturation of myofibrillar proteins and low density of Z lines, which occurs during post-mortem glycolysis[17]. Since the test sample is of lean variety, high correlation was established between the protein changes and the texture scores (Table 2).

A significant ($P<0.05$) decrease in texture scores was observed due to decrease in the protein content of meat. The mean sensory scores of texture during the ice storage period were used to find the acceptability of iced fish (Fig. 4). From the figure it is evident that the pink perch held in ice is rated fair for eight and half days and can be acceptable up to twelve and half days.

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Natural Plant Enzyme Inhibitors : Protease Inhibitors in *Canavalia* Seeds

N. NAGARAJA KUMARI* AND T.N. PATTABIRAMAN**
Kasturba Medical College, Manipal - 576 119,
Karnataka, India

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Nine varieties of seeds belonging to the *Canavalia* species tested, were found to inhibit bovine trypsin and α-chymotrypsin activities. Ratios of antitryptic to antichymotryptic activity varied from 0.92 to 12.5. Chromatographic studies on Sephadex G-100 indicated that the inhibitors have molecular weights around 11.0 kDa. All the seed extracts showed very weak action against the proteolytic activity of human pancreatic preparation. The action on bovine pancreatic extract was 13.6 to 26.6 times more based on the linear range of inhibition. The seed extracts did not cause more than 35% inhibition of the proteolytic activity of human pancreatic extract even at high concentrations of the inhibitor protein.

Jack bean (*Canavalia ensiformis*) and sword bean (*Canavalia gladiata*) are advocated to be good sources for extending protein production in marginal areas, both for human and animal consumption[1]. However, their potential is still limited due to growth inhibiting proteins that must be detoxified before they are edible[2]. Ubatuba[3] identified trypsin inhibitory activity in sword bean in 1955. Other workers identified antitryptic, antichymotryptic and anti-subtilisin activities in jack bean and sword bean[4,5]. Prabhu *et al.*[6] showed that a local variety of jack bean displayed negligible inhibition against the proteolytic activity of human pancreatic extract even though it inhibited the bovine system. These workers reported relatively low antichymotryptic activity in the seed extracts whereas, earlier studies[4] indicated that both jack bean and sword bean obtained from a different region, were equally potent against bovine trypsin and α-chymotrypsin. In view of these ambiguities and also the observation that human pancreatic proteases are not inhibited by jack bean, which is of importance for human nutrition, we extended the studies on protease inhibitory activities to different cultivars of jack bean and sword bean. The results are presented in this paper.

Materials and Methods

Canavalia ensiformis (CE-1) was from Karnataka Agricultural Department, Udupi, CE-2 from Tamil Nadu Agricultural University. Coimbatore, CE-3 from Pocha Seeds Private Limited, Pune, Maharashtra and CE-4 from Indian Agricultural Research Institute, Delhi. Jack bean meal designated as CE-5 was purchased from Difco Laboratories, Detroit, U.S.A. *Canavalia gladiata*, variety 'CG-1', was procured from Hyderabad. 'CG-2' was purchased from Calcutta. 'CG-3' was collected from Guntakal, Andhra Pradesh. *Canavalia virosa* (CV) seeds were collected from the Western Ghat region of Kerala. Bovine trypsin (twice crystallized), bovine α-chymotrypsin (thrice crystallized) and casein were procured from Sigma Chemical Company, St. Louis, U.S.A. Preparation of bovine and human pancreatic powders and their activation were described earlier[6]. Other reagents were analytical grade commercial chemicals.

Measurement of proteolytic activity with casein as substrate and its inhibition by seed extracts were performed as described earlier[7]. Under the assay conditions (pH 7.6, 37°C, 10 min incubation) 6.5 μg of trypsin, 6.5 μg of α-chymotrypsin, 50 μg protein of the activated bovine pancreatic preparation and 100 μg protein of the activated human pancreatic preparation, yielded trichloroacetic acid soluble fragments equivalent to an absorbance of 0.50 (540 nm) when analyzed by the method of Lowry *et al.*[8] One unit of inhibitory activity is the amount that decreased proteolytic activity by one absorbance unit. The seed extracts were prepared as follows. Two g of fine seed powder was homogenized with 20 ml of 0.02 M acetate buffer (pH 4.0), containing 0.15 M NaCl. The homogenate was centrifuged at 10,000 × g for 20 min at 4°C. The clear supernatant was used for inhibitory assays. The samples were dialyzed against 200 volumes of the acetate buffer overnight at 4°C, when necessary. Protein in the seed extracts and pancreatic extracts was determined by the method of Lowry *et al*[8] with bovine serum albumin as a standard.

Gel chromatography was performed as follows. Aliquot (0.2-0.5 ml) of the seed extract was applied to a column of Sephadex G-100 (0.9×57 cm^2, bed volume 36 ml) equilibrated with 0.02 M acetate buffer, (pH 4.0) containing 0.15 M NaCl. The column was eluted with the same buffer at 25°C at a flow rate of 6 ml/hr. One ml fractions were collected

*Department of Physiology; ** Department of Biochemistry.

and assayed for protein and inhibitory activities. The following proteins were used as molecular weight markers : Lima bean inhibitor (M_r 9.7 kDa), Kunitz soya bean inhibitor (20), cytochrome c (13), myoglobin (17.2), and porcine pepsin (35.0). All operations were carried out at 25°C.

Results and Discussion

In Table 1, the protein content and protease inhibitory activities in different varieties of *canavalia* seeds are shown. The *Canavalia gladiata* and *C. virosa* seeds had slightly higher extractable protein levels than *C. ensiformis* seeds. The trypsin inhibitory activity varied over a wider range. Varieties, CE-3 and CG-3 had distinctly higher inhibitor levels. The ratio of antitryptic to antichymotryptic activity also varied. The CG-1 seeds alone had comparable activity against both the enzymes. The inhibitory activity in the seed extracts (CG-3 and CE-3) were linear with respect to protein concentration upto about 60 per cent (224 μ g and 130 μg respectively) and thereafter it was progressive but not-linear. The inhibiting the proteolytic activities of bovine pancreatic extracts than that of the human system (Table 2).

the extent of 65 and 36 for CE-3 and 60 and 52 per cent for CG-3, on heat treatment of the extracts at 100°C for 30 min. The antitryptic and antichymotryptic activities of CE-3 were fully stable on exposure to pH 2.0 (0.2 M HCl-KCl buffer) for 18 hr at 25°C. The antitryptic activities were stable on exposure to pH 11.0 (dilute NaOH) for 18 hr at 25°C. Per cent loss of antichymotryptic activity was around 20-25 per cent under these conditions.

The effect of seed protein concentration on the inhibition of the caseinolytic activities of human and bovine pancreatic extracts is shown in Fig. 1, for some typical seed extracts. Maximal inhibition of the human pancreatic extract did not exceed 35 per cent with any of the seed extracts. However, with bovine preparation, inhibition was progressive over a wider range and 50 per cent inhibition could be achieved in all cases. All the seed extracts were far more effective in inhibiting the proteolytic activities of bovine pancreatic extracts than that of the human system (Table 2).

TABLE 1. PROTEASE INHIBITORY ACTIVITIES IN THE DIFFERENT VARIETIES OF CANAVALIA SEEDS

Seed	Extractable protein (mg/g seed)	Inhibition (units/mg protein) against Bovine trypsin	Bovine α-chymotrypsin
CE-1	168	0.71	0.200
CE-2	176	0.68	0.139
CE-3	130	3.00	0.260
CE-4	112	1.88	0.250
CE-5	176	1.25	0.100
CG-1	200	1.10	1.200
CG-2	232	1.25	0.172
CG-3	224	2.90	0.268
CV	240	1.33	0.200

Values which are based on caseinolytic inhibition are mean of three estimations and are based on linear range of inhibitions.

The seed extracts were subjected to gel chromatography on Sephadex G-100. Typical elution patterns with CE-3 and CG-1 preparations are shown in Fig. 2. With CG-1, alone, the inhibitory activity separated into two fractions. The major inhibitor was eluted with a Ve of 31.0 ml and the minor inhibitor fraction was eluted earlier (Ve 25.0 ml). With all the other seed extracts, inhibitory activity was eluted as a single peak with a Ve value of 31.0-32.0 ml. Both the antitryptic and antichymotryptic activities were eluted in the same region. Based on the elution volumes of the marker proteins, it was calculated that the minor inhibitor in CG-1 had an M_r of 22.6 kDa. All the other inhibitors were found to have M_r values around 11.0 kDa. The minor inhibitor in CG-1 could be a dimer of the native inhibitor.

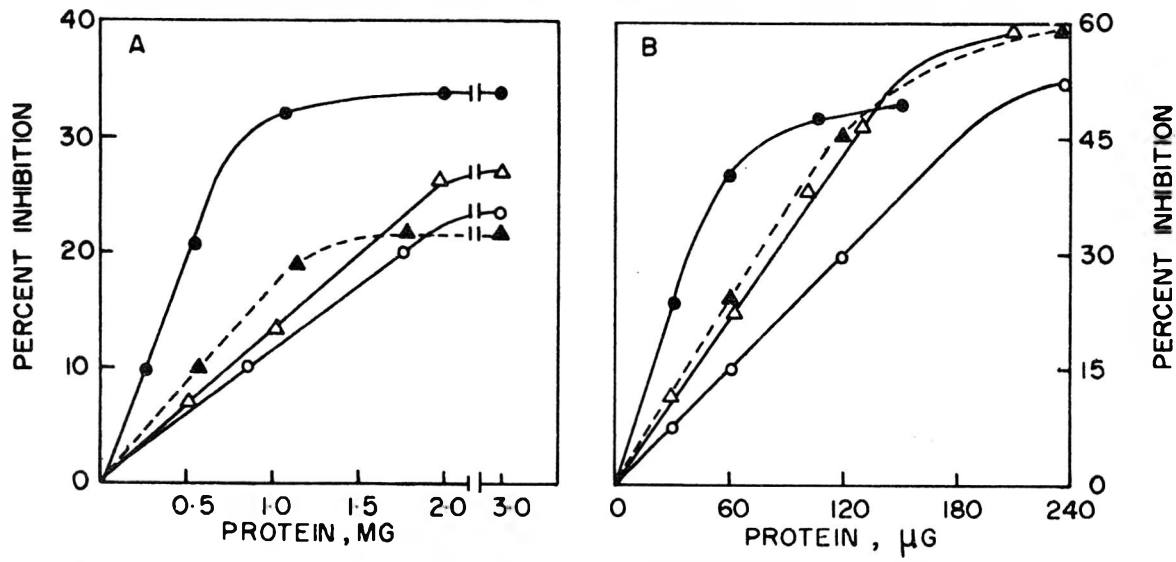

Fig.1. Effect of seed extracts on the caseinolytic activity of activated human (A) bovine (B) preparations. ●——● CE-4. O——O CE-5. ▲——▲ CG-2. △——△ CV.

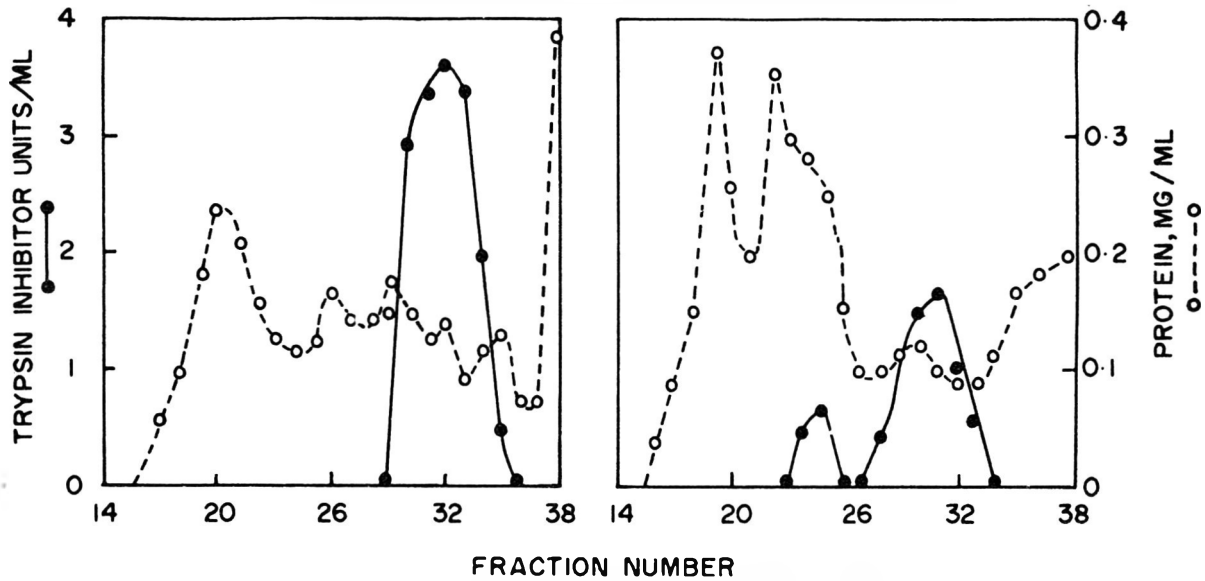

Fig.2. Gel chromatography of *Canavalia* seed extracts on Sephadex G-100 CE-3 (left), CG-1 (right). Legend as in Fig.1.

TABLE 2. RELATIVE INHIBITION OF THE CASEINOLYTIC ACTIVITIES OF BOVINE AND HUMAN PANCREATIC EXTRACTS BY *CANAVALIA* SEEDS

Seed	Inhibition (units/mg protein) against		Ratio: B/H
	Human (H)	Bobine (B)	
CE-1	0.070	1.31	18.7
CE-2	0.050	0.68	13.6
CE-3	0.105	2.15	20.3
CE-4	0.210	4.10	19.5
CE-5	0.070	1.40	20.0
CG-1	0.130	3.13	24.1
CG-2	0.103	2.40	23.3
CG-3	0.078	2.08	26.6
CV	0.080	2.08	26.0

Values are based on linear range of inhibition and adjusting enzyme concentrations to give the same proteolytic activity in the controls. Values are mean of triplicates.

Considerable varietal differences were observed as regards to antitryptic activity and the ratio of antitryptic to antichymotryptic activity in *Canavalia* seeds. This could be attributed to the presence of more than one inhibitor in at least some of the seeds. Since antitryptic activity and antichymotryptic activity coeluted in all cases during gel chromatography, it is probable that the inhibitors have comparable molecular weights. The inhibitors in *Canavalia* seed based on their molecular weight can be classified as belonging to the Bowman-Birk family of inhibitors[9]. Norioka *et al.*[10] indicated that the *Canavalia* inhibitors could belong to this family, even though no experimental evidence is provided for this conclusion. Campos and Filho[11] who identified trypsin inhibitory activity in *Canavalia brasiliensis*, indicated that the factor has an M_r of 11.5 kDa.

The poor activity of *Canavalia* extracts on human pancreatic proteases could be due to weak binding of the *Canavalia* inhibitors to human pancreatic enzymes. Alternately, they are probably hydrolyzed by the enzymes rendering them inactive. Further studies with the purified inhibitor are essential to verify these possibilities. The present observation can be considered as important for human nutrition and *Canavalia* seed proteins may be superior to other legume proteins in this respect.

Acknowledgement

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QUALITY OF EXTRACTED OIL FROM SOME COMMERCIALLY SOLD DEEP-FAT-FRIED SNACKS AND USED OIL

A. NEELIMA AND G. SAROJINI
Department of Foods and Nutrition, College of Home Science
Andhra Pradesh Agricultural University
Hyderabad - 500 004, India.

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Free fatty acids, (FFA) peroxide value (PV) and Iodine value (IV) of fat extracted from four commonly sold savoury products and those of oil used for frying, collected from the sweetmeat shops were studied. For a comparative study, the savoury products were similarly prepared in the laboratory and the product-absorbed oil, the oil used for frying and the fresh oil were also assessed for these characteristics. The mean fat content of the products collected from shops ranged from 24.9 to 43.6%. Its FFA, PV and IV were in the range of 0.97-1.52%; 13-29.1 meq oxygen/kg oil and 84.8-95.8 respectively. The savoury products prepared in the laboratory were found to be relatively superior in quality as the oil in these products contained much lower FFA and PV than similar savoury products collected from the market.

Deep-fat-frying is one of the most common methods of preparation of snacks and in India, major portions of fats and oils are consumed in the form of fried foods. The oil while frying is subjected to high temperature of over 180°C for longer periods and is also exposed to moisture and oxygen. A number of complex desirable and undesirable chemical and physical changes occur under these conditions. Deterioration of fat may reach a point where the nutritive value and safety of the fried food may be affected[1,2]. Much research has been done on the deteriorative changes occurring in oils during frying under laboratory conditions[3,4]. Little information is available on the commercial deep-fat-frying practices which affect the quality of frying oil and also the oil absorbed by fried foods. So, the present study was undertaken to assess the quality of oil absorbed by the deep-fat-fried snacks and the oil used in commercial establishments.

Samples of four most commonly sold savoury products viz. *Boondi* (a spherical, crisp, deep-fat-fried Bengal gram flour better preparation), *Chudwa* (flattened rice fried in oil and seasoned with spices and fried groundnut), *Pakoda* (prepared by frying a batter of Bengal gram flour containing onions and spices) and *Chegodi* (a refined wheat flour preparation made in the form of a ring) were collected from 10 randomly selected sweetmeat shops in Hyderabad. Used oil samples were also obtained. The moisture and fat content of the products were estimated by A.O.A.C. procedures[5]. The oil absorbed by the savoury products and the used oil samples were analysed for FFA, PV and IV as per the procedure of A.O.C.S.[6] For a comparative study, the same savouries were prepared in the laboratory. Oil absorbed by the product in the laboratory prepared savoury samples, the fresh and used oils were also analysed for the above mentioned parameters. Two way classification of analysis of variance[7] was done to find out significant difference, if any.

The mean moisture and fat contents of all the commercial products along with those collected from the laboratory prepared samples are presented in Table 1. The mean moisture content of the savoury products from the market ranged from 0.95 to 7.53 per cent which might be due to variations in the initial moisture content of the dough/batter and extent of frying. Except in *Chegodi*, the moisture content of other market samples was higher than that of laboratory samples.

The fat content of the market savoury products ranged from 24.9 to 43.6 per cent and that of laboratory samples from 20.5 to 45 per cent. In all the four products, the fat content in the market samples was higher than the laboratory products. A significant difference ($P < 0.05$) was observed between various products with respect to fat content. *Boondi* contained significantly high fat, while *Chegodi* contained less fat. The higher fat in *Boondi* may be due to the high initial moisture content of the batter and also due to the addition of baking soda which caused porosity and enhanced oil absorption. *Chegodi* is prepared using a hard (stiff) dough and fat is incorporated in the preparation of dough which does not permit excess fat absorption. This could be the reason for the lower fat content in *Chegodi* and this has also been reported by Masuda[8]. Although differences were noticed in the fat content of market and laboratory samples of the products they were found to be not significant.

The FFA content of oil indicates the extent of hydrolysis of oil. In the present study, the FFA (as per cent oleic acid) content in market samples ranged from 0.97 to 1.52. The FFA in the market products was found to be significantly higher than that of laboratory samples which shows the superiority of laboratory prepared samples over the market products. The FFA content in the oil of market samples of *Boondi* and *Pakoda* were significantly high which may be due to their high moisture content or prolonged storage and exposure in shops.

The mean PV (meq. of oxygen/kg of oil) of the market savouries ranged from 13 to 29.1 and that of samples prepared in the laboratory from 4 to 12.1. The PV of the market samples was found to be significantly higher than that of the laboratory samples. The PV of the market *Chegodi* was found to be significantly higher when compared to other three products. Usually *Chegodi* is stored in the market for longer periods, compared to other products because of its long shelf life.

TABLE 1. MOISTURE AND FAT CONTENT AND QUALITY OF EXTRACTED OIL OF SAVOURIES

Sample source	Moisture (%)	Fat (%)	FFA (as % oleic acid)	PV (meq O_2/ kg oil)	IV
Boondi					
Market	2.13 ± 1.8	43.6 ± 5.8	1.49 ± 0.36	14.8 ± 6.7	95.2 ± 16.2
Laboratory	1.9	45	0.8	6.0	107.4
Chegodi					
Market	1.29 ± 1.2	24.9 ± 4.3	0.97 ± 0.4	29.1 ± 15	84.8 ± 2.0
Laboratory	1.8	20.5	0.5	10.1	105.9
Chudwa					
Market	0.95 ± 0.5	35.3 ± 5.4	1.16 ± 0.3	13 ± 7.4	94.7 ± 12.4
Laboratory	0.7	33.3	0.59	12.1	109
Pakoda					
Market	7.53 ± 4.8	31.4 ± 5.9	1.52 ± 0.4	14.8 ± 9.4	95.8 ± 15.2
Laboratory	6.9	28.5	1.3	4.0	108.7

Therefore, prolonged storage might be the reason for high PV in *Chegodi*.

Prior to the study, a preliminary survey was conducted in the sweetmeat shops from where the samples were collected and it was found that they use refined cotton seed oil for frying the savouries. Refined cotton seed oil has an iodine value (IV) ranging from 103 to 111[9,10]. But in the present study, the IV of the product absorbed oil ranged from 84.8 to 95.8. This may be because of the practice of mixing vanaspathi along with the frying oil to improve the flavour and acceptability of the products in the market.

The IV of the laboratory prepared samples was higher than those of market samples because they were prepared using fresh refined cottonseed oil unlike the blend of oils used for frying commercial products.

The chemical characteristics of the fresh and used oils from the laboratory and market samples are given in Table 2. In the laboratory analysis, the fresh cotton seed oil showed an initial FFA and PV of 0.33 and 6.1, respectively and these increased to 0.59 and 10.1 respectively, after frying the above mentioned savouries. IV decreased from 110.4 to 108.9. The market samples of used oil had slightly high FFA and PV.

Statistical analysis showed that the difference between the used oil and the product absorbed oil of *Boondi* and *Chudwa* was not significant with respect to FFA, PV and IV. In case of *Pakoda*, significant difference was observed only with FFA. The absorbed oil in *Pakoda* had higher FFA than the left over oil in the frying pan. In *Chegodi* significant difference was observed with respect to PV. Absorbed oil in *chegodi* showed higher PV than the left over oil.

The results of the study indicate that no significant deteriorative changes have taken place with respect to quality of oil in the savoury products sold in the market, but the savoury products prepared in the laboratory were found to be superior in quality compared to market samples as they contained much lower FFA and PV than the market samples.

TABLE 2. CHARACTERISTICS OF FRESH AND USED OILS

Oil type	FFA (as % oleic acid)	PV (meq O_2/ kg oil)	IV
Cotton seed oil (fresh)	0.33	6.1	110.4
Cotton seed oil used from lab	0.59	10.1	108.9
Used oil from shop	1.16 ± 0.39	11.59 ± 3.1	104.1 ± 2.2

FFA = Free fatty acid; PV = Peroxide value; IV = Iodine value.

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AMYLOLYTIC ACTIVITIES OF CULTURE FILTRATES OF *RHIZOPUS ORYZAE* AND *BOTRYODIPLODIA THEOBROMAE*

EKUNDAYA O. AFE AND B.A. OSO*
Bendel State University, Dept. of Biological Sciences,
P. M. B. 14, Ekpoma, Nigeria.

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The amylolytic activities of culture filtrates of *Botryodiplodia theobromae* and *Rhizopus oryzae* were determined. Peak amylase production was indicated on the 3rd day for *R. Oryzae* and 5th day for *B. theobromae*. Maximum activity of amylase for both organisms was recorded at pH 4. There was a near doubling of amylolytic activity of culture filtrates with a doubling of the concentration of starch in growth media for both organisms. Increase in amounts of starch in growth media resulted in progressive increase in the dry water of mycelia. *Rhizopus oryzae* produced amylases on glucose, starch, carboxymethyl cellulose and pepper extract media while *Botryodiplodia theobromae* produced amylases on starch and pepper extract media only.

To invade any plant material, spoilage organisms must have the ability to produce extracellular enzymes which are related to the nature of substrates they colonise. Extracellular amylase production has been reported by various workers[1-3]. The enzyme is responsible for hydrolysis of starch to glucose units. This paper presents results of amylolytic activities of the aforementioned fungi.

B. theobromae (IMI 282258) and *R. oryzae* (IMI 282256) used in these studies were isolated from pepper fruits (*Capsicum annuum*) showing signs of soft rot[5]. Starch-yeast extract (SYE) medium of Barneth and Fergus[1] was used for amylase assay. The medium was dispensed in 30 ml aliquots into 150 ml conical flasks and sterilized at 121°C for 15 min. Each flask was inoculated with an agar and mycelia disc (5 mm diameter) of the appropriate test fungus and incubated at 30°C for the desired period of time. After incubation, cultures were filtered through glass wool and filtrates centrifuged. Amylase activity was determined using dinitrosalicylic acid (DNSA) reagent method of Benfeld[6]. Reducing sugars released by the action of cuture of filtrates in one per cent starch solution was estimated.

Production of amylase in relation to time: Inoculated SYE media were incubated at 30°C for 24 h - 12 days to allow mycelia growth of organisms. Harvesting was done daily and filtrates were analysed as earlier described.

Effect of pH on amylase activity: One per cent starch solutions were prepared in 0.2 M citrate-phosphate buffer to give solutions of pH 2-8. To 9 ml of each solution was added 1 ml of filtrate, incubated for 1 hr and the amylase activity determined.

Determination of effect of different concentrations of starch on amylase production: SYE media with concentrations ranging from 0.2 to 4 per cent were dispensed in 30 ml aliquots in a number of 150 ml flasks, warmed to 80°C and sterilized at 121°C for 15 min. Each flask was inoculated with appropriate fungus, incubated at 30°C for 5 days and amylase activity determined.

Determination of effect of different media on amylase synthesis: Amylase activity was determined as before on filtrates from sterilized and inoculated SYE basal media into which were incorporated either one per cent starch, glucose carboxymethyl cellulose or pectin and 10 per cent pepper extract medium after incubation at 30°C for 5 days.

Results show that amounts of amylase produced by the fungi increased with period of incubation until the third and fifth days for *R. oryzae* and *B. theobromae*, respectively after which activity decreased (Fig.1). Chapman[2] made similar observations for *Papylaspora thermophila* on the 4th day on SYE and on 8th day on YE media. Adams[3] recorded highest production for *Mucor pusillus* on 3rd day while Oso[4] observed that *Talaromyces emersonii* had peak activity at different days when incubated at different temperatures. Maximum activity was attained at pH[4] for both organisms as shown in Fig.2. Results also indicate that amylase activity

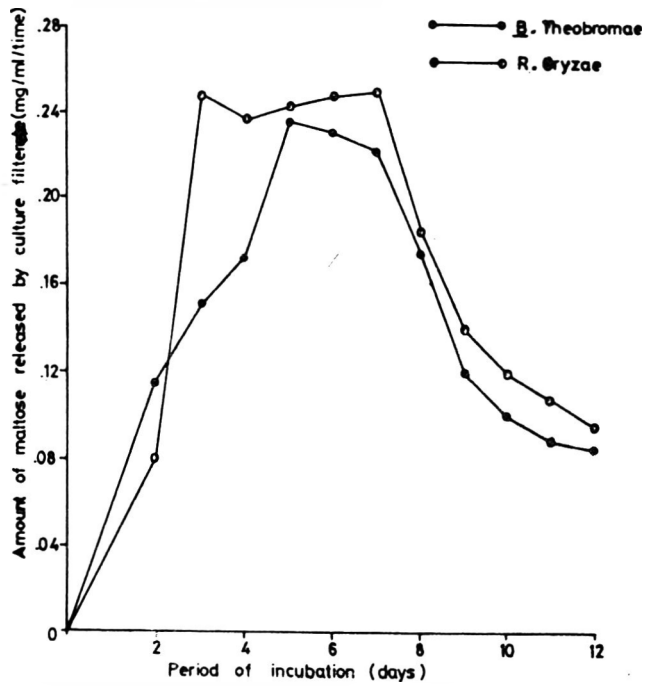

Fig.1. Production of amylase by the isolates in relation to time.

Present address: *University of Ibadan, Nigeria.

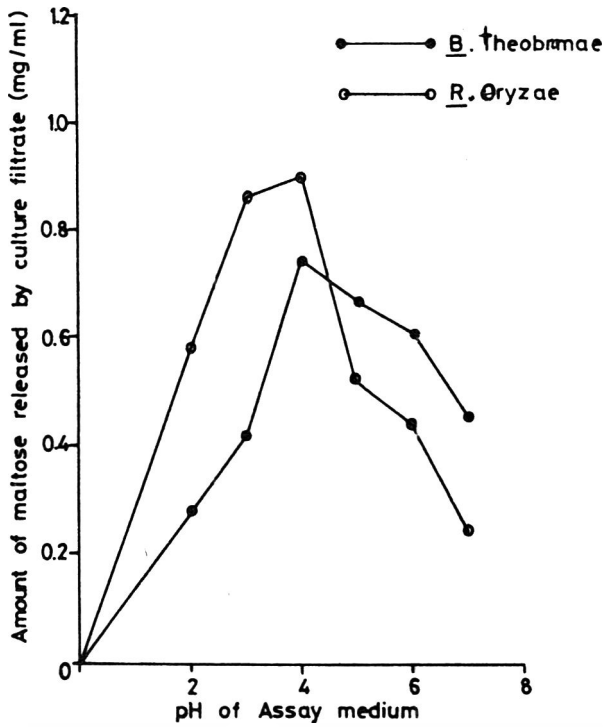

Fig.2. Effect of pH of assay medium on amylolytic activity of culture filtrates.

and mycelia production increased with high concentrations of starch (Table 1). Highest amylolytic activities were observed on starch medium while none was observed on pectin medium (Table 2) agreeing with the observations of Adams[3].

TABLE 1. EFFECT OF DIFFERENT CONCENTRATIONS OF STARCH ON PRODUCTION OF AMYLASE

Starch concn in medium (%)	Maltose units released (mg/ml)		Dry wt. mycelia (mg)	
	B. theobromae	*R. oryzae*	*B. theobromae*	*R. oryzae*
0.2	0.04 ± .005	0.11 ± .01	65	30
0.5	0.08 ± .004	0.18 ± .04	112	40
1.0	0.13 ± .01	0.20 ± .03	130	60
1.5	0.22 ± .01	0.36 ± .04	150	80
2.0	0.25 ± .03	0.48 ± .01	198	80
3.0	0.32 ± .02	0.60 ± .04	282	102
4.0	0.39 ± .02	0.72 ± .02	290	110

Mean = SD of 3 readings.

TABLE 2. EFFECT OF DIFFERENT MEDIA ON PRODUCTION OF AMYLASE BY ISOLATES

Sole carbon source in growth medium	Maltose units released by culture filtrates (mg/ml)	
	B. theobromae	*R. oryzae*
Glucose	00	0.15 ± .03
Starch	0.26 ± .02	0.42 ± .01
Carboxymethyl cellulose	00	0.22 ± .03
Pectin	00	00
Pepper extract	0.12 ± .02	0.22 ± .04

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PROTEIN, LYSINE, MINERAL AND PHENOL CONTENTS OF SOME INDIAN WHEAT *(TRITICUM AESTIVUM* L.) VARIETIES

CHARANJEET K HIRA*, ANITA KOCHHAR, BALWINDER K, SADANA AND KANTA K SHARMA

Department of Foods and Nutrition, Punjab Agricultural University, Ludhiana - 141 004, India

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Nineteen wheat varieties were analysed for crude protein, available lysine, Ca, P, phytate, polyphenols, trace elements and ionizable iron. Mean values for crude protein and available lysine were 11.7% and 2.43 g/16 gN, respectively. Mean phytin P, phenols, Fe, ionizable Fe, Mn, Cu and Zn were 214, 274, 8.2, 3.1, 4.6, 0.65 and 4.25 mg/100 g, respectively. Protein content was not found to be associated with phytate or phenol content.

Wheat is an important source of energy and protein in the diets of populations in developing countries[1]. Being a staple cereal, it contributes more than two third of iron and almost one third of calcium required by adult humans in low socio-economic groups of population in the Northern India. Wheat contains about 8 to 12 per cent protein but is deficient in the essential amino acid, lysine. Minerals from wheat are less bioavailable and phytic acid and polyphenols are thought to be responsible for reduced mineral availability[2]. Therefore, present investigation was undertaken to evaluate nineteen wheat varieties for their protein, lysine, mineral, phytate and polyphenol contents.

Eighteen wheat strains viz 'WL-410', 'WL-711', 'WL-1562', 'WL-2265', 'PBW-12', 'PBW-59', 'PBW-65', 'PBW-120', 'PBW-138', 'PBW-154', 'HD-2009', 'HD-2285', 'HD-2329', 'HD-2428', 'SKAML-1', 'SKAML-3', 'SKA' and 'KAW', grown under similar agroclimatic conditions were procured from Regional Research Station, Faridkot of Punjab Agricultural University, Ludhiana. Commonly consumed wheat was also procured from local market for comparison. Wheat samples were finely ground in an electric stone mill to obtain whole meal and stored in air tight containers for chemical analysis.

Crude protein (N×5.7) was determined using macro- kjeldahl method[3], available lysine by the FDNB modified method[4], calcium and phosphorus using titrimetric and molybdate methods, respectively, as described by AOAC[3]. Phytate phosphorus was determined using the method of McCance and Widdowson as modified by Snook[5]. Ionisable iron was analysed using the method of Narasinga Rao and Prabhavathi[6]. The trace elements, iron, zinc, copper and manganese, were estimated using Atomic Absorption Spectrophotometer after triple acid digestion. Total phenols were determined using AOAC method[3]. All analyses were carried out in triplicate.

Crude protein and available lysine contents of various wheat varieties are presented in Table 1. The crude protein (N×5.7) ranged from 9.3 to 14.6 per cent. Khan and Eggum[7] reported protein content in 11 Pakistani wheat varieties which ranged between 12.3 and 16.7 per cent while Popli and Dhindsa[8] reported protein content of 8.9-12.1 per cent in seven improved wheat varieties of Haryana and Punjab States of India. Available lysine for various wheat varieties ranged between 2.04 and 2.78 g/16 gN with a mean of 2.43 ± 0.25 g/16 gN and the findings are in accordance with earlier reports[7,9,10]. The varietal differences for crude protein and available lysine were significant ($P \leq 0.01$). A very weak negative correlation was observed between protein content and available lysine ($r = -0.34$, $P \leq 0.05$).

Mineral, phytate and phenol contents of various wheat varieties are presented in Table 2. Calcium content ranged between 29 and 54 mg with an average of 39.3 ± 6.4 mg/100 g and varietal differences were significant ($P \leq 0.01$). The results are similar to those of Davis *et al.*[11] and Duhan *et al.*[12] who reported an average of 40 mg and a range of 48-64 mg/100 g, respectively. Total phosphorus content of

TABLE 1. CRUDE PROTEIN AND AVAILABLE LYSINE CONTENT OF WHEAT VARIETIES

Variety/Strain	Protein (N × 5.7) %	Available lysine (g/16 gN)
Local	10.8	2.40
WL-410	12.2	2.12
WL-711	12.1	2.20
WL-1562	10.3	2.32
WL-2265	13.3	2.18
PBW-12	10.9	2.20
PBW-59	12.1	2.04
PBW-65	14.0	2.18
PBW-120	12.1	2.04
PBW-138	9.3	2.60
PBW-154	10.6	2.60
HD-2009	11.0	2.70
HD-2285	11.9	2.71
HD-2329	14.6	2.60
HD-2428	10.5	2.75
SKAML-1	13.1	2.58
SKAML-3	9.5	2.71
SKA	12.5	2.60
KAW	10.9	2.78
Mean ± SD	11.7 ± 1.4	2.43 ± 0.25
Variance F-ratio	31.5*	5.8*

Significant at 1% level.

*To whom all correspondence should be addressed.

TABLE 2. CALCIUM, PHOSPHORUS, TRACE ELEMENTS AND PHENOL CONTENT OF VARIOUS WHEAT VARIETIES. (Mg/100 G)

Variety/Strain	Ca	P		Phenols	Iron		Mn	Cu	Zn
		Total	Phytin		Total	Ionizable			
Local	39	430	198	230	8.1	3.1	4.6	0.6	4.3
WL-410	36	420	206	225	7.4	3.3	4.6	1.1	4.2
WL-711	37	410	198	237	8.4	4.6	4.9	0.5	4.1
WL-1562	35	430	214	300	8.8	4.6	4.2	1.1	4.3
WL-2265	42	430	158	237	9.1	3.1	4.6	0.5	3.6
PBW-12	43	440	198	350	7.4	3.7	4.3	0.6	4.4
PBW-59	34	370	148	307	8.2	2.9	4.9	0.6	3.9
PBW-65	34	450	262	300	7.7	2.8	4.6	0.5	4.4
PBW-120	46	480	198	287	5.0	2.3	4.5	0.6	3.9
PBW-138	32	430	214	257	9.2	3.6	4.2	0.6	2.2
PBW-154	41	470	298	285	9.1	2.9	4.4	0.7	4.5
HD-2009	37	420	188	237	8.3	2.7	5.1	0.7	4.1
HD-2285	29	490	234	300	8.5	2.7	4.1	0.3	3.5
HD-2329	54	460	248	275	7.4	2.5	4.7	0.7	4.1
HD-2428	50	450	248	297	7.0	2.1	4.5	0.6	4.6
SKAML-1	42	420	206	225	9.2	3.7	4.9	0.5	3.9
SKAML-3	36	310	188	337	8.8	4.2	4.5	0.7	4.4
SKA	36	460	228	237	8.1	2.5	4.8	0.6	4.6
KAW	44	380	186	275	8.8	2.5	3.3	0.5	4.7
Mean ± SD	39 ± 6.4	430 ± 40	214 ± 33	274 ± 37	8.16 ± 1.04	3.1 ± 0.83	4.6 ± 0.31	0.65 ± 0.19	4.25 ± 0.31
Variance F-ratio	7.25**	3.40*	16.9**	58.2**	55.4**	50.8**	6.31**	30.00**	10.00**

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

wheat varieties ranged between 310 and 490 mg with an average of 430±40 mg/100 g and was comparable to earlier reports[11,12]. Phytin phosphorus ranged from 148 to 298 mg/100 g. This constituted 40-63 per cent of total phosphorus. Varietal differences for phytin phosphorus were significant ($P \leq 0.01$). Total phenols ranged from 225 to 337 mg with an average of 274±37 mg/100 g and varietal differences were significant ($P \leq 0.01$). A similar value of 0.24 per cent phenols in wheat was reported by Gopal *et al.*[13].

The mean values for iron, manganese, copper and zinc were 8.16±1.04, 4.60±0.31, 0.65±0.19 and 4.25±0.31 mg/100 g, respectively (Table 2). These values were in accordance with the reports of Davis *et al.*[11] and Duhan *et al.*[12] Varietal differences for all trace elements were significant ($P \leq 0.01$). Ionizable iron which is considered to be an indicator of available iron ranged from 2.1 to 4.6 mg with a mean of 3.1±0.8 mg/100 g and constituted 28.4-54.8 per cent of total iron.

Protein content was not found to be significantly related to phenols or phytates. No association was observed among phytin phosphorus and phenols. Therefore, single gene could not be exploited to reduce their contents in wheat. Total phenols were not found to be associated with total ionizable iron or ionizable iron as per cent of total iron. However, a very weak negative correlation was observed between phytin phosphorus and ionizable iron as per cent of total iron ($r = -0.31$, $P \leq 0.05$).

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STUDIES ON COOKING RATE EQUATION OF DHAL

M.B. BERA, S. MUKHERJEE*, R.K. SINGH* AND M. GURUNG*
Department of Food Science & Technology
J.N. Agriculture University, Jabalpur, India

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The cooking mechanism of dhals of pigeon pea and chick pea was investigated in terms of rate equations using cooking core model. The rate equations involve two parameters : the reaction rate parameter of the dhal component with water and diffusion rate parameter of water. The results showed that the cooking rate was mainly limited by reaction rate of the dhal components with water at 98°C. The radius of uncooked core decreased as the time of cooking increased..

Determination of cooking rate equation and calculation of rate parameters i.e., reaction rate and diffusion rate is essential to the design of large scale cooking apparatus[1]. The cooking rate equation could be developed by studying the cooking mechanisms of grain. Theoretical part of the cooking mechanism can be explained on the basis of model situations. The method for establishment of a model is based on a systemetic analysis of the entire cooking process, where one may distinguish two kinds of mechanisms : transport mechanism and mechanism for quality altercations[2]. The optimal process conditions of cooking could be derived from the analysis of these mechanisms. The literature on cooking mechanisms of dhal are fragmentary. In the present investigation, attempts have been made, therefore, to study the cooking rate of dhals of pigeon pea and chick pea by constructing cooking rate equation based on cooking core model[3], as given below:

$$\frac{-dr_c}{d\theta} = \frac{4\pi \ (r^2/r_c^2)\ (C_e - C_0)}{1/(r_c^2/r^2)\ K_r + (r - r_c)/(r_c/r)\ K_m} \quad \ldots\ldots\ldots\ldots (1)$$

Where, $-dr_c/d\theta$, the reduction rate of uncooked core radius, C_e, the equilibrium or saturation moisture content, C_0, the initial moisture content, r, the radius of uncooked core, K_m the diffusion rate parameter and K_r the reaction rate parameter. Since this differential equation could not be solved analytically it was integrated numerically using Runge-Kutta-Gill method[4]. Dhal samples of pigeon pea (variety 'Gwalior-3') and chick pea (variety 'JG-315') were obtained from the department of Post-Harvest Process and Food Engineering, JNKVV, Jabalpur. The initial moisture contents of pigeon pea dhal and chick pea dhal were 9.75 and 9.25 per cent (d.b.), respectively, and these were raised to 25.0 and 42.0 per cent, (d.b.) respectively by soaking. The saturation moisture contents of pigeon pea and chick pea dhal were determined as per the methods of Kulkarni and Bal[5] and found to be 250 and 175 per cent (d.b.) respectively. Five gram dhal each of pigeon pea and chick pea was taken separately in a 100 ml beaker and 50 ml of distilled water was added to each of the beakers. The beakers were immersed in a thermostatically controlled water bath maintained at 98°C. After the predetermined cooking time (15, 30, 45, 60 and 120 min) the dhal sample was removed from the beaker and the changes in volume and weight were noted. The average radius of the dhal was calculated from the volume swelling data. The hardness of cooked dhal was determined as per the method of Bera *et al.*[1], using INSTRON-1104 (UK) universal testing machine. The hardness of the cooked dhal was expressed as the degree of cooking (kg force/g, grain); 0.5 kg force/g grain was taken as the basis for calculating the time required for getting optimum levels of cooking.

The cooking mechanism in the present investigation was studied in terms of two parameters i.e. reaction rate K_r and diffusion rate (Eqn. 1). The K_r and K_m values of pigeon pea dhal and chick pea dhal were calculated after substituting the values of saturated moisture content (M_s) for equilibrium moisture content (C_e) in the equation (1). It is seen that as the time of cooking increased the diffusion rate decreased (Tables 1 and 2). The diffusion rate values (K_m) at 15 and 60 min of cooking of pigeon pea dhal were -3.58×10^{-4}, -3.92×10^{-4} m^2/min and chick pea dhal were -4.49×10^{-4}, -6.44×10^{-4} cm^2/min, respectively. It may be interpreted that the influence of diffusion resistance increases with the increase in growth of cooked layer or growth of gelatinized layer, during cooking of dhal samples. Suzuki *et al.*[3] reported similar observation in cooking of rice. In general, the reaction rate parameter (K_r) increased with the increase in cooking time. The K_r values at 15 and 60 min of cooking of pigeon pea dhal were -4.13×10^{-3}, -0.28×10^{-3} cm/min and chick pea dhal were -6.79×10^{-3} and -0.08×10^{-3} cm/min, respectively. In general, cooking rate of pigeon pea dhal and chick pea dhal is limited by both reaction rate and diffusion rate. However, the relationship between the cooking time and ratio of the parameters (K_m/K_r) indicated that the reaction rate (K_r) influenced the cooking rate with greater intensity than the diffusion rate (K_m) i.e., ratio of parameters decreased with the time of cooking (Tables 1 and 2).

The reduction rate of the uncooked core ($-dr_c/d\theta$) increased with increase in the time of cooking; the radius of uncooked core (r_c) decreased with the increase in cooking

**Present address:* Department of Post-harvest Process and Food Engineering, J.N. Agricultural University, Jabalpur - 482004.

TABLE 1. EFFECT OF COOKING TIME ON RATE PARAMETERS, REDUCTION RATE OF UNCOOKED CORE AND DEGREE OF COOKING OF PIGEON PEA AT 98°C

Cooking time (min)	Rate parameters		$-dr_c/d^c$	K_r/K_m	Degree of cooking (kg force/g grain)
	K_m (cm^2/min)	K_r (cm/min)			
15	-3.58×10^{-4}	-4.13×10^{-3}	78.18	11.530	1.1
30	-3.75×10^{-4}	-4.72×10^{-3}	78.73	12.580	0.8
45	-3.40×10^{-4}	-3.62×10^{-3}	78.89	10.640	0.6
60	-3.92×10^{-4}	-0.283×10^{-3}	84.40	0.714	0.5

TABLE 2. EFFECT OF COOKING TIME ON RATE PARAMETERS, REDUCTION RATE OF UNCOOKED CORE AND DEGREE OF COOKING OF CHICK PEA AT 98°C

Cooking time (min)	Rate parameters		$-dr_c/d^c$	K_r/K_m	Degree of cooking (kg force/g grain)
	K_m (cm^2/min)	K_r (cm/min)			
15	-4.59×10^{-4}	-6.79×10^{-3}	71.46	14.790	1.20
30	-5.79×10^{-4}	-7.77×10^{-3}	87.12	13.419	1.00
45	-6.07×10^{-4}	-0.09×10^{-3}	90.51	0.148	0.75
60	-6.44×10^{-4}	-0.08×10^{-3}	91.55	0.124	0.55

time. The rate of reduction of uncooked core at 60 min of cooking was 84.4 and 91.85 per cent, respectively for pigeon pea and chick pea. It appears, therefore a little increase in cooking time would have completely converted the uncooked core to cooked grain. Hardness data of dhal after cooking at 98°C for various levels of cooking time, revealed that pigeon pea and chick pea dhal took 60 and 67.5 min respectively to attain optimum level of cooking.

It is interesting to note that cooking times calculated from the cooking core model and that from hardness data of pigeon pea dhal and chick pea dhal were almost same thus confirming the suitability of cooking core model in understanding the cooking mechanisms and prediction of cooking time of any food grain.

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RECOVERY OF DHAL FROM REDGRAM STORED UNDER DIFFERENT CONDITIONS

USHA KUMARI * AND N.S. REDDY
Department of Foods and Nutrition,
Marathwada Agricultural University, Parbhani - 431 402, India

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Dhal (dehusked split grains) recovery from redgram (*Cajanus cajan*) grains treated with protectants like dried neem leaves, cow dung ash (1.0%) and mustard oil (0.5%) and stored for four months in tin containers and clay pots was studied. The per cent dhal recovery improved in samples treated with dried neem leaves and mustard oil and stored for four months in tin containers. Highest recovery was (80.8%) in mustard oil treated sample and the lowest (68.6%) was in cow dung ash treated sample. Mustard oil and dried neem leaves treated samples were not infested whereas cow dung ash treated samples showed 61.5% damage due to insect infestation. There was a negative correlation at 5% level of significance.

Redgram (*Cajanus cajan*) accounts for 12-15 per cent of the world's total pulse production[1]. It is consumed mostly as dehusked split grains (dhal). Dehusking and splitting of grains appear to be influenced by factors like moisture content, temperature, relative humidity, seed size and extent of infestation during storage. Husk is attached to the cotyledons by a layer of gum and lignin[2]. The adherence of husk to the cotyledons depends on the tackiness of these gums which in turn depends not only on the amount but also on the chemical nature and extent of hydration.

Low recovery of dhal after prolonged storage is due to the damage caused by insects[3-5]. However, little information is available on the effect of protectants, storage conditions including type of containers and periods of storage. Therefore, present investigation was undertaken and the influence of factors like moisture content, seed size and infestation affecting recovery of dhal were studied.

In the present study, a survey conducted with 150 farmers in Marathwada region of Maharashtra State (India) reveals that some indigenous protectants like dried neem leaves, cow dung ash and vegetable oils are in common use but their effectiveness was not ascertained. Commonly used storage containers by rural people are metal or tin containers and clay pots.

Redgram variety 'IPCL-87' was chosen for the present study. Dried neem leaves, cow dung ash and mustard oil were selected for the treatment of redgram as protectants during storage of redgram. Tin containers and clay pots were used as storage containers. The storage was continued upto four months.

Freshly harvested redgram was procured from the Department of Agronomy, College of Agriculture, Marathwada Agricultural University, Parbhani in one lot. After cleaning, the lot was divided into four equal portions. From one portion of redgram, a sample of 8 kg, without the application of any protectant was stored as a control in each storage container. The same amount of redgram from other portions was stored in each storage container after treating them with protectants like dried neem leaves, cow dung ash and mustard oil.

Determination of dhal yield: About 100 g seed sample (six replicates) of each treatment including untreated was soaked in distilled water overnight and dried in the sun for eight hours by spreading them on a clean cloth. After drying, the grains were dehulled into dhal by using a traditional stone grinder. The husk was separated by winnowing and weight of dhal recovered was determined. The values have been expressed as percentage of dhal yield.

The effect of storage periods, storage containers and protectants on the dhal yield of redgram was determined by analysis of variance of three way classification. Correlation analysis was carried out to find out the relationship between infestation and dhal yield[6].

Dhal yield from redgram stored for varying periods in different containers with and without protectants is presented in Table 1. Dhal yield from redgram before storage was 77.8 per cent which was significantly higher than that of infested samples.

The control samples of clay pot and tin container, 2 months after the storage, did not show any change in the per cent dhal yield. Dhal yield from treated samples in clay pot at 2 months of storage decreased considerably and it varied from 73.0 to 74.4 per cent. The variation in case of treated samples in tin container was 72.2 to 75.5 per cent after 2 months of storage. The lowest and highest per cent of dhal yield were obtained in cow dung and mustard oil treated samples, respectively.

A considerable decrease in dhal yield was noticed in cow dung ash treated samples with increased period of storage. The per cent of dhal yield was the lowest (68.6 per cent) in tin container.

The effect of period of storage, protectants, and storage containers on the per cent of dhal recovery was not significant. But, a highly significant negative correlation was observed between dhal yield and infestation ($r = -0.605$) at 5 per cent level of significance. Present results indicate that neither the storage containers nor the protectants exert a significant effect

Present address: Department of Foods and Nutrition, Rajendra Agricultural University, Pusa, Samastipur - 848 125, India.

TABLE 1. DHAL YIELD FROM TREATED AND UNTREATED REDGRAM STORED FOR VARYING PERIODS IN DIFFERENT STORAGE CONTAINERS WITH CORRESPONDING INFESTATION (I)

Protectants	Clay pot				Tin			
	2 months		4 months		2 months		4 months	
	Dhal recovery (%)	Infestation (%)	Dhal recovery (%)	Infestation (%)	Dhal recovery (%)	Infestation (%)	Dhal recovery (%)	Infestation (%)
Control	77.7	—	79.9	—	78.0	8.0	73.6	12.3
Neem leaves	74.4	—	78.9	—	75.5	—	80.1	—
Cow dung ash	73.0	19.2	72.5	61.5	72.2	17.5	68.6	42.0
Mustard oil	73.1	—	80.2	—	75.2	—	80.8	—

Each value is the mean of six observations.

Main Effects	**DR**	**I**
(i) Storage time		
2 months	74.9	5.6
4 months	76.9	14.5
SE	3.86	0.38
CD	NS	1.04
(ii) Storage containers		
Clay pot	76.3	10.1
Tin	75.5	10.0
SE	3.86	0.38
CD	NS	NS
(iii) Protectants		
Control	77.4	5.1
Neem leaves	77.3	-
Cow dung ash	71.6	35.1
Mustard oil	77.4	—
SE	5.45	0.53
CD	NS	1.47

NS: Not Significant

on dhal yield for four months but increase in infestation decreases the recovery of dhal from grains.

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NUTRIENT CONTENT IN *FLACOURTIA* FROM WESTERN MAHARASHTRA

D.K. KULKARNI, M.S. KUMBHOJKAR, V.V. AGTE, N.S. JOSHI AND V.N. JOSHI*

Maharashtra Association for the Cultivation of Science, Research Institute, Pune-4, India

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It is observed on fresh weight basis that the ripe fruits of *F. montana* has 1.08 g % proteins, 17.21 g % carbohydrates, 1.59 g % fats, 232 mg % calcium, 10.6 mg % phosphorus and 38 mg % tannic acid. Corresponding values for *F. latifolia* were 2.13 g %, 22.86 g %, 2.98 g %, 144 mg %, 19.7 mg % and 31 mg % respectively. Unripe fruits showed marked differences in the contents of calcium and phosphorus. Presence of iron in very low quantities and vitamin C in traces in all the stages of estimations are noteworthy.

Area of Western Maharashtra (15°36′-20°52′ N and 72°54′-75°50′ E) is mostly a hilly desolate terrain. Tribal inhabitants in this area still live in remote places and depend on surrounding forests for supply of food. Several wild edible plants cater to their hunger. Gopalan *et al.*[1] have reported nutrient contents in common edible plants. It is observed that many wild plants hold promise for being multiplied on larger scale for edible purpose. However, a few reports on their nutritional evaluation are available. The genus *Flacourtia* Commers ex L'Herit is one of such examples.

The genus *Flacourtia* Commers ex L' Herit, belonging to the family Flacourtiaceae, has 15 species distributed throughout the world. They occur in Malaysia, Singapore, Sumatra and Penang regions of Far East. In India, they are reported from Assam, Orissa, Eastern Ghats, Mount Abu, Nilgiris, Bihar, Deccan and Konkan[2]; Hooker[3] and Singh and Arora[4]. Area of Western Maharashtra harbours 6 species of the genus *Flacourtia*. Of these, an apparently endemic plant *F. montana* Grah. has been found in Western Maharashtra[5-8]. The other species, *F. latifolia* Cooke is of common occurrence. Both *F. montana* and *F. latifolia* are middle-sized trees or small thorny shrubs and found in deciduous, semi-evergreen and dry parts of Western Maharashtra. Both the species yield edible fruits that are acidic in taste and agreeable in flavour. Fruits ripen in March.

Gopalan *et al.*[1] have reported nutritional analysis of fruits of other species like *F. indica* Merr. and *F. cataphracta* Roxb., while the analyses of *F. occidentalis* Blatter and *F. inermis* Roxb. are found in the Wealth of India[2]. Dinda *et al.*[9] have reported on the chemical composition of *F. jangomas* Raeusch. However, fruits of the species *F. montana* Grah. and *F. latifolia* Cooke have not yet been studied for their nutrient contents and hence present work was carried out.

Ripe and unripe fruits of *F. montana* Grah. were collected from the village Sakedi in Maharashtra State in February. Ripe and unripe fruits of *F. latifolia* Cooke were collected near Pune in March. Whole fruits at both stages of ripening have been used for proximate analysis. The seeds were washed, air-cried, homogenised. Moisture, fat, nitrogen and ash contents were determined[10]. Carbohydrate content was calculated by difference. Energy was calculated by using Atwaters factors. Phosphorus was estimated by using meta-vanadate reagent[11]. Contents of calcium and iron were estimated using Atomic Absorption Spectrophotometer (Perkin-Elmer, U.S.A.). Tannic acid content was determined by Folin Dennis reagent[12], Vitamin C contents were worked out by dye method as per NIN Manual[13].

Observations on proximate chemical composition of *F. montana* and *F. latifolia* are presented in the Table 1. They indicate averages of duplicate estimations run in two independent sets in two stages of ripening. Ripe fruits of *F. latifolia* are observed to have higher values of protein, fat, carbohydrates, phosphorus per cent and energy than *F. montana*. However, the Ca and tannic acid contents as mg/100 g dry matter in *F. latifolia* are found to be lower than *F. montana*. Nutrient composition of other species of *Flacourtia* species has also been reported. The proximate composition and energy value of *F. montana* are comparable with *F. cataphracta*, while that of *F. latifolia* is comparable with *F. indica*. These results indicate good nutritional potential in *F. montana* and *F. latifolia* fruits. When the fruits are compared at two stages of ripening it is observed that unripe fruits have lower moisture content but higher percentage of fats, proteins, carbohydrates, minerals and tannic acid than the ripe fruits. Biochemical changes during 4 stages of ripening of jackfruit

TABLE 1. CHEMICAL COMPOSITION (%) IN FRUITS OF *FLACOURTIA* SPECIES AT TWO STAGES OF RIPENING (FRESH WEIGHT BASIS)

Species	*Flacourtia latifolia*		*Flacourtia montana*	
	Ripe	Unripe	Ripe	Unripe
Moisture g	71.20	68.80	79.70	68.10
Protein g	2.13	2.68	1.08	1.74
Fat g	2.98	3.91	1.59	2.36
Energy Kcal	127.00	145.00	80.00	137.00
Carbohydrates	22.86	24.91	17.21	27.15
Ash g	0.83	0.93	0.42	0.65
Calcium mg	144.00	254.00	232.00	324.00
Iron mg	0.22	0.27	0.31	0.24
Phosphorus mg	19.70	38.90	10.6	17.90
Tannic acid mg	31.00	34.00	38.00	70.00
Vitamin C mg	Traces	Traces	Traces	Traces

and mango[14,15] have been studied by Selvaraj and Pal when similar findings regarding dry matter per cent, starch, sugars, and tannins are observed. They have also reported changes in chemical composition of papaya during growth and development[16] when they observed reduction in dry matter, crude protein, P, K, Ca, Fe, vit. A, vit. C, and starch from 15 days to 130 days after anthesis. Although the fruits have been collected directly from the wild trees, the results about changes in proximate principles during ripening concur with these findings. Further about the observed changes in tannins, similar findings have been reported by Sohan Singh and Dhillon[17] on pears and Gangwar and Tripathi[18] on peach.

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CHANGES IN PHOSPHOLIPID BROWNING OF HENS' WHOLE EGG POWDER PACKED IN DIFFERENT PACKING MATERIALS

T.S. SATYANARAYANA RAO
Defence Food Research Laboratory, Mysore - 570 011, India

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Freeze-dried and foam-mat-dried hens' egg powders were prepared from egg melage of uniform composition and commercial spray dried egg powders were packed in cans and in flexible pouches under air and without air. Drying conditions and packaging materials did not significantly influence the non-enzymatic browning of phospholipid fraction of egg powders during storage (control and at 19-27°C) whereas high temperatures (55°C, 42°C and 37°C) had significant effect on non-enzymatic browning reaction in all three types of egg powders packed in cans and in flexible pouches.

Lipid browning in whole egg powder during storage is accompanied by off-flavour, discolouration, loss of solubility and nutritive value. The non-enzymatic browning to certain extent can be retarded by desugaring egg melange before drying. The interaction between proteins and lipids in egg powder does not appear to be a serious problem since the residual moisture in the product is very low. Stewert *et al.*[1] and Olcott and Herbert[2] have observed that loss of colour and solubility in untreated albumen were appreciably high within few weeks at 30-40°C due to glucose-protein interaction resulting in a brown product. The reaction of phospholipids and aldehydes in egg appears to play an important role in discolouration[3]. Changes in the colour of lipid fraction of dehydrated egg powder during storage are due to the destruction of naturally occurring carotenoid pigments, production of yellow to brown materials from unsaturated fatty acids and by the interaction of amine and aldehyde groups of lipids[4].

So far no systematic study has been done on changes in phospholipid browning of egg powders packed in different packaging materials. Therefore, the present study was undertaken to examine the effect of packaging materials on the phospholipid browning in different types of egg powders stored at different temperatures.

The spray dried egg powder was procured from M/s Foods and Inns, Bombay. The other two types egg powders were prepared as follows. the eggs of 'White Leghorn' birds were procured and pretreated as per the method of Rao *et al.*[5] The egg melange was desugared from an initial level of 400 mg to 20 mg per cent as per the method described earlier[6]. Accelerated freeze drying was carried out using a pilot plant scale (Socaltra make, manufactured by Socite Alsaciennc Etudes et de Travalk, France) on operating with radiant heating. The melange was frozen in trays, sliced into pieces of uniform size (approx. 2.5 × 2.5 × 1.25 cm), deep frozen to −20°C and then freeze-dried for 6 hr keeping the surface temperature at 50°C. For foam-mat-drying, the melange was whipped for 5 min, using a laboratory stirrer with whipping attachment, the foam was spread on a perforated tray measuring 122×46×2.5 cm dried at 50-60°C for 30 min in a cross-flow drier by maintaining the velocity of hot air at 500-600 linear feet/min. The finished product was further dried to a moisture content of below 3 per cent using a desiccant (calcium oxide) or by vacuum drying at 50°C.

All the three types of egg powders were packed in butter size cans (401×300) and in paper-aluminium foil polyethylene laminate pouches (PFP) with and without air, and also in high density polyethylene 300 gauge (HDPE) bags. The packages were stored at 55°C, 42°C, 37°C, 19-27°C, (ambient temperature) and 4°C (control) for different periods and analyzed periodically.

The moisture content was determined as per A.O.A.C. method[7]. The phospholipid content was determined as per the method described by Rouser *et al.*[8] The change in absorbance of phospholipid in duplicate samples at 500 nm was taken as a measure of browning.

The moisture content in spray-dried, freeze-dried and foam-mat-dried whole egg powders were 2.15, 1.86 and 2.17 per cent respectively.

Table 1 represents the changes in absorbance of phospholipid fraction of egg powders packed in different packaging materials stored at 55°C and at 42°C for a period of 90 days and for 365 days. The initial absorbance values of the phospholipid fraction of spray-dried, foam-mat-dried and freeze-dried egg powders were 0.125, 0.115 and 0.110 respectively. A temperature of 55°C was chosen as this temperature is observed in Defence stores in some parts of the country. At 55°C storage, the absorbance increased in all samples as the storage period increased (Table 1). Increases in absorbance values in samples packed under air in both packaging materials may be due to increased lipid oxidation. Similar observations were also made by Lewis *et al.*[9] as oxygen had some effect on browning in relatively diluted acidified sugars. HDPE packed samples showed intense browning. Due to prolonged storage, the changes in absorbances observed at 42°C were larger.

Table 2 indicates the absorbance changes of phospholipid fraction of egg powders packed in different packaging materials. The browning of phospholipid was more at 37°C when compared at 19-27°C and in control samples.

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TABLE 1. ABSORBANCE OF PHOSPHOLIPID FRACTION OF EGG POWDERS PACKED IN DIFFERENT PACKAGING MATERIALS

Egg powder	Storage period (days)	Cans		PFP laminate		HDPE
		N_2 pack	Air pack	N_2 pack	Air pack	
		55°C storage temperature				
Spray-ried	30	0.180	0.185	0.180	0.185	0.185
	60	0.190	0.195	0.190	0.195	0.195
	90	0.210	0.215	0.210	0.210	0.210
Foam-mat-dried	30	0.170	0.175	0.165	0.170	0.175
	60	0.180	0.190	0.185	0.190	0.190
	90	0.200	0.210	0.195	0.210	0.200
Freeze-dried	30	0.175	0.175	0.165	0.180	0.170
	60	0.185	0.190	0.180	0.190	0.190
	90	0.200	0.210	0.210	0.210	0.210
		42°C storage temperature				
Spray-dried	180	0.240	0.235	0.240	0.235	0.240
	365	0.400	0.410	0.410	0.410	0.400
Foam-mat-dried	180	0.230	0.225	0.220	0.230	0.225
	365	0.400	0.410	0.395	0.410	0.400
Freeze-dried	180	0.235	0.230	0.240	0.240	0.235
	365	0.400	0.410	0.400	0.400	0.410

The initial values were: spray-dried 0.125, foam-mat-dried 0.115 and freeze-dried 0.110.

TABLE 2. ABSORBANCE OF PHOSPHOLIPID FRACTION OF EGG POWDERS PACKED IN DIFFERENT PACKAGING MATERIALS

Egg powder	Storage period (days)	Cans		PFP laminate		HDPE
		N_2 pack	Air pack	N_2 pack	Air pack	
		37°C storage temperature				
Spray-ried	180	0.225	0.210	0.220	0.215	0.220
	365	0.350	0.370	0.360	0.375	0.375
Foam-mat-dried	180	0.215	0.210	0.200	0.210	0.215
	365	0.350	0.370	0.365	0.365	0.360
Freeze-dried	180	0.215	0.220	0.215	0.220	0.215
	365	0.360	0.365	0.360	0.370	0.370
		19-27°C storage temperature				
Spray-dried	180	0.150	0.155	0.160	0.150	0.155
	365	0.275	0.300	0.290	0.285	0.290
Foam-mat-dried	180	0.160	0.165	0.150	0.155	0.155
	365	0.280	0.290	0.295	0.300	0.290
Freeze-dried	180	0.155	0.160	0.155	0.155	0.150
	365	0.285	0.285	0.290	0.285	0.270
		4°C storage temperature				
Spray-dried	180	0.140	0.140	0.135	0.135	0.140
	365	0.210	0.200	0.200	0.200	0.200
Foam-mat-dried	180	0.135	0.135	0.135	0.135	0.130
	365	0.200	0.210	0.200	0.210	0.190
Freeze-dried	180	0.140	0.135	0.135	0.130	0.135
	365	0.199	0.200	0.180	0.190	0.190

The initial values were: spray-dried 0.125, foam-mat-dried 0.115 and freeze-dried 0.110.

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DETECTION OF MUTTON, BEEF AND BUFFALO BEEF WITH ANTISERA TO SPECIES LIVER BY DOUBLE GEL IMMUNO-DIFFUSION, IMMUNO-ELECTROPHORESIS AND COUNTER IMMUNO-ELECTROPHORESIS

S. SRINIVAS, P.M. REDDY AND K.S. REDDY
Department of Meat Science and Technology
College of Veterinary Science, Tirupati - 517 502, India

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Antisera were raised in rabbits against fresh (native) liver antigens of sheep, cattle and buffalo. Experiments were conducted to identify meats of sheep (mutton), cattle (beef), and buffalo (buffalo beef) using double gel immuno-diffusion (DID), immuno-electrophoresis (IE) and counter immuno-electrophoresis (CIE) techniques. All the antisera raised showed cross reactions amongst meats of sheep, goat, cattle and buffalo. However, the antisera revealed the presence of one distinct, separate precipitation line of each of sheep, cattle and buffalo species meats tested. When tried to prove the separate line as species - specific antigenic fraction, the sera could not be made species - specific.

Fradulent substitution of cheaper and inferior quality meats for more expensive ones is a world wide phenomenon. Substitution of meats varies from country to country depending upon the cost of the product, demand, consumer preference, socio-religious habits and customs. Hence, species - identification of meats is of great importance and is a challenging task in food hygiene and quality control programmes. Several immuno-chemical methods have been ended with partial success for want of species - specific antibody especially to detect phylogenetically related species. Recent studies by Reddy[1] on adrenal glands revealed the usefulness of organ antigens in developing species - specific antibodies in detecting species - origin of fresh and cooked meats. Hence, the present study was undertaken to determine the efficacy and suitability of fresh liver extracts for raising antibodies in rabbits to differentiate mutton, beef and buffalo beef using DID, IE and CIE techniques.

Fresh liver antigens of sheep, cattle and buffalo were prepared according to the procedure described by Milgrom[2]. Field samples of fresh muscles from cattle (beef), buffalo (buffalo beef), sheep (mutton) and goat (chevon) were collected and stored at —20°C until processed for the preparation of saline muscle extracts of test antigens. To prepare field antigens, 20 g sample of skeletal muscle was blended with 100 ml of physiological saline (20 per cent meat extract) in a homogenizer for 15 min at room temperature and filtered through Whatman filter paper No.4. Thiomersal was added to the filtrate (final concentration of 1 in 10,000) and was stored at —20°C till used. To prepare the cooked meat antigens, 20 per cent fresh meat extract antigens were cooked in pressure cooker for 20 min and centrifuged at 5000 r.p.m. and the supernatant fluid was taken as 20 per cent cooked meat saline extract. The protein concentration in liver and muscle extract antigens was determined by the method of Lowry *et al.*[3] Bovine serum albumin (BSA) was used as standard. Apparently healthy rabbits of 6 months age (body wt 1.25-1.50 kg) were used for raising antibodies as per the procedure described by Reddy[1]. Antisera were collected at regular weekly intervals and stored at —20°C till tested against native as well as cooked muscle extract (CME), buffalo muscle extract (BME), sheep muscle extract (SME) and goat muscle extract (GME). The different immuno-chemical methods used were DID, IE and CIE as described by Ouchterlony and Nilsson[4] to identify the origin of meats of different species.

The reaction of rabbit anti sheep (RAS (N)) serum in DID indicated the presence of one thick line of precipitation with native sheep muscle extract (SME) that fused with a thin line of precipitation formed with native goat muscle extract (GME), cattle muscle extract (CME) and buffalo muscle extract (BME) antigens revealing the presence of identical antigenic fractions confirming the cross reactivity amongst those species meats. However, with native liver extracts of sheep, cattle and buffalo revealed the presence of one separate precipitation line specific to sheep species only and no such precipitation line was observed with cattle and buffalo species. When IE (Fig.1) was conducted, RAS (N) serum showed the presence of one specific separate line of precipitation with homologous (sheep) native muscle extract only and no such reaction with cattle and buffalo species muscle extracts. Similar lines of precipitation were also observed when CIE was performed giving two lines of precipitation with GME, CME and BME and three lines of precipitation with SME native antigens. The results of RAC (N) serum in DID showed the presence of two precipitation lines with CME and one of them was completely identical with BME indicating their phylogenetic relationship. The other line was completely identical with only one line of precipitation developed with SME, and GME native antigens. However, with fresh liver extracts a cattle specific antigenic fraction was observed. In IE and CIE (Fig.2) studies, presence of species - specific line of precipitation was observed against RAC (N) serum with homologous CME native extract antigens. RAB (N) serum in DID (Fig.3) showed the presence of one species specific (buffalo) antigenic fraction as was observed in case of RAS (N) and RAC (N) sera. In IE, it showed three precipitation arcs with buffalo, two with cattle and one each with sheep and goat native muscle extracts. In CIE also, it showed the presence of one fast moving antigenic fraction in all the

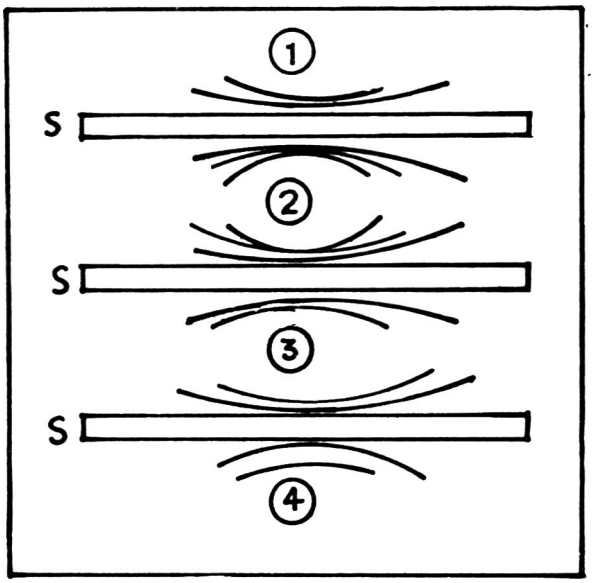

Fig.1. Reaction of RAS (N) Serum with native muscle extract antigens in IE. S : RAS (N) Serum
1: GME 2: SME 3: CME 4: BME

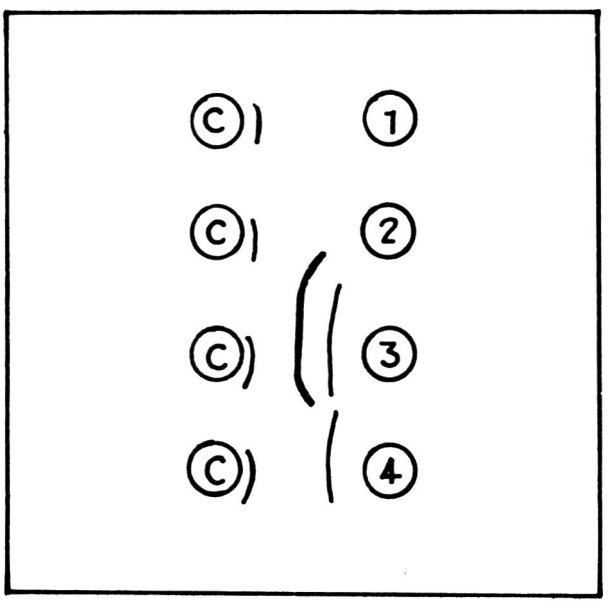

Fig.2. Reaction of RAC (N) serum with native muscle extract antigens in CIE.
c : RAC (N) serum
1: GME 2: SME 3: CME 4: BME

four (BME, CME, SME and GME) types of muscle extracts and two more with BME and one more with cattle.

All the sera RAS (N), RAC (N) and RAB (N) raised in rabbits against fresh liver extracts revealed the presence of cross reactions amongst the native muscle extracts of the four species viz. sheep, goat, cattle and buffalo studied and no visible reaction with cooked muscle extracts of those species. However, mutton, beef and buffalo beef could be differentiated by observing the number of precipitation lines observed as expressed by Bubloz[5] and Ramadas and Misra[6]. In all the

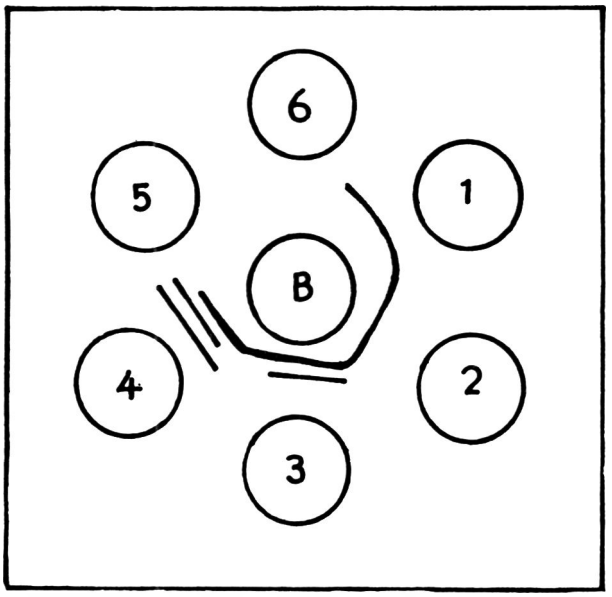

Fig.3. Reaction of RAB (N) serum with native muscle extract antigens in DID.
B : RAB (N) serum.
1: GME 2: SME 3: CME 4: BME.

sera, a separate distinct specific precipitation line was observed in each of the homologous system and the same could not be proved as species - specific due to normal difficulties observed in trial and error method of adding cross reacting heterologous antigens to those sera to remove the cross reacting antibodies, as the sera lost their titre to show any visible reaction. All the sera could not be made mono-specific due to same reasons. Similar difficulties were also experienced by Reddy and Karpas *et al*[7].

Since, it was observed that there were common antigenic fractions amongst sheep, cattle and buffalo species, and as the sera could not be made mono-specific, further studies could be taken up to raise antibodies in phylogenetically related species as recent studies on cross-immunization techniques to develop species - specific antisera were fruitful as reported by Reddy[1] Nath[8] and Bansal and Mandokhot[9].

The authors are grateful to Dr. (Mrs) Usha V. Mandokhot Associate Professor, Haryana Agricultural University, Hisar for her kind encouragement throughout the investigation.

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ESSENTIAL AMINO ACIDS PROFILE IN EIGHT TRADITIONAL CEREAL CULTIVARS OF TRANS-HIMALAYAN REGION

S.K. KATIYAR AND A.K. BHATIA
Ethnobiology Unit, Regional Research Laboratory (CSIR), Jammu - 180 001, India

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Proximate and amino acid composition of eight traditionally cultivated varieties of pseudocereals and cereals viz. *Amaranthus polygamus*, *Fagopyrum esculentum*, *Eleusine coracana*, *Hordeum vulgare*, *Panicum miliare*, *Paspalum scrobiculatum*, *Setaria verticillata*, and *Triticum vulgare* of trans-Himalayan region were chemically evaluated. The proteins of all the cereals are well balanced with respect to their essential amino acid contents. The quantities are comparable to the known standard varieties of rice and wheat. Pseudocereals (*A. polygamus* and *F. esculentum*) possess better amino acids profile with high lysine contents of 4.4 and 4.7 g/100 g protein respectively.

Cereals constitute a major component of diets consumed by the tribals of trans-Himalayan region (altitude, 2500-4500m above sea level). They contribute 70-80 per cent of caloric intake and a significant proportion of several other nutrients except vitamins A and D. Agriculture was and continues to be the main occupation of the local inhabitants. The farmers mostly produce coarse grains which are being grown since prehistoric time on dry land in semi arid trans-Himalayan regions. In addition to these grains, the inhabitants of this region also consume the parts of many wild edible plants as their food[1-3]. The prominent pseudocereals of the region are *Amaranthus polygamus* and *Fagopyrum esculentum* while the cereals are *Eleusine coracana, Hordeum vulgare, Panicum miliare, Paspalum scrobiculatum, Setaria verticillata* and *Triticum vulgare*. The region remains cut off during most part of the year due to heavy snowfall and severe winds. The temperature during winter usually falls upto —40°C. The air is colder, dry and purer though perceptibly lower in oxygen contents.

To evaluate nutritional status of the tribals of trans-Himalayan region i.e. Ladakh in Jammu and Kashmir State, the following cereals and pseudocereals have been selected and collected from the fields of different zones to evaluate their nutritive value. The present communication deals with the study of proximate chemical composition and the essential amino acids profile in proteins of these grains: namely, 1) *Amaranthus polygamus* Linn., 2) *Fagopyrum esculentum* Moench., 3) *Eleusine coracana* (L) Gaertn, 4) *Hordeum vulgare* L., 5) *Paspalum scrobiculatum* L., 6) *Panicum miliare* Lamk., 7) *Setaria verticillata* Beauv. and 8) *Triticum vulgare* Vill.

Grains were collected and botanically identified, cleaned and powdered in a hand grinder to 100-120 mesh size. Moisture, total mineral matter (ash), protein, fibre and starch were determined by AOAC[4] methods. Phosphorus and iron were determined by following the procedure of Fiske and Subba Row[5] and Andrews and Felt[6] respectively while calcium, potassium and sodium were estimated by flame photometry. Three independent replicates were taken for chemical analysis and mean values are reported.

Estimation of essential amino acids was made in the defatted powder. The samples were hydrolysed with 6N HCl for 24 hr at 105°C in a sealed test tube. For tryptophan determination, sample was hydrolysed with 6N NaOH. Two dimensional chromatograms were developed with the solvent system, n-butanol: acetic acid: water (upper layer, 4:1:5), and phenol (80 per cent, w/v) - ammonia. Identification and estimation of individual amino acids were made according to the procedure adopted by Rao and Subramanian[7].

Table 1 shows the proximate composition of the cereals and pseudocereals. *A. polygamus, F. esculentum, H. vulgare* and *T. vulgare* are the dominant crops of snow desert land of Ladakh region. The proximate and amino acid composition of the pseudocereals are superior to the cereals. *A. polygamus* and *F. esculentum* contain (13.8 and 9.9 per cent) protein which are higher than cereals. The mineral content is also higher. Fat content is also comparatively higher. Starch constitutes the main dietary component of the cereals and it varied from 45.0 to 73.3 per cent. It can be mentioned here that for maintenance of energy balance at high altitudes, where oxygen content is low, carbohydrate is superior to fat as a source of energy[8] because oxygen requirement for fat combustion per unit of energy liberated is higher than for either protein or carbohydrate[8].

Essential amino acid profile of the grains is shown in Table 2. The protein content in the cereals varied from 5.4 to 13.8 per cent. All the essential amino acids are present in balanced quantity in each cereal. The amino acid profiles of these Himalayan cereals are more or less similar to the well known standard cereals like rice and wheat[9,10] Amino acid profiles of the proteins of pseudocereals have high level of lysine. Lysine is usually much lower in proteins of most of other cereals and millets. In addition, leucine and isoleucine ranged from 6.5 to 16.6 and 3.1 to 7.5 per cent respectively. These grains can serve as sole source of protein in the diet in general and particularly in the tribal foods of Ladakh region where cultivation of pulses is less. It is reported that some varieties of amaranth contain fat and protein upto 8 and 16 per cent respectively and the protein efficiency ratio of raw seeds (at 10 per cent level) is comparable with that of casein[11,12]. It

TABLE 1. PROXIMATE COMPOSITION OF SOME CEREALS OF TRANS HIMALAYAN REGION

Name of cereal	Moisture (%)	Ash (%)	Crude protein (%)	Fat (%)	Crude fibre (%)	Starch (%)	Other carbo-hydrates	Minerals (mg/100g)				
								Na	K	Ca	P	Fe
Amaranthus polygamus	10.8	2.1	13.8	6.2	3.1	57.3	6.6	20	289	48	583	100
Fagopyrum esculentum	9.6	3.0	9.9	2.2	12.7	57.7	4.9	19	387	152	345	53
Eleusine coracana	10.1	2.2	8.1	1.0	4.1	59.1	15.3	21	408	97	266	16
Hordeum vulgare	7.2	3.1	7.3	1.4	4.3	62.2	14.4	18	510	33	230	40
Panicum miliare	10.5	5.6	7.4	3.2	9.4	45.0	18.9	29	311	95	116	27
Paspalum scrobiculatum	11.6	0.6	5.4	1.5	0.3	73.3	7.3	42	370	120	118	13
Setaria verticillata	9.2	2.9	6.8	4.0	9.2	53.6	14.3	45	247	102	55	58
Triticum vulgare	9.5	4.0	8.4	1.8	2.4	64.3	9.7	16	360	39	315	6

Values are means of three independent replicates.

TABLE 2. ESSENTIAL AMINO ACID (G PER 100 G PROTEIN) CONTENTS IN PROTEINS OF SOME CEREALS OF TRANS-HIMALAYAN REGION

Name of cereal	Protein (%)	Cystine	Histidine	Leucine	Iso-leucine	Lysine	Methi-onine	Phenyl-alanine	Threo-nine	Trypto-phan	Valine
Amaranthus polygamus	13.8	2.1	2.6	6.7	3.1	4.4	2.2	5.3	2.5	1.4	4.1
Fagopyrum esculentum	9.9	2.3	3.7	8.6	5.4	4.7	1.2	5.7	3.0	1.2	6.1
Eleusine coracana	8.1	2.2	1.4	9.1	6.8	2.2	3.0	4.2	3.4	1.5	6.6
Hordeum vulgare	7.3	1.9	1.6	12.7	6.2	2.5	1.8	5.1	3.2	1.1	6.0
Panicum miliare	7.4	1.7	2.0	10.9	6.3	1.9	2.3	4.8	3.6	0.7	5.9
Paspalum scrobiculatum	5.4	2.3	1.8	7.9	5.7	2.1	2.9	7.0	3.4	0.7	5.8
Setaria verticillata	6.8	2.0	2.2	16.6	7.5	2.6	2.9	4.7	2.9	1.0	5.9
Triticum vulgare	8.4	2.3	1.5	6.5	3.6	2.4	1.3	5.2	2.7	1.2	4.2

Values are means of three independent replicates.

may be suggested that the proteins of amaranth can go with other foods to improve their nutritional quality.

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FUNGITOXICITY OF FOUR OXIDIAZOL THIONE DERIVATIVES TOWARDS FUNGI DETERIORATING MOONG (*PHASEOLUS AUREUS* ROXB.) SEEDS

ARCHANA RATHORE AND N. MISRA
Botany Department, University of Gorakhpur,
Gorakhpur - 273 001, India

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Four new organic compounds viz., 3-(3,4 Dimethyl amino methyl) -5- (1-4 methoxy phenyl) -1, 3, 4-oxadiazol-2 thione; 3- (3, 4-Dichlorophenyl amino methyl) -5- (2-4-dichlorophenoxy methyl) -1, 3, 4-oxadiazol-2-thione; Bis (5-p-methoxy phenyl-1,3,4-oxadiazolyl-2) disulphide; 5-p-methoxy phenyl-2-mercapto 1,3,4-thiadiazole were tested for fungitoxicity against *Aspergillus flavus* LK., *A. fumigatus* (Eidam) Wint., *A. parasiticus* Speare, *Cladosporium oxysporum* Bark and Curt, *Fusarium moniliforme* Sheldon and *Penicillium citrinum* Thom at one per cent concentration. Compound 3- 3,4 Dimethyl amino methyl -5- 4-methoxyphenyl)-1, 3,4-oxidiazole-2 thione was non-toxic to moong plants (*Phaseolus aureus* Roxb.). It also checked the appearance of fungi on the seeds in storage.

Storage conditions in most parts of India are very conducive to fungal growth which cause appreciable deterioration in the nutritive quality of stored seeds. Both pathogenic and saprophytic fungi cause deterioration in pulses. They also reduce germination potential and secrete toxic metabolites. Such losses in seed quality can cause great economic disaster. Recently synthetic heterocyclic compounds have been proved effective against fungi[1-4]. The present paper reports the effect of four new organic compounds. 3-[3,4 Dimethyl amino methyl] -5- [1-4-methoxy phenyl] -1,3,4-oxadiazol-2 thione; 3-[3,4- Dichlorophenylamino methyl] -5- [2,4-Dichlorophenoxy methyl] -1,3,4-oxadiazole-2- thione; Bis [5-p-methoxy-phenyl-1,3,4-oxadiazolyl-2-] disulphide; 5-p-methoxy phenyl-2-mercapto 1,3,4-thiadiazole on the mycelial growth of six fungi on Czapex Dox Agar medium. It also examines the effect of these compounds on the viability and growth of seeds, infested with fungi, stored as stocks for crop cultivation in the next year.

These compounds were dissolved in acetone for analysis by the poisoned food technique[5]. Briefly, treatment sets were prepared by dissolving the 5 mg of each compound in 0.5 ml of acetone and mixing it with 9.5 ml autoclaved Czapex Dox Agar medium. In controls, 0.5 ml of acetone was mixed with 9.5 ml Czapex Dox Agar medium. The plates were inoculated aseptically with the assay disc of 2 mm diameter (taken out with the help of cork borer) of each test fungus viz., *Aspergillus flavus* Link, *A. fumigatus* (Eidam) Wint., *A. parasiticus* Speare, *Cladosporium oxysporum* Bark and Curt, *Fusarium moniliforme* Sheldon and *Penicillium citrinum* Thom. The cultures were isolated from moong seeds, identified and further confirmed by the CAB Mycological Institute, Kew, Surrey. Plates were incubated at 24±2°C. Fungitoxicity was estimated after 96 hr (Table 1) by the following formula:

$$\text{Per cent inhibition} = \frac{(C\text{-}T) \times 100}{C}$$

Where, C = Diameter of fungus colony for control plates. T = Diameter of fungus colony for test plates after 96 hr.

In vivo toxicity of all the compounds and their phytotoxic nature were observed on moong seeds. For this, fresh seeds of moong (*P. aureus*) were purchased locally, surface sterilized by one per cent $HgCl_2$ solution and washed several times in sterile distilled water. Sterilized seeds were dried in an oven at 40°C for 12 hr. Fifty grams of seeds in each of the following test sets were separately inoculated with one week old culture of each test fungus. Other 50 g lots were inoculated with a mixture of all six fungi. One such set was dressed with one per cent (w/v) concentration of each of the test compounds. One test set was not treated with any compound. One set of sterilized seeds i.e. undressed and uninoculated seeds, served as control. For inoculum, 5 disc (2 mm) of test fungi were used. All sets were stored for six months at room temperature (18° to 35°C) and relative humidity of 65 to 90 per cent. After storage, appearance and growth of test fungi were tested as recommended by Neergaurd and Saad[6].

Phytotoxicity was determined after storing moong seeds for six months by monitoring the germination, seedling growth, general morphology and health of the plant. All the experiments were repeated twice and each test consisted of three replicates.

TABLE 1. PER CENT INHIBITION OF FUNGI ON CZAPEX DOX AGAR BY 1,3,4, OXADIAZOL-2-THIONE DERIVATIVES

Fungi	% inhibition by indicated compounds*			
	I	II	III	IV
1. *A. flavus*	38	42	42	42
2. *A. fumigatus*	98	48	100	100
3. *A. parasiticus*	39	40	98	49
4. *Cl. oxysporum*	49	80	100	100
5. *F. monoliforme*	45	43	47	49
6. *P. citrinum*	40	80	100	42

Compounds I: 3-[3,4 Dimethyl amino methyl] -5- [1,4 Methoxy phenyl] -1,3,4-oxadiazol-2 thione;
II: 3-[3,4-Dichlorophenyl amino methyl) -5- [2,4-dichloro-phenoxymethyl] - 1,3,4-oxadiazol 2-thione;
III: Bis [5-p-methoxy phenyl-1,3,4-oxadiazolyl -2-]disulphide;
IV: 5-p-methoxy phenyl -2- mercapto -1,3,4-thiadiazole.

Experiments were performed to determine the thermostability of compounds. Different glass vials containing compounds were subjected to different temperature treatment for one hour. This was done at 15°, 20°, 25°, 30°, 35° and 40°C. Fungitoxicity of all the treated compounds was tested separately against test fungi by poisoned food technique.

The effect of storage on fungitoxicity of the compounds was determined by storing them separately in glass vials for 365 days. The compound taken from these stocks at regular intervals of 30 days and fungitoxicity was tested by poisoned food technique.

Results in Table 1 reveal that substitution in oxadiazole 2-thione alters the fungitoxic spectrum. Growth of *Aspergillus fumigatus* and *Cladosporium oxysporum* was completely inhibited by compounds III and IV while growth of *Penicillium citrinum* was hundred per cent inhibited by compound III only. The growth of *Aspergillus flavus* was found to be least affected by any compound.

Seeds inoculated and treated with the four compounds and stored for six months showed the appearance of only one species i.e., *Aspergillus parasiticus* when treated with compounds I, II and IV and *Penicillium citrinum* appeared on the seeds treated with the latter compound only (Table 2).

Results from phytotoxicity tests (Table 2) showed that compound I was least phytotoxic and most effective because it allowed seed germination upto 72, 89, 83 and 92 per cent when inoculated with *A. fumigatus, C. oxysporum, P. citrinum* and mixture of fungi respectively, as did sterilized uninoculated and undressed seeds. Length of root and shoot was also highest as well as healthy in appearance in these seeds. By contrast, compounds II, III and IV were phytotoxic because seed germination was greatly affected.

The toxicity of all the compounds was observed to be thermostable at 15°, 20°, 25°, 30°, 35° and 40°C temperature. At these temperatures, there was 100 per cent inhibition of mycelial growth of all the test fungi.

The toxicity of the compounds was observed not to be affected by the increase in storage period upto 365 days. There was 100 per cent inhibition of mycelial growth of the test fungi.

Biological activities of synthetic heterocyclic compounds have been reported earlier.[1,2] Some of them have been found effective against fungi infesting pulses and spices.[3,4] But those compounds are different in their chemical composition from the compounds being reported in this paper.

The present compounds are disulphides, phenyl amino methyl, and have only mannich base. While the compounds reported earlier[3,4] are thiocarbamoyl and alkyl thio derivatives and have bis mannich base. Thus, the fungitoxicity of the present compounds may be because of the presence of disulphides phenyl amino methyl, mannich base and not because of thio carbamoyl, alkyl thio and bis mannich base. Further, the compounds reported earlier[3] were tested against different species of *Aspergillus* and *Penicillium* infesting seeds of spices.

TABLE 2. PHYTOTOXIC PROPERTIES OF THE DERIVATIVES OF 1,3,4 OXADIAZOL-2-THIONE

Fungi used as inoculum		I	II	III	IV	No compound
A. fumigatus	SG	72	17	42	17	61
	RL	1.1 ± .374*	0.9 ± .489	0.5 ± .195	0.4 ± 00	1.5 ± .482
	SL	2.3 ± .423	9.5 ± .313	1.5 ± .565	0.0 ± 0.0	3.0 ± .328
A. parasiticus	SG	—	—	42	—	28
	RL	—	—	0.5 ± .276	—	0.7 ± .316
	SL	—	—	1.6 ± .762	—	.8 ± .560
Cl. oxysporum	SG	89	61	83	42	38
	RL	1.5 ± .540	0.5 ± .304	1.0 ± .213	0.9 ± .421	0.9 ± .601
	SL	3.0 ± .392	0.5 ± .250	2.0 ± .757	1.4 ± .950	1.2 ± .381
P. citrinum	SG	83	61	83	—	17
	RL	1.0 ± .310	0.7 ± .255	0.5 ± .194	—	1.0 ± .914
	SL	0.5 ± .472	0.3 ± .268	1.6 ± .539	—	1.9 ± .372
Mixture of fungi	SG	92	78	42	17	42
	RL	2.0 ± .336	1.3 ± .439	0.5 ± .187	0.8 ± .416	0.5 ± .652
	SL	3.5 ± .368	1.0 ± .351	1.4 ± .817	1.5 ± .750	1.4 ± .312
Uninoculated seeds	SG	90	50	85	17	87
	RL	1.2 ± .282	1.2 ± .627	0.9 ± .328	1.5 ± .249	
	SL	4.0 ± .312	0.7 ± .256	3.0 ± 1.03	0.5 ± .328	0.6 ± .374

Value of t was found to be significant at 5% level of significance at 9 degrees of freedom for Compound I.
SG = Seed germination (in %),
RL = Root length in cm;
SL = Shoot length in cm;
* = Standard error of mean
— = Fungus appeared on seeds.
I, II, III and IV are compounds as in Table 1.

From the above results, it may be concluded that all these compounds are fungitoxic. Of these, compound I can be classified as non-phytotoxic because per cent seed germination was 90. In other compounds, it was 50, 85 and 17 per cent. In surface sterilized and uninoculated seeds, it was 82 per cent. Although the per cent seed germination is nearly the same in the seeds dressed with derivative and surface sterilized seeds (90 and 87 per cent, respectively), the length of root and shoot was more in the former and they were more healthy.

Because of its lack of phytotoxicity and effectiveness in preventing mould growth, compound I may be tested as seed preservative.

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BOOK REVIEWS

Food Emulsions: Second Edition, Revised and Expanded (Food Science and Technology Series/38) Ed. by Kare Larsson and Stig E. Friberg 1990; Marcel Dekker, Inc., 270 Madison Avenue, N.Y. Pp:504; Price $ 135.00 (U.S. and Canada) $ 162.99 (All other countries)

The realm of surface science is one of the most inter-disciplinary areas of modern science and technology. Although the importance of surface science had been recognised for more than a century, it was really in the last decade or so that a rapid advance in the real understanding of the phenomenon has taken place.

Natural emulsions from milk to rubber latex are generally stabilised by proteins. Surface chemical aspects of protein-lipid associations are important in determining the texture of foods such as cakes and pastries. Emulsions find considerable application in many food products where organoleptic properties of the food have also to be maintained alongwith emulsion stability. Emulsions are important in mayonnaises, salad dressings, margarine, whipped cream, ice creams, puddings and flavour emulsions used in soft drinks.

This book fills a long-standing need of many food industries as well as food scientists for all the up-to-date collective information on all aspects of food emulsions bound between two covers.

The preliminary chapters deal with the theory of two-and three-phase emulsions, their stabilisation and destabilisation. Factors such as crystallisation and polymorphism of fats are dealt with, probably for the first time and this is a novel feature of the book. Several other aspects of food emulsions which might not be found in any other single book are included here. The basis for selection of appropriate emulsifiers for maximum emulsion stability have been brought out very lucidly, using the HLB temperature and HLB number system.

The chapter on food emulsifiers lists important compounds with properties and physical function. The amylose complexing effects of monoglycerides. steroyl lactylates and lysolecithin in starch-based foods are very ably discussed.

Specialised chapters deal with different types of food emulsion systems including dairy, dressings, sauces, beverage emulsions and bakery emulsions. The chapter on ice cream emulsions co-relates emulsion stability with specific properties of the product. Individual fat globules acquire a coating of emulsifier and protein changes occur during freezing of the mix and where lipids and emulsifiers undergo transformations.

The chapter on beverage emulsions is particularly useful to the soft drink manufacturer in today's context. Cloud stability is of prime importance in dilution of the emulsion concentrate of citrus based beverages with sugar solutions. Sensory properties like flavour, colour and appearance depend on stability of cloud. Replacement of BVO with other weighting agents like ester gums and SATB are analysed critically.

Although different chapters of the book are written by various experts in each field, one of the most redeeming features of this book is that all the chapters are interconnected with cross references.

This book is a Real Value asset to Food Technologists and has the most updated information on both basic and applied aspects of food emulsions.

P. J. DUBASH
UDCT, BOMBAY.

Fermentation Process Development of Industrial Organisms: Ed by Justin O Neway, Marcel Dekker Inc., 270, Madison Avenue, N Y 10016 1989; Pp: 344, Price:$99. 75 (US & Canada), $119.50 (All other countries).

The book 'Fermentation Process Development of Industrial Organisms' edited by Justin O. Neway is a commendable compilation of information in the field of bioprocess technology. The book may be recommended to students and active workers in the field of biotechnology. The six chapters of the book have been conveniently arranged by organism. The materials in each chapter have been gathered on a particular type of microorganism covering similar as well as variety of industrial processes and have been enriched by high volume of useful references. Interestingly, the book has covered wide spectra of information on conventional fermentation process for the production of chemicals and antibiotics as well as hitech areas based on genetic manipulations and mammalian cell techniques. It is more valuable as it will be equally useful to biologists as well as engineers engaged in fermentation research or bioprocess scale up studies.

S.K. BASU
CENTRAL DRUG RESEARCH INSTITUTE, LUCKNOW

Environmental Health Criteria 91, *Aldrin and Dieldrin:* World Health Organisation, Geneva; 1989; Pp:336; Price: Sw.fr.34.

The book deals with the current data and information available on environmental health criteria for Aldrin and

Dieldrin. The chapters are (1) Summary, (2) Identity, Physical and Chemical properties, Analytical methods, (3) Sources of human and environmental exposure, (4) Environmental transport, distribution and transformation, (5) Environmental levels and human exposure, (6) Kinetics and metabolism, (7) Effects on organisms in the environment, (8) Effects on experimental animals and *in vitro* test systems, (9) Effects on human beings. (10) Evaluation of human health risks and effects on the environment. These are followed by chapters 11. Recommendations, 12. Previous evaluations by international bodies and the References and Appendix.

This publication was brought out under the International Programme on Chemical Safety and on Sponsorship of the UNEP, ILO and WHO. The World Health Organisation task group on Aldrin and Dieldrin was under the Chairmanship of Dr. R. Goldwin, Guy's Hospital, London, U.K. for collation of data presented in the book.

The pesticides Aldrin and Dieldrin, both organochlorine pesticides and manufactured commercially since 1950 were used extensively throughout the world upto the 1970s. Both compounds were used in agriculture for control of many soil pests and in the treatment of seeds.

Insects controlled by these compounds include termites, grasshoppers, wood borers, beetles and textile pests. Dieldrin has also been used in the public health for the control of Tsetse flies and other vectors of debilitating tropical diseases. Since the early 1970s, both compounds have been severely restricted or banned in a number of countries from use, especially in agriculture. However, the use of these compounds for termite control continues in many countries. Global production is now less than 2500 tonnes per year.

The greatest concern has been due to the environmental levels and human exposures of aldrin and dieldrin. These have been found in the atmosphere in the vapour phase absorbed on dust particles or in rain water of variable levels in the world. The level of 40 ng/m^3 in rain waters, concentrations of the order of 10-20 ng/litre and occasionally higher level has also been recorded. As a result of transplacental exposure, dieldrin is present in blood, adipose tissue and other tissues of the foetus and new born infants. There is no difference between infants and adults in the brain, liver, fat, ratio of dieldrin concentrations. Dieldrin is also excreted in mother's milk. In most of the countries, the dieldrin content in milk amounts to 6 microgram/litre, though higher levels have occasionally been found. The conversion of aldrin to dieldrin by mixed function mono-oxygenases (aldrin epoxidase) in the liver and the distribution and the subsequent deposition of dieldrin (mainly in lipid containing tissues such as adipose tissue, liver, kidneys, heart and brain) proceed much more rapidly than the biodegradation and the ultimate elimination of unchanged dieldrin and its metabolites from the body. Photodieldrin is also metabolised into bridged pentachloroketone in the rat and dog. Most residues in organisms are of dieldrin since aldrin is readily converted into dieldrin in all organisms. In water, protozoa take up more dieldrin than algae. The algal uptake of dieldrin from a medium is very rapid and maximum mobilization occurs within a few hours. The bio-concentration factors for overall efficiency are greater than 10,000. Earthworms take up dieldrin from the soil and concentrate almost 70 times. Many investigations have been carried out to estimate the contents of dieldrin in the tissues or eggs of non target species. Both aldrin and dieldrin are highly toxic for acquatic crustacians, most LC 50 values being below 50 microgram/litre.

In conclusion, the following are noted, the oral toxicity of the compounds in the mice and rats range from 40-100 miligram/kg body wt. depending on the animal species and also the solvent used. In the dog, no effect levels of 0.04-0.2 mg/kg body wt. were found. A number of long term carcinogenecity studies on mice of different stages were carried out with aldrin and dieldrin. In all the studies, benign and/or malignant and liver cells tumour were found. Females were less sensitive than males. Photodieldrin feeding upto a concentration of 7.5 mg/kg diet did not induce tumours. Aldrin and dieldrin are highly toxic for human beings. Severe cases of both accidental and occupational poisoning have occurred but only rarely fatalities have been reported. The lowest dose with a fatal outcome has been estimated to be 10 mg/kg body weight. A daily intake of 0.02 miligram diet per kg body weight/day has been considered to be the threshold as no observed adverse effects were noted. An ADI of 0.1 mg/kg is proposed. Epidemological studies with almost 25,000 men and years of observations have been done and no specific cancer risk associated with employment at this plant could be identified.

This publication is a good source book of information on these two organochlorine pesticides. The tables and references are quite comprehensive. Only the lacuna in the publication is the lack of index particularly the subject index.

S.K. MAJUMDER
JT DIRECTOR, (Rtd), C.F.T.R.I., MYSORE

Dietary W3 and W6 fatty acids: Biological Effects and Nutritional Essentiality. Ed. Claudio Galli and Artenis Simopoulos NATO ASI Series. Plenum Press, New York and London; 1989; Pp:452; Price:$95.

The beneficial effects of dietary polyunsaturated fatty acids (PUFA) on health have been emphasized many times in the past two decades. Elegant studies in 70's by Dyerberg and associates generated lot of interest on the role of dietary lipids and in particular W3 fatty acids as one of the factors responsible for the lowest incidence of heart diseases among Greenland Eskimos whose staple diet is marine foods. Subsequently, many studies conducted by other research

workers firmly established that dietary lipids do modulate risk factors involved in heart diseases Later studies in 80's established that dietary lipids can also modulate cancer and inflammatory process and a strong thrust to use dietary PUFA and in particular W3 fatty acids for the prevention of cardio-vascular diseases, cancer and inflammation was put forward. Some of these studies were, however, contradictory. Therefore, a major conference on the health effects of PUFA was held in Washington, DC on June 24-26, 1985. Based on the recommendations of the Conference, research was intensified on W3 fatty acids of marine origin. During the next five years research was also diverted to W3 fatty acids from terrestrial sources. In addition, much effort was also made in understanding the interactions between W6 and W3 fatty acids. This culminated in NATO advanced research workshop held in Italy on June 20-23, 1988 and the proceedings entitled 'Dietary W3 and W6 fatty acids - Biological effects and Nutritional essentiality' was published in 1989 by Plenum Press, New York. A summary of this proceedings is published earlier (*J. Nutr.* 1989, **119**, 521-528).

The proceedings contain five sections of main articles and the abstracts of the poster sessions. The first part of the proceedings deals with dietary sources of W3 and W6 fatty acids available for human consumption. While marine sources are rich in longer chain PUFA such as eicosapentaenoic and docosahexaenoic acids, the terrestrial foods are rich in linoleic and linolenic acids. The second part of the proceedings deals with chemistry, biosynthesis and interactions of W3 and W6 fatty acids. The dietary lipids affect the synthesis, elongation and desaturation of PUFA and their distribution in tissue lipids. This greatly influences the amount and type of eicosanoids produced in normal and pathological conditions. All the beneficial health effects of fish oils are attributed to eicosapentaenoic acid though it contains equal amounts of docosahexaenoic acid. Interestingly in this session, the role of docosahexaenoic acid as an important regulator of platelet functions has been emphasised. The importance of linolenic acid and its uptake by different tissues are also highlighted. Articles in the third session deal with the role of W3 and W6 fatty acids in the nervous system, brain and retina. The importance of PUFA in infant nutrition and breast milk was studied. W3 fatty acid was shown to be important in learning process and in visual functions. Therefore, an adequate care should be taken in formulating infant foods. The fourth part of the proceedings deals with the biological effects of W3 and W6 fatty acids on cell activation process. In this session, W3 fatty acid is shown to affect prostaglandin production in endothelial cells, arachidonic acid metabolism in platelets, alter inositol metabolism and also influence photoreceptor cells. The fifth part of the symposium deals with the important aspects of W3 and W6 fatty acids in human diseases. It was suggested that W3 PUFA is an essential fatty acid required for normal development and growth. W3 fatty acid may have a beneficial effect in the amelioration of cardiovascular diseases by altering serum lipid profiles and by providing a favourable Thromboxane to prostacyclin ratios. They may ameliorate rheumatoid arthritis by lowering inflammatory eicosanoids and also prevent rapid proliferation of cancer cells by down regulating immuno-suppressive prostaglandins. Alternate sources such as primrose oil, borage and black currant seed oil have also been suggested which may have similar beneficial effects as has been observed with W3 PUFA from fish oils. In the poster sessions, different aspects of PUFA effects on enzyme activities, serum lipid profiles, superoxide production and on some diseases have been presented. Finally a general recommendation for fat intake is given.

Overall I find the articles contributed by outstanding scientists in the field gives a state of the art information on polyunsaturated fatty acids. The book contains exhaustive cross references and covers wide areas in the field of PUFA research. It will be a useful guide for beginners as well as to those who are actively involved in this area of research. It will be a good addition to the library.

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

Environmental Health Criteria 84, 2,4 - Dichlorophenoxyacetic acid - Environmental Aspects: Published by World Health Organisation, Geneva; 1989; Pp: 92; Price:SW.12.

The monograph contains in addition to summary and conclusions, 9 more chapters covering from physical and chemical properties to recommendations for further research. The aim of the document is to take the opinion of ecotoxicologists and consider effects on populations of organisms in the environment. 2,4-D is a selective herbicide, which kills broad-leaved plants but not grasses or conifers. Its chemical structure is a modification of a naturally occurring plant hormone. 2,4-D is available as the free acid but is used in agriculture and forestry in formulations as a salt or ester. 2,4-D does not persist in soil because of its rapid degradation. The bioavailability to and uptake by aquatic acid terrestrial organisms is strongly influenced by the organic matter content of soils, microbiological activity and by environmental conditions such as temperature and pH. In aerobic soils with a high content of organic material and at high pH and temperatures, toxic effects are limited, because of rapid degradation of 2,4-D. uptake followed by rapid excretion in most organisms. With the exception of some algae, the retention of 2,4-D by organisms in the environment cannot be expected, because of its rapid degradation. Some micro-organisms are capable of utilising 2, 4-D as their sole source. Repeated applications to soil stimulate the number of organisms capable of degrading the compounds.

In general, 2,4-D is relatively non-toxic to water and soil microorganisms at recommended field application rates. No effect of 2,4-D on respiration of either sandy loams or dry loam soils was observed at concentrations upto 200 mg/kg. Nitrogen fixation by aquatic algae is affected at high concentrations of 2,4-D-acid. An effect of 2.4-D esters on N-fixation occurs from concentration at 36 mg/litre upwards. In the range of 25.2 to 50.4 mg/litre, 2,4-D was inhibiting to all types of soil fungi. Cell division was reduced in a green alga by 2,4-D at 20 mg/litre. To aquatic invertebrates, ester formulations are more toxic than free acids or salts. No information is available on reproductive development and differentiation or on tissue levels. Based on the available data, no generalisation can be made about the hazard of 2,4-D to mammals in the field.

The Monograph comprises of chapters on Physical and Chemical properties, Sources of environmental pollution, uptake, accumulation, elimination and bio-degradation., Toxicity to micro-organisms., Toxicity to aquatic organisms., Toxicity to terrestrial organisms., Ecological effects from field application., Evaluation and Recommendations for further research. It also contains 189 references about different aspects of 2,4-D.

It is useful, informative and worth possessing by any library.

J.R. RANGASWAMY
C.F.T.R.I., MYSORE.

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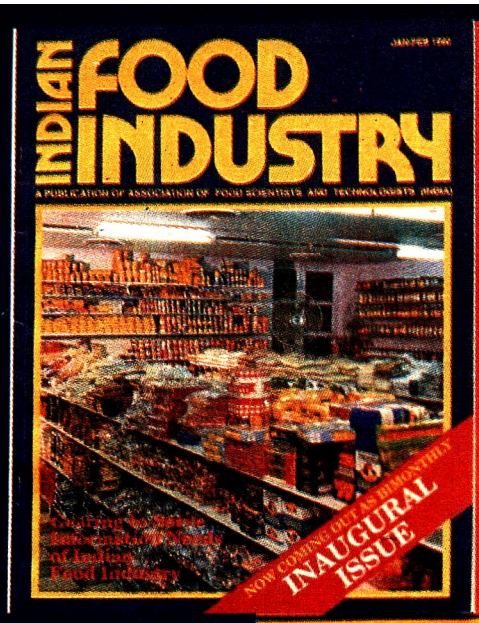

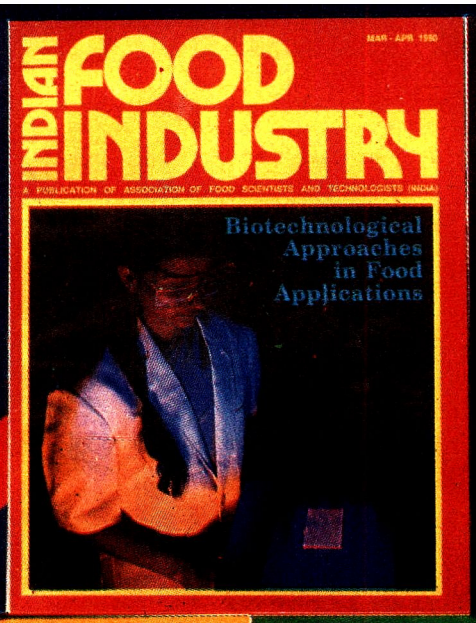

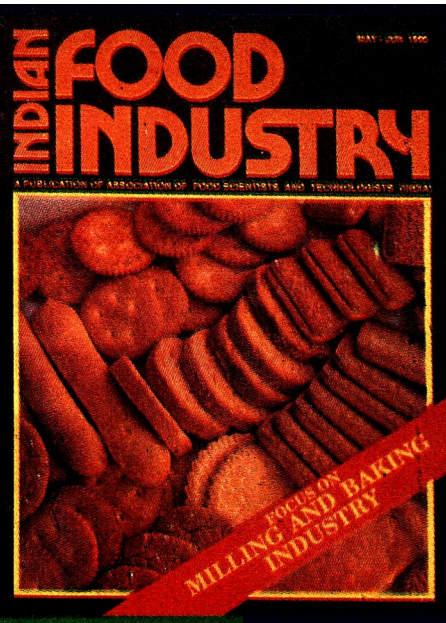

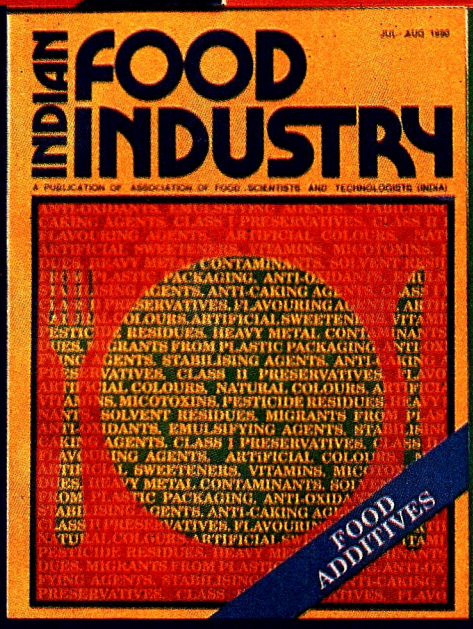

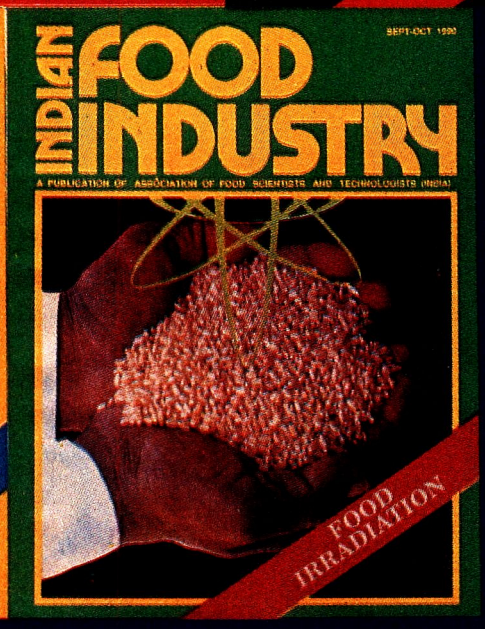

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8. Consult the latest issue of the *Journal* for guidance. For "Additional Instructions for Reporting Results of Sensory Analysis" see **issue No. 1** of the Journal.

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