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Volume 29 Number 5 Sept./Oct. 1992

CONTENTS

Research Papers

Research Notes

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J. Fd. Sci. Technol, 1992, Vol. 29, No. 5, 273—275

Gurdani - An Indian Traditional Sweet: Optimum Recipe for its Preparation

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Received 6 November 1990; revised 20 June 1992.

Gurdani **– an Indian traditional sweet is prepared from Bengalgram flour (*Besan*), deep-fat-fried in the form of *sewian* and subsequently coated uniformly with jaggery (gur). Optimum conditions and recipe for the preparation of *gurdani* have been standardized. *Gurdani* is cylindrical in shape (length 11-66 mm, diameter 10-11 mm) with unit weight ranging from 2.2 to 5.0 g. The product had attractive yellowish brown colour, soft and crisp texture, pleasant aroma and good taste peculiar to *gurdani*. The product could be stored for 3 months without losing its quality in 200 gauge LDPE, 120 gauge PP, 100 gauge HDPE and friction-top-tins. The product, however, registered a gradual loss in moisture and a marginal rise in FFA and PV during the storage period.**

In India, a number of traditional sweets are prepared from a variety of raw materials like Bengalgram flour (*Besan*), fine wheat flour, black gram *dhal*, green gram *dhal* and rice. The quality of sweets available in the market varies significantly and it requires scientific approach with respect to the quality of ingredients, standardisation and packing of the product. *Gurdani*, a deep-fat-fried sweet prepared from *besan*, is consumed in most parts of India. No published information is available on this traditional sweet. The results of studies carried out on various aspects of *gurdani* are presented in this paper.

Materials and Methods

Preparation of gurdani: Freshly prepared Bengalgram flour (*Besan*), *vanaspati ghee* (hydrogenated fat) and golden coloured jaggery (*gur*) were procured locally. The shortening (melted *vanaspati ghee*) at the rate of 0, 15, 20, 25 and 30 parts was mixed into 100 parts of *besan* by rubbing with hand. Water (40 parts)[1] was added slowly to this mass and kneaded into a smooth dough. The dough was extruded, through a hand operated, screw type *sewian* making machine fitted with a die having holes of 8 mm diameter, directly into *vanaspati ghee* pre-heated to 180±5°C. The golden coloured deep-fat-fried *sewian* were taken out from the frying pan at 160±5°C and were lowered into the pre-heated slurry of jaggery (75° Brix) containing gur equivalent to the weight of *besan* and 4% water. It was thoroughly mixed with a wooden laddle to give a uniform coating of *gur* on the *sewian;* the mass so obtained was spread on the trays and allowed to cool for solidification. The product obtained is called *gurdani*. Materials balance data are given in Fig. 1.

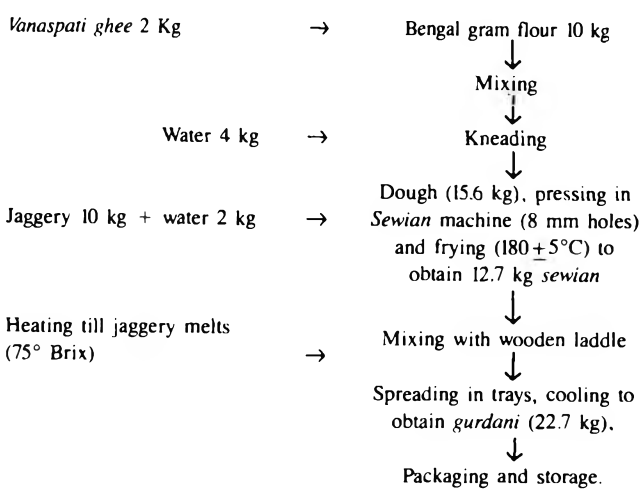

Fig.1. Typical material balance sheet of preparation of *Gurdani*

Packaging and storage studies: Equilibrium relative humidity (ERH) studies were conducted at different relative humidities ranging from 11 to 92% RH, at room temperature (20±5°C) according to the method described by Rockland[2]. Samples of *gurdani* (100 g) were packed in (i) 200 guage low density polyethylene (LDPE), (ii) 120 gauge polypropylene (PP), (iii) 100 gauge high density polyethylene (HDPE) flexible pouches (21×14 cm) and friction-top-tins of 100 g capacity. Six replicates of each were packed, heat sealed and stored at ambient temperature (30±5°C) for subsequent evaluation.

Physical, chemical and sensory qualities: Composite samples of freshly prepared *gurdani* were analysed for moisture, crude fat, reducing sugars (RS), non-reducing sugars (NRS), total solids (TS), total ash, acid insoluble ash (AIA), optical density, free fatty acids (FFA), peroxide value (PV) while stored samples were analysed for moisture, FFA and PV at intervals of 0, 30, 60 and 90 days during storage employing standard methods[3]. *Gurdani* samples were

evaluated for quality parameters like colour, texture, taste and flavour and overall quality by composite scoring test[4].

Results and Discussion

Standardisation of recipe for gurdani *preparation:* Trials conducted on the preparation of *gurdani* showed that product of optimum quality was obtained by using 100 parts *besan*, 100 parts *gur*, 20 parts shortening and 40 parts water[1]. The product had golden colour, soft and crisp texture, appropriate/optimum taste and possessing flavour of *gurdani*. A lower level of shortening caused hardening of the texture of the product while higher levels resulted in a soft product with distinct taste and flavour of *vanaspati ghee*, hence generally considered unacceptable. The samples of *gurdani* prepared with equal parts of *gur* and *besan* had the optimum quality with respect to colour, taste and flavour and overall quality. Lesser quantity of *gur* could not cover the entire surface of *gurdani* pieces uniformly and lacked optimum sweetness while higher levels gave a product with perceptible flavour and taste of gur and considered unacceptable.

Physical and chemical quality assessment: The physical and chemical quality characteristics of the laboratory samples of *gurdani* are presented in Table 1. The *gurdani* pieces were cylindrical in shape having length ranging from 10.50 to 65.50 mm, diameter ranging from 9.85 to 10.60 mm and unit weight ranging from 0.51 to 3.50 g. Samples had attractive yellowish brown colour, soft but crisp texture, pleasant aroma typical to *gurdani* and very good taste. Samples contained (%) moisture 5.2, crude fat 19.9, reducing sugars 3.9, non-reducing sugars 21.6, total sugars 27.9, total ash 2.5, acid insoluble ash 0.2, free fatty acids 0.5 and peroxide value 3.56 milli eq.O_2/kg oil.

Sorption behaviour of gurdani: The equilibrium relative humidity of *gurdani* sample at initial moisture content of 5.31% was 60% RH. (Fig.2). The product became slightly soggy/soft at 65% RH at EMC level of 6.62% which was critical moisture content for the sample (Fig.3). It became very soggy at 76% RH at EMC level of 11.26% on 15 days storage, making it unacceptable. Mould appeared on the samples on 12 and 8 days storage at 86 and 92% RH with EMC of 24.41 and 29.79%, respectively (Fig. 2 and 3).

Changes in moisture, FFA and PV of gurdani *during storage:* Data presented in Table 2 show that during 90 days storage period, the moisture content of *gurdani* packed in all the containers decreased by about 50%. There was very little increase in the free fatty acid (FFA) content of samples. The increase in peroxide value was high in LDPE and PP as compared to HDPE packed samples during 90 days storage.

TABLE1. PHYSICAL AND CHEMICAL QUALITIES OF *GURDANI* PREPARED IN THE LABORATORY

Parameters	Characteristics/Values
Shape	Cylindrical
Average length (cm), range	1.1-6.6
Average diameter (mm), range	9.9-10.6
Average unit wt (g), range	0.5-3.5
Colour	Yellowish brown
Texture	Soft, crisp
Aroma	Pleasant
Taste	Typical
Moisture (%)	5.2
Crude fat (%)	19.9
Reducing sugars (%)	3.9
Non-reducing sugars (%)	21.6
Total sugars (%)	27.9
Total ash (%)	2.5
Acid insoluble ash (%)	0.2
Free fatty acids as (%) oleic acid	0.5
Peroxide value, Milli equiv. O_2/kg oil	3.6

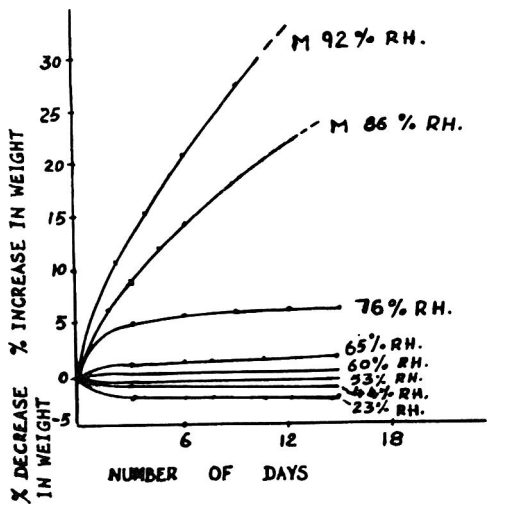

Fig.2. Percent change in weight of *gurdani* at different relative humidities at R.T. (20±5°C), Initial moisture: 5.31%, M:Mould growth

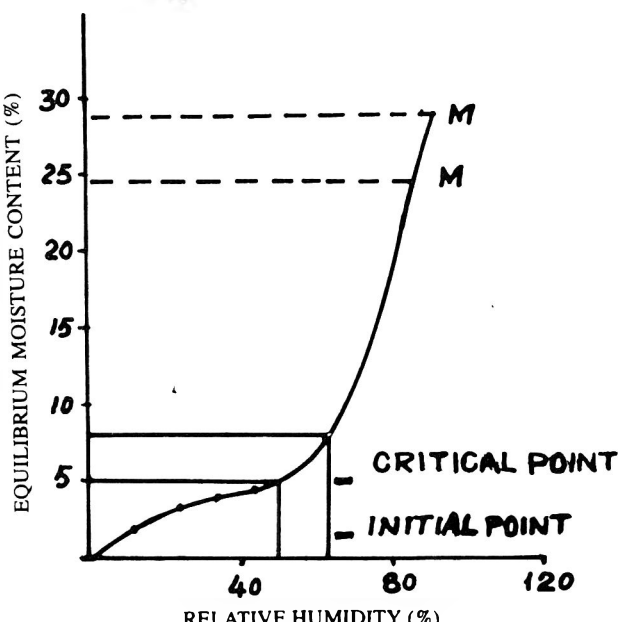

Fig.3. Relationship between relative humidity (RH) relative equilibrium moisture content (EMC) and number of days to attain equilibrium for *gurdani*. Initial moisture: 5.31%, M:Mould growth.

TABLE 2. EFFECT OF PACKAGING AND STORAGE PERIOD ON THE QUALITY OF *GURDANI*

Storage period (days)	Moisture (%)	Free fatty acids (%) (as oleic acid)	Peroxide value (milli equiv. O_2/kg oil)
Polyethylene, 200 g bags			
0	5.22	0.53	3.56
30	3.72	0.57	3.62
60	3.50	0.60	3.90
90	2.41	0.62	4.50
Polypropylene, 120 g bags			
0	5.22	0.53	3.56
30	4.28	0.57	3.98
60	3.98	0.59	4.20
90	2.41	0.60	4.50
High density polyethylene, 100 g bags			
0	5.22	0.53	3.56
30	4.42	0.55	3.69
60	3.68	0.56	3.72
90	2.90	0.56	3.86
Friction top tins			
0	5.22	0.53	3.56
30	3.98	0.55	3.65
60	3.52	0.56	3.82
90	2.42	0.58	3.92

All the samples were acceptable upto 90 days storage in all the packagings.

However, the levels of FFA and peroxide value (PV) showed minor changes and no discernible changes in sensory quality. Hence, all the four packaging materials were found suitable for storage of *gurdani* samples for 90 days. This may be due to the high ERH of the product.

Quality characteristics of gurdani *samples:* The sensory scores of *gurdani* samples for individual characteristics like colour (7.5-9.0), texture (7.0-9.1), aroma (8-9), taste (8-9) and overall quality/acceptability (30.5-36.0) remained acceptable in samples packed in all the packaging materials. Some darkening of colour, changing from yellowish brown to brown during one month storage and toughening in texture due to loss of moisture were, however, observed during storage. No perceptible adverse changes were noticed in taste and flavour during storage.

Acknowledgement

Authors thank Dr. B.L. Amla, Director (Retd) and Mr. K.K. Mookerji, Area Co-ordinator, Regional Centres of the Institute for their keen interest in the work. Thanks are also due to Mr. I. Ragavan, for the preparation of the graph.

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Thin Layer Drying Characteristics of Parboiled Milled Rice

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Thin Layer drying characteristics of a medium grain parboiled milled rice between temperature range of 40 to 100°C and relative humidity range of 4 to 49% were studied. An empirical thin layer drying expression was developed for parboiled milled rice and the constants of the equation were related to the temperature and relative humidity of the drying air.

The knowledge of thin layer drying characteristics becomes essential in grain drying simulations as well as in the design and selection of the drying equipment. To develop different products like quick cooking rice, puffed rice and others, the milled rice is generally treated with aqueous solutions and then it is dried to an optimum moisture level for further processing or storage. Bakshi *et al.*[1] studied the thin layer drying characteristics of raw and parboiled brown rice. They

fitted their drying data in diffusional and empirical equations suggested by Page[2] for corn. They related mass diffusivity to the absolute temperature of the drying air in the form of Arrehenius type relation. Several investigators have studied the thin layer drying of different grains[3-6]. However, no information is available in the literature on thin layer drying of parboiled milled rice. Therefore, the present investigation was undertaken to study the thin layer drying characteristics of medium grain parboiled milled rice between the temperature range of 40 and 100°C and to develop a thin layer drying expression for parboiled milled rice.

Materials and Methods

The parboiled rice was a local 'Kakuria' variety, medium grain type which is preferred for rice puffing. During parboiling in the rice mill, the paddy has undergone rinsing in hot water at 75°C, pressure parboiling at a steam pressure of 240 kPa for 30 min, dehusking in a rubber roll sheller and polishing to about 5 to 6% in a cone polisher. The rice was cleaned, moistened to the desired level and stored in sealed plastic bags in a refrigerator. The drying experiments were carried out using 150 g of rice samples (34.4-34.6% dry basis (db) initial moisture) spread to a single layer thickness at 0.6 m/sec. air velocity, each time in a laboratory model thin layer dryer (Fig.1), where the temperature of the drying air was controlled within ±1°C and the average relative humidity (RH) of the drying air was recorded during each experiment. The weight of the grains with the elapsed drying time was recorded and the initial and final moisture contents of the grains were determined by hot air oven method (105°C, 24 h). The equilibrium moisture content (EMC) of the rice was determined from the drying data[7].

Results and Discussion

The thin layer drying characteristic curves at different temperatures and relative humidities are shown in Fig. 2,3 and 4 for parboiled milled rice. A sharp decrease in moisture content during initial 20 min of drying and about 13 to 20% (db) moisture removal was observed (Fig.2). After 80 min of drying time, the curves became almost flat showing practically very little drying. There was a large reduction in drying time due to an increase in temperature and decrease in RH of the drying air. For example, the time required to dry the rice from 34-13% moisture content at 100°C was five times less than that of drying at 40°C. The plot between drying rate against the drying time at three different temperatures showed that parboiled rice within the present

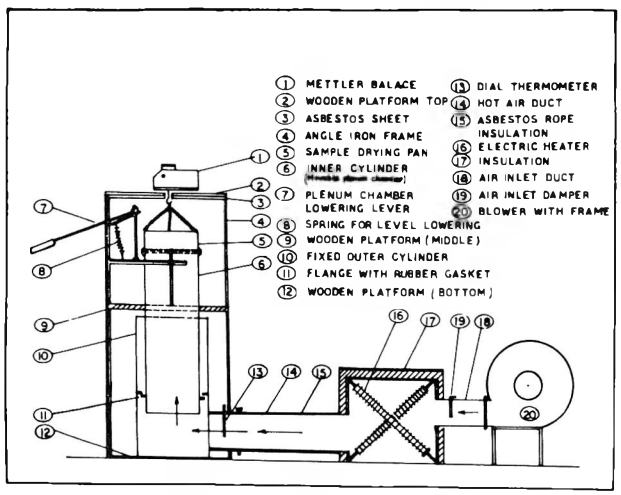

Fig.1. Schematic diagram of the laboratory thin layer dryer set up

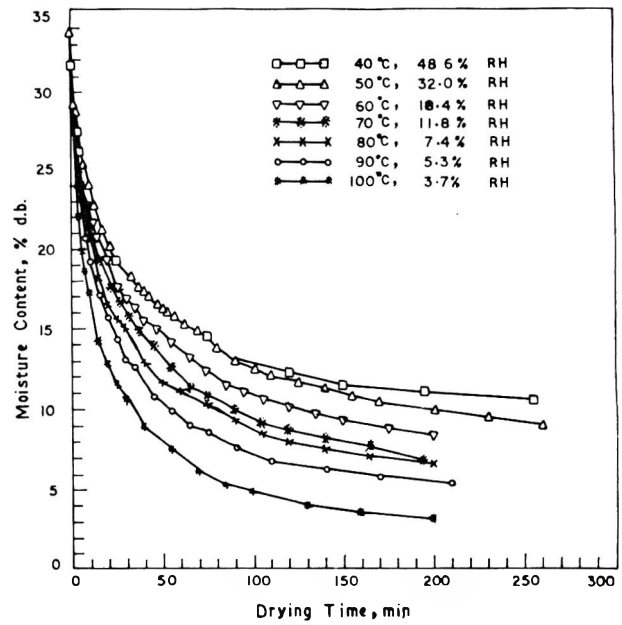

Fig.2. Variation of moisture content of parboiled rice with drying time at different temperatures.

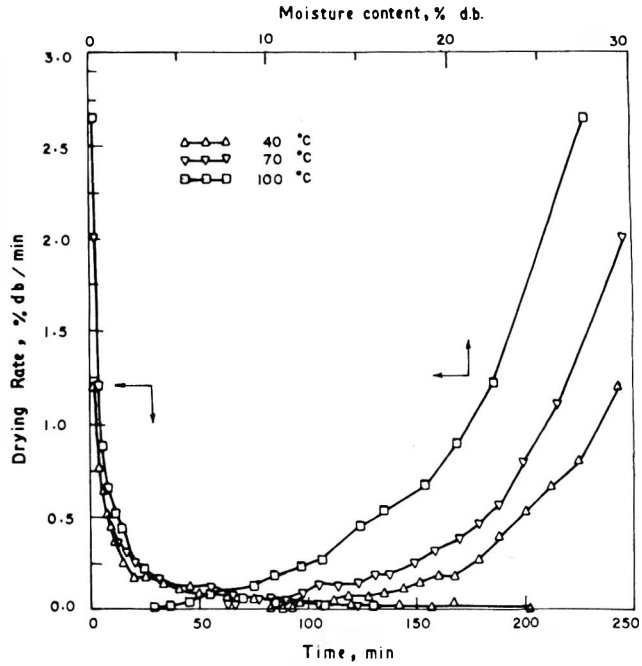

Fig.3. Variation of drying rate with drying time and moisture content at three temperatures for parboiled rice.

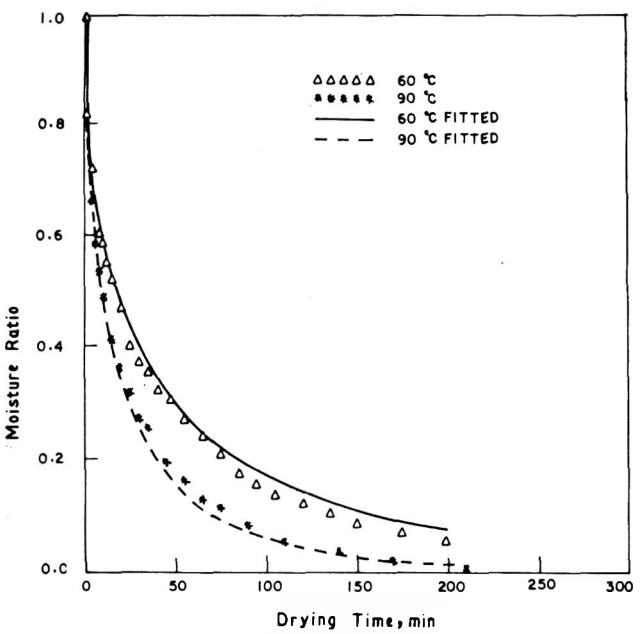

Fig.4. Experimental and predicted moisture ratios with time at two temperatures.

moisture range, solely dried in the falling rate period (Fig.3). The rate of drying was high at the beginning of the experiment, and dropped rapidly as the drying proceeded. The initial higher drying rate can be attributed to the higher moisture potential (M-Me) available for removal at the beginning of the drying process. The rate of drying decreased as the replenishment of water from interior to its surface of the grain could not cope up with the fast removal of moisture at the surface of the grain. An increase in drying air temperature and decrease in RH resulted in increased drying rate at the beginning of the drying experiment. However, after 15 min, almost all the drying curves merged together indicating the ineffectiveness of higher drying air temperatures during later stages of drying.

The relationship between the drying rate and moisture content of the grain at the above drying air temperatures revealed that the rate of drying was high at higher moisture contents and fell due to subsequent drying (Fig.3). The drying rate dropped quite sharply up to 20% moisture content and was significantly influenced by the temperature and RH of the drying air. Moisture ratio (MR) at different drying times were calculated from the experimental data. An attempt was made to express the moisture ratio in terms of drying time and drying air properties like temperature and RH in different forms of available thin layer drying models. However, it was found that a model suggested by Page[2] was expressive of the thin layer drying characteristics of parboiled rice and is given below:

$$MR = \frac{M - Me}{M_o - M_e} = \exp\left[-P * t^Q\right]$$

The constants P and Q are found to depend upon temperature and RH of the drying air and is given as,

$$P = 0.09405919 + 0.9988182\times10^{-3}.T - 0.6346031\times10^{-3}.RH$$

$$Q = -0.555139367 + 0.0104172057.T - 0.125152843.RH - 0.31455985\times10^{-4}.;T^2 + 0.230873453\times10^{-2}.\ T.RH + 0.10131271\times10^{-2}.RH^2$$

$$r^2 = .99$$

where,

T – air temperature, °C; RH-relative humidity of air, %; M– moisture content of grain, decimal (db); M_o–initial moisture content of grain, decimal (db); M_e–equilibrium moisture content, decimal (db); t-drying time, min.

The plot between the moisture ratio against drying time for two temperatures is shown in Fig. 4. It can be observed that the developed model fitted well to the experimental data, thus validating the accuracy of the model within the experimental range.

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J. Fd. Sci. Technol, 1992, Vol. 29, No. 5, 278—280

Sugar and Acid Tolerant Microorganisms Causing Spoilage in Mango Jam *(Muramba)*

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Microorganisms isolated from home made mango jam *(muramba)* samples belonged to 11 bacterial and 2 fungal species. Physiological studies of the isolates with respect to tolerance to sucrose and citric acid incorporated in synthetic medium showed growth at 78% sucrose and 24.5% citric acid by *Aspergillus niger* followed by *Penicillium* sp. (66% sucrose and 18% citric acid), *Bacillus laterosporus* and *Staphylococcus saprophyticus* (70% sucrose and 24.5% citric acid respectively). This forms the first report of these species for sugar tolerance. When artificially inoculated, *Aspergillus niger and Penicillium* sp. caused spoilage in *muramba* samples with 60% sugar and boiled for 30 and 40 min but not in samples with 70 and 80% sugar and boiled for 30 min.

Muramba, a kind of mango jam, is a popular, home made seasonal product of Indian origin commonly prepared using pulp of unripe mango with high sugar concentration and by heat treatment. Traditionally, no chemical preservative is added and it can be stored for one year. Spoilage of such *muramba* is sometimes evidenced in the form of surface growth and fermented smell. This paper reports the microbial species isolated from *muramba* samples, their ability to tolerate high concentrations of sucrose, citric acid and to cause spoilage.

Materials and Methods

Sample collection: Fourteen home-made samples of *muramba* were collected from different houses in Pune city in sterile containers for immediate chemical and microbiological analyses. Apparent spoilage was recorded.

Chemical analysis: One g of the sample was homogenized in 100 ml distilled water and the filtrate was analyzed for pH, titrable acidity and sugar[1,2], Moisture content was also determined.

Isolation and identification of microorganisms: Bacteria were isolated using suitable dilutions of 1% suspension of the sample in sterile phosphate buffer (pH 7.2) and standard plate count agar (pH 7.2). Yeasts and moulds were isolated using Davis Yeast Extract salt agar (pH 5.4) and suitable dilutions of the sample in citrate buffer of pH 5.4. Pour plate (dilution plate) method was followed and the plates were incubated at 28±2°C for 48 h for bacteria and 96 h for yeasts and moulds. Well isolated morphologically distinct colonies were transferred on nutrient agar for bacteria and potato dextrose agar for yeasts and moulds. Bacteria were identified according to Bergey's Manual of Determinative Bacteriology[3] and fungi according to Barnett[4] and Kamat[5].

Tolerance to sucrose and citric acid: All the isolates were tested for their growth at different concentrations of sucrose (5-80%, w/v) and citric acid (0.5-25%, w/v) incorporated individually in Davis Mingolis' synthetic medium for bacteria and Czapeck Dox broth for moulds. The media with sucrose were sterilized by steaming for 20 min on 3 successive days. Since beyond 25% concentration of sucrose, solidification of the medium was difficult, further testing was continued in respective liquid media with increasing concentrations of sucrose. For testing tolerance to citric acid, only liquid media were used. The culture tubes were incubated at room temperature (28±2°C) for 7 and 15 days for bacteria and fungi, respectively. Sporulation at the surface of the liquid medium was considered as the parameter for growth of fungi and turbidity and/or pellicle at the surface for bacteria. The growth in terms of turbidity was compared with uninoculated control.

Ability to cause spoilage in muramba: *Muramba* samples were prepared in the laboratory with 40, 50, 60, 70 and 80% sugar and boiled for 30, 40 and 50 min. The samples were distributed in 20 g aliquots in a total of 90 sterile glass beakers in three sets: (i) experimental set with unsterilized samples inoculated with the spoilage organisms namely *Aspergillus niger, Penicillium* sp., *Staphylococcus saprophyticus* and *Bacillus cereus* (60 samples representing 5 concentrations of sugar, 3 time intervals of boiling and 4 test organisms); (ii) uninoculated unsterilized control (15 samples) and (iii) uninoculated sterilized (at 121°C for 20 min) controls (15 samples). The fungal test organisms were grown on potato dextrose agar for four days and spore suspension was prepared in sterile distilled water. The spore suspension (0.1 ml) with a density of 5×10^5 spores/ml was inoculated in each 20 g sample in the experimental set. Bacteria were grown on

*Corresponding author

nutrient agar for 24 h and suspension prepared in sterile distilled water. The suspension (0.1 ml) containing 3.4×10^4 cells in case of *B. cereus* and 4.7×10^3 cells in case of *S. saprophyticus* was inoculated in each 20 g sample in the experimental set. All the beakers in 3 sets were individually covered with aluminium foil and incubated at room temperature (28 ± 2°C) and observed daily for growth, if any, upto one year. The experiment was initiated in June, the usual season for preparation of *muramba*. The samples were analysed for moisture content, total titrable acidity and viable count of organisms immediately after inoculation and after spoilage.

Results and Discussion

The data on moisture content, pH, total acidity and sugar concentration of the samples showed wide variations and lack of concern for protecting the product from spoilage (Table 1).

All the 14 samples harboured microorganisms. The 88 isolates obtained from these samples include *Micrococcus luteus, Bacillus coagulans, Penicillium* sp., *Aspergillus niger, B. licheniformis, Staphylococcus saprophyticus, B. alvei, B. cereus, B. laterosporus, S. aureus, B. circulans, B. megaterium* and *B. pumilus*. It was observed that incidence of *Micrococcus luteus* was the highest (100%) followed by *Bacillus coagulans* (50%) and *Aspergillus niger* and *Penicillium* sp. (35%) (Table 2).

All the isolated microbial species were sugar and acid tolerant (Table 2). *Aspergillus niger* exhibited maximum tolerance, followed by *Penicillium* sp., *Bacillus laterosporus* and *Staphylococcus saprophyticus*. High salt and sugar tolerances of microorganisms and osmophilic soy-yeasts have been described[6–8]. Among the xerophilic moulds, members of the *Aspergillus glacus* group have been reported to grow on media containing 40% sucrose[9]. An osmophilic bacterium, *Bacillus saccharolyticus* n. sp. was found to propagate in jams containing 50 to 60% sugar[10]. The microbial species described in the present investigation were not reported earlier and thus, this becomes the first report for their high sugar tolerance.

Observations on the spoilage of *muramba* samples inoculated with the test organisms and their respective controls revealed that (i) none of the sterilized control samples of *muramba* spoiled till the end of the year; (ii) none of the samples with sugar concentration of 70 and 80% were spoiled indicating 70% as the inhibitory concentration for microbial spoilage; (iii) all the samples boiled for 50 min did not spoil irrespective of their sugar concentration (however, these became sticky and were not sensorily acceptable); (iv) out of 15 unsterile uninoculated control samples, two were spoiled; and (v) out of 60 unsterile samples inoculated with test organisms, 14 samples were spoiled.

TABLE 2. PERCENT INCIDENCE OF MICROBIAL SPECIES IN *MURAMBA* SAMPLES AND THEIR TOLERANCE TO SUCROSE AND CITRIC ACID

Microbial species	No. of samples positive	Tolerance	
		Sucrose (g%)	Citric acid (g%)
1. *Micrococcus luteus*	14 (100)	35.0	3.5
2. *Bacillus coagulans*	7 (50)	37.0	4.5
3. *Pencillium* sp.	7 (50)	66.0	18.0
4. *Aspergillus niger*	5 (35.7)	78.0	24.5
5. *B. licheniformis*	4 (28.5)	48.0	4.5
6. *S saprophyticus*	4 (28.5)	70.0	4.5
7. *B. alvei*	3 (21.4)	35.0	1.5
8. *B. cereus*	3 (21.4)	48.0	4.5
9. *B. laterosporus*	2 (14.3)	70.0	2.0
10. *S. aureuss*	2 (14.3)	33.0	4.5
11. *B. circulans*	1 (7.1)	30.0	3.0
12. *B. megaterium*	1 (7.1)	30.0	5.0
13. *B. pumilus*	1 (7.1)	30.0	5.0

Figures in parenthesis indicate % incidence.

The data in Table 3 indicate that the sugar tolerant fungi namely *A. niger and Penicillium* sp. could multiply and cause spoilage in the form of unacceptable surface growth. Although *Bacillus cereus* and *Staphylococcus saprophyticus* could multiply (Table 4), the apparent spoilage was in the form of surface growth of fungi. Thus, the inoculated bacteria could not exhibit spoilage because of overgrowth of fungi. Testing spoilage ability in sterilized samples was not practicable since traditionally, the product is not sterilized and its preservation is attained by high concentration of sugar and boiling the preparation. The similarity in the count of bacteria and fungi in a few of the uninoculated and inoculated samples can be attributed to uneven distribution of native flora and post-contamination (Table 3).

Although the incidence of bacterial species in *muramba* samples was more, fungal species mainly caused surface growth and visible spoilage. Mango fruit has native acids like

TABLE 1. PHYSICAL EXAMINATION AND CHEMICAL AND MICROBIOLOGICAL ANALYSIS OF *MURAMBA* SAMPLES

Samples analyzed (Nos)	Physical appearance	Moisture (g%)	Titrable acidity as citric acid, (g%)	Sugar (g%)	No of isolates obtained	
					Bacteria	Fungi
7	Normal	16.8-42.2	0.5-1.8	12-49	2-5	0-2
7	Spoiled*	32.4-63.3	0.2-2.2	23-39	1-4	0-2

The pH range was 3.5 – 4.0 in both the cases

* Spoilage was in the form of surface growth or off flavour

TABLE 3. PHYSICAL, CHEMICAL AND MICROBIOLOGICAL STATUS OF *MURAMBA* SAMPLES BEFORE AND AFTER SPOILAGE BY TEST ORGANISMS

Sugar conc (g%)	Heating time, (min)	Storage period (days)	Inoculated with *A. niger*			Storage period (days)	Inoculated with *penicillium* sp.		
			Moisture (g%)	Titrable acidity (g%)	Fungal Count (Cfu/g)		Moisture (g%)	Titrable (acidity) (g%)	Fungal count (cfu/g)
40	30	10	56.2	8.4	2×10^{10}	10	55.3	6.5	2×10^{9}
40	40	10	54.1	8.1	3×10^{10}	10	51.6	8.7	1×10^{9}
50	30	10	40.7	11.0	$2\times10^{10*}$	10	43.1	1.2	2×10^{10}
50	40	75	43.1	6.4	2×10^{11}	77	33.8	6.8	$2\times10^{10**}$
60	30	91	43.3	8.2	2.6×10^{11}	10	38.4	0.8	1×10^{11}
60	40	91	35.3	6.2	2×10^{12}	77	37.4	6.2	2.7×10^{12}

The spoilage was indicated by surface growth which was black and greenish in case of *A. niger* and *Penicillium* sp., respectively. Initial fungal counts of these cultures were 3×10^{6} and 1×10^{6}, respectively. cfu=colony forming units.
Bacteria were absent in all the cases except for the count of $*7\times10^{10}$ and $**6\times10^{11}$

TABLE 4. DATA ON OTHER SAMPLES SPOILED

Sugar conc (g%)	Heating time (min)	Sample type	Storage period (days)	Moisture (g%)	Titrable acidity (g%)	Microbial load (cfu/g)	
						Bacteria	Fungi
50	30	Uninoculated	35	40.7 (63,4)	11.0 (1.3)	7×10^{10}	2×10^{10}
50	30	Inoculated with *S. saprophyticus*	42	43.2	11.6	8×10^{9} (1.7×10^{7})	3×10^{11}
60	30	Inoculated with *Bacillus*.sp.	81	42.7	6.4	4×10^{10} (1.8×10^{4})	2.3×10^{12}
60	40	Uninoculated	75	37.4 (69.1)	6.2 (1.3)	6×10^{11}	2.7×10^{12}

Figures in parentheses are the initial values, cfu = colony forming units.
The visible spoilage was black/greenish surface growth.

malic and citric acids, the acidities of which could not protect the product from microbial spoilage because of the microbial tolerance to acidity. As regards spoilage ability of *A. niger*, although it exhibited tolerance of 78% sucrose in liquid nutrient medium, it could not cause spoilage at 70% sugar content of the semi-sclid product, probably because of low moisture. The study shows that 70% sugar in *muramba* and boiling the preparation for 30 min could protect it from microbial spoilage.

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Role of Dietary Fibre from Pulses and Cereals as Hypocholesterolemic and Hypolipidemic Agent

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Inclusion of dietary fibre from seed coat of wheat, maize, green seeded gram and soybean in hypercholesterolemic diet, showed no interference with the food intake or its utilization for growth. Fibres lowered the levels of plasma as well as tissue total lipids, cholesterol and glycerides, the effect being prominent with soybean and green seeded gram. In addition, soybean and green seeded gram fibres appeared to be potent anti-atherogenic agents. The hypocholesterolemic action of fibre could be directly correlated with their bile acid binding capacity and inverse relationship to water holding capacity. In general, higher was the lignin content of fibre, better was the hypocholesterolemic effect.

A high level of plasma cholesterol, particularly the LDL-cholesterol has emerged as an important risk factor in atherosclerosis[1]. Scientists have, therefore, been looking for agents which can lower the cholesterol levels to check this disease, Though cholesterol levels can be lowered with the use of drugs, either by inhibiting endogenous synthesis[2] or by lowering cholesterol absorption[3], such an approach is generally not free from side effects. The most suitable approach would be the one involving changes in dietary regimens. Dietary fibre from some sources is known to lower the lipid/cholesterol levels[4-6]. However, an increased intake of refined diet leads to low intake of dietary fibres. In the present investigatioin, the hypocholesterolemic/hypolipidemic action and the physical and chemical properties of fibres from cereals and pulses have been studied.

Materials and Methods

Fibre was isolated from the seed coat of cereals, (wheat and maize) and pulses (green seeded gram (*Cicer arietinum)* and soybean) according to the method of Eastwood and Mitchell[7]. These fibres were analysed for cellulose[8], neutral detergent fibre (NDF), acid detergent fibre (ADF), lignin[9] and ash[10]. Their water holding capacity and bile acid adsorption were also determined[5].

Male albino rats (Wistar strain), 5-6 weeks old, were divided into five groups of six animals each. Rats were given hypercholesterolemic diets containing (g/100 g diet) 64 starch, 15 casein, 10 refined groundnut oil, 1 cholesterol, 4 salt mixture[11], 1 vitamin mixture[12] and 5 fibre or cellulose for control group. The rats were sacrificed after 4 weeks of feeding. Blood and different organs were removed for analysis. Total lipids[13], phospholipids[14], free fatty acids[15], cholesterol[16] and HDL cholesterol[17] were determined. Bile acids were determined[5] in the faecal mass collected on last three days of the experiment.

Results and Discussion

Fibres from soybean and green seeded gram had higher amounts of NDF, ADF, cellulose, hemicellulose and lignin compared to maize and wheat fibres (Table 1) indicating that cereal fibres have higher cell soluble components. Fibre from wheat had maximum ash content whereas fibre from maize had the minimum. Water holding capacity in the presence and absence of some salts (Table 1) was found to be greater for wheat fibre and least for green seeded gram fibre. The effect of salt varied at different concentrations and appeared to be different for different fibres. Determination of *in vitro* bile acid binding capacity of different fibres as a function of time showed that adsorption increased with time and was maximum around 150 min of incubation (Table 2). Adsorption was maximum for deoxycholic acid with all fibres followed by chenodeoxy cholic acid and cholic acid. Bile acid adsorption was, however, more in legume fibres than cereal fibres. Inclusion of dietary fibre from either of the sources did not interfere with food intake or food utilization for growth as evidenced by insignificant effect on food intake, gain in body weight and food efficiency ratio (Table 3). Similarly, intake of fibre did not affect the organ weights.

Plasma lipid profile showed that soybean and green seeded gram fibre fed groups had significantly lower total lipids whereas rats fed cereal fibre had no significant effect (Table 3). The decrease in lipids was mainly reflected in

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TABLE 1. PROXIMATE COMPOSITION AND WATER HOLDING CAPACITY OF DIETARY FIBRE FROM DIFFERENT SOURCES

Factor	Source of fibre			
	Wheat	Maize	Soybean	Green seeded gram
Proximate composition (%)				
Ash	5.5	0.9	2.2	2.3
ADF	18.9	30.6	39.6	36.1
NDF	51.2	76.4	88.4	84.0
Cellulose	13.8	21.4	26.6	25.2
Lignin	5.1	9.2	12.4	10.9
Hemicellulose	32.3	45.8	49.8	47.9
Water holding capacity (g/g)				
Water	5.5	4.7	4.2	3.4
NaCl				
0.05M	4.3	5.4	4.9	4.3
0.1M	5.9	5.6	5.6	4.7
0.5M	4.7	4.0	5.2	3.7
KCl				
0.05M	5.0	4.4	4.3	3.6
0.1M	5.8	5.0	5.5	4.5
0.5M	5.2	5.3	4.1	3.6

Water holding by cellulose in all cases was 7.5-7.7 g/g

cholesterol and glyceride levels. Phospholipids and free fatty acids were, however, hardly affected. Cholesterol lowering effect in plasma was maximum with soybean (43.2%) and green seeded gram (40.3%) whereas it was least with wheat (33.7%) and maize fibres (27.7%). The lowering of cholesterol was mainly from LDL and VLDL fractions. HDL cholesterol was not significantly affected (Table 3). Fibre from soybean lowered the total hepatic and cardiac lipids significantly. The lowering effect was relatively less with other fibre sources (Table 4). Cholesterol to phospholipids ratio was significantly low in groups receiving soybean or green seeded gram fibre. Average bile acid excretion/day or per gram faecal mass was higher in fibre fed groups, the effect being prominent and significant only in case of green seeded gram and soybean fibres (Table 4).

Since the ratio of HDL to total cholesterol is inversely related to the development of atherosclerosis[18], higher ratio observed with fibre from soybean and green seeded gram proved their anti-atherogenic potential. The source of fibre has earlier been reported to be the major determinant of hypocholesterolemic response[19]. The decreases in lipid contents of the tissues (heart and liver) were prominent with legume fibres and are in agreement with the observations of Leelamma *et al*[20]. Better hypocholesterolemic action in

TABLE 2. BILE ACID ADSORPTION (%) BY DIFFERENT FIBRES AS A FUNCTION OF TIME

Time (min)	Bile acid											
	Deoxycholic acid				Chenodeoxycholic acid				Cholic acid			
	W	M	S	GSG	W	M	S	GSG	W	M	S	GSG
30	39.8	40.2	48.4	50.2	30.2	38.2	39.2	40.4	24.0	23.2	28.0	29.6
60	40.2	42.8	50.2	52.2	32.4	40.2	46.2	48.2	29.1	28.0	30.2	32.2
90	42.0	44.5	54.0	56.0	34.8	39.0	48.4	50.0	32.4	30.2	32.1	33.2
150	44.2	48.0	59.0	58.0	40.0	37.6	58.0	54.2	38.4	36.5	34.6	40.2
240	43.0	47.2	58.5	58.1	39.0	36.0	55.2	54.1	37.8	36.0	33.1	41.2
300	43.0	47.0	58.3	58.0	39.0	36.0	55.0	54.0	37.2	36.0	33.0	41.0

W=Wheat, M=Maize, S=Soybean, GSG=Green seeded gram

TABLE 3. EFFECT OF DIFFERENT FIBRES ON FOOD INTAKE, GAIN IN BODY WEIGHT AND PLASMA LIPID PROFILE IN RATS

Factor	Fibre source				
	Cellulose (Control)	Wheat	Maize	Soybean	Green seeded gram
Food intake (g)	228±1.6	230±20	237±17	219±21	246±17
Gain in body wt (g)	41.8±3.8	39.7±4.6	36.7±4.2	36.3±3.3	38.7±4.4
Lipid profile of plasma (mg/100 ml)					
Total lipids	920±104.2	816±96.9[b]	885±99.3	684±82.1[a]	615±73.8[a]
Total cholesterol	198.0±26.4	131.2±18.7[a]	143.0±16.9[a]	112.5±14.3[a]	118.2±13.2[a]
Phospholipids	265±35.4	282±20.7	262±23.4	286±26.7	290±27.8
Free fatty acids	25.5±2.1	22.3±1.8	22.6±2.6	19.9±2.7	24.0±3.2
Glycerides	132±48.6	381.1±42.4	458.8±33.3	278.0±27.2[a]	183.0±24.1[a]
Cholesterol (HDL_c)	47.2±6.1	40.9±7.9	43.2±3.3	45.9±6.7	42.6±3.4
Cholesterol ($LDL+VLDL)_c$	149.6±19.4	92.0±14.7[a]	99.2±7.9[a]	65.7±8.5[a]	72.6±7.9[a]

Values are mean±SD, n=6, $a_p < 0.01$ $b_p < 0.05$

TABLE 4. EFFECT OF DIETARY FIBRES ON LIPID PROFILE OF LIVER, HEART AND FAECAL BILE ACID EXCRETION

Factor	Fibre source				
	Cellulose (Control)	Wheat	Maize	Soybean	Green seeded gram
Hepatic lipids profile (mg/g)					
Total lipids	124 ± 12.0	103 ± 10.5[b]	98.7 ± 7.5[a]	68.5 ± 2[a]	72.6 ± 6.5[a]
Cholesterol	25.0 ± 2.3	18.8 ± 2.0[a]	14.7 ± 2.0[a]	9.8 ± 1.6[a]	11.7 ± 2.1[a]
Phospholipids	13.5 ± 1.5	12.0 ± 1.6	14.5 ± 1.8	16.4 ± 1.4	15.3 ± 1.9
Free fatty acids	14.0 ± 1.3	12.5 ± 0.8	12.3 ± 1.2	16.5 ± 2.9	25.0 ± 3.8
Glycerides	70.9 ± 9.4	60.0 ± 7.3[b]	57.6 ± 8.1[b]	25.0 ± 3.8[a]	29.0 ± 4.2[a]
Heart lipid profile (mg/g)					
Total lipids	53.19 ± 6.38	50.6 ± 6.33	50.35 ± 5.54	40.00 ± 0.80[a]	41.02 ± 5.8
Cholesterol	2.33 ± 0.28	1.75 ± 0.21[a]	1.44 ± 0.15[a]	1.06 ± 0.13	1.28 ± 0.16
Phospholipids	13.29 ± 1.59	13.15 ± 1.53	13.22 ± 1.32	12.35 ± 1.60	12.39 ± 1.61
Free fatty acids	14.58 ± 1.74	14.25 ± 1.56	14.28 ± 1.48	13.98 ± 1.82	14.06 ± 1.96
Glycerides	22.99 ± 2.75	21.53 ± 2.50	22.41 ± 2.30	12.61 ± 1.64[a]	13.29 ± 1.86[a]
Faecal bile acid excretion					
Bile acid* (mg/24 h)	1.82 ± 0.42	2.21 ± 0.38[b]	2.15 ± 0.29	2.90 ± 0.41[a]	3.12 ± 0.43[a]
Bile acid* (mg/g faecal matter)	14.56 ± 1.34	17.8 ± 1.71	16.9 ± 2.19	27.6 ± 3.86[a]	34.6 ± 4.74[a]

Values are mean ± SD, n=6, *Expressed as cholic acid, [a]P < 0.01 [b]P 0.05

fibres with higher lignin content observed was also reported for fibres from other sources[5]. The higher hypocholesterolemic action of legume fibres could be due to increased cholesterol catabolism to bile acids and/or decreased cholesterol and bile acid absorption[5], which in turn, appeared to be due to better bile acid adsorption by these fibres. Thus, the fibres shift the dynamic equilibrium towards catabolism resulting in hypocholesterolemic effect. In conclusion, fibres from legumes proved better hypocholesterolemic/hypolipidemic and anti-atherogenic agents compared to fibres from cereals.

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Physical and Chemical Characteristics of Maize Flour Made after Lime Cooking of Grains

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Physical and chemical characteristics of maize flour cooked with lime water (LHT), water (HT) and raw (UT) were studied. LHT afforded the finest flour among the three treatments as reflected by the optimum water absorption and the particle size index (PSL). Water absorption capacity of maize flour increased significantly after LHT. The alpha-amylase susceptibility was highest in lime treated flour. The contents of total ash and crude protein of maize flour increased whereas those of crude fibre, fat and carbohydrates decreased after lime as well as heat treatments.

Maize *(Zea mays* L.) is a hard grain which cannot be ground finely and the flour obtained lacks gluteneous material[1]. The dough, therefore, is easily disrupted during handling and difficult to roll into a good *chapati*. The coarser outer husk is reported to be responsible for the poor acceptability of maize[2]. The present study was undertaken to evaluate a lime treatment (Nixtamalization) process which is being practised in Mexico, Central and South America for the preparation of flour for *tortilla*[3]. The process has been reported to improve the physical and chemical characteristics of the flour[4].

Materials and Methods

Maize varieties 'VL-16', 'VL-41', and 'VL-42' were obtained from Vivekanand Parvatiya Krishi Anusandhan Shala, Almora while 'D 823', 'D 751' and 'D 771' were from G.B. Pant University of Agriculture and Technology, Pantnagar.

Preparation of flour: Each maize variety was cleaned free of any foreign material and divided into three lots. Out of these, one was marked as control and the second was cooked in double the amount of water (w/v) at 85°C for 45 min, steeped for 14 h, drained and dried at 55°C for 24 h (HT). The third lot was similarly cooked with the lime solution (0.5%) after steeping for 14 h (LHT). All the samples were ground to flour in a laboratory mill (FN 3100, U.S.A.).

Physical characteristics of maize grain: Hardness was determined as force required to break a grain when pressed under Kiya grain hardness tester (Seisa Kusho Ltd., Japan) and expressed as kg/grain. Density of the grain was determined according to water displacement method. Thousand grain weight was determined as described by Jackson *et al.*[5] for maize. Vitreousness of the grain was reported depending on the translucency or capacity of the grains when seen in bright sunlight.

Physical characteristics of flour: Colour of the flour was compared with Munsell soil colour charts and the matching hue value and chroma were recorded. Density was determined by measuring the volume of known weight (50 g) sample and expressed as g/ml. The particle size index (PSI) of the flour samples was determined according to the method of Bedolla and Rooney[4] by sieving 10 g flour in a series of 60 (250 μm), 70 (21 μm) and 80 (177 μm) mesh standard sieves using six metal balls of 1 cm diameter as bouncers for each sieve. The sieves were shaken for 15 min in a ro-tap type sieve shaker, weights of the sample over 60, 70, 80 and through 80 mesh sieves were recorded. PSI was calculated as:
PSI = (0.1) (per cent on 60 mesh) + (0.4) (per cent on 70 mesh) + (0.7) (per cent on 80 mesh) + (1.0) (per cent on 80 mesh).

The optimum water uptake (OWU) was determined according to the method of Anderson *et al.*[6]. Water absorption capacity (WAC) was determined according to ultra-centrifuge method of Preston and Tipples[7] and was expressed as per cent water absorption on 14% moisture basis.

Chemical analysis: The proximate composition including moisture, protein, ash, fat and crude fibre of different flour samples was estimated according to standard AACC methods[8]. Damaged starch was determined according to

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TABLE 1. CHARACTERISTICS OF THE MAIZE VARIETIES

Variety	Hardness (Kg/grain)	Density (g/cc)	Thousand kernel wt (g)
VL-16	29.6	1.2	233
VL-41	24.7	1.2	237
VL-42	24.7	1.2	286
D-741	27.6	1.2	228
D-823	25.2	1.2	254
D-771	30.4	1.2	222
Mean	27.0	1.2	243
CD at 1%	2.9	0.045	18.10
SEM	0.76	0.012	4.65

All values are averages of six replicates.

parameters were calculated from the data so obtained[10]. All statistical analysis were done in Micro-32 computer (E.C.I.L.). All the values are averages of triplicate unless otherwise stated.

Results and Discussion

Physical characteristics of grains: The results of the grain characteristics of the maize varieties, presented in Table 1, reveal that varieties 'VL-41', 'VL-42' and 'D 823' could be classified as soft, while varieties 'VL-16', D 741 and 'D 771' were hard. All varieties were vitreous. According to the thousand kernel weight, variety, 'VL-42' had the largest grain size and 'D 771' the smallest.

Particle size index and water absorption: The data on PSI of the flours (Table 2) indicate a significant reduction in the

TABLE 2. PHYSICAL CHARACTERISTICS, OPTIMUM WATER UPTAKE (OWU) AND WATER ABSORPTION CAPACITY (WAC) OF FLOURS OF UNTREATED, (UT) HEAT TREATED (HT) AND LIME HEAT TREATED (LHT) MAIZE VARIETIES

Variety	Particle size index (PSI)			Density (g/cc)			OWU (%)			WAC (%)		
	UT	HT	LHT	UT	HT	LHT	UT	HT	LHT	UT	HT	LHT
VL-16	32.7	40.1	46.7	0.5	0.5	0.6	85.0	105.0	113.3	94.3	145.9	187.7
VL-41	38.0	40.2	43.7	0.5	0.6	0.7	85.0	96.7	110.0	98.2	153.4	156.6
VL-42	33.9	37.7	40.4	0.6	0.7	0.7	75.0	95.0	110.0	89.0	130.1	163.6
D-741	31.9	34.4	36.4	0.6	0.7	0.7	70.7	100.0	110.0	84.0	130.1	144.5
D-823	35.6	37.0	38.2	0.6	0.6	0.7	72.0	101.7	113.3	80.3	100.3	146.8
D-771	25.3	31.7	34.0	0.7	0.7	0.7	71.0	102.3	111.7	91.9	126.1	135.2
Mean	32.9	36.9	39.9	0.57	0.64	0.68	76.4	100.1	111.4	89.6	131.0	155.7
CD at 1%	2.07	1.47	3.59	0.0069	0.0049	0.0012	1.31	0.93	1.73	5.69	5.40	13.23
SEM	0.54	0.38	0.93	0.19	0.13	0.32	0.35	0.25	0.61	1.97	1.40	3.44

AACC method with slight modification in the estimation of maltose equivalent which was determined according to the procedure of Bernfeld[9].

Statistical analysis: The observations of each characteristics were subjected to analysis of variance (ANOVA) on a completely randomized experimental design. The least significant difference was used to test the significant difference between the means. Correlation coefficients between various particle size of flours on LHT in all the varieties. The particle size of the flour was found to be correlated with grain hardness[11]. The reduction in particle size of the flour on LHT or HT may be due to increase in porosity of the endosperm, thereby reducing the hardness of the grain. Varietal differences in particle size were attributed to the type of endosperm i.e. soft or corneous endosperm causing the variations in the grain hardness, which is based on the ratio of starch to protein in the flour[12]. The water absorption indices increased significantly in HT as well as LHT and the magnitude was greater in LHT. The increase in water absorption indices may be due to the higher content of enzyme susceptible starch[13].

Chemical analysis: From the results of Table 3, it can be seen that both the treatments resulted in higher damage of starch in flour. However, the magnitude of increase was

TABLE 3. DAMAGED STARCH (%) CONTENT OF UNTREATED (UT), HEAT TREATED (HT) AND LIME HEAT TREATED (LHT) FLOUR OF DIFFERENT MAIZE VARIETIES

Variety	Damaged starch (%)		
	UT	HT	LHT
VL-16	42.0	73.0	94.0
VL-41	58.6	67.5	72.4
VL-42	40.0	62.5	77.2
D-741	57.4	69.4	91.2
D-823	59.0	82.1	90.5
D-771	59.0	77.2	81.3
Mean	52.7	71.9	84.5
CD at 1%	3.09	2.19	5.35
SEM	0.80	0.57	1.39

greater in LHT as compared to that in UT. This supports the data on water absorption indices. The varietal variations may be due to the hardness of the grain.

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Nitrogen Solubility of Raw and Autoclaved Faba Bean Flour

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Nitrogen solubilities of raw and autoclaved faba bean flour, over 1-13 pH range and in three dispersion media (water, 0.1 M NaCl and 1.0 M NaCl), indicated increase below and above the isoelectric pH (4.4). Higher salt concentration reduced nitrogen solubility. Analysis showed that pH is the primary determinant of nitrogen solubility.

The functional properties of legumes and oilseeds have specific food applications. Nitrogen solubility, one of the important functional properties of proteins, determines the behaviour of other functional properties in a particular food system[1-2]. Therefore, the nitrogen solubility of raw and autoclaved faba bean flour in various dispersion media was studied to predict its relationship with other functional properties.

Materials and Methods

Faba bean *(Vicia faba)* variety ('JV-1') was obtained from the Department of Plant Breeding and Genetics, J. N. Krishi Vishwa Vidyalaya, Jabalpur. Cleaned seeds (10.5% d.b. moisture content) were ground, passed through a 40 mesh sieve and packed in polyethylene bags. A portion of raw faba bean flour was autoclaved at 121°C (103422 N/m^2) for 10, 20 and 30 min and packed separately in polyethylene bags. The proximate composition of the sample was determined by standard procedure[3]. Nitrogen solubility of both raw flour (RF) and autoclaved flour (AUF) in various dispersion media was determined by a modified method of Betschart[4]. A 2 g sample was weighed directly into a conical flask and dispersed with either distilled water or 0.1 M (low salt) or 1.0 M NaCl (high salt) solution. The dispersion media were adjusted to different pH levels (1.0–13.0) with either 1 N NaOH or HCl. In an another set of experiments, the dispersion medium was adjusted to 2.0, 4.4 and 9.0 pH levels, shaken in Incu-Shaker for 30 min and centrifuged at 1000 × **g** for 20 min. Duplicate aliquots of the supernatant were analyzed for nitrogen by Kjeldhal method. Solubility (%) was calculated as the ratio of total nitrogen in the supernatant to total nitrogen in the sample.

Results and Discussion

The nitrogen solubility profiles of the RF and AUF as functions of pH, ionic strength and salt concentration are shown in Fig 1, 2 and 3. Both RF and AUF samples showed minimum solubility at pH 4.4 (isoelectric pH) and maximum on both sides of the isoelectric pH (Fig. 1). The nature of the nitrogen solubility curve of raw faba bean flour resembles that of moth bean flour[5].

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Effect of autoclaving on nitrogen solubility: In general, nitrogen solubility of AUF sample decreased which may be due to protein denaturation. At pH 10.0, there was a substantial decrease in nitrogen solubility of AUF as compared to the raw flour. Maximum decrease in nitrogen solubility was observed in 30 min autoclaved sample (Fig 2). Similarly at pH 1.0, significant decreases in nitrogen solubilities were observed (50%) in all the autoclaved samples. McWatters and Holmes[6] reported a reduction in nitrogen solubility from 98 to 57% for soyflour and from 91 to 83% for peanut flour at pH 8.0 when the flours were moist heated for 10 min. Similarly, nitrogen solubility of winged bean flour reduced from 95 to 60% at pH 10[7].

Effect of salt concentration on nitrogen solubilities: Both low and high salt concentrations of NaCl in dispersion media decreased the solubility at all the pH levels, when compared with water as dispersion medium. However, reduction in nitrogen solubility was more in the dispersion medium containing 1.0 M NaCl (high salt).

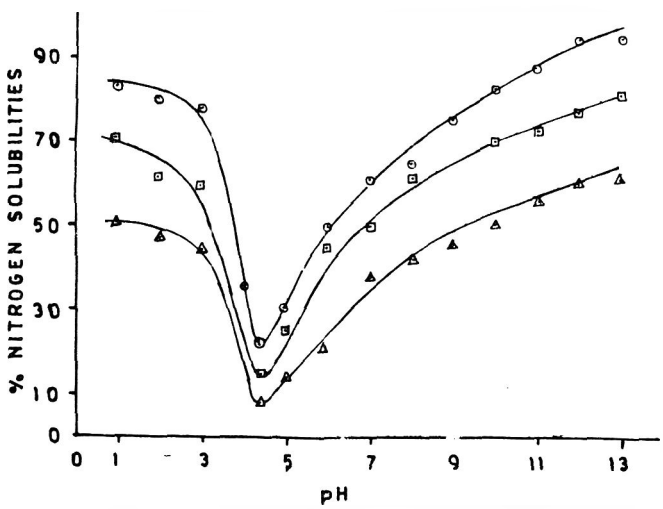

Fig. 1. Effect of pH on nitrogen solubility of raw faba bean at different salt concentrations.
O–O distilled water, □–□ 0.1 M Nacl, △–△ 1.0 M NaCl,

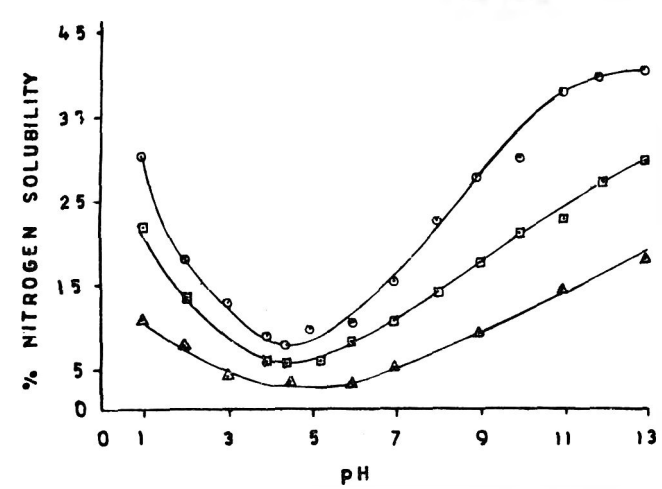

Fig. 2. Effect of pH on nitrogen solubility of 30 min. autoclaved flour of faba bean at different salt concentrations.
O–O distilled water, □–□ 0.1 M NaCl, △–△ 1.0 M NaCl,

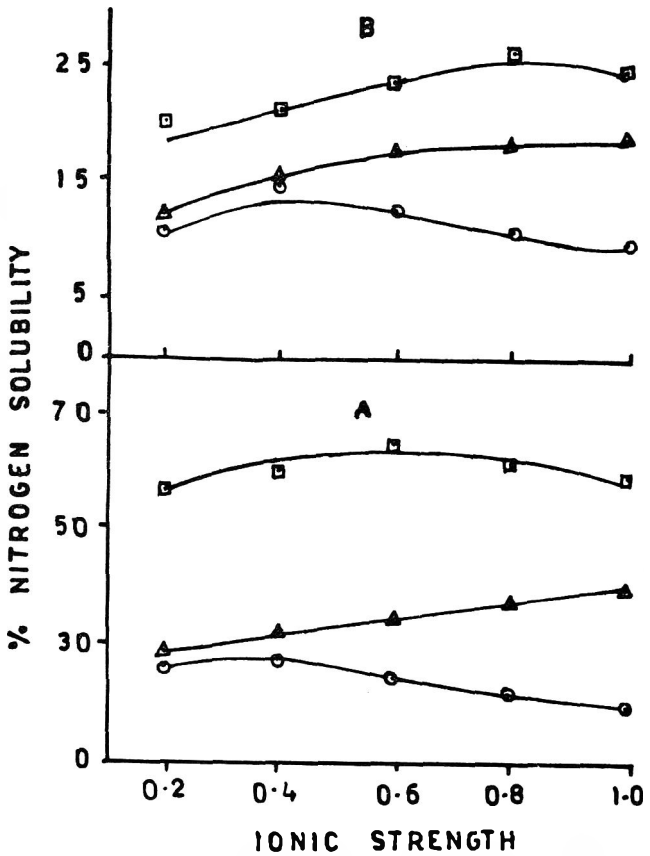

Fig. 3. Effect of ionic strength at different pH on nitrogen solubility of raw (A) and 30 min. autoclaved faba bean flour (B)
O–O 2.0 pH, △–△ 4.0 pH, □–□ 12.0 pH.

No shift in isoelectric pH was observed in the AUF sample and dispersion medium containing salt. The decrease in solubility by salt may be due to salting-out effect on the complex protein system[6].

Effect of calcium chloride (ionic strength) on nitrogen solubility: Nitrogen solubility of the RF and AUF samples increased at ionic strength of 0.2 to 0.4 and then decreased with further increase in ionic strength (Fig. 3). At pH 4.4, however, the solubility increased with an increase in the ionic strength, possibly due to salting-in effect. The decrease in solubility beyond the ionic strength of 0.6 at pH 2.0 and 12.0 may be due to salting-out effect.

It was observed that nitrogen solubility was highly influenced by change in pH and salt concentration. Therefore, multiple regression model was developed to predict the variation of regression of dependent variables on independent variables (Table 1). The significant regression coefficient of salt concentration which was negative indicated that increase in salt concentration would decrease the nitrogen solubility, while the regression coefficient for pH showed the reverse effect on nitrogen solubility. Hermansson and Akesson[8] found good correlation, using simple linear models, and concluded that functional properties could be used as reliable

TABLE 1. MULTIPLE REGRESSION MODELS FOR PREDICTION OF NITROGEN SOLUBILITY OF RAW AND AUTOCLAVED FABA BEAN FLOUR AS INFLUENCED BY pH AND SALT CONCENTRATION

Sample	Dependent variable	Independent variables	Regression coefficient	Constant	Correlation coefficient	F Value
Raw flour	% N solubility	Salt concn. (0.0, 0.1 M and 1.0 M NaCl)	−8.794	10.163	0.70	19.86
		pH (1.0 to 13.0)	1.657			
Autoclaved flour 10 min	% N solubility	Salt concn. (0.0, 0.1 M and 1.0 M NaCl)	−8.206	13.152	0.75	24.43
		pH (1.0 to 13.0)	1.954			
20 min	% N solubility	Salt concn. (0.0, 0.1 M and 1.0 M NaCl)	−9.315	11.148	0.68	19.31
		pH (1.0 to 13.0)	1.521			
30 min	% N solubility	Salt concn. (0.0, 0.1 M and 1.0 M NaCl)	−8.143	6.523	0.67	18.53
		pH (1.0 to 13.0)	1.344			

indicators or predicators of protein behaviour in real food system.

It appears, therefore, that the higher nitrogen could be extracted from the raw faba bean flour, at both acidic and alkaline pH ranges. Hence, it is expected that other functional properties i.e. emulsifying, foaming, and gelation would also be better and may find application as a protein ingredient in the food preparation.

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Studies on Preparation, Packaging and Storage of *Besan* (Bengalgram Flour) *Burfi*

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Preparation of *besan* (Bengalgram flour) *burfis* and their storage behaviour in various packaging materials has been reported. *Besan burfis* remained acceptable for 9 and 6 months at room temperature and 37°C respectively in polyethylene and polypropylene pouches. In paper-aluminium foil-polyethylene pouches, the *burfis* remained acceptable for 13 and 9 months at room temperature and 37°C, respectively. Packaging in BHA and BHT treated polyethylene film considerably reduced the rate of peroxidation during storage due to migration of antioxidants from film to burfis. Comparatively, BHT migrated faster than BHA and the rate of peroxidation was slower in samples packed in BHT treated film. The rate of storage deterioration was lowest at 0.33 a_w and both below and above this level, the rate increased considerably.

Besan burfis, one of the most popular sweets relished all over India, are generally prepared by mixing roasted Bengalgram flour *(besan)* with sugar syrup, milk solids, vegetable oil/*ghee* and flavours. These are also good sources of calories and proteins. However, hardly any data on the composition, method of preparation, shelf-life and packaging requirement of various varieties of *burfis* are available, limiting their large scale production and marketing in pre-packaged form. Studies were, therefore, undertaken to standardise the method of preparation, storage behaviour and packaging requirements to provide a minimum shelf life of one year under all weather conditions.

Materials and Methods

Preparation of Bengalgram flour: Dehusked Bengalgram *(Cicer arietinum) dhal* was ground in a commercial mill to obtain Bengalgram flour *(besan)*. Condensed milk (ISI No. 1166) was procured from the market and used in the preparation of *besan burfi*.

Roasting of Bengalgram flour and preparation of burfis: One kg lots of Bengalgram flour were roasted with 0.6 kg *vanaspati* (hydrogenated fat) in an aluminium pan with continuous mixing. The final temperature of the roasts were allowed to rise upto 140-165°C. The roasts were allowed to cool to 115°C and condensed milk (250 g) was added and mixed thoroughly. The mixture was again heated till the temperature reached 120°C and allowed to cool to 100°C and mixed with powdered sugar (1 to 1.3 kg) and cardamom (5 g). The contents were thoroughly mixed, poured in aluminium trays, rolled and cut into slabs (2''×2''). Each *besan burfi* weighed 25 g and four such *burfis* were packed in 5 in.×5 in. pouches of polyethylene (75 μ), polypropylene (75 μ), paper (40 GSM), aluminium foil (20 μ), polyethylene (37.5 μ) laminate and butylated hydroxy anisole (BHA) and butylated hydroxy toluene (BHT) treated polyethylene film (75 μ) and heat sealed. The pouches were stored at 37°C and at room temperature (15-35°C).

Sensory evaluation: Initially and after every 3 months of storage, *besan burfis* were given to a panel of 10 trained judges for evaluating their quality. Taste, colour, flavour, texture and overall acceptability were graded on a 9-point Hedonic scale having 9 for excellent and 1 for highly disliked samples. The product receiving a mean of 7 and above on 9 point Hedonic scale for overall acceptability was considered acceptable and below 7 was considered unacceptable for estimating the shelf life of the product.

Analysis: Storage changes in *besan burfi* were monitored by determining peroxide value (PV)[1], thiobarbituric acid value (TBA)[2], free fatty acids (FFA)[3], total carotenoids[4], moisture, protein, fat and total sugar[5]. Browning intensity in besan burfi was determined by measuring the optical density of the alcoholic extract at 420 nm (4 g sample + 100 ml of 70% ethanol, shaken for 2 h). To study the effect of water activity (a_w) on the stability of *besan burfi*, 180 g samples were stored for 120 days in petri dishes in desiccators containing phosphorous pentoxide and saturated salt solutions of magnesium chloride, sodium bromide, sodium nitrate to obtain water activity of 0.0, 0.33, 0.57 and 0.73 respectively[6].

Antioxidant content of polyethylene film was determined according to Sharma *et al*[7]. Migration of antioxidants from packaging materials to *burfi* was monitored by determining their concentration in the *besan burfi* after regular intervals during storage. Extraction of the antioxidants from *burfi* was carried out by shaking 20 g samples with 50 ml hexane for

1 h. The mixture was filtered through sintered crucible (G-4), residue was washed twice with 20 ml aliquots of hexane and total volume of the extract made upto 100 ml. From the hexane extract, the antioxidants were extracted with acetonitrile by following AOAC procedure[8]. Concentrations of BHA and BHT were determined by HPLC (Shimadzu Model LC-6A) using following conditions: mobile phase: acetonitrile-water (68:32); column: RP-18 (25 cm × 4.6 mm); flow rate: 2 ml/min: attenuation: 3; and detector: variable wavelength detector at 277 nm.

Results and Discussion

Flavour and texture of *besan burfis* were influenced by the conditions employed during roasting operation. Sensory evaluation of large number of batches of *burfis* prepared from Bengalgram flour roasted at temperatures ranging from 140° to 165°C indicated 160°C to be the most optimum. Also, incorporation of condensed milk in the recipe considerably improved the overall acceptance score of *besan burfi*. In the present study, powdered sugar was directly added to the *vanaspati*-Bengalgram flour mixture as this considerably simplified the upscaling of process. In the wet mix process involving sugar syrup, intensive mixing was necessary at elevated temperature and this posed considerable difficulties in the upscaling operations. The details of the process conditions optimised in the present study are given in the flow sheet (Fig.1.).

The *burfis* prepared by this method had moisture, 1.77%, fat, 26.28%, protein, 9.0%, total sugar, 37.41% and total carotenoids, 13.31 μ g/g. *Besan burfis* equilibrated to 0.63, 2.11, 2.57 and 3.24% moisture at 0.0, 0.33, 0.57 and 0.73 a_w respectively (Fig. 2). Also, no microbial spoilage was observed when *besan burfis* were stored upto 0.73 a_w for 120 days at room temperature (15-35°C). The rate of peroxidation was lowest at 0.33 a_w and both above and below this a_w, the rate of peroxidation increased considerably. This is in

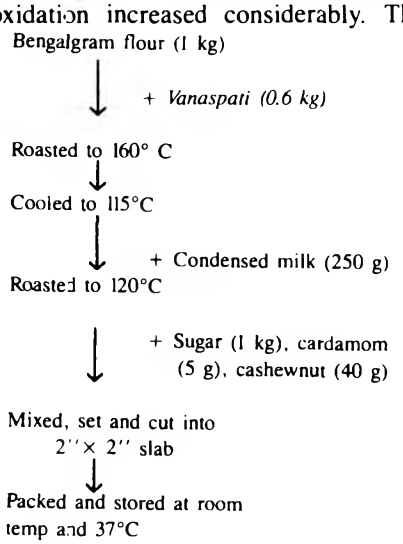

Fig.1. Flow sheet for the preparation of Bengalgram *burfi*

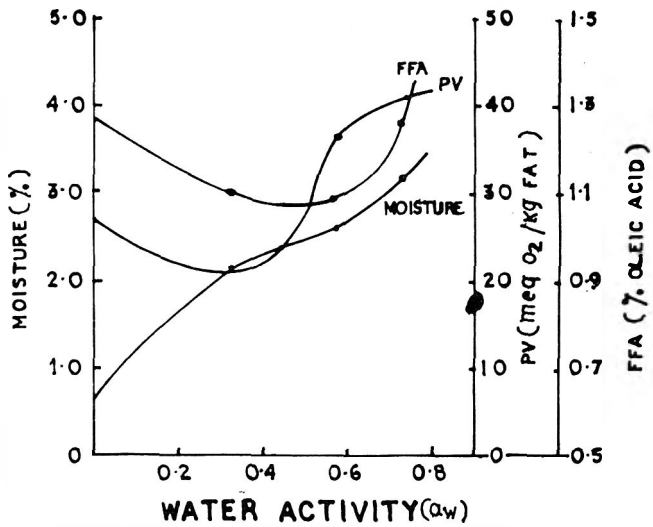

Fig.2. Sorption isotherm, peroxide value (PV) and free fatty acids (FFA) of *besan burfi* after 4 months storage at 15-35°C.

conformity with the published literature[9] as water forms hydrogen bonds with hydroperoxides at lower a_w. This essentially prevents further generation of free radicals from hydroperoxides and thereby lowers the overall oxidation rate. Water also hydrates trace metal ions which are known to catalyse autoxidation of fats. Hydration of metal ions decrease their catalytic activity. At very high a_w(> 0.70), water enhances autoxidation due to increased mobility of the metal catalysts and swelling of the matrix which exposes new catalytic sites. The changes in free fatty acids (FFA) followed the same pattern as those of peroxides suggesting increases in FFA as a result of secondary degradation products of hydroperoxides rather than due to hydrolysis of triglycerides. In *besan burfis*, the rate of browning during storage was slow and was appreciable only at 0.73 a_w.

The effects of packaging materials on the storage changes in PV, TBA value, FFA, carotenoids, browning intensity and overall acceptability scores of sensory evaluation are shown in Tables 1 and 2. As expected, the rates of peroxidation as measured by changes in PV and TBA values were related to the oxygen permeabilities of the packaging materials. The rate of peroxidation was highest in *burfis* stored in polyethylene film and lowest in aluminium foil laminate pouches. The changes in carotenoids and browning also followed the same pattern indicating the role of packaging materials in determining the overall storage changes in *besan burfis*. In samples stored at 37°C, the rate of storage changes was slightly higher. In general, the data indicate the role of storage temperature and packaging materials in determining the intensity of degradative changes during storage.

During storage, *besan burfis* remained acceptable for 9 months in PE and PP pouches at room temperature and 6 months at 37°C. In PFP pouches, these remained acceptable for 9 months and 13 months at 37°C and room temperature respectively.

TABLE 1. STORAGE CHANGES IN *BESAN BURFI* AT ROOM TEMPERATURE (15-35°C) IN DIFFERENT PACKAGING MATERIALS

Storage period (months)	Packaging material	PV (meq O_2/ kg fat)	FFA (% oleic acid)	TBA (mg malon-aldehyde/ kg sample)	Browning (OD)	Carotenoids (μg/g)	Overall acceptability
0		3.4	0.50	0.05	0.08	13.3	8.0
3	PE	3.9	0.55	0.11	0.09	9.4	7.2
	PP	3.8	0.50	0.10	0.09	9.9	7.6
	PFP	3.6	0.47	0.10	0.09	11.5	7.9
6	PE	5.4	0.62	0.11	0.11	8.9	7.2
	PP	4.6	0.60	0.11	0.10	9.4	7.2
	PFP	3.9	0.56	0.10	0.09	11.2	7.4
9	PE	12.6	0.65	0.12	0.12	8.1	7.0
	PP	11.3	0.63	0.11	0.10	9.0	7.1
	PFP	8.6	0.58	0.11	0.11	9.3	7.3
13	PE	15.7	0.67	0.13	0.13	7.6	6.3
	PP	12.2	0.63	0.12	0.12	8.5	6.8
	PFP	10.9	0.59	0.11	0.11	9.1	7.0

PV, Peroxide value; FFA, Free fatty acids; TBA, Thiobarbituric acid value. PE, Polyethylene; PP, Polypropylene; PFP, Paper-aluminium foil-polyethylene laminate. Maximum variations in PV, FFA, TBA, browning, carotenoids and overall acceptability score were 0.01 to 0.11, 0.00 to 0.01, 0.00 to 0.01, 0.00 to 0.01, 0.00 to 0.01, 0.06 to 0.30 and 0.1 to 0.5 respectively.

TABLE 2. STORAGE CHANGES IN *BESAN BURFI* AT 37°C IN DIFFERENT PACKAGING MATERIALS

Storage period (months)	Packaging material	PV (meq O_2/ kg fat)	FFA (% oleic acid	TBA (mg malon-aldehyde/ kg sample)	Browning (OD)	Carotenoids (μg/g)	Overall acceptability
0		3.4	0.50	0.05	0.08	13.3	8.0
3	PE	5.6	0.57	0.10	0.10	9.3	7.0
	PP	5.3	0.51	0.11	0.09	9.6	7.4
	PFP	5.0	0.50	0.11	0.09	11.1	7.8
6	PE	9.1	0.62	0.12	0.11	9.2	7.0
	PP	8.0	0.62	0.11	0.11	9.4	7.1
	PFP	7.1	0.60	0.11	0.10	10.8	7.6
9	PE	14.0	0.80	0.13	0.13	7.2	6.5
	PP	12.1	0.71	0.11	0.12	8.0	6.3
	PFP	11.1	0.70	0.12	0.11	8.9	7.2
13	PE	19.7	0.90	0.15	0.16	7.1	6.1
	PP	14.4	0.78	0.13	0.14	7.3	6.4
	PFP	12.8	0.71	0.12	0.12	8.1	6.8

PV, Peroxide value; FFA, Free fatty acids; TBA, Thiobarbituric acid value. PE, Polyethylene; PP, Polypropylene; PFP, Paper-aluminium foil-polyethylene laminate. Maximum variations in PV, FFA, TBA, browning, carotenoids and overall acceptability score were 0.01 to 0.15, 0.00 to 0.01, 0.00 to 0.01, 0.00 to 0.01, 0.01 to 0.12 and 0.1 to 0.7 respectively.

Since peroxidation of fats is the major cause of storage deterioration in stored *besan burfis*, the effect of incorporating antioxidants (BHA and BHT) in the polyethylene film and their effect on the storage stability of *burfis* when packed in antioxidant treated film pouches were investigated. Incorporation of BHA and BHT in the polyethylene film significantly reduced the rate of peroxidation in *besan burfis* both at room temperature and 37°C (Table 3). The reduction in the rate of peroxidation in *burfis* stored in antioxidant treated films was mainly brought about by the migration of antioxidants from film to *burfis* (Table 3) during storage. Also, BHT migrated faster than BHA and the rate of peroxidation was also slower in BHT treated film than BHA treated film. In both the cases, the rate of migration was considerably higher at 37°C than at room temperature. The concentration of antioxidants in *burfis* when stored in antioxidant treated films increased upto 3 months at 37°C and upto 6 months at room temperature. During subsequent storage, the

TABLE 3. CHANGES IN ANTIOXIDANT CONCENTRATION IN *BESAN BURFIS* ON STORAGE WHEN PACKED IN TREATED AND UNTREATED POLYETHYLENE FILM

Storage period (months)	Storage temp. (°C)	Packaging material	Concn of anti-oxidant in *burfis* (μg/g)	Peroxide value (meq O_2/ kg fat)	Thiobarbituric acid (mg malonaldehyde/ kg sample)
0		–	–	4.0	0.05
3	Room temp	PE	–	4.2	0.10
		PE (BHA)	24.8	4.0	0.08
		PE (BHT)	26.4	3.7	0.09
	37	PE	–	6.9	0.11
		PE (BHA)	52.1	5.4	0.09
		PE (BHT)	82.1	4.7	0.08
6	Room temp	PE	–	9.2	0.12
		PE (BHA)	35.8	6.6	0.10
		PE (BHT)	27.1	6.9	0.09
	37	PE	–	10.0	0.13
		PE (BHA)	38.2	7.6	0.11
		PE (BHT)	60.1	6.3	0.12
9	Room temp	PE	–	12.6	0.12
		PE (BHA)	17.1	8.0	0.10
		PE (BHT)	20.1	7.8	0.10
	37	PE	–	14.0	0.14
		PE (BHA)	29.2	9.2	0.13
		PE (BHT)	53.8	8.6	0.12

Initial concentration of BHT in PE – 0.97%; Initial concentration of BHA in PE – 0.51%; The maximum variation in PV and TBA values were 0.01 to 0.13 and 0.0 to 0.01, respectively.

concentration of antioxidants tended to decrease. This may have resulted due to the reaction of antioxidants with free radicals and hydroperoxides in the stored burfis.

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Effect of Processing Methods on the Quality of Whole Wheat Flour Bread

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Whole wheat flour breads based on straight dough, sponge and dough and mechanical dough development methods were prepared. The specific loaf volume of bread from sponge and dough method was highest (2.44 cc/g) followed by straight dough method (2.31 cc/g) and mechanical dough method (2.13 cc/g). The effect of different methods on the crumb texture of bread was distinct. The crumb texture was very soft, soft and slightly hard for breads by sponge and dough, straight dough and mechanical dough development methods, respectively. The results indicated that sponge and dough method was better suited than straight dough and mechanical dough development methods. However, the breads from different methods possessed wholesome typical wheaty taste.

The production of wheat *(Triticum aestivum)* in India is about 54 million tonnes[1]. Presently, there are about 600 roller flour mills which process 10% of the wheat produced into flour, semolina, resultant *atta* and bran. The disc mills, numbering about 3,00,000 in the country process about 80% of wheat into whole wheat flour (*atta*) which is used for making *chapati*, *parotta* and *puri*. Whole wheat flour can be an alternate raw material for manufacturing breads. Moreover, whole wheat flour bread may find ready acceptance as it offers better nutrition and familiar wholesome wheat taste to the consumers. Such an utilization may prove useful as the popularity of the bakery products has increased in recent years due to their cost competitiveness, ready availability, good taste, texture profile and shelf life.

Rogers and Hoseney[2] studied the problems associated with producing whole wheat flour bread. Lai *et al.*[3] reported that a good quality whole wheat bread could be produced using the highest absorption possible. The results of the studies on the effects of different bread making methods on the quality of whole wheat flour bread are presented in this paper.

Materials and Methods

Wheat milling: A commerical wheat (*Triticum aestivum*) was procured from local market and milled into whole wheat flour in a hammer mill (Model: Apex).

Chemical characteristics: Moisture, total ash, acid insoluble ash, Hagberg's falling number, diastatic activity and damaged starch were determined according to AACC procedures[4]. Particle size distribution of whole wheat flour sample was carried out in Buhler plan sifter (Type MC 41KS) using 200 g flour sample. The overtailings on each sieve were weighed after running the sifter for 10 min and the percentages were calculated. Crude protein (N×5.7) was determined by the micro-Kjeldahl method.

Rheological characteristics: Dough properties of whole wheat flour were studied using the farinograph, extensograph, amylograph and mixograph according to standard AACC procedures[4].

Dough raising capacity of whole wheat flour with different levels of sugar: Dough raising capacity of whole wheat flour with sugar levels of 1.0, 2.5, 5.0, 7.5 and 10.0% was studied according to ISI procedure[5].

Straight dough method: Whole wheat flour bread based on remix procedure of Irvine and McMullan[6] was prepared with reduced fermentation and proof times of 120 and 25 min for the dough instead of 165 and 55 min, respectively. The ingredients used for 100 g flour were yeast, 2.0; malt, 0.5; yeast food, 0.1; potassium bromate, 15 ppm; sugar, 2.5; salt, 1.0; and water: farinograph water absorption.

Sponge and dough method: Whole wheat flour bread using sponge and dough method was prepared according to standard AACC procedure[4]. However, the ingredients used were similar to those of straight dough method.

Mechanical dough development method: The breads were prepared using similar ingredients as those in straight dough and sponge and dough methods. The dough was mixed in Tweedy mixer (Type N23 F-G) applying partial vacuum of 15 in. of mercury. The final dough temperature was maintained at 28°C by using cold water. The cold water temperature was calculated using the formula WT=3×DDT−(FT+RT+FF) where WT=water temperature, DDT=desired dough temperature, FT = flour temperature, RT = room temperature and FF = friction factor of the mixer. The friction factor of Tweedy mixer was 19.

Evaluation of breads: Whole wheat flour breads were cooled and evaluated after 24 h by a panel of six judges.

Results and Discussion

Particle size distribution of whole wheat flour: The particle size distribution of whole wheat flour sample

(Table 1) indicated that maximum flour (69.5%) was retained over 12 ×× followed by 24.2% on 10 ×× sieves.

Chemical characteristics: The data on chemical characteristics of whole wheat flour are presented in Table 2. The presence of 11.92% protein and 10.66% damaged starch indicated that the wheat was of medium hard type. Diastatic activity of 300 mg of maltose/10 g flour and 489 falling number indicated low level of α-amylase activity in the flour.

Rheological characteristics: The dough characteristics (Table 3) showed that the wheat was medium strong for bread making based on farinograph water absorption, dough development time, stability, valorimeter value, extensograph and mixograph area values. The peak viscosity of 540 BU confirms the earlier observation that the whole wheat flour contains insufficient level of α-amylase.

Dough raising capacity of whole wheat flour with different levels of sugar: The data presented in Fig. 1 indicate that the dough raising capacity increased from 76.4 to 84.5% with increase in the sugar level in the dough from 1 to 5%. With further increase in sugar level to 10%, the dough raising capacity, however, decreased to 63.1% probably because the gas production exceeded the gas retention properties of the dough.

Effect of different bread making methods on the quality of whole wheat flour bread: Eventhough, the ingredients used for the preparation of breads were the same for all the three methods, the values for specific loaf volume showed variation (Table 4). All the breads had normal crust shape, brown crust colour, light brown crumb colour, medium fine and uniform crumb grain. The bread making method had a distinct influence on the texture of bread. The softness improved as the specific loaf volume of bread increased. The bread from sponge and dough method had very soft texture in contrast to the soft texture of bread from straight dough method. But the bread from mechanical dough development method showed slightly hard texture. The crumb grain score was equal, i.e. 7, for straight dough and sponge and dough methods as against that of 6.5 for mechanical dough

TABLE 1. PARTICLE SIZE DISTRIBUTION OF WHOLE WHEAT FLOUR

Sieve	Opening (μ)	Overtailings (%)
32	670	0.3
45	480	0.5
7xx	193	0.5
10xx	129	24.2
12xx	112	69.5
15xx	85	1.0
25p	62	1.0
Pan	–	3.0

TABLE 2. SOME CHEMICAL CHARACTERISTICS* OF WHOLE WHEAT FLOUR

Total ash (%)	1.54
Acid insoluble ash (%)	0.03
Protein (N × 5.7) (%)	11.92
Damaged starch (%)	10.66
Diastatic activity (mg of maltose/10 g flour)	300.00
Falling number	489.00

*Values expressed on 14% moisture basis.

TABLE 3. DOUGH CHARACTERISTICS OF WHOLE WHEAT FLOUR

Farinograph	Value
Water absorption (%)	66
Dough development time (min)	2
Stability (min)	3
Mixing tolerance index at 20 min (BU)	70
Valorimeter value	44
Extensograph	
Resistance to extension (BU)	580
Extensibility (mm)	116
Ratio figure, (R/E)	5
Area (cm^2)	83
Mixograph	
Peak time (min)	2
Peak height (cm)	7
Weakening angle (°)	30
Area (cm^2)	73
Amylograph	
Gelatinization temp (°C)	60
Peak viscosity (AU)	540

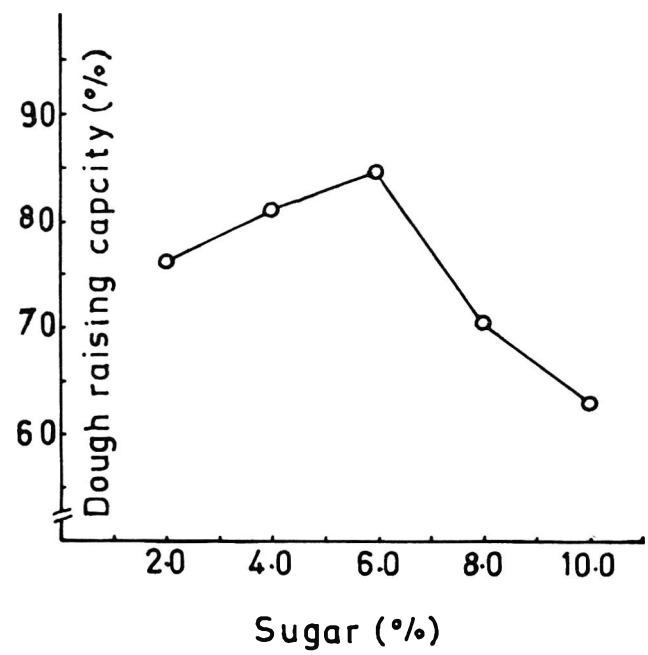

Fig. 1 Effect of addition of different levels of sugar on the dough raising capacity of whole wheat flour.

TABLE 4. EFFECT OF THREE DIFFERENT BREAD MAKING METHODS ON THE QUALITY OF WHOLE WHEAT FLOUR BREAD

Method	Specific loaf vol (cc/g)	Crumb texture	Crumb grain score*
A	2.31	Soft	7.0
B	2.44	Very soft	7.0
C	2.13	Slightly hard	6.5

A: Straight dough method

B: Sponge and dough method

C: Mechanical dough development method

* Max score-8

development method. All the breads possessed typical wholesome wheaty taste.

There are problems associated with producing bread from whole wheat flour since it has germ and bran in it. Galliard[7] reported the presence of relatively high concentrations of low molecular weight thiols, especially reduced glutathione, in germ which activates proteolytic enzymes thereby causing detrimental effect on loaf volume. Lai *et al*[8]. studied the detrimental effect of shorts, a mixture of germ, aleurone and pericarp layers, due to the presence of glutathione-methoxyl hydroquinone (MHQ) mixture. It was eliminated by soaking shorts to allow the indigenous lipoxygenase to neutralize glutathione-MHQ or by adding lipoxygenase. Lipoxygenase oxidizes unsaturated fatty acids to form free radicals and peroxides which; in turn, oxidize glutathione. The bread making quality depends on gas production and gas retention. The low specific loaf volume of bread from whole wheat flour was due to its poor gas retention properties. In the sponge and dough method of bread making, major fermentation is allowed to take place in the first part as 60% of the flour was allowed to undergo all the stress and strain during 4 h sponge time. After sponge fermentation, the dough is strengthened by the addition of remaining 40% of flour to improve gas retention properties. Also, enzyme lipoxygenase present in germ is allowed to act on glutathione due to sufficient time given for its action to be completed during sponge time. As a result, better specific loaf volume of bread in sponge and dough method was obtained when compared to that in straight dough and mechanical dough development methods. It is evident from the results that good quality whole wheat flour bread can be prepared using sponge and dough method.

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Influence of Additives on the Rheological and Bread Making Characteristics of Differently Milled Whole Wheat Flours

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Effect of potassium bromate and ascorbic acid on the dough and bread making characteristics of whole wheat flour milled in hammer, disc, stone, and roller mills indicated that the improvement in the dough properties varied for the differently milled flours. The breads from hammer and roller milled flours were better in quality than those from disc and stone milled flours. Improvement in the quality of breads due to additives was higher in hammer and roller milled flours than in disc and stone milled flours.

Oxidants like potassium bromate and ascorbic acid are generally used for improving the dough and baking characteristics of wheat flour. Bloksma[1] attributed the effect of oxidants on dough properties to the interchange reactions of sulphydryl and disulphide groups present in protein network. Though ascorbic acid is a reducing agent, it exerts the effect of an oxidising agent. The mechanism involves the oxidation-reduction of ascorbic acid by enzymes, ascorbic acid oxidase and dehydro ascorbic acid reductase, respectively.[2-4].

Whole wheat flour bread is one of the speciality products made in a number of bakeries. The loaf volume of whole wheat bread is substantially less, than what is expected, solely due to dilution of gluten and presence of bran particles[5]. Eighty per cent of wheat produced in India is processed into whole wheat flour and used mostly for the preparation of chapati[6]. The whole wheat flour is produced by grinding in disc, hammer, stone or roller mills. The quality of flours obtained differs widely due to variation in severity of grinding. This paper reports the effect of additives on the dough and bread making characteristics of differently milled whole wheat flours.

Materials and Methods

A commercial (*Triticum aestivum*) wheat, from local market, was milled into whole wheat flour in hammer, disc, stone and roller mills separately. The quality characteristics of these flours have already been reported[7]. The effect of additives at the levels of 20 ppm of potassium bromate and 200 ppm of ascorbic acid, as permitted by Prevention of Food Adulteration Act[8] on dough and bread making characteristics, was studied.

Rheological characteristics: Dough properties were determined using farinograph, mixograph, and extensograph according to standard AACC procedures[9].

Bread making quality: Breads were prepared according to remix procedure of Irvine and McMullan[10] with a reduced fermentation period of 120 min for the dough instead of 165 min. Evaluation of breads was carried out after 24 h by a panel of six judges.

Results and Discussion

Farinograph characteristics: The data (Table 1) indicate that the whole wheat flours milled in different mills had a maximum difference of 7.7% in water absorption. Both disc and stone milled flours showed higher water absorption as compared to hammer and roller milled flours. The difference in water absorption of different flours may be attributed to variation in severity of grinding in the mills. The improvement in dough development by 0.5 min on the addition of potassium bromate was seen only in disc and stone milled flours while 0.5-1.0 min increase was observed in all flours on the addition of ascorbic acid. Dough stability of flours improved by 0.5-1.0 min with potassium bromate and 0.5-2.5 min with ascorbic acid. With only a maximum change of 20 BU in mixing tolerance index value, the dough consistency of different flours was not affected with the additives. The valorimeter value, an index of the strength of dough, increased by 2 on addition of potassium bromate and by 2-6 with ascorbic acid for different flours.

Mixograph characteristics: Table 2 indicates that peak time which was 2.0-3.0 min for different flours improved by 0.5 min and 0.5-2.5 min with addition of potassium bromate and ascorbic acid, respectively. Incorporation of additives showed negligible effect on peak height values. Similarly, weakening angle was unaffected except for 1 and 2° reduction with the addition of ascorbic acid for hammer and roller milled flours respectively, indicating negligible effect on the mixing tolerance. The area values showed an increase by 1.2-2.9 cm^2 and 3.0-6.4 cm^2 with the addition of potassium

TABLE 1. EFFECT OF ADDITIVES ON THE FARINOGRAPH CHARACTERISTICS OF DIFFERENTLY MILLED WHOLE WHEAT FLOURS

Type of mill	Water absorption (%)	Dough development time (min)			Dough stability (min)			Mixing tolerance index at 20 min (BU)			Valorimeter value		
		C	PB	AA	C	PB	AA	C	PB	AA	C	PB	AA
Hammer	64.9	3.5	3.5	4.0	4.0	5.0	4.5	80	80	100	58	60	60
Disc	70.5	4.0	4.5	5.0	2.0	2.5	3.0	120	120	120	52	54	54
Stone	72.6	4.5	5.0	5.5	3.0	4.5	4.5	120	100	130	52	54	58
Roller	65.9	5.0	5.0	6.0	5.0	5.5	7.5	100	80	80	58	60	62

C—Control, PB-Potassium bromate (20 ppm) and AA-ascorbic acid (200 ppm)

TABLE 2. EFFECT OF ADDITIVES ON THE MIXOGRAPH CHARACTERISTICS OF DIFFERENTLY MILLED WHOLE WHEAT FLOURS

Type of mill	Peak time (min)			Peak height (cm)			Weakening angle(°)			Area (cm^2)		
	C	PB	AA	C	PB	AA	C	PB	AA	C	PB	AA
Hammer	2.0	2.5	4.5	5.3	5.4	5.3	10	10	9	53.2	55.5	59.6
Disc	2.0	2.5	3.0	5.5	5.4	5.5	10	10	10	48.4	51.3	54.8
Stone	3.0	3.5	3.5	5.5	5.5	5.5	10	10	10	46.5	47.8	49.5
Roller	3.0	3.5	4.0	5.4	5.3	5.4	8	8	6	60.8	62.0	64.1

C-Control, PB-Potassium bromate (20 ppm) and AA—ascorbid acid (200 ppm)

TABLE 3. EFFECT OF ADDITIVES ON THE EXTENSOGRAPH CHARACTERISTICS OF DIFFERENTLY MILLED WHOLE WHEAT FLOURS

Type of mill	Resistance to extension, R (BU)			Extensibility, E (mm)			Ratio R/E			Area (cm^2)		
	C	PB	AA	C	PB	AA	C	PB	AA	C	PB	AA
Hammer	440	515	850	133	117	87	3.3	4.4	9.8	77.2	89.1	105.5
Disc	320	380	585	113	106	86	2.8	3.5	6.8	50.5	64.2	64.6
Stone	330	380	600	110	100	80	3.0	3.8	6.3	46.9	58.2	63.2
Roller	420	450	680	128	113	95	3.3	4.0	7.2	68.7	80.8	85.8

C-Control, PB-Potassium bromate (20 ppm) and AA-ascorbic acid (200 ppm)

bromate and ascorbic acid, respectively, thereby indicating improvement in the strength of the doughs.

Extensograph characteristics: The effect of additives on dough properties was distinct as shown by the extensograph dough characteristics (Table 3). The resistance to extension of 320-440 BU of differently milled flours increased to 380-515 BU with potassium bromate and to 585-850 BU with ascorbic acid. The extensibility for different flours decreased by 10-16 mm and 27-46 mm with potassium bromate and ascorbic acid, respectively, while the corresponding ratio figures increased by 0.7-1.1 and 3.3-6.3. The strength of the dough improved with the increase in area values by 11.3-13.7 cm^2 with potassium bromate and 14.1-28.3 cm^2 with ascorbic acid for different flours. The results indicated improvement in the gas retention properties of the doughs with the additives.

Bread making characteristics: The specific loaf volume (Table 4) was highest for hammer milled flour and lowest for stone milled flour. The increase in specific loaf volume varied from 0.0-0.08 ml/g and 0.03-0.34 ml/g with the addition of potassium bromate and ascorbic acid, respectively. The

TABLE 4. EFFECT OF ADDITIVES ON THE BREAD MAKING CHARACTERISTICS OF DIFFERENTLY MILLED WHOLE WHEAT FLOURS

Type of mill	Specific loaf vol (ml/g)			Crumb score**		
	C	PB	AA	C	PB	AA
Hammer	2.31	2.39	2.47	7.0	7.0	7.0
Disc	2.15	2.18	2.28	6.0	6.0	6.5
Stone	1.97	1.97	2.00	6.0	6.0	6.5
Roller	2.17	2.21	2.51	7.0	7.0	7.0

C-Control, PB-Potassium bromate (20 ppm) and AA-ascorbic acid (200 ppm)

**Maximum-8

hammer and roller milled flours showed better response to additives in bread making than the disc and stone milled flours. At the permitted levels of 20 and 200 ppm of potassium bromate and ascorbic acid respectively, the improvement brought about by the latter in specific loaf volume for all the flours was relatively higher. The breads from hammer and roller milled flours were better than those from disc and stone

milled flours as judged by the higher specific loaf volume and crumb score and crumb texture. All the breads from different flours with and without additives had normal crust shape, brown crust colour, light brown crumb colour and typical wholesome wheaty taste.

It can be concluded from the results that the dough properties of whole wheat flour milled in hammer, disc, stone and roller mills varied and improved with the additives to varying extents. In general, potassium bromate and ascorbic acid improved specific loaf volume of breads made from different flours. The breads made from hammer and roller milled flours either with or without additives were better in quality than those from disc and stone milled flours.

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Quality Characteristics of *Paneer* Prepared from Different Varieties of Soybean

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Eight soybean varieties were used to study the quality characteristics of soy *paneer*. The protein content of the variety was significantly correlated with protein content of soy milk (r= +0.92) and soy paneer (r= +0.76), respectively. However, no significant correlations between (i) protein content of the bean and paneer yield, and (ii) protein content of the bean and its % recovery in the product were observed. The moisture content of the product significantly influenced its porosity (r= +0.96) and shear strength (r= −0.99). Deep-fat-frying (180°C for 8 min) substantially reduced moisture content of the product and enhanced its fat content. On sensory qualities, *paneer* prepared from 'Pb-1' variety was superior to paneer prepared from other varieties.

Many dairy analogues of acceptable quality have been developed from soybeans. These products are becoming increasingly popular in Western countries because of the desire of the people to reduce their intake of fat and cholesterol; and in developing countries because of shortage and higher cost of milk and milk products[1]. Coagulation of soy milk with salts/acids yields a soft, white gelatinous mass with bland taste and unique body. It resembles milk *paneer* in appearance, colour and texture. Attempts have, therefore, been made to prepare a *paneer* analogue from soybean which can serve as a substitute for milk *paneer*[2,3]. Processing conditions such as variety[4], kind and concentration of coagulant[5], and heat treatment[6] influence the quality of soybean coagulated products. The present investigation was, therefore, undertaken to study the quality characteristics of soy *paneer* prepared from different varieties of soybean.

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Materials and Methods

Dry, mature seeds of soybean varieties 'PK-262' 'PK-327' , 'PK-374', 'PK-386', 'PK-416', 'DS-76-1-37-1', 'Macs-13' and 'Pb-1' were used in this study. The beans were cleaned and stored in air tight containers at ambient temperature (20-25°C) until use. Whole soybean seeds (300 g) of the test variety were soaked in tap water (1:3, w/v) for 16-18 h at room temperature. The soak water was decanted and the hulls were removed by hand rinsing. The washed beans were ground in a Waring blender for 3-5 min using bean to water ratio of 1:9 (w/v). The resulting slurry was filtered using double layered muslin cloth. Two litres of soy milk thus obtained were used for preparing *paneer* according to the procedure described by Nasim *et al.*[3] using coagulation temperature of 75°C and 2% citric acid as coagulant. The coagulum thus obtained was pressed using 0.12 kg/cm^2 pressure, sliced into blocks of appropriate size and stored at 5°C.

Standard procedures were used to determine moisture, protein (N×6.25), fat and ash contents of the samples[7]. Carbohydrates were calculated by difference, Shear strength using shear test apparatus developed by Kulshrestha *et al.*[8]. and porosity were determined according to the methods described by Nasim *et al*[3]. Trypsin inhibitor activity was estimated according to the method of Kakade *et al*[9]. Colour of the samples was evaluated visually. For sensory evaluation, soy *paneer* samples were cut into pieces of uniform size of 1.5×1.5×1.0 cm and deep-fat-fried in hydrogenated vegetable oil at 180°C for 8 min. A panel consisting of ten semi-trained members from among the staff and students of the department evaluated the samples for colour, flavour and texture on a 9-point scale, where 1 represented extreme dislike and 9 represented extreme like[10]. The samples were served to the same panelists in random order (two replicates). The data were analysed as per analysis of variance and correlation coefficients were calculated as per the procedures described by Snedecor and Cochran[11].

Results and Discussion

The characteristics of soy milk and soy *paneer* prepared from different varieties are shown in Table 1. The values for total solids and protein contents of soy milk and soy *paneer* obtained in this investigation are in agreement with earlier reports[3,4]. The yields of paneer prepared from different varieties were lower than those reported for a salt coagulated product; but were more or less same as reported for acid coagulated product. Coagulation of soy milk with salts such as calcium sulphate yielded a product with high moisture content (84-88%) which consequently resulted in a greater yield[4,12]. However, the product contained only 7-8% protein. In contrast, acid coagulation of soy milk yielded a product with higher protein (15-16%) and lesser moisture (74-75%) which resulted in comparatively lower yields[3]. The recovery of total solids and protein in *paneer* prepared from different varieties ranged from 40.56 to 51.82% and 55.08 to 67.65%, respectively. Wang *et al.*[4] have also made similar observations for these attributes.

Table 2 shows the physical characteristics and sensory attributes of soy *paneer* obtained from different varieties. The colour of *paneer* samples varied from whitish to greyish white. The ranges for porosity and shear strength for different samples were 0.21-0.45 and 1.9-3.1 dynes/cm^2×10^4, respectively. Statistical analysis of the data showed that different samples differed significantly ($P < 0.05$). Among the varieties tested, *paneer* prepared from 'Pb-1' secured highest overall score followed by 'Macs-13' and PK-486'. The panelists recorded that *paneer* samples, in general, were devoid of beany flavour. However, *paneer* prepared from 'Pb-1' exhibited greater resemblance to milk *paneer* in colour and texture than others.

TABLE 1. CHARACTERISTICS OF SOY MILK AND SOY *PANEER* PREPARED FROM DIFFERENT VARIETIES[1].

Variety	Soybean		Soy milk		Soy *paneer*		
	Total solids (%)	Protein (%)	Total solids (%)	Protein (%)	Yield (%)	Total solids (%)	Protein (%)
PK-262	87.2	35.2	6.8	2.8	122	29.1	15.9
PK-327	87.5	36.8	6.0	3.1	126	29.2	16.5
PK-374	87.2	38.2	6.8	3.2	142	29.5	16.7
PK-416	88.2	35.2	6.0	2.9	132	28.3	15.8
PK-486	87.4	37.0	6.7	3.1	119	30.5	17.1
DS-76-1-37-1	89.5	34.9	6.5	2.8	135	26.9	15.9
Macs-13	89.0	36.0	7.0	3.1	141	30.6	17.3
Pb-1	89.0	39.0	7.3	3.4	148	31.1	17.6
Mean	88.1	36.5	6.6	3.0	133.1	29.4	16.6
SD	±0.9	±1.5	±0.5	±0.2	±10.3	±1.4	±0.7

[1]Average of two determinations.

TABLE 2. PHYSICAL CHARACTERISTICS AND SENSORY ATTRIBUTES OF SOY *PANEER* OBTAINED FROM DIFFERENT VARIETIES

Variety	Moisture (%)	Shear strength ($Dyn/cm^2 \times 10^4$)	Porosity	Colour	Flavour	Texture	Overall quality
PK–262	70.9±0.9	2.4±0.3	0.36±0.05	6.6±0.4	5.8±1.3	5.3±0.7	5.9±0.8
PK–327	70.8±2.0	2.5±0.2	0.30±0.11	5.7±0.4	5.2±0.4	4.1±1.3	5.0±0.7
PK–374	70.5±1.6	2.6±0.4	0.28±0.08	5.9±0.6	5.6±0.6	4.4±0.9	5.3±0.7
PK–416	69.6±1.0	2.8±0.4	0.27±0.04	5.8±0.6	5.5±0.4	5.4±0.8	5.6±0.6
PK–486	73.1±1.0	1.9±0.3	0.45±0.02	6.7±1.1	5.9±0.9	6.5±0.6	6.4±0.9
DS–76-1-37-1	69.4±1.9	2.9±0.3	0.22±0.04	6.6±0.4	5.3±0.6	5.1±0.4	5.7±0.4
Macs–13	68.9±1.3	3.1±0.5	0.21±0.07	6.5±0.9	5.8±1.1	6.9±0.6	6.4±0.9
Pb–1	69.3±0.1	2.2±0.7	0.39±0.06	7.7±0.3	7.2±0.6	7.8±0.3	7.6±0.4

The colour was whitish for varieties PK-262, PK-416, Macs-13 and Pb-1 in contrast to yellowish white for PK-486 and greyish white for other varieties.

The correlation coefficients of different quality attributes gave interesting results. The protein content of soybean was found to be significantly correlated with protein content of soy milk ($r = +0.92$) ($P < 0.01$), and protein content of soy *paneer* ($r = +0.76$) ($P < 0.05$). A significant correlation ($P < 0.01$) was also observed between protein content and total solids of soy *paneer* ($r = +0.89$). The moisture content of soy *paneer* exhibited a positive correlation with its porosity ($r = +0.96$) ($P < 0.01$) and a negative correlation with its shear strength ($r = -0.99$) ($P < 0.01$).

Table 3 shows quality characteristics of unfried and fried soy *paneer* samples prepared by using 'Pb-1' variety. Deep-fat-frying substantially reduced moisture content of *paneer*, but enhanced its fat content. The increase in fat content may be ascribed to both expulsion of moisture and absorption of fat by the product during deep-fat-frying. Frying of the product also completely inactivated trypsin inhibitors and increased its shear strength by approximately six folds and its porosity by 1.3 fold. Upon frying, soy *paneer* exhibited golden brown colour, almost identical to the fried milk *paneer*. The results of this investigation indicate that varietal differences influence quality characteristics of soy *paneer*.

TABLE 3. QUALITY CHARACTERISTICS OF UNFRIED AND FRIED SOY *PANEER* OBTAINED FROM VARIETY Pb-1.

Constituent	Unfried	Fried
Colour	Whitish	Golden brown
Moisture (%)	68.9±0.4	30.0±1.2
Protein (%)	17.6±1.6	27.9±0.4
Fat (%)	4.9±0.5	30.5±1.3
Fat in dry matter (%)	15.6	43.6
Ash (%)	1.2±0.1	1.3±0.3
Carbohydrates (%) (by diff)	7.5	10.3
Trypsin inhibitor activity (TUI/mg sample)	4.9±0.9	0
Shear strength ($Dynes/Cm^2 \times 10^4$)	2.2±0.7	13.2±0.9
Porosity	0.39±0.06	0.52±0.09

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J. Fd. Sci. Technol, 1992, Vol. 29, No. 5, 301—303

Sensory Evaluation of Soy Milk-Based Yoghurt

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Soy yoghurt with improved sensory characteristics was prepared from a base that consisted of 22% soybean solids, 4% sucrose, 2% corn starch, 0.3% sodium citrate, water, and fermented with 5% active mixed starter culture (*Lactobacillus bulgaricus* and *Streptococcus thermophilus*). Comparative sensory evaluation of cow milk yoghurt and improved soy yoghurt produced 9 point mean Hedonic scores of 6.2 and 5.9 for overall acceptability which were insignificantly different ($\alpha = .01$). Seventy three per cent of the respondents rejected soy yoghurt as an alternative to cow milk-based yoghurt.

Soy milk-based yoghurt (SMY) has been developed and well described[1-3]; but its acceptability has not been evaluated in some parts of the world, particularly in Sub-Saharan Africa, where consumption of cultured dairy products is not widely popular. In some parts of the Sub-region where low yielding dairy cows are commonly reared, yoghurt is traditionally made by fermentation of unpasteurized defatted cow milk by its natural flora, and it is sometimes consumed with milled and cooked cereal, or millet. In view of insufficient milk production in the Sub-region, it is desirable to replace cow milk with inexpensive soy milk for yoghurt production.

Previous work to improve SMY quality by fortification with sucrose has been reported[1,4]. Other workers[3,5] also have attempted to improve sensory characteristics of SMY by addition of non-fat-dry milk, whey protein concentrate, evaporated cow milk and fructose. The use of low cost ingredients is critical in the development of affordable and consumer acceptable SMY for low per capita income countries, particularly those in Africa and Asia. Inexpensive ingredients that would lead to improvements in flavour, taste, aroma and body/texture are needed for enhanced SMY acceptability.

The aim of this studies was to modify soy milk base for the preparation of soy-yoghurt with improved sensory characteristics, utilizing conventional yoghurt starter cultures and relatively low cost ingredients. A survey of selected human populations in the sub-Sahara for yoghurt acceptability also was done.

Materials and Methods

Preparation of soy yoghurt base: Two hundred g soybean (variety 'TGX 526 02D') was blanched in boiling solution of 0.25% (w/v) sodium bicarbonate for 30 min, hand dehulled and hulls removed by floatation in tap water. The cotyledons were ground in a kitchen blender using hot water to yield 1.5 l slurry which was filtered through gauze metal and calico[6]. The soymilk extract was simmered for 15 min, fortified with 4% sucrose, pasteurized in a water bath at 63°C for 30 min to form the soy yoghurt base and stored at 5±2°C. Aliquot of the base was oven-dried at 80°C to constant weight to determine per cent solids[6].

Lactic starter culture propagation: Lyophilized mixed yoghurt starter cultures of *Str. thermophilus* and *Lact. bulgaricus* were activated by inoculating 10 ml sterile reconstituted low fat milk powder [15% total solids] with two loopfuls of culture, thorough mixing and incubation at 45°C for 24 h; 0.5 ml activated culture was separately sub-cultured twice in 10 ml freshly sterilized soy milk (16% soy solids) containing 1% sucrose and reconstituted low fat cow milk (15% TS), and these were incubated at 45°C for 24 h. The pH was measured after incubation and cultures were chilled till further use.

Production of soy milk-based yoghurt: One hundred ml soy yoghurt base in 250 ml cotton plugged conical flasks, was heat treated at 80°C for 30 min in a water bath. The contents were cooled to 45°C; 5% of the fully active soy milk culture was added and the dispersion was incubated at 45°C until pH was reduced to 4.5 in 7 h. The resultant soy yoghurt was pasteurized at 63°C for 30 min and stored at 5±2°C. Conventional cow milk-based yoghurt (CMY) was similarly prepared with reconstituted unsweetened low-fat milk powder (15% TS), using 5% cow milk-base starter culture.

Development and sensory evaluation of improved soy yoghurt: Moderate dislike of SMY observed in a preliminary study has prompted the modification of the soy base as follows:—(i) increasing soy solids concentration by separately utilizing 275 g and 413 g soybean for base formulations, (ii) addition of 0.02 and 0.04% $CaCl_2$ to aliquots of the base, (iii) addition of 1,2 and 3% corn starch to the base alone, and in combination with $CaCl_2$ and (iv) addition of 0.1, 0.3 and 0.5% sodium acetate or sodium

citrate alone and in combination with $CaCl_2$, and corn starch to the base formulation. All the formulations (50 ml each) were processed for yoghurt production as described above. Preliminary screening of all the SMY samples for acceptable taste/flavour, body/texture, aroma and colour was done by the authors.

Two improved SMY varieties, formulated after preliminary screening, contained 275 g of soybean base, 4% sucrose, 2% corn starch, and 0.3% sodium acetate or sodium citrate, were compared with CMY in a preference test[7] for the above characteristics. Hedonic scale of 1 to 9 was used. Four panels of at least 50 judges each, comprising both sexes were selected randomly from Imo State University community.

Statistical analysis: Sensory evaluation data were analyzed by analysis of variance. Tukey's multiple comparison of means was used to select yoghurt samples with superior sensory characteristics. All methods utilized were as described by Neter and Wasserman[8], and Winer[9].

Results and Discussion

Consumer survey: All the population surveyed have not consumed SMY before, in contrast to frequencies of CMY consumption of 3, 22, 17 and 58% daily, occasionally, rarely and never, respectively. Seventy three per cent of the respondents rejected SMY as an alternative to CMY. Twelve per cent of the total respondents were of the opinion that SMY was nutritionally inferior to CMY, 28% expressed opposite opinion, while 60% indicated ignorance. Thirty two per cent of all responses to the question on the preference for one of the two yoghurt varieties (if both were nutritionally similar) was in the affirmative, 20% was negative and 48% was indecisive.

Effects of soy solids and calcium chloride on soy yoghurt characteristics: Yoghurt made with 22% soy solids which corresponded to the use of 275 g of soybean for base formulation, and contained 0.02% $CaCl_2$ was of acceptable quality. While yoghurt that contained 16% soy solids (200 g soybean) was visibly fluid and quite undesirable, the 33% soy solids (413 g of soybean) variety had heavy body, and formed semi-solid mass in the presence of 0.04% $CaCl_2$. Non-fat-dry milk is often added to milk base for yoghurt making to increase total solids[5], improve flavour, and ensure optimum acid production by lactic starter culture in soy yoghurt[2,3]. Recently, whey protein concentrate has been used as a yoghurt ingredient to improve sensory properties[3]. Increasing soy solids concentration in the present study appears to be a cost-effective substitute for added non-fat-dry milk and whey protein concentrate to increase soy yoghurt total solids.

All the above yoghurt samples exhibited distinct separation of whey on top, and the cream coloured soy solids flocculated at the bottom of the containers. Calcium chloride was added to increase the cross linkages between soy proteins[10]. Free whey observed in all the samples indicated that $CaCl_2$ did not achieve the desired objective. Tofu-like gel properties appeared to have been produced in SMY that contained 33% soy solids and 0.04% $CaCl_2$. A desired yoghurt gel structure has sufficient firmness but minimal syneresis[10]. High level of $CaCl_2$ (0.04%), however, imparted mild bitterness to the taste of the SMY samples. Generally, addition of 4% sucrose to all the samples guaranteed acceptable sweetness[4]. Chalky mouthfeel[1] was prominent in samples made with 33% soy solids, and this was undesirable. Acid production was adequate in all the samples and a pH range of 4.5 to 4.7 was observed after 7 h incubation period. On the basis of the above observations, 22% soy solids and 4% sucrose were accepted as minimum ingredient required for producing acceptable low cost SMY.

Effect of corn starch addition: A remarkable effect of corn starch on the characteristics of SMY was the prevention of syneresis or inhibition of whey separation. Two per cent corn starch produced a desirable body/texture in the SMY. Stabilizer gums were added to yoghurt base to control viscosity, gelation and syneresis in the product[3]. Whey immobilization by gelatinized starch most probably was responsible for the inhibition of syneresis. In addition, the water binding capacity of soy protein gels is known[10,11]. The sweetness produced by the addition of 4% sucrose was still detected at all levels of starch addition.

Addition of sodium citrate and sodium acetate: The lowest concentration of 0.1% of each salt produced undetectable change in flavour and aroma in the SMY; sodium citrate, however, at 0.3 and 0.5% showed weak aroma improvement and at 0.5%, both salts produced unacceptable taste/flavour. Overall, there was no distinctly discernible change in aroma, consequent upon addition of these salts during preliminary screening of the SMY samples.

Sensory evaluation of improved soy yoghurt and cow milk-based yoghurt: Comparison of two improved SMY with CMY showed insignificant differences at $\alpha = 0.01$ for taste/flavour and colour (Table 1). Highly significant differences ($\alpha = 0.01$), however, were observed for aroma,

TABLE 1. COMPARATIVE SENSORY EVALUATION OF IMPROVED SOY MILK-BASED AND COW MILK-BASED YOGHURT VARIETIES*

Yoghurt variety	Taste	Aroma	Body	Colour	Overall** acceptability
Cow milk	5.8^a	7.0^a	5.8^a	6.3^a	6.2^a
Soy milk citrate	5.6^a	5.3^b	6.4^a	6.3^a	$5.9^{a,b}$
Soy milk acetate	5.4^a	5.4^b	5.6^b	6.0^a	5.6^b

*Means with different superscripts in the same row are significantly different ($\alpha = .01$)

**Overall acceptability score was the weighted average of all the senosry parameters evaluated for each yoghurt variety.

and the two SMY varieties showed insignificant differences. Addition of citrate produced unexpected significant improvement in body/texture compared to acetate containing SMY, and CMY varieties. While CMY-and SMY-citrate varieties were insignificantly different from each other, CMY- and SMY-acetate showed significant (α =0.01) differences for overall acceptability. The panelists generally did not indicate the existence of beany flavour in SMY varieties. Blanching soybean in bicarbonate solution reduces beany flavour in the resultant soymilk[1]. Taste improvement in SMY varieties was enhanced by the addition of 4% sucrose before starter inoculation. Citrates and acetates are precursors for the synthesis of aromatic compounds in fermented dairy products, and are both present in cow milk but probably absent in soy milk[12]. Inclusion of citrate or acetate in the improved soy yoghurt base was to enhance diacetyl production. The use of a different starter inoculum, *Lactobacillus casei* may have been partly responsible for improved citrate utilization in imitation cream cheese resulting in enhanced flavour as reported by Hofmann and Marshall[12]. The low level of detectable aroma in the improved SMY varieties suggests the development of new soy yoghurt starter for diacetyl production. Aromatic substances enhance consumer acceptability of fermented dairy products, and soy-based dairy analogues are expected to be similarly affected.

The significantly higher mean score for body/texture of SMY-citrate as compared to SMY-acetate and CMY (Table 1) was quite unexpected. Possible explanation for this discrepancy may be that interactions between citrate, corn starch and soy proteins at acidic pH led to improved gel development with minimal syneresis. A total of 166 male and 44 female judges evaluated the yoghurt samples, and they indicated mean scores of 6.0 and 5.7 which were significantly different at α = 0.05. Interaction between sexes and yoghurt samples were insignificant. Research is in progress to develop a new lactic starter for soy yoghurt to ensure improved aroma characteristics.

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J. Fd. Sci. Technol, 1992, Vol. 29, No. 5, 304—306

Study of the Feeding Ability of Vertical Screw During Extrusion

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Surface Response Modelling of parameters involved in single-screw extrusion of casein showed that the optimum mass feed rate was achieved at extruder screw speed of 172-192 rpm and at feeding screw speed of 75-95 rpm. For the extrusion of a mixture of casein and corn grits (70: 30), maximum mass feed rate was found at particle size of 0.4 mm. The mass feed rate was decreased by above 1.2 times when extruder screw compression ratio was increased from 1:1 to 3:1.

The feeding of the raw material to extruder has a significant effect on the extrusion process and is mainly governed by physical and chemical properties of the material[1-3]. The particle size of the material is important. For instance, corn grits having particle sizes more than 1.2 mm can not be processed properly in single-screw extrusion. In recent years, processing of milk protein by extrusion cooking has assumed industrial importance. Extrusion of casein in combination with cereals has been reported[4,5]. Present investigation was undertaken to find out (i) the dependence of the mass feed rate of the vertical feeding screw with feed moisture, feeding screw speed and extruder screw speed, and (ii) the effect of the particle size of the raw material on the mass feed rate of the feeding screw during extrusion cooking of a mixture of casein and corn grit.

Casein (88.8% protein, 13.5% moisture and 1.1% fat) having mean particles size 0.96 mm was used in the experiments. A mixture of 70% casein and 30% corn grits of 1.25, 1.0, 0.8, 0.63, 0.4 and 0.315 mm particle size was used. Corn grits contain 13% protein, 10.3% moisture and 2.2% fat. The mixing was done in a mixer for 10 min. Before extrusion, the samples were moistened with distilled water to a total moisture content of 12, 15 and 18%. A laboratory single-screw food extruder (Brabender 20 DN model) with a 20 mm diameter screw was used at a screw compression ratio of 3:1. The mass feed rate of the feeding screw was calculated based on the time required to feed 0.1 kg of sample to extruder.

A central composite 2^3-quadratic experimental design was used. In the second part of the investigation, the screws with compression ratios of 1:1, 2:1 and 3:1 were used. Extruder screw speeds were varied between 150 and 220 rpm with an increment of 35 rpm and that of feeding screw from 60 to 100 rpm with 20 rpm During this study, a first order experimental design was applied. Table 1 shows the process variables and their levels. The statistical analysis as well as the contour maps were done with computer "Pravetz 8M".

TABLE 1. RESPONSE SURFACE MODEL

Variables	Upper limit $Z_j^u (X_j^u)$	Lower limit $Z_j^l (X_j^l)$	Centre point Z°_j	Interval Z_j	Star points R
Feed moisture	18	12	15	3	+R= 19
Z_1 (X_1 %)	(+1)	(−1)	(0)		−R= 11
Feeding screw	120	60	90	30	+R=130
speed Z_2 (X_2), min^{-1}	(+1)	(−1)	(0)		−R=50
Extruder screw	220	150	185	35	+R=232
speed Z_3 (X_3), min^{-1}	(+1)	(−1)	(0)		−R=138

An average of three measurements for each data point in the experimental design was taken into consideration and the results are presented in Table 2.

The following is the (at 5% significance level) equation showing the relation between the mass feed rate of the feed screw (G_{fs} and the independent variables, whose real (Z_j) and codded (X_j) values are given in Table 1.

$$G_{fs} = 4.687 - 1.006\ X_1 + 2.36\ X_2 + 1.303\ X_3 - 0.312\ X_1X_2 + 1.337\ X_2X_3 + 5.24\ X_1^2 + 4.41\ X_2^2 + 4.89\ X_3^2 \quad (1)$$

The graphical representation of equation 1 to explain the character of the interactions is shown in Fig. 1. It is clear that the mass feed rate of the feeding screw decreased both at high or low rotational speeds of the extruder as well as feeding screws, thus giving rise to target-shaped contour plots. The feed moisture within the experimental area seems to have no effect on feeding ability of feeding screw. Highest mass rate within the experimental region occurred at extruder screw speed of 172-192 rpm. and at feed screw speed of 75-95 rpm.

The effect of particle size of a mixture of casein and corn grit on the mass feed rate of the feeding screw (Fig. 2.) showed that the mass feed rate of the feeding screw was

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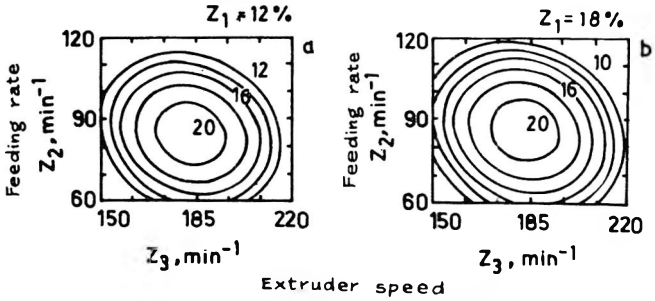

Fig.1 Mass feed rate of the feeding screw (G_{fs}, kg/h) as screws at the function of rotational speeds of the extruder (Z_3) and the feed moisture (Z_1: (a) 12%; (b) 18%.

increased with increasing its speed. But the increment was dependent on speed and compression ratio of the extruder screw. At the same screw compression ratio, the mass feed rate of the feeding screw increased at higher feeding screw speed (100 rpm) with increasing extruder screw speed. This was not true at low feeding screw speeds (60 and 80 rmp). The increased rotational speeds of the extruder and the feeding screws transported more material through the extruder barrel thereby leading to the mass feed rate increase. At the same speed of the feeding and the extruder screws, higher screw compression ratio reduced the mass feed rate (Fig 2), keeping the relationship almost unchanged. The distance between the extruder screw and the barrel decreased with higher screw compression ratio, leading to more friction and due to that, the material flowed through the extruder barrel with great difficulty. Ultimately, the mass feed rate decreased. With the increment of particle size of the raw material, the mass feed rate of the feeding screw increased to a certain extent and after that it started to decrease (Fig. 2). From these graphs

TABLE 2. EXPERIMENTAL DESIGN AND RESULTS

Trial No.	Factors			Response
	X_1	X_2	X_3	G_{fs}, kg/h
1	−1	−1	−1	13.3
2	−1	+1	−1	15.6
3	+1	−1	−1	11.2
4	+1	+1	−1	12.9
5	−1	−1	+1	12.9
6	−1	+1	+1	21.2
7	+1	−1	+1	11.6
8	+1	+1	+1	18.0
9	−R	0	0	15.6
10	+R	0	0	13.8
11	0	−R	0	9.0
12	0	+R	0	15.6
13	0	0	−R	12.0
14	0	0	+R	15.3
15	0	0	0	17.1

R=1.353

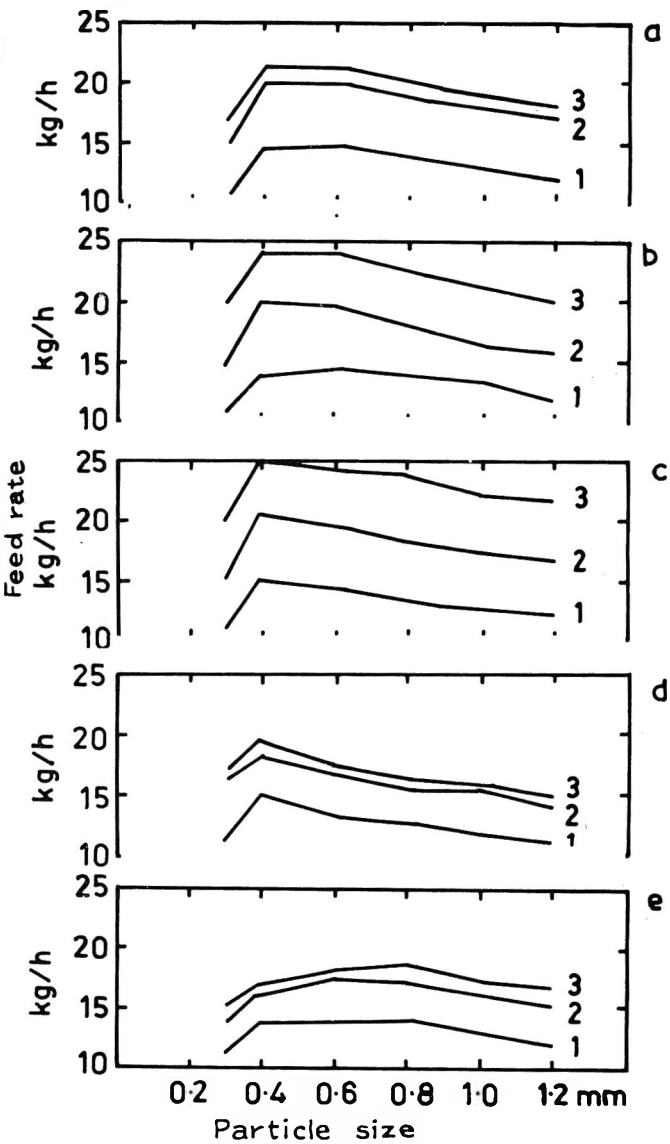

Fig. 2 Effects of particle sizes of mixture of casein and corn grits (70% : 30%) on the mass feed rate of the vertical feeding screw at different feeding screw speeds:

1, 60 rpm; 2, 80 rpm; 3, 100 rpm. a-1 extruder screw compression ratio 1:1 & speed 150 rmp; b, 1:1 & 185 rpm; c, 1:1 & 220 rpm; d, 2:1 & 150 rpm; e, 3:1 & 150 rpm

it was possible to find out optimum particle size, where the maximum mass feed rate was achieved.

At low screw compression ratio (1:1) and at low feed screw speed (150 and 185 rpm), the optimum particle size of the raw material was from 0.4 to 0.6 mm in contrast to that of 0.4 mm at high feed screw speed. When the screw compression ratio was increased to 2:1, the maximum mass feed rate was achieved with particle size of 0.4 mm at low feed screw speed. It is interesting to note that the maximum mass feed rate of the feeding screw was shifted to higher particle size (0.6 to 0.8 mm) when the screw compression ratio was further increased to 3:1 (Fig 2).

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Microorganisms Associated with the Fermentation of *Prosopis* Seeds for *Ogiri-okpei* Production

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Microorganisms associated with the fermentation of *Prosopis* seeds for the production of Ogiri-okpei were identified as *Bacillus subtilis, Staphylococcus aureus, Proteus mirabilis, Pseudomonas aeruginosa, Enterobacter cloacae* and *Lactobacillus plantarum*. The pH of the fermenting seeds dropped to 5.0 while temperature rose to 38°C at the end of fermentation.

Prosopis africana (Guill. and Perr.) is a leguminous shrub which grows best in the Savanna and Sub-Saharan soils of Northern Nigeria. The bark is used for extracting tannins, while the ground leaves are used as local aphrodisiac and the pods to stupefy fish[1]. Among the Igbos of Eastern and Igalas of Northern Nigeria, the seeds are fermented to produce *Ogiri-okpei*, a food condiment which imparts pleasant aroma and flavour to soups and stews.

Various reports on the microbiology and biochemistry of *Ogiri* production from different local substrates are abound[2-5]. However, there is a paucity of information on the production of *Ogiri-okpei*. In this communication, the isolation, characterization and succession of micro-organisms associated with *Ogiri-okpei* production are described.

Processing and fermentation of seeds: The traditional method of processing was used. About 250 g of the *Prosopis africana* seeds were boiled for 7 h. The cotyledons were removed, washed with water and further boiled (30 min) with 200 ml of water until the water was completely evaporated. On cooling, 200 g (wet weight) of the cotyledons were wrapped in washed plantain *(Musa sapientum* var. *paradisiaca* Linn) leaves and allowed to ferment for 96 h at room temperature (28-30°C), with intermittent exposure (2-3 h) of the packet to sunlight. At the end of the fermentation, the seeds were mashed with a sterile porcelain mortar and pestle into a paste, moulded into small balls and sun-dried to obtain *Ogiri-okpei*. The pH, temperature and moisture content of the fermenting seeds were determined daily.

Isolation and identification of microorganisms: Isolation of micro-organisms was performed as described by Odibo and Umeh[5]. Duplicate samples (1 g) of the fermenting seeds were removed daily from the packet, mashed into a paste with a sterile mortar and pestle for determination of the microbial flora and succession by dilutions with sterile distilled water. Isolations were made in duplicate on petri dishes of nutrient agar, Rogosa agar and Sabouraud dextrose agar (all Oxoid formulations), containing 0.05 mg/ml of chloramphenicol, using the drop method[6]. One set of the petri dishes was incubated aerobically at 28°C for 24-48 h, and the other was incubated under an atmosphere of hydrogen at 28°C for 72 h. Representative colonies of microorganisms were purified on fresh media on which they were isolated and stored on agar slopes at 4°C prior to characterization. The isolates were characterized following the methods outlined by Collins and Lyne[6] and identified following the description of Bergey's Manual of Systematic Bacteriology[7,8]. Fermentation of sugars by the isolates was tested using Andrade peptone water (Oxoid CM 61) as a basal medium in which acid production within 48 h indicated positive result. Proteolytic activity of the isolates was tested by gelatin liquefaction[6] while Tween 80 was used to assess lipolysis[9].

The bacteria of the species *Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeruginosa, Proteus mirabilis, Enterobacter cloacae* and *Lactobacillus plantarum* were recovered from the aerobic plates, while *Staph. aureus, P. mirabilis, E. cloacae* and *L. platarum* were found in the anaerobic plates. A similar microbial spectrum was isolated by Odunfa[3], and Odibo and Umeh[5] from water melon *(Citrullus vulgaris* Schrad) and fluted pumpkin *(Telfairia occidentalis* Hook) seeds, respectively, for *Ogiri* production.

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Furthermore, examination of samples of *Ogiri-okpei* purchased from local market gave a similar flora in addition to the presence of *Pediococcus* sp, *Escherichia coli* and *Streptococcus faecalis*. The isolation of *E. coli* and *Strep. faecalis* from the market samples is an index of poor sanitary handling of the food condiment by the sellers. It is, however, expected that the high heat treatment subjected to *Ogiri-okpei* during cooking will destory the micro-organisms and possibly the toxins elaborated in the condiment.

The succession of bacteria in the fermenting *Prosopis* seeds is shown in Fig.1. *B. subtilis* was the only organism isolated at 0 h followed by *S. aureus*, *E. cloacae* and *Ps. aeruginosa* which appeared after 24 h. Other organisms appeared after 48 h of fermentation and persisted throughout the fermentation. The non-occurrence of the other isolates except *B. subtilis* at 0 h showed that the vegetative cells were destroyed during boiling, but reappeared from the leaves used in wrapping the seeds or from the air[5]. The pH of the fermenting seeds feel from 6.3 (0 h) to 5.0 (96 h) while the temperature (32-38°C) and moisture content (30.2-39.9 %) increased. The proliferation of *L. plantarum* could account for the fall in pH and subsequent decrease in the counts of the other isolates towards the end of the fermentation. Some of the isolates were either proteolytic or lipolytic or both. The proteolytic and lipolytic activities of these isolates might be responsible for the aroma and flavour of *Ogiri-Okpei*.

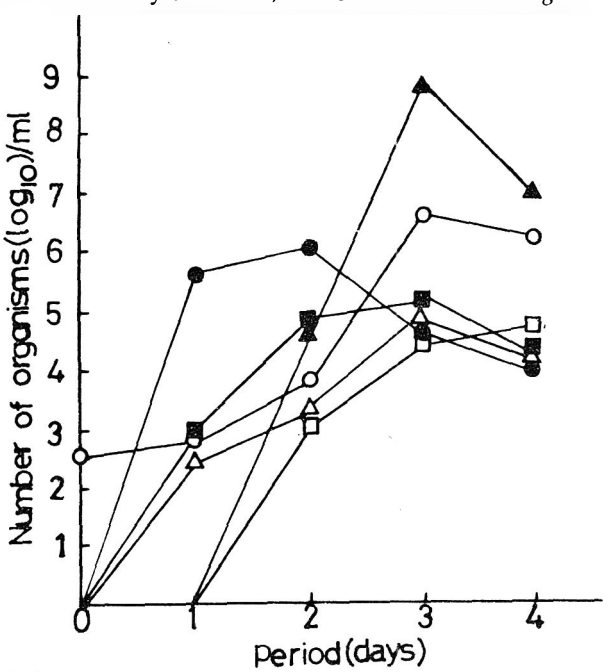

Fig. 1. Succession of micro-organisms during fermentation of *Prosopis* seeds. *Bacillus subtilis* –O– *Staphylococcus areus* –●–; *Pseudomonas aeruginosa*, –△–; *Proteus mirabilis*, –■–; *Lactobacillus plantarum*, –▲–; *Enterobacter cloacae*, –□–.

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Hygienic Quality of Rohu Fish *(Labeo rohita)* Sold in Ranchi Town

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The gills of Rohu fish *(Labeo rohita)* had higher bacterial load and faecal contamination indicative microorganisms followed by skin and muscles. On an average, Rohu fish sold was found to be of poor hygienic quality.

It is desirable to determine the hygienic quality of fishes as sold in the market to safeguard consumer's health. In India, quality control of fish and fishery products appears to be in the infancy as little work has been done on fresh water fish[1,2]. This study was undertaken to determine the hygienic quality of Rohu marketed in Ranchi, India.

Thirty Rohu fishes were collected aseptically in sterilized polythene packets over a period of about 5 months (June to November 1989) from different markets of Ranchi town, iced and brought to laboratory in a thermos flask. Total viable counts (TVC) and other bacterial counts per cm^2 of skin and per gram of muscle and gills were enumerated as per the recommended procedures[3]. Standard plate agar, Mac Conkey's agar, Slanetz and Bartley's agar and egg yolk free tryptose sulphite cycloserine agar were used for total viable, coliform, faecal streptococcal and sulphite reducing clostridial counts, respectively. Total viable count was determined by pour plate method while surface spreading method was used to count coliform and faecal streptococci. The sulphite reducing clostridial count was determined by pouring 10-15 ml of molten egg yolk free tryptose sulphite cycloserine agar into sterile tubes with 1.0 ml inoculum of suitable dilutions and placing at 37°C in water bath. Black colonies were counted after an incubation of 24 ± 1 h. The counts were expressed in $\log_{10}$ scale.

The different bacterial counts per gram of muscle (Table 1) were higher than the standards suggested by Shewan[4] viz., TVC $\not>$ 5.0000, Coliform $\not>$ 2.3010, *E. coli* $\not>$ 2.0000 and *Staph. aureus* $\not>$ 2.0000 per gram ($\log_{10}$ scale) at 35°C for fish and fishery products in U.K. This might be because of differences in the type of fish, methods of harvesting and subsequent handling/storage. Higher TVC than those observed by Nair and Nair[2] on freshly caught *Labeo rohita* and *L. calbasu* from Krishnarajendra Sagar reservoir might be due to the fact that fishes in the market are not fresh and get surface contaminated during harvesting, transportation and storage. Exposure to air, for several hours in the market might also lead tofurther contamination. Similar findings have been reported by Youssef[5] for four types of marketed fresh water fishes viz., *Tilapia nilotica, Clarias lazira, Mormyrus caschiv* and *Synodentis membranaceus.*

TABLE 1. COUNTS OF MESOPHILES AND INDICATOR ORGANISMS (LOG_{10} SCALE).

	TVC	Coliform	Faecal streptococci	Sulphite reducing clostridia
		Per cm^2 skin		
Mean	7.0723 ±0.1110	4.9396 ±0.1407	3.6712 ±0.3118	3.2435 ±0.1794
Range	5.5–8.1	3.5–6.4	0.-5.8	0-4.5
No of + ve sample	30 (100)	30 (100)	26 (86.67)	28 (93.33)
		Per g muscle		
Mean	5.8928 ±0.1512	3.9976 ±0.2298	2.6313 ±0.3524	2.2975 ±0.3205
Range	4.1–7.9	0–6.2	0–4.8	0–4.8
No of + ve sample	30 (100)	28 (93.33)	20 (66.67)	20 (66.67)
		Per g gills		
Mean	8.0079 ±0.1093	5.8914 ±0.1373	5.0652 ±0.2250	4.4662 ±0.1201
Range	7.0–9.1	4.1–7.3	0–6.9	3.1–5.8
No of + ve sample	30 (100)	30 (100)	29 (96.67)	30 (100)

Figures in the parentheses indicate % positive samples

The higher percentages of positives for samples of skin and muscle indicate faecal contamination of marketed Rohu which

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might have occurred during, pre-or post-harvesting period. Recovery of coliform, faecal streptococci and sulphite reducing clostridia is indicative of the presence of enteric pathogens also. The bacterial counts and percentage of positives indicated that gills, skin and muscle of marketed Rohu had a high incidence of sulphite reducing clostridia. Hence, possibility of the presence of food poisoning clostridia viz. *Clostridium perfringens* and *C. botulinum* type E, which also reduce suphite[6], can not be ruled out. The gills showed higher bacterial load and more samples were positive for indicator organisms followed by skin and muscle. Gills are respiratory organ and almost act like filtering membrane. Obviously, there should be deposition of material present in the water on gills. Thus, the load of indicator organisms on gills reflect the sanitary condition of the water from where it originated.

The findings of the present study advocate the need of hygienic measures which should be taken during harvesting, transportation, storage and marketing, so that marketed Rohu fishes will have an acceptable hygienic quality.

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Bacteriological Quality of Ready-to-Eat Pork *Kabab* Stored under Marketing Conditions

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Samples of pork kabab from eight batches, incubated at 37°C, were found to be free of *Salmonella*, sulphite reducing clostridia, coliforms, faecal streptococci and *Escherichia coli* at 0 and 8 days of storage. One sample yielded coliform at 44°C incubation while two samples were positive for staphylococci at 37°C. Mesophilic bacteria increased significantly as against no change in the count of psychrophilic bacteria upon storage for 8 days. The water activity of the product did not change to any appreciable extent.

The demand for ready-to-eat meat products is increasing along with the industrial development and urbanisation in India. The load of saprophytic and pathogenic bacteria in these products depends on the processing method, post-processing handling and preservation. As information on bacteriological quality of ready-to-eat meat foods is limited[1,2], the present study was undertaken to assess the bacteriological quality of pork *kabab* stored under marketing conditions.

Twenty eight *kabab* (Ranbac) samples (200 g) in polyethylene packets, from eight different batches, were collected. From batches one to six, three samples each were stored in the refrigerator (4-10°C) of a shop in the city for 8 days and only one corresponding sample of 7th and 8th batch each was stored similarly. The samples were brought to the laboratory in a thermocool, thoroughly minced individually without any delay in sterilized mortar and pestle, 10 g minced sample was weighed on a sterile butter paper, transferred to a conical flask containing 90 ml sterile normal saline solution and serial dilutions were used in duplicate to enumerate different groups of bacteria. Mesophilic and psychrophilic counts were made on tryptone glucose yeast

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extract agar by pour plate technique[4]. The incubation was at 37°C for 24 h and 7°C for 120 h, respectively. Coliform count was made at 37 and 44°C at 24 h on violet red bile agar by spread plate technique[4]. Faecal streptococci count was made on Slanetz and Bartly agar by spread plate technique[5] by incubating at 37°C for 48 h. *Staphylococcus aureus* count was done on tellurite polymyxin egg yolk agar by spread plate technique at 37°C for 24 h[6]. Sulphite reducing clostridial count was made at 46°C for 24 h in egg yolk free tryptone sulphite cycloserine agar by agar tube method[7].

For detection of *Salmonella*, 2×25 g minced samples were aseptically transferred into two conical flasks containing 75 ml sterile nutrient broth and incubated at 37°C for 24 h. To each of these flasks, 75 ml double strength Mullor Kauffman tetrathionate broth was added and one flask was incubated at 37°C and the other at 43°C for 24 h. The isolation and identification of *Salmonella* from these enriched samples were carried out according to Edwards and Ewing[8]. The water activity of each sample was measured following the method described by Hauschild and Hilscheimer[9].

The data on bacterial load of fresh finished *kabab* and of samples stored in shop refrigerator for 8 days are presented in Table 1. The water activity of these samples did not change. All samples of *kabab* were free from *Salmonella* and sulphite reducing clostridia. Staphylococci were found only in two samples, while thermotolerant coliform in one. The average counts of these were very low. Mesophilic and psychrophilic bacterial counts averaged 5.1×10^3 and 4.3×10^3 per gram respectively. After storage for 8 days in shop refrigerator, only the mesophilic bacterial count showed an increase but this was not significant. The bacteriological quality of fresh and stored *kabab* compared well with the guidelines/standards recommended for similar heat treated products[10].

TABLE 1. BACTERIAL PROFILE AND WATER ACTIVITY OF *KABAB* SAMPLES

Bacteria	Microbial counts 0 day (Cfu/g) ($\times10^4$)	8 days (Cfu/g) ($\times10^4$)
Mesophiles	0.51 ± 0 .19	3.11 ± 0.87
Coliforms at 44°C	0.0003 ± 0.0002	0
Staphylococci	0.00675 ± 0.0057	0
Psychrophilic bacteria	0.43 ± 0.18	0.44 ± 0.09

Escherichia coli, coliforms at 37°C, faecal streptococci, sulphite reducing clostridia and *Salmonella* were absent in all the samples. The water activity at 0 and 8 days were 0.902 and 0.843-0.902, respectively.

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Evaluation of Reversed Passive Latex Agglutination Test Kits for the Detection of Staphylococcal Enterotoxins A, B, C and D in Fishery Products

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The SET-RPLA kit for the detection of staphylococcal enteroxins A, B, C and D showed high specificity and sensitivity with a minimum detectable limit of 0.30 to 0.60 ng enterotoxin/g of fishery products. The test provides a simple, inexpensive means for semi-quantitative assay within 24 h.

Most foods implicated in staphylococcal food poisoning out-breaks contain low levels of enterotoxin, often less than 1 μg/100 g food[1]. Traditional methods for the detection of staphylococcal enterotoxins in food[2-4] are less sensitive. Developments in chemical immuno-diagnostics, such as enzyme linked immuno-sorbent and agglutination assay have in recent years led to sensitive rapid techniques which are now being used for the analysis of food[5]. Reversed passive latex agglutination (SET-RPLA) test kit, involving cross linking of antibody coated latex particles in the presence of staphylococcal enterotoxins[6,7] have been used in recent years for the detection of staphylococcal enterotoxins in dairy and meat products. As no such information in respect of fish and fishery products is available, the present study was undertaken.

Prawns, crab meat and fish *kheema*, in frozen state, were obtained from the cold storages situated in and around Cochin. SET-RPLA kits and microtiter plates were kindly provided by Natural Resources Institute, U.K. Purified staphylococcal enterotoxins A, B, C and D were obtained from Food Research Institute, University of Wisconsin, U.S.A. The samples were thawed and 50 g of each were homogenised in a blender and transferred into 250 ml conical flasks. Staphylococcal enterotoxins A, B, C and D were diluted with phosphate buffered saline to get a working solution of 1 μg/ml. Samples were separately inoculated with 1 ml each of enterotoxins A, B, C and D to give a concentration of 20 ng enterotoxin/g of the sample. Enterotoxins were extracted from the samples by homogenising with normal saline (1:1 w/v). Ten ml of the homogenate was centrifuged (9000×g) at 4°C for 30 min. The supernatants were filtered through 0.22 μm membrane filter (Millipore).

To each of the wells in the five rows of V-type micro-titer plate, 25 μl of the diluent from SET-RPLA kit was added. Two fold dilutions of the test samples were made for use in seven wells of each of the five rows. The eighth well of each row contained diluent only. The rows were marked A, B, C and D and 25 l of the latex sensitized, corresponding with the sensitized anti-enterotoxin was added. Twenty five 1 of the latex control from SET-RPLA kit was added to row E. The plates were left undisturbed on a vibration free surface at ambient temperature for 24 h. To read the results, each well was examined for the degree of agglutination according to the illustrations supplied by OXOID with each kit. The SET-RPLA test kits did not show any non-specific reactions with extracts of fishery products with respect to the enterotoxins. Park and Szabo[8] have observed the same specificity with the extracts of beef, pasta, ham, turkey and salami.

In extracts of fishery products, the minimum detectable limit varied, depending on the type of the product and enterotoxin. In prawn homogenate, the minimum detectable amount of enterotoxins was 0.30 ng/g for all enterotoxins, but in crab meat it was 0.60 ng/g. In fish *kheema*, it was 0.30 ng/g for all enterotoxins except for C for which it was 0.60 ng/g. Studies by Park and Szabo[8] have shown that the range of detectable limit was 0.25-0.33 ng/ml in beef, wet noodle, ham, turkey and salami as against 0.42-0.50 ng/ml for crude extracts from cheese. They have also reported that the sensitivity of RPLA test is comparable with that of RIA[9] and ELISA[10]. The amount of enterotoxin was greater than 4 ng/g in 26 different foods involved in staphylococcal foodborne disease[11]. The results indicate that the sensitivity of SET-RPLA kits satisfies the requirement for the detection of staphylococcal enterotoxins in fishery products. The interesting feature of the RPLA test is that it is semi-quantitative, since the amount of enterotoxin can be estimated on the basis of the end point in serial two fold dilutions.

Authors are grateful to Dr. R Fuchs, Microbiology and Fermentation Section, Natural Resources Institute, U.K. for providing SET-RPLA kits, micro-titer plates and to Dr. M.S. Bergdoll, Food Research Institute, University of Wisconsin, U.S.A. for supply of enterotoxins. They are also thankful to Shri M.R. Nair, Former Director, Central Institute of Fisheries Technology, Cochin, for kind permission to publish this paper.

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Chalkiness in Parboiled Paddy due to Microbial Contamination

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Microbial infection in parboiled paddy caused chalky kernels. Moulds like *Mucor, Aspergillus flavus, A. fumigatus,* and *A. niger* often occur in parboiled paddy during incomplete yard drying especially in monsoon periods of October-November in coastal Tamil Nadu. Such infection converts the translucent kernels into chalky ones. Re-parboiling reduced the microbial population and improved the head rice recovery.

Chalkiness in raw paddy arises due to immaturity of grains[1] or delayed harvest after maturity[2] and is dependent on varietal characteristics[3]. Kernel chalkiness predisposes the grains to easier cracking and in greater milling breakage. Kernel defects such as broken, cracked, chalky, insect infested and immature kernels contribute to breakage in milling. Generally, parboiling improves the milling quality, off-setting some of these defects as the kernel attains hardness due to gelatinization. Although breakage occurs in parboiled milled rice due to uncontrolled conditions in normal yard drying[4], it becomes relatively higher whenever parboiled paddy is infected by microbes. Infection occurs due to inadequate or slow drying in rainy weather. If rainy weather sets in after the steaming operation, paddy could not be spread in the yard and had to be kept under cover till the weather clears during which infection occurs causing severe spoilage and deterioration. Infection of wet parboiled paddy causes softness in kernels and thus generates air space inside. The resultant rice becomes chalky instead of translucent and is heavily broken during milling. The present investigation deals with the re-processing of infected parboiled paddy to obtain maximum head rice with minimum of chalky kernels.

'ADT 31' variety (20 Kg), infected due to inadequate drying in humid rainy weather, was used. One lot (10 kg) was re-processed by a 12 h soaking in cold water and then steamed for 10 min, dried and milled. Another similar lot was air-dried and milled. 'ADT 31' paddy, drawn from an identical raw paddy lot, was parboiled and dried quickly in the yard under bright sunshine as practised in rice mills, with minimum chances for microbial infection. Samples were dehusked in a laboratory model Satake rubber roll sheller and 150 g of dehusked rice was milled in McGill Mill No. 1. The number of chalky kernels, those exhibiting opaque blotches in otherwise translucent grains, were separated and counted in 150 g dehusked grains before milling and also in polished rice to ascertain their percentage and also influence on milling. The breakage due to infected chalky grains was determined based on the number of whole chalky kernels present in the dehusked rice and the number left unbroken after milling. The brokens in the polished rice were separated,

weighed and expressed as percentage over the total polished rice.

The oil and free fatty acid (FFA) contents in bran were determined employing standard methods[5]. The extent of microflora present in infected parboiled paddy, initially and after re-processing, was determined by serial dilution plate technique using Martin's rose Bengal and nutrient agar media. The individual fungal colonies were examined microscopically[3] and were identified following the key given by Gilman[6]. Sedimentation test was carried out as described by Bhattacharya and Zakiuddin Ali[7].

Parboiled paddy, if not dried in a day due to overcast sky or incessant rain, leads to heat development, discolouration, breakage and loss in head rice yield due to microbial growth. Initially, *Mucor mucedo* ramified the whole lot and later members of the *Aspergillus* group appeared. The incidence of *A. flavus* was relatively higher than other species (Table 1). The microbial infection converted part or whole of the gelatinized translucent kernel to opaque chalky rice which broke upon milling. During soaking for parboiling, the micropores and air spaces in starch granules, that cause opaqueness to raw rice are filled with water and the starch granules swell, gelatinize and fuse irreversibly upon steaming for gaining translucency[8]. When parboiled paddy is infected, starch is degraded in regions of colonization by bacterial cells or fungal strands, the grains become soft and opaque loosing the translucency due to disruption of irreversibly fused and gelatinized starch causing pores and void spaces for re-entry of air. In grains with infection limited to micropylar end or exposed kernel surface, chalky patches appear only in the infected areas while other regions remain translucent. Infection induced chalkiness resulted in heavy breakage with reduction in rice out turn. Well dried parboiled paddy gave 68.5% rice yield than a comparable lot of infected paddy which yielded only 53.5% rice out turn with as much as 58.1% brokens (Table 2). Similar rice losses due to infection in inclement weather have already been reported[9].

Breakage in grain might arise due to mechanical impact, thermal or moisture stress during processing. Heat development in infected lot might render the grains weak. Further, as chalkiness results in softening of the hard kernel, the influence of this attribute alone on breakage might be substantial in the milling stress in processing. Infection reversed the strength achieved in parboiling, swinging towards raw rice characteristics. This is evident from the sedimentation test that the infected parboiled rice showed a sedimentation volume of 5.5 ml whereas uninfected parboiled rice and raw rice had a sedimentation volume of 6.2 and 5.0 ml respectively.

The infected parboiled paddy tested contained 76.6% chalky kernels (whole and partly chalky) after dehusking and, on milling, resulted in 58.1% breakage with only 15.4% chalky head rice. It is evident that, out of this breakage, the extent contributed by chalky grains alone was 79.8% i.e. 46.4% out of the total. The starch in chalky regions got re-gelatinized and the hardness regained by re-processing the infected lot with 12 h soaking and steaming and hence the rice yield improved from 53.5 to 64.9% and the breakage dropped to mere 5.4% from 58.1%. This improvement in milling is essentially due to the complete re-gelatinisation of the infected chalky kernels. There was a reduction in chalkiness to the extent of 75.3% due to re-processing.

As the breakage decreased, pulverisation and mixing of rice brokens with bran is substantially reduced and improved its oil content. Well dried parboiled paddy, when milled after complete dehusking, yielded a bran with about 32% oil with 5.2% FFA, whereas bran from infected lot had 13.8% oil with 40.6% FFA. Bran from re-processed lot had 30% oil with 22.5% FFA. The reduction in FFA on parboiling is well known. Although there was no marked reduction in bacterial flora, the toal micoflora was reduced to 9.2×10^5/g from 66.1×10^5/g. The partial sterilization of paddy occurring

TABLE 1. MICROBIAL POPULATION IN INFECTED AND RE-PROCESSED PADDY (ADT 31)

Organism	Infected paddy	Re-processed paddy*
Bacteria ($\times10^6$/g)	147.9	125.6
Total fungi ($\times10^5$/g)	66.1	9.2
Mucor mucedo	18.5	2.0
Aspergillus flavus	26.4	5.2
A. fumigatus	6.6	–
A. sydowi	6.6	1.0
A. candidus	4.0	1.0
A. niger	4.0	1.0

*12 h soaked + steamed

TABLE 2. BEHAVIOUR OF INFECTION INDUCED CHALKY GRAIN (ADT 31)

Particulars	Potential yield (%)	Breakage (%)	Chalkiness in brown rice (%)	Reduction in chalkiness by re-processing	Chalky head rice after milling (%)	Breakage due to chalkiness (%)	Oil (%)	FFA (%)
Well dried paddy	68.5	1.6	–	–	–	–	32.1	5.3
Infected paddy	53.5	58.1	76.6	–	15.4	79.8	13.8	40.6
Re-processed paddy*	64.9	5.4	1.3	75.3	0.2	84.6	30.0	22.5

*12 h soaked + steamed

during steaming[10] is in agreement with the present investigation.

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Effect of Primary Processing on Dietary Fibre Profile of Selected Millets

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Effect of primary processing on dietary fibre profile of sorghum, bajra, ragi and wheat showed highest and lowest total dietary fibre in ragi and bajra. The insoluble fibre content of unprocessed and processed flour samples was found to be high in ragi. Conversely soluble dietary fibre content was found to be high in bajra, though its total dietary fibre content is low. The total dietary fibre content of sorghum bran was found to be low and wheat bran was high. A significant ($P < 0.01$) decrease in total dietary fibre and its components in all the samples was observed on processing.

Total dietary fibre has been called as roughage, bulk, bran, fibre, plant residue, unavailable carbohydrates[1] and plantix[2]. Dietary fibre consists of the endogenous components of plant material which are resistant to digestion in the human gastro-intestinal tract[3]. Total dietary fibre has been broadly classified as soluble and insoluble dietary fibre. Main components of soluble dietary fibre are hemicelluloses, pectic substances, gums and polysaccharides. Insoluble dietary fibre consists mainly of cellulose, lignin and some of the insoluble hemicelluloses[4]. The initial interest in fibre as an important dietary constituent was stimulated by epidemiological studies which linked its deficiency to chronic bowel related diseases, obesity, cardiovascular diseases and diabetes[5]. Cereals and millets are the staple food items of Indian population and they are the major contributors of fibre in the diet. Most of the millets are consumed in the rural areas of Andhra Pradesh after primary home-scale processing. So, the changes in total dietary fibre and some of its components in selected millets, after primary home-scale processing, were estimated.

Sorghum (*Sorghum vulgare*), Bajra (*Pennisetum typhoideum*) and Ragi (*Eleusine coracana*) and PDS as well as Bansi varieties of wheat (*Triticum vulgare*)from local market were processed. One kg of grain (sorghum, bajra and ragi) was taken and approximately 150 ml water was added and pounded separately. The grain and bran were separated by winnowing and the grain was washed for sun-drying. Finally, it was ground into a fine powder to pass through a 60 mesh sieve. Wheat was milled in a commerical mill and flour and bran were separated by using a 60 mesh sieve.

Total dietary fibre, soluble and insoluble fibre contents of unprocessed and processed flour and bran samples were estimated by the enzymatic method of Asp *et al*[6]. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were estimated by detergent methods[7,8]. Crude fibre (CF) was estimated by the standard procedure of the AOAC[9]. All the analyses were carried out in triplicate. Cellulose, hemicellulose and lignin contents were calculated as follows[10]. Cellulose = Crude fibre (CF); Hemicellulose =

TABLE 1. TOTAL (TDF), INSOLUBLE (IDF) AND SOLUBLE DIETARY FIBRE (SDF), NEUTRAL DETERGENT FIBRE (NDF), ACID DETERGENT FIBRE (ADF), CELLULOSE (CF), HEMICELLULOSE AND LIGNIN CONTENTS OF UNPROCESSED AND PROCESSED FLOUR AND BRAN SAMPLES (g%)*

Sample	TDF	IDF	SDF	NDF	ADF	CF	Hemicellulose	Lignin
Sorghum								
Unprocessed	9.4	7.5	1.9	8.3	2.9	2.0	5.4	1.1
Processed	7.8	6.4	1.5	5.9	2.1	1.5	3.8	0.6
Bran	26.3	23.7	2.6	21.5	10.8	6.9	10.7	3.9
Bajra								
Unprocessed	8.9	5.4	3.5	7.1	2.0	1.5	5.1	0.5
Processed	6.5	4.7	1.8	4.8	1.3	1.0	3.4	0.3
Bran	31.5	26.5	4.9	24.8	13.5	8.7	11.4	4.8
Ragi								
Unprocessed	17.6	15.7	1.8	15.6	5.2	4.0	10.4	1.3
Processed	16.2	14.7	1.5	11.5	3.7	2.8	7.8	0.9
Bran	40.7	37.8	2.9	37.4	16.8	11.8	20.6	5.0
Bansi wheat								
Unprocessed	11.9	10.2	1.7	11.4	2.9	1.9	8.5	1.0
Processed	10.8	9.5	1.4	7.9	2.4	1.6	5.5	0.7
Bran	44.8	41.9	3.0	44.8	9.6	8.3	35.2	1.3
PDS wheat								
Unprocessed	10.6	9.3	1.3	10.3	2.8	2.0	7.5	0.8
Processed	9.3	8.2	1.0	6.3	2.1	1.5	4.2	0.6
Bran	38.5	36.2	2.3	32.0	9.1	7.9	23.0	1.1

*± SD ranged between 0.06-2.66 for all the values

NDF−ADF; Lignin = ADF−CF. Average yield of sorghum, bajra and ragi on processing was in the range of 77-79%.

The dietary fibre (DF) profile of sorghum, bajra, ragi and wheat is presented in Table 1. The total dietary fibre (TDF) content of unprocessed and processed flour samples was found to be in the range of 6.5-17.6% with ragi having the highest, and bajra lowest, in contrast to intermediate value for wheat and sorghum. Anderson and Bridger[11] and Knudsen and Munck[12] have also reported similar values for wheat and sorghum respectively. Insoluble dietary fibre (IDF), neutral detergent fibre, acid detergent fibre, crude fibre, hemicellulose and lignin contents were found to be high in ragi and low in bajra. In contrast, soluble dietary fibre (SDF) content of unprocessed and processed flour and bran was high in bajra and low in PDS wheat. The total dietary fibre content of bran was highest in wheat and lowest in sorghum. Insoluble dietary fibre, neutral detergent fibre and hemicellulose contents were found to be high in wheat bran followed by ragi bran. Acid detergent fibre, cellulose and lignin were highest in ragi bran. In all the samples, a significant ($P < 0.01$) decrease in dietary fibre and its components on primary processing was observed. The dietary fibre composition of Bansi and PDS wheat was found to be more or less similar. On the whole, dietary fibre composition of bajra was slightly different because of its high soluble dietary fibre content in flour as well as in bran samples. The total and insoluble dietary fibre contents of ragi were found to be high.

Indian adult may consume 50-120 g dietary fibre/day depending upon the type and amount of cereal/millet used, with a desirable level of 40 g/day[13]. Consumption of high amount of dietary fibre was reported to have undesirable effects on health and nutritional status of an individual. In the light of this, the observed decrease in dietary fibre content of millets on primary processing, which is followed in the rural areas of Andhra Pradesh, seems to be beneficial.

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Utilization of Hulless Barley in *Chapati* Making

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Addition of hulless barley flour to wheat flour increased protein content, but it had diluting effect on the gluten content. The water absorption capacity of blended samples was higher. Puffing of *chapatis* in all composite flours was satisfactory. Colour, appearance and texture of *chapatis* were good upto 30% of hulless barley flours in the blends, but flavour score was slightly decreased. Chewability of *chapati* was acceptable upto 40% of hulless barley flour in the blend.

Composite flours have received great emphasis for improving protein content and nutritive quality of products[1,2]. Wheat flour is generally blended with high protein non-wheat flours like legume flours. Hulless barley is the cheaper source of protein and other nutrients as compared to legumes or pulses, although some legumes or pulses are slightly better in protein quality. The utilization of hulless barley is also important for the diabetic patient[3]. Hulless barley can be used with wheat flours for making *chapati* or other products. Bhatty[4] reported that barley has many potential uses in bread and non-bread barley products. Present work was, therefore, undertaken to evaluate composite flours of wheat and hulless barley flours for making *chapatis*.

Samples of wheat (variety 'Sonalika') and hulless barley (variety 'Dolma'), commercially grown in Himachal Pradesh, were obtained from the Department of Plant Breeding of the University. Before milling, wheat and hulless barley grains were conditioned to desired moisture contents (wheat, 14.5% and hulless barley, 14.0%) for 48 h under laboratory conditions.

Conditioned samples were milled in stone mill and sieved to obtain uniform extraction rate (70%). The wheat and hulless barley flours were blended in different proportions for making *chapatis*.

Moisture, protein and gluten contents of samples were analysed by the method of AACC[5]. *Chapatis* were prepared by the procedure described by Austin and Ram[6]. One hundred grams of flour and required amount of water were mixed manually to obtain dough of suitable consistency. The dough was rounded manually and kept for 30 min at room temperature (20°C). The dough was divided into four equal parts and moulded into circular *chapatis* of 15 cm diam using rolling pin and board. Traditional home baking procedure was followed to bake *chapatis* on *tawa* (hot plate). After baking, *chapatis* were cooled and analysed for physical and sensory characteristics.

Protein and gluten contents of the blended samples are presented in Table 1. Blending of hulless barley to wheat flour increased the protein content in the composite flour. On the other hand, blending had diluting effect on gluten content.

TABLE 1. PROTEIN, GLUTEN AND WATER ABSORPTION OF WHEAT AND HULLESS BARLEY FLOUR BLENDS AND SENSORY EVALUATION OF THE *CHAPATIS*

Blends		Protein (N×6.25) (%)	Gluten* (%)	Flour water absorption (%)	Sensory Quality**					
Wheat (%)	Hulless barley (%)				Appearance	Colour	Flavour	Texture	Chewability	Overall
100	0	10.7	7.5	52.6	7.8	7.8	7.2	7.7	8.2	7.7
90	10	11.4	6.8	56.1	7.5	7.2	6.8	7.0	7.2	7.1
80	20	12.1	6.0	60.2	6.8	7.0	6.0	6.7	6.7	6.5
70	30	12.8	5.3	61.6	6.7	6.8	5.8	6.7	6.7	6.6
60	40	13.1	4.5	62.2	6.3	6.0	5.3	5.0	7.0	5.9
50	50	14.2	3.8	64.8	5.8	5.8	5.2	5.0	6.0	5.6

*On dry wt basis. **Scale used: 0-1 = off; 2-3 = Poor; 4-6 Fair, 7-9 = Good and 10 = perfect.

So, this affects the dough handling. Blending of hulless barley flour to wheat flour increased the water absorption capacity of composite flours thereby affecting dough handling (Table 1.). The results of water absorption capacity are in agreement with the findings of Prentice *et al.*[7] who reported that the water absorption of the flour increased, when wheat flour is replaced with barley meal. The dough handling property was affected due to the nature of the protein of the hulless barley flour and its property to absorb more water.

chapatis prepared from all the composite flours puffed the highest and almost similar to that prepared from 100% wheat flour *chapatis*. The appearance of *Chapatis* was good upto the addition of 30% of hulless barley flour. Further blending produced *Chapatis* which were slightly uneven at the edges. The colour of the *chapatis* was creamish upto the use of 30% of hulless barley flour and it became slightly dark with further increase in the concentration of the hulless barley flour. The flavour of *chapati* was acceptable to panelists and also had good texture upto 40% blending of hulless barley flour. The chewability of *chapati* was acceptable upto 40% blending of hulless barley flour. The present study indicates that the fortification of hulless barley to wheat flour upto 30% is feasible for preparing acceptable quality *chapatis*.

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Effect of Temperature and Surface Area on Drying of Dehulled and Water-Blanched Soybeans

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Surface area of the blanched soybean splits *(dhals)* increased two folds by flaking, thereby reducing the drying time by half. Mechanical drying was found to be better than sun-drying. The rate of drying seemed to increase with temperature. Mechanical drying at 60°C for 4 h for unflaked sample and for 2 h for flaked sample were found suitable for the drying of dehulled and blanched soybeans for milling.

Among the several soy products, full-fat soy flour has considerable potential for introduction into the dietary systems, specially in rural areas. For preparation of full-fat soy flour, thermal processing of soybean is essential. A number of investigators have reported the superiority of heat processed soybean meal[1-4]. Among the different thermal processes known, blanching has been found to be more effective for inactivation of anti-nutrients while retaining the nutrients[5]. The present study was taken up to evaluate the drying behaviour of dehulled and blanched soybeans with respect to temperature and surface area.

Soybeans (*Glycine max* cv. Bragg) were dehulled and blanched by dipping the splits, held in a fine muslin cloth bag, in boiling water for 5 min before drying by sun or by mechanical methods. Soybean *dhals*, immediately after thermal processing, were flaked using a flaker consisting of two rollers adjusted to a clearance of 0.05 cm. The atmospheric temperature and relative humidity during sun-drying of flaked and unflaked beans in thin layer were 28±2°C and 68±2% respectively. In mechanical drying, a cabinet dryer was used at 50°, 60° and 70°C with 90 metres per min air velocity. Samples were drawn at half-hourly intervals and analysed for moisture content[6]. The surface areas of dehulled soybeans (raw soy *dhal)*, blanched soy *dhal* and flaked soybeans were measured from projected areas using planimeter.

The initial moisture content of raw, dehulled soybeans was 8.4% and it increased to 52.2% (db) upon blanching. In sun-drying, the dehulled and blanched but unflaked beans took 24 h for the moisture content to reduce to 7.9% (db). In mechanical drying at 50°, 60° and 70°C, the final moisture contents were 7.4, 10.3 and 9.3% (db) after drying for 6, 3 and 3 h, respectively. Both temperature and time had pronounced effect on the drying of beans in both methods. However, drying was faster during initial stages in mechanical drying at all the temperatures (Fig 1). Rate of drying was slow

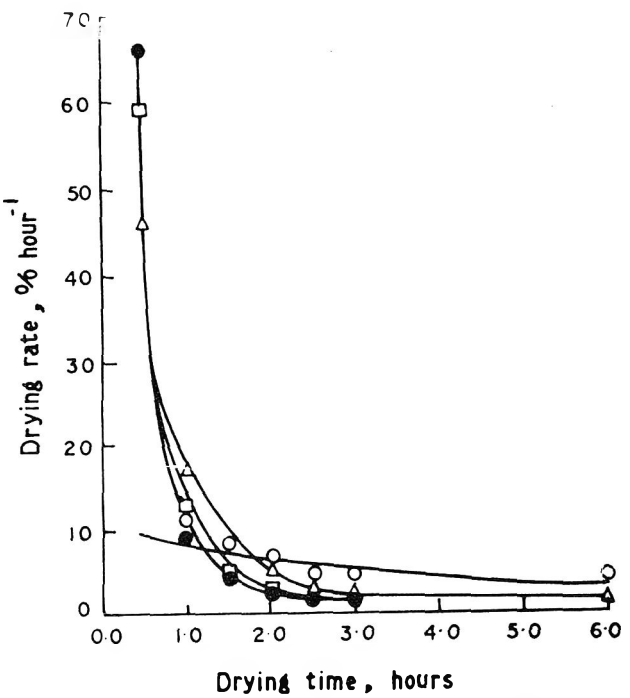

Fig.1 Effect of temperature and time on drying rate of dehulled and blanched soybeans.
O—O Sun drying (28±2°C); △—△ Mechanical drying at 50°C; □—□ Mechanical drying at 60°C; ●—● Mechanical drying at 70°C.

in sun-drying, while in mechanical drying, the rate increased with the increases in temperatures of drying.

Mean flat surface area of dehulled soy splits was 0.04 cm^2 (SD 0.0824) which increased to 0.58 cm^2 (SD 0.0709) as a result of blanching at 100°C for 5 min, and further increased to 1.1 cm^2 (SD 0.1746) in flakes, indicating a nearly two-fold increase as a result of flaking. The surface area of the cotyledons did not have much effect on the drying rate till the later stages of drying. This may be due to the fact that the high initial moisture content of the samples enhanced the rate of evaporation during initial stages and hence, only the

effect of temperature was observed. In all the cases, the rate of drying was around one per cent per hour during the last phase of drying.

In sun-drying, the desired final moisture content of 7-8% (db) for milling was obtained after 12 and 24 h in flaked and unflaked samples, respectively. In case of mechanical drying, the desired final moisture content was attained after drying for 6, 4 and 4 h in unflaked cotyledons and 3,2 and 2 h in flaked ones, at 50°, 60° and 70°C, respectively. The samples dried at 70°C were darker in colour compared to those dried at 50° and 60°C. Mechanical drying of unflaked samples at 60°C for 4 h and 2 h of flaked sample appears to be potential.

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Oligosaccharide Composition and Functional Properties of Flour and Starch Isolates from Four Cultivars of Bambarra Groundnut Seeds

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Proximate composition of flour and starch isolates of Bambarra groundnut seeds, showed that whole seeds contained 19-22% protein, 6-9% fat, 53-56% total carbohydrates and 4-12% soluble carbohydrates. Flatulent sugars as revealed by chromatography ranged from 1.0 to 2.6%. Water holding capacities of cultivars varied between 4.0 and 7.2 g of water/g of flour. Brabender amylograph indicated that starch gelatinized between 65 and 74°C, formed stable paste and showed moderate swelling capacity.

Bambarra groundnut (*Voandzeia subterranea* Thouars L), a tropical pulse (with underground pods), is one of the legumes of papillionaceae sub-family. It is a small herb with trifoliate leaves, which are palatable to domestic animals. The legume also has good potential for use as livestock feed and human food. Detailed studies are lacking on the functional properties of the flour and starch of this legume. The present investigation was designed to study the flatulent oligosaccharides and functional properties of four cultivars of Bambarra groundnut seeds.

Dry wholesome seeds were cleaned, soaked at 40°C for 10 h and oven-dried to a moisture content of 10%. The dried seeds were cracked in a hammer mill and detached hulls were winnowed off. The seeds were pulverized in a Wiley mill (Cyclotex 1053,Tecator instruments) to a particle size of 212 μ (U.S.A standard testing sieves). Flour samples were prepared from four cultivars of Bambarra groundnut seeds. Proximate analysis of whole seeds, flour and seed coat was done according to A.O.A.C procedures[1]. The moisture, ash, crude protein and carbohydrate contents of samples were determined. For the determination of soluble sugars, the anthrone-sulphuric acid method was used[2], with glucose as standard. Determination of oligosaccharides was carried out by thin-layer chromatography, using pre-coated plates and butanol-ethanol-water (5:3:2), for separation. Benzidine, α-naphthol, aniline and 2,6 dinitrophenyl-hydrazine were used as chromogenic reagents. Standard sugars include glucose, sucrose, raffinose and stachyose. Acid and invertase hydrolysis were used to confirm the identity of the oligosaccharides. For acid hydrolysis, a few ml of the purified sugar (by preparative thin-layer chromatography), was hydrolysed with conc HCl until it gave a positive reaction

with Benedict's solution. Invertase hydrolysis was carried out by incubating the oligosaccharides with 1% invertase at 40°C for 24 h in a water bath, followed by sugar determination, using Benedict's solution. A modification of the method of Schoch *et al*[3] was used for starch extraction. Fifty g raw, soaked seeds were ground in cold distilled water in a Waring blender, sieved to pass a 65 mesh sieve (212 μ)and subsequently a 325 mesh sieve (45μ). The resulting filtrate was allowed to sediment and the upper layer was decanted. The starch sediment obtained was re-slurried several times until the upper layer was clear of any haze and the resulting purified starch was dried. Water holding capacity of flours (about 212 μ) and starch isolates was estimated using a modification of the method of Lin *et al*[4]. One g powder was weighed into graduated test-tubes to which 10 ml distilled water had been added. The samples were vortexed and allowed to stand for 1 h at 26°C and at 100°C before centrifugation at 2000×g for 20 min. Excess water was decanted and the weight of bound water was calculated by difference. The Brabender amylogram (C.W Brabender Corp. S.O. Hackensack N.J), was used to monitor the heating and cooling of starch, prepared from four cultivars of Bambarra groundnut seeds. Five and 8% starch slurries were prepared to give a total weight of 500 g. The heating rate was 1.5°C per min up to 92°C, at which starch slurries were held for 15 min and subsequently cooled to 50°C. Gelatinization temperatures of starch isolates were determined using a polarizing microscope[5]. Measurement of gel strength was carried out using the method of Ihekoronye[6]. Swelling power of flour and starch was determined by a modified method of Leach *et al*[7]. The weighed starch (2%) and flour

TABLE 1. PROXIMATE COMPOSITION OF BAMBARRA GROUNDNUT SEEDS

Cultivar	Crude protein (%)	Fat (%)	Moisture (%)	Carbohydrates Soluble (%)	Carbohydrates Total (%)	Ash (%)
Whole Seed						
Red (V_1)	19.5	6.5	8.0	7.6	54.4	3.0
Black (V_2)	21.7	8.5	9.0	4.0	52.8	3.5
Cream (V_3)	19.5	6.0	9.7	6.5	56.0	2.5
Brown (V_4)	19.0	6.5	10.3	12.0	54.4	3.0
Flour						
Red (V_1)	20.9	3.0	9.3	2.2	48.0	2.0
Black (V_2)	22.6	4.0	9.0	1.4	32.0	2.0
Cream (V_3)	22.3	3.0	9.0	1.6	49.6	1.5
Brown (V_4)	19.4	3.5	10.0	2.9	48.0	2.0
Seed Coat						
Red (V_1)	5.7	0.5	3.0	2.6	8.4	1.0
Black (V_2)	6.1	2.0	3.5	3.0	6.0	1.5
Cream (V_3)	6.8	1.0	3.0	1.8	9.2	1.0
Brown (V_4)	6.3	2.0	3.0	0.5	9.1	1.0

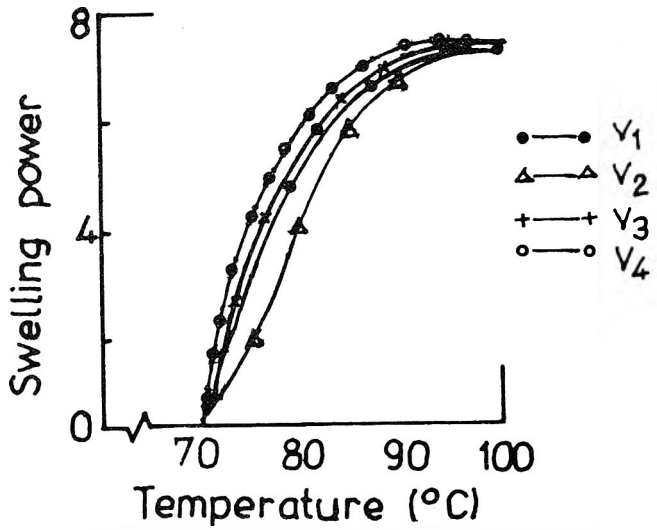

Fig. 1. Swelling capacity of Bambarra groundnut flour

(2%) were suspended in distilled water in graduated tubes. The tubes were heated at 95°C in a thermostatically controlled water bath for 1 h. Samples were stirred at intervals to keep the starch granules suspended. They were subsequently centrifuged, the aqueous supernatant was decanted and the final volumes and weights noted. The swelling power was

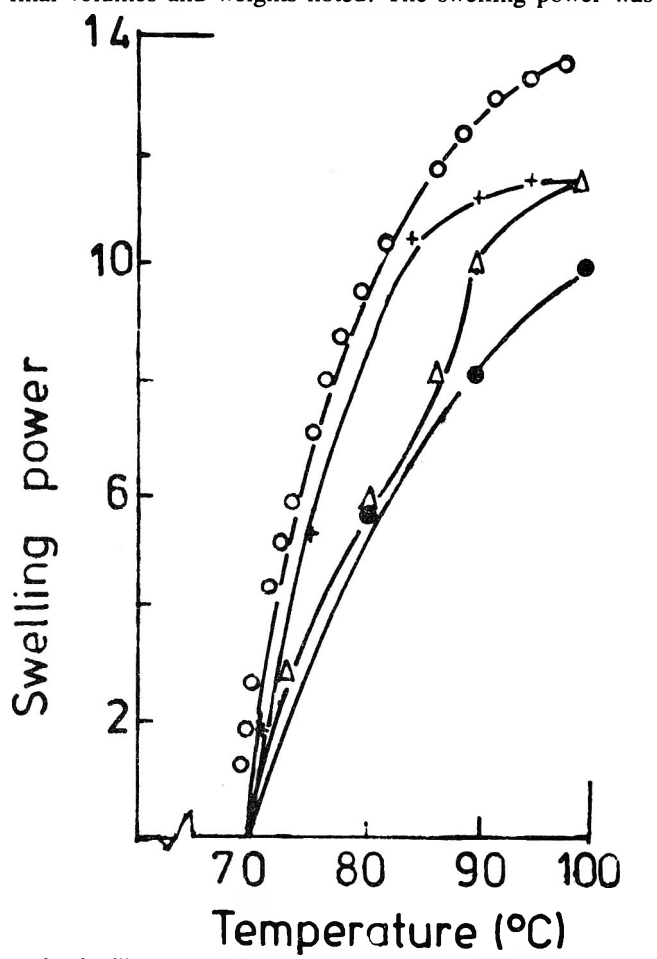

Fig. 2. Swelling capacity of starch isolated from Bambarra groundnut flour. Samples as in Fig. 1.

TABLE 2. VISCOSITY (VIS.), GELATINIZATION TEMPERATURE (GT) AND WATER BINDING CAPACITIES (WBC) OF STARCH ISOLATES FROM FOUR CULTIVARS OF BAMBARRA GROUNDNUT SEEDS

Cultivar	GT (C°)	Cold WBC at 26°C (g H_2O/100g)	Hot WBC at 100°C (g H_2O/100g	Peak Vis. BU (a)	Vis at 92°C		Vis at 50°C (BU) (d)	Drop in Vis. (a−c) (BU)	Set back vol (d−a) (BU)	Consistency (d−c) (BU)
					Initial (b)	Final (C)				
Red (V_1)	68.0–74.1	7.2	12.1	750	735	730	990	20	240	260
Black (V_2)	66.5–73.5	5.0	11.9	880	770	785	1180	95	300	395
Cream (V_3)	68.5–74.1	7.1	13.5	780	740	680	890	100	110	210
Brown (V_4)	66.0–72.0	4.0	13.2	850	770	690	980	160	130	290

calculated as a ratio of the volume of the intial sediment to the volume of the swollen sediment.

Experimental values for chemical constituents of whole seeds flours and seed coats are presented in Table 1. Glucose, sucrose, raffinose and stachyose were found to be present in Bambarra groundnut seed cultivars. The red coloured cultivar (V_1) contained virtually no raffinose, while the black coloured cultivar (V_2). contained little or no stachyose. Oligosaccharide content of Bambarra groundnut seed cultivars has not been found to be higher than that of other legume seeds already evaluated[8]. Water holding capacity of starch isolates varied with cultivar as well as temperature (Table 2). The water binding capacity at 26°C varied from 2.2 to 3.9 g/H_2O/g sample, the highest being for the red cultivar and the lowest for the brown cultivar. At 100°C, it was in the range of 10.5-11.9 g H_2O/g flour sample. The data on viscosity and gelatinization temperatures of starch isolated from all the four cultivars are shown in Table 2. Fig 1 and 2, show the swelling capacity of flour samples and starch isolates respectively. All flour samples and starch isolates showed resistance to swelling at low temperatures. Swelling of flour was evidently lower than that of starch, possibly as a result of effect of the presence of other food components on the starch. Substances such as lipids and absorbents on starch surfaces have been implicated in the reduction of the viscosity and swelling power of starch[9,10]

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Texture Profile and Consumer Acceptability of Defatted Soyflour Substituted Traditional Foods

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The substitution of chickpea flour with defatted soyflour (DSF) at 25% level did not significantly alter breaking strength of *Murukku*, (snack) but had a significant effect on the breaking strength of *Nankhatai*. Bulk density of DSF-substituted *Mysore Pak* (sweet preparation) was higher than the bulk density of *Mysore Pak* prepared from chickpea flour. Consumer acceptance tests showed that the products were well accepted.

The use of solvent extracted edible grade soyflour has potential in day-to-day Indian foods. Its low starch content, however, causes changes in sensory characteristics of the soyflour-incorporated product[1]. Preliminary attempts on the incorporation of defatted soyflour (DSF) at lower levels in some traditional foods showed encouraging results[2,3]. The present study is aimed at incorporating DSF in a variety of traditional food preparations at levels which do not alter their textural properties.

Three traditional snack foods, viz. *Murukku, Nankhatai* and *Mysore Pak* were prepared as per recipes standardized by Sharma *et al.*[4] but using different levels of DSF incorporation. On the basis of preliminary trials, the levels of incorporation of DSF selected were not less than 25% for *Murukku* and *Nankhatai* and 100% for *Mysore Pak*. The products were tested on the Instron Universal Testing Machine (Model 6021) for their textural properties (breaking strength), in addition to consumer acceptance. The moisture and protein contents of the snack foods were determined (intriplicates) by standard procedures of the AACC[5] and average values have been reported.

Instrumental objective analysis: The DSF-substituted and control *Murukkus* were made in five replicates, each comprising of eight pieces of uniform size (length 2.5 cm and diam.1 cm),and were tested by the method described by Chauhan[6] Two-way analysis of variance[7] was performed on the results. The control and experimental samples of *Nankhatai* were made in five replicates, each with five *Nankhatais* (10 g each) for the same purpose. The bulk density of *Mysore Pak* was determined by the rapeseed displacement method (AACC)[5]. Moisture and crude protein contents of *Murukku, Nankhatai* and *Mysore Pak* were estimated.

Large batches of the three foods were made by laboratory-standardized recipes for consumer acceptance trials. One hundred and twelve consumers from university campus were asked to rate each snack on a 5 point facial Hedonic scale developed by the Continental Can Company[8]. Results were expressed as percentages of positive responses.

Incorporation of DSF at 25, 15 and 100% levels in *Murukku, Nankhatai and Mysore Pak*, respectively, increased the protein level by two-folds in the first two products and three-folds in the last one. This shows that there is nutritional improvement by DSF substitution in these products.

The mean values (Newtons) for breaking load under compression in five replicates for each of the two samples of *Murukku* were 2.02 E-01 for the 25% DSF substituted-product and 1.60 E-01 for the control. Incorporation of DSF did not affect the breaking strength of *Murukkus* significantly (P=0.05), as shown by statistical analysis of deformation force data. Similar values for five replicates of the three samples of *Nankhatai* were 264.8, 215.7 and 187.1 N for control, 15% DSF-substituted and 25% DSF-substituted *Nankhatai*, respectively. Statistical analysis of the data by two-way analysis of variance showed that the difference between replicates was non-significant. However, there was a significant difference between the control and DSF-substituted sample at P=0.05. There was no significant difference between the two DSF-substituted *Nankhatais*. The mean value for bulk density of DSF-substituted *Mysore Pak* was higher (0.15) than that of control (0.13). The responses obtained from 112 consumers on a 5 point scale are presented as % responses in Table 1. The samples of *Murukku, Nankhatai* with 15 and 25% DSF and *Mysore Pak* were scored positively by 80, 93, 85 and 72% of the respondents, respectively.

The results of this study showed that in the preparation of *Murukku* and *Mysore Pak*, defatted soyflour can be incorporated to the extent of 25 and 100% respectively, without significantly affecting their textural properties. However, in *Nankhatais*, DSF incorporation at 15% level did not affect the sensory characteristics and consumer

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TABLE 1. CONSUMER ACCEPTANCE RATING (%)

Preparation	DSF level (%)	Dislike extremely	Dislike slightly	Neither like nor dislike	Like slightly	Like extremely
Murukku	25	0	2	18	39	41
Nankhatai	15	0	1	5	47	46
	25	0	2	13	48	37
Mysore Pak	100	2	6	20	42	30

acceptability adversely, although deformation force was affected significantly. The addition of defatted soyflour increased the protein content to a great extent.

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Effect of Concentration Conditions on Texture of *Khoa*

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The steam kettle process A of *khoa*-making yielded a product that was significantly harder, springy, gummy and chewy, but less adhesive than that from the simulated traditional process B. Sensory evaluation also showed that firmness and chewiness were higher for *khoa* A. Having higher smoothness and lower crumbliness, *khoa* made by process B was rated appreciably more desirable from the view-point of overall textural quality. High-moisture *khoa (Dhap)* was softer and smoother, but less gummy and less chewy as compared to low-moisture *khoa (Pindi)*. The interactions of process with moisture and milk acidity were statistically non-significant for all texture parameters except sensory chewiness.

Preparation of *khoa* essentially involves heat coagulation of milk concentrated by boiling under atmospheric conditions[1]. Thus, the rate of heating as well as scraping, and pattern of foaming during boiling become important to the textural quality of the finished product. In the traditional process employing a thick-walled iron pan heated over a brisk non-smoky fire, milk is concentrated in such a manner that it attains a definite concentration, usually about 3-folds, before an abrupt coagulation takes place, and thereafter, evaporation is continued until the desired consistency is obtained. When the product is made using a steam kettle, the concentration conditions are different from those in the conventional process, and result in localized concentration and coagulation of milk on the hot kettle walls. This, in turn, is expected to influence the textural characteristics of the product. The objective of the present study was, therefore, to assess the texture of *khoa* made under two different sets of concentration conditions employing a steam kettle.

Pooled raw buffalo milk (titratable acidity, 0.15-0.17% lactic acid), obtained from the Institute's herd, was standardized

to a fat-solids-not-fat (SNF) ratio of 0.6, the total solids (TS) content of the standardized milk being 15-16%. A 10 l lot of standardized milk was transferred to a steam-heated stainless steel kettle (Capacity, 80 l) and converted into khoa under two sets of concentration conditions. In the ususal steam kettle method (A), milk was boiled vigorously (under 'high' heat; steam pressure, 0.9-1.2 kg/cm^2) and allowed to foam while frequently scaping the kettle walls, using an iron scraper, until a concentration ratio of approximately 1:2 was attained, and the foam tended to subside (i.e. after 8-10 min). A portion of the partially concentrated milk was then briskly spread on the hot surfaces (sides) of the kettle ('reduced' heat; steam pressure, 0.6-0.8 kg/cm^2) and the pools of concentrate/coagulate were quickly scraped down to mix with the remainder of the concentrate simmering on the kettle bottom. The spreading-and-scraping operation was continued for 15-17 min so as to impart a paste-like consistency to the concentrate (concentration ratio, approximately 1:3). The resulting coagulated mass was further concentrated in a similar fashion under 'low' heat (0.2-0.3 kg/cm^2) to a

TABLE 1. TEXTURE PROFILE PARAMETERS OF KHOA MADE UNDER DIFFERENT CONCENTRATION CONDITIONS

Milk acidity (% lactic acid)	Moisture (%)	Concen. conditions	Hardness N	Cohesivenes	Adhesive force, N	Springiness, mm	Gumminess, N	Chewiness N. mm
0.15	41.7	A	0.859	0.657	0.082	6.0	0.555	3.853
		B	0.785	0.621	0.104	5.9	0.457	2.861
0.15	32.3	A	6.610	0.482	0.104	6.8	3.156	20.700
		B	3.639	0.438	0.237	4.9	1.522	7.572
0.17	39.2	A	1.970	0.733	0.085	7.9	1.400	11.089
		B	1.143	0.619	0.128	6.8	0,699	4.737
0.17	31.0	A	6.016	0.520	0.085	6.8	3.144	21.602
		B	4.055	0.527	0.189	6.3	2.052	12.849

TABLE 2. VARIANCE RATIO (F) FOR INSTRUMENTAL TEXTURE PROFILE PARAMETERS

Variable[+]	Hardness	Cohesiveness	Adhesive force	Springiness	Gumminess	Chewiness
Concn. conditions	5.84*	1.37	9.62**	5.17*	8.28*	12.74**
Moisture	41.55**	17.27**	4.95*	1.52	31.27**	24.09**
Milk acidity	0.29	1.60	0.17	6.93*	1.68	3.48

[+]Two-way and three-way interactions were non-significant. *P < 0.05 **P < 0.01. Figures without asterisk are non-significant.

TABLE 3. SENSORY TEXTURE DESCRIPTORS OF KHOA MADE UNDER DIFFERENT CONCENTRATION CONDITIONS

Milk acidity (% lactic acid)	Moisture (%)	Concen conditions	Firmness	Crumbliness	Stickiness	Elasticity	Smoothness	Chewiness	Overall texture quality
0.15	41.7	A	29.1	36.6	54.7	48.9	42.5	38.7	49.1
		B	24.0	35.3	67.7	48.8	60.7	42.9	62.8
0.15	32.3	A	69.3	60.1	25.5	53.7	30.6	53.0	51.8
		B	57.2	48.7	34.7	52.8	45.0	46.9	66.3
0.17	39.2	A	49.3	54.6	36.1	61.1	36.9	66.5	45.3
		B	24.5	33.8	56.2	52.6	59.3	34.8	58.3
0.17	31.0	A	66.6	63.5	41.6	46.7	30.2	58.1	43.9
		B	58.0	49.8	32.8	49.1	45.2	46.9	60.4

TABLE 4. VARIANCE RATIO (F) FOR SENSORY TEXTURE DESCRIPTORS

Variable	Firmness	Crumbliness	Stickiness	Elasticity	Smoothness	Chewiness	Overall texture quality
Concn conditions (A)	7.10*	5.32*	2.14	0.16	10.61**	5.70*	6.47*
Moisture (B)	42.59**	9.14**	12.14**	0.26	5.10*	1.37	0.09
Milk acidity (C)	0.98	1.06	0.48	0.09	0.11	1.76	0.95
A×C	0.73	1.13	0.22	0.08	0.05	4.76*	0

*P < 0.05 **P < 0.01 Figures without asterisk are non-significant

concentration ratio of 1:3.9 to obtain a high moisture, semi-solid product (*Dhap* with 37-45% moisture) in 3-4 min, or to a concentration ratio of 1:4.3 to obtain a low moisture, solid product (*Pindi* with 28-35% moisture in 5-6 min. In the simulated traditional method (B), milk was boiled vigorously for 2-3 min to attain a concentration ratio of 1:1.3 and allowed to simmer under reduced heat (0.5-0.7 kg/cm^2) while continuously scraping the kettle bottom (but avoiding the spreading-cum-scraping step of process 'A') until a distinct coagulation was noticed (approximately 1:3 concentrataion). The coagulated mass was further concentrated under low heat as in 'A'.

The product filled in covered crystallizing dishes (50×100 mm), so as to minimize drying losses, was held at 30° ± 1°C for 24 h before subjecting it to analysis. Instrumental texture profile analysis was carried out on cylindrical samples of *khoa* using Instron machine as detailed earlier[3]. Cylindrical sample of *khoa* (19 mm in diam and 20 mm high) were also assessed for various sensory texture descriptors and overall textural quality by 10 panelists using a score card carrying 100-point unstructured linear intensity scales[4,5], the lowest intensity or acceptability score being 1, and the highest being 100. Both instrumental and sensory data were statistically analysed by employing 2^3 factorial design[6]. Titratable acidity was determined by titrating 10 ml of milk with 0.1 N NaOH to phenolphthalein end point. The moisture content of *khoa* was determined by taking approximately 2 g sample in a tared aluminium dish and drying it in an air-oven at 103° ± 1°C to a constant weight.

As shown in Tables 1 and 2, instrumental hardness of *khoa* B was lower ($P < 0.05$) than that of *khoa* A. Similarly, springiness, gumminess and chewiness ($P < 0.05$) were also lower for *khoa* B than for *khoa* A. While cohesiveness of *khoa* B was not significantly different from that of *khoa* A, adhesiveness was higher ($P < 0.01$) in *khoa* B as compared to *khoa* A. Sensorily, *khoa* A was more firm and crumbly ($P < 0.05$) but less smooth ($P < 0.01$) as compared to *khoa* B (Tables 3 and 4). However, the differences between these two products, in respect of stickiness and elasticity, were statistically non-significant. From the overall textural point of view, *khoa* B was rated distinctly superior to *khoa* A ($P < 0.05$) irrespective of the moisture content or acidity of the milk used.

According to Davies[7], the major physical change in milk during *khoa*-making is heat-induced coagulation of milk proteins resulting in formation of a semi-solid mass. Frothing of milk during preparation of *khoa* might enhance the coagulation process. Further, heat treatment of concentrated milk is known to result in formation of particulate material consisting of casein aggregates[8] which form the structural units of the coagulated mass. The nature of these aggregates forming the individual granules that constitute the *khoa* mass may decide the texture of the resulting product[9]. Evaporation conditions in process B, unlike those in process A, did not permit extensive foaming of milk during boiling. Further, during the spreading-and-scraping process in method A, localized heating appeared to facilitate appreciable protein coagulation in pools of the partially concentrated milk on the hot kettle walls. Hardening of granules during further evaporation would conceivably impart a differential texture to *khoa*.

Thus, the coagulation process B was apparently more close to the traditional process of *khoa*-making, in which a smooth fine grained mass is obtained by abrupt coagulation of the concentrate, and overheating of the granules is largely avoided. Considerably higher smoothness of *khoa* B (Table 3) is indicative of lower granularity of this product. Similarly, the higher values for hardness and firmness of *khoa* A (Tables 1 and 3) may be attributed to hardening of the granules in this product. Higher springiness of this product, though not equally reflected in sensory elasticity, may also be largely due to the increased springiness of the hardened individual granules that make up the bulk of the product. Chewiness, a property exhibiting the combined effect of hardness and springiness was expectedly higher for *khoa* A than for *khoa* B. High-moisture or *Dhap khoa* was conceivably more cohesive ($P < 0.01$), but had a lower hardness, adhesiveness, gumminess and chewiness ($P < 00.5$) in comparison with low-moisture or *Pindi khoa* (Table 1). Instrumental springiness of the two products was, however, similar (Table 2). Higher initial milk acidity yielded a more springy khoa ($P < 0.05$), but the other texture profile parameters were unaffected by milk acidity. The interactions of moisture and milk acidity with concentration conditions were non-significant in respect of all texture profile parameters.

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Effect of Age and Live Weight on the Carcass Components of Spent Hens

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The dressing percentage decreased significantly ($P \leq 0.05$) with increase in live weight. The carcass components such as giblets, cuts and total inedible parts were more influenced by live weight of the spent hens than age.

Economics of poultry production and the quality of processed products are dependent on carcass characteristics. Information on the carcass components of spent hens is limited[1,2], in contrast to other meat animals. In the present study, the effects of age and live weight on the carcass components of spent hens, maintained under local agro-climatic conditions of Himachal Pradesh, were evaluated.

Carcass characteristics of 194 spent 'White Leg Horn' hens of a commercial strain (Key Stone Golden), maintained in a research farm, were recorded. The chicks were reared from one day old stage and birds were maintained on deep litter system with uniform feeding and managemental conditions according to restricted feeding schedule. The birds in which hen-day egg production (HDEP) dropped below 35% were categorised as spent hens. The spent hens were grouped according to age (50-55 weeks and 56-60 weeks) and live weight (below 1.75 kg, 1.75-2 kg and above 2 kg). The live weights were recorded after starving the birds for 15 h. The birds were slaughtered, dressed manually and de-skinned prior to recording the dressed weights. The weights of hot dressed carcasses for giblets (heart, liver, gizzard) and cuts (leg, wing, breast, neck and back) were noted[2]. Total weights of inedible parts were calculated by adding feather, skin, head, shank, gastro-intestinal tract, lungs, kidney and spleen. Data were analysed following the statistical method of Snedecor and Cochran[3] and Duncan's multiple range test[4].

Weights of different carcass components based on the age and live weights are presented in Tables 1 and 2. Results revealed that live weight of the spent hens increased significantly ($P \leq 0.05$) with weight as compared to age. In contrast, the dressed weight increased significantly ($P \leq 0.05$) with increasing age and live weight. Dressing percentage was, however, significantly ($P \leq 0.01$) influenced by live weight as compared to age and it decreased significantly with increasing live weight. Giblet weight increased significantly ($P \leq 0.05$) with age and live weight. Amongst the primal cuts, the leg, wing and breast weights increased significantly

TABLE 1. EFFECT OF AGE ON CARCASS COMPONENTS OF SPENT HENS

Components	50-56 weeks	56-60 weeks	Overall mean
Live wt. (kg)	1.8 ± 0.0^{a}	2.0 ± 0.0^{a}	1.9 ± 0.0
Dressed wt. (g)	897.0 ± 12.1^{b}	989.5 ± 9.0^{a}	960.9 ± 7.9
Dressing (%)	51.0 ± 0.6	50.8 ± 0.3	50.8 ± 0.3
Giblet wt. (g)	75.8 ± 1.9^{b}	80.8 ± 1.7^{a}	79.3 ± 1.3
Giblet (% live wt.)	4.3 ± 0.1	4.1 ± 0.1	4.2 ± 0.0
Giblet (% dressed wt.)	8.4 ± 0.2	8.1 ± 0.1	8.2 ± 0.1
Leg wt. (g)	281.9 ± 6.6	309.8 ± 6.2	299.4 ± 5.1
Leg (% dressed wt.)	31.5 ± 0.5	31.9 ± 0.4	31.7 ± 0.3
Wing wt. (g)	123.8 ± 5.6^{a}	127.9 ± 3.1^{a}	126.4 ± 2.8
Wing (% dressed wt.)	13.3 ± 0.3	13.2 ± 0.2	13.2 ± 0.2
Breast wt. (g)	251.1 ± 6.6	253.6 ± 6.2	252.7 ± 4.6
Breast (% dressed wt.)	28.1 ± 0.5^{a}	26.1 ± 0.5^{b}	26.8 ± 0.4
Back and neck wt. (g)	255.1 ± 6.7^{b}	283.2 ± 5.4^{a}	272.7 ± 4.8
Back and neck (% dressed wt(g)	28.5 ± 0.7	29.3 ± 0.7	29.0 ± 0.5
Total inedible wt(g)	805.2 ± 23.2^{b}	876.7 ± 8.7^{a}	868.5 ± 15.3
Total inedible (% live wt.)	45 ± 0.7	$45. \pm 0.2$	45.1 ± 0.3

Means with same superscript in each row do not differ significantly ($P \leq 0.05$)

TABLE 2. EFFECT OF LIVE WEIGHT ON CARCASS COMPONENTS OF SPENT HENS

Components	< 1.75 kg	1.75-2.00 kg	> 2 kg
Live wt. (kg)	1.6 ± 0.0^{c}	1.9 ± 0.0^{b}	2.1 ± 0.0^{a}
Dressed wt. (g)	855.1 ± 11.9^{b}	937.8 ± 6.3^{b}	1063.8 ± 9.3^{a}
Dressing (%)	52.9 ± 0.7^{a}	50.0 ± 0.3^{b}	50.2 ± 0.1^{b}
Giblet wt. (g)	64.6 ± 1.6^{b}	73.4 ± 1.1^{b}	96.4 ± 2.0^{a}
Giblet (% live wt.)	4.0 ± 0.1^{b}	3.9 ± 0.1^{b}	4.5 ± 0.1^{a}
Giblet (% dressed wt.)	7.6 ± 0.2^{b}	7.8 ± 0.1^{b}	9.1 ± 0.2^{a}
Leg wt. (g)	261.9 ± 7.9^{b}	300.6 ± 4.2^{a}	325.0 ± 6.5^{a}
Leg (% dressed wt.)	30.9 ± 0.9	31.9 ± 0.4	32.1 ± 0.4
Wing wt. (g)	113.1 ± 3.6^{b}	125.9 ± 4.0^{a}	136.9 ± 4.5^{a}
Wing (% dressed wt.)	13.3 ± 0.6	12.9 ± 0.2	13.5 ± 0.4
Breast wt. (g)	224.9 ± 5.7^{b}	254.1 ± 6.5^{a}	271.4 ± 4.7^{a}
Breast (% dressed wt.(g)	26.6 ± 1.1	26.9 ± 0.7	26.8 ± 0.3
Back and neck wt.(g)	264.4 ± 16.5	273.1 ± 3.0	278.3 ± 8.9
Back and neck (% dressed wt.)	$31.1 \pm 1.6^{a}7$	28.9 ± 0.3^{a}	27.5 ± 0.7^{b}
Total inedible wt(g)	703.8 ± 18.8^{c}	861.1 ± 6.0^{b}	959.0 ± 9.8^{a}
Total inedible (% live wt.)	43.3 ± 0.8^{b}	46.1 ± 0.3^{a}	45.2 ± 0.4^{ab}

Means with same superscript in each row do not differ significantly ($P \leq 0.05$)

($P \leq 0.05$) with live weight and the same were not influenced by age of birds.

Back and neck weight increased significantly ($P \leq 0.05$) with advancing age; however, the same decreased significantly ($P \leq 0.05$) with increasing live weights. Total inedible weights increased significantly ($P \leq 0.05$) with age and live weights.

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Processing of Wild Pomegranate (*Punica granatum* L.) for *Anardana*: Effect of Thermal Treatments and Drying Modes on Quality

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Comparison of deep hot sand roasting of whole fruit, dry roasting on heater and blanching in boiling water for 5 min to remove fleshy seeds from wild pomegranate fruits indicated best results with the first method. The quality of the dried seeds was far superior when dried in solar drier as compared to conventional sun drying or hot air drying.

The wild pomegranate tree is ubiquitous in submontane tracts in the outer Himalayas upto an elevation of about 1800 metres above sea level. The wild pomegranate fruit, popularly known as *Daaru*, is borne on shrubs 4.6 metre high[1]. The fruits are round, oblate or obovate in shape, vary in diameter from 3.5-5.0 cm, and have thick or thin skin with pale yellow to crimson colour on maturity. The seeds of wild pomegranate fruits being highly acidic, are usually dried to obtain *Anardana*, which is used as an acidulant in curries, chutneys and other culinary preparations in North India[2]. For preparation of *Anardana*, the fleshy seeds which are tightly adhering to each other are often removed by hand. It invariably results in the staining of hands and clothes of the workers, besides affecting the yield and quality of the product. Moreover, the manual process is tedious, laborious, cumbersome and increases the cost by 30%. The present investigation was undertaken to study the effect of deep sand roasting, dry roasting on heater, and water blanching for 5 min, solar drying, conventional hot air drying, and open sun-drying, on the quality of *Anardana*. Simple solar cabinet dryer (plain glass) designed by the Basic Sciences Department of the University was used for solar drying at 48-52°C. Conventional cabinet type laboratory hot air dehydrator was operated at 60 ± 1°C.

The ratio of fruit weight to that of sand or water (in sand roasting or water blanching) was kept at 1:8. The per cent saving on time compared to the conventional method was also worked out. The total soluble solids (°Brix), pH, acidity, tannins, reducing, non-reducing and total sugars were determined according to A.O.A.C. procedures[3]. The physical characteristics of *Anardana*, viz., drying ratio and rehydration ratio were determined according to the prescribed method[4], whereas optical density and quality of seeds were studied according to the standard methods[5]. The number of fruits per kg ranged between 25 and 28, and the recovery percentage of seeds on the whole fruit basis was 43.2. The results of physical and chemical analysis of *Daaru* fruit are given in Table 1.

For removing the fleshy seeds, three thermal treatments were tried. The temperature of the hot sand used for treatment was measured to be around 165-170°C. In all the treatments, the internal temperature of the fruit did not increase above $35° \pm 1$°C throughout the pre-treatment period. All the thermal treatments economised on the labour over the manual

TABLE 1. PHYSICAL AND CHEMICAL CHARACTERISTICS OF *DAARU* FRUIT

Juice (%)	:	52.4
T of juice (°B)	:	16.0
Titratable acidity (as % citric acid)	:	5.1
pH of juice	:	2.8
Tannins (as tannic acid) (mg/100 ml of juice)	:	145.0
Reducing sugars (%)	:	7.1
Non-reducing sugars (%)	:	0.5
Total sugars (%)	:	7.9
Sugar: acid ratio	:	1.6

TABLE 2. EFFECT OF THERMAL TREATMENT ON SEPARATION OF SEEDS

Treatment	Time needed to separate seeds (min)	% labour saving*	
		Excluding treatment time	Including treatment time
Manual	35	—	—
Water blanching (5 min)	20	42.8	28.5
Sand roasting (5 min)	28	20.0	5.7
Roasting on heater (5 min)	30	14.2	3.4

*1 kg of fruit was processed in all cases

practice to an extent of 14.2-42.8% (Table 2). Though the highest labour saving was recorded with water blanching, the quality of the separated seeds in terms of taste, flavour and appearance were far inferior to that from the other two treatments. The gelatinization of the whole mass observed in fruits from this treatment may probably be attributed to heat-induced water diffusion into the fruit. From the view point of quality, ease of handling, and economics, deep sand roasting for 5 min yielded better quality of *Anardana*. The separated seeds were further dried by different methods as mentioned above.

The study revealed that the conventional hot air drier took about 4 h to dry the seeds to a moisture level of 16-18% compared to 15 h in solar drier and open sun-drying, respectively. The drying ratio for all the three drying modes was uniform at 5:1, while the rehydration ratio stood at 2.06:1, 2.1:1 and 2.2:1, respectively. The differences in O.D at 440 nm, which ranged between 0.15 and 0.18, were negligible. The quality of the dried product was observed to be the best with the solar drier, followed by open sun-drying while it was quite inferior in the conventional hot air drier.

With a view to upgrade the rural technology, it is recommended that *Daaru* fruit should be given hot sand roasting before removing the seeds followed by drying in solar drier for making better quality *Anardana*.

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J. Fd. Sci. Technol, 1992, Vol. 29, No. 5, 329—330

Nitrate and Nitrite in Some Non-Alcoholic Beverages and Water Supplies in Onitsha, Nigeria

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Nitrate and nitrite analyses of about 200 water samples from different sources in Onitsha metropolis reveal that water from wells and boreholes are the most widely contaminated with 180-360 ppm and 2.4-36.0 ppm nitrate and nitrate, respectively. Presence of nitrate is attributed to the nitrate reductase activity of the microbial flora. Analysis of non-alcoholic beverages revealed an ubiquitous contamination of 0.33-3.48 ppm of nitrite.

Over the past few decades, a number of reports have appeared on contamination of foods and beverages by nitrite, nitrate and nitrosamine[1,2]. An upward trend in nitrate (NO_3) levels have been recorded in rivers, streams and groundwater aquifers[3] with higher values for areas with intensive farming and fertilizer application[4]. Improper disposal of municipal solid waste has also been implicated[5]. Reports of nitrate, nitrite and nitrosamine contamination of fermented alcoholic beverages[6], dairy products[7], food materials and bread snacks[8] indicate that their levels in foodstuffs vary widely and depend upon exposure from various sources. With this type of ubiquitous distribution, nitrate and nitrite require a quantitative control. But the paucity of biochemical and hydro-geological literature in this regard discourages strategic approach to the ecotoxicological and epidemiological control of these pollutants/contaminants in Nigeria. Onitsha, a metropolitan highly populated city in West Africa, generates a high volume of municipal solid waste (MSW), the so-called refuse or garbage and mounting accumulation of these wastes contaminate underground waterways with nitrate[5]. Use of these polluted water in the liquid beverage industries can be a ready source of contamination. This study was, therefore, taken up to critically examine the nitrate and nitrite concentrations in different non-alcoholic beverages, surface and sub-surface water sources.

Sample collection: Water samples (~ 200 ml) were collected in aseptic containers from taps, wells, boreholes and metallic tank reservoirs (holding rainwater) from different parts of Onitsha. Containers were stored in the refrigerator for hours/days until required. Various brands of beverages produced at Onitsha were purchased randomly from market by covering a wide geographical area. These include soda, lemon, tonic water, coffee, tea, dry milk, orange juice and soft drinks such as cola, orange, malt and cocoa. Solid beverages (5 mg each), such as tea, coffee, etc., were dissolved in hot water (100 ml) to extract nitrite[1] and the extracts were clarified using a column of activated charcoal. Liquid beverages, like soft drinks, malt drinks and fruit juices were clarified in the same way but without any extraction. Nitrate and nitrite estimations were performed using Brucine colorimetric[9] and Montgomery and Dymock[10] methods respectively.

A loopful of well water, which was positive for nitrate and nitrite, was streaked on nutrient agar plates, incubated aerobically at room temperature (31°C) for 48 h and representative colonies were purified by serial dilution. The isolates were Gram stained and preserved on agar slants at 4°C. For nitrate reductase activity, purified isolates were inoculated into nitrate broth prepared according to the method of Cowan and Steel[11], incubated aerobically at room temperature (31°C) for 48 h and tested for the presence of nitrite[10]. To media showing negative results, powdered zinc (5 mg/ml of culture) was added and allowed to react. A positive nitrite result after addition of zinc powder, indicated residual nitrate and hence lack of nitrate reductase activity.

Table 1 shows the nitrate and nitrite concentrations in different potable water sources in Onitsha metropolis. The pH values of the water samples were within moderate acidic

TABLE 1. NITRATE AND NITRITE CONTENTS IN GROUNDWATER AND SURFACE WATER SOURCES

Source of water	Samples analysed (Nos)	pH range	No_3 range (ppm)
Well/borehole	40	4.8-5.7	180-360
Metallic tank reservoirs	10	4.7-5.1	180-306
Tap*	10	5.1-5.5	13.5-32.7
Tap	140	6.1-7.3	n.d

NO_2 in well/borehole water samples was 2.41-36.03 ppm. while it was absent in six samples. $NO_2$was not detected in other samples.

*Rusted and leaking pipes.

range (4.7-5.7) except for the tap water where most samples (about 80%) fell within the pH range of 6.1-7.3 (which is within the acceptable range of water quality)[12]. There was a preponderance of nitrite in all the water samples except in tap water. Nitrite in well water could be attributed to the activity of the microbial flora. Positive nitrate reductase activity was observed in case of three Gram negative bacilli isolated from the water samples. However, other gram positive bacilli and gram nagative cocci were negative for nitrate reductase activity.

Table 2 shows the nitrate and nitrite contamination levels of the different Nigerian non-alcoholic beverages. While highest values were recorded for coffee and orange juice, tea had the lowest level. The presence of nitrite in these samples and the implicating role of microbial reduction poses a further danger since nitrite is directly associated with the formation of N-nitroso compounds that are carcinogenic[13]. This reaction is favoured by acidic conditions[14]. The acidic pH range (4.7-5.7) of the water samples (Table 1) are, therefore, likely to promote nitrosation reaction. Though nitrite, nitrate and nitrosamines have been reported in palm-wine and beer[6]. their consumption does not cause cancer in humans[15]. But epidemiological studies have implicated high levels of dietary nitrate in gastric cancer mortality[16]. The exceedingly high nitrite values consistently found in coffee makes it a likely source of concern. Excessive consumption of coffee may alter the bladder mucosa, make it more sensitive to prolonged exposure to nitrosodibutylamine and/or other carcinogens[17,18]. For the liquid beverages, water is an additional source of contamination. Moreover, a variety of common drugs such as oxytetracyclines and aminopyrine react very rapidly in the stomach with nitrous acid to form nitrosodimethylamine[19]. The high value of nitrite in orange juice, inspite of the fact that ascorbic acid destroys nitrite[20], indicates the strong role of high levels in the groundwater.

TABLE 2. NITRATE CONTENT IN NIGERIAN NON-ALCOHOLIC BEVERAGES

Soft Drink samples	No_2 content (ppm) Range	Mean
Cola	2.07–2.40	2.19
Soda	2.20–2.40	2.30
Lemon	1.09–2.07	1.58
Tonic water	2.20–2.40	2.30
Orange drink	1.32–1.74	1.53
Malt drink	0.43–3.05	1.74
Cocoa drink	0.76–3.05	1.91
Coffee	3.20–3.48	3.34
Tea	0.33–0.43	0.38
Dairy product (dry milk)	0.76–3.48	2.12
Orange juice	3.05–3.48	3.17

2 brands of each products were analysed
except for 4 brands each of malt drinks and dairy products.

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Development and Evaluation of Concentrated Soymilk Beverage

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A concentrated soymilk beverage of 32% total solids content was developed using soybean extract, palm kernel oil, sucrose, *trona* extract (a local emulsifier and tenderizer) and water. Sensory evaluation of the beverage in a preference test showed consumer acceptance of the beverage in contrast to the preference for the evaporated milk varieties. Male panelists scored significantly ($\alpha = .05$) higher overall mean acceptance scores for the milk products and soy beverage than females. Development of a low cost soy-based evaporated cow milk analogue thus may be feasible.

Adoption of soymilk as cow milk substitute has been advocated[1], and is receiving widespread attention in the sub-Saharan Africa[2], Home preparation of soymilk is becoming common and most popular. Milk consumption in Nigeria has taken the form of addition of small amounts of concentrated milk products such as evaporated milk or milk powder to breakfast cereals, porridge, cocoa beverages, tea and coffee. Soymilk is consumed directly like a beverage and its addition to cereals or beverage is not common. Indications are that home prepared soymilk is watery and addition of large quantities of it to produce a milky taste or whitening of beverage are needed[1,3]. This note summarizes the development and evaluation of concentrated soymilk beverage (CSB).

The 'TGx 536 02D' variety of soybean was procured from the International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. Method was standardized to produce CSB with about 32% total solids content following the steps recommended by International Soybean Program (INTSOY)[4] but with reduced amount of water. Five hundred g clean whole soybean were washed in tapwater, blanched in 0.25% sodium bicarbonate solution for 30 min and strained with gauze metal. The soybeans were rinsed in tap water, hand dehulled, and hulls removed by floatation. Dehulled soybeans were ground to a slurry with boiling water in a variable speed kitchen blender (Sunbean Corp, USA). Approximately 3 l slurry was produced, which was first filtered through wire mesh and then through double layered calico cloth. The filtrate was simmered for 20 min in a sauce pan with lid partly open and intermittent stirring. The resulting soymilk (800 ml) was left in the sauce pan and kept hot at very low heat.

Five g of *trona*, a local emulsifier and tenderizer, which is a complex salt consisting primarily of sodium sesquicarbonate ($Na_2Co_3.NaHCO_3.2H_2O$), traces of sodium chloride, sodium sulphate, ferrous sulphate and insoluble components including clay (Dr. Emma Iwuoha, private communication) were dispersed in 100 ml hot water by blending in the Osterizer. The suspension was allowed to settle for about 20 min and the soluble fraction was decanted. The clear trona decantate was put in the Osterizer along with 40 g refined table sugar and blended until the sugar dissolved. Sixty g refined, bleached and deodourized palm kernel oil was added to the dispersion and the mixture was blended at high speed to form an emulsion. The hot freshly simmered soymilk concentrate was then added to the emulsion, after which hot water also was added to make upto 1 l. The resulting dispersion was finally blended at high speed for 3 min to yield CBS.

Total solids in CSB samples were determined by pipetting 2 ml samples on a triple layer dry filter papers placed in a clean, dry porcelein dish. The samples were then dried to constant weight in an oven at 80°C and cooled in a desiccator. The difference in weight was used to calculate per cent moisture. Total solid concentration was deduced by substracting per cent moisture from 100. The pH of CSB was determined at room temperature (30°C) with a calibrated pH meter.

An acceptance/preference test of CBS as compared with low cost soy-based evaporated cow milk (ECM) and a new locally manufactured brand of filled evaporated milk (FEM) with 24% total solids, was conducted by a panel of at least 50 judges each time consisting of both sexes drawn randomly from Imo State University community. Evaluation was on a 9-point Hedonic scale[5] and the sensory characteristics evaluated were taste, odour, mouthfeel and colour. All statistical analyses were carried out as per the method of Neter and Wasserman[6].

The CSB contained 32% total solids, a value similar to that of ECM (31%). The pH was 8.0, which was partly influenced by sodium bicarbonate and *trona* used in processing. A

desirable pH after manufacture would be near neutrality. The results of consumer acceptance tests (Table 1) showed that overall acceptance of the three milk products was in the order ECM≥FEM>CSB, with corresponding scores of 7.2, 6.3 and 5.7 respectively, which were significantly different from each other at $\alpha = 0.01$. A total of 209 judges (137 males and 72 females) participated in the evaluation studies, and insignificant differences were observed between panels of judges for all the sensory characteristics evaluated. The sensory characteristics of ECM are known to several Nigerians, but those of FEM are relatively unknown because the product is new in the country. Though it is possible to produce CSB similar in total solids content to ECM, the present investigation has shown that it is necessary to improve the sensory characteristics of CSB. Further, in the present study, the milk products evaluated were not reconstituted. An appropriate sensory study may compare scores when breakfast cereals, tea or coffee are prepared with CSB simulating the exact present local usage of ECM.

The two factor (sex × milk product) analysis of variance (Table 2) showed that overall mean scores by sex (M=6.5, F=6.2) for the milk products were significantly different at $\alpha = 0.05$, but insignificant interaction existed between sex and milk products. Effects of other factors like income group and age of panelists were not evaluated because real ages are not readily disclosed publicly in this part of the world; also students constituted a large percentage of the panelists and they generally do not earn.

TABLE 1. MEAN NINE-POINT HEDONIC SENSORY EVALUATION SCORES FOR CONCENTRATED MILKS

Milk product	Taste	Odour	Mouthfeel	Colour	Overall acceptance
Conc. soymilk beverage	5.6[a]	5.9[a]	5.5[a]	5.9[a]	5.7[a]
Evaporated cow milk	7.3[c]	7.3[c]	7.1[c]	7.3[c]	7.2[c]
Filled evap. milk	6.1[b]	6.4[b]	6.0[b]	6.8[a]	6.3[b]

Means with different superscipts in the same column are significantly different from each other at $\alpha = 0.01$ in Tukey's multiple comparison; 209 judges scored each milk product.

TABLE 2. TWO-FACTOR ANALYSIS OF VARIANCE OF SENSORY EVALUATION SCORES FOR CONCENTRATED MILK PRODUCTS

Sources of variation	SS	DF	MS	F[1]
A (sex)	0.5	1	0.5	6.6*
B (milk product)	8.8	2	4.4	62.9**
A×B	0.2	2	0.1	1.1
Error	1.2	18		

[1]The ratio was significant at: $\alpha^* = 0.05$, $\alpha^{**} = 0.01$

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Effect of Minerals on Lipid Production By *Rhizopus nigricans* and *Penicillium nigricans* on Tamarind Kernel Powder

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The role of various metal ions at different concentrations on lipid production by *Rhizopus nigricans* and *Penicillium nigricans* in tamarind kernel medium indicated positive role of magnesium, potassium, ferric and zinc ions, in contrast to negative effect of calcium ion. Copper and manganese affected lipid production by *R. nigricans* and *P. nigricans*, respectively.

The concentration of mineral nutrients is highly specific for lipid production by different moulds[1]. This fact was further supported by the findings on the effect of varying concentration of mineral salts on the biosynthesis of fat by different oleaginous moulds[2]. Tamarind kernel powder (TKP) has very low ash level and therefore, its use as raw material for microbial fat production may require enrichment with various metal ions. The present investigation was, therefore, undertaken to elucidate the role of various metal ions and to determine their optimum concentration for maximizing the lipid production by *Rhizopus nigricans* and *Penicillium nigricans*.

Basal TKP medium for *R. nigricans* contained (g/l) acid treated TKP (TKP in 1% HCl autoclaved at 10 lb pressure for 15 min) 50, ammonium nitrate 0.3737, disodium hydrogen phosphate 9.3, magnesium sulphate 1, potassium sulphate 0.44 ferric chloride 0.02, zinc sulphate 0.002, copper sulphate 0.0004, calcium chloride 0.05, manganese sulphate 0.002, pH 4.5. Basal TKP medium for *P. nigricans* was similar except for the use of 30 g acid treated TKP and the pH of 5.5.

The sterilized medium in conical flasks was inoculated separately with *R. nigricans* and *P. nigricans* and incubated for 7 and 9 days, respectively at 30°C. After incubation period, the growth was arrested by keeping the flasks in refrigerator. The mycelial mat was separated to obtain biomass which was dried in a vaccum oven at 70°C for 24 h to constant weight. Lipids were extracted from dry mycelia by solvent extraction method of Bligh and Dyer[3] and were determined gravimetrically. Total sugars in the fermented broth were analysed by anthrone method[4]. Values presented are the averages of four replicates and showed close agreement with each other.

The results of experiments on biomass and lipid production by *R. nigricans* and *P. nigricans* grown on TKP medium using different minerals are given in Table 1. Highest lipid and biomass production by *R. nigricans* were observed with 2000 mg/l of magnesium sulphate. However, the highest lipid production and biomass of *P. nigricans* were obtained with 500 mg/l magnesium sulphate. Different workers have suggested a positive role of magnesium ion on lipid production by moulds[5,6]. The maximum lipid production by *R. nigricans* and *P. nigricans* was obtained with 880 mg/l of potassium sulphate in the medium. Similar results were earlier observed in case of different oleaginous moulds in glucose salt medium and molasses[7,8]. Maximum lipid production by *R. nigricans* was obtained when 10 mg/l of ferric chloride was supplied in the medium, though the effect of added ferric ions was not significant in case of *P. nigricans*. Higher fat production by *Rhodotorula gracilis* in absence of ferric chloride than its presence has also been reported[9]. For maximum lipid production by *R. nigricans* and *P. nigricans*, 2 and 4 mg/l of zinc sulphate respectively was required to be added in the medium. Our results are in contrast to the findings of Chand Ratan and Srinivasan[10] and Cioffi and Varetto[11]. Maximum total lipids was produced in the absence of added calcium ion in the TKP medium for both the organisms. Similar inhibitory effect of calcium was reported earlier in case of *Fusarium* sp[10]. The positive effect of calcium ion on lipid production was also described using glucose salt medium and waste liquor from sulphite mills[11,12]. In case of *R. nigricans*, lipid production was inhibited in presence of added copper ions in the TKP medium, though a minimum amount of copper sulphate (0.2 mg/l) was needed to produce maximum total lipids by *P. nigricans*. Inhibition of lipid production by *Penicillium javanicum* in presence of copper ions was reported earlier[11]. A minimum of 1 mg/l of manganese sulphate was required for maximum biomass and lipid production by *R. nigricans*, though it lowered the lipid production by *P. nigricans*. Similar results were earlier observed in case of *P. javanicum*[11].

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TABLE 1. EFFECT OF MINERAL NUTRIENT CONCENTRATION ON LIPID PRODUCTION BY *RHIZOPUS NIGRICANS* AND *PENICILLIUM NIGRICANS*

Mineral salt concn (g/l)	*Rhizopus nigricans*			*Penicillium nigricans*		
	Biomass (g%)	Lipid content of biomass (mg%)	Sugars utilized (%)	Biomass (g%)	Lipid content of biomass (mg%)	Sugars utilized (%)
			Magnesium sulphate			
0	1.0	39.2	58.6	0.8	29.7	52.0
0.5	1.3	39.4	66.7	1.0	34.2	58.5
1.0	1.4	39.5	64.6	1.0	30.1	59.2
2.0	1.7	42.2	62.6	0.9	29.9	60.5
4.0	1.3	39.5	59.3	0.8	29.7	73.8
			Potassium sulphate			
0	1.1	39.4	51.6	0.7	29.5	46.2
0.22	1.1	39.3	51.8	0.8	29.7	61.1
0.44	1.4	39.5	64.6	1.0	30.1	60.5
0.88	1.5	42.3	68.0	1.0	40.2	46.0
1.76	1.4	39.4	70.7	0.9	30.0	44.0
			Ferric chloride			
0	1.1	39.4	63.2	1.0	30.0	39.0
0.01	1.3	42.3	57.2	1.0	30.0	46.9
0.02	1.4	39.5	64.6	1.0	30.1	60.5
0.04	1.3	39.4	65.3	0.8	29.8	49.7
0.08	0.9	39.2	68.0	0.8	29.7	46.3
			Zinc sulphate			
0	1.4	36.7	68.6	0.9	30.0	31.2
0.001	1.4	36.7	60.6	0.9	30.0	40.4
0.002	1.4	39.5	64.6	1.0	30.1	60.5
0.004	1.2	36.5	72.9	1.0	34.3	61.2
0.008	1.0	36.1	64.6	1.0	30.0	62.1
			Calcium chloride			
0	1.4	42.3	56.5	1.0	34.3	42.3
0.025	1.4	39.4	51.8	1.1	30.2	60.5
0.050	1.4	39.5	64.6	1.0	30.1	60.5
0.100	1.1	39.3	66.2	0.8	29.8	52.4
0.200	0.9	39.2	66.7	0.7	29.6	43.4
			Copper sulphate			
0	1.4	42.2	61.3	1.0	30.1	42.7
0.0002	1.4	39.4	71.3	1.0	34.2	61.8
0.0004	1.4	39.5	64.6	1.0	30.1	60.5
0.0006	1.1	39.3	62.4	0.9	29.9	46.0
0.0008	0.9	39.2	59.3	0.8	29.7	44.4
			Manganese sulphate			
0	1.1	39.3	64.8	0.9	34.3	65.2
0.001	1.4	42.3	59.3	1.0	30.2	64.7
0.002	1.4	39.5	64.6	1.0	30.1	60.5
0.004	1.1	39.4	72.2	0.9	30.0	49.4
0.008	0.9	39.2	72.8	0.8	29.7	46.2

Initial sugar concentration was 4.348 and 2.608 g% for *R. nigricans* and *P. nigricans*, respectively.

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Organochlorine Insecticide Residues in Vegetables of Lucknow Market in India

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Vegetables collected from Lucknow were found contaminated with organochlorine insecticides such as HCH, DDT, aldrin and endosulfan. Among these, the concentration of HCH was highest (0.0638-0.4908 ppm) followed by DDT (0.0012-0.1068 ppm) and aldrin (0.0012-0.0486 ppm). Trace amounts of endosulfan ranging from 0.00005-0.0009 ppm were present in all the vegetables. The residue levels of organochlorine insecticides in different vegetables analysed were below the maximum permitted residue limits.

Large scale use of organochlorine insecticide (OCI) in developing countries and their long persistence in the environment is of serious concern from the view points of public health and environmental pollution. Indiscriminate use of pesticides on vegetable crops, their mishandling and negligence to follow proper waiting period make marketed vegetables very often contaminated with pesticides[1-3]. Thus contamination of the vegetable crops, sometimes may reach more than the prescribed tolerance limit. The present monitoring study was undertaken to identify the presence of OCI residues in commercial vegetables marketed in and around Lucknow, India.

Five hundred g of each vegetable was collected from different markets in and around Lucknow. The vegetables selected for analysis were radish *(Raphanus sativus)*, *tinda (Citrullus vulgaris)*, cauliflower *(Brassica oleracea)*, brinjal *(Solanum melongena)*, potato *(Solanum tuberosum)*, *arabi (Colocasia esculenta)*, green beans *(Phaseolus lunatus)*, onion *(Allium cepa)*, and tomato *(Lycopersicon esculentum)*. Each vegetable was cut into small pieces and mixed thoroughly. Vegetable samples were taken in replicates of ten, extracted and cleaned according to the method of AOAC[4]. Analyses were carried out by using a Varian Aerograph series 2400 equipped with ^{3}H-electron capture detector. A glass column (1.5×2mm id) packed with 1.5% OV−17+1.95% QF-1 on 100-120 mesh chromosorb WHP was used. Operation temperatures were 195, 200 and 220°C for column, injector and detector, respectively. Purified N_2 gas passing through column and molecular sieves was used as carrier gas at the flow rate of 60 ml/min.

Recovery values of individual pesticides from different fortified vegetables are shown in Table 1. In all cases, the percentage recoveries were above 80%, therefore, the recovery correction factor was not applied.

Residue levels of different OCI in various vegetables are shown in Tables 2 and 3. Alpha,-beta-and gamma-isomers of HCH, aldrin and endosulfan were found in all the vegetables. Among the vegetables, the concentration of total

TABLE 1. PERCENTAGE RECOVERY OF ORGANOCHLORINE INSECTICIDES° IN VEGETABLES*

Vegetables	α−HCH	β−HCH	γ−HCH	pp'−DDE	op'−DDT	pp'DDD	Aldrin	Endosulfan
Radish	90.8	90.8	89.8	90.8	88.5	91.5	91.8	91.5
Tinda	87.8	85.5	81.5	87.0	82.5	89.0	95.0	90.5
Cauliflower	90.5	90.0	91.0	90.5	82.8	89.0	90.1	88.5
Brinjal	81.0	80.1	80.0	82.5	80.2	80.5	87.0	87.5
Potato	85.4	85.5	85.5	90.4	90.5	89.8	89.0	89.1
Arabi	82.9	80.9	81.9	85.3	84.5	82.5	89.0	82.5
Green beans	91.5	90.3	90.5	92.5	95.5	80.5	82.5	89.0
Onion	92.6	91.0	92.0	91.0	89.5	82.8	88.0	88.9
Tomato	85.8	84.8	84.5	90.0	88.5	84.9	88.0	85.4

*Mean of three replicates each.
°Fortification levels of all isomers of HCH, DDT were 10 ppm and aldrin, endosulfan were 25 ppm.

TABLE 2. RESIDUE LEVELS OF ORGANOCHLORINE INSECTICIDE IN VEGETABLES OF LUCKNOW MARKET

Vegetables	alpha−HCH (ppm)	Gamma−HCH (ppm)	beta−HCh (ppm)	Total HCH (ppm)
Radish	0.3044 (0.128−0.625)	0.0432 (0.071−0.094)	0.1432 (0.035−0.294)	0.4908 (0.102−0.801)
Tinda	0.1056 (0.035−0.160)	0.0218 (0.007−0.034)	0.0238 (0.010−0.055&	0.1602 (0.052−0.0231)
Cauliflower	0.0926 (0.015−0.169)	0.0228 (0.021−0.032)	0.0240 (0.004−0.032)	0.1394 (0.001−0.017)
Brinjal	0.0260 (0.009−0.037)	0.0094 (0.001−0.015)	0.0284 (0.004−0.112)	0.0638 (0.011−0.133)
Potato	0.0596 (0.016−0.160)	0.0328 (0.004−0.093)	0.0406 (0.004−0.093)	0.1330 (0.013−0.0282)
Arabi	0.0844 (0.021−0.573)	0.0222 (0.004−0.045)	0.0210 0.010−0.048)	0.1276 (0.034−0.0289)
Green beans	0.1216 (0.006−0.573)	0.0027 0.001−0.108)	0.0045 (0.0009−0.016)	0.1288 0.008−0.598)
Onion	0.0642 (0.004−0.148)	0.0048 (0.002−0.021)	0.0310 (0.002−0.017)	0.1000 (0.032−0.206)
Tomato	0.0504 (0.017−0.122)	0.0098 (0.001−0.018)	0.0152 (0.005−0.033)	0.0754 (0.018−0.140)

Values are mean of ten samples.
Figures in parenthesis indicate range.

HCH residue was maximum in radish and minimum in brinjal. Endosulfan was present only in traces. It is interesting to know that pp'DDE was noticed in all the vegetables, op'DDT in radish, *tinda*, cauliflower and brinjal. However, pp'-DDD was present only in *tinda*, cauliflower, and brinjal. Concentration of DDT (total) residues ranged from 0.0008-0.440 ppm. which suggested its continued presence in food chain.

The lower levels of OCI in different vegetables are in conformity with the reports of other workers[5-8] and are below the maximum residue limits prescribed by FAO/WHO and PFA[9,10]. Application of DDT and aldrin is restricted only to public health and termite control. However, the presence of these two insecticides in vegetables seems to be due to previously used insecticide contamination. The use of HCH in the country is increasing while that of DDT is declining during the last few years[11]. This could be one of the reasons of low level of DDT (0.0012-0.1068 ppm) and comparatively higher level of HCH (0.0638-0.4908 ppm) in vegetable samples.

Further, the half life period of many OCI was found to be less in tropical countries[8]. This could be another reason for the presence of low level of insecticide in the vegetables. OCI enters and accumulates into the human body through consumption of contaminated food ietms such as meat, fish oils, milk and milk products[12]. Vegetables form an important food item and proper care should be taken to use very safe insecticide for avoiding potential risk to humans. It has been advocated that minimum safety periods prescribed for various insecticides should be observed and the vegetables should not be sold in the market before the expiry of waiting periods.

TABLE 3. RESIDUE LEVELS OF ORGANOCHLORINE INSECTICIDES IN VEGETABLES OF LUCKNOW MARKET

Vegetables	pp'–DDE (ppm)	op'–DDT (ppm)	pp'–DDD (ppm)	Total DDT (ppm)	Aldrin (ppm)	Endosulfan (ppm)
Radish	0.0184 (0.001–0.054)	0.0072 (0.016–0.036)	ND	0.0256 (0.001–0.054)	0.0486 (0.019–0.103)	0.009 (0.005–0.002)
Tinda	0.005 (0.010–0.015)	0.0540 (0.036–0.124)	0.0478 (0.012–0.127)	0.1068 (0.058–0.267)	0.0176 (0.006–0.03)	0.006 (0.002–0.009)
Cauliflower	0.0034 (0.009–0.029)	0.0058 (0.015–0.059)	0.0118 (0.015–0.059)	0.0210 (0.021–0.105)	0.0120 (0.003–0.012)	0.002 (0.0005–0.001)
Brinjal	0.008 (0.001–0.004)	0.0392 (0.020–0.196)	0.0482 (0.050–0.241)	0.0882 (0.220–0.440)	0.014 (0.009–0.03)	0.004 (0.0005–0.001)
Potato	0.0038 (0.007–0.012)	ND	ND	0.0038 (0.007–0.012)	0.0248 (0.012–0.037)	0.005 (0.0009–0.0003)
Arabi	0.0028 (0.006–0.006)	ND	ND	0.0023 (0.004–0.006)	0.0160 (0.009–0.044)	0.00005 (0.00007–0.0002)
Green beans	0.0026 (0.003–0.013)	ND	ND	0.0026 (0.003–0.013)	0.0012 (0.001–0.006)	0.007 (0.005–0.002)
Onion	0.0025 (0.008–0.012)	ND	ND	0.0025 (0.008–0.012)	0.0157 (0.008–0.045)	0.002 (0.00007–0.0008)
Tomato	0.0012 (0.001–0.006)	ND	ND	0.0012 (0.001–0.006)	0.0049 (0.009–0.012)	0.00009 (0.00009–0.0003)

Values are mean of ten samples.
Figures in parenthesis indicate range.
ND – Not Detectable.

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ERRATUM

Ref: Research Note entitled "Influence of Water Activity on Autoxidation of Methyl Linoleate During Storage" by A.G. Gopala Krishna, Published in the Journal of Food Science and Technology, Vol. 29, No. 5, Sept/Oct. 1992, pp. 252.253.

Printed on p. 253, 2nd para, 2nd line as 357 M/M and 344 M/M, 4th line 185 M/M.

Should be read as 357μ M/M and 344 μ M/M, 4th line 185 μ M/M.

J. Fd. Sci. Technol, 1992, Vol 29, No. 5, 338—339

Lindane: Environmental Health Criteria-124, Published under the joint sponsorship of the UNEP, ILO and WHO. Drafted by Dr. M Herbst, France and Dr. G. J. Van Esch, The Netherlands under the International Programme on Chemical Safety (IPCS) 1991, pp: 208.

This document is an outcome of the meeting of the WHO Task Group on Environmental Health Criteria for Lindane, held in Moscow, USSR, during 20-24th Nov. 1989. This document comprises of the following 10 Sections; 1 Summary and evaluation; conclusions; recommendations, 2 Identity; Physical and Chemical properties, Analytical methods. 3 Sources of human and environmental exposure, 4 Environmental transport, distribution and transportation, 5 Environmental levels and human exposure, 6 Kinetics and metabolism, 7 Effects on laboratory mammals and *in vitro* systems, 8 Effects on humans, 9 Effects on other organisms in the laboratory and field, 10 Previous evaluations by international organisations followed by Appendix-I containing chemical structure; 612 references and Resume given in two European languages.

Section 1 contains the general properties of lindane, its transport, distribution and transformation in the environment; kinetics and metabolism effects on microorganisms, aquatic and terrestrial bioform and humans. Section 2 covers in detail the properties of technical product; several analytical methods and advance techniques developed till 1987. Description about the manufacture of lindane, the extent of its use and the types of formulations and their application for insect control are covered in Section 3. A critical review has been made regarding the volatilization, precipitization and migration in soil; uptake in translocation in plants besides biotransformation and biodegradation in field conditions and in water. A comprehensive data are presented in Table 3 including bioconcentration factors of lindane in organisms exposed to contaminated water. Detailed information on accumulation and biomagnification in environment in humans and fields forms Section 4. In Section 5, the levels of lindane in air, water, soil, drinking water, food and feed and in terrestrial and aquatic organisms; exposure-effects on the general population, concentration in human samples are reviewed comprehensively. Section 6, enormously covers the absorption profile of lindane as a result of oral, dermal and other routes in experimental animals, the pattern of distribution; enzymic involvement in its metabolic transformation; tracking of metabolites in various tissues of animals and human beings; elimination and excretion in air, faeces and urine of experimental animals, retention, turnover and isomerisation. The metabolic pathway of lindane in animal system is very well represented in Fig 2, in lettuce and endive in Fig 3, and micro-organisms in Fig 4.

The results of the acute, short and long term toxicity in several animals orally, intraperitonially and intramuscularly are described in detail. The effects of lindane on reproduction, embryo toxicity and teratogenicity and on chromosomes are very well presented. Results of mutagenicity tests in various systems (Table 9), other genetic effects (Table 10) and DNA damage (Table 11) summarise the in-depth studies. Tests on carcinogenicity, mode of action, immuno-suppression, neurotoxicity are covered. Acute toxicity, poisoning incidence in humans, long and short term exposure controlled human studies, epidemiological studies, effects resulting in occupational exposure are well presented in Sections 7 and 8. The acute toxicity of *gamma*-HCH to fishes is summarised in Table 17. A summary of the previous evaluation conducted by International Organization supplemented with Table 21 representing the maximum residue limit for HCH of the Codex Alimentaries Commission forms Section 10.

The painstaking work of the Committee in bringing out this volume is highly commendable. This document will be very useful for researchers, students, policy makers, industrialists, manufacturers, Ministries of Plant Protection, Food and Agriculture. Because of the residual nature, many organochlorine pesticides are being reviewed. This document will certainly help pragmatically in assessing the relative safety/toxicity of lindane for its further usage or otherwise. A critical analysis of the references cited in this document indicates that information published in Proceedings of the Symposium on 'Lindane', Lyon-Chazay-1976 in Lindane Cial- has not been adequately covered. However, it was a privilege to go through the realm of lindane which was once a boon for controlling insects.

DR (MRS) M.K. KRISHNAKUMARI
and M. JAYARAM,
CFTRI, MYSORE.

Basic Bioreactor Design: by Klaas Van't Riet and Johannes Tramper, Marcel Dekker Inc. New York 1991; pp:V + 465; Price: US $ 155.25.

The book is written to provide basic principles of reactor design; in addition, it also outlines the relevant principles and data for practical process engineering. The book is divided into 4 parts. Part 1 defines the subject and describes, in general, about various types of bioreactors and the concepts used therein giving several examples. Part 2 gives the basic principles of reactor design and parts 3 and 4 deal with the engineering aspects and process of bioreactors. Since the book has been based on the course material of the graduate course in biochemical engineering, it would be an invaluable

companion to the students in particular and the practitioners in the industry in general.

Very lucid descriptions of the fundamental principles leading to the detailed design of the reactors that could be put to practice are often accompanied by worked out examples. This has been the most outstanding feature of this book. However, it is imperative that the reader possesses a good background in general and applied mathematics for understanding the treatment and effective utilization of various themes presented in the chapters.

The usefulness of the book is enhanced by the inclusion of pertinent references which have been cited after each chapter. Considering the tremendous improvements in the Bioreactor technology, it is expected that this book may have to be revised in future and hence we would like to suggest two important inclusions in the future editions of this book. Firstly, the illustrations and/or photographs of productive large size bioreactor systems may be included. Secondly, a mention of relevant national/international standards pertinent to such process equipment. data on material of construction, fabrication process and different codes may also be beneficial in the fabrication process.

A. S. BHAGWAT AND D. CHATTOPADHYA
BARC, BOMBAY.

Food Processing Operations and Scale-up: Edited by Kenneth J. Valentas Leon Levine, and J. Peter Clark, Published by Marcel Dekker Inc. New York. Hongkong, Basel 1991, pp:408; Price:US $ 99.75. (US and Canada) and US $ 119.50 in all other countries.

The book primarily provides an engineering orientation to the food industries. Authors' extensive experience in both industrial and academic settings have been highly useful in writing this text. The text runs into 11 chapters. The first chapter deals with the basic concepts of process engineering and its application in developing various processes and food product designs. The illustrations on processing in poultry and meat products, beer and low-caloric beers are helpful to the students in understanding the application of basic principles of food science and engineering. Chapter 2 describes the dynamics of food industry, and underlines the concepts of computer-integrated-manufacturing, flexible manufacturing systems, productivity improvement, and quality controls in food industry. Chapter 3 discusses the investments and financial analysis of the capital expenditure in plants made on the basis of relative merit of proposals to sustain returns and ensure profits. The authors reveal that the projects that are controlled by compliance with laws and regulations follow good manufacturing practice and product safety and the like are not evaluated on the basis of a financial returns. However, projects intended to add profitability must be measured in an objective manner. Chapter 4 deals with the basic concepts of Chemistry and Physics of food material. Normally, a process engineer engaged in the food industry has enough knowledge to design the equipments so as to control heat and mass transfer rates during the operation, but he may be not fully conversant with the effects of heat transfer through the food material for maintaining its food value and preserving the aromatic properties. The flow sheet of digestive system illustrates that how the food is digested. The attention of food engineers towards the concept of solubility and denaturation of proteins, sugars, sweeteners, viscosity effects; hygroscopicity, browning reaction, gelatinization temperatures, etc. have been drawn to design effective food products and process development. Chapter 5 discusses the application of engineering principles in manufacturing of various soy-food products such as soy-protein isolates and concentrates, margarine, cooking oil and fats, salad oil, salad dressings, Tofu, texturised meat and animal feeds. The authors have strengthened the text by giving real-life problems. Chapter 6 deals with the processing of Ready-to-eat (RTE) foods from solids and semi-solid materials. The authors have grouped the RTE foods into five generic type of categories. The application of physics and mathematics in explaining the machanics of puffing, cooking and flaking, etc. have been illustrated with the help of Charts, Figures and Tables. Chapter 7 discusses various dairy operations and processes such as homogenization, pasteurization, deodorization, packaging and safe storage of dairy products. The formulations and preparations of various milk products such as ice-cream, cheese and their by-products for large scale manufacturing have been described. The concept of using membrane processing for concentrating whey, and the application of reaction kinetics for optimizing the design parameters of various processes have been presented. The case study of orange juice discussed in Chapter 8 on processing and production technology of orange juice, peel and pulp, and freezing and filtration of juice imbibes an in-depth knowledge to the readers. Chapter 9 discusses the hand to hand role of process engineers and food scientists in developing new food products. Chapters 10 and 11 offer a comprehensive treatment of scale-up the food process operations. The authors have critically emphasized the role of primary and secondary scale-up criteria in food industries through real life problems specially on extrusion, and two-phase (gas-liquid) mixing. The authors have provided the useful rules of thumb about the scale-up experiments and applied dimensional analysis techniques for solving the problems involving the primary and secondary criteria associated with scale-up of food processes and food product designs.

R. P. SAXENA
G. B. PANT UNIVERSITY, PANTNAGAR.

AFST (I) News

Bombay Chapter

The Annual General Body Meeting of the above Chapter was held on 4th July 1992, at the old Auditorium, UDCT, Matunga, Bombay. Dr. C. L. Nagarsekhar, President, Bombay Chapter, welcomed the members. Dr. S. R. Padwal Desai, read the minutes of the last AGBM. The reports of the Secretary and the Treasurer were passed unanimously.

The Local Executive Committee met on 13 occasions during the year 1991. The Chapter in colaboration with Konkan Krishi Vidhyapeeth, Dapodi had organised a two-day seminar on "Food Industries in Rural Development" on 19-20, April, 1991.

The following 3 lectures were arranged during the year. i) Marketing of Food Products", by Sri J. K. Sanzgiri, Parle (Export) Ltd. ii) "Recent Developments in Genetic Engineering" by Dr. P. R. Mahadevan, Director, Foundation of Medical Research, and iii) "Human Resources Development for Technology in the Third World" by Dr. H. A. B. Parpia, Ex-Director, CFTRI, Mysore.

A two day National Seminar on "Challenges to the Indian Food Industries-Widening of Export and Domestic Market was also organised. Dr. S. R. Bhowmik, Director, CFTRI, Mysore inagurated the seminar. Eminent food scientists gave talks on different issues concerning food scientists. Over 200 delegates participated in the deliberations.

The following office bearers were elected for the year 1992:

President	:	Dr. C. L. Nagarsekhar
Vice Presidents	:	Dr. J. S. Pai
		Dr. A S. Golap
Hon. Secretary	:	Dr. D. R. Bongirwar
Committee Members	:	Dr. S. R. Aggarwal
		Dr. G. D. Joshi
		Dr. M. Y. Kamat
		Dr. S. V. Padgaonkar
		Dr. J. V. Parekh
		Dr. (Ms) G. Subbalakshmi
		Dr. S. B. K. Warrier

The posts of Hon. Jt. Secretary, Hon. Treasurer and a Committee Member will be filled up in due course.

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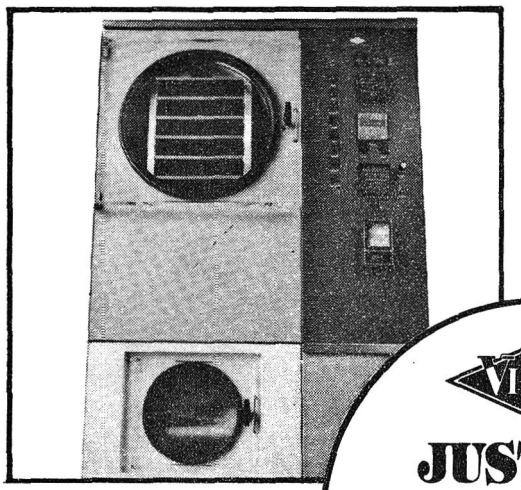

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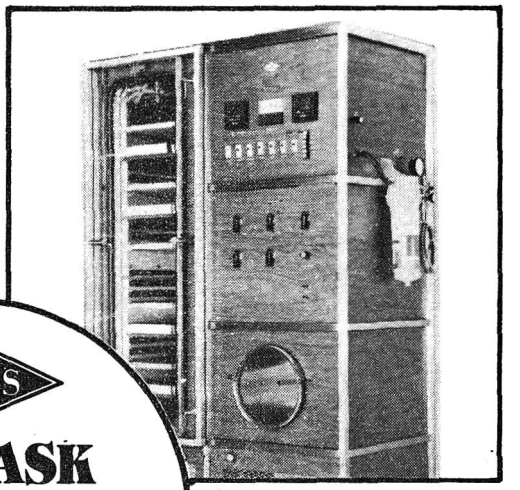
Offering dramatically increased shelf area and shelf clearance, the Supra Chamber 24 incorporates a space-saving rectangular vacuum chamber design. This versatile bulk/stoppering unit combines a wide variety of shelf area and shelf clearance options.



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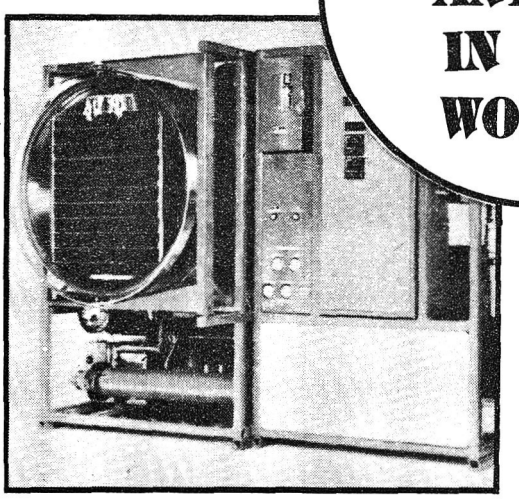

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BANGALORE-BOMBAY-CALCUTTA-HYDERABAD-LUCKNOW-NEW DELHI

ASSOCIATION OF FOOD SCIENTISTS AND TECHNOLOGISTS (INDIA)

Central Food Technological Research Institute Campus, Mysore - 570 013, India.

Invites Nominations for Fellows of AFST (I) for the year 1992.

The Association has pleasure in inviting nominations from persons to be conferred as Fellows of ASFT(I) entitled "Fellow of Association of Food Scientists and Technologists (India)". (FAFST) to honour those who have contributed significantly to the progress of Food Sciences and Technology.

General

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

The title of Fellows has so far been awarded to 27 AFST(I) members and 5 non-members who have contributed to the progress of Food Science and Technology.

Eligibility

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

Nominations

1. The nomination for Fellow should be proposed by five AFST(I) members of good standing for a minimum of 5 years or by 2 Fellows of the Association. This is applicable to AFST(I).members as well as non-members.
2. Any regular or life member of AFST(I), who has been continuously a member of the Association can sponsor the nomination for only one Fellow in a particular year.
3. The nomination shall be accompanied by acceptance of the person proposed.
4. The nomination shall be in the format given. A brief bio-data of the nominee highlighting the Scientific or Technological achievements in the area of Food Science and Technology, supported by a list of publications not exceeding 10 important research papers or other supporting documents not exceeding 20 pages must accompany the nominations.
5. Central Executive Committee Members of AFST(I) are not eligible to the nominated as Fellows.
6. The nomination duly proposed and accepted by the nominee's consent shall be sent to the Hony. Executive Secretary, AFST(I) by 1st February 1993.

Selection of Fellows

The nominations received will be placed before an Expert Committee appointed by the CEC for suitable recommendations to CEC each year. CEC by majority decision will finalise the names of Fellows for each year. The decision of the CEC in this matter will be final.

Privileges of a Fellow

The Fellow shall be entitled to the following rights:

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

Cessation of Fellow

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

Conferring as Fellows

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

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

Please forward your nominations duly filled as per the format given and mail it by Registered post to the Hony. Executive Secretary, AFST(I), CFTRI Campus, Mysore-570 013 before *Ist February 1993.*

The envelope containing the nomination along with the bio-data and contributions (5 copies) should be superscribed 'Nomination for Fellow AFST(I)'.

DR. M. N. KRISHNAMURTHY
HONY. EXECUTIVE SECRETARY

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

Nomination Form For Fellows

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

Full name and academic distinction

FULL NAME
DATE OF BIRTH
AREAS OF SPECIALIZATION
ACADEMIC QUALIFICATIONS:

---

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

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

.....

Seconder's name & signature
Date:
Station:

Proposer's name & signature
Date:
Station:

(Signature of supporters from personal/general knowledge)

(1) (2) (3)

I agree for the above nomination

(Name & Signature)

.....

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

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

(3) Last date for receipt of nomination at the office is 1st February 1993.

ASSOCIATION OF FOOD SCIENTISTS & TECHNOLOGISTS (INDIA)

CFTRI Campus, Mysore–570 013, India

INVITES

NOMINATIONS FOR AFST (I) AWARDS FOR 1992

Nominations for the following awards of the AFST (I) for the year 1992 are invited. All nominations should be sent by Registered post, so as to reach Honorary Executive Secretary, Association of Food Scientists and Technologists (India), CFTRI Campus, Mysore–570 013, before Ist February 1993.

PROF. V. SUBRAHMANYAN INDUSTRIAL ACHIEVEMENT AWARD

The guidelines for the award are:

(i) Only Indian nationals with outstanding achievement in the field of Food Science and Technology will be considered for the award.

(ii) The nominee should have contributed significantly to the enrichment of Food Science and Technology, and the development of agro-based food and allied industries in India.

(iii) The nomination duly proposed by a member of the Association must be accompanied by the bio-data of the candidate highlighting the work done by him for which he is to be considered for the award.

(iv) The awardee will be selected by an expert panel constituted by the Central Executive Committee of the Association.

(v) Central Executive Committee Members of AFST (I) are not eligible to apply for the award during their tenure.

The envelope containing the nominations along with bio-data and contributions (five copies) should be superscribed "Nomination for Prof. V. Subrahmanyan Industrial Achievement Award – 1992.

LALJEE GODHOO SMARAK NIDHI AWARD

The guidelines for the award are:

(i) The R & D group/person eligible for the award should have contributed significantly in the area of Food Science and Technology in recent years with a good standing in his/her field of specification.

(ii) The nominee(s) should be duly sponsored by the Head of the respective Scientific Institution and the application for this award should highlight complete details of the contributions made by the candidates and their significance.

(iii) The nomination duly proposed by a member of the Association must be accompanied by the bio-data of the Asscciation.

(iv) Central Executive Committee Members of AFST(I) are not elibible to apply for the award during their tenure.

The envelope containing the nominations along with bio-data and contributions (five copies) should be superscribed Laljee Godhoo Smarak Nidhi Award 1992.

BEST STUDENT AWARD

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

The guidelines for the award are:

(i) The applicant must be an Indian national

(ii) He/She must be a student of one of the following courses:

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

(b) B. Tech., B.Sc. (Tech), B.Sc. (Chem. Tech) with Food Technology specialisation.

(iii) He/She should not have completed 25 years of age on 31st December 1992.

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

The envelope containing the nomination should be superscribed "Nomination for Best Student Award – 1992.

YOUNG SCIENTIST AWARD

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

The guidelines for the award are:

1 The candidate should be an Indian national below the age of 35 years on 31st December 1992 working in the area of Food Science and Technology.

(i) The candidate should furnish evidence of either:

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

OR

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

The application along with details of contributions of bio-data (five copies) may be sent by registered post with the envelope superscribed: "Nomination for Young Scientist Award 1992.

BEST PAPER AWARD

The award is to be given by the 'AFST(I) Educational and Publication Trust' to the author(s), who have contributed the best paper to the Journal of Food Science and Technology published in 1991. A panel of experts constituted by the Central Executive Committee will scrutinize the journals and select the best paper for the award.

INSTRUCTIONS TO AUTHORS

Manuscript, in triplicate should be typed/printed in double-space on one side of A_4 size/bond paper, leaving 2.5 cm margin on all four sides of the page. The data reported in the manuscript must be original with clear definition of objectives, materials used, methods employed and without repetition. It should not have been published or offered for publication elsewhere. The manuscript must be as per format of the journal and authors should consult a recent issue of the journal for style and layout. The manuscript will be returned to authors, if it departs in any way from the required format and style. Papers essentially of an advertising nature will not be accepted. Footnotes for text are to be avoided. All submissions will be reviewed by two referees and an appropriate editorial board member.

Four different types of papers are published:

1. Research Papers with a maximum length of 14 manuscript pages, including figures, tables and references.
2. Research Notes which are limited to a maximum length of 6 manuscript pages, all inclusive.
3. Rapid Communication of the size of the maximum length of 8 manuscript pages (all inclusive) will be published rapidly, out of order of submission. Such communications must be based on new results of impact making quality. The authors have to append a note, indicating novelty, implications of the results and urgency in publication. The editor reserves the right to decide, what constitutes a Rapid Communication.
4. Mini-Reviews on specific topics of higher utility and current trends (by invitation only)

Materials and Methods must give sufficient details for the work to be repeated. Methods of sampling, number of replications and relevant statistical analyses should be indicated. Any hazard must be mentioned and the relevant safety precautions described or reference made to safety procedures. The use of proprietary names should be avoided.

Each paper should be provided with an abstract of maximum ten line length in the manuscript, reporting concisely on the principal findings of the paper and in the form acceptable to abstracting agency.

The manuscript of the research paper should be divided into sections viz. Abstract, Introduction, Materials and Methods, Results and Discussion and References. The research notes will be without these sections, except for Abstract and References. The chemicals are to be referred by names and not by formula in the text.

The title of the paper is to be typed in capital and small letters for all types of papers. Authors' names should be in capitals and the affiliation in capital and small letters. This should be followed by Abstract and Introduction (without heading).

Tables, numbered consecutively with Arabic numerals are to be typed on separate sheet and placed after references section. No vertical lines be used and the table should not have more than nine columns. Nil results should be indicated by using zero, while absence of data by the sign '—'.

Graphs and line drawings must be in a style and standard of draughtsmanship. These should be drawn in Indian ink, with stencilled lettering, on tracing paper or white drawing paper or preferably art paper. The lettering should be twice the size of the printed letter. Photographs should be submitted as clear black-and-white prints on glossy paper and must have good contrast. High quality computer generated line diagrams or glossy prints are also acceptable. Legends for all the figures are to be typed on separate page with details of symbols. The graphs, line drawings and photographs must be protected adequately against damage and bending of the envelop during transit. The manuscript will be returned to authors, if these requirements are not satisfied.

References should be cited at the appropriate point in the text by a superscript numeral in the order of their citing in the text. A list of references, in numerical order, should appear at the end of Results and Discussion section, maintaining the same order of numbers. Abbreviations such as *et. al., ibid, idem* must be avoided. The titles of all scientific periodicals should be abbreviated in conformity with the World List of Scientific Periodicals, Butterworth Scientific Publications, London, 1962. Unpublished data or private communications should not appear in the list, but can be indicated in the text. The examples of layout of typical references are as below (please note the italic portions and bold figures):

a) Tairu A O, Omotosu M A, Oderinde R A and Bamiro F O, Studies on oxidative stability of crude and processed yellow nutsedge tuber and almond seed oil. *J Fd Sci Technol*, 1991, **28**, 8.

b) Hacking A J, *Economic Aspects of Biotechnology*, Cambridge University Press, Cambridge, 1986, 306.

c) Kurtzman C P, Phaff H J and Meyer S A, in *Yeast Genetics, Fundamental and Applied Aspects*, by Spencer J F T, Spencer D M and Smith A R W, Springer-Verlag, New York, 1983, 139.

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

e) Ramesh M V, Production of Heat Stable Bacterial Alpha-Amylase, *Ph.D. Thesis*, University of Mysore, Mysore, India, 1989.

f) Sreekantiah K R, Jaleel S A and Ramachandra Rao T N, *Indian Patent* No. 115537, 1968.

g) Srihari K A, Vijaya Rao D and Siddaiah C H, Microbiological quality of spice mixtures as evidence of safe manufacturing capabilities, Paper Presented at 32nd Annual Conference, Association of Microbiologists of India, Madurai, India, 10-12 January 1992.

There are no page charges. One off-print of the paper is provided free of charge to first author of each published paper. Additional off-prints can be ordered, on payment only, after receipt of the acceptance letter.

REG. NO. 24918/64

JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

Vol.29, No.6 **Contents of forthcoming issue** **Nov/Dec. 1992**

Research Papers

Research Notes

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