ISSN: 0022-1155

JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

ASSOCIATION OF FOOD SCIENTISTS & TECHNOLOGISTS, INDIA

VOL. 21. NO. 4. JULY / AUGUST 1984

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(INDIA)

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JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

Volume 21 Number 4 July/Aug. 1984

CONTENTS

Pigment Production by a Strain of *Aspergillus* Sp.

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Manuscript received 20 *September* 1982; *revised* 19 *January* 1984

A strain of *Aspergillus oryzae* var. *effusus* was found to produce an orange-red pigment on starch medium. Of the many carbon sources examined for maximum production of the pigment, tapioca starch and tapioca starch factory refuse have been found to initiate pigmentation at 2% level of the basal medium. Study on mineral requirements indicated that ammonium dihydrogen orthophosphate was required for both growth and pigment production. Spectroscopic studies indicated that the pigment belonged to anthraquinone group.

The colour of marketable commodity contributes to eye appeal. Many natural and synthetic colours are being used in food items. Natural colours were used in food products, traditionally, with the rapid development of processed food industry, the demand for colourents increased and synthetic colours were added to food products, which was a health hazard. Search for alternate sources of colours was intensified and many plant parts were used to extract colours. In China and other Oriental countries certain fungal strains are being utilized in the manufacture of fermented food "Ang-Khak" or red-rice. The organism which imparts red colours to the preparation has been isolated and identified as *Monoascus purpureaus* and *M. anka*[1]. Attempts have been made by several workers[2–6] to produce pigments by fermentation. A patented process is available for producing red pigment from *Monoascus* which could be utilized in food preparations[7].

During the screening programme of fungi for amylase production, a strain of *Aspergillus* was found to elaborate a red pigment into the medium. Since the fungus was producing pigment in a medium containing starch, possibility of employing alternate economical substrates like tapioca starch factory refuse (TSR) was studied. Data relating to the isolation and partial characterization of the pigment are presented in this communication.

Materials and Methods

The fungal strain, which was tentatively identified as *Aspergillus oryzae* (Ahlb) Coh. var. *effusus* (Tira) Chara, was maintained on potato dextrose agar and Coleman-Elliott's—agar[8] slants. Inoculated tubes were incubated for 7 days at 30°C and stored in the refrigerator until used.

Basal medium (referred to as nutritive solution)[8] contained the following ingredients per litre. $NH_4H_2PO_4$ 0.173 g; $MgSO_4 . 7H_2O$ solution 1 ml (24.658 g/100 ml); $CaCl_2$ 1 ml (14.7 g/100ml); $FeCl_3$ 0.5 ml (16.221 g/100 ml); $ZnSO_4$ 1 ml (28.756 g/100 ml); sodium citrate 0.1176 g; carbon source 100 g; distilled water to make upto 1 l. Fifty ml of the medium in 250 ml Erlenmeyer flask was autoclaved at 1.1 kg/cm^2 pressure for 30 min.

Inoculum was prepared by suspending the spores of 7-day old agar slant in 10 ml sterilized distilled water containing 0.1 ml of tween-80. One ml of the inoculum was used per flask (1×10^6 spores per ml).

Inoculated flasks were incubated on the lab bench at ambient temperature (22-30°C). After desired period of growth, the mycelial mat was separated by filtration and the culture filtrate was lyophilized.

Paper and thin layer chromatography of the concentrate were carried out using following solvent systems:

(*a*) Butanol: Acetic acid: Water (4:1:5)
(*b*) Ethyl acetate: Acetic acid: Water (2:1:1)
(*c*) Chloroform: Ethyl acetate: Formic acid (5:4:1)
(*d*) Ethyl acetate: Methanol: Water (100:16.5:13.5)

Carl-Zeiss spectrophotometer was used and the colour (orange-red) was measured at 330 nm. Lyophilized crude samples dissolved in ethanol (1-2 mg in 25 ml) were used for both spectral studies and analysis of quinones by oxidation reduction test[9]. Since the visual evaluation of colour intensity matched with O.D. values recorded in spectrophotometer, only visual observations were made in subsequent experiments.

Results

Initially, the fungal isolate was cultured on a medium containing 10 per cent soluble starch. After the vegetative growth phase of seven days, the fungus was observed to secrete the pigment and by 21 days, the maximum intensity was recorded.

When pigment production was observed on different concentrations of soluble starch, it was observed that

the intensity of colour ranged from light pink to deep red. The intensity of colour deepened till the starch concentration in the medium reached 10 per cent; pigment production was not observed in 1 per cent starch.

Effect of carbon sources on pigment production: Different carbon sources including tapioca starch factory refuse (TSR) were examined for their suitability for pigment production. The results are presented in Table 1. The results indicate that, the intensity of pigmentation in media containing dextrin and maltose was the highest. Colouration was slightly lower in media prepared from starches, TSR or TSR fortified with different sugars.

When the fungus was grown in medium containing TSR and tap water (not containing any nutrients of basal medium) there was no pigment production indicating the essentiality of nutrient solution for pigment production.

Different concentrations of tapioca starch or TSR were tested for the production of maximum intensity of the pigment. Media containing different concentrations of the material were prepared and the fungus was cultivated under stationary condition for 21 days. The observations are presented in Table 2.

It was observed that tapioca starch or TSR at 1 per cent level did not favour pigment production. The colour of the medium was pink at 2 per cent level and at 5 per cent level the colour was red which was same upto 10 per cent level. The intensity of colour reached a maximum within 17 days after inoculation.

Effect of ingredients of basal medium on pigment production: To find the effect of different ingredients of basal medium on intensity of pigment production, the fungus was cultured in media in which one of the ingredients of the basal nutrient solution was missing. TSR at 2 per cent level was used as carbon source, since there was visible pigment production at this level of carbohydrate itself. Observations are recorded in Table 3.

It was observed that the fungus did not grow in medium devoid of ammonium phosphate. The pigment production was not observed when the medium did not

TABLE 1. EFFECT OF DIFFERENT CARBOHYDRATE SOURCES ON PIGMENT PRODUCTION BY *ASPERGILLUS ORYZAE* VAR. *EFFUSUS*

Substrate	Growth§	Pigment production intensity	Optical density at 330 nm
Corn starch in nutrient solution (NS)	6	+ +*	0.6
Corn starch in tap water (TW)	6	—	—
Potato starch in NS	6	+ + + +	0.80
Potato starch in TW	6	—	—
Tapioca starch in NS	7	+ + + +	0.8
Tapioca starch in TW	8	—	—
Tapioca starch refuse (TSR) in NS	8	+ + + +	0.91
TSR in TW	8	—	—
Dextrin in NS	8	+ + + + +	1.3
Dextrin in TW	8	—	—
Sucrose in NS	6	—	—
Glucose in NS	8	+ + +	0.75
Maltose in NS	6	+ + + + +	1.8
TSR+Dextrin in NS	8	+ + + +	1.0
TSR+Sucrose in NS	6	+ + + +	0.9
TSR+Glucose in NS	8	+ + + +	1.0
TSR+Maltose in NS	8	+ + + +	0.84

*+=light pink; + +=pink; + + +=light red; + + + −=red; + + + + +=deep red.

§Number of days needed to cover the surface of the medium.

—indicates no colour production.

TABLE 2. EFFECT OF DIFFERENT CONCENTRATION OF CARBON SOURCES IN THE MEDIUM ON PIGMENT PRODUCTION BY *A. ORYZAE* VAR. *EFFUSUS*

Carbohydrate concn (%)	Intensity of colour*
Tapioca flour	
1	+
2	+ + +
3	+ + +
4	+ + +
5	+ + + +
6	+ + + +
7	+ + + +
8	+ + + +
9	+ + + +
10	+ + + +
Tapioca starch residue	
1	—
2	+ + +
3	+ + +
4	+ + +
5	+ + + +
6	+ + + +

Abbreviations as in Table 1.

*Measured in the medium after 21 days of growth

— indicates no pigment production.

TABLE 3. EFFECT OF MINERALS IN BASAL NUTRIENT SOLUTION ON PIGMENT PRODUCTION BY *A. ORYZAE* VAR. *EFFUSUS*

Minerals missing	Pigment production
KCl	+ + + +
$CaCl_2$	+ + + +
$NH_4H_2PO_4$	no growth
$ZnSO_4$	+ + + +
$MgSO_4$	+ +
$FeCl_3$	+
Sodium citrate	+ +

Abbreviations as in Table 1.

contain ferric chloride substantiating the earlier reports.[10] Lack of magnesium sulphate and sodium citrate also reduced pigment production by the fungus.

The spectral characters in UV and visible ranges showed a typical anthraquinone spectrum indicating the pigment to be an anthraquinone.

Discussion

As noted in the introduction, the suitability of utilization of tapioca starch factory refuse for pigment production was studied. Highest intensity of colour was observed in dextrin and maltose medium. But the same intensity was not found when starches were fortified with these sugars. This may be attributed to the presence of starch in the medium.

There was no growth in the medium devoid of ammonium phosphate, even though other nutrients were present in the medium, thus indicating the essentiality of phosphate and nitrogen for growth of the organism.

The absence of iron in the medium affected pigment production. It has been reported[13] that ferric ions are essential for colour formation by a strain of *Aspergillus* sp. in which, iron gets incorporated in the structure of the pigment. The lack of pigment production in the absence of iron indicates that iron might get incorporated in the pigmet structures.

The spectral studies have tentatively indicated that the pigment is an anthraquinone. Since many plant parts naturally contain anthraquinones, it might be possible to use the pigment obtained by *Aspergillus oryzae* var. *effusus* as a colouring agent after complete characterization and toxicological studies of the compound are made.

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Biodegradation of Gum by *Penicillium* Sp. and Its Control

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Manuscript received 2 *September* 1982; *revised* 30 *January* 1984

Penicillium sp. **was isolated from the spoiled gum samples undergoing biodegradation. This mould could grow in the presence of gum, glucose, some disaccharides or polysaccharides and possessed the ability to degrade proteinic and polysaccharidic materials by producing considerable levels of proteases, invertase, amylase and CMCase. Borax seems to be an important compound which can be tried for preservation of the gum arabic.**

Gum arabic is a dried exudation obtained from *Acacia senegal* and related species. It is of commercial importance and is used in the textile, mucilage, food, paste, polish, and confectionary industries, and as a glaze in painting[1]. In medicine it is used as an emulsifying agent and as a demulcent[2]. It is susceptible to microbial attack by *Aspergillus* spp., yeast, *Aerobacter, E. coli* and *Lactobacillus* spp.[3] In the present investigation, a *Penicillium* sp. was isolated from commercially available gum arabic undergoing biodegradation. Attempts were made to find out the mechanism by which the mold degrades and utilizes the components of the gum and also to find out an antifungal compound which inhibits the growth of this biodeteriogen.

Materials and Methods

Penicillium sp. was isolated from the spoiled gum sample (from commercially available gum bottles). Gum used for further studies was a commercially available variety of *Acacia arabica*. The methods for the isolation of fungal cultures, the composition of the synthetic medium, the method used for measuring the growth and observing the effect of anti-microbial compounds were the same as described earlier[4]. The assay methods used for proteases, amylase, invertase and CMCase; and for the protein estimation were the same as reported earlier[5,6]. Glucose was estimated according to the method of Dahlquist[7].

Results and Discussion

Penicillium sp. was able to grow in a medium where gum was supplied as the sole source of carbon eventhough it exhibited better growth in glucose or sucrose or in other carbon sources (Table 1). Gum from *Acacia arabica* is known to contain L-arabinose, D-galactose, D-glucuronic acid and L-rhamnose[8], which might be utilized by the fungus. However, it was not able to utilize galactose or lactose when supplied as sole carbon source.

TABLE 1. EFFECT OF CARBON SOURCE ON THE GROWTH OF *PENICILLIUM* SP.

Carbon source (4 g%)	Growth (mg*)
Gum	29.5
Glucose	419
Maltose	320
Sucrose	497
Arabinose	431
Xylose	346
Starch	279
Dextrin	307
Sorbose	250
Lactose	Negligible
Galactose	Negligible

*Dry mat weight per 100 ml medium

TABLE 2. CONTENT OF PROTEIN AND GLUCOSE AFTER GROWTH OF *PENICILLIUM* SP. IN THE SYNTHETIC MEDIUM CONTAINING GUM

Component	Before growth (mg/100 ml)	After growth (mg/100 ml)	% utilization
Protein	17.5	11.4	34.8
Glucose	1.7	1.1	35.3

Commercial gum of *Acacia arabica* also contained traces of glucose and protein, which were also utilized by the mould (Table 2). Mould showed high levels of proteases, invertase, amylase and CMCase activities (Table 3). These enzyme activities showed the general

TABLE 3. EXTRACELLULAR PROTEASE, INVERTASE, AMYLASE AND CMC ASE ACTIVITIES OF *PENICILLIUM* SP.

Enzyme	Sp. activity (units/mg protein)
Protease	
Acidic	16.000
Neutral	3.800
Alkaline	0.465
Invertase	0.177
Amylase	0.171
CMCase	4.020

TABLE 4. LD_{50} VALUE OF SOME ANTIMICROBIAL COMPOUNDS, FOR *PENICILLIUM* SP.

Antimicrobial compounds	LD_{50} (mg/ml)
Vitamin K_3	0.735
Aureofungin	0.154
Borax	0.150
Ca-propionate	1.0

ability of the mould to degrade proteinaceous and polysaccharide substrates.

Careful prevention and successful preservation of gum from microbial attack needs some attention. Amongst various antifungal compounds tested, borax was found to be the most effective having LD_{50} value of 0.15 mg/ml (Table 4). Borax is comparatively harmless and has been used to increase the viscosity of the mucilage prepared from gum arabic. It was found that with the increase in the proportion of borax, the mucilage thickens considerably; 100-150 mg of borax was found to be the safe limit in the formulation of mucilage[9]. So, borax can be used to increase the viscosity as well as an antimicrobial compound.

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Shelf Life Studies on Maize Based 'Balahar'

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Manuscript received 29 *July* 1983; *revised* 16 *January* 1984

Effect of heat treatment and addition of antioxidants to extend the shelf life of 'Balahar' (a mixture of maize semolina, edible groundnut flour and defatted soya flour in the ratio of 70:15:15) was studied. Exposure of 'Balahar' to 100°C for 10 min protected the material against FFA development during storage. There was a marginal increase in thiobarbituric acid (TBA) and peroxide values as a result of heat treatment. Addition of antioxidant and jaggery retarded peroxide value and TBA formation, but had no effect on FFA development. Acceptability of the stored product was correlated to FFA content. Large scale trials have confirmed that toasting of 'Balahar' controls FFA development and extends the shelf life of the product.

'Balahar', a mixture of pre-cooked and dried maize semolina, edible groundnut cake flour and defatted soya flour in the proportion of 70:15:15, respectively, is being manufactured by the Food Corporation of India,

for mid-day feeding programme in schools. This product is reported to have poor shelf life and develop bitterness during storage. Investigation was undertaken to improve shelf life of the product, the results of which are reported here.

Materials and Methods

After studying the process of 'Balahar' production by the Food Corporation of India (FCI), ingredients used in its manufacture namely, maize, edible groundnut cake flour, defatted soya flour, maize semolina (partially heat processed as per method currently practised by FCI) as well as raw maize semolina; 'Balahar' as produced at FCI factory and 'Balahar' prepared using raw maize semolina were collected.

'Balahar' prepared using raw maize semolina was subjected to the following treatments:

(*i*) Steaming at atmospheric pressure for 30 min and drying in a truck dıier at 60°C for 60 min to a final moisture content of 7.5 per cent;

(*ii*) Toasting at 100°C for 10 min in an electrical roaster;

(*iii*) Heating in the roaster (with the lid closed air-tight) at 110°C for 10 min (humid heat treatment);

(*iv*) Treatment same as in (*iii*) but moisture content adjusted to 15 per cent.

The material was cooled to ambient temperature. Humid heat treatment was given according to the method described by Viraktamath and Desikachar[4].

Antioxidant treatment: 'Balahar' of FCI was used for this treatment. BHA with citric acid as synergist (at 0.02 and 0.005 per cent levels respectively on the weight of the fat in the material) or jaggery at 2 per cent level on the weight of the 'Balahar' were used as antioxidants.

The antioxidant was triturated with a smaller quantity of 'Balahar' and this was mixed with the entire lot to ensure uniform distribution of the antioxidant.

Packing and storage: Materials were packed in polyethylene pouches (300 gauge) and fumigated with methyl bromide at 32 mg/l for 24 hr. The samples were aerated for 5 hr after fumigation, sealed and kept for storage. All the samples (control and treated) were stored in a cabinet maintained at 37°C and 66-68 per cent relative humidity (RH), withdrawn at monthly intervals and analysed by standard methods for moisture[5] free fatty acids (FFA), peroxide value (PV)[6], thiobarbituric acid value (TBA)[7] and alcoholic acidity (AA)[8]. Organoleptic quality in terms of off-flavour, bitterness and rancidity was assessed by a panel.

On the basis of the results obtained with the first set of laboratory experiments, a second series of studies was undertaken to find out, if, heat treatment of the major ingredient—maize semolina was adequate instead of heat treatment of the final product. This set of experiments included toasting at 100°C for 10 min of (*i*) 'Balahar' prepared by FCI; (*ii*) 'Balahar' prepared in the laboratory using raw maize semolina; (*iii*) 'Balahar' prepared using pre-cooked and toasted maize semolina (other ingredients unheated); (*iv*) 'Balahar' prepared using un-toasted ingredients.

Toasting was generally carried out on 25 kg lots. The 'Balahar' samples were packed in 300 gauge low density polyethylene pouches and stored at 37°C and 66-68 per cent RH for periodical analysis. Only data on FFA development are presented for this series as PV and TBA did not correlate with organoleptic tests.

Organoleptic evaluation: Stored products were evaluated for acceptability by a panel of six judges selected from the staff of the laboratory. In the initial evaluation the samples were presented to the panel in both cooked and raw forms. In later evaluation the samples were presented in the raw form only. The panel was asked to indicate if the samples were acceptable or not. The opinion of the majority of the members of the panel was recorded.

Results and Discussion

Poor shelf life of composite mix flours containing cereals and oilseeds is generally due to rancidity/bitter-

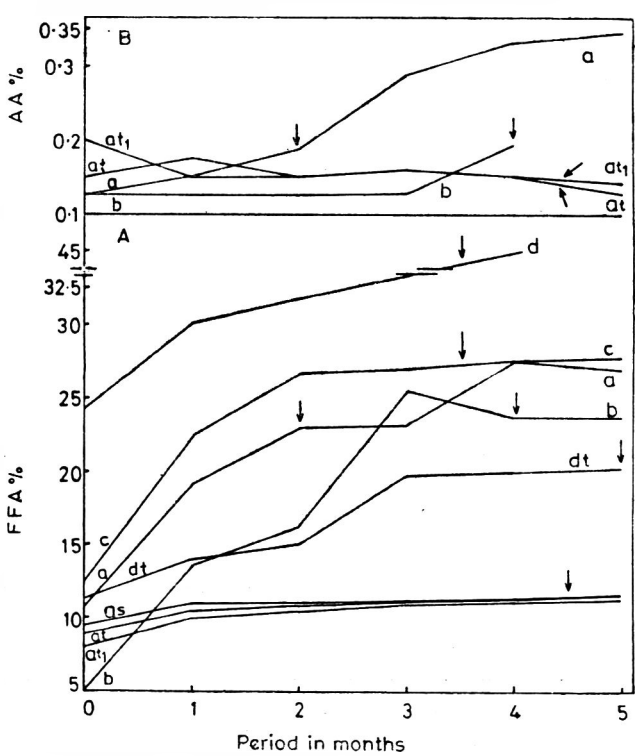

Fig. 1. Changes in free fatty acid and alcoholic acidity during storage of the constituent raw materials of 'Balahar'.
(a) Maize semolina, control; (as) Maize semolina, steamed; (at) Maize semolina, toasted; (at_1) Maize semolina, toasted in closed chamber; (b) Maize semolina with antioxidant; (c) Soya flour, untoasted; (d) GN cake flour, untoasted; (dt) GN cake flour, toasted.

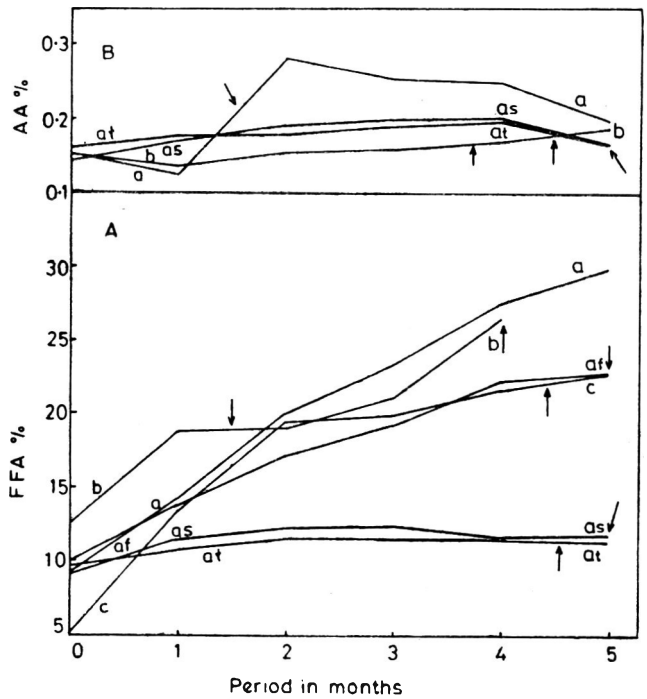

Fig. 2. Changes in free fatty acid and alcoholic acidity during storage of 'Balahar' samples under different treatments.

(a) Balahar, control; (as) Balahar, steamed; (at) Balahar, toasted; (af) Balahar, fumigated; (b) Balahar, with antioxidant; (c) Balahar with 2% jaggery.

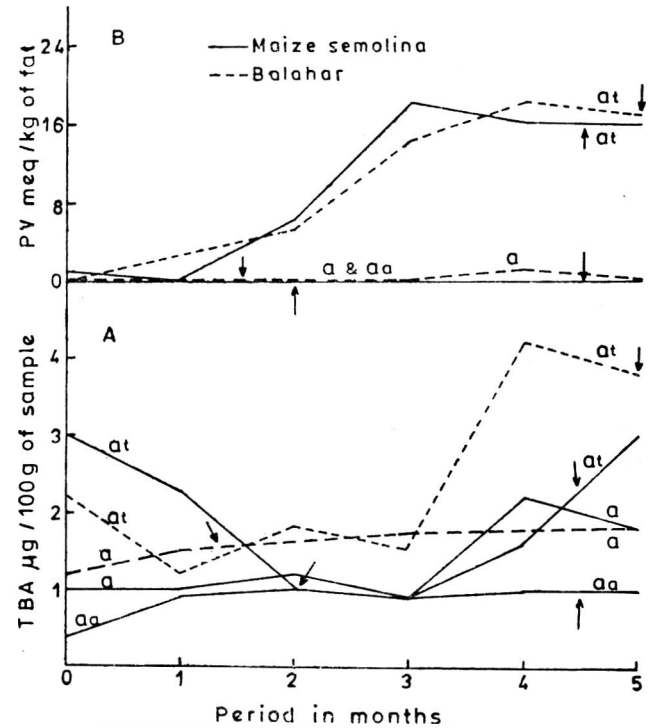

Fig. 3. Changes in thiobarbituric acid and peroxide values of Maize semolina and 'Balahar'

(a) control; (at) toasted; (aa) with antioxidant

ness caused by lipolytic/hydrolytic enzymes[1-3]. 'Balahar' also developed rancidity or bitterness or some off-flavour during storage. Preliminary studies carried out to correlate the development of unacceptable flavours with chemical indices were unsuccessful. The peroxide values (Fig. 3B) were low, the TBA (Fig. 3A) and the AA (Fig. 1B and 2B) were erratic when the product became unacceptable (shown by an arrow). However, the FFA (Fig. 1A and 2A) increased progressively with storage. Hence, the development of FFA was used as an index for evaluating the efficacy of various treatments.

Effect of heat treatment:

(*i*) *Development of FFA:* Fig 1A and 2A show the development of FFA in raw materials and 'Balahar' during storage. As can be seen from Fig 1A relating to raw materials, the unheated samples showed high increase in FFA from 14 to 21 per cent during storage, while FFA in the heat treated samples remained almost stationary during the entire period of storage. A similar effect has been noticed with 'Balahar' formulations also (Fig. 2A). While the unheated controls increased progressively in FFA from an initial value of 9 to about 30 per cent, the FFA in the heat treated samples was almost constant.

(*ii*) *Alcoholic acidity:* The typical trend of development of alcoholic acidity for certain samples of raw material as well as finished 'Balahar' are presented in the respective figures at 1B and 2B. The results presented in the figures indicate that heat treatment effectively controlled development of alcoholic acidity which is somewhat analogous to the effect on FFA development.

(*iii*) *Changes in TBA and PV:* Unlike the FFA development, the changes in TBA and PV (Fig. 3A and 3B) were irregular. The heat treated samples had more TBA and PV than the unheated controls. There was a small decrease in the TBA value for the first two months followed by an increase in the next three months. This increase in TBA and PVs in the heat treated samples could be attributed to the destruction of antioxidant factors in the raw materials.

(*iv*) *Moisture pick-up by samples during storage:* The unheated materials had moisture contents ranging between 8 and 12 per cent. The heat treated samples, particularly the dry toasted materials, lost moisture during treatment and had a moisture content of about 2-4 per cent. During the storage period of 5 months, all samples picked-up moisture to an extent of 0.5-1.5 per cent.

Effect of antioxidant and jaggery treatment:

(*i*) *Development of FFA:* The FFA value of raw semolina containing the antioxidant increased from about 5 to 25

per cent in 3 months (Fig. 1A-curve b), whereas the heat treated samples had only marginal increase in FFA showing that, antioxidant had no effect on FFA development. A similar trend is observed in 'Balahar' containing antioxidant or jaggery (Fig. 2A-curves b and c) and in heat treated samples, confirming that the antioxidant treatment had no effect on FFA development.

(*ii*) *Alcoholic acidity:* Alcoholic acidity values of the raw materials and the finished products are shown in Fig 1B and 2B. Although there was some effect of antioxidant on alcoholic acidity in 2-3 months of storage, the increasing trend is observed towards the end of the storage.

(*iii*) *Changes in TBA and PV:* As seen in Fig 3A and 3B, addition of antioxidant prevented the oxidative rancidity in both raw materials and 'Balahar' (curves a_a (3A) and a_a (3B)). The values were higher in the heat treated samples compared to the unheated ones.

Acceptability: The heat treated samples, both raw materials and finished products, were acceptable upto 5 months, while the unheated controls developed off-flavour after 6 weeks.

Stabilization trials on large scale: From the laboratory studies, it is evident that appropriate heat treatment could increase the shelf life of 'Balahar' by controlling the development of FFA. The large scale studies were conducted to confirm the laboratory data and also to find out the effect of final toasting of the formulated product. As can be seen from Fig 4. 'Balahar' formulation containing all the ingredients in the unheated condition developed maximum FFA during storage. Partial heat treatment of the semolina, as in the commercial formulation, controlled the FFA only to a limited extent. 'Balahar' formulated either with heat treated ingredients or with raw ingredients mixed and then heat treated, stored well with only very small increase in FFA during the 5 months period. Heat treatment of semolina only (the major ingredient) without treatment of the two minor ingredients, groundnut and soya flour was not as effective as earlier treatments. The present results therefore suggest that, improved shelf life and storage stability can be given to the 'Balahar' if the finished product is given a final toasting treatment as an end-step of the manufacturing process.

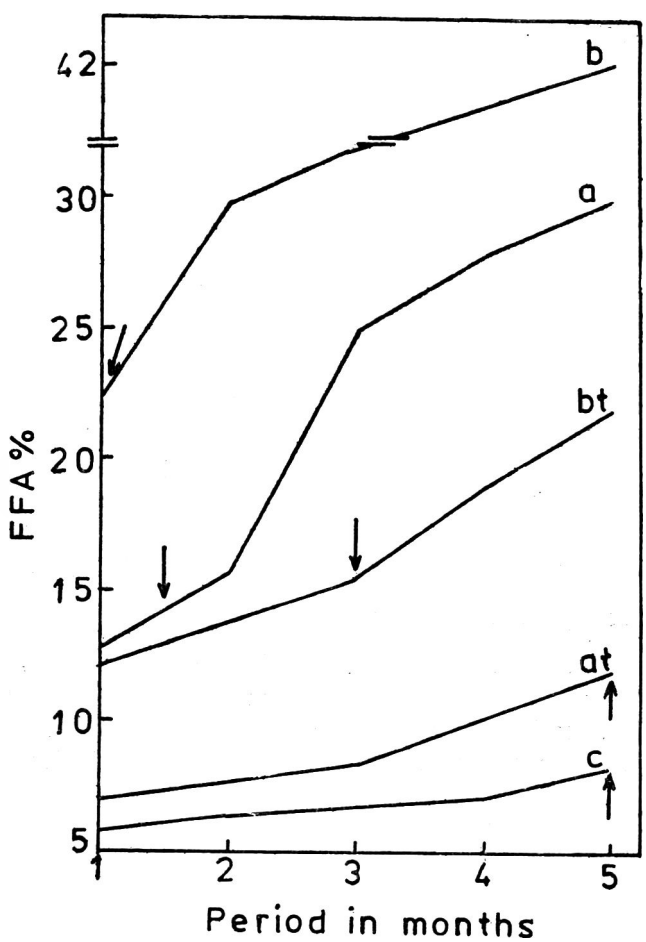

Fig. 4. Changes in free fatty acid values of 'Balahar' samples in bulk treatment trials.

(a) Balahar (FCI); (at) Balahar (FCI), toasted; (b) Balahar (with raw maize semolina); (bt) Balahar (with raw maize semolina, toasted); (c) Balahar (precooked and toasted maize semolina + toasted GN cake flour + soya flour)

Acknowledgement

The authors thank the Director of the Institute, Mr. Laljeet Singh of Modern Bakeries, New Delhi, Mr. Sen, Modern Maize Mill, Faridabad and Mr. O. P. Beerh, CFTRI Experiment Station, Ludhiana, for their keen interest in the work. The investigation was supported by a Grant-in-Aid by the Department of Food, Ministry of Agriculture, Government of India.

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Studies on the Suitability for Canning of New French Bean *(Phaseolus vulgaris)* Selections

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Manuscript received 24 *June* 1982; *revised* 6 *January* 1984

A few selections of French beans developed at the Indian Institute of Horticultural Research (ICAR) were assessed for physico-chemical characteristics and suitability for canning. Selection Nos, 5 and 2 were found better than variety 'Contender,' which is reported to be the best for canning.

French bean is consumed fresh or preserved in cans or frozen or dehydrated.

All varieties of French bean are not suitable for processing. The desirable characters are pod type, colour, flavour and chemical composition. Yield per hectare is another important criterion. Few selections of French bean developed at the Indian Institute of Horticultural Research were screened for canning and the data are given in this paper.

Materials and Methods

Four selections along with the variety 'Contender' known for its desirable qualities, were used in the present study. Five kg pods of uniform size and maturity were harvested and used for analysis and canning. Maturity was decided by the colour and rigidity of the pod.

AOAC procedures were followed for chemical analysis[1]. Total soluble solids was recorded by using hand refractometer.

Preparation loss was calculated by the following formula:

$$\text{Preparation loss (\%)} = \frac{\text{Wt. of snipped portion} \times 100}{\text{Wt. of French bean}}$$

Cut pieces (2.5 cm long) were blanched at 90°C for 2 min and filled into A $2\frac{1}{2}$ (401 × 411) size cans at the rate of 450 g per can. Brine of 2 per cent sodium chloride was used. The cans were exhausted to 85°C, sealed with MB Sealer, processed at 10 kg/sq cm. pressure for 30 min, cooled in running water and stored at room temperature (21 to 35°C).

Samples of cans were drawn after 8 and 12 months and analysed for vacuum, head space, drained weight (%) and internal and external condition following F.P.O. specifications[2]. Analysis was carried out in triplicates.

Organoleptic quality of canned bean was evaluated by an experienced taste panel of 13 to 15 members drawn from the staff members of the Institute. The score was recorded for colour, flavour (taste and aroma) and texture in a score card as per U.S.D.A.[3] procedure. The organoleptic score of the taste panel was statistically analysed.

Results and Discussion

Physico-chemical characters of selections of French bean are presented in Table 1. Highest yield was obtained with the selections 5 and 9. All selections except 'Selection-9' were at par with 'Contender' which has been considered as processing variety in the Western countries. 'Selection-9' was found to be fibrous, flat in shape and broadest. Weight of pods varied from 6.13 to 8.90 g, while length varied from 12.00 to 15.4 cm, and was not found suitable for processing.

'Selection-6' showed the highest TSS, followed by 'Contender', 'Selection-2, 5 and 9' in that order (Table 1). Dry matter content was found to be the lowest in 'Selection-5' and highest in 'Contender'. Colour of

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TABLE 1. YIELD AND PHYSICO-CHEMICAL CHARACTERS OF FRENCH BEAN VARIETIES

Variety	Yields* (kg/ha)	Pod type	Pod weight (g)	Length (cm)	Breadth (cm)	Thick-ness (cm)	Plant height (cm)	T.S.S. (%)	Dry matter (%)	Chlorophyll (O. D)	Colour	Preparation loss (%)
Selection-2	2200	Round, straight and fleshy	7.20	12.8	0.93	1.00	35.6	5.00	8.06	0.0410	Green	6.55
Selection-5	2500	Round, thick, straight and fleshy	7.25	14.5	0.94	1.07	36.0	4.50	7.29	0.0506	Green	6.59
Selection-6	1500	Round, curved ends and fleshy	6.13	12.0	0.80	0.85	42.5	7.00	9.99	—	Purple	6.44
Selection-9	2500	Flat, straight and slightly fibrous	7.23	15.4	1.40	0.80	37.5	4.00	8.00	0.0410	Green	7.41
Contender	1800	Round and curved	8.90	14.7	0.85	0.84	31.4	6.00	10.49	0.0458	Green	6.82

*Row to row distance 50 cm; Plant to plant distance 10 cm.

pods of all selections was green except 'Selection-6', which had purple colour. Maximum chlorophyll was present in 'Selection-5' followed by 'Contender' and 'Selections 2 and 9' (Table 1). Preparation loss was about 6.0 per cent in all the selections.

External condition of can was normal throughout storage period in all varieties except in cans of 'Selection-6' which developed pin holes between storage of six and twelve months. In case of 'Selection-2', there was no sulphur staining on the internal surface of can except feathering during the storage period of 12 months. However, the cans of other bean selections developed sulphur staining with feathering. In commercial canning practice[4], 7m Hg is commonly accepted as the minimum satisfactory vacuum. The values of vacuum noticed during storage period of one year in the cans of all varieties was above 7m Hg and this indicates the safety of the product. As per F.P.O. specifications[2] for canned vegetables, the drained weight (%) should be more than 55 per cent. Drained (%) values for varieties under study during storage were found to be in the range of 56 to 62 per cent conforming to the FPO specifications.

Organoleptic score of stored canned French bean is presented in Table 2. During storage period of 12 months, colour of canned French bean from 'Selection-6' rated significantly low. This may be due to the inherent

TABLE 2. ORGANOLEPTIC SCORE OF CANNED FRENCH BEANS DURING STORAGE OF 12 MONTHS

Variety	Colour			Texture			Flavour (taste and aroma)			Overall		
	0	6	12	0	6	12	0	6	12	0	6	12
Selection-2	20.75	22.11	24.00	24.37	22.70	25.22	28.30	27.10	27.60	71.75	72.20	76.88
Selection-5	23.37	19.22	23.11	23.12	22.00	23.88	26.22	29.20	29.10	74.47	71.10	76.55
Selection-6	17.62	16.22	20.77	20.12	18.10	20.23	24.62	25.50	27.20	63.62	61.50	67.77
Selection-9	17.87	21.44	21.66	14.87	18.70	21.66	21.37	26.70	27.77	54.12	67.70	70.66
Contender	20.12	20.55	21.77	19.00	20.30	23.66	25.87	25.30	27.22	65.00	65.90	72.00
F.Test	**	**	**	**	NS	*	*	NS	NS	**	NS	NS
S E M	1.1586	1.0213	1.2488	1.2190	1.4686	1.0704	1.4036	1.4599	1.09	2.6281	2.7353	2.6321
C D (5%)	3.3552	2.9428	3.5986	3.5305	4.2143	3.0704	4.1431	4.1893	4.6470	7.6107	7.8492	7.5844

**Highly significant; *Significant; NS: Non-significant

'purple colour of variety. Initially 'Selection-2' scored the highest for texture followed by 'Selection-5', 'Selection-6' Contender' and 'Selection-9'. However, all varieties were at par after storage of six months. This may be ascribed to the softness of beans in all the samples. After storage of 12 months, score for 'Selection-2', '5' and 'Contender' was significantly more than the score for 'Selections-9' and '6' (Table 2). Initially, score for flavour (taste and aroma) in case of 'Selection-9' was significantly low as compared to other varieties like 'Selections-2, 5' and 'Contender'. However, after storage of 6 and 12 months, there was no significant difference among the score for different varieties indicating that there was little loss of flavour in all the varieties.

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Development of Soycheese Spread

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Manuscript received 13 *May* 1983; *revised* 23 *January* 1984

A cheese-like product named soycheese spread, has been developed by utilizing a blend of soybean and milk solids, which takes 8-10 days for preparation. Dehulled, preboiled soybean and sterilized sodium chloride solution are ground and fortified with soyprotein concentrate, cream and/or skim milk powder. The mix is pasteurized and inoculated with 5% *S. lactis* and 0.01% rennet and incubated at 30°C. Initial and daily pH adjustment to 5.3 and daily agitation are essential to acceptable flavour development. The desirable flavour is associated with realatively low rate of acid development and controlled proteolysis. Soycheese spread resulting from this formulation contains about 35% total solids, 18% fat, 11% protein, 2% sodium chloride and 3% ash.

The use of soybean as a human food is limited especially in India due to its beany flavour, anti-nutritional factors and development of flatulence after consumption. Anti-nutritional factors and beany flavour can be minimised by suitable heat treatment; flatulence and residual beany flavour can be overcome by fermentation. In order to utilize the beneficial effect of heat and fermentation, attempt was made to develop a cheese-like product from soybean.

Materials and Methods

Soy-slurry was prepared from dehulled soybean (variety-Bragg), soyprotein concentrate, cream and spray dried skim milk powder (SMP). Dehulled soybean was cleaned, blanched in a double jacketed kettle (open pan) with 10 times its volume of 1 per cent sodium bicarbonate (weight basis of dehulled soybean) solution at 1.55 kg/cm^2 steam pressure for 60-70 min and ground in a colloidal mill with a mixture of soyprotein concentrate, cream and/or skim milk powder and salt solution (Fig. 1)

The pH of soy-slurry was adjusted to 5.3 with 75 per cent lactic acid. Soy-slurry was pasteurized at 75°C for 30 min in glass jars and cooled to 30°C. The *S. lactis* culture and rennet were added at the rate of 5 per cent and 0.01 per cent, respectively. The inoculated slurry was maintained in a water bath at 30°C. The content was agitated daily with a sterile spatula for proper aeration and representative samples collected.

Processing of ripened soy-slurries: Prepared soy-slurry was pasteurized at 75°C for 15 min after addition of 2 per cent sodium citrate, packaged in clean and sterilized glass bottles and stored in a refrigerator.

The samples of soy-slurries were assessed for flavour and chemical changes during ripening. Samples were

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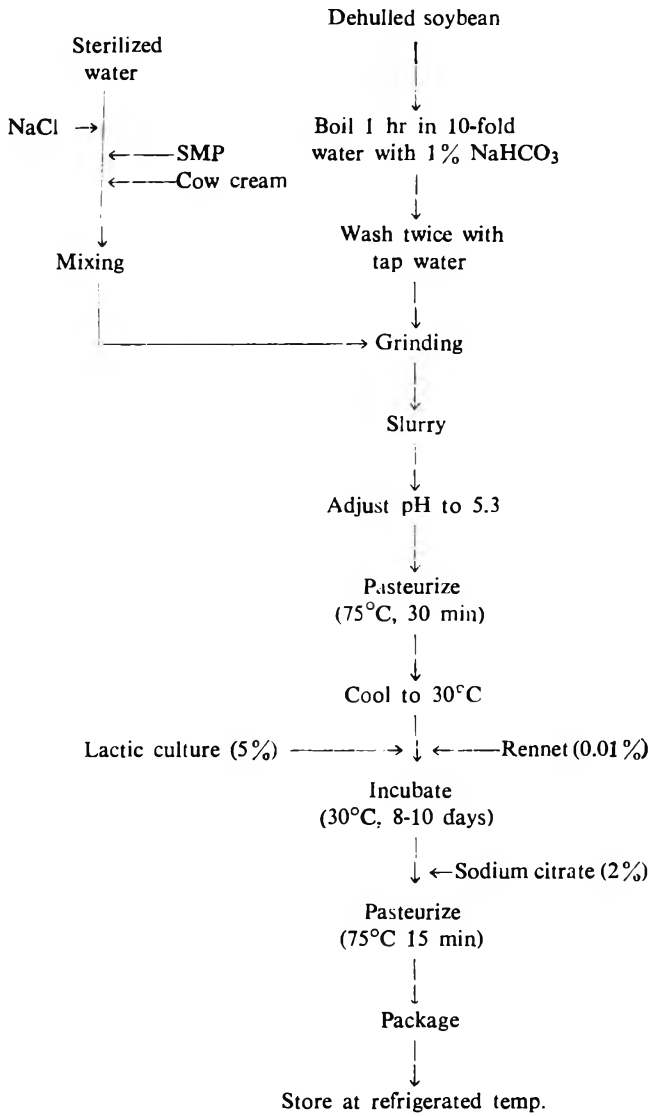

Fig 1. Preparation of soycheese spread

examined daily for flavour, while chemical analysis was done on 4th day and 8th day.

Flavour evaluation was done on an 8-point arbitrary scale, where 8 denoted an excellent product while 2 cr less than that indicated poor quality. Total solids were determined by gravimetric method, the protein content by Kjeldahl method, soluble portein by the method recommended by Kosikowski[1], fat and ash by AOCS method[2]. The pH of sample was determined daily, with the help of systronic pH meter (Type 323), adjusted to 5.3 with 50 per cent NaOH when necessary. The titratable acidity was determined by the method of AOAC[2].

Results and Discussion

Formulations: With the object of getting a product of 35-40 per cent total solids of proper protein:fat ratio and other acceptable qualities, six formulations consisting a fixed quantity of dehulled soybean and varying proportions of soyprotein concentrate, cream and skim milk powder were prepared, as shown in Table 1.

The formulations possessed different proximate composition, body, texture and flavour development during ripening. Proximate composition of different formulations is presented in Table 2.

Of the six formulations, it was observed that the last formulation containing cream and skim milk powder only resulted in a superior product both in composition and in flavour (Table 3). A protein:fat ratio of 0.6 was found to be optimum. The increase in milk solids had a positive effect on the flavour characteristics of the product, particularly when soyprotein concentrate was used. When the soyprotein concentrate was excluded completely from the formulation, need for milk solids could be curtailed markedly without affecting its flavour characteristics adversely. Formulation C (Cream), and CS (Cream-Skim milk powder) resulted in a quite satisfactory product even with 28 and 34 per cent of milk solids, respectively.

Flavour development: Table 3 shows the effect of different formulations on flavour development in soy-slurries. It is apparent that formulation SC1 (Soyprotein conc-Cream) where only soy concentrate and cream were used, resulted in a fair level of flavour (score 3) after 8 days of storage. The product was however

TABLE 1. DIFFERENT FORMULATIONS OF SOY SLURRIES

Formulation	Dehulled soybean (kg)	Soy conc (kg) (kg)	Cream 60% (kg)	SMP (kg)	Salt (kg)
SC 1	1	0.4	0.80	—	0.12
SC 2	1	0.6	1.50	—	0.12
SCS 1	1	0.2	1.25	0.25	0.12
SCS 2	1	0.3	1.50	0.55	0.12
C	1	—	0.55	—	0.09
CS	1	—	0.55	0.125	0.09

SC=Soyprotein concentrate-cream; SCS=Soyprotein concentrate—cream—skim milk powder; C=cream; CS=cream—skim milk powder.

TABLE 2. PROXIMATE COMPOSITION OF DIFFERENT FORMULATIONS OF SOY SLURRIES

Formulation	Total solids (%)	Fat (%)	Protein (%)	Ash (%)	Salt (%)	Protein/fat ratio	Soy solids (%)	Milk solid (%)
SC 1	37.0	16.0	15.0	3.2	1.75	0.9	70	30
SC 2	41.0	20.0	12.8	2.0	1.5	0.6	60	40
SCS 1	36.0	18.6	12.8	2.75	1.5	0.7	51	49
SCS 2	42.8	18.5	12.8	2.75	1.5	0.7	45	55
C	33.0	18.0	10.5	2.65	2.0	0.6	72	28
CS	36.5	18.0	11.0	2.75	2.0	0.6	66	34

TABLE 3. FLAVOUR SCORE* FOR DIFFERENT FORMULATIONS OF SOY-SLURRIES DURING RIPENING AND AFTER PROCESSING

Formulation	Ripening period (days)			Processed cheese spread
	0	4	8	
SC 1	0	1.5	3.0	3.5
SC 2	0	1.0	2.0	2.5
SCS 1	0	2.0	3.5	4.0
SCS 2	0	2.5	4.0	5.0
C	0	3.0	4.5	6.0
CS	0	2.5	4.5	6.5

*Cheese-like flavour: 1.0-2.0 Poor, 2.5-4.0 Fair, 4.5-6.0 Good, 6.5-8.0 Excellent.

bitter. After processing, the acceptability further improved (score 3.5) but the bitterness persisted. When the content of soy concentrate and cream was further increased, the flavour quality deteriorated, the main defect being again bitterness. Thus, it was concluded that probably soyproteins are responsible for this defect. Therefore, in formulation SCS 1 (soyprotein concentrate-Cream-Skim milk powder) some milk protein was added through spray dried SMP. This improved the flavour characteristics of the product, particularly pleasant, creamy flavour which turned into a mild cheese flavour after 8 days of ripening. Processing of ripened slurries further improved the acceptability. Further increase in milk solids through cream and SMP enhanced the desirability of SCS 2 (soyprotein concentrate-Cream-Skim milk powder). Complete elimination of soyprotein concentrate further improved the flavour development in C and CS. It also provided greater scope for enhanced proportion of soy solids. This shows that it was soy concentrate which was responsible for off-flavour development. Thus, elimination of soy concentrate not only simplified the manufacturing technique and improved the flavour acceptability, but also resulted in a relatively low cost product, the cost of soy concentrate being considerably higher. The final formulation (CS) containing 0.55 kg of cream and 0.125 kg of SMP per kg of dehulled soybean resulted in the most acceptable product.

Chemical changes: Changes in titratable acidity of different formulations of soy-slurries during ripening are shown in (Table 4). The initial titratable acidity of the blend was approximately 0.55-0.60 per cent. Following addition of 5 per cent lactic culture and the adjustment of pH to 5.3, the acidity ranged from 0.63 to 0.75 per cent. The titratable acidity of SC1, SC2, SCS2 and C increased rapidly during the entire storage period. In SCS1 and CS, acidity increased rapidly upto to 4 days, then slowed down. The final acidity after 8 days ranged from 1.15 to 2.20 per cent, the lowest being in CS. In CS, besides the final concentration being lowest, the rate of acid development after 4 days of storage was also lowest. The lactic acid formed during the latter part of ripening might be getting converted into other flavouring components. Similar observations were made by Singh and Kristoffersen during their studies on cheddar curd slurries[3]. They reported that it is not only the final concentration of lactic acid which is important to cheese flavour development, but also the rate at which the lactic acid developed during the fermentation process.

The pH of the fresh slurries ranged from 5.8 to 6.7 depending on formulations. It was adjusted to 5.3 in the beginning of each experiment. The pH tended to decrease steadily during the first 4 days followed by an increase upto the end of storage (Table 4). The range of pH on 4 and 8 days of storage was 4.4-5.0 and 5.1-5.4,

TABLE 4. EFFECT OF DIFFERENT FORMULATIONS ON TITRATABLE ACIDITY, PH AND SOLUBLE PROTEIN OF SOY SLURRIES DURING RIPENING (STORAGE) AT 30°C

Formulations	Titratable acidity (as % lactic acid) during ripening at indicated days			pH during ripening at indicated days			Soluble protein (%) during ripening at indicated days		
	0	4	8	0	4	8	0	4	8
SC_1	0.75	1.23	1.85	5.30	4.75	5.25	0.20	2.40	3.50
SC_2	0.69	1.34	2.20	5.30	5.00	5.10	0.22	1.40	2.20
SCS_1	0.73	1.50	1.75	5.30	4.40	5.10	0.20	0.95	1.60
SCS_2	0.72	1.35	1.94	5.30	5.00	5.10	0.22	1.40	1.67
C	0.63	0.92	1.34	5.30	4.80	5.20	0.15	0.68	1.10
CS	0.71	1.10	1.15	5.30	4.80	5.40	0.17	1.22	1.50

respectively. It was observed that the stabilization of pH served as an index of the end of ripening period.

Table 4 shows the effect of different formulation on proteolysis of soy-slurries. The fresh slurries exhibited a soluble protein of 0.15 to 0.22 per cent which increased during ripening reaching values of 0.68 to 2.40 per cent and 1.1 to 3.5 per cent on 4 and 8 days of storage, respectively. It is apparent that the rate and extent of proteolysis was highest in SC1 and SC2, in which the major source of protein was soy-concentrate. These two samples were also bitter. It may be due to soyproteins and their degradation products. Addition of protein through SMP resulted in lower proteolysis and improved flavour characteristics. Thus the extent of proteolysis was closely related to the development of bitterness. Abberation in proteolysis is known to be responsible for bitterness in cheese[4].

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Microbial Changes in Stored *Shrikhand* and their Application in Predicting the Sensory Quality of the Product

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Manuscript received 8 *September* 1982; *revised* 31 *January* 1984

Five lots of plain *shrikhand* prepared using mixed culture *Streptococcus lactis* C-10 and *Streptococcus diacetylactis* DRC-1 were stored at 7±2°C and −7±2°C for 50 days. Changes in total bacterial, psychrotrophic, acid producing, *Lactobacillus*, proteolytic, lipolytic and yeast and mold flora showed a steady increase which was found statistically significant. The coliform count was negative in 0.1 g of the sample in all the cases. The product was unacceptable in about 40 days when stored at 7±2°C and 50 days at −7±2°C. There was good correlation between different microbiological tests and also with sensory evaluation. Total bacterial, coliform, yeast and mold counts can be relied upon for evaluating the quality of *shrikhand*.

Shrikhand is an indigenous sweetened fermented milk preparation traditionally prepared in India. The product is now being manufactured by organized dairies in Gujarat and very little information is available on the

bacteriological quality of *shrikhand* stored under commercial conditions. Upadhyay *et al.*[1] and Sharma and Zariwala[2] observed large variations in the microbiological quality of market samples of *shrikhand*. Use of single and mixed starter cultures in the preparation of the product has been studied by Gandhi and Jain[3] and Waghmare *et al.*[4] Deterioration in the quality of *shrikhand* during storage was observed by Sharma and Zariwala[5]. The present paper deals with the changes occurring in microbiological and organoleptic qualities of *shrikhand* prepared in the laboratory and stored at 7±2°C and −7±2°C. These storage temperatures were selected on the basis of commercial practices.

Materials and Methods

Five lots of *shrikhand* were prepared in the laboratory using a mixed culture of *Streptococcus lactis* C-10 and *Streptococcus diacetylactis* DRC-1[6].

The average (per cent) chemical composition of *shrikhand* is as follows: fat, 5.16 (from 4.98 to 5.38); protein, 6.59 (from 5.92 to 7.10); reducing sugar, 1.63 (from 1.40 to 1.84); non-reducing sugars, 39.37 (from 37.50 to 4.120) and moisture, 47.24 (from 44.34 to 49.50) Each lot of *shrikhand* was divided into two portions and packed in sanitized screw capped bottles of 1 kg capacity and stored at 7±2°C and −7±2°C and examined at intervals of 10 days, for psychrotrophic, acid producers, *Lactobacilli*, proteolytic, lipolytic coliforms and total bacterial counts as also for yeast and molds. Appropriate dilutions of the samples were plated using different selective media.

Total bacterial counts: Standard procedure was followed[7]. The petri plates were incubated at 37°C for 48 hr and the colonies were counted using a colony counter.

Psychrotrophic bacteria: The procedure adopted was same as above except that the petri plates were incubated for 7 days at 7°C.

Acid producers: Appropriate dilutions were plated using lactose agar medium[8] with the incorporation of 0.001 g calcium carbonate per litre of the medium as suggested by Wade *et al.*[9] for obtaining clear zones. The petri plates were incubated at 30°C for 48 hr.

Lactobacilli: Appropriate dilutions were plated using MRS medium[10]. The petri plates were incubated at 37°C for 48 hr.

Proteolytic bacteria: The procedure used for this purpose was similar to that adopted for milk by Safford and Stark[11]. The petri plates were incubated at 7°C for 7 days and the colonies with clear zones were enumerated.

Lipolytic organisms: Appropriate dilutions were plated using tributyrin agar[12] and the petri plates were incubated at 7°C for 7 days.

Yeast and mold: Appropriate dilutions were plated using Potato Dextrose Agar[13] and the petri plates were incubated at 25°C for 5 days.

Coliforms: Appropriate dilutions were plated using McConkey's Agar as suggested in Indian Standards procedure for milk[7] and the petri plates were incubated at 37°C for 48 hours.

All results were expressed as colony forming units (cfu) per gram of sample.

Sensory evaluation: Fresh and stored samples of *shrikhand* were scored organoleptically by a selected panel of six judges. The method and score card used was as suggested by Duthie *et al.*[13] for yoghurt.

Statistical analysis: The data were analysed by analysis of variance[14] and the best correlation between different microbiological tests and the sensory evaluation was calculated according to the method of Steel and Torrie[15].

Results and Discussion

The changes noticed in microbiological population of stored *shrikhand* samples are illustrated in Fig. 1 and 2. There was an overall increase of microbes except coliform at both temperatures of storage. Coliforms could not be detected in fresh as well as in stored samples of *shrikhand*. The increase in counts were significant throughout the storage period both at 7±2°C and −7±2°C but was higher in the former case.

Studies on market samples of *shrikhand* by Upadhyay *et al.*[1] and on laboratory samples by Sharma and Zariwala[5] showed no coliforms, which is confirmed by the results of the present study. Sharma and Zariwala[5], however, observed irregular patterns in all

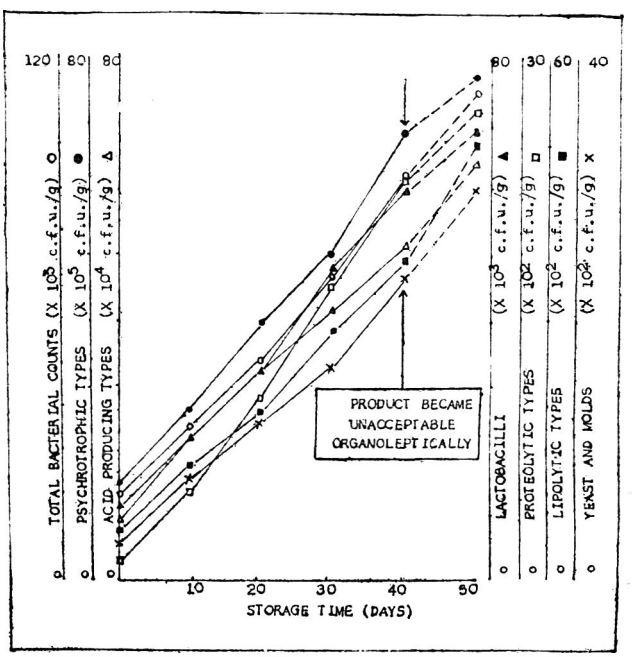

Fig. 1. Microbiological changes in *Shrikhand* stored at 7±2°C.

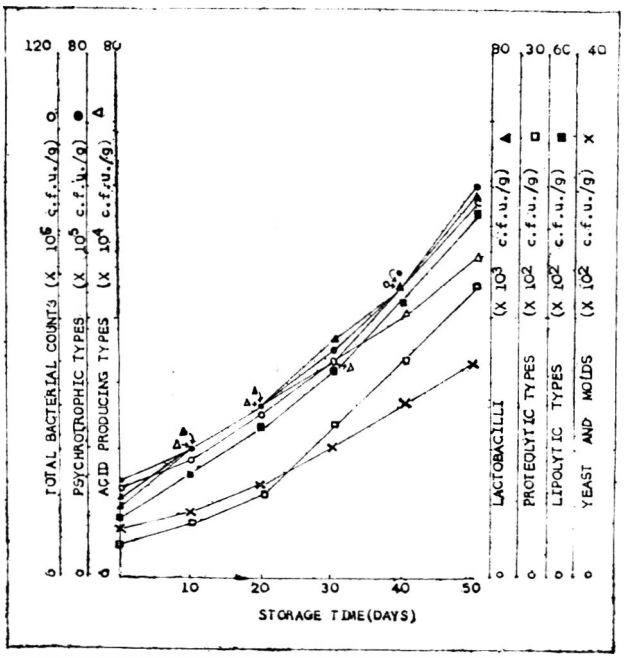

Fig. 2. Microbiological changes in *Shrikhand* stored at -7±2°C

TABLE 1. CHANGES IN SENSORY EVALUATION SCORES (OUT OF 18) OF *SHRIKHAND* DURING STORAGE

Storage period (days)	Temp. of storage 7±2°C	-7±2°C
Fresh	16.40	16.40
10	16.40	16.40
20	15.58	15.74
30	14.82	15.14
40	14.24	14.72
50	11.94	13.52

Critical difference at 5%; Storage time (S) 0.674; Temperature (T) 0.426; S×T interaction Not-significant.

the types of microorganism when the samples were stored at 37°C for 14 days. Such changes were not observed in the present study. Eventhough the storage temperatures adopted in these experiments are not optimum for the growth of microorganisms, increase in counts may be attributed to adaptation of these microorganisms and also to the repair of damaged cells, during the long storage period. Stainer *et al.*[16] have reported the growth of bacterial culture at -10°C, when high solute content of the medium prevented it from freezing. Frazier[17] has given the data on low temperature growth of bacteria and yeasts in different foods where temperatures as low as -10°C and -17.8°C permitted growth in meats and oysters respectively. Derbinova[18] reported the growth of citrate positive coliforms in ice cream stored at -20°C. All the above reports support the findings of the present study on the possible growth of microflora in *shrikhand* even when stored at -7±2°C.

There was a decrease in sensory evaluation score from 16.40 to 13.52 and 11.94 in *shrikhand* stored for 50 days at -7±2°C and 7±2°C respectively (Table 1). Significant differences were also noticed at different storage periods. *Shrikhand* was unacceptable organoleptically within 40 days at 7±2°C and in 50 days at -7±2°C, when the scores were 14.24 and 13.52, respectively. Sharma and Zariwala[5] have also observed similar trend in results in *shrikhand* samples stored at 10±3°C.

The data on correlations among the different microbiological tests showed significant correlations with each other at one per cent levels and also with data on sensory evaluation (Table 2). These results indicate that microorganisms contribute to the deterioration of *shrikhand*.

Present findings suggest that microbial load can be used as a routine quality control test with a limit of not more than 85×10^5 c f u/g for total bacterial counts,

TABLE 2. COEFFICIENT OF CORRELATION BETWEEN DIFFERENT MICROBIOLOGICAL TESTS AND SENSORY EVALUATION OF *SHRIKHAND*

Tests	Psychrotrophic types	Acid producing types	*Lactobacilli*	Proteolytic types	Lipolytic types	Yeast and molds	Sensory evaluation
Total bacterial counts	0.953**	0.904**	0.701**	0.850**	0.848**	0.924**	-0.822**
Psychrotrophic	—	0.885**	0.718**	0.823**	0.780**	0.898**	-0.734**
Acid producing	—	—	0.696**	—	—	—	-0.742**
Lactobacilli	—	—	—	—	—	—	-0.308**
Proteolytic	—	—	—	—	—	0.791**	-0.820**
Lipolytic	—	—	—	—	—	0.722**	-0.942**
Yeast and molds	—	—	—	—	—	—	-0.711**

**: Significant at 1 % level.

18.4×10^2 c f u/g for yeast and mold counts and absence of coliforms in 0.1 g of *shrikhand*. The above tests with the few chemical tests suggested earlier[6] may prove useful in ascertaining the quality of the product.

Acknowledgement

The authors are thankful to Dr. R. M. Patel, Department of Agricultural Statistics, B.A. College of Agriculture, Gujarat Agricultural University, Anand for his help in statistical analysis of the data.

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Manufacture of Butter Powder from Buffalo Milk*

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Manuscript received 29 *March* 1982; *revised* 26 *November* 1983

Free flowing butter powder containing 80% fat was manufactured from buffalo milk solids. The product made from ripened cream and skim milk powder was observed to be the most acceptable. It scored the highest for flavour (63.2 out of 65.0), had the greatest bulk density (0.29 g/cc), maximum flowability (minimum angle of repose, 44.8°) and fairly low free fat content (83.8%). The reconstituted spread obtained from this combination also secured the highest flavour score (45.2 out of 50.0) and overall sensory score (85.2%) as well. Sensory evaluation revealed that the butter powder containing 80% fat (as compared to 85 or 90%), and its reconstituted spread was better than that of higher fat contents; cow milk product rating slightly better than the buffalo one.

Several methods for the manufacture of high fat (80 per cent) butter powders from cow milk, suitable for making acceptable cakes, have been described in literature.[1-4] These powders are characteristically non-

*Data taken from first author's Ph.D. thesis, 1981, Kurukshetra University, Kurukshetra.

greasy and reasonably free flowing and remain in that condition even at high ambient temperatures. Such products have considerable application in food industry wherever dry blending of fats and oils with other dry ingredients is needed. Although butter powder can not be converted into normal butter by addition of water and working, because of its higher solids-not-fat (SNF) content, it can be converted easily into a table spread suitable for use as butter replacement.

Since fat is the major constituent of the high-fat powders, the quality of the product and its use mainly depend on the quality and quantity of the fat used. The sources of fat for butter powder can be cream, butter, ghee, butter oil and fractionated butter fat, vegetable oils generally form the fatty phase in the powdered shortenings and similar products[5]. Irrespective of the source, fat content plays an important role in the product. Ordinary cream powder (72 per cent) has been found to be tacky, difficult to convey in the dryer, and liberate free fat with the slightest pressure[6]. Higher ratios of fat to SNF can be obtained by drying the mix of higher fat content. However, such powders are usually difficult to manipulate by conventional drying methods, and are not free flowing. If the content of SNF in the powder is reduced below 14 per cent, insufficient protein is present to coat the fat globule surfaces and the fat is not stable when spray dried[7].

Since nearly 90 per cent of the milk handled by the organized dairy sector in this country is from buffalo and because of differential composition and also physico-chemical make up of the constituents in buffalo milk compared to cow milk, the technology of buffalo milk has often posed problems in the manufacture of products[8]. Hence, an attempt was made to manufacture butter powder from different sources and levels of fat, and enacpsulating material and their effect on the physico-chemical and sensory characteristics of the powder and reconstituted spread was investigated.

Materials and Methods

Manufacture of butter powder: The method outlined by Hansen[1] was followed with certain modifications. Ripened (by inoculating LF-40 mixed lactic culture at the rate of 1 per cent and incubating at 22°C till 0.25 to 0.30 per cent lactic acidity was obtained) or unripened cream, butter (using Silkebog Top butter churn of 100 kg capacity) made from ripened or unripened cream, or ghee (prepared from washed butter by heating at not more than 110°C in a jacketted kettle, filtering and storing at 4 to 5°C) was used as a source of fat. Skim milk powder (made by preheating skim milk to 80°C, condensing to 40 per cent solids under 61.0-63.5 cm vacuum and spray drying in an Anhydro spray drier at 190±2°C inlet and 95±2°C outlet air temperatures), sodium caseinate (made by precipitating skim milk at pH 4.3-4.6 with dilute 1:6 hydrochloric acid at 32-33°C washing the curd three times with acidulated water of pH 4.3-4.4, pressing, shredding, dispersing and peptizing at pH 6.8-7.0 in luke warm water with 2.5 N sodium hydroxide, adjusting the total solids content to 15 to 20 per cent, filtering, pasteurizing and spray drying under similar conditions as for skim milk powder) or a mixture (1:1) of these two was taken as the encapsulating material. Calculations were made to achieve a dried product giving 80 per cent fat and 1 per cent each of sodium citrate and glycerol monostearate (GMS). For investigations on the role of level of fat, butter pwoder was made from ripened cream and skim milk powder and the dried product contained 80, 85 and 90 per cent fat and was made from both buffalo and cow milk ingredients.

Sodium citrate was mixed with the fat. Sodium caseinate was dispersed in water at 40 to 45°C by vigorous stirring, and skim milk powder was reconstituted and filtered. These ingredients were mixed, warmed to 66–80°C followed by the addition of molten GMS and standardization of mix to 40 per cent solids. The mix was homogenized (Manton-Gaulin, U.S.A.) at 65°C at 141+35 kg/cm^2. The emulsion was pasteurized (at 75°C for 1 min), cooled to 30°C and finally spray dried at an inlet air temperature of 170–180°C and outlet air temperature of 80–85°C. The powder adhering on the inside wall of the spray drier was scrapped with the help of built-in chain scraper by running it for 1 to 2 min at intervals of 30 min. The powder was collected in polyethylene bags and placed in cold storage (5°C) for at least 12 hr. The powder was dry mixed with a free flowing agent (sodium aluminium silicate 0.5 per cent or starch 0.5, 1.0 or 1.5 per cent), sieved and filled in enamelled tins (under nitrogen) or polyethylene bags (300 gauge).

Preparation of reconstituted spread: Nineteen parts of water (or 12 parts for higher fat powders) at room temperature was added to 81 parts (88 for higher fat powders) of powder and prepared into a homogeneous plastic product, which was then packed in wooden frame of inner dimensions 40×40×40 mm, and cooled to 10°C in a refrigerator for 30 min. The cubes were removed, wrapped in butter paper and stored in refrigerator.

Analytical procedures: Standard methods were used for the fat[9] and solids not fat content of milk,[10] fat[11], solids-not-fat[12] content of cream, and moisture, fat and curd contents[13] of butter. The butter powder was analysed for moisture,[14] fat,[15] free (extractable) fat and bulk density,[16] expressible fat,[17] flowability[18], and particle size distribution.[19] The reconstituted spread was measured for its hardness with a precision penetro-

meter.[20] Microstructural studies of the powder were made under high power microscope by dispersing the powder in a mineral oil and preparing a smear on a microslide.

Sensory evaluation: Sensory evaluation was done by a panel of judges selected by a triangle test, using a 100-point descriptive scale. The butter powder was evaluated for colour, appearance and flavour. The reconstituted spread as 20×20×20 mm cubes, maintained at 15± 0.5°C for at least 5 hr, was evaluated for colour, body, texture, spreadability (on bread) and flavour.

Results and Discussion

The mix containing more than 40 per cent total solids tended to become appreciably viscous as a result of homogenization. During homogenization the newly formed fat globules can be clustered into smaller or larger aggregates. They are disintegrated into separate globules when both a calcium-chelating agent and a suitable surfactant are added,[21] suggesting that the globules are held together by casein micelles. Addition of sodium citrate and GMS prevented an excessive thickening of the emulsion in the homogenizer. The second stage of homogenization at low pressures helps in disruption of the clusters. Viscosity of the mix during homogenization was reduced appreciably with the inclusion of sodium caseinate as an ingredient when compared with skim milk powder as encapsulating material.

High fat to non-fat solids ratio in mix poses some problems in spray drying, especially if the emulsion is not stable[5], which may be due to insufficient homogenization or lack of emulsifying agents. Sometimes, destabilization is also caused by excessive acidity. As for example, a mix acidity of 0.4 per cent resulted in greater drying problems. Even neutralization of the high acid mix could not attain a stable emulsion during drying. All these result in sticking of the powder to the walls and ducts of the drier. Under extreme conditions, these deposits tend to cake together and may choke the duct thus interfering with the drying operations. The powder no longer remains free flowing and results in inferior quality product. It can however, be dried very satisfactorily in the Anhydro spray drier, running continuously for 6 hr, by maintaining proper drying conditions.

Role of source of fat and encapsulating material:

Bulk density (loose): The bulk density of the butter powder (Table 1) ranged from 0.14-0.29 g/cc depending on the type of encapsulating material used. It was generally higher when skim milk powder was used, either alone or in combination with sodium caseinate. This could be due to the higher bulk density of SMP compared to sodium caseinate. Similar values were reported by Parekh.[22] Thus the source of encapsulating material showed considerable effect on the bulk density of the butter powder.

Flowability: Mixing a free flowing agent to powdered milk product increases the flowability. The data (Table 2) showed that the encapsulating material, source of fat

TABLE 1. EFFECT OF SOURCE OF FAT AND ENCAPSULATING MATERIAL ON LOOSE BULK DENSITY, G/CC

Encapsulating material	Unripened cream	Ripened cream	Unripened cream butter	Ripened cream butter	Ghee	Mean
Skim milk powder	0.26	0.29	0.24	0.22	0.21	0.24
Skim milk powder + sodium caseinate	0.20	0.26	0.18	0.18	0.21	0.20
Sodium caseinate	0.20	0.16	0.17	0.14	0.15	0.17
Mean	0.22	0.23	0.20	0.18	0.19	—

CD: Encapsulating material, 0.032.

TABLE 2. EFFECT OF SOURCE OF FAT AND ENCAPSULATING MATERIAL ON FLOWABILITY AND ANGLE OF REPOSE (DEGREE)

Source of fat (F)	Encapsulating material								Mean (F)
	Skim milk powder		SMP + Sod. caseinate		Sod. caseinate		Mean (FS)		
	No silicate	0.5% silicate	No silicate	0.5% silicate	No silicate	0.5% silicate	No silicate	0.5% silicate	
Unrepened cream	46.28	45.32	48.00	46.90	53.00	48.67	49.09	46.96	48.03
Ripened cream	49.96	44.82	49.42	45.14	51.01	50.33	50.13	46.76	48.45
Unripened cream butter	48.70	45.96	50.23	47.38	50.91	49.51	49.95	47.62	48.78
Ripened cream butter	49.98	48.27	50.55	49.11	50.62	49.89	50.38	49.09	49.74
Ghee	52.48	48.69	50.98	50.14	53.72	52.04	52.39	50.29	51.34
Mean: encapsulating material		48.05		48.79		50.97			

SMP=Skim milk powder. CD for encapsulating material, 1.09; CD for source of fat, 1.40, and for silicate, 0.89.

and sodium aluminium silicate had significant ($P<0.01$) influence on the flowability of the butter powder. The powder made with sodium caseinate had the least flowability while the SMP based product had the greatest flowability. Among the fats, those with the unripened cream had the highest flowability and ghee based product had the lowest.

Addition of sodium aluminium silicate improved the flowability in all cases. But the improvement was not as much as reported by Sjollema,[18] or Tripp *et al.*[23] The lesser improvement in the present study could be attributed to the coarseness of the locally available sodium aluminium silicate.

Free (extractable) fat: The free fat content of the butter powder was considerably affected by the source of fat and encapsulating material (Table 3). Free fat content in cream based butter powder was significantly ($P<0.01$) lower than that of butter based product. This may be due to the presence of originally emulsified fat (as globules) with the native fat globule membrane in cream. Snow *et al.*[17] explained this on the basis of phospholipids present in the naturally occurring fat globule membranes.

There was a significant ($P< 0.01$) correlation observed between free fat content and bulk density (r–0.6829) and between bulk density and angle of repose (r–0.8565). Free fat content and angle of repose were also significantly ($P<0.05$) correlated with each other (r–0.5608) indicating that increase in free fat decreased the flowability.

Sensory evaluation: Buffalo milk butter powder (BBP) was white in colour; slightly more white with sodium caseinate. The product made with unripened cream and SMP scored (Table 4) maximum (9.6) while

TABLE 3. EFFECT OF SOURCE OF FAT AND ENCAPSULATING MATERIAL ON THE FREE FAT CONTENT OF BUTTER POWDER (PER CENT OF TOTAL FAT)

Encapsulating material	Unripened cream	Ripened cream	Unripened cream butter	Ripened cream butter	Ghee	Mean
Skim milk powder	82.74	83.79	85.62	85.78	85.97	84.78
Skim milk powder + sodium caseinate	82.79	85.20	86.72	87.84	85.30	85.57
Sodium caseinate	83.68	85.80	90.45	91.03	87.15	87.62
Mean	83.07	84.93	87.60	88.21	86.14	

CD for encapsulating material, 1.61; and for source of fat, 2.08

TABLE 4. EFFECT OF SOURCE OF FAT AND ENCAPSULATING MATERIAL ON SENSORY SCORE OF BUTTER POWDER

Sensory characters	Unripened cream	Ripened cream	Unripened cream butter	Ripened cream butter	Ghee
		Skim milk powder			
Colour	9.6	8.5	8.8	9.1	9.1
Appearance	23.5	21.3	22.2	23.2	22.7
Flavour	61.9	63.2	56.8	61.3	61.2
Total	95.0	93.0	87.8	93.6	93.0
		Skim milk powder + sodium caseinate			
Colour	9.0	8.2	9.1	8.9	9.2
Appearance	22.0	21.4	22.7	22.8	23.2
Flavour	57.4	59.3	58.2	59.6	59.1
Total	88.4	88.9	90.0	91.3	91.5
		Sodium caseinate			
Colour	9.0	8.2	9.3	9.3	9.2
Appearance	22.0	20.7	22.5	23.5	23.1
Flavour	56.3	57.5	55.3	58.7	58.7
Total	87.3	86.4	87.1	91.5	91.0

CD for colour: source of fat, 0.45; CD for appearance: source of fat, 0.97;
CD for flavour: encapsulating material, 1.88, and CD for total score:
Encapsulating material, 2.8.
Maximum score for: colour – 10, appearance – 25 and flavour – 65.

that made with reipened cream+sodium caseinate scored the lowest (8.2) for colour. This may be attributed to higher acidity of the latter product which might have adversely affected the colour during drying.

Irrespective of the source of fat or encapsulating material, the butter powders were observed to be free flowing. The lower apearance score of ripened cream+sodium caseinate product could be due to higher acidity which caused more lumpiness.

Butter powder made from ripened cream and SMP scored the maximum (63.2) for flavour. The presence of slightly developed acidity probably helped in masking the powdery flavour of the product. The use of sodium caseinate imparted gluey flavour.

The source of fat did not have a significant effect on the overall sensory quality of the butter powder. However, the encapsulating material significantly ($P<0.05$) affected the quality. The powder made with SMP scored the maximum followed by the mixture of SMP and sodium caseinate and sodium caseinate alone.

The colour of the reconstituted spread was dull white as compared to shining white of buffalo milk butter. The use of SMP as encapsulating material resulted in slightly superior product. Like with butter powder, the reconstituted spread made from ripened cream or ripened cream butter powder was appreciably duller in colour than other products (Table 5).

The spread from ripened cream+SMP scored the maximum (17.3) for body and texture while the ghee+sodium caseinate product scored the least (14.3).

All spreads except the one made from ghee had good spreadability. Ripened cream produced a superior product so far as flavour was concerned, followed by unripened cream butter, unripened cream, ghee and ripened cream butter spreads. Due to gluey flavour imparted by sodium caseinate, SMP encapsulated products were considered to be superior.

Overall sensory scores (Table 5) of the spreads varied from 85.2 for the ripened cream+SMP to 75.6 for ghee+sodium caseinate product. The higher score for the former could be attributed to flavouring compounds produced during the ripeneing of the cream. The source of fat had a highly significant ($P<0.01$) effect on the overall sensory quality of the reconstituted spread. While the ripened cream product was slightly, but not significantly, better than the unripened cream and unripened cream butter spreads, it was significantly superior to the products made from ripened cream butter or ghee (C. D. -2.68). Though encapsulating material had no significant affect on the overall sensory quality of the spread, the SMP based product was definitely better than either SMP+sodium caseinate or sodium caseinate based butter powder.

TABLE 5. EFFECT OF SOURCE OF FAT AND ENCAPSULATING MATERIAL ON THE SENSORY SCORE OF RECONSTITUTED SPREAD

Sensory characters	Unripened cream	Ripened cream	Unripened cream butter	Ripened cream butter	Ghee
Skim milk powder					
Colour	7.7	6.5	7.5	6.2	7.2
Body and texture	15.7	17.3	16.0	15.7	15.7
Spreadability	17.1	17.2	16.0	16.8	15.7
Flavour	43.0	45.2	43.2	41.0	42.7
Total	83.5	85.2	82.7	79.7	81.3
Skim milk powder + Sodium caseinate					
Colour	7.8	6.5	7.9	6.3	6.9
Body and texture	15.7	17.0	15.9	15.3	15.8
Spreadability	17.6	16.6	15.6	16.5	14.9
Flavour	42.3	44.4	42.9	38.5	42.4
Total	83.4	84.5	82.3	76.6	80.0
Sodium caseinate					
Colour	7.4	6.1	7.5	6.5	6.8
Body and texture	15.4	16.4	16.3	15.7	14.3
Spreadability	17.4	15.7	16.3	16.8	14.7
Flavour	41.7	42.5	41.8	39.5	39.8
Total	81.9	80.7	81.9	78.5	75.6

CD for colour: Source of fat, 0.37; CD for body and texture: Source of fat, 0.79;

CD for spreadability: Source of fat, 0.87; CD for flavour: Encapsulating material, 1.08, and source of fat, 1.40; CD for total (overall) score: Source of fat, 2.68.

Maximum score for colour —20, body and texture —20,, spreadability —20 and flavour —50

Role of level of fat: The 40 per cent solids mix tended to become appreciably viscous, as observed earlier also, on homogenization, more so with buffalo milk mix than with cow milk mix. This may be ascribed to the differential nature of milk proteins and lipids of the two systems. However, the differences disappeared with an increase in the fat to non-fat solids ratio.

Increassing the fat content of buffalo milk butter powder mix resulted in greater stickage of the powder to the walls of the drier and the duct conveying powder and exhaust air. Using cow milk solids, butter powder with 90 per cent fat could be prepared without difficulty, whereas buffalo milk solids at even 85 per cent fat level posed serious problems during drying. Presumably

TABLE 6. EFFECT OF LEVEL OF FAT ON THE PHYSICO-CHEMICAL PROPERTIES OF BUTTER POWDER

Level of fat (%)	Moisture (%)	Fat (%)	Free fat (%)	Expressible fa.*		Particle dia. (μ)	Particle size distribution (% of total particles) (dia μ)				Bulk density, (g/cc)	
				at 30°C	at 45°C		<20	21-40	41-60	>60	Loose	packed
Buffalo fat												
80	0.77	80.89	88.35	23.37	72.56	42.28	0.95	47.94	42.29	8.82	0.354	0.505
85	0.65	85.34	90.50	44.15	78.41	41.62	1.27	47.73	44.41	6.59	0.345	0.504
90	0.41	89.50	90.74	55.48	81.60	44.66	3.45	32.04	51.42	13.09	0.307	0.487
Cow fat												
80	0.77	80.57	83.15	41.71	66.21	31.63	13.29	66.83	18.52	1.36	0.255	0.391
85	0.60	85.43	84.56	48.75	82.93	33.55	4.37	74.11	20.27	1.25	0.282	0.428
90	0.51	89.51	86.89	50.06	87.47	36.60	1.48	66.74	29.15	2.63	0.286	0.444

*% of total fat.

CD for free fat: milk, 1.658; and fat level, 2.031; CD for expressible fat at 30°C: milk, 1.709, fat level, 2.093; CD for expressible fat at 45°C: fat level, 2.963; CD for average particle size (dia): milk, 3.816; CD for loose bulk density: milk, 0.0148; CD for packed bulk density: milk, 0.024.

poor emulsion stability of the buffalo milk mix might have caused this difference. This also affected the free flowing nature of the powder. However, the tendency of 90 per cent fat BBP to stick reduced considerably when the fat was encapsulated with SMP+sodium caseinate.

Increase in fat to solids-not-fat ratio resulted in lowering of the moisture content in the dried product under the same conditions of drying (Table 6). The correlation between moisture and fat content was highly significant ($P < 0.01$), its coefficient being 0.861 and 0.818 for BBP and cow milk butter powders (CBP) respectively; the overall correlation coefficient was 0.837.

Free (extractable) fat: BBP contained greater quantity of free fat as compared to CBP (Table 6). Similar observations were made by Sharma[24] in cream powders. This indicates that the mix emulsion prepared from buffalo milk ingredients was less stable than that from cow milk ingredients. Free fat content in the powder also increased at higher level of fat in the product supporting the findlings[24-27]. Tripp and coworkers[3-4] observed that the free fat content in the powders was proportional to its fat content. This could be attributed to the reduction in the amount of encapsulating material with an increase in the fat content of the powder. Correlation coefficients of 0.767 and 0.527 were observed between the free fat and total fat contents of BBP and CBP respectively.

Expressible fat: BBP was pbserved to contain (Table 6) lower expressible fat at 30°C, in 80 and 85 per cent fat systems but more in 90 per cent as compared to similarly made CBP. However, at 45°C the expressible fat in BBP was considerably higher at 80 per cent fat level and lower at the other two fat levels. The total fat content seemed to have a direct bearing on the expressible fat content at both 30 and 45°C, the latter increasing with the former. Very close and significant correlation ($P<0.01$) was observed between these parameters, its coefficient being 0.97 and 0.887 at 30°C 0.962 and 0.952 at 45°C for BBP and CBP respectively.

Particle size distribution: The particles size of the butter powder ranged from 31.6 to 44.7 μ with considerably larger particles in BBP than in CBP, The fat level did not seem to appreciably affect the number of particles in their size groups except for the smallest particle size group (20 μ or less) that the fat level had any appreciable influence on the proportion of the powder particles, (Table 6). However, the effect was opposite in the two types of butter powder. In general, particle size was significantly correlated (r–0.771) with the free fat content. Understandably, the free fat caused coalascence of the tiny fat droplets resulting in a continuous layer of fat surrounding the particles, and hence larger sized particles. Similar observations were made by Sharma.[24]

Bulk density: Loose bulk density of BBP was significantly ($P<0.01$) higher than that of CBP (Table 6). Similar observations were made by Sharma.[24] This is contrary to what would be expected[18,28] on the basis of larger particle size and higher free fat content in the buffalo milk product. Less uniformity in particle size distribution of the BBP might have resulted in closer packing and thus a higher bulk density. The increase

TABLE 7. EFFECT OF LEVEL OF FAT AND FREE FLOWING AGENT ON THE FLOWABILITY (ANGLE OF REPOSE) OF BUTTER POWDER, IN DEGREE

Level of fat (%)	Free flowing agent (%)				
	Control	Sod. Al. silicate	Starch		
		0.5	0.5	1.0	1.5
Buffalo fat					
80	48.06	44.57	45.26	45.18	46.05
85	48.71	42.20	45.93	46.94	45.22
90	44.67	43.89	44.90	43.97	44.15
Cow fat					
80	49.85	46.02	46.25	46.28	46.86
85	51.63	49.90	50.29	51.68	52.36
90	49.16	44.92	48.74	48.14	50.38

CD: Milk, 0.468; CD: Fat level, 0.574; CD: Free flowing agent, 0.741.

in fat level slightly decreased the bulk density of BBP and increased that of CBP. More or less similar observations were made with regard to packed bulk density.

Flowability; BBP had significantly ($P<0.01$) better flowability than CBP (Table 7). Although the fat level was found to have statistically significant ($P<0.01$) effect on the flowability, no conclusive pattern could be made out in this regard. The addition of free flowing agent (sodium aluminium silicate or starch) significantly ($P<0.01$) increased the flowability, sodium aluminium silicate being more effective than starch. Furthermore, addition of more than 0.5 per cent starch was of no greater advantage.

TABLE 8. EFFECT OF LEVEL OF FAT ON THE SENSORY CHARACTERISTICS OF BUTTER POWDER

Level of fat (%)	Colour (max. 10)	Appearance (max. 25)	Flavour (max. 65)	Total
Buffalo fat				
80	8.8	21.5	60.8	91.1
85	8.7	21.2	59.8	89.7
90	8.6	20.9	55.8	85.3
Cow fat				
80	8.7	21.4	60.2	90.3
85	8.3	21.7	60.6	90.6
90	8.9	21.4	57.4	87.7

CD for flavour: Fat level, 2.187; CD for total score: Fat level 3.412.

Sensory characteristics of butter powder: As the fat content increased, the colour score of BBP decreased (Table 8), however no such trend was observed in case of CBP. Generally, the butter powder was more smooth than whole milk powder. The scores for appearance were similar as for colour particularly in BBP. This could be due to greater stickage of the BBP on the walls of the spray drier as well as greater free fat content, as the level of fat increased in the butter powder. A definite trend of decreasing flavour score was observed with increase in fat level, greater difference being at higher level. This may also be due to greater tendency of 90 per cent fat powder to stick on the walls of the drier and the extensive heat exposure might have imparted a 'burnt' or oily flavour to the product. In general, CBP appeared to be slightly superior to BBP. Increase in fat content seemed to decrease the overall sensory score, which could be due to destablization of the product. Although there was no appreciable difference in the total scores of BBP or CPB, the latter was however, generally superior to the former.

Sensory characteristics of reconstituted spread: Though 19 per cent moisture level was found to be most suitable with 80 per cent fat butter powder, a lower level (12 per cent) was also tested so as to produce a spread closer to butter in its fat content when made from 90 per cent fat powder. Higher fat level in the butter powder, made de-emulsification during reconstitution much easier and provided the necessary release of the fat to give the desired body and texture to the spread.

The colour score (Table 9) of CBP increased with an increase in the fat content since there was no appreciable stickage of the powder to the drier walls unlike for the buffalo butter powder spread. The moisture level had no effect on the colour score of the spread. Cow milk product, however, was rated better than BBP spread. The score for body and texture in case of BBP spread decreased with an increase in the fat content, particularly at 12 per cent moisture level, but reverse was true for CBP product at both moisture levels. The spreadability was affected by the source of milk, fat and moisture level. The BBP spread scored less than the CBP spread. Since the buffalo milk fat has been reported[29] to be harder than the cow milk fat, presumably due to higher content of long chain saturated fatty acids[8], the former may be expected to be less easily spreadable. While the spreadability score increased with an increase in fat level in CBP at either of the two moisture levels, no particular trend could be observed in the BBP spread (Table 9).

The flavour score of the spread followed the same trend as was observed in the powder (Table 9). In general, better flavour was observed in CBP spread than in BBP, except at 80 per cent fat level. The 80 per cent fat BBP spread scored maximum at both moisture levels.

TABLE 9. EFFECT OF LEVEL OF FAT AND MOISTURE ON THE SENSORY CHARACTERISTICS OF RECONSTITUTED SPREAD

Level of fat (%)	Moisture in spread (%)	Colour	Body and texture	Spreadability	Flavour	Total
			Buffalo fat			
80	19	8.1	16.1	17.0	43.8	85.0
	12	8.1	16.5	16.5	43.6	84.7
85	19	8.9	16.3	16.8	43.2	85.0
	12	8.6	16.3	16.1	43.3	84.3
90	19	8.1	15.6	17.1	42.5	83.3
	12	7.9	16.0	16.8	42.3	83.0
			Cow fat			
80	19	8.1	16.5	16.8	42.9	84.3
	12	8.4	16.1	16.3	43.2	84.1
85	19	8.5	17.1	18.1	45.9	89.5
	12	8.5	17.1	17.7	45.5	88.8
90	19	8.7	17.8	18.1	45.4	90.0
	12	8.6	17.6	17.6	46.2	90.0

CD for colour: milk, 0.127, fat level, 0.1556; CD for body and texture: milk, 0.3858; CD for spreadability; milk, 0.3989, fat level, 0.4885, moisture, 0.3989; CD for flavour: milk, 0.6055, fat level, 0.7416; CD for total score: milk, 1.0781, fat level, 1.3204.

Maximum scores are for: colour—10, body and texture, —20, Spreadability—20, and flavour —50.

while in case of CBP spread the one made from 85 per cent fat and 19 per cent moisture, and 90 per cent fat and 12 per cent moisture scored highest. Overall quality of the spread was significantly ($P<0.01$) affected by the type of milk (cow or buffalo) and fat level; the moisture content did not seem to affect, although the score was slightly less at 12 per cent moisture in both BBP and CBP as compared to 19 per cent.

Hardness of the spread: Among the various physical properties of the spreadable product like butter, hardness is considered to be the most important; it determines the ease with which the spread can be applied on bread. Although the spreadability of spread was assessed in sensory evaluation, its hardness was measured using a penetrometer. The penetration value decreased with an increase in the fat content irrespective of moisture content (Table 10). The penetration value was greater at higher moisture level in both BBP and CBP spreads, and at lower moisture level (12 per cent), BBP spread being slightly harder than the CBP spread.

TABLE 10. EFFECT OF LEVEL OF FAT AND MOISTURE ON THE PENETRATION VALUE OF THE RECONSTITUTED SPREAD, mm

Moisture in spread (%)	Buffalo fat level (%)			Cow fat level (%)		
	80	85	90	80	85	90
19	6.23	6.15	6.12	6.08	5.93	5.80
12	5.20	4.44	3.89	5.38	5.22	5.07

CD: Fat level, 0.394, moisture, 0.321.

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Production of Full Fat Soy Flour at the Rural Level

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Manuscript received 16 *August* 1982; *revised* 6 *January* 1984

An improved immersion cooking process is developed for the production of full fat soy flour at the rural level with the equipment available at the farmers' houses. The process includes the preparation of soya dhal, blanching in 1% $NaHCO_3$ (w/v), immersion cooking in boiling water (100°C), drying and milling. From 10 kg raw beans about 7.5 kg flour is obtained. The product has 40% protein and 20% oil and devoid of antinutritional factors. The flour has a fineness modulus of 3.87 and could be blended at 20% level with wheat flour to make *Chapatis*. They are widely accepted by the consumers. The cost of production of one kilogram of flour is about Rs. 1.00, which includes mostly the family labour.

Soybean (*Glycine max* Merr) which contains 40 per cent protein and 20 per cent oil also contains an unusually large number of biologically active components which are to be eliminated prior to human consumption[1]. Most of them are thermolabile and are easily destroyed by heat treatment[2-4]. The soybeans are processed into various products namely, oil, flours, protein concentrates, and isolates and other fermented products. The soy protein has all the essential amino acids in adequate quantities except the sulphur containing amino acids.

The soy oil is rich in poly unsaturated fatty acids which are highly desirable. Despite their nutritional importance, the soy products are not very popular in India as they possess a characteristic beany flavour/greasy flavour[5]. This off flavour may not be completely eliminated but could be minimised by the addition of Na OH or HCl to the cooking water[6]. Among these soy products, full fat soy flour is of immense value in Indian context. The flours are commercially produced by continuous extruder cooker process[7]. They are easily blended with various cereal/millet/pulse products at different proportions to prepare a number of traditional dishes. The present investigation is carried out to develop a simple technology for making full fat soy flour at the village level/cottage industry level so that the rural people could easily process the soybean with the equipment available with them for their consumption.

Materials and Methods

The soybean variety 'PT 49' was obtained from the Farm Section, Central Institute of Agricultural Engineering, Bhopal.

Production process: The process involves the processing in 10 kg batches using the equipment and utensils already available with farmers:

Cleaning: Soybean (8 per cent mc wb) was freed from dirt, foreign matter and brokens with an air clean basket. It has a capacity of 4 kg/hr.

Cracking and winnowing: The cleaned beans were cracked with a hand stone grinder of a capacity of 10 kg/hr and the hulls were removed by winnowing with an air clean basket. The hulls constituted 10 per cent of the whole beans.

Steeping: The spilt beans were filled in cloth bags to 1/3 of their capacity and soaked in water containing one per cent (w/v) Sodium bicarbonate at room temperature for 4 hr. The beans to water ratio was 1:3 (w/v). The beans were conditioned to 52 per cent moisture content.

Immersion cooking: The cloth bags alongwith the split pulse were kept in boiling water (100°C) for 20 min. Later the the excess water was drained. Domestic stove using fuels like agricultural wastes, or kerosene stove was used.

Drying: The cooked split pulse was spread in single layers on a white polyethylene sheet/cloth and sun-dried to 8 per cent moisture content (wb). It took about 36-48 hr.

Milling: Further reduction of split beans to flour was accomplished by grinding in a hand stone grinder.

Utilization: The produce is ready for human consumption after blending with cereal /millet/pulse products at 15-20 per cent levels.

Packaging: The flour may be stored in used metallic tins/cloth bags.

Quality of the product: The AACC[8] methods of analyses were used for the determination of protein, oil, urease activity and lysine[9]. The water absorption isotherm[10] was also estimated.

Sieve analysis of the flour: The sieve analysis was carried out with I.S. Sieve No. 15, 20, 25, 40, 85, 140 and 200 for determining the fineness medulus.

Organoleptic evaluations: The flour was organoleptically evaluated by distirbuting half a kg of flour to about 50 selected farm families and their opinion was sought for various parameters like taste, flavour, colour, feeling/texture, appearance and general acceptability. A nine point scale[11] of excellent–9, very good –8, good –7, below good and above fair –6, fair –5, below fair and above poor –4, poor –3, very poor –2, extremely poor–1, was followed to assess the opinions of the consumers.

Economics of the process: The cost of production of a kilogram of full fat soy flour by this method was worked out by considering the cost of raw beans, family labour employed and other unit operations.

Results and Discussion

Production process: From 10 kg raw beans about 7.5 kg flour is obtained. The losses are mainly through hulls and the water soluble leachable solids lost either in steeping, boiling or in other unit operations. The soy-products are having the characteristic beany flavour. It cannot be eliminated completely but minimised to a greater extent by either pre roasting the beans at 80°C for a few minutes or steeping the beans for 4 hr in water containing one per cent (w/v) sodium bicarbonate at room temperature. The pre-conditioning of beans to 52 per cent moisture content (wb) facilitates the effective detoxification of beans. The addition of baking soda brings the pH to 8.0-8.5, which enhances the inactivation of the lipoxygenase. This enzyme is mainly responsible for the beany flavour. All the unit operations were carried out with the available equipment and utensils at the village community so that the farmers

TABLE 1. CHEMICAL COMPOSITION OF THE FULL FAT SOY FLOUR

	Values
Moisture (% wb)	8.0
Protein (N×6.25) (%)	40.0
Oil (%)	20.0
Urease activity (change in pH units)	0.0-0.1
Water absorption isotherm (%)	206
Available lysine (% protein)	6.0-6.5
PER	2.0 (2.5 casein)

can process soybean for their own consumption or sell as a value added product. The flour may be blended with either cereal/millet/pulse products to prepare a variety of Indian recipes. The flour can be utilised immediately or stored in the cloth bags/metallic tins for future use.

Quality of the product: The chemical composition of the full fat soyflour is shown in Table 1. It contains 40 per cent protein and 20 per cent oil.

Sieve analysis of the flour: The fineness modulus of the flour was determined and the results are presented in Table 2. It was 3.87. The flour can be easily blended with wheat flour at 15-20 per cent level.

Organoleptic evaluation: The opinions of the farm families were collected and the results are presented in Table 3. The soy flour was blended with wheat flour at 20 per cent level and the *Chapati* prepared were organoleptically evaluated. The results show the wide acceptability by the consumers.

For each character the opinion is found to be always good or above good except for the flavour. The soy products gain consumers' acceptability if they are within the reach of the rural people. A number of other traditional dishes prepared by blending the soy flour with various cereal/millet/pulse products have also got the consumers' acceptability.

TABLE 2. SIEVE ANALYSIS OF THE FLOUR

Sieve ISS	Nos. ASIM	Width of opening (mm)	% wt. retained	Cumulative % retained
200	10	2.032	0.00	0.00
140	14	1.405	0.00	0.00
85	20	0.954	1.00 × 5	5.00
40	40	0.420	88.40 × 4	353.60
25	60	0.251	7.46 × 3	22.38
20	70	0.211	2.60 × 2	5.20
15	100	0.151	0.40 × 1	0.40
Pan	Pan	—	0.14 × 0	0.00

Fineness modulus (Total/100) of the flour is 3.8658

TABLE 3. MEAN SCORE VALUES FOR SENSORY QUALITY CHARACTERISTICS OF *CHAPATIS* PREPARED FROM SOY-WHEAT BLEND

Character	Mean score value
Flavour	6.2
Taste	7.1
Feeling/texture	7.0
Colour	7.9
Appearance	7.6
General acceptability	7.0

TABLE 4. COST OF FULL FAT SOY FLOUR PRODUCTION (10 KG BATCH)

Unit operation	Cost (Rs)
Raw soybeans	37.50
Processing cost*	5.40
Package (metallic tins)	5.00
Production cost (7.5 kg flour)	42.90
Cost/kg of flour	5.72

*Includes cleaning, dehulling, winnowing, steeping, fuel and size reduction.

Economics of the process: The cost of production of full fat soy flour was calculated and is given in Table 4. The results reveal that a kg of soy flour costs about Rs. 5.72.

The present investigation thus shows that the soybeans can be processed into full fat soy flour at the rural level with the available equipments at the farmers' houses. In these days of energy crisis this kind of technology will be a vital proposition. The full fat soy flour available for household and other diverse utilization help solving the problems of protein/calorie malnutrition prevailing in the rural areas of India.

Acknowledgement

Authors are grateful to the Director, Central Institute of Agricultural Engineering, Bhopal, for providing the facilities in conducting the experiment.

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Effect of Degree of Milling on Tocopherol Content of Rice Bran

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Manuscript received 9 *June* 1983; *revised* 5 *January* 1984

The effect of milling brown rice to very low, low and medium degrees on the tocopherol content of the bran has been studied in 'Madhu' (improved), 'Jaya', 'Pushpa' and 'IR-20' varieties of rice. The total tocopherol content ranged from 3000 to 5000 μg per 100 g of brown rice. ∝-tocopherol constituted about a third of the total tocopherols. The germ accounted for more than 95% of the total tocopherols and nearly one third of the oil content of the rice grain. The germ of 'pushpa' had 25% oil and the total tocopherol content of the germ oil was 551 mg per 100 g. The quantity of oil removed from the rice grain during milling increased with the degree of milling. About 50% of the total oil of the whole grain is removed when milled to medium degree. The oil content of the bran varied with the variety (20.4 to 23.7%), but also to a lesser extent influenced by the degree of milling. The tocopherols content of the bran varied with the degree of milling but the percentage of tocopherols removed from brown rice increased with degree of milling.

Little use is made of the nutritional qualities of rice bran for human foods, though such use has long been suggested[1]. Besides the protein and edible oil, rice bran is a rich source of tocopherols (Vitamin E), the content of which ranges from 50 to 4000 mg per 100 g bran oil[2-4] Though extraction of oil from rice bran is extensive in Japan and is increasing in a number of other countries, there is hardly any commercial production of Vitamin E concentrates from rice bran or the bran oil. However, with the increasing interest in natural sources of vitamins, rice bran may have a place as a commercial source for the preparation of natural Vitamin E concentrates. While investigating some of these aspects, we observed a wide variation in tocopherol content of rice bran obtained from the local market. This necessitated the present investigation on the effect of degree of milling of rice on the tocopherol content of the bran. The results obtained with four varieties of rice under three conditions of milling are reported in this paper.

Materials and Methods

Sample preparation: 'Madhu' (improved), 'Jaya' 'Pushpa' and 'IR-20' varieties of paddy were procured from the Agricultural Research Station, Nagenahalli, Mysore. Paddy, (5 kg) of each variety was hulled using a McGill sample sheller. The brown rice (750 g lots) from each variety was milled using a McGill Miller No. 3 to very low, low and medium degrees (corresponding to degree of milling of approximately 2, 3 and 5 per cent respectively) and the polishings were collected. The milled rice in each case was sifted using a No. 16 B.S. sieve and the material passing through the sieve was combined with the respective polishings. The pooled polishings in each case were sieved using a No. 22 B.S. sieve and the sievings were collected as pure bran.

Soxhlet extraction of the dried rice, rice bran and rice germ for the estimation of oil content was carried out using petroleum ether (40-60°C) as the extracting solvent.

Tocopherol estimation: The sample (10 g) taken in a 250 ml round bottom flask was refluxed with 100 ml of reagent grade hexane on a hot water bath for 30 min, and filtered using a Buchner funnel. The residue was washed twice with fresh hexane and the pooled filtrate was desolventised under reduced pressure below 35°C in a rotary flash evaporator. The oil obtained was estimated for total and ∝-tocopherol content[5] with the following modifications in the isolation of ∝-tocopherol.

Isolation of ∝-tocopherol: A known aliquot of total tocopherol extract obtained after saponification and removal of sterols was subjected to two-dimensional

paper chromatography on Whatman Chromatographic paper No. 3 using benzene and hexane-diethyl ether (90:10 v/v) as developing solvents in the first and second directions, respectively. The spot having R_f similar to d-∝-tocopherol was located under UV light and carefully cut out for colorimetric determination. The paper chromatographic technique yielded higher recoveries of ∝-tocopherol than the TLC technique described by Meijboom and Jongenotter[6].

Colorimetric determination: The strip of paper containing ∝-tocopherol was taken in a stoppered test tube, one ml of ethanolic dipyridyl solution was added and gently swirled for 1 min. Ethanolic ferric chloride solution (1 ml) was added and the total volume made upto 10 ml with ethanol. After allowing the colour to develop for 10 min, the absorbance was read at 520 nm in a Bosch and Lomb Spectronic-20 colorimeter. A blank was simultaneously run using a strip of paper corresponding to the R_f of the sample cut out from the same chromatogram.

Calibration curve: A calibration curve of standard d-∝-tocopherol was prepared using 10, 20, 30,40 and 50 μg of d-∝-tocopherol in ethanol. Recovery was 90 to 95 per cent.

TABLE 1. BRAN REMOVED FROM BROWN RICE DURING MILLING

Variety	Bran (% of brown rice) removed at diff. degrees of milling		
	Very low	Low	Medium
Madhu	1.5	3.0	4.7
Jaya	1.9	3.8	4.3
Pushpa	—	2.7	4.7
IR—20	1.3	3.3	—

Results and Discussion

The progressive removal of the various constituents with varying degrees of milling of brown rice is shown in Tables 1-4. Table 1 shows the extent of bran removal under the test conditions. The data in Table 2 indicate that the amount of oil lost from the brown rice into the bran increased with degree of milling of brown rice. The amount of oil lost from brown rice into the bran even

TABLE 2. OIL CONTENT OF BRAN AND THE EXTENT OF OIL REMOVAL FROM BROWN RICE AT DIFFERENT DEGREES OF MILLING

Variety	Oil (% of bran) obtained at diff degrees of milling			Oil (% of brown rice)	% oil removed from brown rice at diff degrees of milling		
	very low	low	medium		very low	low	medium
Madhu	23.7	23.7	23.7	2.3	15	31	48
Jaya	20.4	21.6	21.3	2.1	19	32	43
Pushpa	—	23.0	23.7	2.3	—	27	49
IR-20	23.0	23.4	—	2.6	11	30	—

TABLE 3. TOTAL TOCOPHEROLS CONTENT OF BRAN AND EXTENT OF THEIR REMOVAL FROM BROWN RICE AT DIFFERENT DEGREES OF MILLING

Variety	Tocopherols (μg/g bran) at diff. degrees of milling			Tocopherols (μg/g of brown rice)	% tocopherols removed from brown rice at diff degrees of milling		
	very low	low	medium		very low	low	medium
Madhu	390	540	360	31.3	20	58	58
Jaya	270	270	460	36.3	16	26	58
Pushpa	—	280	390	45.4	—	19	46
IR-20	430	440	—	48.7	12	32	—

TABLE 4. ALPHA TOCOPHEROL CONTENT OF BRAN AND THE EXTENT OF REMOVAL OF ALPHA TOCOPHEROL FROM BROWN RICE AT DIFFERENT DEGREES OF MILLING

Variety	∝-tocopherol (μg/g bran) at diff. degree of milling			∝-tocopherol (μg/g brown rice)	% ∝-tocopherol removed from brown rice at diff degrees of milling		
	very low	low	medium		very low	low	medium
Madhu	130	110	90	10.3	21	38	44
Jaya	110	150	200	11.4	21	43	84
Pushpa	—	80	190	15.9	—	15	62
IR-20	140	260	—	16.4	11	56	—

TABLE 5. PERCENTAGE OF ALPHA TOCOPHEROL IN TOTAL TOCOPHEROLS OF BRAN AND BROWN RICE

Variety	% ∝-tocopherol in bran at diff degrees of milling			∝-tocopherol in brown rice (μg/g)	% ∝-tocopherol removed from brown rice at diff degrees of milling		
	very low	low	medium		very low	low	medium
Madhu	33.3	20.4	25.0	32.9	35.5	21.6	25.1
Jaya	40.7	55.6	43.5	31.4	42.9	51.6	45.3
Pushpa	—	28.6	48.7	35.0	—	29.1	47.6
IR-20	32.6	59.1	—	33.7	31.0	59.7	—

TABLE 6. TOCOPHEROL CONTENTS OF RICE AND WHEAT GERM OILS

Sample	Germ (% of grain)	Oil (%) in germ	Oil (%) in whole grain		Tocopherol in germ (μg/g)	Tocopherol (μg/g) in whole grain		Tocopherol (μg/g)	
			Total	Constituted by germ		Total	Constituted by germ	in germ oil	in whole grain oil
Pushpa var rice	2.7	25.0	2.3	0.67	1378	45.4	37.0	5510	1980
Red Winter wheat [9], [10]*	2.0–3.5	10.5	1.5	0.22	500	—	13.8	4762	—

*As reported in literature

at medium milling was only about 50 per cent of the total oil present in brown rice. This is in agreement with the data reported by Sondi *et al.*[7] The oil content of the bran changed slightly with the degree of milling, which is in agreement with literature reports[8]. The variety 'IR-20' had the highest total tocopherol content among the varities examined (Table 3). The total tocopherol content of the bran increased with the degree of milling of brown rice, but it had no relationship to the amount of bran removed. The ∝-tocopherol content was approximately one third of the total tocopherol content in all the varieties of brown rice (Table 4) and ranged from 31.4 to 35.0 μg/g. In 'Madhu' (improved) variety, the proportion of ∝-tocopherol in the bran decreased with milling (Table 5) for reasons unknown and could be a varietal characteristic.

The rice germ oil is comparable to wheat germ oil in its tocopherol content (Table 6). In rice growing countries, the rice polishings could be a potential source of natural Vitamin E. With the production of 42 million tonnes of rice in India, there is a possibility of recovering as much as 1.05 million tonnes of rice germ equivalent to about 2,50,000 tonnes of germ oil and 1,378 tonnes of natural Vitamin E from the polishings.

Acknowledgement

The authors are grateful to Dr. B. L. Amla, Director, of the Institute, for his keen interest in the investigation, to Dr. K. R. Bhattacharya, for the valuable suggestions and to Shri R. Shankara, for assistance in milling of paddy.

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Influence of Curcumin and Capsaicin on the Composition and Secretion of Bile in Rats*

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Manuscript received 21 *September* 1983; *revised* 12 *March* 1984

The intragastric administration of 50 mg curcumin (125 mg/kg body weight) or 1.5 mg capsaicin (3.75 mg/kg body weight) per rat increased the bile secretion rate; the effect of capsaicin was more pronounced. The output of cholesterol and bile acids in bile was higher only in rats forcefed with 100 mg curcumin. Feeding 7.5 or 15 mg% capsaicin or 0.2 or 0.5% curcumin in the diet for 4 weeks did not alter the bile secretion but significantly increased the total bile acids output. The results suggest that the active principles stimulate the bile forming function of the liver and of the conversion of cholesterol to bile acids, the latter being independent of their hydrocholagoguic property.

Spices are known to possess many beneficial effects among which their influence on the digestive tract is an important one[1]. Two such spices, red pepper (*Capsicum annum* L.) and turmeric (*Curcuma longa* L) are very widely used in our dietary. Glatzel[2] showed that red pepper or chillies stimulated salivary and gastric secretion in humans. Ramaprasad and Sirsi[3,4] reported that sodium curcuminate, the sodium salt of curcumin which is the active principle of turmeric, exerted choleretic and cholagoguic effect in dogs. More recent studies have indicated that curcumin[5] and the active principle of red pepper capsaicin[6], possess hypocholesteremic activity in rats maintained on an atherogenic diet. With a view to understanding some of the biochemical and physiological effects of these two spices we undertook a study of the influence of curcumin and capsaicin on bile secretion and its composition in the rat and the findings are reported in this paper.

Materials and Methods

Male albino rats of the Wistar strain weighing 340-400 g were used in these experiments. They were housed in individual cages and had free access to diet and water. Natural curcumin was a gift from Flavours and Essences Pvt Ltd, Mysore, India. Capsaicin (N-vanillylnonanamide) and urethan were purchased from Fluka, Switzerland and Loba Chemicals, India respectively. All other chemicals and solvents were of analytical reagent grade and solvents were distilled before use.

Single dose study: Five groups of six rats each were maintained on a 18 per cent casein diet[7] for two weeks. After an overnight fast but with no restriction for water, the active principle was forcefed by gavage as a suspension in 1.0 ml of a 10 per cent (W/V) aqueous dispersion of soluble starch. Curcumin and capsaicin were administered at 50 and 100 mg and at 1.5 and 3 mg per rat respectively. Control rats were administered starch only.

Dietary feeding study: The control group of rats was fed with a basal 18 per cent casein diet. Four other groups of rats were respectively fed the basal diet to which was added (*i*) 7.5 mg per cent capsaicin, (*ii*) 15 mg per cent capsaicin, (*iii*) 0.2g per cent curcumin, and (*iv*) 0.5 g per cent curcumin for 4 weeks. After an overnight fast but with no restriction for water, all rats were forcefed by gavage 1.0 ml of 10 per cent (W/V) aqueous starch so as to make it comparable to the single dose study.

Bile cannulation: Three hours after the administration of the active principle or starch, rats were anaesthetised with ethyl urethan (1.5 g/kg i.p) and 45 min later laparatomy was performed and the common bile duct was cannulated with PE-58 polythylene tube (Rhomans, India). Bile was collected for 3 hr; during this time body temperature was maintained at 36±0.5°C using incandescent lamps. All samples were kept frozen until used for analyses.

Dry matter in the bile was determined by gravimetry. Lipids were extracted by the method of Bligh and Dyer[8]; cholesterol and phospholipid in the chloroform extract were estimated by the method of Searcy and Bergquist[9] and of Marinetti[10] respectively. The total bile acids in

*Part of the data was presented at the 3rd Indian Convention of Food Scientists and Technologists held at Mysore in June 1983.

TABLE 1. EFFECT OF INTRAGASTRIC ADMINISTRATION OF CURCUMIN AND CAPSAICIN ON BILE FLOW AND COMPOSITION

Dose/rat	Bile flow (ml/hr)	(% increase)	Bile solids (g%)	Cholesterol (μM/ml)	Total bile acids (μM/ml)	Phospholipid (μM/ml)
Control	0.30±0.03		3.31±0.19	0.82±0.05	6.82±0.5	3.91±0.24
50 mg curcumin	0.42±0.03[a]	40	2.79±0.1[b]	0.89±0.03	6.64±0.27	3.84±0.31
100 mg curcumin	0.41±0.05	37	3.21±0.08	1.11±0.12	8.78±0.71	5.93±0.9
1.5 mg capsaicin	0.42±0.04[b]	40	2.88±0.15	0.89±0.12	8.21±0.83	4.42±0.83
3.0 mg capsaicin	0.36±0.04	20	3.05±0.24	0.82±0.03	6.43±0.74	4.08±0.44

Values are Mean±SEM of 6 rats. [a]$p<0.02$, [b]$p<0.05$.

the methanolic layer were further extracted and estimated by the method of Mosbach[11]. Differences between groups were evaluated for significance by the Student's t test[12].

Results and Discussion

Table 1 shows data of the single dose study. Curcumin at 50 mg (equivalent to 0.5 per cent of diet or 125 mg per kg body wt.) and capsaicin at 1.5 mg/rat (equivalent to 15 mg per cent of the diet or 3.75 mg/kg body wt.) enchanced bile secretion significantly. At the high doses of 100 mg curcumin and 3.0 mg capsaicin, the increases in bile secretion were not more than at the lower dose; in fact with capsaicin, the increase was much less at the higher dose. While there was a marked decrease in bile solids with the lower dose of curcumin, it was not so marked with the lower dose of capsaicin. The higher doses of curcumin and capasaicin hardly influenced bile solids. Cholesterol and total bile acids content of the bile were significantly higher only in rats that were given 100 mg curcumin; curcumin at the lower dose of 50 mg or capsaicin at either dose did not influence the secretion of cholesterol or bile acids. Phospholipid concentration in bile was also not affected by curcumin and capsaicin at either dose.

As contrasted with the single dose study, feeding of these active principles in the diet for 4 weeks did not influence bile secretion or its dry matter content (Table 2). Whereas cholesterol and phospholipid concentrations were not altered, the total bile acid concentration was significantly higher with both levels of curcumin and with 7.5 mg per cent capsaicin in the diet. A higher level of capsaicin in the diet did not make any difference to bile acid secretion.

The results reported in this paper indicate that both curcumin and capsaicin are hydrocholagogues as they cause an increase in bile flow with a concomitant decrease in solids. Considered on the basis of the dose administered, capsaicin is a better stimulant of bile flow than curcumin. As contrasted with Ramprasad and Sirsi's[3] observation of about a 100 per cent increase in bile flow in dogs given 25 mg/kg of sodium curcuminate, rats appear to respond much less with only a 40 per cent increase on a dose of 125 mg/kg of curcumin. The difference in response is probably due to the absence of the gall bladder in the rat. Since reabsorption of bile salts

TABLE 2. EFFECT OF CURCUMIN AND CAPSAICIN FEEDING FOR 4 WEEKS ON BILE SECRETION AND COMPOSITION

Treatment	Bile flow (ml/hr)	Bile solids (g%)	Cholesterol (μM/ml)	Total bile acids (μM/ml)	Phospholipids (μM/ml)
Control	0.45±0.03	2.86±0.09	0.99±0.07	10.70±0.73	4.48±0.33
7.5 mg% capsaicin	0.40±0.03	2.91±0.14	1.06±0.08	13.23±0.86[a]	5.55±0.57
15.0 mg% capsaicin	0.45±0.05	2.74±0.08	0.92±0.05	12.53±0.44	4.64±0.31
0.2 g% curcumin	0.42±0.03	2.74±0.08	0.91±0.05	19.29±0.07[b]	4.63±0.55
0.5 g% curcumin	0.38±0.04	2.84±0.10	0.85±0.09	20.56±0.58[b]	4.72±0.39

Values are Mean±SEM of 6 rats in each group. [a]$p<0.05$, [b]$p<0.001$.

was suppressed by diversion of the normal route, the excess bile salt production is considered to be due to the increased conversion of cholesterol to bile acids by the liver. This inference is in agreement with the observations on the hypocholesteremic activity of turmeric and curcumin[5] as also of red pepper and capsaicin[6]. The increased output of bile salts caused by either active principle administered intragastrically or fed in the diet, may be interpreted as due to the true stimulation of the bile forming function of the liver. Further, in the long term feeding experiment, increased bile acid concentration is not accompanied by enhanced bile flow and the converse is true in the single dose experiment. It is therefore inferred that the stimulation of cholesterol metabolism is independent of the hydrocholagoguic property. Whether other commonly used spices have any effect on bile production and composition is being investigated.

Acknowledgement

GB is grateful to the Council of Scientific and Industrial Research, India for the award of Junior Research Fellowship.

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Acceptability and Vitamin Contents of Foods as Affected by Cooking in a Sauce Pan, Pressure Cooker and Solar Cooker

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Manuscript received 22 *March* 1983; *revised* 20 *January* 1984

Acceptability and vitamin retention of seven commonly used North Indian dishes cooked in a sauce pan, pressure cooker and solar cooker were evaluated. Solar cooking was the best for colour, flavour, texture, taste and overall acceptability of all the preparations. Pressure cooking secured the maximum score for doneness. The losses in thiamine, riboflavin and vitamin C contents of foods during cooking were the maximum in sauce pan cooking followed by pressure cooking and solar cooking.

Different cooking methods have varied effect on the nutritional[1,2] and organoleptic qualities[3] of food. Utilization of solar energy is of late gaining special significance due to the energy crisis. Besides numerous innovations, this has resulted in the invention of solar cooker. With the development of solar cooker, it has become desirable to explore its utility and also to assess the effects of solar cooking on the nutritive value and acceptability of foods. In the present study some common North Indian food items were cooked using the

solar cooker and evaluated for their organoleptic acceptability and vitamin retention and compared with the dishes prepared by the existing methods of cooking namely, sauce pan and pressure cooking.

Materials and Methods

Seven commonly prepared dishes of India viz., plain rice, wheat porridge, green gram, *chana urad dal* (dehusked Bengal gram and black gram, 1:2), '*Kabuli chana*' (white gram), 'potato curry' and one seasonal vegetable i.e., *tinda* were prepared in a sauce pan (SP), pressure cooker (PC) and solar cooker (SC). The pressure cooker (Hawkins, 2½ kg capacity), sauce pan (2 kg capacity) and the cooking containers (2½ kg capacity flat bottomed *Patiala* with lid) of the solar cooker were all made of aluminium. The solar cooker used was developed at the Agricultural Tools Research Centre, Bardoli in 1976. For pressure and sauce pan cooking kerosene stove with wicks was used.

All the ingredients including rice (*Oryza sativa*), 'Basmati Var wheat (*Triticum aestivum*), green gram (*Phaseolus aureus* Rexb), *chana* (*Cicer aestivum*), *urad* (*Phaseolous mungo*), *Kabuli chana* (*Cicer arietinum*), potato (*Solanum tuberosum*), *tinda* (*Citrullus vulgaris*), onion (*Allium cepa*), tomato (*Lycopersicon esculentum*), spices and cooking oil were procured from the local market in Hissar. Tap water was used in all the preparations.

The methods of preparing these dishes in a SP, PC. and SC were standardized. The initial and final temperatures inside the solar cooker were recorded (Table 1). All the dishes were prepared according to the recipes normally followed in North India. All seasonings were prepared and added to the cooking mixture before starting the cooking.

The preparations were evaluated for vitamin content, colour, flavour, texture and overall acceptability. The organoleptic evaluation was conducted by serving the preparations to a panel of 10 judges selected randomly from the staff and students of the Haryana Agricultural University, Hissar. Each preparation was served thrice during the course of evaluation. Only two dishes prepared by all the three methods of cooking were served at a time. A five point scale consisting of liked very much, 4; liked moderately, 3; neither liked nor disliked, 2; disliked moderately, 1 and disliked very much, 0 was used. The mean scores were analysed statistically.

Cereal and pulse preparations were assayed for thiamine and riboflavin[4]. Vitamin C was analysed in raw and cooked potato and *tinda* using indophenol dye[4].

TABLE 1. AMOUNT OF MAJOR INGREDIENT, TEMPERATURE AND TIME REQUIRED FOR COOKING IN SOLAR COOKER

Name of the preparation	Major ingredient (g)	Temp. inside solar cooker (°C)	Final (°C)	Cooking time (min)
Plain rice	300	23.8	48.8	45
Wheat porridge	250	21.1	49.4	55
Green gram dal	250	21.1	53.3	135
*Chana urad dal**	300	26.6	53.3	145
*Kabuli chana**	250	21.1	56.1	160
Potato curry	600	21.1	49.4	110
Tinda curry	700	26.6	49.2	100

*Ingredient as given in text

Results and Discussion

Organoleptic evaluation: Table 2 gives the mean scores for different quality characteristics and overall acceptability of different food preparations by three different modes of cooking. It is observed that for rice, mean scores for colour, flavour, texture, and overall

TABLE 2. MEAN SCORES FOR ORGANOLEPTIC EVALUATION

Preparation	Colour			Flavour			Texture			Overall acceptability		
	SP	PC	SC	SP	PC	SC	SP	PC	SC	SP	PC	SC
Plain rice	2.8	3.2	3.8	2.8	3.3	3.3	2.8	3.2	3.7	3.0	3.4	3.7
Wheat porridge	3.0	3.5	3.2	3.1	3.1	3.2	3.1	3.0	2.7	3.1	3.4	3.2
Green gram (whole)	3.3	2.9	3.0	2.8	2.8	3.0	2.7	3.0	3.0	2.8	3.1	3.1
Chana urad dal	2.8	3.1	3.1	2.9	3.0	3.0	2.7	3.1	3.1	2.7	3.0	3.1
Kabuli chana	3.1	3.6	3.3	3.0	3.3	3.1	3.1	3.3	3.3	3.1	3.5	3.4
Potato curry	3.3	3.4	3.5	3.3	3.3	3.5	3.1	3.2	3.3	3.0	3.3	3.6
Tinda curry	3.6	2.7	3.0	3.4	3.0	3.0	3.5	3.0	3.0	3.5	2.9	3.0

SP=Sauce pan cooking; PC=Pressure cooking; SC=Solar cooking

acceptability were highest for cooking in solar cooker. Wheat porridge when prepared in pressure cooker got the maximum scores for colour and overall acceptability. For texture, wheat porridge obtained the maximum score for SP cooking and for flavour, the highest score was obtained for the product prepared in SC.

The SP cooked green gram dal scored maximum for colour whereas flavour was good in SC. Green gram cooked in PC and SC obtained a score of 3.0 each for texture and a score of 3.1 each for overall acceptabiity.

In the preparation of *chana urad dal*, SC and PC both had the highest score 3.1 each for colour as well as texture and a mean score of 3.0 each was obtained for flavour. In case of *kabuli chana*, PC was found to be the best for all quality characteristics.

It was observed that for potato curry, mean scores for colour, flavour, texture and overal acceptability were highest in SC. *Tinda* prepared in SP scored the highest for all the quality characteristics.

Statistical analysis of the data revealed that there was no significant difference in the scores for colour, flavour, texture and overall acceptability in the products prepared by different modes of cooking. Thus, the products prepared in the solar cooker were as acceptable as those prepared in sauce pan or by pressure cooking. Dhesi *et al.*[5] reported that food items cooked in the solar cooker were appreciably good and were acceptable for their appearance, shape, colour, texture, taste, flavour and doneness and that the average scores obtained from organoleptic evaluation for the products cooked in SC were not much different from the scores of the products cooked on gas. Similarly, findings by Sharma[3] revealed that the recipes prepared in a solar cooker were found to be tasty and attractive.

Vitamin composition: The amount of thiamine was less in cooked foods than that in uncooked raw foods; loss was the lowest for all the foods cooked in SC (Table 3).

In the preparation of rice, the loss of thiamine was more in SP than in PC and SC. However, the losses in the present investigation are within the range of losses reported by Swaminathan[6] and Asha Rani[7]. The percentage loss of vitamins in wheat porridge was highest in SP and lowest in SC. Lincoln *et al.*[8] reported 27 per cent loss in thiamine contents of cracked wheat when cooked in water.

In green gram (whole), loss of thiamine was highest in SP and lowest in SC. Vallidevi *et al.*[9] reported 14.7 per cent loss of thiamine by cooking green gram at 10 psi for 10 min. Kaliravana[10] observed 15.0 to 15.8 per cent loss in pressure cooked green gram. The losses of thiamine due to cooking are higher in the present investigation than those reported earlier. This may be due to difference in the time used for cooking and also the mode of cooking. In *Chana urad dal* and *Kabuli chana*, the highest loss of thiamine was found in SP and lowest in SC. A loss of 8-18 per cent in the thiamine content of Bengal gram[9,10] and black gram[9] during pressure cooking has already been reported.

The loss of riboflavin in plain rice was almost same in all the three methods of cooking. In the preparation of wheat porridge, the highest loss of riboflavin was in SP and lowest in SC. Asha Rani observed 15 to 22 per cent loss of riboflavin in pressure cooked rice. The difference in losses of riboflavin reported may be due to difference in the variety of rice and mode of cooking.

In the preparation of green gram (whole), the highest loss of riboflavin was in SP and lowest was in SC. Riboflavin loss of 8-16 per cent in green gram during pressure cooking has been reported[9,10].

The percentage losses of riboflavin in *Chana urad dal* were 35.0, 30.0, 20.0 for SP, PC and SC respectively. The percentage losses of riboflavin in *Kabuli chana* was 38.9 in SP, 27.8 in PC and 22.2 in SC. Studies of Vallidevi *et al.*[9] and Raghunathan and Belavady[2].

TABLE 3. THIAMINE AND RIBOFLAVIN CONTENT OF RAW AND COOKED FOODS (DRY MATTER BASIS)

Nutrient	Cooking method	Plain rice		Wheat porridge		Green gram		*Chana urad dal*		*Kabuli chana*	
		(mg/100 g)	(% loss)	(mg/100 g)	(% loss)	(mg/100 g)	(% loss)	(mg/100 g)	(% loss)	(mg/100 g)	(% loss)
Thiamine	Uncooked	0.16	—	0.23	—	0.75	—	0.70	—	0.82	—
	SP	0.12	25.0	0.15	34.8	0.50	33.3	0.48	31.4	0.48	41.5
	PC	0.14	12.5	0.17	26.1	0.57	24.0	0.55	21.4	0.56	31.7
	SC	0.14	12.5	0.18	21.7	0.62	17.3	0.59	15.7	0.59	28.1
Riboflavin	Uncooked	0.08	—	0.31	—	0.26	—	0.20	—	0.18	—
	SP	0.07	12.5	0.25	19.4	0.17	34.6	0.13	35.0	0.11	38.9
	PC	0.07	12.5	0.27	12.9	0.20	23.1	0.14	30.0	0.13	27.8
	SC	0.07	12.5	0.28	9.7	0.20	23.1	0.16	20.0	0.14	22.2

TABLE 4. VITAMIN CONTENT (MG/100G) OF RAW AND COOKED FOODS

Preparations	Cooking methods	Vitamin C*	Vitamin C**	% loss
Potato curry	Uncooked	10.79	64.07	—
	SP	5.07	43.32	32.2
	PC	7.17	50.45	21.3
	SC	8.61	55.36	13.6
Tinda	Uncooked	3.80	81.06	—
	SP	0.87	54.54	32.7
	PC	1.25	62.45	23.0
	SC	1.73	69.32	14.5

*Fresh weight basis; **Dry matter basis

indicated similar losses in riboflavin contents of Bengal gram and black gram during pressure cooking.

The data on vitamin C content of raw and cooked foods are shown in Table 4. In the preparation of potato curry and *tinda* curry the highest loss of vitamin C was in SP and lowest in SC. Pelletier *et al*[11]. noted 20 per cent loss of vitamin C in potatoes boiled with skin and about 30 per cent for fried potatoes. Sood and Bhat[12] reported 39 to 68 per cent loss of vitamin C in fry pan method, 20 to 54 per cent in pressure cooking and 56 to 72 per cent loss in the traditional method of cooking green leafy vegetables.

The present findings reveal that solar cooker can be successfully used for different preparations as the foods investigated in this study scored well for organoleptic acceptability. Nutritionally, the foods cooked in the solar cooker showed better retention of vitamins as compared to those cooked in pressure cooker or sauce pan.

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Announcement

The Editorial Board of the Journal of Food Science and Technology at its recent meeting has decided to accept and publish only *invited review papers* in the Journal. Hence, contributors of review papers to the Journal are requested not to send any review article for publication in JFST.

Editor
JFST

RESEARCH NOTES

BACTERIAL FLORA OF BENGAL GRAM AND BLACK GRAM

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Manuscript received 18 *July* 1983; *revised* 14 *January* 1984

Bacterial flora of Bengal gram, (*Cicer arietinum* L) and black gram (*Phaseolius mungo* L) were enumerated which consisted of fourteen bacterial types belonging to *Enterobacter*, *Flavobacter*, *Bacillus*, *Micrococcus* and *Streptococcus*. Difference in the bacterial load of both the pulses immediately after harvest as well as during storage were studied.

Pulses constitute important source of protein and are next to cereals in their food value[1]. Bengal gram, (*Cicer arietinum* L) and black gram, (*Phaseolus mungo* L) are the principal pulses grown in India[2]. Bruchids are the main insect pests affecting pulses in field as well as during storage. Two cowpea weevils, *Callosobruchus analis* and *C. maculatus* (Coleoptera: Bruchidae) are serious pests of Bengal gram and black gram[3].

Deterioration of grain in the field as well as during storage may be caused by different agents, but micro organisms and insects associated with them are of primary concern[4]. The gut bacterial flora of two insect pests, *C. analis* and *C. maculatus* infesting Bengal gram and black gram have already been isolated and reported[5]. There are numerous reports on fungi associated with grains[4] but that on bacteria associated with pulses are less. The present investigation reports the bacterial flora of two pulses, Bengal gram and black gram in fresh as well as in storage conditions.

Bengal gram and black gram, soon after harvest as well as stored samples were procured from various fields and warehouses and brought to laboratory in clean sterilised plastic vials. The samples were pooled separately and divided into 10 lots, each consisting of one gram. Thus, in all 20 lots from each of the pulses were processed independently. Pulses were immersed in a known quantity of peptone broth (0.1 per cent) for an hour. The supernatant was decanted in sterile vials and incubated at 30±2°C for 24-48 hr, which served as the original inoculum. Ten fold dilutions of the original inoculum was made unto 10^{-6}. One milli liter aliquots of suitable diluent plated in duplicate was used for qualitative and quantitative estimation of bacteria. Different media employed for qualitative estimation were nutrient agar, glucose agar, MacConkey agar, blood agar and sodium azide agar. The bacterial numbers obtained from nutrient agar were considered as total counts and were used for quantitative assay. Determination of the bacterial colonies was made at 30±2°C after 24-48 hr of incubation. Count at 48 hr incubation also includes those forms whose growth rate is slow. Representative colonies were maintained on nutrient agar slants, and biochemically characterised[6,7].

Results of bacterial flora from two pulses revealed that in all fourteen different types of bacteria were associated with harvested and in post harvest storage conditions. Eleven bacterial types from Bengal gram and ten types from black gram were isolated. These bacteria belong to five groups; *Enterobacter*, *Flavobacter*, *Bacillus*, *Micrococcus* and *Streptococcus*. The bacterial types were *Enterobacter aerogenes*, *E. cloacae*, *Citrobacter intermedius*, *C. freundii*, *Proteus vulgaris*, *P. rettgeri*, *Pseudomonas aeruginosa*, *Ps. putida*, *Flavobacterium devorans*, *Bacillus megaterium*, *B. polymyxa*, *B. coagulans* *Micrococcus varians* and *Streptococcus faecalis*.

The bacterial counts per gram of pulses on sodium azide agar, blood agar, MacConkey agar, glucose agar and nutrient agar from harvested Bengal gram ranged from $1.1\pm0.52\times10^6$ to $126.0\pm18.96\times10^6$ and the same from stored Bengal gram ranged from $9.0\pm3.21\times10^6$ to $331.0\pm17.79\times10^6$. Similarly, bacterial counts from harvested black gram ranged from $1.0\pm0.44\times10^6$ to $65.0\pm21.75\times10^6$ and the same from stored black gram was $6.0\pm2.32\times10^6$ to $261.5\pm10.24\times10^6$. The total bacterial counts on nutrient agar from harvested and stored Bengal gram was $126.0\pm18.96\times10^6$ and $331.0\pm17.79\times19^6$ respectively, while the corresponding values for black gram were $65.0\pm21.75\times10^6$ and $261.5\pm10.24\times10^6$ respectively. The count on nutrient agar is taken as total bacterial count and is considered for statistical analysis.

The statistical analysis revealed that the bacterial load is significantly high ($P\leq0.01$) in stored pulses compared to pulses in harvested condition. This high bacterial load may be due to higher contamination occurring during processing and storage. Bengal gram is found to be heavily contaminated ($P\leq0.01$) compared to the black gram in both harvested as well as post harvest conditions. Bacterial flora of both the pulses obtained from harvested conditions varies qualitatively from that of pulse samples in stored conditions.

Interestingly, the bacteria associated with Bengal gram and black gram are similar to those isolated from

the gut of the insects, *C. analis* and *C. maculatus*[5] which usually infest these pulses. Thus, pulses constitute an ecosystem centre for bacteria associated with them and also insects infesting them.

Authors are grateful to Dr. M. Nagaraj, the Vice-Chancellor, Gulbarga University, Gulbarga for encouragement and facilities.

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HEAT AND PARTICULATE RECOVERY FROM SPRAY DRYER EXHAUST USING VERTICAL VENTURI SCRUBBER

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Manuscript received 6 *June* 1982; *revised* 16 *January* 1984

A vertical venturi scrubber (sanitary type) was designed and installed on the spray dryer exhaust of the experimental dairy of National Dairy Rresearch Institute, Karnal. It did not affect the performance of the dryer. The study demonstrated that particulate recovery of 80 to 90% and 6 to 10% of heat recovery for spray dryer exhaust is feasible when the ratio of scrubbing liquid to air flow rate is 0.24 to 0.35 l/m³ of the exahust air. The system does not cause any bacterial contamination to the scrubbing liquid. The skim milk was tried as a scrubbing liquid. The system was also found economically viable for adoption.

Production of spray dried milk and milk products has become an increasingly important segment of the dairy industry. In almost all the spray dryers, cyclones are used for the separation of dried product from the drying air. Cyclone separators can effectively separate particles of size greater than 5 microns. But the particles in the range of 2-10 microns escape separation. As reported by Janson,[1] 0.4-0.8 per cent (175-350 mg/m³) of powder losses are taking place in skim milk. Many manufacturer's of modern spray dryers claim that the powder lost from the cyclone system is not more than 0.5 per cent of the maximum output of the dryer or 140 mg/m³ of air, which seems to be extremely small. However, in case of a large plant of 18 ton capacity, the powder loss is 90 kg/day (30,400 kg/year). Spray dryer exhaust besides containing the particulate is usually at a temperatures of 80-100°C (50-75 Kcal/m³ of exhaust air). A plant of large capacity of exhaust volume (3600 m³/hr) gives out about 2,70,000 Kcal/hr of heat to the atmosphere as a waste energy. Apart from appreciable loss of product and heat energy, it also give rise to environmental pollution in the immediate vicinity.

A vertical venturi scrubber was designed and installed with the spray dryer exhaust duct of the experimental dairy of National Dairy Research Institute, Karnal. In addition, a powder measuring device, a powder feeding device and an air-scrubbing liquid separator were also coupled for estimation, calibration and recovery respectively.

The integration of the vertical venturi scrubber with the spray dryer exhaust did not affect the performance of the spray dryer and the stack losses were found to be 105 to 115 mg/m³ for skim milk, 87.5 to 92.3 mg/m³ for icecream mix powder and 72 to 85 mg/m³ for malted milk food.

Heat energy recovery varied from 3.25 to 9.41 per cent as the scrubbing liquid flow rate was varied from 120 to 360 l/hr (Table 1). When plotted on graph (Fig. 1), increase in heat recovery was found to be directly proportional to the increase in the scrubbing liquid flow rate. However, temperature rise of scrubbing liquid was more (8 to 12°C) at lower flow rate of scrubbing liquid (120 to 240 l/hr). As the flow rate was increased to 360 l/hr, the temperature rise was dropped to 6 to 8°C in single circulation.

Particulate recovery increased from 69 to 91 per cent as the flow rate of the scrubbing liquid was increased from 120 to 360 l/hr. However, Fig. 1 shows that the percentage recovery increased at a faster rate as the flow rate was increased from 120 to 240 l/hr. (69 to 85 per cent), but percentage recovery was increased at a lower rate as the flow rate was increased from 240 to 360 l/hr (85 to 91 per cent).

The relative humidity of the exhaust air before recovery system varied from 16 to 24 per cent and after the recovery system, it increased to 74-84 per cent. The

TABLE 1. EFFECT OF RECIRCULATION OF SCRUBBING LIQUID (SKIM MILK) ON EVAPORATION, HEAT AND PARTICULATE RECOVERY

Recirculation (Nos.)	Flow rate of scrubbing liquid (l/hr)	Concn of powder in the exhaust air (%)	Concn of powder in the exhaust air (mg/m³ of air)	Powder recovery (%)	Heat recovery (%)	Evaporation (%)
1				75.21	4.47	0.69
2	120	0.88	115.46	78.36	4.29	0.69
3				77.11	4.47	0.69
1				84.99	7.90	0.80
2	240	0.84	112.74	86.63	8.28	0.80
3				82.78	7.90	0.80
1				88.65	9.23	1.01
2	360	0.76	98.54	86.83	9.23	1.01
3				89.23	9.77	1.01

Total solids in the product, 44 per cent; Velocity of the exhaust air, 2200 f.p.m.

moisture picked up by the exhaust air from the scrubbing liquid was in the range of 1 to 3 kg of water per hour. Moisture pick up increased with increase in scrubbing flow rate, thus causing partial evaporation of the scrubbing liquid. Partial evaporation due to moisture absorption by exhaust air was observed to be 0.62 to 1.3 per cent.

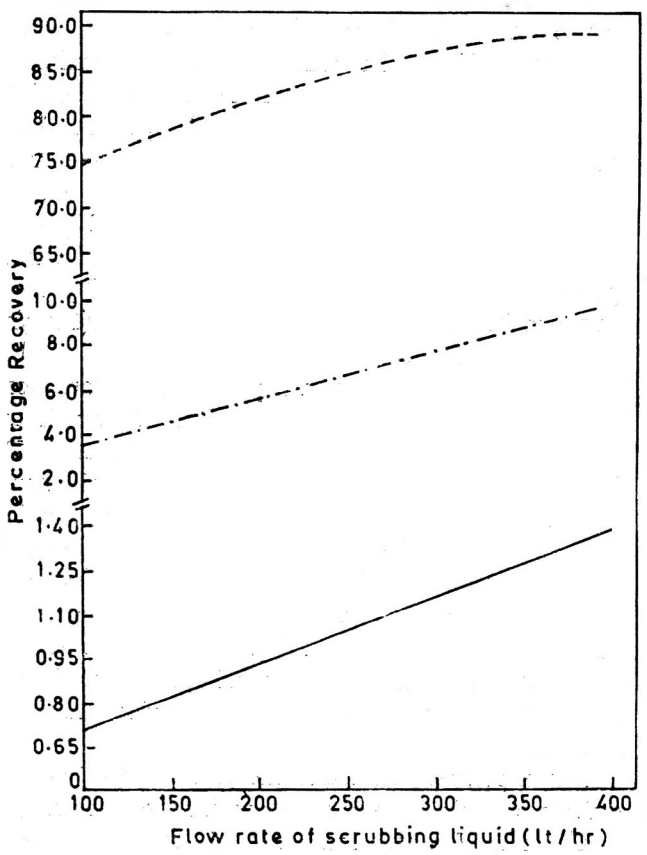

Fig. 1. Effect of flow rate of scrubbing liquid on evaporation, heat and particulate recovery

—— particulate recovery; —.— heat recovery; —— evaporation

The normal concentration of particulate in the exhaust air was changed from 105 to 200 mg/m³ and subsequently from 200 to 315 mg/m³ with the aid of powder feeding device. The particulate recovery was found in the range of 72 to 79, 82 to 86 and 87 to 90 per cent at flow rate of 120, 240 and 360 l/hr of the scrubbing liquid respectively. Graphical representation showed no direct relation with the concentration of the particulate on the particulate recovery.

Standing plate count test revealed that the recovery system does not cause any bacterial contamination to the scrubbing liquid.

Thus, on the basis of results, it can be concluded that dairy industries engaged in the manufacture of spray dried products can integrate this vertical venturi scrubber satisfactorily to the existing spray dryer exhaust for heat and particulate recovery, by scaling up the design as per the required plant capacity. Skim milk being fed to the condensing unit is recommended as scrubbing liquid. It also gets preheated and partially concentrated by absorbing heat and particulate matter of the exhaust air.

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MICRO ASSAY OF GUAR MEAL TOXIN BY *IN VITRO* CHICK-EMBRYO CULTURE TECHNIQUE

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Manuscript received 22 *March* 1982; *revised* 12 *January* 1984

A micro assay system was developed to assay the toxicity of guar meal chromoprotein toxin. The explanted chick-embryos treated with crude and purified toxins showed gross abnormalities and death. Treatment with detoxified meal protein showed normal development of the embryos.

In the work on the detoxification and quality evaluation of unorthodox protein-rich materials such as seed meals, animal experiments using mice or rats to test the toxicity are time consuming, expensive and need large amount of test material. It becomes impracticable to use this technique to evaluate the extent of detoxification achieved at each step of the various procedures employed. In this paper a simple and quick method to assess the toxic properties of the chromoprotein toxin of guar (*Cyamopsis tetragonoloba*) is described.

A detailed work on detoxification of guar meal and characterization of the meal toxins has been carried out in this laboratory and is being reported elsewhere. Since the purified guar chromoprotein toxin did not possess any specific biological activity such as protease inhibition or hemaglutination as exhibited by other plant toxins, the development of a micro assay method to evaluate this material receives special significance.

The method described by New[1] was followed for *in-vitro* culturing of chick embryo. Fresh fertilized eggs of 'White leghorn' hens were incubated at 37±1°C for 18 hr upto the primitive streak stage of the embryo. The vitelline membrane along with the blastoderm was explanted on a watch glass and cultured in a presterilised Pannet-Compton medium which was isotonic with the blastoderm cells and supplied nutrients to the developing embryo. The medium was composed of (per litre) glucose 9 g, NaCl 4.84 g, KCl 620 mg, $Na_2HPO_4.12\ H_2O$ 274 mg, $CaCl_2$ 616 mg, $MgCl_2$ 508 mg and NaH_2PO_4 10 mg. The embryos were treated with the test substance for a specific period and again allowed to develop under normal conditions. After sufficient development, the treated and control embryos were observed under dissection microscope for any abnormality due to the effects of the test substance.

Toxic protein was extracted from guar meal with 0.25N HCl. This crude protein extract was chromatographed on DEAE—cellulose column and the chromoprotein which was earlier found to be toxic to albino rats and mice was used in the present test. The fraction was eluted, dialyzed thoroughly and lyophilized. Solutions containing 1 to 10 mg per ml of this lyophilized material were prepared in Pannet—Compton solution. Embryos after explanting on a watch glass were treated with three drops (0.06 ml) each of these solutions, using 5 embryos for each concentration. The contact was allowed for 6 hr at 37°C. At the end of this period the embryos were washed 3 times and then incubated after suspending in the Pannet-Compton solution. These embryos were observed after 18 hr i.e., after 24 hr of explantation along with control embryos.

Table 1. EFFECT OF GUAR MEAL CHROMOPROTEIN TOXIN AND DETOXIFIED PROTEIN ON CHICK EMBRYOS

Substance tested	Concn (mg/ml)	No. of embryos tested	Normal embryos	Abnormal embryos (%)
Dialysed acid extract of guar meal	2	14	0	100
Detoxified protein	2	30	24	20
Chromoprotein	1	20	6	70

Deformed and dead embryos were found at the toxin concentration of 1 mg/ml or 60 μg per embryo and more. Hence, 1 mg/ml was taken as the minimum level for producing abnormalities in chick embryo. The protein isolated from the detoxified guar meal after thorough dialysis and lyophilization was used at 2 mg/ml.

It can be seen from Table 1 that all the embryos treated with 2 mg/ml crude extract or 120 μ g per embryo were found dead, 80 per cent of the detoxified protein treated embryos were normal and 70 per cent of the embryos treated with the purified toxin (1 mg/ml) died or deformed.

Chick-embryos treated with purified guar meal toxin showed death or overall retardation of growth and malformation of almost all the organ systems. The brain lacked its usual differentiation whereas the neural tube was open. Heart growth was retarded and developed as a straight tube. Somites showed a diffuse nature and reduction in number. Due to these abnormalities, the embryonic axis was considerably shortened. It therefore seems that the toxin fraction brings about a profound disturbance in the morphogenesis of the embryo ultimately resulting in death or retarded and abnormal growth.

This experiment indicates the utility of *in-vitro* chick embryo culturing as a test method for the assay of guar meal toxin. The technique may offer an elegant means for assessing toxicity of other substances as well. This is being assessed in the case of other plant toxins.

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SURVIVAL OF *VIBRIO PARAHAEMOLYTICUS* IN DRY FISHES

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Manuscript received 20 *June* 1983; *revised* 13 *January* 1984

A survey of the dry prawns and fishes obtained from Mangalore fish market indicated that *Vibrio parahaemolyticus* can sometimes be recovered from dry fishes. Under experimental conditions, *V. parahaemolyticus* in fish did not withstand the process of sun-drying and survival of *V. parahaemolyticus* smeared on dry fish appeared to be less than two hours.

Vibrio parahaemolyticus is an important causative agent of gastroenteritis associated with seafoods having a world wide distribution. In India, De and associates[1] showed the incidence of *V. parahaemolyticus* in marine fishes in Calcutta to be 35.2 per cent and Natarajan *et al.*[2] reported 36.8 per cent occurrence in fishes and brackishwater environs while Karunasagar and Mohan Kumar[3] observed the incidence to vary from 8.33 to 33.3 per cent in different samples. Since this organism is associated with edible aquatic animals *in situ*, it would be extremely difficult to prevent their occurrence in raw seafoods. Therefore, the seafood handling and processing methods greatly influence the extent of danger to the health of the consumer from this organism. While the response of *V. parahaemolyticus* to refrigerated[4] and frozen[5] storage has been studied, there appears to be no information on its survival in dry fishes. In view of this, we studied the occurrence of this organism in dry fishes obtained from Mangalore fish market. Furthermore the ability of *V. parahaemolyticus* to survive the process of sun-drying was also investigated.

Following dry prawn and fish in 250 g quantities were drawn at monthly intervals from Mangalore (South India) fish market depending on availability: white sardines (*Kowala* spp.), white bait (*Anchoviella* spp.), silver belly (*Stolephorus* spp.), croaker (*Johnius* spp.), shark (*Scoliodon* spp.) and *Lactarius* spp. Sampling was done between June 1982 and August 1982 and December 1982 and April 1983. A total of 36 samples of salted dry fishes, 4 samples of dry prawns and 5 samples of unsalted dry fish were examined.

Enumeration of *V. parahaemolyticus* was carried out by a slight modification of the method described in Bacteriological Analytical Manual[6]. Five tube MPN method with glucose salt teepol broth (GSTB) as the enrichment medium was employed. Twenty five grams of fish were homogenised with 225 ml sterile 3 per cent NaCl solution and 10, 1 and 0.1 ml of homogenates were inoculated to 10 ml double strength and single strength broths respectively. After incubation for 18 hr at 37°C, they were subcultured to Thiosulphate Citrate Bile Salt Sucrose (TCBS, Hi Media) agar. Typical bluish green colonies appearing on the latter were subjected to the following biochemical tests: TSI reaction, 0/129 sensitivity, growth in presence of 0, 8 and 11 per cent NaCl, ability to decarboxylate lysine, ornithine and arginine. Where the colonies were finally identified biochemically as *V. parahaemolyticus*, reference was made to original positive dilutions on GSTB and applying the 5 tube MPN table[7], final enumeration was carried out.

To examine whether *V. parahaemolyticus* in fish can survive the process of sun-drying, the following experiments were conducted. Fresh white sardines (*Kowala* spp.), purchased from Mangalore fish market were divided into two batches. One batch was contaminated with *V. parahaemolyticus* to a level of 10^3/g and sun-dried for 4 days. The other batch was salted in the ratio of 1:1 and kept overnight. The next day, these salted fishes were washed, contaminated with *V. parahaemolyticus* to a level of 10^3/g and then sun-dried for 4 days. For contamination, a Kanagawa negative strain (TY 68) isolated from fish and a Kanagawa positive strain (TY 81) isolated from case of gastroenteritis was used to investigate the differences, if any, in the behaviour of these two groups of organisms. Uncontaminated controls were maintained for both salted and unsalted batches. After drying, survival of *V. parahaemolyticus* was tested by using GSTB, Trypticase Soy Broth (TSB, Hi Media) with 7 per cent NaCl[8] (TSBS) and salt water yeast extract (SWYE) broth[3] for enrichment. Since dry fishes are likely to contain stressed or injured bacteria, both selective enrichment (GSTB and TSBS) as well as non-selective enrichment (SWYE) were tried. Further, the duration of survival of *V. parahaemolyticus* smeared on dry fish was studied as follows: Dried white sardine, both salted and unsalted were smeared with an 18 hr culture of *V. parahaemolyticus* in Trypticase soy broth using cotton swabs to give a final count of 10^4-10^5 organisms per g. Both Kanagawa positive and negative strains mentioned above were included in the study. *V. parahaemolyticus* counts in these fishes were performed at 2 hr intervals for 8 hr on TCBS agar.

Of the samples of dry fish obtained from fish market, only one sample of salted white bait examined in June 1982 showed the presence of *V. parahaemolyticus* to the extent of 20/100 g. This is very significant from the point of view of fish consumers in India where nearly a third of the marine fish landed are marketed in salted or dried form[10]. The levels encountered, however, are very low. Sakazaki *et al.*[11] suggested an acceptance

limit for *V. parahaemolyticus* of 10^4 per 100 g of raw fish as well as fish meat. Since the numbers in dry fish are below this limit, it might not be a serious public health problem. However, it was of interest to examine whether *V. parahaemolyticus* could survive the process of sun-drying or whether the incidence of this organism in dry fish could be due to post-process contamination. When the white baits contaminated with *V. parahaemolyticus* to the level of 10^3/g were subjected to sun-drying, it was observed that the salted and unsalted fish were free from this organism on the 4th day when the fish were dried to the same extent as the commercial samples obtained from the market.

The results suggested that *V. parahaemolyticus* encountered in market samples of dry fish could be due to post-process contamination. In view of the unfavourable conditions prevailing on the dry fish for survival of bacteria, it can be speculated that the contamination might be recent and heavy. This is supported by the observation that even when the dry fish are contaminated at levels ranging from 10^3 to 10^5/g, *V. parahaemolyticus* did not survive for even two hours after inoculation. There are ample opportunities for contamination of the dry fish in the market environment. A survey of the fish market environment in Mangalore revealed that *V. parahaemolyticus* was present in drain water and bird droppings.

Temmyo[12] reported rapid death of *V. parahaemolyticus* when inoculated membrane filters were placed in a container with silica gel and when an inoculated chopping board was allowed to dry. The results of the present study indicate that even in dry fish, the survival period of *V. parahaemolyticus* is very short. Therefore, it is unlikely that dry fish may be involved in cases of gastroenteritis due to *V. parahaemolyticus* unless they are contaminated heavily just before consumption.

The authors thank Prof. H. P. C. Shetty, Director of Instruction of the College for his encouragement and for providing necessary facilities. This research has been financed in part by the United States Department of Agriculture under Cooperative Agricultural Research Grant Program (PL-480).

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FORMULATION OF PROTEIN RICH BISCUITS FROM JOWAR, SOYBEAN AND SKIM MILK

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Manuscript received 18 *January* 1982; *revised* 19 *January* 1984

The protein-rich biscuits of acceptable quality were prepared using Jowar (sorghum), soybean and skim milk (in 60: 30:10 proportion). The method of manufacture consisted of pregelatinization of 30 parts of jowar flour and dry mixing remainder 30 parts with 30 parts of full-fat soy flour, 10 parts of skim milk powder, 0.5 parts CMC and 1.0 parts of baking soda. The vegetable fat (9.35 parts for low fat and 24.2 parts for high fat biscuits) was rubbed with ground sugar (36.0 parts for low fat and 44 parts for high fat biscuits) to creamy consistency and mixed with pregelatinized jowar flour and other dry-mix ingredients. The dough was worked and then rolled to 3 mm thickness, cut into small pieces, and baked at 170°±5°C for 15–20 min.

Efforts have been made to develop protein-rich biscuits using wheat, milk and milk products.[1-3] There-

fore, use of locally available inexpensive ingredients such as jowar and soybean for the manufacture of protein-rich biscuits would be a healthy proposition.

This paper presents a simple technology for the manufacture of acceptable protein-rich biscuits from jowar, soybean and skim milk.

White jowar, purchased from grain market of Delhi, was washed with water and dried after draining, in hot-air tray drier (forced circulation) at 55-60°C to 12-14 per cent moisture level. The dried jowar was then ground in a flour mill and passed through No. 30 and 60 mesh (BSS) sieve. For pregelatinization of jowar flour equal volume of jowar flour and boiling water was mixed and worked for 5 min.

The mixed variety of soybean obtained from Haldwani market, U.P. was water blanched[4], soaked in 0.5 per cent sodium bicarbonate solution for 8-12 hr and blanched after draining, in boiling 0.5 per cent sodium bicarbonate for 30 min. The beans were then dehulled in a dehuller (fabricated at N.D.R.I. Karnal) and the hulls removed by floatation. The cotyledons were then dried in tray drier at 60°C to 7 per cent moisture. The dried cotyledons were then ground in micropulverizer fitted with a 15 mesh screen and the flour was sieved through 30 and 60 mesh screen (BSS).

The double acting baking soda was prepared by mixing food grade calcium dibasic phosphate and sodium bicarbonate in the ratio of 10:3.3. Sugar used in the study was ground in a micropulverizer fitted with 15 mesh screen. The carboxy methyl cellulose (CMC) obtained from V.P. Chest Institute, New Delhi; synthetic pineapple flavour and hydrogenated vegetable oil were used in this study.

Biscuit making: Jowar, soybean and skim milk (JSM) in the ratio of 60:30:10 was used as this combination was found to give higher PER value in earlier studies in this laboratory[5]. This JSM mixture contained 22.1 per cent protein, 9.0 per cent fat, 56.7 per cent carbohydrates, 3.0 per cent ash, 7.5 per cent moisture, 340 mg per cent calcium and 180 mg per cent phosphorus. The ingredients were used in such a proportion as to give a proximate composition of biscuits similar to those laid down by ISI[6] for high protein biscuits. The weighed quantity of sugar and vegetable fat was rubbed to get a creamy consistancy. This was then mixed with JSM mixture, CMC, baking soda and water and kneaded to a smooth dough. The dough was then rolled with wodden roller to desired thickness, cut to required size with a mould and baked in a hot air oven.

The JSM mixture and biscuits were analysed for protein[7], fat[8], ash[9], moisture[9], calcium[10], phosphorus[11], urease activity[12] and PER[13].

The JSM biscuits were assessed for acceptability on the basis of their sensory characteristics by a trained panel using a 9-point hedonic scale.

In order to get the high protein biscuits conforming to ISI specification of a minimum of 12.0 per cent fat and 13.0 per cent protein, the three main ingredients in the proportion of 60:30:10 with vegetable fat 9.4 parts and sugar 36.0 parts were needed. Initial trials were conducted to assess the optimum time-temperature combination for baking and flour particle size so as to get an acceptable product.

It was observed that the biscuits were harder on complete baking at 140-150°C for 40 min. as compared to baking at 170±5°C for 15-20 min. Similarly, the biscuits made from 30 mesh flour had a gritty texture. A satisfactory product was obtained when biscuits were made from 60 mesh flour and baked at 170±5°C for 15-20 min. and therefore, these parameters were used for further study.

The product, however, was only slightly acceptable (score, 6) and had poor body and texture (score, 5.8). In order to improve the body and texture of biscuits, different combinations of CMC (0.5 and 1.0 per cent of JSM mixture) and baking soda (0.5 and 1.0 per cent of JSM mixture) were studied. The thickness of biscuits was kept at 9-10 mm. As can be seen from Table 1. the use of CMC and baking soda at the level of 0.5 and 1.0 per cent respectively, improved body and texture appreciably (score, 6.7) and thus the overall acceptability as well (score 6.8).

With a view to improve the acceptability of the biscuits further, 25, 50 and 100 per cent of the jowar flour in the mixture was pregelatinized and its effect on the flavour, body, texture and colour was studied. The CMC and baking soda was used at 0.5 and 1.0 per cent of JSM mixture respectively. It was observed that (Table 2) the pregelatinization did not improve the acceptability of the biscuits on account of their softness and lack of crispness. The biscuits of 5.0 mm thickness, made from 50 per cent gelatinized jowar flour had cosiderably improved the flavour (score, 7.3), body

TABLE 1. EFFECT OF CARBOXY METHYL CELLULOSE (CMC) AND BAKING SODA LEVELS ON ACCEPTABILITY OF BISCUITS PREPARED FROM A MIXTURE OF JOWAR, SOYBEAN AND SKIM MILK IN THE RATIO OF 60 : 30 : 10

CMC(%)	Baking soda (%)	Flavour	Body and texture	Colour and appearance	Overall acceptability
0.5	0.5	6.5	6.0	6.8	6.5
0.5	1.0	6.6	6.7	7.0	6.8
1.0	0.5	6.4	5.9	6.5	6.2
1.0	1.0	6.7	6.3	6.8	6.6

TABLE 2. EFFECT OF PREGELATINIZATION OF JOWAR FLOUR, BISCUIT THICKNESS AND FAT LEVEL ON ACCEPTABILITY OF BISCUITS

% Gelatinization	Biscuit thickness (mm)	Fat level (%)	Flavour	Body and texture	Colour and appearance	Overall acceptability
25	9- 10	12.5	6.4	5.3	6.7	6.1
50	9- 10	12.5	6.2	5.2	6.6	6.2
100	9- 10	12.5	6.4	5.6	6.9	6.0
50	5- 5.5	12.5	7.3	6.9	7.4	7.2
50	5- 5.5	19.5	7.4	7.7	7.5	7.5

and texture (6.9), colour and appearance (7.4) and overall acceptability (7.2). The resultant biscuits were moderately soft and had characteristic crispness. Addition of strawberry flavour at the level of one mililitre per 200 g. JSM further improved the acceptability slightly (7.3). The gelatinization of jowar flour also improved the rolling characteristics of the dough, i.e., it could be rolled into a thin sheet without cracking.

Increasing the level of fat in biscuits from 12.5 to 19.5 per cent (by using the ingredients in the proportion of JSM 100 parts, vegetable fat 24.2 parts and sugar 44.0 parts; CMC and baking soda at 0.5 or 1.0 per cent of JSM mixture respectively and 50 per cent pregelatinized jowar flour considerably increased the flavour (score, 7.4), body and texture (7.7), colour and appearance (7.5) and overall acceptability (7.5). The increased acceptability could be due to the softening effect of fat on dough consistancy. The resultant biscuits were soft, crisp and were comparable to the conventional biscuits made from wheat flour.

Chemical composition and nutritive value: Both types of protein-rich JSM biscuits (low fat and high fat) thus standardized were analysed for their proximate composition and the data are presented in Table 3. As can be seen, both low fat and high fat biscuits had a composition satisfying the ISI specification.

TABLE 3. PROXIMATE COMPOSITION OF PROTEIN-RICH JOWAR, SOYBEAN AND SKIM MILK BISCUITS

Characteristic	High fat	Low fat	ISI specification
Moisture (%)	4.58	4.47	6.0
Protein (%)	13.25	15.18	13.0 (min)
Fat (%)	19.50	12.50	12.0 (min)
Total ash (%)	2.86	3.60	—
Total carbohydrates (%)	59.81	64.25	—
Calcium (mg %)	575	605	450 (min)
Phosphorus (mg %)	425	460	—
Urease activity (%)	0	0	—

The PER of the unbaked biscuit blend and baked biscuits estimated were observed to be 2.3 and 2.1 respectively; indicating a decrease of 8.7 per cent as a result of baking. These results are in close agreement with those observed by Chandrasekhara *et al.*,[14] wherein the PER of the protein rich biscuits made from groundnut protein isolate decreased from 2.26 to 1.97 (a decrease of 12.8 per cent). The result also showed that, the PER of the protein rich biscuits made from JSM (2.1) conform to the Protein Advisory Group recommendation[16], which specifies a minimum PER of 2.1 for protein rich cereal based foods.

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ON THE USE OF POTATO AND CASSAVA FLOURS IN SOFT DOUGH BISCUITS

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Manuscript received 7 *October* 1983; *revised* 31 *January* 1984

Laboratory studies on the utilisation of non-wheat flours for biscuit making have shown that, soft dough biscuits of acceptable quality could be prepared by incorporating upto 20% of cassava flour or 30% of potato flour. It was possible to replace upto 40% of wheat flour for making biscuits of improved acceptability by using a 60:20:20 blend of wheat, cassava and potato flours. Use of potato flour helped to overcome the undesirable effect of cassava flour, like fragility, mouthfeel and colour.

In biscuit manufacture, it is often beneficial to incorporate some quantity of starch or non-wheat flour, especially in case of hard or medium hard wheat flours to dilute the gluten and to impart crispness to the biscuits. In the absence of panary fermentation, biscuit allows a higher level of incorporation of starch or non-wheat flour than bread. Acceptable cookies have been prepared from a variety of cereal flours including hard wheat, rice, sorghum, millet, barley, triticale and corn flours and from non-cereal flours such as cassava and sweet potato flours[1].

Studies on 'soft dough' type biscuits with incorporation of flours processed from two important high yielding tubers, namely cassava and potato blended with wheat flour, either individually or in combination were carried out and the data presented in this paper.

Preparation of wheat-tuber flour blends: A sweetish commercial variety of cassava, '*H*-2304' obtained from Central Tuber Crops Research Institute, Trivandrum and a popular high yielding potato variety, 'K. Chandramukhi' procured from Potato Research Station, Pune were processed into flours according to Chandra Shekara and Shurpalekar[2]. The yields of cassava and potato flours on the basis of raw tubers were about 30 and 20 per cent respectively. Wheat flour used in the present studies was milled to an extraction rate of 65 per cent from a locally procured commercial soft wheat having a protein content of 9.3 per cent. The chemical composition of the flours used for blending is presented in Table 1.

Biscuit making quality: Samples of biscuits, based on the following ingredients (g) were prepared according to the traditional 'creaming method' described by Whitley[3].

Wheat flour-tuber flour blend 64, sugar 18, shortening 16, non-fat milk solids 1, glucose 1, ammonium bicarbonate 0.5, sodium bicarbonate 0.2, sodium chloride 0.4, baking powder 0.2, vanillin 0.05, water (variable) 15-18.

The dough based on the above formulation was sheeted on a specially fabricated aluminium platform using a wooden rolling pin to obtain a sheet of uniform thickness of 2.5 mm. Using a biscuit cutter, the sheet was cut into circular biscuits of 5.1 cm diameter and baked for 10 min at 205°C. Biscuits thus obtained were cooled to room temperature and packed in glassine covered by high density polyethylene.

Evaluation: Diameter and thickness of 6 biscuits were measured by placing the biscuits edge to edge and by stacking one above the other respectively. Measurements by rearranging and restacking were made and average values were taken to calculate the spread factor.

Crust and crumb colour, flavour, texture and eating quality were scored by a panel of 6 experienced judges with the weightages given for different parameters

TABLE 1. CHEMICAL COMPOSITION OF WHEAT AND TUBER FLOURS*

Constitutent	Wheat flour	Cassava flour**	Potato flour
Crude protein‡ (%)	8.4	1.7	8.1
Total ash (%)	0.6	2.0	2.5
Ether extractives (%)	1.2	0.7	0.8
Crude fibre (%)	0.6	0.9	1.3
Carbohydrates (%) (by diff)	89.2	94.7	87.3

*Values expressed on moisture-free basis; moisture in wheat flour: 10.5%, cassava flour: 9.6%, potato flour: 9.7%

**Cassava flour sieved through 10XX sieve (136 μ)

‡Calculated as N × 5.7 for wheat and N × 6.25 for cassava and potato

TABLE 2. EFFECT OF INCORPORATION OF CASSAVA OR POTATO FLOURS ON THE QUALITY CHARACTERISTICS OF BISCUITS

Flour used (%)	Diameter* (mm)		Thickness* (mm)		Spread factor		Colour		Texture		Flavour		Overall quality	
Ca/Po	Ca	Po	Ca	Po	Ca	Po	Ca	Po	Ca	Po	Ca	Po	Ca	Po
0	49.0		4.2		100.0		GB		Cp		HA		E	
10	49.2	50.0	4.1	3.8	103	113	LB	GB	Cp	Cp	HA	HA	G	G
20	49.6	51.0	4.0	3.8	106	115	LB	B	Cp	Cp	A	HA	S	S
30	51.0	52.0	3.9	3.6	112	124	DLB	DB	CpF	Cp	JA**	A	F	S
40	52.0	52.0	3.8	3.6	117	124	DLB	ED	CpF	CpF	UA	JA	P	F

*Average value of six biscuits

**Leaves residual feeling of cassava flour on the tongue

Ca — Cassava, Po — Potato, GB — Golden brown, LB — Light brown, B — Brown, DLB — Dull light brown, DB — Dark brown, ED — Extremely dark, Cp — Crisp, CpF — Crisp & fragile, HA — Highly acceptable, A — Acceptable, JA — Just acceptable, UA — Unacceptable, E — Excellent, G — Good, S — Satisfactory, F — Fair, P — Poor.

according to AACC[4] except that, weightage given for flavour and spread factor was modified to 30 per cent each instead of recommended 20 and 40 per cent to suit the Indian palate. Different biscuits were graded on the basis of a total score out of a maximum of 100 obtained as follows: excellent 91-100, good 81-90, satisfactory 66-80, fair 51-65 and poor 50 or less.

Utilisation of cassava flour in biscuits: It is evident from the data presented in Table 2 that, biscuits could be prepared with wheat-cassava flour blend containing upto 20 per cent cassava flour with little change in acceptability. Biscuits with 40 per cent or more of cassava flour were graded as poor, because of their dull whitish colour, fragile texture and predominant cassava flavour.

Utilisation of potato flour in biscuits: Unlike cassava flour, potato flour could be used upto 30 per cent for blending. Biscuits prepared had an attractive brown colour with an acceptable mild potato flavour. Work on similar lines with sweet potato flour has indicated the maximum limit to be 40 per cent according to Kwon *et al.*[5] In biscuits containing 40 per cent potato flour, the potato flavour became more pronounced and the colour was undesirably dark.

Potato flour gave higher values for spread factor as compared to cassava flour at corresponding levels of blending (Table 2). This may be due to the tendency of the potato flour to make the dough more extensible, with a low resistance to extension, as observed on the extensograms.[2]

Further, biscuits containing 40 per cent potato flour were not as fragile as those containing cassava flour. The differences observed with the crust colour and fragility at comparative levels of addition of cassava and potato flours may be attributed to their widely differing contents of damaged starch of 4.8 and 31.3 per cent respectively, as compared to 11.4 per cent of wheat flour used.

Biscuits based on blends of wheat, potato and cassava flours: In view of potato flour possessing some positive attributes over cassava flour, studies carried out on biscuits with 40 per cent of wheat flour being replaced by different levels of potato and cassava blends indicated the following advantages.

(*i*) Biscuits containing potato flour were found to possess relatively darker and attractive colour, when compared to biscuits based on wheat-cassava flour blends. (*ii*) Relatively higher levels of potato flour could be used in biscuit preparation than cassava flour. (*iii*) In biscuit, acceptability tolerance for potato flavour was better than cassava flavour.

Results presented in Table 3 indicate that, potato flour plays a complementary role in improving colour, flavour, and overall quality and also, in reducing significantly the tendency towards fragility observed in finished products containing higher levels of cassava flour. The unacceptable mouth feel due to the left-over residue on the tongue, when higher levels of cassava flour were used for blending, could be avoided by the use of potato flour.

The cost of cassava flour from sun-dried chips will be less than that of wheat flour while in case of potato, the cost could be minimised by processing and preserving

TABLE 3. QUALITY CHARACTERISTICS OF BISCUITS BASED ON 60:40 BLENDS OF WHEAT AND TUBER FLOURS

Flours of wheat: cassava: potato (%)	Diameter* (mm)	Thickness* (mm)	Spread factor	Colour	Texture	Flavour	Overall quality
100: 0: 0	49.0	4.2	100	Golden brown	Crisp	Highly acceptable	Excellent
60: 0:40	52.0	3.6	124	V. dark	Crisp & fragile	Just acceptable	Fair
60:10:30	52.0	3.6	124	Brown	Crisp	Acceptable	Satisfactory
60:20:20	51.0	3.8	115	Golden brown	Crisp	Acceptable	Good
60:30:10	52.0	3.8	117	Light brown	Crisp & fragile	Acceptable	Satisfactory
60:40: 0	52.0	3.8	117	Dull light brown	Crisp & V. fragile	Unacceptable**	Poor

*Average value of 6 biscuits

**Leaves residual feeling of cassava flour on the tongue

the product during glut season which coincides with summer, thereby facilitating sun-drying of sulphited chips.

In the present study, soft wheat flour with a low protein content and weak gluten has been used. As most of Indian wheats are medium hard, it can be inferred that, such wheat flours can yield, even better quality biscuits at corresponding levels of non-wheat flours.

It may be inferred from different trials on the preparation of biscuits based on wheat, cassava and/or potato flour blends that highly acceptable biscuits could be prepared by using (*i*) 90:10 wheat-cassava flour blend or 80:20 wheat-potato flour blend, (*ii*) 60:20:20 wheat, cassava and potato flour blend and quite satisfactory biscuits at levels of 20 and 30 per cent of cassava and potato flour additions respectively. A 60:10:30 or 60:30:10 blend of wheat, cassava and potato flours respectively also yielded quite satisfactory biscuits.

At higher levels of incorporation of tuber flours, than that mentioned above, the overall quality of biscuits was somewhat inferior.

These findings are of considerable practical utility in countries, where the short supply of wheat could be overcome by partially replacing wheat with tubers which are cultivated extensively.

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NON-ENTEROTOXIGENIC *STAPHYLOCOCCI* FROM MARKET *KHOA*

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Manuscript received 9 *July* 1982; *revised* 16 *January* 1984

Production of thermostable deoxyribonuclease (TDNase) and coagulase by non-enterotoxigenic *Staphylococci* was studied. Although there was 100 per cent correlation between enterotoxigenicity and TDNase and coagulase production, non-enterotoxigenic *Staphylococci* also produced these enzymes. Out of 236 isolates, 60 (29.2%) and 129 (54.6%) produced coagulase and TDNase, respectively. Among 167 coagulase negative isolates, 68 (40.7%) of them produced TDNase, while 8 (7.5%) out of 107 TDNase negative isolates produced coagulase. Results conclusively indicate that enterotoxigenicity of staphylococcal isolates should be confirmed by serological techniques, even though the organisms are positive for TDNase and/or coagulase production.

Among several microorganisms of public health significance, *Staphylococcus aureus* is important as the strains of this species elaborate six antigenically different types of thermostable enterotoxins in various foods including milk and milk products. Enterotoxin detection has been accomplished by serological techniques,

However, the difficulties encountered in the biological and serological methods of enterotoxin detection led to the consideration of a few important biochemical characteristics, such as, production of thermostable deoxyribonuclease (TDNase) and coagulase as potential indicators of enterotoxigenicity[1-3]. Emphasis cannot be laid just on TDNase and coagulase reactions in assessing the enterotoxigenicity of the strains. In an earlier study[4], it was observed that a set of characterisitics, such as, production of TDNase, coagulase, phosphatase, acetoin and mannitol fermentation appeared to be more closely related to enterotoxigenicity of staphylococcal cultures. Although enterotoxin production appears to be well correlated with both coagulase and TDNase production, a few reports[5,6] have described production of enterotoxin by cultures negative for coagulase and/or TDNase production. Similarly, cultures positive for coagulase and TDNase production have also failed to produce enterotoxin. Therefore, in the present study, an attempt has been made to find out the possible relationship between non-enterotoxigenic staphylococcal isolates and a few important characteristics like pigmentation, production of TDNase, coagulase, phosphatase and acetoin and mannitol fermentation.

Three hundred staphylococcal isolates obtained from 100 samples of market *Khoa* (an Indian dried milk product) were selected as test organisms in this study. Brain heart infusion (BHI) culture supernates of the test organisms obtained by cellophane-over-agar plate method of Jarvis and Lawrence[7] were screened for enterotoxins—A,B,C,D and E individually by optimal sensitivity plate (OSP) method of Robbins *et al*[8]. All the 300 test organisms were characterised for pigmentation, mannitol fermentation and production of coagulase, TDNase, phosphatase and acetoin according to the methods described by the authors in an earlier paper[9].

Among 300 staphylococcal isolates, only 64 (21.33 per cent) were found to be enterotoxigenic and the remaining 236 isolates (78.67 per cent) were non-enterotoxigenic. While all the enterotoxigenic isolates were positive for production of TDNase, coagulase, phosphatase and acetoin and mannitol fermentation, 33 (51.6 per cent) and 31 (48. 4 per cent) of them produced golden yellow and white pigmentation, respectively (Table 1). It may be seen from the same table, that out of 236 non-enterotoxigenic staphylococcal isolates, 127 (53. 8 per cent) and 109 (46.1 per cent) were golden yellow and white pigmented, respectively; 117 (75.0 per cent) fermented mannitol and 176 (74.6 per cent), 198 (84.0 per cent), 69 (29.2 per cent) and 129 (54.7 per cent) isolates produced acetoin, phosphatase, coagulase and TDNase, respectively.

An almost equal distribution of golden yellow and white pigmentation observed among the enterotoxigenic and non-enterotoxigenic isolates were similar to the observation made by Ghosh[10]. The findings emphasise the unreliability of pigmentation as a criterion in identifying enterotoxigenicity of *Staphylococci*. From the results, it is evident, that nearly 75 per cent each of non-enterotoxigenic isolates were positive for mannitol fermentation and production of acetoin and phosphatase, with the result that these characteristics cannot be individually considered as indices of enterotoxigenicity, however, can be of secondary importance to TDNase and coagulase production.

The earlier views[1-3] of TDNase and coagulase production correlating well with enterotoxin production finds agreement in this study, as far as only enterotoxigenic isolates were considered. The observation of 29.2 and 54.7 per cent of the non-enterotoxigenic isolates being positive for production of coagulase and TDNase respectively, would indicate the doubtfulness of these two characteristics, and hence cannot be entirely relied upon in all instances. On the basis of positive characteristics

TABLE 1. CHARACTERISTICS OF ENTEROTOXIGENIC AND NON-ENTEROTOXIGENIC *STAPHYLOCOCCI*

Characteristics		Enterotoxigenic isolates (64)		Non-enterotoxigenic isolates (236)	
		(Nos)	(%)	(Nos)	(%)
Pigmentation	Gy	33	51.6	127	53.8
	W	31	48.4	109	46.1
Mannitol fermn*		64	100.0	177	75.0
Acetoin prodn		64	100.0	176	74.6
Phosphatase prodn		64	100.0	198	84.0
Coagulase prodn		64	100.0	69	29.2
TDNase prodn		64	100.0	129	54.7

*Aerobic and anaerobic conditions; Gy=Golden yellow; W=White

TABLE 2. CHARACTERISTICS OF COAGULASE AND TDNASE NEGATIVE *STAPHYLOCOCCI*

Characteristics	Coagulase –ve isolates (167)		TDNase –ve isolates (107)	
	(Nos)	(%)	(Nos)	(%)
Pigmentation Gy	79	47.3	45	42.0
W	88	52.7	62	58.0
Mannitol fermn*	109	65.2	62	58.0
Acetoin prodn	87	52.0	60	56.1
Phosphatase prodn	131	78.4	73	68.2
Coagulase prodn	Nil	Nil	8	7.5
TDNase prodn	68	40.7	Nil	Nil

* Aerobic and anaerobic conditions; Gy = Golden yellow; W = White

shown by TDNase and coagulase negative isolates (Table 2), it is evident, that among TDNase and coagulase production, the former appears to be a more reliable indicator of enterotoxigenicity. However, it is the relationship shown by the negative isolates in their ability to produce TDNase and coagulase and vice-versa, wherein 40.7 per cent of coagulase negative isolates produced TDNase and only 7.5 per cent of TDNase negative isolates produced coagulase which suggests that coagulase production cannot be entirely relied upon and the test performed for coagulase production by *Staphylococci* has to be further standardised, if at all this character has to be considered as a potential indicator of enterotoxigenicity. TDNase production, however, has been demonstrated in a few coagulase negative strains of *S. aureus*[11,12]. It was also observed[1,13,14] that 21.0-24.4 per cent of coagulase negative strains formed TDNase upon prolonged incubation for 24 hr.

From the above data, it is evident, that all enterotoxigenic strains are TDNase and coagulase positive, while all TDNase and coagulase positive strains need not be enterotoxigenic. In view of this, it would be appropriate to screen all the isolates for enterotoxin production by serological methods, irrespective of the isolates being TDNase and/or coagulase positive.

In this study, the inability of TDNase and coagulase positive staphylococcal isolates to elaborate enterotoxins may be due to one of the following two reasons. Firstly, the enterotoxin(s) produced by these isolates may be below the detectable level of OSP method followed here, the minimum detectable concentration being 2 μg/ml and secondly, the ability of staphylococcal isolates to elaborate enterotoxins may be related to the sources of their isolation.

The senior author expresses his sincere thanks to CSIR, India for the financial assistance.

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STUDIES ON CALCIUM LACTATE AS *CHHANA* COAGULANT

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Manuscript received 17 *May* 1983; *revised* 27 *December* 1983

Studies on the use of calcium lactate as a coagulant for *chhana* (milk coagulate) indicate that the yield is higher (23.6 and 24.8%) when compared to citric acid (16.8% 18.0%) at coagulation temperatures of 85° and 80°C respectively. Higher yield is attributed to better retention of moisture and higher recovery of milk solids. Sensory evaluation revealed that colour, body, texture and flavour (taste) of calcium lactate *chhana* were significantly different from that of citric acid *chhana*; taste of whey also was different.

Chhana coagulated milk is an Indian dairy product, used chiefly in the preparation of sweets like *Rosogolla*,

Sandesh etc. It is estimated that around 4 per cent of the milk produced in India is converted into *chhana*[1]. Traditionally, citric acid, lactic acid, sour whey, lime juice are used as coagulants in the preparation of *chhana*. Of late, considerable quantity of homemade *chhana* in West Bengal is obtained by using calcium lactate (CL) as coagulant[2]. Since no systematic study has so far been carried out, the present investigation was taken up to find out the possible reasons for the use of CL in *chhana* production.

chhana was prepared by the conventional batch method as prescribed by De and Roy[3] from pooled milk containing 3.8 per cent fat, 9.04 per cent solids-not-fat (SNF) and 0.16 per cent titratable acidity. To lots of 500g of milk, 4 per cent calcium lactate (CL) or citric acid (CA) solutions were used for coagulation. The milk fat content was determined by Gerber method[4].

SNF and TA determined as per ISI method[5]. Moisture content in *chhana* was determined as per the ISI method[6]. A double beam balance was used for weighing milk and *chhana*. The sensory characteristics between the two types of *chhana* and whey were compared. *Sandesh* was prepared from both type of *chhana* and these were judged on the basis of 9-point hedonic scale[7].

On the basis of preliminary trials, 4 per cent solution of CL (and also CA for comparison) was used in the present study. Yield of *chhana* from CL and CA treatments at average coagulation temperatures of 85°C and 80°C are presented in (Table 1). The average temperature of 85°C with CL was made up of an initial temperature of 92°C for milk and final temperature of 78°C for *chhana* whey; and that for 80°C was 88 and 72°C respectively. Similarly, for CA when the average coagulation temperatures were maintained at 85 and 80°C, the initial and final temperatures of milk and whey were 87, 83 and 83, 77°C respectively. The moisture content and per cent recovery of milk solids in *chhana* were also estimated for CL and CA *chhana* at both the coagulation temperatures. The sensory evaluation of *chhana* included colour, body and texture, flavour, overall appearance and suitability for *sandesh* making. The whey obtained from both the types of *chhana* was given to the judges for organoleptic evaluation. The findings of these observations are presented in table 1.

TABLE 1. YIELD AND COMPOSITION OF CALCIUM LACTATE AND CITRIC ACID COAGULATED *CHHANA* AT TWO COAGULATION TEMPERATURES

Coagulant used	Coagulation temp. (°C)	Yield (as % of milk taken)	Moisture in *chhana* (%)	% Recovery of milk solids in *chhana*
Citric acid	80	18.0	57.80	59.15
,,	85	16.8	55.42	58.31
Cal. lactate	80	24.8	66.78	64.15
,,	85	23.6	65.12	64.09

Note: Each of the above trials was repeated five times to obtain average representative data.

Yield and moisture content of chhana: The CL *chhana* gives much higher yield than the CA *chhana* in both the cases. The results reveal that the moisture retention of CL *chhana* is much higher than the CA *chhana* irrespective of the coagulation temperatures. Thus, the moisture per cent of CL and CA *chhana* are 65.12, 66.78 and 55.42, 57.80 at 85°C and 80°C respectively.

Recovery of milk solids in chhana: The per cent recovery of milk solids in CL *chhana* is more than CA *chhana* at both the average coagulation temperatures. The higher yield of *chhana* (wet basis) and higher recovery of milk solids are probably the two major reasons of using CL as *chhana* coagulant.

Sensory evaluation: The colour of the CL *chhana* is much whiter than CA *chhana*. The body and texture of CL *chhana* are comparatively soft, smooth and elastic than CA *chhana*. This may be due to the presence of higher moisture content in CL *chhana*.

The CL *chhana* is sweeter in taste than CA *chhana* and the overall appearance of CL *chhana* is also more attractive than CA *chhana*. It was further noted that the CL whey is sweeter than CA whey. *Sandesh* was prepared from both types of *chhana* separately, and both were accepted by the judges, whose score ranged from 6 to 8. All the above characteristics should favour the use of CL for *chhana* making.

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PERFORMANCE OF CROSSBRED CHICKENS FOR *TANDOORI* PREPARATION

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Manuscript received 3 *December* 1982; *revised* 19 *January* 1984

The performance of 5, 6 and 7-week old crossbred chickens of Cornish×Rock and Rock×Cornish for *tandoori* preparation were examined, Crosses of Cornish× chickens from Rock were superior due to higher meat yield. Six week old chickens were found to be the best for *tandoori* preparation.

Usefulness of crossbred chicknes for *tandoori* preparation has been reported[1]. The present paper reports the perfoimance of four different crosses of 'Cornish' and 'Rock' namely, IC-2 × IR-3, IC-3 × IR-2, IR-2 × IC-3 and IR-3 ×IC-2 at five, six and seven weeks of age.

Twenty four chickens were utilised in this experiment. Duplicate samples were randomly taken from each of the crosses which were reared on floors under identical conditions of feeding and management, eviscerated and processed in the form of ready-to-cook chicken. The eviscerated weight of each carcass without giblets and without any chilling was recorded. After draining, each carcass was rubbed with salt followed by cut lime and kept for 15 min at ambient temperature (25-26°C). The spice mixture consisted of (in per cent) coriander seed 1, cumin seed 1, red chilli 0.5, turmeric 0.5, cardamom 0.2, cinnamon bark 0.2, clove 0.1, peeled garlic 1, peeled ginger 1, peeled onion 5, curd 10, hydrogenated vegetable oil 10, vinegar 2 and lime juice 2.

Peeled and sliced onion, garlic and ginger were blended together with powdered spices and vinegar to a fine paste. Finally curd was added and mixed thoroughly. This mixture was applied all over the surface of the carcass and the latter set aside for 4 hr.

A locally made earthen *tandoor* was maintained at 175-190°C using hard wood as fuel. The seasoned carcasses were hung in the middle of the *tandoor* using iron hooks. Care was taken to get uniform cooking. Approximately 15 min of cooking was done. The carcasses were tested for doneness by twisting the drumsticks or wings. When the carcass was almost done, it was taken out of the *tandoor* and hydrogenated vegetable oil was applied all over the chicken with a brush and was returned to *tandoor* to cook for another 2-3 mins.

The cooked chickens were weighed individually to determine the cooking loss and presented to a panel of five judges for sensory evaluation (overall acceptability) on a seven point Hedonic scale. The data were analysed statistically[2].

The mean and standard error of live weight and evisceration percentage are given in Table 1. The effect of the crosses on live weight indicated that IC-2×IR-3

TABLE 1. MEAN AND STANDARD ERROR OF LIVE WEIGHT AND EVISCERATION PERCENTAGE

Crosses	Live weight (g)			Evisceration percentage		
	5 weeks	6 weeks	7 weeks	5 weeks	6 weeks	7 weeks
IC-2 X IR-3	580.0^{Aa}	645.0^{Ba}	832.0^{Ca}	57.31^{Da}	60.07^{Ea}	61.25^{Fa}
	±10.0	± 5.0	± 7.5	±0.20	±0.07	±0.64
IC-3 X IR-2	577.0^{Aa}	650.0^{Ba}	812.5^{Ca}	56.27^{Db}	56.15^{Db}	59.38^{Eb}
	±17.5	± 0.0	±12.5	±0.00	±0.76	±0.00
IR-2 X IC-3	470.0^{Ab}	565.0^{Bb}	755.0^{Cb}	54.25^{Dc}	57.07^{Ebc}	58.61^{Fbc}
	± 0.0	± 5.0	± 5.0	±0.34	±0.00	±0.71
IR-3 X IC-2	465.0^{Ab}	630.0^{Bb}	730.0^{Cb}	53.76^{Dc}	57.14^{Ec}	58.21^{Fc}
	± 5.0	±10.0	±10.0	±0.56	±0.10	±0.17

Values with same lowercase letter column-wise and same uppercase letter rowwise are not significantly ($P \leq 0.05$) different.

TABLE 2. MEAN AND STANDARD ERROR OF PERCENT COOKING LOSS AND OVERALL ACCEPTANCE SCORES

Crosses	Cooking loss			Overall acceptance scores*		
	5 weeks	6 weeks	7 weeks	5 weeks	6 weeks	7 weeks
IC-2 X IR-3	15.00^{a}	11.60^{b}	9.80^{c}	6.20^{de}	6.40^{d}	6.00^{e}
	± 0.95	± 0.10	± 0.17	± 0.37	± 0.40	± 0.00
IC-3 X IR-2	13.85^{a}	12.33^{b}	11.38^{b}	6.20^{d}	6.40^{d}	6.20^{d}
	± 0.37	± 0.14	± 0.76	± 0.37	± 0.24	± 0.20
IR-2 X IC-3	13.69^{a}	12.40^{b}	10.73^{c}	5.60^{d}	6.80^{e}	6.00^{f}
	± 1.41	± 0.10	± 0.60	± 0.24	± 0.20	± 0.31
IR-3 X IC-2	13.00^{a}	12.49^{ab}	11.76^{b}	5.40^{d}	6.60^{e}	5.80^{f}
	± 0.84	± 0.17	± 0.10	± 0.24	± 0.24	± 0.20

Means with same superscript in each row do not differ significantly ($P \leq 0.05$)
*7=Like very much. 1=Dislike very much.

and IC-3×IR-2 ('Cornish'×'Rock') were significantly ($P \leq 0.05$) superior to IR-2×IC-3 and IR-3×IC-2 ('Rock'×'Cornish'). With respect to evisceration percentage, the IC-2×IR-3 had significantly ($P \leq 0.05$) higher value than others, which indicated that this particular cross had superiority over others for this trait, possibly because of better hybridizing effect.

The average cooking loss (expressed as percentage of eviscerated weight) showed no significant difference between crosses at their same age (Table 2), however, the overall acceptance scores were significantly ($P \leq 0.05$) higher at six weeks of age.

Thus, it was concluded that although the four crosses used in this experiment were fit for utilization as *tandoori* chickens, the crosses produced by 'Cornish'×'Rock' (particularly IC-2×IR-3) were superior in performance due to higher meat yield and preferably at six weeks of age because of their optimal overall acceptability.

The authors thank Dr. S. C. Mohapatra, P.C.P.B. (AICRP) for the suggestions in this investigation.

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SCREENING OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL) VARIETIES FOR STORAGE AND BIOCHEMICAL CHANGES

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Manuscript received 30 *May* 1983; *revised* 27 *December* 1983

Seven varieties of tomato (HS-102, HT-1, Punjab chhuhara, S-12, HT-6, Pusa Ruby and HT-8) were screened for their storage performance by open tray, polythene cover and wax coating (at ventral end). Polythene cover and wax coating although enhanced the shelf life of other vegetables, did not prove useful in case of tomato. Under open tray conditions 'HT-8' variety showed longest shelf life (16-18 days) followed by 'Punjab chhuhara' and 'S-12' (15-16 days). Amongst biochemical parameters, total soluble solids and pH decreased whereas ascorbic acid increased during storage in the case of all the varieties. On the other hand, reducing sugars were found to change in decreasing pattern.

The varieties of tomato can be grouped as determinate, indeterminate and interminate. Determinate types have less storage life; the other are pear shaped and withstand long distance transport. Several workers[2-3] have reported that there is considerable variation in biochemical constituents of tomato in the world germ-

TABLE 1. CHANGES IN BICCHEMICAL CONSTITUTENTS DURING STORAGE OF TOMATO (WITHOUT COVERINGS)

Variety	Before storage				After storage			
	TSS (%)	Reducing sugar (%)	pH	Ascorbic acid (mg/100g)	TSS (%)	Reducing sugar (%)	pH	Ascorbic acid (mg/100g)
HS-102	5.9	3.10	5.00	27.97	4.20	2.59	4.2	45.54
HT-1	5.2	5.00	4.80	14.58	4.30	4.63	4.5	35.67
Punjab chhuhara	3.0	3.00	5.00	12.32	2.40	2.08	4.6	14.26
S-12	5.3	5.16	4.40	17.50	4.74	2.41	4.0	33.47
HT-6	4.5	4.25	5.15	18.23	3.50	3.00	4.7	23.72
Pusa ruby	5.0	3.00	4.40	12.56	4.00	1.58	4.0	31.13
HT-8	4.0	2.98	4.30	13.34	3.00	2.87	3.8	37.20

Relative humidity: 35-90%; Temperature: Max. 21 to 36°C; Min 15.5 to 21°C.

plasm[4,5]. Scanty information is available regarding the varietal performance of tomato for storage purpose. The present study was made under hilly conditions, during the months July-August 1982 in DRDO Agricultural Research Unit, Almora. In our earlier communication[6], we have reported the successful use of polythene cover (perforated and unperforated) and wax coating for the enhancement of shelf life of various vegetables. Polythene cover specially suited to leafy vegetables, cauliflower, cabbage and knol-khol, whereas wax coating suited well for brinjal and capsicum. In the present studies, all these conditions were tried, but without any significant gain.

Seven varieties of tomato ('HS-102', 'HT-1', Punjab chhuhara', 'S-12', 'HT-6', 'Pusa Ruby' 'HT-8') were grown in experimental fields of ARU Hawalbagh (Almora) in randomized block design. Fruits of different stages of maturity (mature green, turning pink and pink) were picked up. Composite sample for each variety was prepared by taking 9-10 fruits of each kind in equal ratio. Relative humidity and temperature were recorded throughout the experiment. Ascorbic acid and reducing sugar were estimated by known methods[7]. Total soluble solids content was determined by hand refractometer, pH of the fruit juice was determined.

Values for ascorbic acid, reducing sugar, TSS and pH, determined at the time of storage and after storage are given in Table 1. From the results, it is seen that TSS and pH decreased during storage. Sharp increase in ascorbic acid content was observed during storage, which may be due to the formation of ascorbic acid from glucose during storage. Further, decrease in reducing sugar (Table 1) also supports this view. Kaur *et al.*[8] had also reported a similar pattern of change in ascorbic acid and acidity during storage. Performance of different varieties for storage under open, polythene and wax application on the ventral-end of the fruit are presented in Table 2 on the basis of their deterioration during

TABLE 2. STORAGE LIFE OF VARIOUS TOMATO CULTIVARS UNDER DIFFERENT TREATMENT CONDITIONS

Variety	Without cover		Polythene cover		Ventral end wax tipping	
	Days	Deterioration (%)	Days	Deterioration (%)	Days	Deterioration (%)
HS-102	8 - 10	5 - 6	8 - 9	6 - 7	7 - 8	5 - 7
HT-1	12 - 13	5 - 5	10 - 11	5 - 6	6 - 8	6 - 6
Punjab chhuhara	15 - 16	4 - 5	15 - 17	5 - 6	16 - 17	4 - 6
S-12	15 - 16	7 - 7	12 - 14	8 - 8	17 - 18	7 - 8
Pusa ruby	14 - 16	5 - 7	12 - 14	6 - 7	13 - 14	5 - 7
HT-8	16 - 18	4 - 5	14 - 15	4 - 6	11 - 12	5 - 6
HT-6	10 - 12	6 - 6	10 - 12	6 - 7	9 - 10	7 - 7

storage. Deteriorated fruit becomes loose and infected with certain microbes. Generally, the fruit is declared as deteriorated when it is not fit for human consumption. It was observed that varieties widely differ in their storage life. 'HT-8' variety have longer storage life (16-18 days) followed by 'S-12' and 'Pusa Ruby' (15-16 days).

The authors thank Shri M. C. Joshi, Director, ARU, Almora and Shri T. Pant for the encouragement during the investigations.

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STUDIES ON THE PREPARATION OF AROMA CONCENTRATE FROM CASHEW APPLE (*ANACARDIUM OCCIDENTALE*)

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Manuscript received 15 *March* 1983; *revised* 19 *December* 1983

Volatile components in the sulphited cashew apple juice were recovered in the Holstein and Kappert aroma recovery unit of 400 l/hr capacity and the juice was concentrated to 68° Brix in a forced circulation evaporator. The volatiles were separated by gas chromatography. Dowex 1×8 (OH^-) was found to remove almost all sulphur dioxide from the aroma distillate. The gas chromatogram of aqueous aroma distillate after passing through Dowex 1×8 (OH^-) shows recovery of almost all the components.

The production of cashew apple in India is estimated at 8.4 lakh tonnes. The cashew apple is not fully utilised much because of its astringency, perishable nature and transportation problems. However, 10 to 15 per cent is utilised for the preparation of an alcoholic beverage called "Fenny" in Goa.

Concentration of fruit juices reduces the bulk which is important for storage, packaging and transportation. However, during conventional concentration processes most of the aroma is lost. Therefore, it is necessary to remove the aroma fraction from the fruit juice prior to concentration. There are several reports on the different processes used for aroma recovery and juice concentration[1-9]. The aroma concentrate and the juice concentrate can be reconstituted whenever required. The cashew apple aroma concentrate and the stripped juice concentrate can be stored separately. The aroma concentrate can be added back to the juice concentrate to get full flavoured cashew apple beverage.

The studies reported in this paper were aimed at recovering aroma concentrate from sulphited cashew apple juice under the optimum operating conditions in Holstein and Kappert aroma recovery unit, concentration of stripped juice and the subsequent removal of sulphur dioxide from the aroma concentrate.

Fresh cashew apples were procured from Plantation Corporation of Kerala, Kasargod, India and were washed thoroughly with water and the juice extracted in a screw type juice extractor. It was sulphited at 1000 ppm level of sulphur dioxide (1 g/kg) in the form of potassium metabisulphite and stored at room temperature. For aroma recovery, the juice was treated with 0.05 per cent gelatin to remove tannins, filtered and fed directly into the feeding tank of aroma recovery unit.

The aroma concentrate was recovered in the Holstein and Kappert aroma recovery unit, using the principle of evaporation and fractional distillation.

The aroma concentrate was extracted with chilled methylene chloride. The methylene chloride extract was dried over anhydrous sodium sulphate and was injected into the gas liquid chromatograph.

The volatiles were separated on a Varian Aerograph series 1400 gas chromatograph, equipped with flame ionization detector, employing a 9 ft×1/8 in. I.D. stainless steel column packed with 15 per cent carbowax 20 M on 80-100 mesh acid washed chromosorb—W. Sulphur dioxide present in the aroma concentrate was removed by passing the aroma concentrate through a column filled with Dowex 1×8 (OH^-) resin. The column was then washed twice with 4 bed volumes of water. Sulphur dioxide was estimated by the method of Monier and Williams[10]. Brix was determined by hand refractometer and tannins and acidity by standard AOAC methods[10].

The analysis of cashew apple juice is given in Table 1. Sulphur dioxide content in the aqueous aroma distillate

TABLE 1. CHEMICAL ANALYSIS OF CASHEW APPLE JUICE

Soluble solids (°Brix)	11.0 - 12.5
Acidity (% anhydrous citric acid)	0.15 - 0.35
Tannins (%)	0.35 - 0.55

TABLE 2. SO_2 IN DIFFERENT FRACTIONS OF CASHEW APPLE JUICE AND IN AROMA CONCENTRATE BEFORE AND AFTER PASSING THROUGH DOWEX 1×8 (OH^-) COLUMN

Sample	SO_2 (ppm)
Unclarified juice	792.0
Clarified juice	760.0
Aqueous aroma distillate	952.0
Aqueous aroma distillate passed through Dowex 1×8 (OH^-)	Nil

after passing through Dowex 1×8 (OH^-) column shows its complete removal as compared to the sulphur dioxide contents initially (Table 2).

The gas liquid chromatogram of aqueous aroma concentrate after passing through Dowex 1×8 (OH^-) (Fig. 2) and compared with the aqueous aroma concentrate containing sulphur dioxide (Fig. 1) shows recovery of almost all the peaks. The peak height however, decreases in some cases. The decrease in peak height may be due to adsorption of those flavour components on the Dowex 1×8 (OH^-) column. However, both the

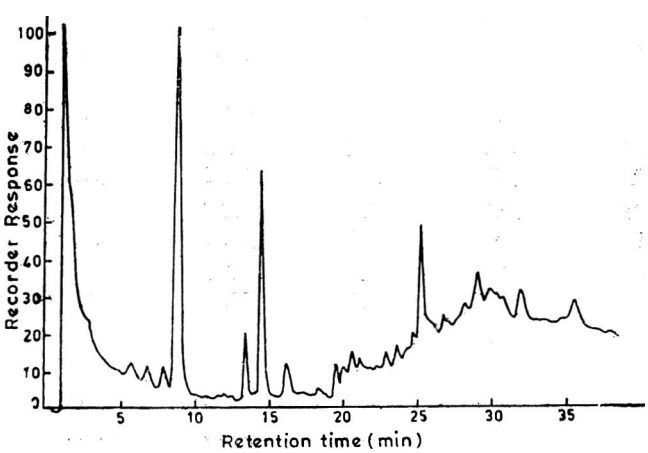

Fig. 1. Gas liquid chromatogram of cashew apple aroma containing SO_2

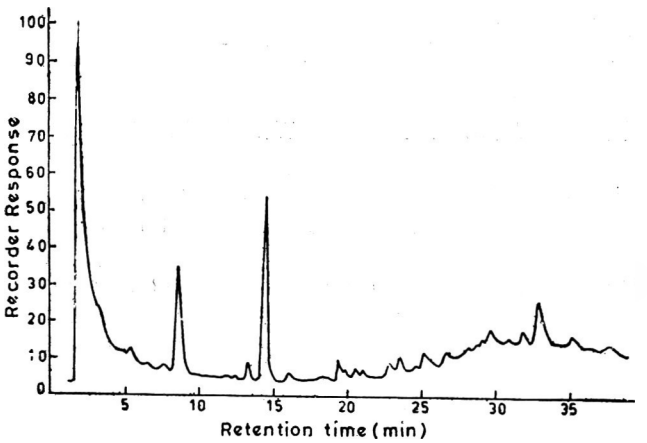

Fig. 2. Gas liquid chromatogram of cashew apple aroma after passing through Dowex 1×8 (OH^-) column

samples possessed the typical strong cashew apple flavour as evaluated by sensory evaluation method of RTS beverage prepared from fresh cashew apple juice and RTS beverage prepared from aroma concentrate after passing through Dowex 1×8 (OH^-) column.

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CHEMICAL AND NUTRITIONAL CHANGES IN BLACK GRAM (*PHASEOLUS MUNGO*) DURING STORAGE CAUSED BY THE ATTACK OF PULSE BEETLE *CALLOSOBRUCHUS MACULATUS* (FABR)

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Manuscript received 7 *March* 1983; *revised* 12 *January* 1984

The qualitative and quantitative losses in black gram caused by *Callosobruchus maculatus* Fabr. during storage were evaluated. It was observed that the moisture content, insect population, weevilled grain, weight loss, protein, fat, calcium, phosphorus, free fat acidity, total ash, acid insoluble ash, reducing sugar, crude fibre, alcoholic acidity and uric acid increased during 6 months of storage period while viability, 1000 kernel weight, non-reducing sugar and starch decresaed as the percentage of weevilisation increased.

Pulses are one of the important sources of protein in Indian diet and the crop being seasonal needs storage for different periods. Whole pulses are severly damaged by bruchids in storage. Besides affecting the market value and its acceptability, infestation is also likely to affect the nutritive value and hygienic condition of the processed materials.

Five hundred grams of freshly harvested and sterilised black gram (*Phaseolus mungo*) variety 'Type-9' (12 per cent moisture content) was taken in glass jars. Five pairs of *Callosobruchus maculatus* adults, 1 to 3 days old, were released in each jar except the control. These jars were kept in incubator at 27±2°C temperature and 65-70 per cent relative humidity. All treatments were in triplicates. Monthly observations were recorded on moisture content, viability, 1000 kernel weight, insect population, weevilled grain and weight loss as well as on chemical parameters like protein, crude fat, free fat acidity, total ash, acid insoluble ash, calcium, posphorus, reducing and non-reducing sugars, starch, crude fibre, alcoholic acidity and uric acid which were analysed by standard methods[1-13].

Results given in Table 1 indicate that the per cent weevilisation and weight loss increased from the initial 0 to 92.0 and 46.3 per cent respectively, during 6 month storage period, with the increase in population of *Callosobruchus maculatus*, while viability decreased from 94.0 to zero per cent in infested kernels. Similar conclusions were drawn by Pingale *et al.*[14] Venkat Rao *et al*[15], Shehnaz and Theophilus[16]. Protein, crude fat,

TABLE 1. QUALITATIVE AND QUANTITATIVE LOSSES IN BLACK GRAM (VAR. T-9) BY *CALLOSOBRUCHUS MACULATUS* DURING STORAGE

Storage period (months)	Moisture (%)	Viability (%)	1000 kernel wt (g)	Adults in 500 g	Wt loss (%)	Weevilled grain (%)	Protein (%)	Crude fat (%)
0	12.0	94	52.0	nil	nil	nil	22.5	2.62
1	12.1 (12.1)	91 (94)	51.8 (52.0)	88 (nil)	0.41 (nil)	1.0 (nil)	22.7 (22.5)	2.63 (2.62)
2	12.4 (12.2)	82 (94)	50.2 (52.0)	490 (nil)	4.5 (nil)	8.6 (nil)	24.3 (22.5)	2.75 (2.62)
3	13.2 (12.4)	26 (94)	42.3 (52.2)	2432 (nil)	23.6 (nil)	43.6 (nil)	28.6 (22.48)	3.27 (2.61)
4	15.0 (12.6)	12 (93.6)	34.8 (52.3)	3825 (nil)	39.2 (nil)	78.0 (nil)	33.2 (22.46)	3.78 (2.61)
5	15.2 (12.8)	6 (93.3)	33.2 (52.4)	4632 (nil)	42.9 (nil)	85.2 (nil)	34.0 (22.46)	3.89 (2.60)
6	15.4 (13.0)	nil (93.0)	31.3 (52.5)	5425 (nil)	46.3 (nil)	92.0 (nil)	34.9 (22.45)	3.90 (2.60)
S.E.	0.021	0.6820	0.1292	23.34	0.05	0.30	0.0323	0.0258
C.D. at 5%	0.1353	1.5194	0.2878	52.00	0.10	0.66	0.0703	0.0562
(S.E.)	(0.0408)	—	(0.10)	—	—	—	—	—
C.D. at 5%	(0.0890)	—	(0.2179)	—	—	—	—	—

Figures in parentheses are for uninfested control grain

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TABLE 2. CHEMICAL CHANGES IN BLACK GRAM (VAR. T-9) INFESTED BY *CALLOSOBRUCHUS MACULATUS* DURING STORAGE

Storage period (months)	FFA (mg KOH/ 100 g grain)	Total ash (%)	Acid insol. ash (%)	Cal. (mg/100g)	Phos. (mg/100g)	Sugars		Starch (%)	Crude fibre (%)	Alcoholic acidity (%)	Uric acid (mg/100g)
						Reducing (%)	Non-reducing (%)				
0	24.8	3.35	0.252	170.5	349.0	0.60	1.38	51.6	4.62	0.12	Nil
1	24.8 (24.8)	3.36 (3.35)	0.258 (0.252)	171.5 (170.5)	349.6 (349.0)	0.61 (0.61)	1.36 (1.38)	51.2 (51.6)	4.69 (4.62)	0.13 (0.12)	38 (nil)
2	25.1 (24.8)	3.51 (3.35)	0.288 (0.252)	180.0 (170.5)	356.7 (349.0)	0.66 (0.61)	1.29 (1.38)	50.2 (51.58)	5.2 (4.62)	0.15 (0.13)	221.0 (nil)
3	60.2 (32.0)	4.22 (3.35)	0.433 (0.252)	209.0 (170.5)	390.4 (349.0)	0.93 (0.68)	0.92 (1.38)	44.54 (51.56)	7.84 (4.62)	0.20 (0.14)	1280 (nil)
4	112.4 (35.2)	4.92 (3.35)	0.539 (0.252)	259.0 (170.5)	423.3 (349.0)	1.20 (0.63)	0.65 (1.39)	38.0 (51.56)	10.4 (4.62)	0.36 (0.15)	2217 (nil)
5	128.6 (40.8)	5.07 (3.35)	0.589 (0.252)	267.2 (170.5)	430.2 (349.0)	1.24 (0.65)	0.58 (1.36)	37.8 (51.52)	10.9 (4.62)	0.38 (0.16)	2391 (nil)
6	128.8 (42.4)	5.20 (3.35)	0.645 (0.252)	274.5 (170.5)	436.6 (349.0)	1.30 (0.65)	0.52 (1.36)	36.6 (51.52)	11.4 (4.62)	0.40 (0.16)	2800 (nil)
S.E.	0.115	0.0416	0.0033	0.0408	0.075	0.0033	0.0032	0.1794	0.32	0.0042	8.20
C.D. at 5%	0.230	0.0906	0.0072	0.0889	0.1634	0.0072	0.0071	0.3909	0.69	0.0091	18.20

Figures in parentheses are for uninfested control grain

calcium, and phosphorus increased (Table 2) in infested kernels after six months storage period, which could be attributed to the endosperm portion being eaten away by *Callosobruchus maculatus*. The bran portion which is rich in protein, fat, calcium and phosphorus remains intact even in the insect damaged kernels.

Similar studies done by Shehnaz and Theophilus[16] on Bengal gram and field bean also showed an increase in all the above parameters regularly in damaged pulses during storage.

The content of reducing sugar increased while non-reducing sugar and starch decreased as storage period prolonged. This may be due to the increase in moisture content resulting in biochemical changes. The starch content reduced as a result of consumption of endosperm (rich in starch) by *Callosobruchus maculatus*. Uric acid which was nil in fresh balck gram, increased upto 2800 mg/100 g of grain in infested b ack gram after six months of storage. At this stage, the weevilisation was 100 per cent and population of *Callosobruchus maculatus* was 5425.

Venkat Rao *et al*[17]., Shehnaz and Theophilus[16] and Swaminathan *et al*[18]., while conducting similar type of studies also concluded that the uric acid content increased rapidly in stored pulses with the increase of pulse beetle infestation during prolonged storage. The uric acid produces the unhygienic condition in stored food-grains and also causes physiological disorders like rheumatic pain, etc. in human body system when insect contaminated grains are consumed.

The free fat acidity and alcoholic acidity increased in infested and uninfested black gram during storage, but the increase was rapid in infested black gram than in uninfested (control) black gram. This may lead to bitter taste and off flavour in cooked pulses.

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TOXICITY CHANGES IN PYRETHROID RESIDUES FROM SOIL, SILICA GEL AND WATER

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Manuscript received 20 *May* 1983; *revised* 6 *January* 1984

Toxicity of residues of synthetic pyrethroids (permethrin, cypermethrin, decamethrin and fenvalerate) both in aqueous solution and as deposits on solid surfaces like soil and silica gel to houseflies was studied after exposure to sunlight for 8 hr daily. The residues were extracted after 2 and 4 days intervals and their toxicity to houseflies was determined through topical application. The persistent toxicity values indicated a fall in toxicity of all the four pyrethroids with time; fall in toxicity was maximum with decamethrin and least with permethrin. In general, the persistence of pyrethroids was least in water and highest in soil.

The natural pyrethrins and many highly insecticidal synthetic chrysanthemates are not suitable for control of agricultural pests because of insufficient stability in light and air[1]. Considerable efforts made in recent years to improve the photostability of pyrethroids by modifying their structure have resulted in the production of a number of photostable pyrethroids many of which are available commercially. Reports on the degradation and persistence of pyrethroids in the environment and biota are scanty. Pyrethroids differ among themselves in their toxicity to insects and mammals and their persistence in the environment. Results of our investigations on toxicity changes in the four pyrethroids—permethrin, cypermethrin, decamethrin and fenvalerate when mixed individually with soil, silica gel and water and exposed to sun light, are presented here.

Technical grade permethrin (94.7 per cent) and cypermethrin (90.9 per cent) supplied by Alkali and Chemical Corporation of India, fenvalerate (93.7 per cent) by Rallis India Limited and decamethrin (99 per cent) by Roussel Ucla Procide, Paris (France) were used. Silica gel used was TLC grade supplied by National Chemical Laboratory, Pune (India). Soil was collected from the Institute garden. It was air dried and sieved through 100 mesh BSS sieve.

Each pyrethroid was dissolved separately in acetone (10 per cent level) and one millilitre of the solution was mixed with 10 g of soil or silica gel or water in duplicates. These samples were exposed to sun light for 8 hr per day for 2 and 4 days. The pyrethroids from soil and silica gel were extracted with acetone. From water suspensions the pyrethroids were extracted with 3×25 ml of ether. The ether extract was concentrated and finally dried under nitrogen. The residue was dissolved in acetone and after suitable dilution it was used for bioassay studies with houseflies. For toxicity studies, 3-4-day old female houseflies were used. Topical application was done using an agla micrometer syringe as described earlier[6].

To find out the LD_{50} values, the standard pyrethroid solutions in acetone were applied topically to houseflies and 24 hr mortality counts were noted. The results of toxicity studies were subjected to probit analysis[7]. From the regression equation obtained, mortality curves were drawn (Fig. 1). Persistent toxicity (PT) at the end was calculated from the toxicity results as suggested by Pradhan[8] and modified by Senapati and Satpathy[9].

The results of toxicity studies presented in Table 1 indicate that the order of persistence of pyrethroids, as judged by the PT values, was permethrin >fenvalerate > cypermethrin > decamethrin. Decamethrin was found to be least persistent, both in aqueous solution and on solid surfaces like soil and silica gel, indicating that it undergoes photolysis more readily than the other three pyrethroids and that the resulting mixtures of decamethrin photoproducts from aqueous solutions and from solid phase reactions were relatively less toxic to houseflies after 4 days of exposure to sun light.

The order of persistence of pyrethroid residues was similar both on solid surfaces and in aqueous solution, but the degree of persistence varied. The persistence of all the pyrethroids was maximum in soil and minimum

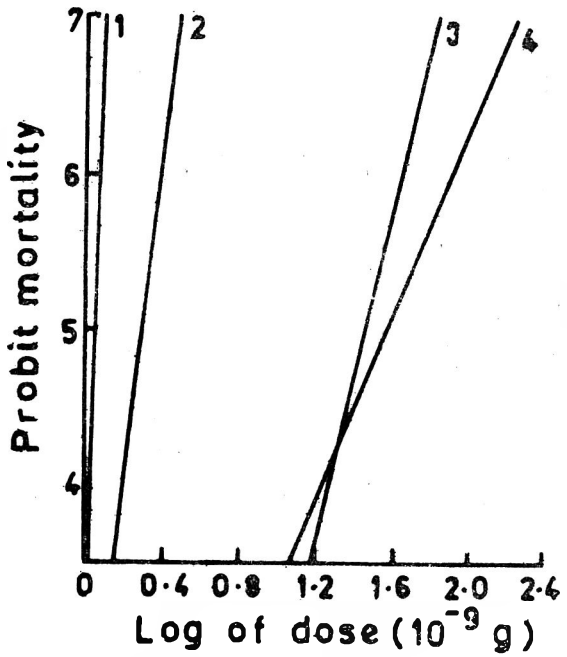

Fig. 1. Toxicity of synthetic pyrethroids to houseflies
1) Decamethrin 2) Cypermethrin 3) Permethrin. 4) Fenvalerate

in water. The maximum possible value for PT at the end of 4 days, had there been no fall in toxicity, would have been 400. However, the PT values in Table 1 indicate that there was a fall in toxicity of all the pyrethroids with time. The values for per cent fall in toxicity (PT values) of permethrin, cypermethrin, decamethrin and fenvalerate in soil were 13.0, 23.5, 70.0 and 16.0, respectively, whereas the corresponding values for fall in toxicity in water were 42.0, 68.5, 78.0 and 59.5 respectively. The values for fall in toxicity of residues from silical gel were intermediate between those of soil and water. Since silica gel can absorb more quantum of light energy than soil, the degradation of pyrethroids is more in silica gel than in soil and hence the quantities of pyrethroid residues in silica gel were less than in soil, as can be seen from Table 1. Secondly, the lowest persistence of pyrethroid residues in water may be attributed to the hydrolysis of esters (pyrethroid) by water in addition to the photochemical reactions by sun light. These results are in agreement with the general observation that many pyrethroids undergo rapid photolysis when exposed to sun light or irradiation in aqueous medium or as thin films on glass or as deposits on silica gel, resulting in the lowering of residual toxicity. The observed fall in toxicity of pyrethroid residues in the present case may be due to any one of the photolytic reactions of pyrethroids such as (*i*) isomerization of the cyclopropane ring and the alkenyl substituents, (*ii*) oxidation of functional groups in the acid and alcohol moieties, (*iii*) reductive dehalogenation of dihalovinyl substitutes, (*iv*) photoelimination of carbon dioxide, (*v*) ester bond cleavage, and (*vi*) dimerization of free radicals.

TABLE 1. TOXICITY OF PYRETHROID RESIDUES FROM SOIL, SILICA GEL AND WATER TO HOUSEFLIES

Source of residues	Pyrethroid	Av. % mortality		P	T	PT	% fall in toxicity
		2 days	4 days				
Soil	Permethrin	90	84	4	87.0	348	13.0
	Cypermethrin	79	74	4	76.5	306	23.5
	Decamethrin	50	10	4	30.0	120	70.0
	Fenvalerate	88	80	4	84.0	336	16.0
Silica gel	Permethrin	74	60	4	67.0	268	33.0
	Cypermethrin	58	40	4	49.0	196	51.0
	Decamethrin	42	6	4	24.0	96	76.0
	Fenvalerate	68	54	4	61.0	244	39.0
Water	Permethrin	66	50	4	58.0	232	42.0
	Cypermethrin	41	22	4	31.5	126	68.5
	Decamethrin	40	4	4	22.0	88	78.0
	Fenvalerate	47	34	4	40.4	162	59.5

P—Period in days for which toxicity persisted
T—Average residual toxicity
PT—Persistent Toxicity

Acknowledgement

The authors thank Dr. B. L. Amla, the Director of the Institute for his keen interest in this work.

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BOOK REVIEWS

R & D at the CFTRI—The First Three Decades—1951–1980: Edited by M. R. Raghavendra Rao, K. R. Bhattacharya and J. V. Shankar; Central Food Technological Research Institute, Mysore-570 013, India; 1982; Pp. 360; Price: Rs. 100.

This book is an interesting compilation of the glorious history in relation to R & D of the above Institute during 1951–1980, the first three decades of its existence. The CFTRI which had a modest beginning in 1949 with a handful of scientists has now emerged as a premier institute of food technology in the country, dealing with research, development, training and transfer of technology relating to all kinds of food and having six Experiment Stations located in north, south and west of the country.

In this book the research activities of the Institute have been described commodity-wise rather than discipline-wise for the convenience of readers. The book has been divided into the following chapters:—

1. Introductory: growth of CFTRI.
2. Commodity research—food grains, oilseeds and unconventional sources of protein and fats, animal foods, fruits and vegetables, plantation products and food flavours.
3. Multi-commodity research—control of pests of stored foods and food grains, food packaging, food engineering, sensory evaluation, microbiological researches, biochemical and nutritional researches.
4. Formulated foods and beverages.
5. Other essential activities—technology transfer, National Information Centre for Food Science and Technology (NICFOS), animal house, special instrument facility, analytical quality control laboratory, training programme, public relations and publications.

Appendices:

Technologies transferred to industry, technologies ready for commercialisation, consultancy for food industry, project/feasibility reports and techno-economic studies.

Important work and findings in the areas stated above commodity-wise have been precisely described in each chapter. At the end of each chapter all the relevant publications of the Institute have been compiled. Moreever relevant photos of the laboratories, instruments and equipment being used or developed by the Institute have been attached with each chapter. The last chapter and the appendices will be a good guide book for entrepreneurs who could know about the kind of guidance and assistance CFTRI might offer and the facilities and infra-structure available with the Institute related to food processing.

The book is not just the history of development of CFTRI, but it can be considered as an important handbook or reference book for research workers, industrialists and professional technologists, as it has stated the major developments in the country in connection with processing, preservation, storage, packaging and transport of almost all kinds of foods.

But some of the outstanding achievements of CFTRI which has led to the shaping of food industry in the country on scientific foundation or introduction of newer concepts in food processing or utilisation of raw materials which were poorly utilised so far, have not been properly highlighted. Moreover, the training programme which is the backbone of advanced research activities has not drawn adequate attention in the book. The syllabi alongwith programme of studies for the M.Sc. course as well as other important training courses, if included in the appendix, could have been an useful addition.

The book, however, will be an excellent reference book for all persons interested in food handling and processing.

SUNIT MUKHERJEE
JADAVPUR UNIVERSITY, CALCUTTA

Post-harvest Physiology and Crop Preservation: Edited by Morris Liberman, NATO Advanced Study Institute Series A: Life Science, Vol. 46, Plenum Press, New York & London, 1981; pp. 572; Price: $ 81.00.

This good, thought provoking book is the proceedings of a NATO Advanced Study Institute on post-harvest physiology and crop preservation, held between 28th April and 8th May 1981 in Sounion, Greece. This volume comprises topics on all the scientific disciplines relevant to crop preservation, contributed by leading international biochemists, plant physiologists, horticulturists, agronomists, physicists, engineers and agricultural economists. Dr. Morris Liberman, late Director

of NATO Advanced Study Institute, who edited this book, a compilation of the latest information on post-harvest physiology and crop preservation, had done an immense service to all those interested in this subject.

This book consisting of research papers presented by various experts, is divided into 5 sections: (I) Biochemistry and physiology of senescence with 6 papers; (II) Characteristics of senescence in special crops with three papers; (III) Post-harvest pathological aspects-5 papers; (IV) Manipulation of the pre and post-harvest environment; and (V) on post-harvest losses in the developing world, economic aspects with 3 papers.

This book is of topical interest, since the reduction in the post-harvest losses depends on proper use of current technology evolved from the developments of a broad spectrum of scientific disciplines. Application of this technology, based on sound scientific methods, to the post-harvest crop preservation enables us to enjoy year-round access to a wide range of perishable fruits and vegetables, besides curtailing the post-harvest losses.

The various chapters in this book emphasise the basic concepts of biocehmistry and physiology of crop senescence and include broad coverage of such topics as genetic, hormonal and respiratory controls and membrane alterations. In this work, extensive coverage is given to practical considerations of the post-harvest atmosphere, post-harvest disease control and quality maintenance. Further, it also deals with the theoretical aspects of new technology of hypobaric storage and instrumental techniques for assessing the quality of post-harvest crops.

The special problems of post-harvest crop preservation faced in the developing countries wherein the conditions are quite different from those of Western world are well tackled and will be certainly useful to them. In addition, this book provides useful information on theoretical and practical knowledge of current and emerging technology which will pave way in advancing post-harvest technology and crop preservation world wide.

This book will be of interest to all concerned, especially to those working in the fields of food science, horticulture, plant physiology and plant biochemistry.

P. NARASIMHAM
C.F.T.R.I., MYSORE

Sanitation, Safety and Environmental Standards: Vol. 2, by Lewis J. Minor, AVI Publishing Co., Inc., Westport Connecticut, USA; 1983; pp 245; $ 20.75

The book is very rightly dedicated to hotel, restaurant and institutional management students, managers, chefs, dieticians, engineers, manufacturers, distributors, planners, and operators. These are the people who strive hard to achieve high quality food service standards by developing and marketing very modern lines that give relevance to the complex food service industry. This book, second in the series, provides helpful guidelines for food service managers so as to enable them to maintain high quality standards in food production. The book is divided into nine chapters together with subject index. Each chapter extensively covers the subject area supported by relevant references. The first chapter is entirely devoted to standards relating to food service industry which is broadly covered under different subtitles. The second chapter dealing with sanitation standards covers aspects like microbial food hazards and is in essence an introductory chapter on food microbiology with reference to spoilage and organisms of public health significance. Very useful chapter indeed giving information on all aspects of food microbiology. Preventive aspects of other food hazards forms the subject material of third chapter wherein food contaminations from chemicals, antibiotics, hormones; metal contamination and fish and seafood poisoning are dealt with. Chapter four covers the important area of safe food handling along with microbiological standards for foods and microbiological guidelines and standards for foods established by individual agencies. Information on food definitions, grades and labelling (Chapter 5) gives useful hints for quality food purchasing. The chapter on warewashing and environmental standards provides (Chapter 6) systems information which is useful in kitchen planning and operation. Occupational health and safety standards (Chapter 7) is especially useful in management training of employees. Kitchen safety and maintenance (Chapter 8) and food wastes control standards (Chapter 9) give valuable suggestion pertaining to control of food service operations by improving environmental safety and control of menu portions.

Different agencies have different food policies. It is for the individual in cooperation with food service industry to make his own decisions, which effect the environment and the availability of safe and abundant supply of good wholesome food priced economically. The volume is very informative, comprehensive and up to date and is a useful reference book for all those who are engaged in the production of high quality standard foods in food service industry. This volume would be a welcome addition to all libraries.

C. T. DWARAKANATH
C.F.T.R.I., MYSORE

Automatic Control of Food Manufacturing Processes: by Ian Mc Farlane, Applied Science Publishers Ltd., Ripple road, Barking, Essex, England; 1983; pp. 319; Price: £ 34.00

The automation in food industry ensures rigid quality control of the processing techniques. The automation can be justified by one or more of the following benefits: labour saving, better functional performance, lower running cost and lower energy requirements. In the earlier days, automation was mainly based on pneumatic control technology, but recently the developments of electronics have created a massive expansion in the application of automation in food processing. At this juncture, a well documented book like "Automatic Control of Food Manufacturing Process" is an urgent need.

The book is divided into eight chapters. The first two chapters cover the introduction to industrial process control and raw materials handling, respectively. The chapters three and four deal with recipe dispensing and preprocessing, covering a wide spectrum of processes like refining of oils and fats, chilling and freezing, freeze drying, freeze concentration, evaporation, spray-drying, filteration and osmosis.

The chapters five and six deal with cooking processes and biochemical processes covering as vast a topic as thermal processing, microwave cooking, extrusion cooking, fermenters, bacterial cultures and enzyme technology. Last two chapters deal with finishing and packaging and integrated plant control. Modelling of dynamic systems, closed loop control, dead-time controller and multivariable control are very well covered in four appendices.

During the last decade, considerable progress has been made in sensors as well as in control equipments. Design of these control systems have been greatly influenced by the progress made in electronics engineering practices, which has brought a high standard of reliability to process control systems.

The book is very informative, comprehensive, upto date and fully supported by the illustrations and mathematical concepts. The literature cited at the end of the book is very useful to the readers. The book is very well organised and all the latest concepts of automatic control in food processing are well presented. The book will be very much useful to the researchers, industrial engineers, food scientists and technologists as a ready reference for their day-to-day work and will be welcome addition to libraries.

M. M. KRISHNAIAH
C.F.T.R.I., MYSORE

Advances in Biochemical Engineering/Biotechnology: Vol. 27. Pentoses and Lignin, Ed. A. Fiechter, Springer-Verlag, Berlin; 1983, pp. 186, Price: $ 34.20

This volume contains seven chapters: Utilization of xylose by bacteria, yeasts and fungi; D-xylose metabolism by mutant strains of *Candida* sp; Ethanol production from D-xyolose and several other carbohydrates by *Pachysolen tannephilus* and other yeasts; Biology and physiology of the D-xylose fermenting yeast *Pachysolan tennophilus*; Bioconversion of pentoses to 2-3 butanediol by *Klebsiella pneumoniae*; Bacterial conversion of pentose sugars to acetone and butanol and Lignin-biosynthesis, application and biodegradation.

Agricultural and forest phytoresidues contain three principal organic constituents, namely, cellulose (30-45 per cent) hemicellulose (20-40 per cent) and lignin (20-30 per cent). Since 2 decades, a lot of effort has gone into developing methods of breaking down cellulose into chemical and fermentation feed-stock. Comparatively hemicelluloses and lignin have received less attention. During the last few years research on pentoses and lignin is being carried out the world over in order to convert these material into useful products. This book, devoted to pentoses and lignin, has come out at an appropriate time.

First six chapters are devoted to topics related to breakdown and bioconversion of pentoses in general and xylose in particular. Jefferies who belongs to Wiscosin group of Forest Products Laboratory, USDA, discusses in the first chapter distribution of pentoses in plant material and recovery of hemicellulosic sugars. Metabolism of D-xylose in bacteria, yeasts and fungi, regulation of metabolism, aerobic and anaerobic utilization are also reported. Depolymerization of xylan by bacteria, yeasts and fungi and simultaneous saccharification and fermentation by bacterial and fungal systems are also mentioned.

The second chapter exclusively deals with D-xylose metabolism of a mutant of *Candida* sp. Ethanol as a product resulting from D-xylose metabolism by yeasts was recognised only recently. Recent reports reveal that a wide range of yeasts including those belonging to the genera *Saccharomyces* and *Schizosaccharomyces* are capable of producing ethanol from D-xylose. Extensive studies have been carried out on this subject on strains of *Candida tropicalis*, *Pachysolen tannephilus* and a mutant of *Candida* sp. A review on the enzymes involved in pentose metabolism by yeasts and D-xylose metabolism in *Candida* sp and its mutants are presented in the chapter.

Recent progress achieved by the Canadian group of workers in obtaining yeast strains, capable of converting D-xylose to ethanol efficiently, through selection and genetic engineering form the subject matter of the third chapter. Fifteen yeasts from seven genera were tested for converting D-xylose to ethanol during aerobic growth. Performance of some yeast strains with other carbohydrates are also discussed.

Kurtzman reviews the Biological and Physiological aspects of D-xylose fermentation by *Pachysolen tannophilus* in chapter four. The topics dealt with are: Survey of Yeast species for D-xylose fermentation; Source of *Pachysolen tannophilus* strains; their vegetative and sexual reproduction; fermentation and assimilation of carbon compounds, extracellular polysaccharide, taxonomy and phylogeny and conditions for fermentation.

Stressing the importance of utilizing hemicellulose fraction of the plant biomass as fermentation feed stock, Jansen and Tsao elaborate on the process details for the bioconversion of pentoses to 2,3-butanediol by *Klebsiella pneumoniae*. Biochemical pathways leading to 2,3-butanediol production from pentoses are presented in detail. Other physical and nutritional parameters for optimum yield of the product are also presented.

Sixth chapter is devoted to acetone-butanol fermentation of pentose sugars. Clostridium is the only genera important as far as acetone-butanol fermentation is concerned. Biochemistry of pentose utilization, production of the solvents and the current trend in the development of the process have recived attention by the two authors. A schematic flow-chart for the process is given at the end of the chapter.

The last chapter is devoted to lignin: its biosynthesis, application and biodegradation. The authors discuss the formation of phenyl propane amino acids which are utilized for the synthesis of protein, lignin and flavonoids. Steps involved in the case of lignin biosynthesis, wherein cinnamoyl-CoA esters of substituted cinnamic acids which are then reduced to cinnamyl alcohols or monolignols, i.e. p-coumaryl, coniferyl and synopyl alcohols, are presented. The review also deals with the distribution and function of lignin in plants, processing of plant material for lignin recovery, chemistry of lignin, biodegradation and transformation of lignin. Methods available for the study of lignin structure and degradation are also mentioned. Organism both fungi and bacteria responsible for degradation of lignin, either complete decomposition to CO_2 and H_2O or to various modifications or bioalterations such as demethylation and partial oxidation are listed and their activity explained. Enzymology and mechanism of lignin degradation and significance of its potential, and outlook for the utilization of this valuable raw material are also presented.

The book thus brings out the status of research directed towards the utilization of lignin and pentosans in general and that of D-xylose in particular.

K. R. SREEKANTIAH
C.F.T.R.I., MYSORE

ASSOCIATION NEWS

Madras Chapter

The Annual General Body Meeting was held on 7th April 1984. It was decided that those who are holding office for 1983–84 will continue as office bearers for 1984–85. They are:

President:	Dr. K. S. Holla,
Vice-President:	Dr. A. Srinivasan,
Hon. Secretary:	Mr. K. L. Sarode.
Jt. Secretary:	Mr. N. Ibrahim,
Treasurer:	Mr. T. John Lazarus.

Calcutta Chapter

The 24th Annual General Body Meeting was held on 27th April 1984. The following office bearers were elected for 1984–85.

President:	Mr. K. R. Narasimhan.
Vice-President:	Dr. D. K. Chattaraj,
Hon. Secretary:	Dr. S. C. Chakravorthy,
Jt. Secretary:	Mr. Amit Ghosh,
Treasurer:	Dr. S. K. Mukherjee.

Ludhiana Chapter

The Annual General Body Meeting was held on 8th August '84 and the following office bearers were elected:

President:	Dr. K. S. Sekhon,
Vice-President:	Dr. K. L. Bejaj,
Hon. Secretary:	Mr. Ahluwalia,
Jt. Secretary:	Mr. G. S. Mudahar,
Treasurer:	Dr. K. S. Sandhu.

Conference on

ENVIRONMENTAL MUTAGENS AND HUMAN HEALTH: PROBLEMS AND PERSPECTIVES

by

ENVIRONMENTAL MUTAGEN SOCIETY OF INDIA

The 10th Annual Conference of the EMSI will be held at Bhabha Atomic Research Centre, Bombay, from Feb. 18-21, 1985. The theme of the conference will be "Environmental Mutagens and Human Health: Problems and Perspectives".

The first day of the 4-day conference will be devoted to Plenary lectures on:

*Genetic Diseases *Cancer (epidemiology) Environmental Mutagens and Carcinogens *Occupational & Industrial Health.

The following five symposia will be organised:

*Human genetic ill-health as a component of the human disease burden.

*Mutagens and carcinogens in the human environment *Newer approaches of mutagenicity/carcinogenicity evaluation *Mechanisms of mutagenesia, chromosome aberrations and DNA repair *Problems of evaluation of genetic risk to man.

For any other particulars please write to:

Dr. M. S. Chadha, Chairman. Organising Committee, Bio-Organic Division, Bhabha Atomic Research Centre, Bombay-400 085.

First Circular

ASSOCIATION OF FOOD SCIENTISTS AND TECHNOLOGISTS (INDIA)
CFTRI CAMPUS, MYSORE-570 013

Sub: **National Symposium on "THE RECENT DEVELOPMENTS IN FOOD PACKAGING" to be held on 17th and 18th January 1985, at CFTRI, Mysore.**

The AFST (I) has decided to hold a National Symposium on the above subject. A large number of participants drawn from various R & D organisations, Universities, Food Packaging Industries and the Government is expected to attend the Symposium.

Packaging is the key to the successful marketing of modern food products. In recent years fast developments have been noticed in the field of food packaging materials, packaging system and machineries throughout the world. In India, many of these developments have been adopted and also many research organisations are engaged in the R & D efforts to introduce modern packaging materials for packing food products for better attraction and improved shelf life in the internal market and to compete in the world market.

The main objective of the Symposium is to bring out an overview of the present status and the future requirement of food packaging industry in the country. This important subject will be of interest to food technologists, scientists, food manufacturing industries, manufacturers of packaging materials, packaging machinery manufacturers, transporting agencies and others who are interested in the preservation of food products.

The Symposium will cover different aspects of food packaging including packaging materials and forms, performance and shelf life, packaging methods, safety, quality control, packaging machineries and transportation containers.

The deliberations will be held by presentation of papers from the representatives of R & D organisations, industries, universities etc.

The symposium gives an opportunity for the manufacturers of packaging materials, food manufacturers, food packaging scientists, machinery manufacturers, quality control organisations and marketing organisations to exchange ideas and discuss various problems for further improvements in the field of food packaging.

Special lectures on the interested topics of food packaging will also be arranged.

It is proposed to organise an exhibition on this occasion to display different packaging materials, packed food products and machineries.

AFST(I) requests your kind participation in this Symposium which is of vital importance to the country.

Laljeet Singh
President
AFST(I)

M. Mahadeviah
Hony. Exec. Secretary
AFST(I)

NOMINATIONS FOR AFST(I) AWARDS FOR 1984

Nominations for the following awards of the AFST(I) for the year 1984 are invited. All nominations should be sent by Registered post, so as to reach Dr. M. Mahadeviah, Honorary Executive Secretary, Association of Food Scientists and Technologists (India), CFTRI Campus, Mysore-570 013, **before 31 December 1984.**

PROF. V. SUBRAHMANYAN INDUSTRIAL ACHIEVEMENT AWARD FOR THE YEAR 1984

The guidelines for the award are:

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

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

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

iv. The awardee will be selected (from the names thus sponsored) by an expert panel constituted by the Executive Committee.

The envelope containing the nominations along with bio-data and contributions should be superscribed as 'Nomination for Prof. V. Subrahmanyan Industrial Achievement Award'.

LALJEE GODHOO SMARAK NIDHI AWARD FOR THE YEAR 1984

The guidelines for the award are:

i. The R & D group/person should have contributed significantly in the area of Food Science and Technology in recent years.

ii. The nominee(s) should be duly sponsored by the Head of the respective Scientific Institution and send the application for this award, giving complete details of the contribution.

iii. The awardee(s) will be selected by an expert panel constituted by the Executive Committee.

iv. It consists of a cash award of Rs. 1000/- and a Certificate.

The envelope containing the nominations along with the bio-data and contributions should be superscribed as 'Nomination for Laljee Godhoo Smarak Nidhi Award'.

SUMAN FOOD CONSULTANTS TRAVEL AWARD 1984

This award is instituted in the name of "Suman Food Consultants" to Post-Graduate Degree/ Diploma students in Food Science/Technology. The Award will be of Rs. 500/- which will enable the awardee to attend the Annual General Body Meeting and the Technical Seminar/Symposium of the AFST(I) in that year.

The selection of the Award will be based on an essay competition. The subject for essay is "Prospects of Aseptic Packaging Technology in Food Industries".

Four copies of the essay are to be submitted to the AFST(I) office, Mysore, before 31st December 1984. The essay may contain 15-20 pages of typed matter and be comprehensive. A certificate from the head of the department under whom the student is working should be enclosed along with the essay.

BEST STUDENT AWARD

This award is to be given every year to two students with distinguished academic record and undergoing final year course in Food Science and Technology. The aim of the award is to recognise the best talent in the field and to ensure wider recognition of food science and technology as professional discipline.

Each award comprises Rs. 500/- and a certificate.

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

1. They must be Indian nationals.

2. They must be students of one of the following:
   (a) M.Sc (Food Science)/(Food Technology).
   (b) B.Tech., B.Sc. Tech., B.Sc. Chem. Tech., in Food Technology.
   (c) B.Tech., in Food Sciences.

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

Head of Post-Graduate Departments in Food Science and Technology may sponsor the name of one student from each Institution supported by the candidate's biodata, details starting from high school onwards, including date of birth and post-graduate performance to date (4 copies).

The envelope containing the nominations should be superscribed as 'Nomination for Best Student Award'.

YOUNG SCIENTIST AWARD FOR THE YEAR 1984

This award is for distinguished scientific research and technological contributions to the field of Food Science and Technology.

The award consists of a cash prize of Rs. 1000/- and a certificate.

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

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

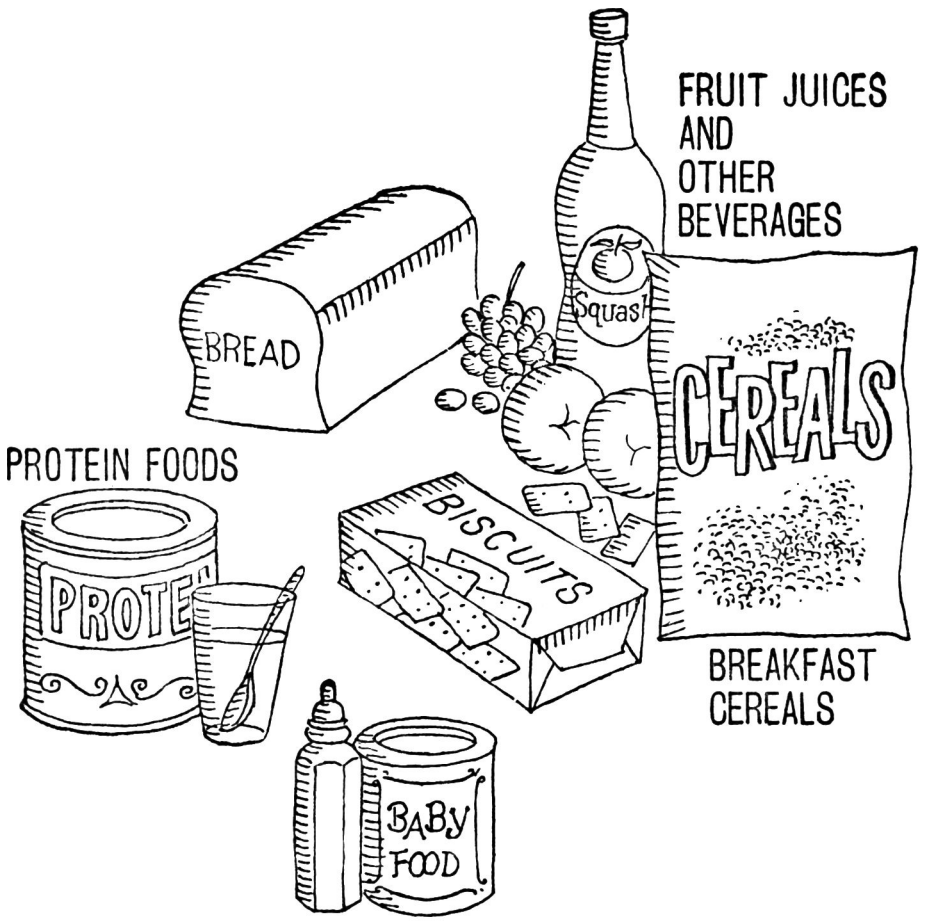
ii. The candidate should furnish evidence of either;
   (a) Original scientific research of high quality, primarily by way of published research papers and (especially if the papers are under joint authorship) the candidate's own contribution to the work.

   OR

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

The application along with details of contributions and biodata (4 copies) may be sent by Registered post with the envelope being superscribed as 'Nomination for Young Scientist Award'.

FORTIFY



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INSTRUCTIONS TO AUTHORS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

REG. NO. 24918/64

JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

Vol. 21 No. 5 Contents of forthcoming issue Sept./Oct. 1984

Research Papers

Research Notes

Review Papers

Printed and Published by Dr. M. Mahadeviah, Secretary, AFST (India), CFTRI, Mysore-570013, at Sharada Press, Mangalore-575001.