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(INDIA)

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Studies on Low Temperature Storage of Alphonso Mango

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A comparative study on the effect of low temperature storage of freshly harvested Alphonso mango at 7°C and 30°C was made with respect to histochemical and chemical changes. These changes were similar in fruits stored at both the temperatures, but there was a delay in the changes at 7°C storage. Beyond four weeks of storage at 7°C, disruption of mesocarp cells was observed. Carotenoids development was inhibited at 7°C storage and fruits did not show normal ripening even after prolonged storage of 5 weeks. Hot water or ethrel dip treatment of fruits stored at 7°C failed to induce normal ripening.

The use of refrigeration for extending the post harvest storage life of tropical fruits is limited by development of the physiological cold damage referred to as low temperature breakdown (LTB). In mango, LTB has been reported below 15°C storage[1-3]. The symptoms manifest as discoloured pitted areas, failure to ripen with normal colour and flavour and a decline in the resistance to diseases[4]. But Mann and Singh[5,6] have reported successful storages of Langra and Dashehari mangoes at 7° and 9°C for 35 to 45 days. Many of these studies are limited to small experimental samples, without serious consideration for the post storage ripening of mango or its effects on histochemical and chemical changes. In the present investigation, an attempt has been made to study the histochemical and chemical changes in Alphonso mango stored at 7°C and followed by ripening at 30°C. Further, the effect of post - storage treatments of these fruits on improvement of quality was also studied.

Materials and Methods

Freshly harvested mature Alphonso mangoes were selected, packed in ventilated wooden boxes and held at 7° and 30°C. Each box had 50 fruits and samples (2-3 boxes) were taken out at intervals of 1, 2, 3, 4 and 5 weeks, and ripened at 30°C for further observations.

Observations on development of physical symptoms of LTB, firmness of the fruit and the quality of edible ripe fruits were recorded. Symptoms of LTB appeared initially as brownish spots gradually enlarging to form lesions. If more than 10 per cent of the fruit surface was covered with these dots or lesions, they were classified as fruits with LTB.

Histochemical studies: Fruit pieces of 1 cm^3 were fixed in Carnoy's B fixative (6 parts of ethyl alcohol + 3 parts of chloroform + 1 part of acetic acid) for 2 hr, and dehydrated using ethyl alcohol and n-butanol. The dehydratede tissue was infiltrated with and embedded in paraffin of 56°C. Serial sections of 7 μm. thickness were stained with periodic acid Schiff's (PAS) reagent[7] for localising insoluble polysaccharides. The photomicrographs were taken with an Olympus photomicrographic equipment.

Chemical analysis: Total soluble solids, per cent acidity and sugars (reducing and total) were determined according to A.O.A.C.[8] and total carotenoids were measured by extraction with acetone, transferring to petroleum ether (60-80° B.P.) and reading the colour at 455 nm. in a spectrophotometer.

Post storage treatments: One hundred fruits were removed from storage every week, divided into 3 lots after removing the injured fruits and were treated as follows:

1) Kept at 30°C for ripening as control. 2) Dipped in hot water at 52° ± 1°C for 5 min and kept at 30°C for ripening. 3) Dipped in ethrel (500 ppm) solution for 5 min. and kept at 30°C for ripening.

Fruit ripening was judged by softening, surface colour and aroma development. Consumer's acceptability of the soft fruits was judged based on appearance and taste of the fruit by a panel of judges. Based on the average scoring, it was concluded as good, acceptable and not acceptable. Figures for spoilage included fungal spoilage and fruits with LTB.

Results and Discussion

Storage and ripening: The effect of different periods of storage at 7°C on development of LTB is shown in

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TABLE 1. EFFECT OF PERIOD OF STORAGE ON DEVELOPMENT OF LOW TEMPERATURE BREAKDOWN (LTB) IN ALPHONSO MANGO STORED AT 7°C

Storage period (wk)	Green and firm fruits (%)	Fruits with LTB (%)	Symptoms of injury*	Quality of fruits ripened at 30°C
1	100	Nil	Nil	Good
2	100	Nil	Nil	Good
3	90	15	Brown spots	Not acceptable
4	90	26	Brown spots forming bigger patches	Not acceptable
5	80	40	Scattered brown lesions	Not acceptable

Values are means of 3 replicates of 50 fruits each.
*Based on external symptoms only.

TABLE 3. EFFECT OF POST STORAGE DIP TREATMENT OF FRUITS STORED AT 7°C AND RIPENED AT 30°C.

Storage period at 7°C (wk)	Untreated		Hot water dip at 52° ± 1°C*	Ethrel dip 500 ppm at 30°C*
	Soft (%)	Spoilage (%)	Spoilage (%)	Spoilage (%)
1	80	24	5	30
2	86	24	10	30
3	80	40	15	40
4	85	40	30	60
5	80	60	60	70
Control**	82	20	10	22

* 100 per cent were soft in these treatments.
** Control fruits ripened at 30°C in 14 days.

Table 1. There was no external symptoms of LTB for 2 weeks and thereafter the symptoms appeared as brown spots, gradually enlarging with increase in storage period. Upto 2 weeks of storage, there was no ill effect on ripening of the fruit (Table 1). But, beyond 2 weeks of storage, 90 per cent of the fruits looked green and firm, and did not ripen satisfactorily with the desirable flavour and colour after removal to ambient conditions of storage. The number of fruits with LTB increased from zero to 40 per cent during storage from 0 to 5 weeks.

Chemical composition: Chemical composition of the fruit during different periods of storage at 7°C and its subsequent ripening at 30°C is shown in Table 2. Storage at 7°C for 5 weeks increased TSS, decreased acidity and increased reducing and total sugars. The rates of decrease of acidity and increase of sugars were slow at 7°C storage. Besides, the percentage of reducing sugars was more, total sugars and carotenoids were less as compared to fruit ripened at 30°C storage. Similar observations were made by Thomas[3] and Saucedo *et al*[9] in different varieties of mango.

Post harvest treatments on quality: In the control, soft fruits (meaning ripe) varied from 80 to 85 per cent and that of spoilage from 20 to 60 per cent during storage upto 5 weeks (Table 3). In hot water dip and ethrel treatments, soft fruits were 100 per cent and spoilage increased from 5 to 70 per cent during one to 5 weeks of storage. In fruits held at 30°C, 82 per cent was ripe in control with 20 per cent spoilage in 14 days, as compared to 100 percent ripe and 10 to 20 per cent spoilage in hot water and ethrel treatments.

The fruits stored at 7°C upto 2 weeks gave good quality ripe fruits. Post storage dip treatments only stimulated the softening process. No improvement in quality was observed. Similar observations were made

TABLE 2. EFFECT OF STORAGE AT 7°C AND SUBSEQUENT RIPENING ON CHEMICAL CONSTITUENTS OF ALPHONSO MANGO

Storage period at 7°C (wk)	Ripened at 30°C (days)	Total soluble solids (%)	Acidity (%)	Sugars		Total carotenoids/ ug/100 g
				Reducing (%)	Total (%)	
	0 day*	8.2	2.8	2.1	3.0	666
	14 days*	19.0	0.1	2.2	15.4	13,875
1	—	8.0	2.7	2.0	2.3	687
1	10	18.0	0.4	3.5	12.2	12,807
2	—	9.3	2.3	2.4	3.1	1,288
2	6	17.8	0.5	3.2	13.8	10,050
3	—	11.2	2.4	2.3	7.8	1,050
3	5	16.0	0.6	3.9	10.2	7,942
4	—	13.3	2.0	4.5	9.1	1,350
4	4	17.5	0.5	4.9	10.5	4,783
5	—	16.5	0.3	5.4	12.2	4,675
5	2	17.5	0.5	4.9	13.0	4,975

Values are means of 3 replicate analysis. * Fruits stored at 30°C and ripened.

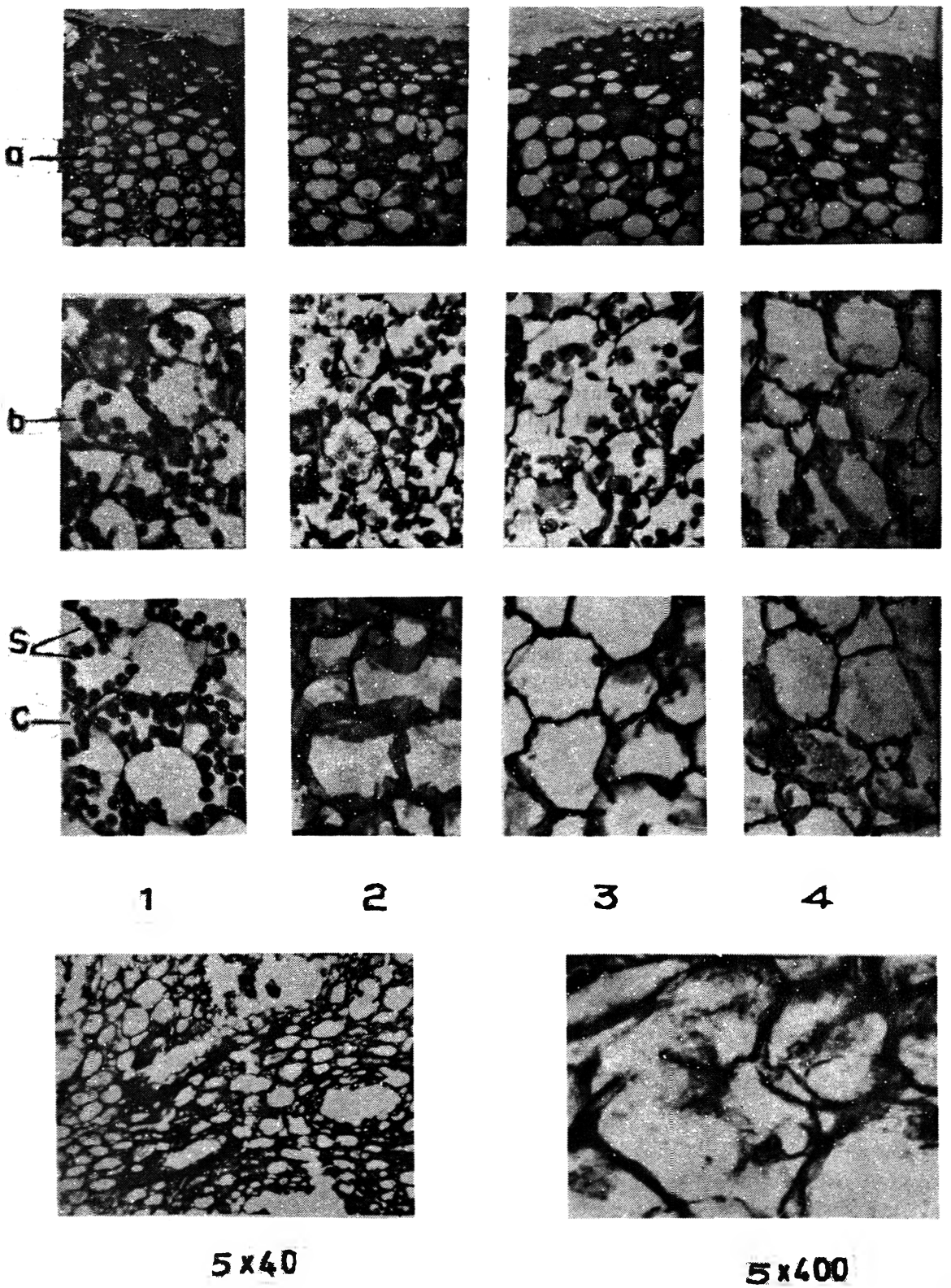

Fig. 1 - 5. Sections of mango fruit (Alphonso) during ripening at 30°C. stained with periodic acid Schiff's(PAS) method
Storage after Fig. 1 - 0 days. Fig. 2 - 5 days. Fig 3 - 10 days and Fig 4 - 5 days. Fig. 1 - 4 ×
Fig. 5a and 5b disintegrating mesocarp cells of fruits stored at 7°C. 5a - × 40, 5b - ×

(a-Epicarp: b-outer mesocrap: c-inner mesocarp: s-starch granules

by Sadasivam *et al*,[10] in *Totapuri* variety of mango.

Histochemical changes: Histochemical changes pertaining to total insoluble polysaccharides are shown in Fig. 1 to 4. The epicarp of the mature fruit had a thick waxy cuticle. In fruits stored at 30°C, the cuticle became thinner in a period of 15 days. The cell walls of the epicarp thickened during storage while those of mesocarp became thinner. The reserve starch in mesocarp cells degraded almost completely by 15th day during storage while sugars increased. The starch degradation initiated from the interior of the mesocarp and extended to the periphery.

In fruits stored at 7°C, the histological changes were similar to those found in the fruits stored at 30°C. However, the changes such as thinning of cuticle, thickening of the cell walls of epicarp, thinning of cell walls of mesocarp and degradation of starch were delayed and took 35 days (five weeks). By the end of the fifth week even though the fruit was green and firm with no apparent symptoms of physical injury, the mesocarp and cell contents showed signs of disintegration (Fig.5). Further detailed studies at the cellular level are essential to understand the development of low temperature breakdown.

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Carcinoscorpius Amoebocyte Lysate Assay for the Rapid Determination of Microbial Status and Quality of Meat

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The microbial quality of raw mutton was determined both by conventional plate counts and by endotoxin assay using for the first time *Carcinoscorpius* amoebocyte lysate (CAL) which reacted with gram negative bacteria (GNB) present in the sample by forming a gel at 37°C after 1 hr. In tests employing several decimal dilutions of fresh and frozen meat samples, a maximum gelling dilution (MGD) of 10^{-1} or 10^{-2} corresponded with standard plate counts (SPC) of upto 10^5/g. The MGD of 10^{-3} and 10^{-4} were obtained when SPC levels reached 10^7/g. With SPC 10^8/g, the MGD values were 10^{-5} and above. A statistically valid relation exists between SPC and GNB on the one hand and between MGD and SPC or GNB on the other. From a microbial reference chart consisting of a range of MGD values corresponding to a range of total viable counts, the microbial status of a test meat sample can be assessed. The CAL test can be carried out in a moderately equipped laboratory and completed in about 1.5 hr.

The most common and universally accepted index of microbial quality of foodstuffs is the standard plate counts[1] (SPC). It provides a means of measuring the composite microbial population in foods prior to the onset of sensory deterioration[2]. The conventional methods of counting colonies on solid media require 24-48 hr and are thus not useful in determining the microbial status of raw meat which undergoes rapid deterioration in the unchilled state. This happens particularly during the transportation of fresh (unfrozen) and frozen raw meat to distant army units. To assist the inspecting veterinary officer in assessing and certifying to the quality of meat before despatch and help the military field laboratory at the receiving unit which has few facilities to test for acceptance, alternative methods giving rapid results are necessary.

Although a wide choice of new procedures is now available for the rapid determination of microbial populations in terms of their cell size, constituents, metabolic products, electrochemical changes brought about in growth media, fluorescence and immuno-fluorescence techniques[3] etc. all of them require sophisticated and sensitive instrumentation, considerable support facilities and skilled staff. Where these are lacking, a simpler procedure was called for. The detection of endotoxin or lipopolysaccharide (LPS, pyrogen) a constituent of gram negative bacterial (GNB) cell wall by the *Limulus polyphemus* amoebocyte lysate (LAL) is well known[4,5]. The reaction with LAL is specific to endotoxin and takes place at 37°C in about one hour resulting in a gel. The ability to induce a gel depends on the sensitivity of the lysate and the concentration of gram negative bacterial cells or of pure endotoxin. Amoebocyte lysate from *Carcinoscorpius rotunda cauda*, a crab found in the Bay of Bengal and related to the Atlantic species *Limulus* was shown to react with LPS[6]. The preparation of *Carcinoscorpius* amoebocyte lysate (CAL) and standardisation of the test procedures have been previously described[7,8]. The endotoxin test therefore was selected as being simple and rapid for meat testing.

To apply the CAL-endotoxin test for the determination of the microbial status of raw meat for the purpose of acceptance or rejection, data are required on (i) the concentration of GNB (participating in gelling) and total microbial load (SPC, as one of the accepted quality indices) and the interrelationship between the two groups of bacteria in acceptable and deteriorating meat by examining a wide variety of samples collected at random as well as studying selected fresh samples under predetermined conditions such as exposure to warm temperatures, freezing, etc and (ii) the confidence with which the test can be used to simultaneously predict the microbial status and the possible sensory status by the statistical evaluation of microbiological and gelling data. Experiments were therefore conducted to obtain pertinent data from the examination of fresh meat (raw) as sold in the market, of samples allowed to deteriorate and of samples subjected to simulated freeze-thaw temperature abuse.

From the recorded observations, a reference chart was constructed for predicting the microbial status for the purpose of acceptance or rejection of a sample based on the gelling data obtained from the CAL-endotoxin test.

In all the experiments, the primary microbiological data were obtained by the conventional methods considered to be unavoidable for validation of any new procedure being tested to replace them. The results of these experiments are communicated in this paper.

Materials and Methods

All chemicals used were of the highest purity commercially available. Bacteriological media and their component ingredients were the products of Difco Co. (Detroit, USA), Oxoid Co. (UK) and Himedia (India).

Endotoxins: Pure *E. coli* 0111 LPS (Sigma Co., USA) was dissolved in depyrogenised water (1 mg/ml) and aliquots from several 10-fold dilutions were used as standard endotoxin control in the CAL test. 'Pyrotrol' positive control standard supplied with the Difco pyrotest-TM was used in 2-fold dilutions as directed. *E. coli* cells (a food isolate) were grown in brain heart infusion for 16 hr, harvested, washed by centrifugation and suspended in 0.015 M NaCl to a density of about 10^4 cells/ml as determined by plate counts on plate count agar and lyophilised in 0.2 ml volumes.

CAL: The preparation of the lysate from freshly caught *Carcinoscorpius* crabs has been described previously[8]. The lysate used in the present tests had a detection sensitivity of 0.1 ng of endotoxin.

Mutton: Market samples of mutton of unknown postmortem age and exposure time and from sheep slaughtered under hygienic conditions were obtained. The sample size which varied from 250 g to 2 Kg was usually derived from the hind leg.

Bacterial enumeration: Ten to 50 g meat from each sample were aseptically removed, macerated in 10 volumes of 0.1 per cent sterile peptone water and 10-fold dilutions prepared in the same diluent. One ml aliquots were plated on plate count agar and incubated at 37°C for 48 hr for SPC, on violet red bile agar incubated at 37°C for 18 hr for total coliforms and on enterobacteriaceae medium incubated at 30°C for48 hr for total gram negative bacteria[9]. The average counts of colonies appearing on duplicate plates from countable dilutions were recorded.

Depyrogenisation: This is a very important and necessary step for the success of the endotoxin test. Glassware was acid washed, rinsed in several changes of glass distilled water and heated at 230°C for 30-60 min. Water used for preparing normal saline diluent was obtained by triple glass distillation or double quartz distillation using pyrogren free collection flasks. Water and saline solution were autoclaved at 30 psi for 2 hr to render them pyrogen free.

CAL test: Ten g of mutton was aseptically excised using a flame sterilised knife, cut into small pieces and dropped into 90 ml of depyrogenised water contained in a 150 ml conical flask. After shaking by rotary movement (1-2 min) and standing (5 min), 1 ml of the turbid liquid was withdrawn and several 10-fold dilutions prepared in depyrogenised saline. The lysate tubes (two per dilution to be tested) were kept in crushed ice and sample aliquots (0.2 ml from each dilution) were added and stirred to dissolve dry lysate. Pyrogen free water (Difco) was used as negative control in the tests; pure LPS solution and *E. coli* cells were used as positive controls to ensure that the test lysate was indeed capable of gelling in the presence of endotoxin. All tubes were incubated at 37°C without shaking. After 75 min, they were examined for the appearance of a firm gel which would not break when the tube was inverted. The dilutions of the sample which gave rise to firm gel (positive reaction, +) were recorded. The maximum gelling dilution (MGD) or the dilution end point of a mutton sample was that dilution beyond which no firm gel could be observed when used in the CAL test. Loose gel which disintegrated when the tube was tilted was taken to be a doubtful (±) reaction. Free flowing liquid observed after incubation was taken to be a negative (—) reaction.

No cell rupture is necessary to carry out this test since whole cells (bound endotoxin) can participate in the reaction. Further, the test is specific to endotoxins which are lipopolysaccharide in nature. Since only gram negative bacteria possess them, no interference from other organisms or any meat constituent is expected.

Statistical analysis: The data were statistically analysed[10] to establish correlation between standard plate counts and gram negative bacteria. Regression coefficients for standard plate counts and gelling dilution and for gram negative bacteria and gelling dilution were calculated.

Results and Discussion

Levels of standard plate counts (SPC), coliforms and total gram negative bacteria (GNB) in mutton: In 155 samples of varying and unknown postmortem age and freshness, the total aerobic viable bacteria (SPC), the total coliforms and the total gram negative bacteria (GNB) were enumerated by conventional agar plate method (Table 1). The SPC were higher by one to two orders of magnitude than both the coliforms and the GNB. Coliforms were fewer than the GNB where levels of SPC were low. The observed differences (of 1-2 orders of magnitude) between levels of SPC and GNB in all categories of samples (correlation coefficients r = 0.82

TABLE I. CORRELATION BETWEEN STANDARD PLATE COUNTS (SPC) AND TOTAL GRAM NEGATIVE BACTERIA (GNB) IN DIFFERENT RAW MUTTON SAMPLES

Mutton sample	No. of samples	Bacterial load/g			Correlation coefficient (r) for SPC & GNB
		SPC	Coliforms	GNB	
Sheep slaughtered and dressed hygienically in the lab	10	$5 - 8 \times 10^2$	Upto 10	50	0.90
Market samples, postmortem age 2-3 hr	23	$5 - 8 \times 10^3$	Upto 10	$50 - 4 \times 10^1$	0.90
Market samples, postmortem age unknown classified on basis of SPC	45	$1 - 7 \times 10^4$	$2 \times 10^2 - 3 \times 10^3$	$1 \times 10^2 - 6 \times 10^3$	0.86
Market samples unknown postmortem age classified on basis of SPC	32	$1 - 8 \times 10^5$	$3 \times 10^3 - 6 \times 10^4$	$1 - 7 \times 10^4$	0.85
Market samples with slight odours	20	$1 - 6 \times 10^6 - 7 \times 10^7$	$5 \times 10^4 - 5 \times 10^5$	$1 - 5 \times 10^5 - 2 \times 10^7$	0.86
Fresh samples held at 37°C for 12 hr distinct off odours	25	$2 - 5 \times 10^8 - 2 \times 10^{10}$	$3 \times 10^6 - 6 \times 10^8$	$2 \times 10^7 - 7 \times 10^8$	0.82

to 0.90) were significant at 99 per cent level. Correlation tests with coliforms were less significant. Therefore, using GNB content as an index, its rapid estimation by a convenient technique such as endotoxin assay was expected to lead a successful prediction of the SPC in a given meat sample thus indicating its general microbial status. Jay *et al.*[11] found a similar relationship between gram negative bacteria and SPC in some frozen minced beef samples. Data on microbial interrelationships between SPC and gram negative bacteria in mutton cuts or chunks kept at warm ambient temperatures are lacking, although our previous findings had shown that there was a definite and quantifiable relationship between the proportion of gram positive and gram negative flora on mutton kept at different temperatures[12]

Microbial concentration in relation to sensory changes in meat exposed to warm temperatures: This experiment was conducted to study the onset of sensory deterioration indicating threshold of spoilage in terms of microbial load. It was deemed necessary to establish the levels of GNB and SPC under conditions of microbial growth so that future gelling data could be referred to in terms of microbial indices as well as possible sensory changes.

One set of 12 samples (100 g each, in chunks) was incubated at ambient room temperatures (30°C ± 2) and the second set of 12 samples was incubated at 37°C. At intervals of 6 hr, samples were removed in triplicate and analysed for SPC and GNB and examined to detect sensory alterations. The increase in microbial levels was more rapid at 37°C than at ambient temperature (Fig. 1a and 1b) even when the initial counts in samples were higher when held at the latter temperature. In 6 hr of exposure, while no off-odours appeared at ambient temperature, they were detectable in one out of three samples kept at 37°C. The SPC at this stage approached 10^7 cells/g, but was more than 10^7 cells/g at 37—C. The GNB level was lesser at both temperatures by about one order of magnitude. After 12 hr of exposure, samples kept at both the temperatures registered SPC of more than 10^8/g and also developed detectable off odours. The GNB count of 10^7/g at 37°C corresponded to the stage of off-odour detection but at ambient temperature, they were more variable (10^6—10^8/g) at the time of odour detection. From these observations, three quality zones could be identified based on the presence or absence of odour as indicative of spoilage at known levels of SPC and GNB as shown in Fig 1a and 1b. A close relationship between the level of SPC and off-odour formation in other foodstuffs has also been reported[2,13].

Interrelationships between maximum gelling dilution and microbial load: Analyses of 78 fresh and

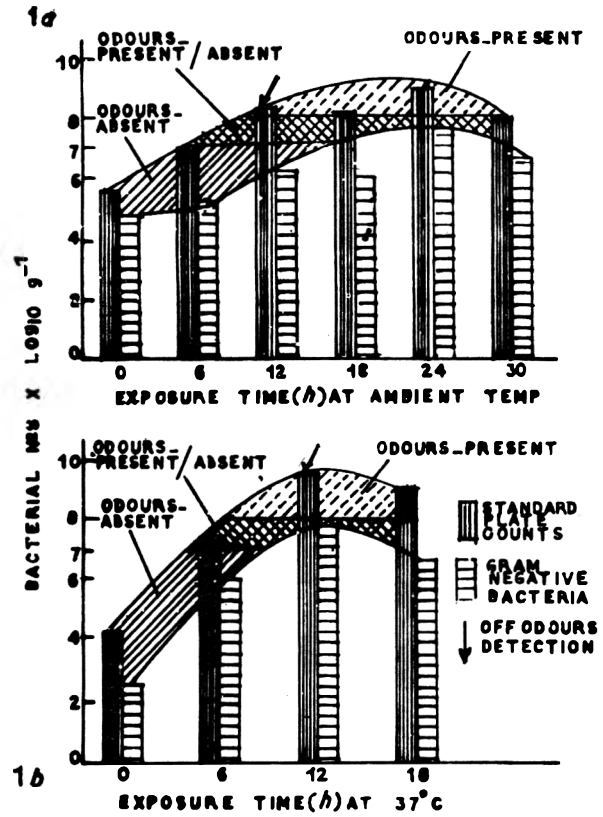

Fig. 1. Microbial growth in mutton exposed to ambient temp (30 ± 2°C) and 37°C.

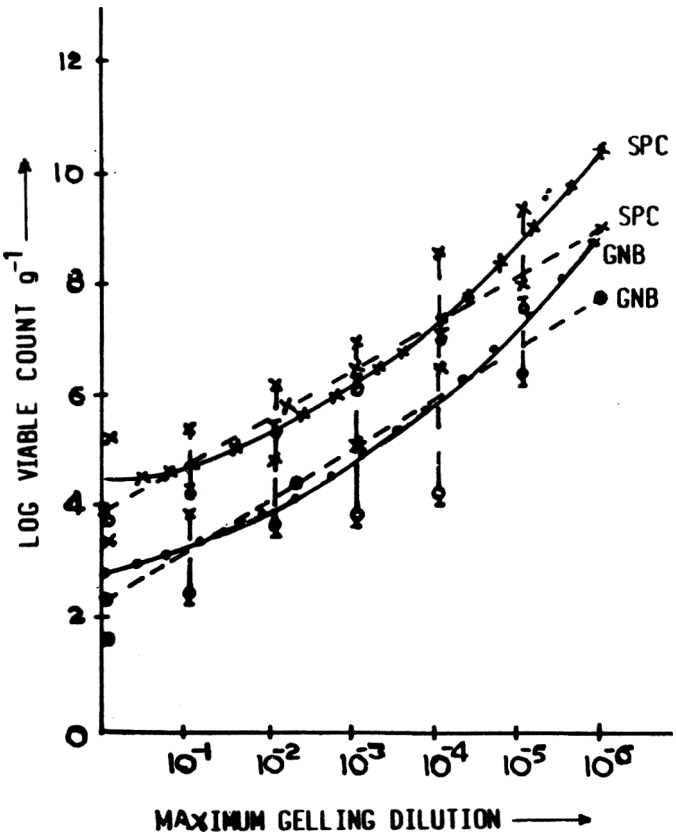

Fig. 2. Regression graphs for SPC, GNB and the corresponding MGD found in raw mutton samples (———) linear regression (—) = quadraticregression and ‡ variation in SPC and ‡ variation in GNB for the same gelling dilution.

stale mutton samples selected at random were carried out by the plate count method and by determining the maximum gelling dilution using a range of sample dilutions from 10^{-1} to 10^{-6} in the CAL test. The data on gelling were individually regressed against the two groups of bacteria for a linear as well as quadratic fit (Fit.2). The latter was significant at 99 per cent level. MGD values of 10^{-1} to 10^{-2} corresponded to GNB and SPC levels of 10^3/g and 10^5/g respectively, MGD of 10^{-6} was recorded with samples showing SPC of 10^9/g or GNB of $10^{7\cdot8}$. A minimum of 10^3/g of GNB were required to cause positive gelling at 10^{-1} dilution in this test. This means that for a brief period postmortem, the meat which has low microbial counts (10^4—10^5 cells/g) will exhibit either no gelling or gelling only at 10^{-1} dilution depending on the actual GNB content at the time of examination. From the data presented, it can be stated that a definite significant and predictable relation exists between GNB and MGD.

Simultaneous CAL test and sensory examination of meat samples: To determine the MGD values which corresponded directly with sensorily acceptable state of a sample, fifteen samples were subjected to two types of evaluation at the same time. Each sample (about 250 g in weight) was divided into two portions. One portion was immediately analysed by the CAL test and its maximum gelling dilution determined. The second portion was then presented to three judges for sensory evaluation who examined it principally for general appearance and presence of-off odours. If no off-odours were detected by all three and the general appearance of the sample was satisfactory to them, the sample was scored as acceptable (A); if all the three judges detected off-odours and found any softening of or discolouration in the sample, it was scored as not acceptable (NA). If there was disagreement among the three about the quality, the sample was graded as doubtful. The data (Table 2) arranged in the order of increasing MGD show that samples gelling at dilutions of 10^{-3} or less were rated as acceptable outright and those gelling at dilutions of 10^{-5} were declared not acceptable. Two samples (10^{-3} and 10^{-4} were rated as doubtful. Therefore, a, meat sample with 10^{-5} and above of MGD corresponding to high GNB content can be declared unfit while at 10^{-4} the sample is poised for spoilage which may or may not exhibit sensory changes.

The effect of repeated freezing and thawing on the MGD of frozen mutton: Frozen cut meat is airlifted from army supply depots to certain border areas and

TABLE 2. EVALUATION OF RAW MUTTON BY TWO INDEPENDENT TESTS

Sample	CAL Test MGD*	Sensory test+
1	10^{-1}	A
2	10^{-1}	A
3	10^{-1}	A
4	10^{-2}	A
5	10^{-2}	A
6	10^{-3}	A
7	10^{-3}	?
8	10^{-3}	A
9	10^{-4}	?
10	10^{-5}	NA
11	10^{-5}	NA
12	10^{-5}	NA
13	10^{-5}	NA
14	10^{-5}	NA
15	10^{-6}	NA

*7 decimal dilutions used ? Doubtful
A: No odours, acceptable +Based on odours.
NA: Not acceptable

considerable delays are incurred during further transportation by road to distant army units. In the event also of an abortive air sortie, the consignment is returned to base and refrozen for later despatch. The meat has been observed to undergo one to three such freezings before it is delivered. The interval between two freezings is the period of thawing and can be as long as 4-6 hr. It was necessary to determine if such meat is acceptable. To simulate these conditions, six individual mutton samples (100 g each) were sealed in 200 gauge polyethylene pouches and frozen at -18°C for 24 hr. They were all taken out of the freezer and left at room temperature (33°C ± 2) for 4 hr after which time they were all returned to the freezer, retaining two samples for analysis. This constituted one freeze thaw cycle. In five separate experiments, 32 samples were thus subjected to 2-3 freeze thaw cycles. Unfrozen samples were used for initial analysis. Viable counts and MGD values of the samples examined (Table 3) showed that the low MGD values increased in the second cycle in samples with low initial microbial load (upto 10^5/g) but increased in the first cycle where the initial viable counts were 10^7/g. The viable counts in the frozen-thawed samples varied from the initial levels, however, due to microbial multiplication during the thaw period and due to injury or death of cells in the freezing period. Since the endotoxin test does not differentiate between viable and non-viable GNB cells both types of cells contribute to the elevated MGD values. A parallel is found in drinking water and renovated water where the viable counts did not correspond to the expected MGD values[14,15]. However, the elevated MGD in meat receiving such temperature abuse is still within the expected range for fresh meat. Therefore, it can be said that when confronted with a sample of frozen mutton of unknown history of freezing and thawing, MGD of 10^{-3} may be considered wholly acceptable.

Assessment of microbial quality and spoilage status by the CAL test method: Based on experimental data presented, a reference table was constructed for the quality assessment of a given mutton sample subjected to CAL test (Table 4). From the MGD value obtained, the corresponding microbial status could be directly read off the reference chart and the sample classified as belonging to one of four categories, on each of which further action could be taken on the suggested lines.

It is concluded that *carcinoscorpius* amoebocyte lysate with a sensitivity of at least 0.1 ng can be successfully used for determination of microbial status and assess the quality of meat.

The test in a portable kit form and containing the reference chart has already undergone field trials, the outcome of which will form the subject of a later communication.

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TABLE 3. MICROBIAL QUALITY OF FROZEN MUTTON SUBJECTED TO REPEATED FREEZING AND THAWING AS DETERMINED BY STANDARD PLATE COUNTS (SPC)* AND MAXIMUM GELLING DILUTION (MGD)

	Initial quality		First freezing and thawing		Second freezing and thawing		Third freezing and thawing	
Experiment	SPC/g	MGD	SPC/g	MGD	SPC/g	MGD	SPC/g	MGD
1	10^4	10^{-1}	10^5	10^{-1}	10^4	10^{-2}	10^5	10^{-2}
2	10^4	10^{-1}	10^5	10^{-1}	10^5	10^{-3}	10^4	10^{-3}
3	10^5	10^{-2}	10^4	10^{-1}	10^6	10^{-3}	10^4	10^{-3}
4	10^7	10^{-3}, 10^{-4}	10^6	10^{-4}	xx	xx	xx	xx
5	10^8	10^{-4}, 10^{-5}	10^7	10^{-5}	xx	xx	xx	xx

* Average of two samples analysed in duplicate. For convenience the counts have been reflected only as $\log_{10}$ values.
xx Not done

TABLE 4. MICROBIAL QUALITY ASSESSMENT OF RAW MUTTON BASED ON MAXIMUM GELLING DILUTION IN THE CAL TEST

Sample type	Max. gelling dil.	General observations	Suggested further action
A	10^{-2}	Fresh	Accept. can be held for about 3 hr
B	10^{-3}*	Fresh, no odour	Accept, wash surface, minimise further handling
C	10^{-4}	Exposed sample, slight odours may be perceptible	Use immediately with thorough washing, no further storage
D	10^{-5}	Spoiled, mild to distinct odours	Not recommended for acceptance
E+	Upto 10^{-4}	No off odours	Accept, use immediately, no further delay or temp abuse

*Occasionally 10^{-4}
+Frozen mutton

facility for evaluating data by regression analysis.

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An Intercomparison of Bread Quality Assessment Tests Using Indian Wheats

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The applicability of Pelshenke, Zeleny, SDS, Acetic acid Swelling Index and Gluten turbidity tests to Indian wheats for assessing the breadmaking quality was compared. The SDS values for whole meals of seventeen cultivars were highly correlated with the values for flours (r =.943) of the same cultivar. The spread in the SDS values for flours of different cultivars was from 31-52 ml as compared to 17-26 ml of Zeleny test.

Several screening tests are available to assess the breadmaking quality of wheat. Pelshenke value[1] and Zeleny sedimentation test[2] are used more commonly by the wheat breeders for evaluating the quality of bread wheats. The Sodium Dodecyl Sulphate (SDS) sedimentation test has been developed by Axford *et al.*[3] in preference to Pelshenke and Zeleny sedimentation tests for breadmaking quality. Blackman and Gill[4] compared residue protein, SDS-Sedimentation, Pelshenke and modified extensometer test values for appraisal of breadmaking quality of breeders samples. Modified Zeleny test using acetic acid has also been suggested as an alternative[5]. Berliner test[6] has also been popular for assessing the quality of bread wheats. In case of Indian bread wheats, Pelshenke test has been used principally for assessment of chapati-making quality[7]. The Indian breeders depend mainly on the Pelshenke test for evaluation of the quality of bread wheats. It was of interest to compare the results of various quality assessment tests using indigenous wheat cultivars instead of a single test such as Pelshenke used by the Indian breeders.

Materials and Methods

Wheat samples of seventeen varieties of bread wheats wheats (*Triticum aestivum*) were obtained from 1986-87 crop grown on experimental farms of the Punjab Agricultural University, Ludhiana. Representative samples of the cultivars were ground in the Falling Number Kamas AB mill (0.8 mm sieve). The flour samples were prepared using the quadrumat junior mill after conditioning to 15.5 per cent moisture.

The samples were analysed for grain characteristics according to AACC methods[8]. The flour and meal samples were analysed for moisture, protein, gluten, damaged starch and falling number values by the AACC methods[8].

Quality tests: AACC[8] procedure for Pelshenke value (Wheat meal fermentation test) and Zeleny sedimentation test was followed.

SDS-sedimentation test: This was determined according to Axford *et al.*[3].

Gluten turbidity test: Gluten from the meal and flour was separated according to the Berliner test[6]. Weighed samples (0.5g) of gluten was cut into small bits and transferred to wide mouth test tube to which 10 ml of 0.02 N lactic acid was added. After stoppering, it was inverted at intervals of 30 and 40 min in case of wholemeal and flour glutens, respectively. The contents were allowed to settle and absorbance of the supernatant was measured at 403 nm in the Bausch and Lomb Spectronic 20 photocolorimeter. The values were reported as absorbance. The lower the value better the gluten quality.

Acetic acid Swelling Index: The swelling index of the sample using 6 per cent acetic acid was determined according to ISO procedure[5].

The results of various quality tests were compared by computing coefficients of correlation between the values for wheat meals and those of flours.

Results and Discussion

Considerable variation in 1000 grain weight of the cultivars was obtained (Table 1). The protein content of cultivars (14 per cent mb) varied from 8.5 to 11.7 per cent. Level of damaged starch in flours was more than that of wheat meals. The falling number values of the flours varied widely depending on the wheat cultivar with the range of 98-795 and mean value of

TABLE 1. MEAN AND RANGE OF GRAIN CHARACTERISTICS OF DIFFERENT VARIETIES OF INDIAN BREAD WHEATS

Parameters	Mean	Range	Std. dev	Co-eff. variation (%)
Moisture, (%)	10.0	9.5—11.1	± 0.38	3.80
Hectolitre wt (kg)	84.3	78.1—88.9	± 2.66	3.16
1000 grain wt (g)	37.5	28.0—44.8	± 5.16	13.76
Gluten, (%) Wet	34.1	30.1—38.5	± 2.74	8.04
Dry	11.9	9.9—13.7	± 0.95	7.98
Protein, (%)	10.2	8.5—11.7	± 0.79	7.75
Damaged starch, (%)	5.8	5.1—6.5	± 0.42	7.24

TABLE 2. MEAN AND RANGE FOR PHYSICO—CHEMICAL CHARACTERISTICS OR INDIAN BREAD WHEAT FLOURS.

Parameters	Mean	Range	Std. dev.	Co-eff. var. (%)
Gluten, (%) Wet	33.8	28.7—38.6	± 2.83	8.37
Dry	11.1	9.5—12.7	± 0.85	7.66
Protein, (%) (N × 5.7)	8.7	7.7—9.8	± 0.67	7.70
Damaged starch, (%)	8.6	6.3—11.5	± 1.36	15.8
Falling No. (sec)	565	98—795	± 148.6	26.3

565 sec (Table 2). Tara and Bains[9] reported a similar mean falling number value of 571 with a range of 334-939 in Indian wheat flours.

Quality assessment: The value for Pelshenke test ranged from 36-253 sec and 71-171 sec in wheat meal and flour, respectively (Table 3). There was more of variation in whole meal Pelshenke values than in flours. Bains and Irvine[10] reported range of 56-243 sec Pelshenke value in Indian wheats. Zeleny sedimentation and Acetic acid Swelling Index values were similar with means of 20.7 and 19.8 ml, respectively. A mean value of 27.5 ml for Zeleny sedimentation was reported by Finney *et al.*[11] in Indian wheats. The SDS sedimentation value showed greater range as compared to the Zeleny sedimentation value.

TABLE 3. MEAN AND RANGE FOR QUALITY TESTS OF INDIAN WHEATS

Parameters	Mean	Range	Std. dev.	Co-eff. var. (%)
Pelshenke time				
Wheat meal	129.2	36—253	± 73.0	56.5
Flour	99.1	71—171	± 22.5	22.5
Zeleny volume				
Flour	20.7	17—26	± 2.6	12.5
SDS volume				
Wheat meal	41.7	34—52	± 6.0	14.3
Flour	40.4	31—52	± 6.2	15.3
Swelling Index				
Flour	19.8	16—27	± 3.2	16.1
Gluten turbidity				
Wheat meal	0.162	.10—.25	± 0.046	28.4
Flour	0.266	.16—.59	± 0.125	47.0

The correlation co-efficient (r) between wheat meal and flours in SDS test was 0.943 and was highly significant ($P<0.01$). For Pelshenke and Gluten turbidity tests, the correlation values between wheat-meal and flours were 0.597 and 0.508, respectively, which were significant ($P < 0.05$). The coefficient of determination (r^2) is as high as 0.89 in SDS as compared to 0.36 and 0.25 for Pelshenke and turbidity tests, respectively. The regression of SDS values for wholemeal Vs flour was linear (Fig. 1) over a wide range of values for the cultivars. On the other hand, the relationship between Pelshenke values for whole meal Vs flour though linear but the value for intercept of the Y-axis precludes its application to breeders samples (Fig. 2). This establishes that the SDS sedimentation test is sufficiently accurate measure for assessing the quality of Indian wheats using whole meal or flour in preference to Pelshenke and turbidity tests.

Interrelations between the quality tests: To establish the interrelations between the quality tests, co-efficient of correlations were calculated (Table 4). SDS values were highly correlated ($P < 0.01$) with the values for

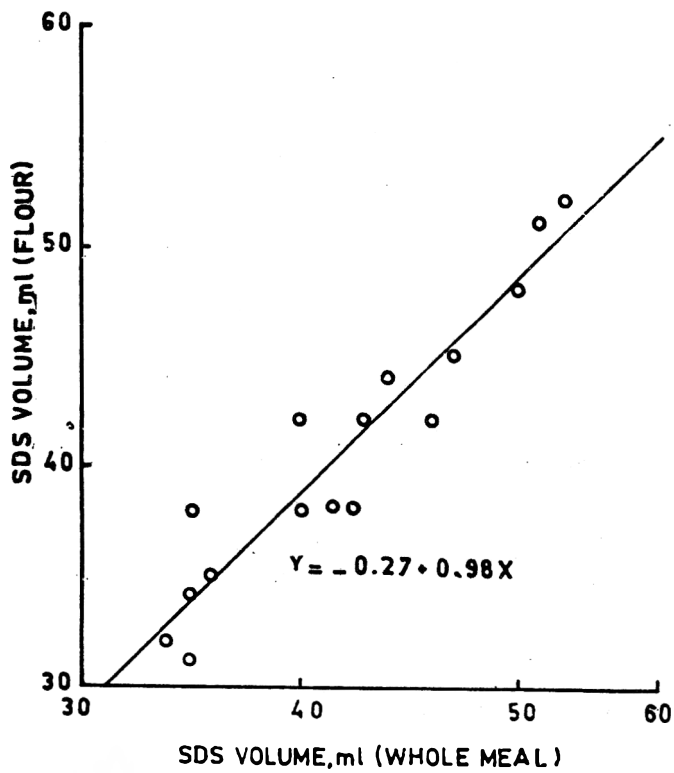

Fig. 1. Relationship between the SDS volumes for whole meal vs those of flours of different cultivars of Indian wheats.

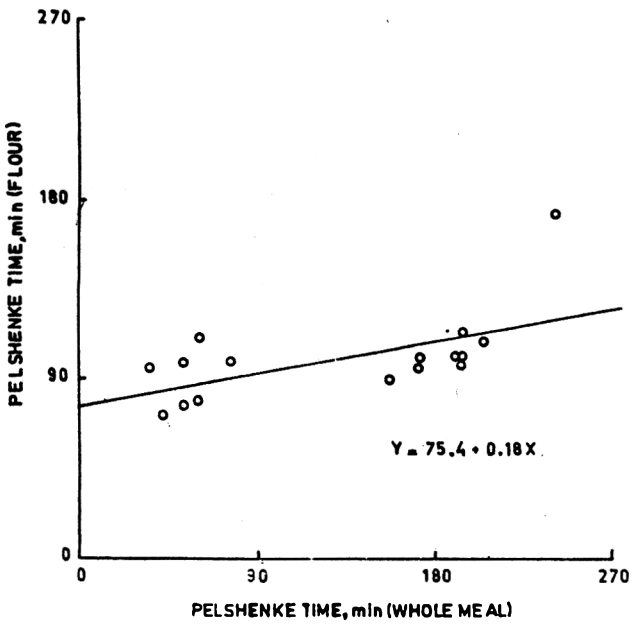

Fig. 2. Relationship between the Pelshenke time for whole meal vs those of flours of different cultivars of Indian wheats.

TABLE 4. RELATIONSHIP BETWEEN VARIOUS BREADMAKING ASSESSMENT QUALITY TESTS

Parameters	Wheat meal	't' value	Flour	't' value
Pelshenke vs Zeleny.	.358	1.48	.614**	3.02
Pelshenke vs SDS	.615**	3.02	.643**	3.25
Pelshenke vs Turbidity	.418	1.78	—.365	1.52
Pelshenke vs Swelling Index.	.752**	4.42	.503*	2.26
Zeleny vs SDS	.865**	6.66	.879**	7.13
Zeleny vs Turbidity	.489*	2.17	—.379	1.59
Zeleny vs Swelling Index	—	—	.924**	9.38
SDS vs Turbidity	—.644**	3.26	—.393	1.65
SDS vs Swelling Index	.752**	4.42	.738**	4.23
Turbidity vs Swelling Index	—.490*	2.18	—.265	1.06

*** Significant at the 0.05 and 0.01 probability levels, respectively

Pelshenke, Zeleny, Swelling Index and Gluten turbidity test applied to whole meal and flour, except non-significant correlation between SDS vs gluten turbidity in case of flour. The correlation between Zeleny and the Acetic acid Swelling Index tests was also highly significant ($P<0.01$) with 0.85 value for co-efficient of determination (r^2). The Acetic acid Swelling) test offers the advantage of eliminating the refluxing step essential for lactic acid in Zeleny test. The correlation between Zeleny and Gluten turbidity tests was also significant, but the co-efficient of determination (r^2) was 0.239. The correlation between the Zeleny and Pelshenke tests was non-significant, On the other hand, the Pelshenke values were highly correlated with SDS and Swelling Index ($P < 0.01$). The correlation between Pelshenke and SDS values is 0.615. Blackman and Gill[4] reported similar correlation of 0.68 between SDS and Pelshenke values. The correlation of —0.644 was obtained between SDS and turbidity values of wheat meal which is indicative of quality associated with the lactic acid insoluble proteins. The proportion of lactic acid insoluble proteins in wheat is an important determinant in breadmaking quality[12].

For the range of protein content in the present cultivars, the relationship between protein and SDS sedimentation was non-significant. Similar observations have been reported by U.K. workers [3,4]. However, correlation co-efficient of 0.629 between SDS and protein content has been obtained [13] in US wheat variety Wanser with much higher range of protein (9.9-14.9 per cent) than encountered in the case of Indian and UK wheats.

Payne *et al.*[14] found SDS values associated with particular glutenin subunit in segregating population of a cross between poor and good breadmaking variety indicating SDS as the better test for measuring inherent protein quality. A high correlation of 0.80 and 0.82 was derived from SDS volume and loaf volume by long fermentation procedure and 0.84 and 0.78 by Chorley Wood bread process[3]. A similar correlation of 0.68 and 0.83 was reported by Blackman and Gill[4] between loaf volume and SDS volume in bread wheats grown at two different sites.

The foregoing discussion of the results established the superiority of SDS test for assessment of bread quality of Indian wheat cultivars as well. The test is more discriminatory with wider range of the values for quality of the cultivars with equally dependable applicability to wheat meal as well as milled flour.

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Effect of Bread Wheat, Durum Wheat and Triticale Blends on Chapati, Bread and Biscuit

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The 50:50 or 25:75 blends of triticale and bread wheat resulted in improved loaf volumes and specific volumes. Triticale also improved the baking performance of 33:33:33 grist. Incorporation of triticale at equal proportions with durum and bread wheats improved cookie spread, thickness, surface cracking and crispness of cookies.

The bread wheats, durum wheats and triticale are technologically different[1–6]. An increase in the proportion of durum wheat and triticale in bread wheat lots would affect concerned industrial sectors. This study was thus undertaken to probe the effect of admixture of these materials on different products.

Materials and Methods

Representative samples of bread and durum wheat and triticale varieties viz. WL 711', PBW 34' and TL 1210' respectively were obtained from the wheat section of the department of plant breeding at Punjab Agricultural University, Ludhiana. The cleaned samples were conditioned to optimum level of moisture and given rest period of 48 hr. Different blends were prepared in lots of 1.5 kg and milled on the Buhler pneumatic laboratory mill (MLU-202). All the flour streams alongwith the dusted flour obtained from the shorts with the bran finisher were mixed together to constitute the straight grade flour' which was used in the studies. Wheat wholemeal was produced by grinding the cleaned wheat on the laboratory stone grinder for analysis and chapati making.

Protein content was determined by micro-kjeldhal method, gluten with the help of gluten washer, and sedimentation value using the mechanical shaker according to the approved methods of AACC[7]. The constant flour weight and the straight dough methods of AACC[7] were used for Farinographic and baking studies respectively. The cookie test was conducted as is followed at the International Maize and Wheat Improvement centre, Mexico. The chapati making test was conducted according to the method described by Sekhon *et al.*[8] and evaluated on a 30 point scale. The results were statistically tested using 'paired t' test.

Results and Discussion

Gluten: The wet and dry gluten contents ranged from 15.3—27.9 per cent respectively (Table 1). The gluten recovery was highest for bread wheat (27.9per cent) which decreased with the increasing proportion of both durum wheat and triticale in the grist. The gluten quality as evidenced by sedimentation value showed that admixture of bread wheat with durum affected the values negatively. As the proportion of durum wheat was increased from 25 to 75 per cent, sedimentation value decreased from 23.5 to 14.5 cc. The relative decrease on admixture with triticale was from 23.5 to 21.0 cc.

Chapatis: Bread wheats produced very good chapatis (Table 2) whereas the chapatis from triticale were adjudged fair mainly due to their red colour. By increasing levels of durum and triticale from 25 to 75 per cent, chapati quality decreased. At 75 per cent level the triticale imparted red colour to the product thereby

Table 1. Physical characteristics of different blends of bread wheat, durum wheat and triticale

Sr. No.	Blends BW: DW: TR	Sedimentation value (cc)	Gluten content (%) Wet	Dry
1	4 : 0 : 0	23.5	27.9	9.9
2	3 : 1 : 0	18.0	27.1	9.3
3	2 : 2 : 0	16.0	23.1	9.7
4	3 : 0 : 1	22.0	25.1	9.0
5	2 : 0 : 2	21.0	24.2	8.8
6	1 : 0 : 3	22.5	21.1	7.5
7	0 : 0 : 4	23.0	19.5	6.7
8	2 : 1 : 1	19.0	25.1	9.1
9	1 : 1 : 1	21.0	23.1	8.6
10	1 : 2 : 1	17.5	23.8	8.5
11	1 : 1 : 2	17.5	23.1	8.5
12	0 : 1 : 3	18.0	15.3	5.4
	Mean	18.7	22.5	8.1
	't' value	14.18*	1.80*	0.96*

BW = Bread wheat - *significant at 5% level
DW = Durum wheat TR = Triticale

TABLE 2. CHAPATI MAKING CHARACTERISTICS OF DIFFERENT BLENDS OF BREAD WHEAT, DURUM WHEAT AND TRITICALE

Sr. No.	Blends BW: DW: TR	Colour of chapati	Puffing	Total score	Rating
1	4 : 0 : 0	Creamish	Full	30	V. Good
2	3 : 1 : 0	"	"	30	"
3	2 : 2 : 0	"	"	30	"
4	3 : 0 : 1	"	"	30	"
5	2 : 0 : 2	"	"	30	"
6	1 : 0 : 3	Red	"	26	Good
7	0 : 0 : 4	"	"	24	Fair
8	2 : 1 : 1	Creamish	"	30	V. Good
9	1 : 1 : 1	"	Partial	28	Good
10	1 : 2 : 1	"	Full	28	Good
11	1 : 1 : 2	Red	Partial	24	Fair
12	0 : 1 : 3	"	Full	22	Fair

BW = Bread wheat
DW = Durum wheat
TR = Triticale

TABLE 3. BAKING CHARACTERISTICS OF DIFFERENT BLENDS OF BREAD WHEAT, DURUM WHEAT AND TRITICALE

Sl. No.	Blend BW: DW: TR	Bread characteristics					Cookie characteristics	
		Loaf vol (cc)	Sp vol (g/cc)	Crumb characters grain	Texture	Width(w) (cm)	Spread factor (W/T)	Acceptability
1	4 : 0 : 0	635	4.4	Fine	Soft	5.30	5.58	Good
2	3 : 1 : 0	610	4.5	Fine	S. hard	5.50	6.11	Good
3	2 : 2 : 0	570	4.0	M. Fine	S. hard	5.45	6.06	V. good
4	3 : 0 : 1	645	4.8	Fine	Soft	5.62	5.79	"
5	2 : 0 : 2	660	4.8	Fine	Soft	5.80	5.80	"
6	1 : 0 : 3	675	4.9	Fine	Soft	5.60	5.89	"
7	0 : 0 : 4	575	4.4	Fine	Soft	5.76	6.40	"
8	2 : 1 : 1	612	4.2	Fine	Soft	5.30	5.76	Good
9	1 : 1 : 1	640	4.5	Fine	Soft	6.10	6.78	V. good
10	1 : 2 : 1	575	4.0	Fine	Soft	5.62	5.92	"
11	1 : 1 : 2	575	3.9	Fine	Soft	5.35	5.82	Good
12	0 : 1 : 3	510	3.7	M. Fine	Hard	5.65	6.28	V. good

MF = Medium fine SH = Semi hard W = Width T = Thickness BW = Bread wheat DW = Durum wheat TR = Triticale

reducing its acceptability.

Biscuits: The triticale variety produced best cookies followed by bread wheat (Table 3). The durum wheat alone produced poor cookies but when mixed with bread wheat to a level of 50 per cent, it improved both the spread factor and the consumer acceptability probably by weakening the gluten. The triticale improved the quality of wheat cookies by way of inherent capacity to produce better quality cookies as reported by Sehgal *et al* [9]. However, the best cookies with highest spread factor and very good consumer acceptability were produced by a blend of all the three in equal proportions.

Bread: The data reveal that upto a level of 50 per cent triticale improved the absolute and specific loaf volume of bread wheat (Table 3). The variety WL 711 produced a loaf volume of 635 cc as compared with 575 cc and 475 to that of triticale and durum wheat variety. The highest loaf volume of 660 cc and specific volume of 4.9 cc/g were produced by 50:50 and 25:75 blends of bread wheat and triticale respectively. The

TABLE 4. STATISTICAL RESULTS USING PAIRED T TEST

Characteristics	Observed mean (O)	Expected mean (E)	Diff (O—E)	't' value
Sed value	18.71	20.50	—1.79 (0.35)	5.11*
Wet gluten	22.46	22.14	0.32 (0.42)	0.76 ns
Dry gluten	8.11	8.09	0.02 (0.19)	0.10 ns
Loaf volume	568.60	561.70	6.90 (10.11)	0.67 ns
Cookie spread	5.52	5.88	—0.088 (0.09)	0.91 ns

Figures in parenthesis indicate standard error
*Significant at 5% level ns: Non significant

increase of durum wheat from 25 to 75 per cent in the blends progressively decreased the absolute and specific loaf volumes. However, a blend of all the three in equal proportions produced a better loaf than the bread wheat alone. As regards the crumb characteristics viz. grain and texture, the durum wheat had a deleterious effect but no such effect was noticed with triticale or in the blends of all the three. This brings out the fact that triticale in the mixed grist can counteract the damaging effect of durum wheat on the bread crumb to a certain level.

Table 4 shows that differences between experimental and the theoretical values were significant only for sedimentation value. Differences in values for other factors were non-significant.

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Studies on Soy Paneer

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A process was developed for the manufacture of soy paneer from defatted soy flour using organic acids. A total solids content of 7.58% (defatted soy flour to water ratio of 1:12.5) and temperature of 95°C were found to be the optimum for coagulation of soy slurry using citric, tartaric, lactic or acetic acid as coagulants. Addition of cow's milk (from 10 to 30%) to soy slurry increased the yield of paneer with higher total solids and lesser protein content. Recovery of protein in soy paneer was highest with acetic acid as coagulant followed by citric, tartaric, and lactic acids. The overall acceptability of fried soy paneer increased as the concentration of cow's milk in soy slurry increased. The product coagulated with tartaric acid had the highest acceptability amongst the coagulants.

Most of the soybean crop in India is used for extraction of oil and deoiled meal is largely utilized as animal and poultry feed. Only a small percentage of meal or soybeans are as such processed for direct human consumption.

Varieties of imitation dairy products have been developed from soybean[1]. The development of soy paneer would provide a substitute for paneer during the lean periods. Soy curd (tofu) obtained by coagulation of soy milk by calcium sulphate is a white soft gelatinous mass which could be used as a substitute for milk paneer[1].

Vijaylakshmi and Vaidehi[2] prepared acceptable products from the coagulum obtained by precipitation of soy milk or its blends with other milks[2]. Naseem *et al.*[3] developed a process for preparation of acceptable soy paneer by precipitation of soy bean milk with organic acids. The manufacture of soy paneer from soybean is a lengthy process which requires high initial investment which in turn increases the cost of manufacture. Therefore, the present investigation was undertaken to develop a process for preparation of soy paneer by precipitation of soy slurry prepared from defatted soyflour and its blends with cow's milk.

Materials and Methods

Food grade defatted soy flour was obtained from M/s Prag Oil and Ice Mills Ltd. Aligarh (UP). Cow's milk was obtained from Livestock Research Centre of the University.

Preparation of soy slurry: Defatted soy flour (100g) was soaked in tap water in the ratios of 1:10, 1:12.5 and 1:15 for one hour at room temperature (20-22°C). The soaked flour was then blended in waring blender for 5 min. The resulting suspension was filtered through double layered cheese cloth and filtrate was boiled for 10 min with continuous stirring to prevent sticking of solids and scorching.

Preparation of cow milk-soy slurry blends: Cow milk-soy slurry blends were prepared by blending boiled cow's milk to soymilk in the ratio of 10:90, 20:80 and 30:70 for 5 min in blender.

Preparation of soy paneer: Preliminary trials were carried out to determine appropriate temperature for coagulation of slurry. The temperatures tested were 75°, 85° and 95°C. It was found that coagulation of slurry at 95°C yielded soy paneer with maximum total solids (32.7-37.5 per cent) and highest recovery of protein (84.14-90.34 per cent). Therefore, this temperature was used for coagulation of slurry throughout the study. Citric acid, tartaric acid, lactic acid and acetic acid (LR grade, 100 ml of 2 per cent solution per litre of slurry) were used as coagulants.

Soy slurry and cow milk-soy slurry blends (2 l) were brought to the coagulation temperature. The coagulant solution was added with continuous and gentle stirring. The coagulum was left undisturbed for 15 min. After cooling to about 60°C, the whey was removed by filtration through a double layered cheese cloth. The coagulum thus obtained was pressed in a wooden box

(30x20x15cm) by applying 2 kg weight for one hr to expel the whey. The product was then stored at 4-5°C for further analysis.

Deep-fat-frying: The soy paneer was cut into pieces of uniform size of 1.5x1.5x1 cm and deep-fat-fried in double refined soybean oil for 8 min at 180°C.

Total solids, protein and fat contents were determined according to AOAC[4] procedures.

Sensory evaluation: Fried soy paneer was evaluated for sensory quality. The sensory panel consisted of nine semi-trained members of the department. They were asked to record their performance on a Hedonic scale rating[5] ranging from 1 to 9, where 1 represented dislike extremely and 9 represented like extremely.

Results and Discussion

Effect of soy flour to water ratio on total solids of soy slurry: The defatted soy flour used in this study contained 7.8, 52.5 and 1.8 per cent of moisture, protein and fat, respectively. The effect of defatted flour to water ratio on yield, total solids and protein content of soy slurry and soy paneer is presented in Table 1. Soy flour to water ratio of 1:15 yielded soy slurry with lowest total solids (6.35 per cent) and protein content (3.31 per cent); but gave most recovery of total solids (93.7 per cent). As the soy solid content in slurry increased, there was a corresponding decrease in protein in soy slurry. Several workers[3,6] have reported that a level of 100g soybean per litre of water was optimum for the extraction of soy solids and proteins. High solids content in slurry yielded more viscous suspension causing difficulty in filtration and thus resulted in greater losses of solids and protein in the residue.

Effect of total solid content of slurry and coagulants: As the soy solids increased in soy slurry, there was a decrease in recovery of soy solids and protein and reverse was true when the solids content decreased from 9.46 to 7.58 per cent, there was an increase in yield, total solids and protein content and protein recovery. But, further lowering of soy solids from 7.58 to 6.35 per cent decreased total solids and protein content in soy paneer (Table 2).

The yield of soy paneer on dry matter basis did not differ appreciably with different total solids concentration or acid used. A total solid content of 7.58 per cent seemed to give higher protein content in soy paneer with any acid than either 9.46 or 6.35 per cent total solids. Soy paneer having greatest solid content was obtained with citric acid followed by lactic acid, acetic acid and tartaric acid. These observations

TABLE 1. EFFECT OF DEFATTED SOY FLOUR TO WATER RATIO ON TOTAL SOLIDS, PROTEIN CONTENT AND RECOVERY OF PROTEIN IN SOY SLURRY

Flour:water ratio	Yield of soy slurry/100g flour (ml)	Total solids (%)	Total solids recovered (%)	Protein (%)	Protein recovered (%)
1:10	958	9.46	90.5	4.95	90.32
1:12.5	1218	7.58	92.3	3.96	91.87
1:15	1476	6.35	93.7	3.31	93.05

TABLE 2. EFFECT OF SOY SOLID CONCENTRATION OF SOY SLURRY ON YIELD, TOTAL SOLIDS, PROTEIN CONTENT AND RECOVERY OF PROTEIN IN SOY PANEER

Coagulant	Total solids in soy slurry (%)	Paneer yield (g/100 g flour) (d.b.)	Total solids in paneer (%)	Protein content (%)	Protein recovered (%)
Citric acid	9.46	66.4	27.4	57.4	72.6
	7.58	69.4	37.5	67.4	89.1
	6.35	56.4	28.4	64.1	69.0
Tartatic acid	9.46	67.3	26.0	55.7	71.5
	7.58	68.8	31.2	66.0	86.5
	6.35	56.0	25.6	63.2	67.2
Lactic acid	9.46	67.3	27.0	53.9	69.1
	7.58	69.1	35.7	67.7	89.2
	6.35	54.3	30.3	64.1	66.7
Acetic acid	9.46	69.2	26.1	54.6	72.0
	7.58	70.8	32.7	67.1	90.3
	6.35	57.3	31.4	64.9	70.8

Average of duplicate determinations

TABLE 3. EFFECT OF COW'S MILK SUBSTITUTION IN SOY SLURRY ON YIELD, TOTAL SOLIDS, PROTEIN CONTENT AND PROTEIN RECOVERY IN SOY PANEER

Coagulant	Cow's milk:soy slurry	Yield (% d.b)	Total solids (%)	Protein (%)	Protein recovery (%)	Fat (% d.b.)
Citric acid	0:10	57.1	37.5	67.4	89.3	1.5
	10:90	58.0	38.5	66.0	90.8	6.0
	20:80	58.5	40.1	64.9	92.0	10.5
	30:70	59.7	41.7	63.6	94.1	15.3
Tartaric acid	0:10	56.5	31.2	66.0	86.5	1.4
	10:90	57.8	32.5	64.9	88.9	6.0
	20:80	60.1	33.7	63.7	92.8	10.7
	30:70	63.0	35.0	62.2	97.1	15.1
Lactic acid	0:10	56.8	35.7	67.7	89.2	1.5
	10:90	57.5	37.0	66.4	90.5	5.8
	20:80	58.6	38.5	64.1	91.0	10.3
	30:70	59.3	40.7	62.6	92.0	15.3
Acetic acid	0:10	58.1	32.7	67.0	90.3	1.4
	10:90	59.7	34.0	65.0	92.0	5.0
	20:80	60.1	35.0	63.8	92.9	10.5
	30:70	61.2	38.0	61.9	93.9	15.2

confirmed the findings of Naseem *et al.*[3]. Maximum protein recovery was observed with lactic acid and minimum with tartaric acid at the same concentration of addition. Taking the average of all three concentrations of soy solids, the highest amount of protein was extracted with acetic acid followed by citric, tartaric and lactic acids. The pH played an important role in the precipitation of soy slurry. The isoelectric point of soy proteins is in the range of 4.2 to 4.6. Smith *et al.*[7] reported that solubility of soy protein is minimum between pH 4.2 and 4.6. The values of the pH of whey obtained in the present study were 5.23, 5.28, 5.45 and 5.65 for acetic, citric, tartaric and lactic acids, respectively. Hence, lower the pH of precipitation, greater was the protein recovery in soy paneer.

Effect of cow's milk substitution: The cow's milk used in this study contained 85.90, 3.39, 4.90, 5.08

TABLE 4. EFFECT OF COW'S MILK SUBSTITUTION IN SOY SLURRY ON TOTAL SOLIDS, PROTEIN AND FAT CONTENTS AND ORGANOLEPTIC SCORE OF FRIED SOY PANEER

Coagulant	Cow's milk:soy slurry	Total solids (%)	Protein* (%)	Fat* (%)	Sensory score (Max.9.0)
Citric acid	0:10	66.7	45.0	30.4	5.62
	10:90	61.3	43.0	34.5	6.14
	20:80	63.1	41.0	37.4	6.40
	30:70	66.0	39.0	41.0	6.92
Tartaric acid	0:10	70.4	40.6	30.8	5.13
	10:90	63.4	38.0	33.9	6.30
	20:80	64.8	35.5	37.1	7.25
	30:70	67.6	34.0	40.0	7.69
Lactic acid	0:10	71.2	48.0	30.0	6.41
	10:90	63.9	45.0	34.0	6.50
	20:80	65.4	43.0	38.0	6.63
	30:70	68.4	42.0	42.8	6.94
Acetic acid	0:10	74.2	43.0	29.0	5.00
	10:90	66.9	41.0	33.0	5.39
	20:80	70.4	39.6	36.5	6.50
	30:70	71.1	38.0	41.0	7.16

*On dry wt. basis

and 0.73 per cent moisture, protein, fat, lactose and ash, respectively. Table 3 shows the effect of cow's milk addition in soy slurry on yield, total solids, protein content and protein recovery in soy paneer.

The yield of soy paneer increased with the increase in the proportion of cow's milk. The maximum yield was in case of soy paneer made from cow's milk to soy slurry (30:70) using tartaric acid (63.0) followed by acetic (61.2) citric (59.7) and lactic acid (59.3). The soy slurry made from defatted soy flour contains denatured proteins. These denatured proteins result in more brittle and finer gel. The fine particles have a tendency to go along with whey upon filtration. Addition of cow's milk perhaps binds these fine paqrticles which result in higher yields of soy paneer. Hence creater was the cow's milk addition, greater was the yield.

As the cow's milk proportion increased in soy slurry the total solids in soy paneer increased but there was a simultaneous decrease in protein content. This could be a attributed to higher total solids but lower protein content of cow's milk compared to soy slurry.

Fat content of fried soy paneer: The soy-paneer prepared from soy slurry had approximately 1.5 per cent fat. After deep-fat-frying, the fat content of soy paneer was increased from 20 to 22 times. This increase in fat content could be accounted for both the absorption of fat and expulsion of moisture during deep-fat-frying. Addition of 10 per cent cow's milk to soy milk resulted in approximately six fold increase in fat content of fried paneer analogue. The increase in cow's milk proportion from 10 to 20 per cent and 20 to 30 per cent in cow milk-soyslurry blends increased fat content of fried soy paneer by four and three times, respectively. The higher absorption of fat during deep-fat-frying by the paneer analogue prepared from cow milk-soy slurry blends with higher proportion of cow's milk may be attributed to the increasingly higher porosity of the gel formed in combination with cow's milk as well as higher fat content (4.9 per cent) of cow's milk.

Sensory evaluation: The average acceptability score of soy paneer made from soy slurry and cow milk-soy slurry blends using different acid coagulants are presented in Table 4. The results show that acceptability of soy paneer increased with an increase in the proportion of cow's milk in blends.

Comparing tne average acceptability score of paneer analogue prepared by different acid coagulants, it was observed that the ones from tartaric acid had greatest acceptability score followed by acetic, lactic and citric acid ones. The panelists noted that the soy paneer made from cow milk-soy slurry blends using different coagulants had much less beany flavour.

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Studies on the Development of Colour and Flavour During Production and Storage of Sterilized Buffalo Cream

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There was no visible change in colour and flavour of buffalo cream immediately after its sterilization. However, during storage at 37°C, the development of brown colour and increase in hydroxy methyl furfural (HMF) were observed. The intensity of brown colour became predominant and the development of off-flavour occurred after a storage period of 60-75 days.

Most dairy plants in India are dependent upon buffalo milk. During the flush season, conservation of fat and solids-not-fat (SNF) in the form of a product other than the conventional butter and ghee is a problem. By sterilization and adopting suitable packaging devices, surplus buffalo milk fat and SNF can be preserved for retail selling as well as for bulk utilization by manufacturing of sterilized buffalo cream on large and small scale as well. Studies on heat induced changes after manufacturing and during storage will safeguard the interest of consumers with reference to colour and flavour. Though sufficient work has been done on cow cream in foreign countries but the same is scanty in case of buffalo cream which has major contribution for dairying in India. Buffalo cream differs from that of cow with respect to calcium and casein micelles size[1]. Indian Standards Institution[2] has fixed standards for sterilised cream with respect to fat (not less than 20 per cent) but not for the SNF which plays a major role in colour and flavour.

Materials and Methods

Milk produced at NDRI from Murrah buffalo herd was used for the production of sterilized cream. Observations were made with respect to colour and flavour of cream immediately after production and during storage.

The method for production of sterilized cream comprises of the following steps:

Buffalo milk was warmed in a plate-heat exchanger at about 45 to 50°C. It was passed through the Titan Cream separator operating at 7000 rpm. After regulating the cream flow, about 2 kg of cream and 3 kg of skim milk were collected. The cream and skim milk were tested for their fat and acidity as per ISI method[3].

The cream obtained above was having 50 to 55 per cent of fat and the quantity of skim milk (0.05 - 0.1 per cent fat) required to reduce the fat to 20 per cent was calculated using Pearson's Square Method. Skim milk was slowly added to the cream with minimum agitation. The standardized raw cream was tested for fat percentage. A slightly higher level of fat per cent was maintained to keep a margin for the addition of stabilizer solution.

Five to 5.5 kg of cream was taken in stainless steel degchi and was placed in multipurpose jacketted water bath. During heating, minimum agitation was given to prevent rising of fat to the top. The cream was heated to 85°C for 15 min. and the time of holding was counted when cream attained the temperature of forewarming. The forewarmed cream was cooled to 65 ± 2°C by running tap water into the bath and giving slow and continuous agitation with a glass rod for quick heat transfer.

Homogenization of cream was carried out in a Gaulin homogenizer using a pressure of 2500 psi in first stage and 500 psi in the second stage. For each trial, the homogenizer was flushed with hot water and then 120±5 ppm. chlorine solution.

A calculated amount of 10 per cent solution of tri-sodium citrate was added to the cream with a proper mixing so that the total concentration of stabilizer was 0.2 per cent of the cream.

The cans and lids were cleaned thoroughly and sterilized in hot air oven for one hour at 160 ± 5°C. During the packaging, all utensils and glassware were rinsed with 120 ± 5 ppm chlorine solution. Cans were filled with cream leaving a space of 3 to 4 mm from the top for expansion. Thereafter, the lids were kept immediately over the cans, seamed in s Metal Box seamer and marked for identity.

Filled and seamed cans were immersed in a water bath maintained at 90 - 95°C for 5 minutes to detect any leak.

For sterilization of canned cream, the small rotary sterilizer developed by Banerjee and Bagchi[4] was used. The product was held at sterilization temperatures (110°C/15 min, 115°C/15 min and 120°C/15 min) and during this period, the crate was rotated at 5-6 rpm. Thereafter, the cans were cooled to about 60°C by introducing cooling water and subsequently removed from the crate. Four trials were conducted for each time-temperature combination of sterilization. As there were three combinations, 12 trials were conducted in all. The cans containing sterilized cream were stored at 37 ± 1°C to examine their keeping quality.

Raw standardised and sterilized cream samples were examined for quality immediately after sterilization and at fortnightly intervals during storage. Brown colour was estimated by the method of Choi *et al.*[5] whereas total HMF (free plus potential HMF) was estimated by method-B of Keeney and Bassette[6] by taking 10 g of cream and diluting to 100 ml. All estimations were carried out in duplicate.

Results and Discussion

The intensity of brown colour (estimated as colour units per g of cream using a standard curve) increased with higher heat treatment viz. for sterilization temperature of 120°C/15 min and the colour units increased from 0.255 for standardised raw cream to 0.266 for the finished product (Table 1). However, the quality of cream with respect to colour was acceptable for all the three sterilization temperatures.

The quality of cream during storage at 37°C was examined upto 90 days of storage. The development of brown colour was somewhat slow upto a storage period of 45 days and thereafter the rate of increase of browning was rather high for all the three sterilization temperatures (Fig. 1). The values for colour units were comparatively great for higher sterilization temperature. After 45 days of storage, the brown colour was not visible to the naked eye in samples sterilized at 110°C/15 min whereas it was visible in samples sterilized at 115°C and 120°C. The brown colour became predominant in all the three categories after 60 days of storage.

No published information is available on the colour of sterilized buffalo cream. Further, the phenomenon of browning[7] in milk and milk products is also not

TABLE 1. COLOUR AND FLAVOUR OF BUFFALO CREAM STERILIZED AT 110°C/15 MIN, 115°C/15 MIN AND 120°C/15 MIN

Raw standardised cream		Sterilized cream	
Colour (unit/g)	HMF (μm/100 g)	Colour (unit/g)	HMF (μm/100 g)
		110°C/15 min	
0.255	0.778	0.263	1.035
		115°C/15 min	
0.257	0.783	0.260	1.612
		120°C/15 min	
0.255	0.778	0.266	2.811

Figures are average of 4 trials.

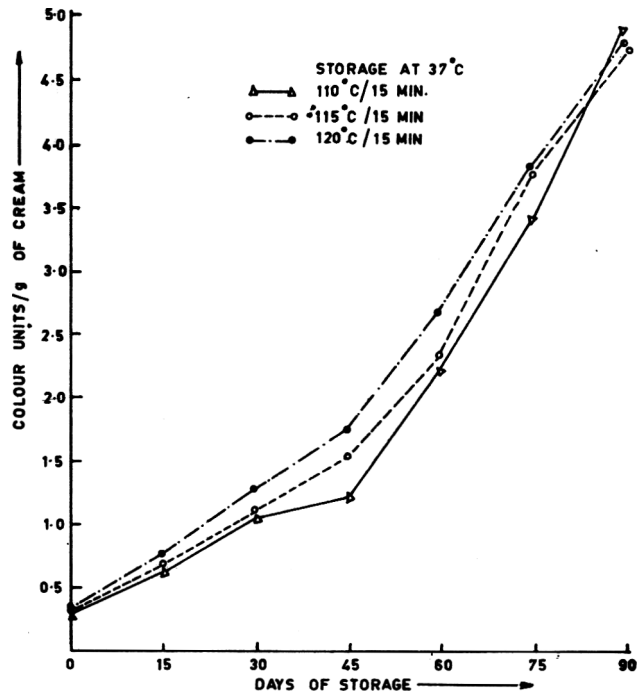

Fig. 1. Effect of sterilization and storage at 37°C on development of brown colour in sterilized buffalo's cream

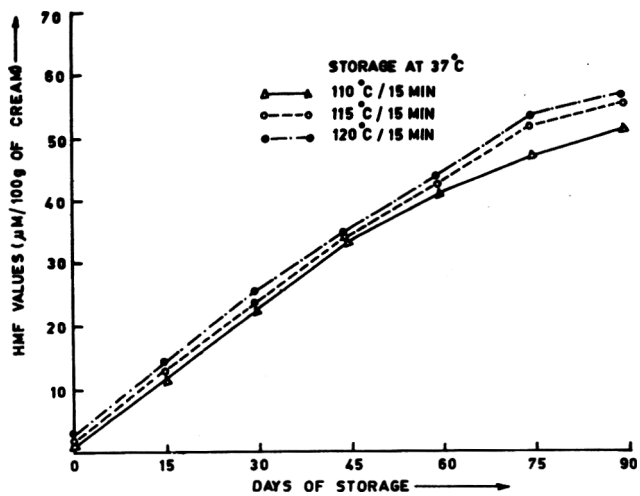

Fig. 2. Effect of sterilization and storage at 37°C on production of HMF in sterilized buffalo's cream

very clear. The extent of heat treatment is one of the probable reasons for browning. It was noted that colour intensity[8] of concentrated milk increases with storage temperature of 40°C which was in agreement with the findings in the present investigation, although no information is available on buffalo cream as such.

The HMF values were taken as indices of flavour. Table I shows that HMF values of raw standardised cream increased upon sterilization. The increase was comparatively more for a higher sterilization temperature of 120°C/15 min.

It was observed from Fig 2 that on storage at 37°C, the HMF values increased during the course of storage. The cream sterilized at 120°C/15 min has HMF value of 2.811 expressed as micromoles per 100 g immediately after sterilization and this value increased to 56.344 after a storage period of 90 days. All categories of cream samples showed off-flavour development after 60-75 days. The lower range of 60 days pertained to cream samples sterilized at 120°C/15 min.

Zadow[9] observed that heating of skim milk at 98 to 145°C/3 sec resulted in an increase in the initial HMF values with increased processing temperature. As reported by Della Monica *et al.*[10], the HMF formed during processing measures the incidence of heat exposure of milk, provided solid content is kept constant. King[11] detected the oxidized flavour in milk with the help of thiobarbituric acid (TBA) reaction. Similarly, the flavour defects in edible casein and skim milk powder were detected by Walker[12] with the help of TBA reaction. It is, thus, increasingly clear that TBA method can detect browning and fat oxidation in milk products and thereby serves as index of their quality with respect to flavour.

Cream samples sterilized at 110°C/15 min remained in acceptable condition only upto 45 days whereas the samples sterilized at 115°C/15 min and 120°C/15 min kept in good condition for a period of 75 days and 60 days respectively. Hence, it is concluded that a sterilization temperature of 115°C/15 min is optimum for buffalo cream to obtain a product of good keeping quality with respect to colour and flavour.

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Shelf-life of Frozen Stored Clam (*Meretrix casta*) Meat

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Shelf-life of clam (*Meretrix casta*) meat during frozen storage for 200 days was determined by chemical and sensory evaluation. Clam meat can be stored in an acceptable condition for 130 days. During frozen storage, decreases in moisture, total nitrogen and glycogen were noticed. Among the freshness parameters, TVBN (5.62 to 19.27 mg%), PV (0.89 to 31.93 millimoles of oxygen/kg fat) and TBA number (0.11 to 0.63) increased, whereas NPN (75.3 to 57.8 mg%) and AAN (52.39 to 40.01 mg%) decreased. Sensory evaluation of the frozen stored clams revealed the limits of acceptability of the product to be TVBN ≤ 17.1 mg%, PV≤15.5 and TBA number ≤0.23.

In recent years, processing of clams and mussels have undergone extensive development because of the increasing demand in overseas countries for such delicacy foods. Although previous investigators have examined the influence of seasonal parameters on meat composition and yield[1-3]. Studies on shelf-life of Clam meats under frozen storage are very limited[4]. Clam meat undergoes changes in chemical, microbial and organoleptic characteristics during frozen storage. These alterations could be used to measure the shelf-life of the product. Considering the importance of clam meat as an export commodity, it is necessary to establish the shelf-life during frozen storage in order to maintain proper quality standards. The present paper describes the keeping quality of *Meretrix casta* during storage at −20°C as assessed by biochemical parameters and sensory means.

Materials and Methods

Live clams (*M. casta*) collected from Talapady estuary were depurated under running water for 24 hr followed by 5 ppm chlorinated water for 2 hr. The depurated clams were immersed in water at 60°C for 2 min to facilitate shucking after which the meat was picked manually. 250g each of shucked meat were packed in galvanised iron trays lined with polythene sheets and immediately frozen in a coil freezer for 48 hr, glazed and stored at −20°C in a master carton. Samples were drawn randomly at 25 days intervals and analysed for chemical and organoleptic qualities.

Drip: Drip was determined by obtaining the representative sample from each frozen block of clam meat with a 20 mm diameter cork borer and weighing the sample accurately before and after thawing, which was done by placing it between two filter papers at 0 ± 2°C for about 3-4 hr.

Chemical analyses: Moisture was estimated by the AOAC procedure[5]. Total lipids (TL) were extracted with chloroform - methanol[6]. Total nitrogen (TN) and non-protein nitrogen (NPN) were determined by the method of Srikar and Chandru[7], glycogen by the method of Seifter *et al.*[8]. PV and TBA were measured following the methods of Jacobs[9] and Tarladgis *et al*[10]. Total volatile base nitrogen (TVBN) and alpha amino nitrogen were determined according to Beatty and Gibbons[11] and Pope and Stevens[12] respectively.

Sensory evaluation: Clam meat sample was cooked for 2 min. cooled and assessed for organoleptic qualities by eight trained panelists on the basis of appearance, colour, odour, taste, flavour, texture and overall acceptance using a five point hedonic scale ranging from excellent' (5), good' (4), fair' (3), acceptable' (2) and not acceptable (1).

Statistical analysis: The data from chemical analyses were subjected to ANOVA and Duncan's new multiple range test[13] to determine differences between experimental period of storages. The mean sensory scores for overall acceptance of the product were correlated with storage time and the shelf-life of clam meat during frozen storage was calculated using linear regression plot.

Results and Discussion

Changes in thaw drip percentage and proximate

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TABLE 1. CHANGES IN PROXIMATE COMPOSITION AND THAW DRIP LOSS DURING FROZEN STORAGE AT −20°C

Storage period (days)	Thaw drip (%) (n = 2)	Moisture (%) Mean ± S.D.	Total N (%) Mean ± S.D.	Total lipids (%) Mean ± S.D.	Glycogen (%) Mean ± S.D.
0	7.79	77.26[a] ± 0.02(5)	1.82[a] ± 0.06(5)	1.97 ± 0.02(3)	6.23[a] ± 0.21(5)
25	9.20	77.21 ± 0.05(5)	1.81 ± 0.04(5)	2.04 ± 0.01(3)	6.32 ± 0.16(5)
50	10.90	77.14 ± 0.01(5)	1.75 ± 0.01(5)	2.06 ± 0.02(3)	6.13 ± 0.18(5)
75	12.50	77.02[b] ± 0.05(5)	1.73[b] ± 0.02(5)	2.06 ± 0.02(3)	6.04[b] ± 0.19(5)
100	13.90	76.78 ± 0.02(5)	1.71 ± 0.01(5)	2.08 ± 0.04(3)	5.80 ± 0.17(5)
125	15.20	76.63 ± 0.02(5)	1.68 ± 0.01(5)	2.04 ± 0.04(3)	5.78 ± 0.18(5)
150	16.30	76.39 ± 0.09(5)	1.69 ± 0.01(5)	2.13 ± 0.01(3)	5.71 ± 0.19(5)
175	15.40	76.41 ± 0.01(5)	1.64 ± 0.01(5)	2.15 ± 0.01(3)	5.48 ± 0.18(5)
200	15.90	76.35[c] ± 0.01(5)	1.58[c] ± 0.01(5)	2.15 ± 0.01(3)	5.28[c] ± 0.18(5)

Figures in parenthesis indicate number of samples analysed
Figures in columns with different superscripts differ significantly. ($P < 0.05$)

composition during frozen storage of clam meat are given in Table 1. Thaw drip loss increased from 7.79 per cent to 15.9 per cent during 200 days. It has been observed that the drip loss in both mussels and clams during frozen storage is largely affected by the duration and temperature of storage[4]. Free drip to a certain extent reflects the degree of protein denaturation resulting from surface dehydration, ice crystal formation and cell rupture.

Moisture content of *M. casta* decreased from 77.26 to 76.35 per cent ($P<0.05$). the decrease was not significant during the first 75 days of frozen storage. The decrease in total nitrogen (TN) from 1.82 to 1.58 per cent was significant ($P<0.05$). the total lipids (TL) fluctuated from 1.97 to 2.15 per cent. A decrease in TN was observed by Ablett *et al*[14]. In *Villorita* sp and *M. edulis*, a decrease in moisture content was observed during frozen storage[4].

Clams are known to contain high amounts of glycogen which vary with season and the condition of the material. Glycogen content decreased from 6.32 to 5.28 per cent during storage at −20°C ($P<0.05$). A 16.5 per cent reduction was observed in the present study which corroborates with the observation of Slabyj and Carpenter[15] in *M. edulis* (12 per cent). This decrease may be attributed partly to the breakdown of glycogen in post-mortem muscle. Further, loss through thaw drip could not be ruled out.

Changes in freshness parameters *viz.*, PV, TBA and TVBN in frozen stored clam meat are given in Table 2. PV increased from 0.89 to 31.93 while TBA increased from 0.11 to 0.63 during 200 days of storage ($P<0.05$) thus indicating that clam meat lipids are oxidised during frozen storage. TVBN increased significantly from 5.62 to 19.27 mg per cent during storage ($P<0.05$). Increase in TBA value during frozen storage has been observed in edible mussels[14].

The NPN and AAN showed a significant decrease from 75.5 to 57.8 mg per cent and 52.39 to 40.01 mg per cent respectively ($P<0.05$) (Fig. 1). Molluscs and

TABLE 2. CHANGES IN FRESHNESS PARAMETERS DURING FROZEN STORAGE OF CLAM MEAT

Storage (days) period	PV* Mean ± S.D.	TBA (mg/kg meat) Mean ± S.D.	TVBN (mg%) Mean ± S.D.
0	0.89[a] ± 0.24 (4)	0.11[a] ± 0.01 (6)	5.62[a] ± 0.85 (5)
25	1.12 ± 0.03 (4)	0.12 ± 0.02 (6)	7.20 ± 0.70 (5)
50	1.38 ± 0.05 (4)	0.13 ± 0.02 (6)	9.83 ± 0.16 (5)
75	3.75[b] ± 0.03 (4)	0.14 ± 0.02 (6)	13.06 ± 0.70 (5)
100	10.77 ± 0.06 (4)	0.19 ± 0.02 (6)	13.22 ± 0.64 (5)
125	14.05 ± 0.06 (4)	0.23 ± 0.02 (6)	16.98 ± 0.21 (5)
150	20.06 ± 0.06 (4)	0.32 ± 0.03 (6)	14.09 ± 0.30 (5)
175	28.24 ± 0.47 (4)	0.50 ± 0.02 (6)	18.33 ± 0.21 (3)
200	31.93[c] ± 0.29 (4)	0.63[c] ± 0.03 (6)	19.27[c] ± 0.23 (4)

Figures in parenthesis indicate number of samples analysed
*m. moles/Kg fat
Values in the same columns with different superscripts differ significantly. ($P < 0.05$)

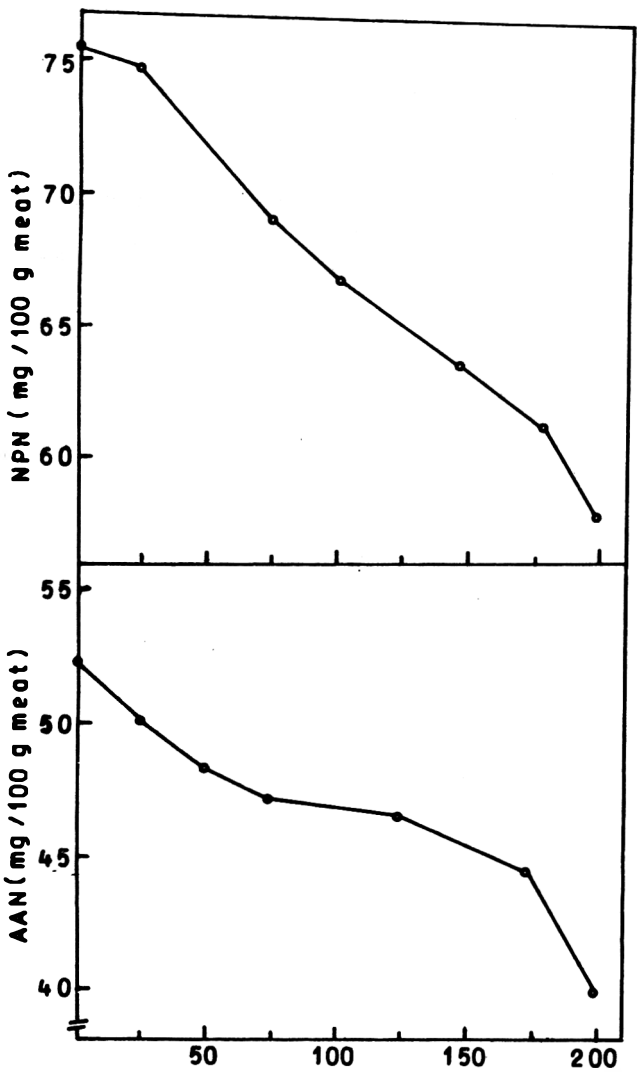

Fig. 1. Changes in AAN and NPN contents of clam meat during frozen storage

crustaceans are known to contain high quantities of free amino acids in their muscle, the AAN accounting for 20-70 per cent of NPN[16]. AAN of clam meat in the present study constitutes 69.4 per cent of NPN. The decrease in amino nitrogen could be attributed to the deamination of amino acids and possible loss through thaw drip.

A significant decrease in organoleptic scores ($P<0.05$) was noticed for all the characteristics judged throughout the period of storage (Table 3). These results confirm previous observations that the sensory acceptability of bivalves held under frozen storage conditions decline steadily[4,14]. Sensory evaluation data for frozen stored clam meat showed a high negative correlation between mean panel scores for overall acceptance and storage period. A linear regression equation $Y = -0.0163 \times +4.1368$, with a correlation coefficient (r) = −0.9907 was obtained. The product was rated fair upto 70 days and acceptable upto 130 days. A comparative evaluation of organoleptic and chemical scores indicated that product which was rated fair during the first 70 days had a TVBN 12.3 mg per cent, PV 3.2 m. moles and TBA less than 0.14 mg of malonaldehyde. However, the product was in acceptable condition during 130 days of storage at −20°C, the corresponding chemical scores being TVBN ≤17.1 mg per cent, PV ≤15.5 and TBA number ≤0.23. Beyond these values, the clam meat was found to be unacceptable. The decrease in AAN paralled the loss in flavour.

The results of the present investigation indicate that clam meat stored under frozen conditions undergo a progressive decline of sensory quality which is clearly associated with storage duration.

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TABLE 3. SENSORY PERFORMANCE OF CLAMS UNDER FROZEN STORAGE*

Storage period (days)	Appearance	Colour	Odour	Taste	Flavour	Texture	Overall acceptance
0	4.0[a]	3.8[a]	4.2[a]	3.8[a]	3.8[a]	4.0[a]	4.1[a]
25	4.0	3.8	3.8	3.8	3.6	3.6	3.6
50	3.8	3.8	3.6	3.4	3.8	3.4	3.4
75	3.6[b]	3.6[b]	3.6[b]	3.2[b]	3.2[b]	3.2[b]	3.0[b]
100	3.6	3.4	3.4	3.0	3.0	3.2	2.7
125	3.2	3.4	3.2	3.0	2.8	2.8	2.0
150	3.2[c]	2.8[c]	2.2[c]	1.4[c]	1.9[c]	1.6[c]	1.6[c]

Figures in the same column with different superscripts differ significantly. (P 0.05)
* values represent the mean of hedonic scores

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Utilization of Sunflower Proteins in Yogurt

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Sunflower proteins were used in yogurt, either by replacing up to 20% of the milk proteins or by their addition in the same proportions. Both physical and sensorial variables were measured. It appeared that sunflower proteins have no gel forming ability in normal conditions, and interact with casein micelles, weakening the casein network and producing a softer gel.

Sunflower is one of the main oileced crops, second in the world as a source of vegetable oil[1] and the fastest developing one[2]. The by-product of the oil extraction, the sunflower meal was given great attention because of it's high protein content[2,2]. The sunflower proteins have unique properties since they are free from any antinutritional or antitryptic factors[4]. Nevertheless, their utilization in human nutrition is limited because of the presence of polyphenolic compounds which develop undesirable colour under alkaline conditions. Chlorogenic acid (CGA), the main polyphenolic compound (up to 3.5 per cent of the meal[5]), is chemically a hydroxy-quinone which, upon oxidization into an o-quinone at pH values over 8, gives coloured complexes. The o-quinone binds irreversibly either with the ϵ-amino group of the lysine or the thiol group of the methionine[6], developing a persistent green or brown colour. This can decrease both extractability and digestibility of the proteins. Different extraction procedures have been in practice, which can yield light coloured protein concentrates or extracts at laboratory scale[7,8,9].

The complete or partial replacement of milk solids with plant proteins has been extensively investigated because of its economical and nutritional interests[10,11,12]. Soy proteins were given the more attention, but other sources of vegetable proteins such as wheat, cottonseed and chickpea were also studied. Several problems in utilizing these proteins were encountered with undesirable flavour and colour and proteins insolubility[13]. In the case of sunflower proteins, milk-like beverages were prepared by blending 50 per cent milk with 50 per cent sunflower milk[13], but no attempt was done to make coagulated products.

The effect of replacing milk proteins by sunflower proteins, or their addition to milk, on both sensory and physico-chemical properties of yogurt is reported in this paper.

Materials and Methods

Sunflower seeds of mixed cultivars for oil extraction were purchased from the American market. Milk (Snow Brand, fat 3.4 per cent, solids-non-fat 8.2 per cent), skim milk (Snow Brand, protein 34.8 per cent, lactose 52.4 per cent) were purchased. A Zorbax ODS 4.6 mm × 25 cm column from Dupont Instruments was used for the analysis of chlorogenic and the ascorbic acids. The colorimeter used was Model TC-1500 from Tokyo Denshoku Co., Ltd., connected to a Sharp PC 7200. Titration was done with a TOA titrator Model TSC-10A connected to a TOA Auto Burette Model TSB-10A. *Streptococcus thermophilus* 10Y and *Lactobacillus bulgaricus* BY were obtained from the National Institute of Animal Industry, Tsukuba, Japan.

Protein extraction: Sunflower seeds were dried at room temperature (25-30°C) for 48 hr, dehulled, ground, then defatted three times with hexane at room temperature. The dried sunflower meal (fat content of 3.6 per cent) was suspended in precooled, nitrogen saturated water containing 5 mM of ascorbate, at a ratio of 1/10 (W/V). The pH was adjusted to 8.3 with 1N NaOH and kept constant, and the solution stirred vigorously for 5 min, then centrifuged to 12,000 g for 25 min. The pH of the supernatant was adjusted to 4.5 with 1N HCl, while the decantate was resuspended at pH 9.3

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and processed as above. After decantation, the precipitates were solubilized at pH 7, then freeze-dried. Both precipitates were used together after mixing. The freeze-dried product has been termed as sunflower protein extract (SFPE).

Although the SFPE obtained with this procedure is mainly composed of water soluble proteins, it also contains salt soluble proteins because of the ionic strength due to the components of the sunflower meal. Theerta Prasad[1] identified the total extractable sunflower proteins in defatted sunflower meals as follows: globulins 50.8 per cent, albumins 31.2 per cent, glutelins 11.4 per cent and prolamines 6.5 per cent. The major component of the SFPE appears to be the albuminic fraction of the sunflower meal.

Yogurt making: Three different types of yogurt were made to study the influence of sunflower proteins (SFP) on the quality of yogurt. First type had a total protein content of 4 per cent, with substitution levels of 0, 5, 10, 15 and 20 per cent with SFP. The second type had a total protein content of 5 per cent, with the same levels of substitution while the last type had a fixed milk protein content of 4 per cent, to which 0, 5, 10, 15 and 20 per cent SFP were added. Skim milk was used to get the required protein contents in the final product. The concentrations of sucrose (4 per cent) and lactose (5.7 per cent) were kept constant. The preheated milk (at 60°C for 10 min) was inoculated with 2 per cent of *Streptococcus thermophilus* 10Y and 2 per cent of *Lactobacillus bulgaricus* BY. After further mixing, the milk was filtered through 2 layers of gauze to remove a small amount of insoluble SFPE particles, then dispensed into cups and incubated at 43°C. When the titratable acidity was between 0.9 and 1.1 per cent of lactic acid, the samples were stored at 4°C.

Chlorogenic acid (CGA) was first extracted with 70 per cent methanol solution[13] with shaking at 55°C for 5 hr, then determined by HPLC[14] by injecting 70 µl sample after filtration on 0.22 µm Millipore filter. The ascorbic acid content was also measured by HPLC[15] with a 1.5 per cent $NH_4H_2PO_4$ solution as the mobile phase. The syneresis of yogurt was determined by draining 100ml yogurt sample at 4°C on 3 layers of gauze for 3 hours. The gel strength of yogurt was measured at 4°C by Tensipressor Model TTP-50BX (Taketomo Electric Inc., Tokyo) with a 13mm diameter plunger at a byte speed of 120 mm/min on yogurt samples prepared in Petri dishes (diameter: 90mm, height: 20mm). Nitrogen, acidity, fat content and dry matter were measured according to AOAC[16] and a multiplication factor of 5.7 was used to get the protein content. The acidity was measured with an automatic titrator with a final pH value of 8.5. The sensory evaluations were done by 35 panelists in case of substitution with SFP, 40 panelists in case of addition of SFP. The tested yogurts were made the day before the sensory evaluations, and 30-40 ml of each sample were presented in small glass cups at temperature of 8-12°C. The colour, flavour, acidity, smoothness and total acceptance were recorded on a 5 level scale in case of substitution with SFP, and 7 level scale in case of addition of SFP. The data were analyzed by analysis of variance.

An analysis of the principal components was performed in order to compare all variables. A total of 19 variables were used: 5 sensory variables — colour, acidity, flavour, mouthfeel and preference, 5 variables related to the protein content — the SFP content, the SFP to casein ratio, the casein and the total protein content and the ratio of SFP to total proteins. Last 9 variables are — the components "a", "b", and "L" of the colour, the square root of a^2+b^2, the gel strength, the acidity, the pH, the syneresis and the CGA content.

Except for the sensory evaluations, all values were obtained from at least 2 measurements.

Results and Discussion

During protein extraction, ascorbic acid (5 mM) was used as antioxidant to inhibit the development of a persistent greenish brown colour, while in the yogurt, the pH values are low enough to prevent any further colour development caused by the presence of residual CGA. The prepared SFPE has a pale brownish grey colour.

The defatted meal and the SFPE had a protein content of 49.3, and 77 per cent respectively. For the commodity of utilization, a value of 75 per cent was used. The CGA content was 3.16 per cent and 0.27 per cent in the meal and the SFPE respectively. The residual ascorbic acid content in the SFPE was less than 50 ppm..

Quality of yogurt samples: Data shown in the Tables 1 and 2 are for the yogurt with 4 per cent total milk proteins with addition of SFP. Yogurt samples containing SFPE were easily distinguished from controls made with whole milk (Tables 1 and 2). In general, it is observed that the differences between control samples and samples containing SFPE were greater than the differences among samples with SFPE. Marked differences were observed in flavour (Table 1), negligible in mouthfeel (Table 2) and no differences in acidity (not shown). As for the general preference (Table 2), the differences were significant. Similar results were obtained in case of substitution of milk proteins.

The sensory variables: The correlation values between the preference for colour and flavour, as

TABLE 1. MEAN DIFFERENCES FOR COLOUR AND FLAVOUR BETWEEN YOGURT CONTAINING 4 PER CENT OF MILK PROTEIN

	Levels of substitution with sunflower proteins				
	0%	5%	10%	15%	20%
0%	—	0.45*	0.63**	0.70**	0.90**
5%	0.63**	—	0.18	0.25	0.45*
10%	0.68**	0.05	—	0.08	0.28
15%	1.15**	0.53*	0.48*	—	0.20
20%	1.33**	0.70**	0.65**	0.18	—

Above diagonal: colour, below diagonal: flavour.
* and **: significant difference respectively for $P<0.05$ and $P<0.01$. Number of degrees of freedom: 156. For colour d(0.05)=0.367, d(0.01)=0.491, for flavour d(0.05)=0.451, d(0.01)=0.603.

TABLE 2. MEAN DIFFERENCES FOR THE MOUTHFEEL AND THE GENERAL PREFERENCE BETWEEN YOGURT CONTAINING 4 PER CENT OF MILK PROTEIN

	Levels of substitution with sunflower proteins				
	0%	5%	10%	15%	20%
0%	—	0.15	0.38	0.48*	0.80**
5%	0.78**	—	0.23	0.33	0.65**
10%	0.90**	0.13	—	0.10	0.43
15%	1.58**	0.80**	0.68**	—	0.33
20*	1.83**	1.05**	0.93**	0.25	—

Above diagonal: mouthfeel, below diagonal: preference.
* and **: significant difference respectively for $P<0.05$ and $P<0.01$. Number of degrees of freedom: 156. For mouthfeel d(0.05)=0.438, d(0.01)=0.586, for preference d(0.05)=0.492, d(0.01)=0.658.

judged by the panelists were high (0.86 and 0.96 respectively), while the mouthfeel had a low correlation value with the preference (0.48). Both colour and flavour seem to play an important role in the determination of the preference, while the mouthfeel is appreciated in a different way since there is no standard strength of gel for yogurt, some people prefer soft gels while others prefer strong gels.

Because of its undesirable effects, the off-flavour should be regarded as an important limiting factor in the utilization of SFP in yogurt. Heat treatment and drying were used to inactivate off-flavour producing enzymes in soy proteins[17,18]. The mechanism of its apparition in the SFPE should be understood in order to know whether any treatment could improve its quality.

The gel: The presence of SFP tended to weaken the gel (Fig 1) even when the casein content remained constant. It appears as if the SFP interferes with the milk proteins either by interacting with the casein micelles or with the Ca^{++}, in a behaviour similar to the one observed in soy proteins[10]. This makes caseins lose their network structure, giving a softer gel. However, contrarily to soy proteins, lowering the pH and increasing the milk solids concentration do not improve the gel strength of the yogurt. It is also possible to observe that even though the gel lost its strength, no natural off-wheying occurred in any sample.

On the other hand, clotting started very early in all samples containing SFPE, about 20 to 50 min after addition of the SFPE to the milk, even if the pH was above 6. It has been suggested that this early clotting

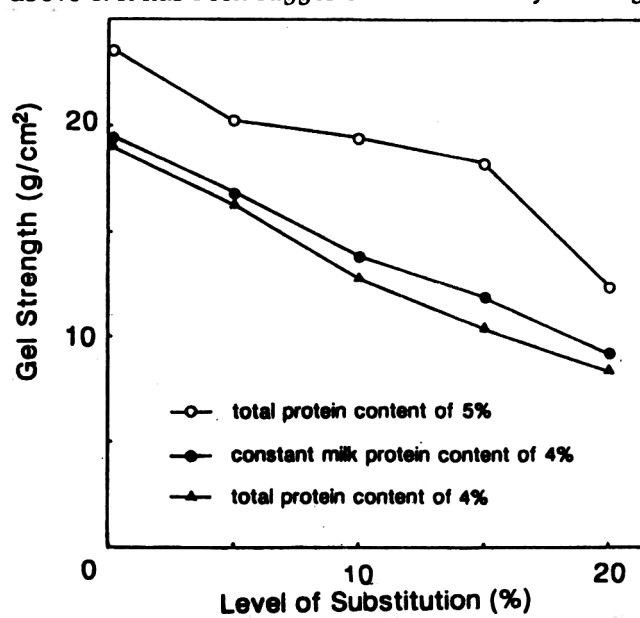

Fig. 1. Decrease of gel strength as function of the level of substitution with SEP.

TABLE 3. CORRELATION VALUES WITH GEL STRENGTH AND TEXTURE AS OBTAINED THROUGH ANALYSIS IN PRINCIPAL COMPONENTS

	SFP (%)	Casein (%)	Total protein (%)	Syneresis (%)	Preference
Gel strength (g/cm^2)	−0.75	0.76	0.24	−0.92	0.72
Mouthfeel (sensory)	−0.18	−0.3	−0.44	0.03	0.48

All percentages are in g product/100 g yogurt.
Degrees of freedom: 13.
$r > 0.5139$ ($P < 0.05$), $r > 0.641$ ($P < 0.01$)

TABLE 4. CORRELATION VALUES WITH DIFFERENT COLOUR VARIABLES AS OBTAINED THROUGH ANALYSIS IN PRINCIPAL COMPONENTS

	Measured values			
	a	L	b	$a^2 + b^2$
Preference	−0.85	0.79	−0.22	0.07
SFP content (%)	0.77	−0.94	0.32	0.06
Colour (sensory)	−0.75	0.86	−0.29	−0.04

Degrees of freedom: 13
$r > 0.5139$ ($P < 0.05$), $r > 0.641$ ($P < 0.01$).

was caused by the proteolytic enzymes present in the SFPE[19].

The lack of gel forming ability of the SFP and the SFP-milk protein interactions appear to be one of the major limiting factors in the utilization of SFPE in yogurt. The maximum possible level of SFP substitution for milk proteins is around 20 per cent when no gel strengthening agent is used. As shown in Table 3, the gel strength is negatively correlated with the SFP content indicating that any increase in the amount of SFP induces a decrease in the strength of the gel.

Colour: The correlation values (Table 4) showed that a and L are the more representatives of the four variables used to represent the colour: a, b, L and square root (a^2+b^2). The yellow component of the colour, b, seems to be negligible because of the yellow colour naturally present in the milk.

It appears to be important to get whiter CGA free of SFPE if they are to be used in human food and an economical method for removing the CGA before the protein extraction seems to be essential.

Acidity and pH: Measured and sensory evaluated acidities and pH didn't show any significant correlation values with any variable, suggesting that they have no significant effect on the texture and the acceptance.

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Some Physico-chemical Characteristics of Defatted Soy Flour Fortified Noodles

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Noodles prepared from the blends of durum semolina and aestivum flour with defatted soy flour exhibited harder texture as compared to those prepared from aestivum semolina-defatted soy flour blend. Higher water soluble nitrogen (WSN) and available lysine contents were observed in noodles prepared from the blends containing defatted soy flour. However, WSN in noodles decreased considerably after cooking whereas lysine content remained almost unaffected. Trypsin inhibitor as well as lipoxygenase activity were higher in uncooked noodles containing defatted soy flour and were inactivated completely after cooking. Similarly, reducing sugars which were higher in the noodles made from aestivum-defatted soy flour blend decreased sharply after cooking.

Pasta products such as macaroni, spaghetti and noodles are very popular in Europe and in the Western hemisphere. However, the consumption of the convenience foods is increasing rapidly with the advancement in the economic condition of the developing countries too. In India, the use of pasta products, particularly noodles is increasing steadily. The technology of preparing noodles permits enrichment of products and with the increasing popularity of noodles among all age groups, these products can serve as a medium for more intake of proteins[1]. Soybean with 40 per cent good quality protein, rich in available lysine, can be used as a source of protein in different forms such as full fat soy flour, protein isolate etc. to supplement the cereal based foods which are deficient in essential amino acid lysine[2]. Authors earlier[3] evaluated cooking as well as sensory properties of soy fortified noodles. Noodles, being one of the future cereal based promising products, were selected to supplement with defatted soy flour.

Materials and Methods

The samples of durum wheat ('PBW 34') and aestivum wheat (UP 2003') were procured from Crop Research Centre of this University and defatted soy flour was obtained from M/S Prag Ice and Oil Mills Ltd., Aligarh. Rice ('Jaya') was purchased from the local market.

Durum as well as aestivum wheats were cleaned manually, conditioned to the moisture content of 16 per cent for 36 hr and milled into semolina and flour in Buhler mill (Model MLU 202). Semolina was sifted through a sieve of 20 mesh to remove bran portion and flour through 60 mesh to obtain uniform mixing.

Raw milled rice was converted into fine flour using Fitz mill.

Semolina of durum as well as aestivum wheats and the flour of aestivum wheat were blended with defatted soy flour in the ratio of 90:10, respectively. Each blend was sieved through a sieve of 40 mesh for uniform mixing.

To prepare noodles, each blend (100g) was mixed with salt (1g), sodium tripolyphosphate (0.25g), rice flour (10g) and water (46 ml) and swirled by mixing for 2 min at 58 rpm and for 1 min at 104 rpm. The dough was rested for 15 min and remixed to obtain a smooth dough. Then the dough was pressed into noodles by using hand press. The noodles were dried at 45°C for 7-8 hr using tray drier and packed in polythene bags until analysed.

Moisture, protein, fat and total ash contents were determined by using AACC methods[4]. Carbohydrate content was calculated by difference.

Water soluble nitrogen and reducing sugars were determined by AACC[4] methods. Available lysine was estimated by Carpenter's method[5]. The modified method of Kakade *et al.*[6] and lipoxygenase activity was determined by thiocyanate method of Sumner[7] as modified by Koch *et al*[8]. AACC method[4] was used for the estimation of pigment content. All the analyses were done in duplicate and the average values have been reported.

Wink's weight equilibrium method as described by

Ranganna[9] was used to determine equilibrium relative humidity. All the samples were evaluated for textural changes at equilibrium moisture content and microbial infection by sensory test and visual observations, respectively.

Results and Discussion

Durum semolina, aestivum semolina, aestivum flour and defatted soy flour showed protein contents of 12.1, 10.3, 10.1 and 56.0 percent, respectively whereas the corresponding values for ash contents were 0.73, 0.42, 0.42 and 6.9 per cent on dry weight basis. The approximate composition of blends changed proportionately with the level of raw ingredients. The values for approximate composition of various raw materials are within the range reported earlier[10-12].

The water soluble nitrogen (WSN) and available lysine content of noodles containing 10 per cent defatted soy flour increased about one and half folds (Table 1). Cooking of noodles resulted in considerable loss of WSN whereas no decrease was observed in available lysine content. This indicated that the decrease in WSN was more due to thermal effect than leaching and the increased extracted solids in supplemented noodles are most of nitrogen free nature as reported earlier by the authors[3]. Molina[13] *et al.* also obtained the same effect of soy flour supplementation and cooking on available lysine content of pasta products.

The trypsin inhibitor activity of noodle containing 10 per cent defatted soy flour was about 4 per cent which is far below the harmless limit of 20 per cent[14]. However, optimum cooking[3] of noodles inactivated trypsin inhibitor as well as lipoxygenase completely (Table 1).

The noodles prepared from aestivum flour showed higher sugar content as compared to those prepared from semolina which may be attributed to more damage of starch in former resulting in higher amylase acitivity during resting of dough. Supplementation with defatted soy flour further increased the content of reducing sugars (Table 2). This may be due to degradation of higher molecules of carbohydrates[10]. However, reducing sugar content decreased sharply upon cooking, (Table 2). The main reason for this decrease may be the leaching of sugars into cooked water.

The pigment content of noodles prepared from durum semolina-defatted soy flour blend was higher

TABLE 1. WATER SOLUBLE NITROGEN (WSN), AVAILABLE LYSINE AND TRYPSIN INHIBITOR ACTIVITY (TIA) OF UNCOOKED AND COOKED (13 min) NOODLES

Noodle type	WSN (%) of total N)		Available lysine (g/100 g protein)		TIA	
	Uncooked	Cooked	Uncooked	Cooked	Uncooked	Cooked
Durum semolina	22	11	2.10	2.25	Nil	Nil
Durum semolina + 10% DSF	29	14	3.43	3.51	4.1	Nil
Aestivum semolina	19	10	1.95	2.10	Nil	Nil
Aestivum semolina + 10% DSF	30	16	3.42	3.60	3.8	Nil
Aestivum flour	17	10	1.90	2.15	Nil	Nil
Aestivum flour + 10% DSF	28	17	3.40	3.60	3.9	Nil

All values are on dry weight basis.
DSF = Defatted soy flour.
TIA expressed on per ml of extract prepared from 1g sample to 50 ml and then 1 ml diluted to 50 ml.

TABLE 2. REDUCING SUGARS AND PIGMENT CONTENT OF UNCOOKED AND COOKED (13 min) SOY FORTIFIED NOODLES

Noodle type	Reducing sugar (mg maltose/100 g)			Pigment content (ppm)	
	Uncooked	Cooked	Loss (%)	Uncooked	Cooked
Durum semolina	198	82	116	1.81	1.30
Durum semolina + 10% DSF	322	106	116	2.00	1.24
Aestivum semolina	195	81	114	1.62	1.00
Aestivum semolina + 10% DSF	334	116	218	1.65	1.10
Aestivum flour	282	95	187	1.42	1.00
Aestivum flour + 10% DSF	385	126	259	1.50	1.11

All values are on dry weight basis
DSF = Defatted soy flour

TABLE 3. EQUILIBRIUM RELATIVE HUMIDITY (ERH)-MOISTURE RELATIONSHIP OF NOODLES PREPARED FROM THE BLEND OF DURUM SEMOLINA AND DEFATTED SOY FLOUR (90:10)

ERH (%)	Equilibrium moisture content (%)	Textural quality
10	6.8	Hard and brittle
20	8.2	Hard and brittle
30	8.5	Hard and brittle
40	9.0	Hard and brittle
50	10.3	Slightly soft and brittle
60	10.5	Slightly soft and brittle
70	10.7	Soft and slightly sticky
80	13.2	Soft and sticky
90	19.1	Soft and sticky

as compared to others (Table 2) because the former contains more pigments. The cooking of noodles reduced the pigment content of the products due to leaching into cooked water.

The noodles containing defatted soy flour exhibited a typical sigmoid sorption isotherm, characteristic of farinaceous material. The equilibrium moisture content of the product was greatly monitored by ERH (Table 3). However, the change in equilibrium moisture content was not so conspicuous upto 70 per cent ERH. But later on, it increased rapidly. From the sensory test, it was observed that noodles lost their textural properties above 40 per cent ERH corresponding to 9 per cent equilibrium moisture content.

The product was susceptible to microbial growth at 90 per cent ERH and also became soft and sticky due to rapid increase in moisture content. The water activity of the product was 0.4 corresponding to an equilibrium moisture content of 9 per cent.

From the results of this study, it can be concluded that an equally acceptable[3] noodle of better nutritional value can be manufactured by supplementing durum semolina/aestivum flour with 10 per cent defatted soy flour and can be stored at room temperature (30± 2°C) under 40 per cent RH without affecting the qualities.

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A Study of Some Factors Affecting the Hydraulic Pressing of Palm Kernel

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Hydraulic pressing of palm kernel was done in a perforated mould with a plunger at a pressure of 25MPa. Optimum processing conditions were determined by response surface analysis. The factors investigated were roasting temperature, time and sample weight. An optimum oil yield of 31.3% was obtained when 95.8g of milled palm kernel cake was roasted at 88.3°C for 9.8 min and expressed at 25MPa. This yield corresponds to an expression efficiency of 64%. Models were developed relating the oil yield at the optimum processing condition to applied pressure and pressing time.

Vegetable oils are important agricultural products and one of the most abundant sources of vegetable oil in West Africa is the palm fruit. The palm fruit is made up of a fleshy outer layer called the mesocarp and a hard core called the nut. The nut comprises the endocarp (shell) which encloses the endosperm (kernel). Two types of oil are obtainable from the palm fruit, mesocarp oil (palm oil) and endocarp oil (palm kernel oil). Palm oil is used for the preparation of soup and margarine in many countries. It is also used in the manufacture of soaps and cosmetics. Palm kernel oil is similar to coconut oil and is used in the manufacture of soaps, toiletries, surface active ingredients (the active constituents of detergents and cleaners), bakery coatings, whipped creams and sugar confectionery. The meal obtained after oil extraction from the kernel is also valuable as animal feed.

Palm kernel is obtained as a by-product after the expression of the palm oil from oil palm fruits. The kernel contains about 47-49 per cent oil which can be obtained by mechanical expression, solvent extraction and a combination of expression and extraction. Mechanical expression can be achieved either by the use of screw or hydraullic pressess. However, in Nigeria hydraulic presses are more commonly used in small scale industries.

The yield of mechanically expressed oil is known to be dependent on pre-pressing factors such as seed moisture content, particle size, pre-heat temperature, hold-period at this temperature, cake thickness and applied pre-pressure[1-5]. Sivakumaran *et al*[6]. used response surface methodology to show that the conditions for maximum oil expression from peanut in the screw press are pre-heat temperature 95.6°C, moisture content 5.4 per cent and pre-heat time 27.4 min. No published reports appear to be available describing the effect of different processing factors on the oil yield from palm kernel expressed by hydraulic pressing. Some researchers have developed models relating oil yield to some of these processing factors[5,7].

The objective of this investigation was to obtain the processing conditions that maximize the oil yield from palm kernel in an hydraulic press. The factors studied were pre-heat temperature, period of pre-heating and the quantity of material in the press. The effect of applied pressure on the yield and rate of expression were also studied.

Materials and Methods

The palm kernel used in this study was purchased from a local farmer and milled in a plate mill. Sieve analysis was performed as described in ASAE[8] using silica as a dispersion agent. The milled cake had a geometric mean diameter of 1.73 mm and a standard deviation of 1.26. The moisture content of the milled cake was obtained by oven-drying method at 130°C for 6 hr.

Expression was carried out in an expression cell which consists of an 8 cm long cylindrical mould made from 4cm diameter aluminium pipes and a 5 mm thick base plate. Holes (3.0 mm in diameter) were drilled on the base plate to allow for oil drainage during expression. Wire gauze wrapped with clean cheese

cloth was fitted into the cylindrical mould over the perforated base plate to make sure that cake and fines are not expressed with oil. A 2.54 cm plunger 10 cm in length made from iron rod was attached to a 3.6 m long bar. The bar was hinged at one end with the plunger at a distance of one eighth of its effective length from the pivot. Loads are attached at the free end of the bar such that the desired expression pressures are obtained in the expression cells through the plunger.

Measured amounts of milled palm kernel cake were roasted in a covered pan placed in a pre-set Gallenkamp OV 440 oven for a pre-determined length of time. The roasted cake was then wrapped in a fine cheese cloth in order to prevent material seepage with oil during expression. The wrapped cake was placed in the expression cell and pressed at 25MPa (Mega Pascal). The amount of oil expressed was determined by evaluating the difference in weight before and after pressing and expressing the difference as percentage of initial weight of the cake.

Preliminary experiments were performed to obtain the levels of the factors to be used in the first factorial design. From the results obtained, it was decided that the first factorial design should be performed at roasting temperatures of 60 and 100°C, roasting times of 5 and 15 min., using sample weights of 60 and 100 g.

Additionally, three runs were performed at the midpoints of the design (90°C, 10 min, 80g) in order to estimate experimental error and to detect possible curvature of the surface.

From the results of these experimental runs, additional experiments were designed to augment the first design to form a central composite rotatable design. This was done by varying the levels of the factors by +1.68 and −1.68 of design points from the midpoints with an additional three midpoints. This plan is recommended by Cockran and Cox[9]. The response surface was determined by the SAS software package RSREG[10]. The SAS software was also used to plot two - dimensional oil yield contours of the response surface and optimum processing conditions were established.

Oil was expressed from milled kernel processed at the optimum conditions obtained using different pressure levels (5, 10, 15, 20, 25 MPa) to study their effect on the yield. The expressed oil was collected in a measuring cylinder and its volume noted every minute until there was no further expression. The experiment was repeated twice.

Results and Discussion

The results of the first factorial design are presented in Table 1. The results show that at the 0.05 level none of the factors or interactions were significant but at 0.10 level the interactions roasting temperature/time, and roasting time/sample weight were significant. All the co-efficients of the planar model were found to be small indicating that the surface is a plateau. In such cases, Cockram and Cox[9] recommend that for further exploration of the surface, a 2nd order design should be constructed by addition of points to the 2^3 factorial design to make a central composite rotatable design as shown in Table 2. This design provides a measure of the lack of fit of the quadratic surface and an estimate of the experimental error variance.

The equation of the response surface was found to be given by:

$$y = -4.830 + 0.306X_1 = 2.212X_2 + 0.245X10_3 - 0.001X^2_1 - 0.014X_1X_2 - 0.014X^2_2 + 0.0002X_1X_3 - 0.007X_2X_3 - 0.001X^2_3 \ldots \ldots (1)$$

TABLE 1. RESULTS OF FIRST EXPERIMENTAL DESIG..

Expt No	Roasting temp. (°C)	Roasting time (min)	Sample wt. (g)	Yield** (%)	Analysis Factors	Analysis Effects
1	80	5	60	28.3	Mean	30.6
2	100	5	60	30.0	Temp. T	0.18
3	80	15	60	31.7	Time, t	−0.03
4	100	15	60	30.0	Tt	−1.68*
5	80	5	100	31.0	Wt, w	1.18
6	100	5	100	32.0	Tw	0.18
7	80	16	100	31.0	tw	−1.68
8	100	10	80	29.7	Ttw	0.03
9	90	10	80	32.5		
10	90	10	80	31.2		
11	90	10	80	30.0		

*Significant at 0.10 level

**Mean of two replicates

TABLE 2. RESULTS OF THE SECOND SET OF EXPERIMENTAL RUNS

Expt No.	Roasting temp. (°C)	Roasting time (min)	Sample wt. (g)	Yield* (%)
1	90	10	80	31.5
2	90	10	80	30.0
3	90	10	80	31.3
4	73	10	80	30.6
5	107	10	80	30.6
6	90	1.5	80	28.5
7	90	18.5	80	31.3
8	90	10	46.5	29.4
9	90	10	113.5	30.8

*Mean of two replicates.

where,

y = oil yield, %
X_1 = roasting temp °C
X_2 = roasting time, min
X_3 = sample wt, g.

The r^2 or 0.72 obtained is low but the equation gives a root mean square error of 0.82. Table 3 shows that the r^2 was accounted by 0.34, 0.13 and 0.24 from the cross product, quadratic and linear terms respectively and that the lack of fit test shows that the lack of fit mean square is less than the mean square for pure error. The lack of fit is not significant at 0.10 level indicating that the quadratic surface is quite adequate in representing the response surface.

The solution for optimum response occurs when the sample weight of 95.8 g was roasted at 88.3°C for 9.8 min. This optimum was found to be a saddle point because of the relatively flat nature of the surface. The yield at this optimum was 31.3 g (oil content in kernel is 49 per cent) which corresponds to an oil expression efficiency of 64 per cent. Figures 1, 2 and 3 show the two-dimensional contours of the response surface. The figures show the variation in yield as the factors considered are varied from the point of optimum response. Each plot shows the effect of two factors whilst the third is kept at its optimum point and each contour on the plots corresponds to a specific oil yield. The contours in Fig. 1 indicate that as roasting temperature is increased the roasting time has to be reduced to maintain the oil yield. At lower roasting temperatures, an increase in roasting time leads to an increase in oil yield. At roasting temperatures beyond 95°C, increase in roasting temperatures beyond not significantly change the yield but beyond 10 min. the yield is decreased. The contours in Fig. 2 do not show any interaction between roasting time and sample weight. Increasing sample weight up to 95 g increased the oil yield. Further increase in sample weight decreased oil yield. Contours in Fig. 3 show

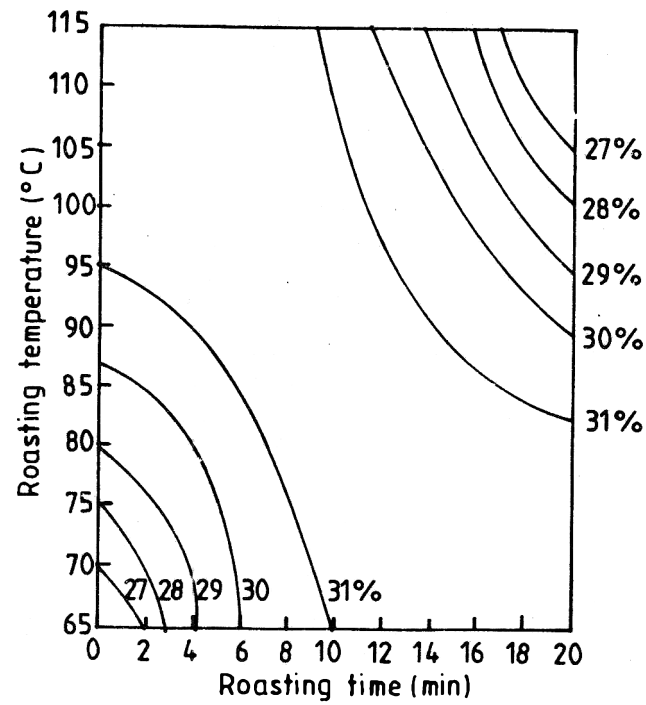

Fig. 1. Oil yield contours showing the effect of roasting temperature and roasting time (sample wt. is constant).

TABLE 3. ANALYSIS OF THE QUADRATIC MODEL

Source	Degrees of freedom	Sum of squares	Mean square	r-square	F ratio	Probability
Regression						
Linear	3	5.74	—	0.24	2.86	0.09
Quadratic	3	3.01	—	0.13	1.50	0.27
Cross product	3	8.13	—	0.34	4.05	0.04
Total regression	9	16.89	—	0.72	2.80	0.06
Residual						
Lack of fit	5	2.11	0.42	—	0.46	0.79
Pure error	5	4.59	0.92	—	—	—
Total error	10	6.70	0.67	—	—	—

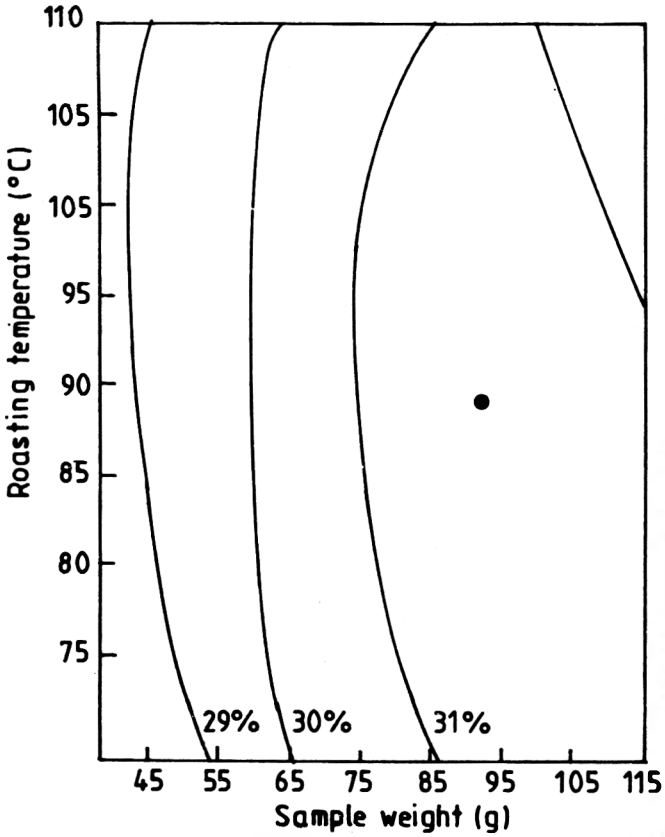

Fig. 2. Oil yield contours showing the effect of roasting temperature and sample weight (roasting time is constant).

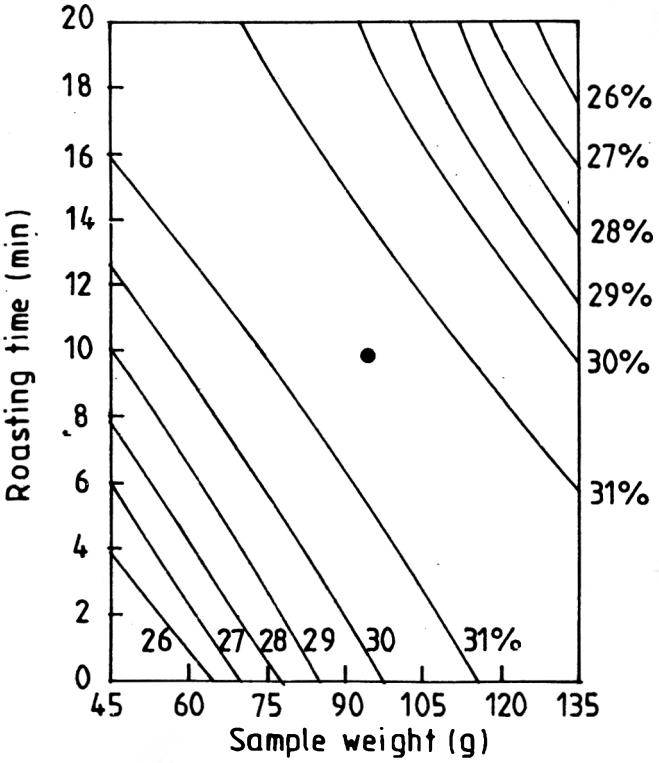

Fig. 3. Oil yield contours showing the effect of roasting time and sample weight (roasting temp. is constant).

significant interaction between roasting time and samples weight. In general, as the roasting time is increased the sample weight has to be decreased to maintain the oil yield.

Fig. 4 shows the effect of applied pressure on oil yield from palm kernel processed at the conditions of optimum response. It was observed that straight line model of the form:

$$y = aP + b \quad ..(2)$$

where, y = oil yield, %
p = applied pressure, MPa
a,b = constants of the model.

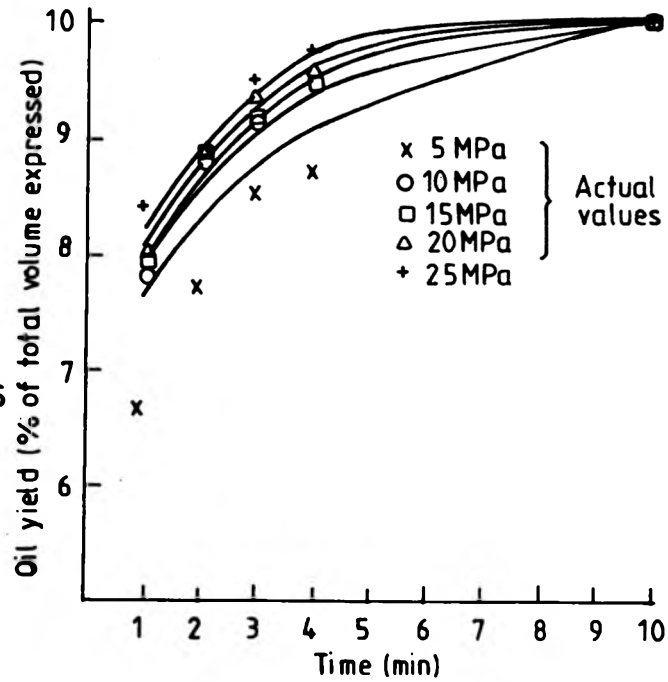

Fig. 4. Effect of applied pressure on oil yield at the condition of optimum oil yield.

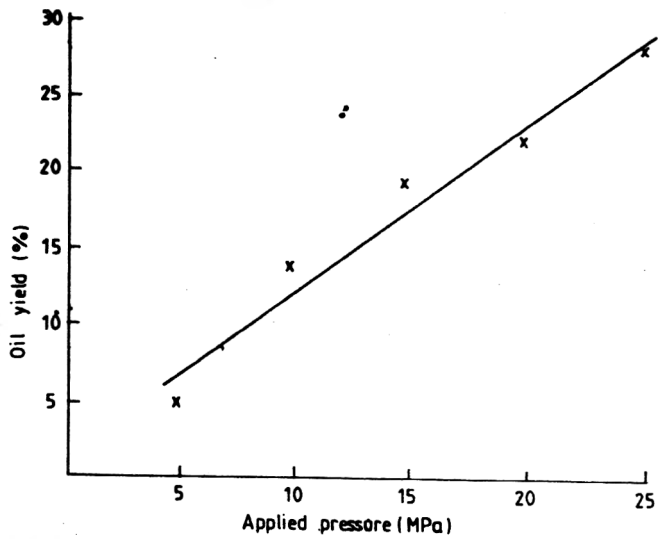

Fig. 5. Effect of applied pressure on the rate of oil removal.

gave a good fit on the data. Least square estimates of the constants are a = 1.08, b = 1.4, and the correlation coefficient is 0.98.

Originally, it is expected that as applied pressure is increased an increase in oil yield is obtained, However Bangirwar *et al.*[11] and Pomiski *et al*[12]. observed that beyond a point, any increase in the applied pressure only decreased the oil yield. The results shown in Fig. 4 indicate that higher pressures than MPa will be required before an increase in applied pressure will lead to a decrease in yield. This is believed to be due to the fact that palm kernel is a hard oilseed thus requiring high pressures for oil expression. Fig. 5 shows plots of oil removed against duration of expression. It was observed that for the conditions considered no further expression of oil took place after 10 min. of pressing. The higher the applied pressure the higher the rate at which oil was expressed. Emperical models were fit to the data and the one that gave the best result is given by:

$$y_v = aP^bt^c \quad .. (3)$$

where,

y_v = oil yield, percent of total volume expressed

t = duration of expression, min.

p = applied pressure, MPa

a,b,c, = model constants

Genstat optimization[13] was used to obtain least square estimates of the model constants and standard error of predicted values. The least square estimates are a = 0.715, b = 0.042, c = 0.127 and standard error of estimate is 0.01.

It is concluded that an optimum oil yield was obtained for hydraulic pressing of palm kernel when 95.8g of the milled kernel was roasted at 88.3°C for 9.8 min. At this point, the oil yield was 31.3 per cent which corresponds to an expression efficiency of 64 per cent. Models have been developed to relate yield at this point to the applied pressure and the time of pressing. The results provide basis for further work in optimizing the conditions for hydraulic pressing of palm kernel.

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Studies on Fruit Softening Enzymes and Polyphenol Oxidase Activity in Ripening Mango (*Mangifera indica* L.) Fruit

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Fruits of 7 mango, cultivars viz., 'Alphonso', 'Banganapalli', 'Dasheri', 'Fazli', 'Langra', 'Suvarnarekha' and Totapuri were analysed at four ripening stages for softening enzymes, polyphenol oxidase and physico-chemical parameters associated with ripening. The decrease in fruit firmness, alcohol insoluble solids, tannins and increase in pulp colour were the general physico-chemical features accompanying the ripening of mango fruit. The activities of key softening enzymes viz., pectinesterase, polygalacturonase and cellulase, in general, increased from harvest maturity to colour break stage. Polyphenol oxidase activity in ripening mango marginally increased from harvest maturity to ½ ripe stage followed by a decline in 'Banganapalli', 'Dasheri', 'Fazli' and 'Langra' and declined from harvest maturity till eating ripe stage in Alphonso', Suvarnarekha' and Totapuri'.

Apart from changes in respiration, aroma profile and other biochemical constitutents, softening is considered as most important change taking place during fruit ripening. Softening occurs in fleshy fruits after the mature stage and the peak of ripeness is generally associated with a fairly narrow range of firmness. This change is brought about by the co-ordinated action of hydrolytic enzymes on pectins and other carbohydrates. A few reports are published on softening enzymes activity during mango fruit ripening. Physiological maturity in tree ripened mango fruit was reported to be associated with drop in pectine sterase (PE) activity[1]. Mango peel was reported to have high PE activity than pulp[2]. The loss of firmness in ripening 'Keitt' mango was reported to be correlated with marked increase in cellulase activity[3]. The present study is concerned with changes in the activities of PE (EC 3.1.1.11) which splits the methyl ester of polygalacturonic acid, polygalacturonase (PG) (EC 3.2 1.15) which catalyses the hydrolytic cleavage of glycosidic linkages in pectic substances and cellulase (EC 3.2.1.4) which hydrolyse, β-1:4 glycosidic linkages between anhydroglucose units in cellulose in relation to softening in ripening mango cultivars. Polyphenol oxidase (PPO) (EC 1.10.3.1) which catalyses the oxidation of monophenols and p-diphenols was also studied.

Materials and Methods

Fruit samples: Mango fruits of 7 cultivars 'Alphonso', 'Banganapalli', 'Dasheri', 'Fazli', 'Langra', 'Suvarnarekha' and 'Totapuri' were collected from trees grown at the experimental orchard, Hessaraghatta. Fruits collected at harvest maturity stage were kept at ambient temperature (25 ± 2°C) and at 70 ± 5 per cent relative humidity (RH) for ripening. Each cultivar was analysed at four ripening stages viz., at harvest maturity (0 days), ½ ripe (pulp colour turning, 2 days after harvest) stage, ¾ ripe (pulp colour fully yellow but not ripe 4 days after harvest) stage and eating ripe (6 to 8 days after harvest depending on the Cv.) stage. Each sample consisted of 10 fruits of same maturity stage. There were 2 independent samples for each maturity stage.

Fruit firmness was measured using fruit pressure tester model PT 327. For estimating pulp colour, weighed quantity of pulp was extracted thoroughly with ethanol : petroleum ether 60-80°C (1:1 ratio) mixture. The composited extract after removing the water and dried over anyhydrous sodium sulphate was used for absorbance measurements at 448 nm. Fruit pulp was extracted with 80 per cent ethanol in a Soxhlet extractor. The alcohol insoluble solids (AIS) were dried and weighed after removing alcohol. Tannins in water extract were estimated using Foline Dennis reagent[4].

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Enzyme assays: Edible pulp after the removal of peel and stone was composited and a sample size of 1 kg pulp was used for acetone powder preparation. Acetone powder was prepared by homogenising fruit pulp with five volumes of chilled acetone, filtered through a Buchner funnel and washed with excess chilled acetone. The residue was spread on filter paper to remove traces of acetone and stored in sealed polythene covers below 0°C. Enzyme activity was measured in extracts prepared from acetone powder.

Pectinesterase: Five hundred mg of acetone powder preparation of mango pulp was suspended in 10 ml 8.8 per cent NaCl and kept overnight at 0 to 4°C. It was homogenised, squeezed through four layers of muslin cloth and centrifuged at 20,000 × g for 10 min. at 0 to 4°C. The supernatant after adjusting the pH to 7.5 with dilute NaOH was used as crude enzyme extract. The assay mixture consisted of 2 ml 0.5 per cent citrus pectin, 0.15 ml 0.01 per cent Bromothymol Blue and 0.85 ml water. (Pectin solution, indicator dye and water were adjusted to pH 7.5 with dil. NaOH before use). Initial absorbance at 625 nm was determined against water blank at 25°C. The reaction was started by adding 0.5 ml enzyme extract and the absorbance change monitored spectrophotometrically. The assay was calibrated using galacturonic acid[5]. Enzyme activity was expressed as μg of acid produced/min/mg protein.

Polygalacturonase: Five hundred mg of acetone powder was suspended in 10 ml 1.2 M NaCl, pH 6.5 and kept overnight at 0 to 4°C. It was homogenised, squeezed through four layers of muslin cloth and centrifuged at 14,000 × g for 20 at 0 to 4°C. The supernatant was used as crude enzyme extract. The assay mixture consisted of 0.5 ml 0.5 per cent of polygalacturonic acid pH adjusted to 4.5, 1.5 ml 0.2 M NaCl and 1.0 ml enzyme extract. The reducing groups formed after incubation at 37°C for 90 min were estimated[6]. Blanks were run in duplicate with boiled enzyme. PG 1 activity was measured by estimating the residual activity after heating the enzyme extract for 5 min at 65°C. PG 2 was calculated as the difference between total PG and PG 1 activities. Enzyme activity was expressed as mg of glucose equivalent released/hr/mg protein.

Cellulase: Five hundred mg of acetone powder was suspended in 10 ml 0.05 M phosphate buffer pH 7.0 and kept overnight at 0 to 4°C. It was homogenized, squeezed through four layers of muslin cloth and centrifuged at 3500 × g for 10 minutes at 0 to 4°C. The supernatant was used as crude enzyme extract. The assay mixture consisted of 2 ml 0.05 M phosphate buffer pH 7.0, 2 ml 0.05 per cent carboxymethyl cellulose and 1 ml enzyme extract. The reducing sugar content after incubation at 37°C for 2 hr was determined Enzyme activity was expressed as mg of glucose equivalent released/hr/mg/protein.

Polyphenol oxidase: Five hundred mg of acetone powder was suspended in 10 ml 0.05 M phosphate buffer pH 6.8 and kept overnight at 0 to 4°C. It was homogenised, squeezed through four layers of muslin cloth and centrifuged at 14,000 × g for 10 min at 0 to 4°C. The supernatant was used as crude enzyme extract. The assay mixture consisted of 3.4 ml 0.05 M citrate phosphate buffer pH 6.8, 0.1 ml 1.25 per cent phyrogallol and 1 ml enzyme extract. The optical absorbance increased at 450 nm was measured[8]. Enzyme activity was expressed as optical absorbance change at 450 nm/min/mg protein.

Protein: Protein in enzyme extract was measured by the method of Lowry *et al*[9] using bovine serum albumin as standard.

Results and Discussion

The data on changes in fruit firmness, pulp colour and alcohol insoluble solids at four ripening stages of seven mango cultivars (Cvs.) are given in Table 1. Softening as indicated by fruit firmness measurements decreased considerably during mango fruit ripening. Softening starting at ½ ripe, increased by ¾ ripe stage attaining the maximum value at eating ripe stage. These changes are due to PG and PE enzymes[10] in addition to cellulase[11,12]. Visible changes in pulp colour occurred from harvest maturity to ½ ripe stage and maximum colour development coincided with eating ripe stage. AIS decreased considerably during the ripening process in all 7 mango Cvs. This decrease reflected the conversion of pectic substances to alcohol soluble compounds and starch to soluble sugars. Such decrease in AIS during ripening was reported for 'Keitt' mango[3] and papaya[10].

PE activity in ripening mango cultivars showed three distinct patterns (Table 2). In cultivars 'Alphonso' and 'Totapuri', the activities increased gradually from harvest maturity to ¾ ripe stage and declined. 'Dasheri', 'Fazli', 'Langra' and 'Suvarnarekah' recorded increased activity levels from harvest maturity to ½ ripe stage, declined a little in ¾ ripe stage and declined considerably in ripe fruits. In 'Banganapalli' cultivar activity declined more or less steadily from harvest to ripe stage. However, the decline in activity was sharp from ¾ to eating ripe stage. A number of studies have shown that PE activity increased during the ripening period. Increase in PE activity coinciding with softening was reported for papaya cultivar Coorg

TABLE 1. CANGES IN PHYSICO-CHEMICAL PARAMETERS OF RIPENING MANGO FRUIT

Cultivar	Ripeness stage	Fruit firmness (Kg/cm^2)	Pulp colour (OD at 448 nm)	Alchohol insoluble solids (%)	Tannins (mg %)
Aphonso	1	9.2	0.097	8.16	11.38
	2	7.8	0.301	7.84	8.64
	3	7.0	1.097	4.69	7.34
	4	4.3	1.301	2.95	6.56
Banganapalli	1	11.0	0.061	9.12	6.74
	2	9.0	0.810	9.00	5.56
	3	6.3	0.970	4.60	5.76
	4	5.5	1.050	2.74	5.20
Dasheri	1	>12.0	0.174	10.72	9.70
	2	6.0	0.495	7.24	9.51
	3	4.1	0.523	4.75	5.00
	4	3.2	0.585	4.39	4.82
Fazli	1	8.5	0.155	4.75	10.75
	2	6.1	0.395	3.60	9.33
	3	3.4	0.721	2.84	8.40
	4	2.8	1.017	2.30	8.05
Langra	1	>12.0	0.187	11.05	8.81
	2	12.0	0.552	5.73	7.53
	3	11.2	1.046	5.64	8.80
	4	10.5	1.048	4.69	6.90
Suvarnarekha	1	9.5	0.041	8.17	7.96
	2	6.0	0.300	8.50	6.94
	3	5.5	1.020	4.40	5.65
	4	4.3	1.200	1.90	5.04
Totapuri	1	11.0	0.020	7.51	7.45
	2	8.9	0.146	6.50	6.80
	3	6.7	0.817	2.64	6.25
	4	4.0	0.850	2.25	5.84

1. Harvest maturity. 2. ½ ripe (pulp colour turning stage). 3. ¾ ripe (pulp colour fully yellow but not ripe). 4. Eating ripe. Values are the average of 2 independent determinations.

Honey Dew'[13], grape cultivar, 'Bangalore Blue'[14], five guava cultivars and two hybrids[15] and Sapota cultivars 'Cricket Ball' and 'Oblong'[7].

PG activity in 'Banganapalli' and 'Fazli' cultivars decreased from harvest to ripe and/or ¾ ripe stage (Table 2). However, in cultivars 'Alphonso', 'Dasheri', Langra', 'Suvaranarekha' and 'Totapuri', the activities increased from harvest to ½ ripe stage. Thereafter, activity declined a little in ¾ ripe stage and declined markedly in eating ripe fruits. Two iso-enzymes of PG namely PG1 and PG2 were assayed and PG1 activity formed 40 to 70 per cent of total PG activity in 'Alphonso', 30 to 80 per cent in 'Banganapalli', 30 to 90 per cent in 'Dasheri', 50 to 90 per cent in 'Fazli', 60 to 70 per cent in 'Langra' and 'Suvarnarekha' and 60 to 80 per cent in 'Totapuri' at four ripening stages. In a number of climacteric fruits, whose texture alters considerably during ripening, maximum loss of firmness was reported to coincide with rapid synthesis of PG[6]. In freshly harvested green, half ripe and full ripe papaya, PG activity was reported to be increased with ripeness[10]. In apple PG, activity reached maximum level after climacteric peak in respiration[16]. However, in Guava, it is reported that PG activity was not marked until full ripeness and increased thereafter[17].

Cellulase activity in 'Alphonso', 'Dasheri', 'Fazli', 'Suvarnarekha' and 'Totapuri' increased from harvest maturity to ½ ripe stage and decreased in ¾ and eating ripe stages (Table 2). Whereas in 'Banganapalli' and 'Langra', activities registered increasing patterns upto ¾ ripe stage and declined in ripe fruits. Cellulase was

TABLE 2. SOFTENING ENZYMES AND POLYPHENOL OXIDASE ACTIVITY IN RIPENING MANGO FRUIT

Cultivar	Ripeness stage	Pectin-esterase[a]	Polygalact-uronase[b]	Cellulase[c]	Polyphenol oxidase[d]
Alphonso	1	0.239	0.0125	0.144	0.070
	2	0.273	0.0139	0.378	0.058
	3	0.281	0.0075	0.114	0.027
	4	0.222	0.0068	0.126	0.017
Banganapalli	1	0.223	0.0132	0.096	0.114
	2	0.181	0.0065	0.168	0.125
	3	0.175	0.0053	0.234	0.074
	4	0.057	0.0022	0.132	0.055
Dasheri	1	0.265	0.0149	0.162	0.101
	2	0.403	0.0151	0.294	0.103
	3	0.310	0.0072	0.174	0.093
	4	0.172	0.0017	0.072	0.054
Fazli	1	0.132	0.0164	0.192	0.087
	2	0.230	0.0155	0.330	0.110
	3	0.047	0.0047	0.066	0.078
	4	0.030	0.0076	0.054	0.036
Langra	1	0.145	0.0051	0.120	0.058
	2	0.377	0.0060	0.144	0.062
	3	0.331	0.0055	0.180	0.038
	4	0.194	0.0027	0.060	0.031
Suvarnarekha	1	0.113	0.0333	0.186	0.084
	2	0.163	0.0507	0.296	0.074
	3	0.087	0.0082	0.078	0.034
	4	0.031	0.0051	0.058	0.015
Totapuri	1	0.155	0.0048	0.090	0.059
	2	0.216	0.0081	0.156	0.047
	3	0.241	0.0038	0.132	0.034
	4	0.110	0.0015	0.078	0.013

a) μg of acid produced/min/mg protein b) and c) mg of glucose equivalent released/h/mg protein. d) absorbance increase at 450 nm/min/mg protein.
Values are the average of 2 independent determinations

reported to play a minor role in softening of tomato[18], peaches[19] and pears[20], but appeared crucial for avocado fruit[21] ripening. In detached avocado, cellulase activity was directly correlated with ripening process such as climacteric rise in respiration, ethylene evolution and softening[22]. Earlier studies in ripening sapodilla[7] cultivars 'Cricket Ball' and 'Oblong' showed very little change in cellulase activity while ripening contrary to papaya cultivar 'Coorg Honey Dew'[13] where the activity declined a little from harvest maturity to climacteric peak in respiration and then increased till ripe stage.

Very little tannin was noticed in mango fruit pulp and the concentration decreased considerably during ripening (Table 1). PPO activity increased marginally from harvest maturity to ½ ripe stage and then declined till eating ripe stage in 'Banganapalli', 'Dasheri', 'Fazli' and 'Langra'. However, 'Alphonso', 'Suvarnarekha' and 'Totapuri', the activities decreased from harvest maturity to ripe stage (Table 2). The published data on mango indicate a peak of activity 66 days after fruitset in fruit pulp, followed by a drop while in peel activity drop steadily from 12 days after fruitset. Very little or no activity was detectable in ripe mango pulp and peel tissues[23].

The study on the activity of enzymes involved in fruit softening and polyphenol oxidase during ripening revealed that considerable variability in activity level existed among the seven mango cultivars. This could probably be explained by the fact that unlike most other fruits, each cultivar of mango when ripe has distinguishing characteristics in terms of texture, colour

and flavour. It also appears from the study that in mango, all the three enzymes viz., PE, PG and cellulase are related to softening. In a similar study in Avocado[21], it was reported that PE and cellulase rather than PG was linked with climacteric rise and softening. However, in tomato[24], PG rather than PE and cellulase was reported to be linked with climacteric and softening during ripening.

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INSTRUMENTAL TEXTURE PROFILE ANALYSIS OF SOYBEAN CURDS PREPARED BY ACID AND SALT COAGULATION

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Texture profile of soybean curd prepared by acid and salt coagulation was determined on Instron-6021 machine. The coagulants used were acetic acid, citric acid, calcium sulphate and magnesium sulfate. Acid coagulated soybean curds exhibited greater hardness, springiness, gumminess and chewiness as compared to the salt coagulated curds. The cohesiveness of different curds was practically the same.

Texture profile analysiws (TPA) is commonly used as of soybean curd, is influenced by processing conditions[1-3], coagulant[2,4], and the chemical compositior. of soybean[1,5]. The hardness of the curd increases with the duration of heating[3] and has been attributed to sulphydral groups[1]. Curds prepared by the chlorides of calcium and magnesium have greater hardness and brittleness than the curds prepared by the sulphates of the same[2]. The calcium sulphate coagulated curds exhibit smooth and elastic texture unlike the curds prepared from other coagulants[4]. The varietal differences also influence the hardness of soybean curd[5].

Texture profile analysis (TPA) has commonly used as an objective method of food texture determination[6-9]. TPA yields many textural parameters for the product including hardness, cohesiveness, springiness, gumminess and chewiness. A number of researchers[7,8,9] have attempted to correlate the TPA parameters with sensory evaluation with varying degrees of success. In the present investigation, the influence of acid and salt coagulation on the texture of soybean curd was studied using texture profile analysis.

Dry mature soybean (var: 'Bragg') was obtained from the Plant Breeding Department of the University. The beans were cleaned, soaked for 16-18 hr in tap water in 1:3 w/v ratio, wet ground for 3-5 min in 1:9 bean water ratio, and filtered to yield soymilk. The soymilk was boiled for 10 min, coagulated at a temperature of 75-80°C and cooled. Whey was removed by filtering the content through a double layered cheese cloth. The curd was pressed in a wooden box (3"×3"×4.5") at a pressure of about 1.22 psi for 1 hr. The product was removed from the box and the free moisture adhering to it was wiped off.

Coagulants: Reagent-grade calcium sulphate, magnesium sulphate, acetic acid and citric acid were used as coagulants. Preliminary investigations showed that an addition of 0.4 g of calcium sulphate or magnesium sulphate, or 1.26 ml acetic acid or 1.44 ml citric acid (10 per cent solutions) were sufficient to completely coagulate 100 ml of soybean milk. Hence these quantities of coagulants were used in this study.

Texture profile analysis: Cylindrical samples (13 mm diameter) were extracted using a core sampler and

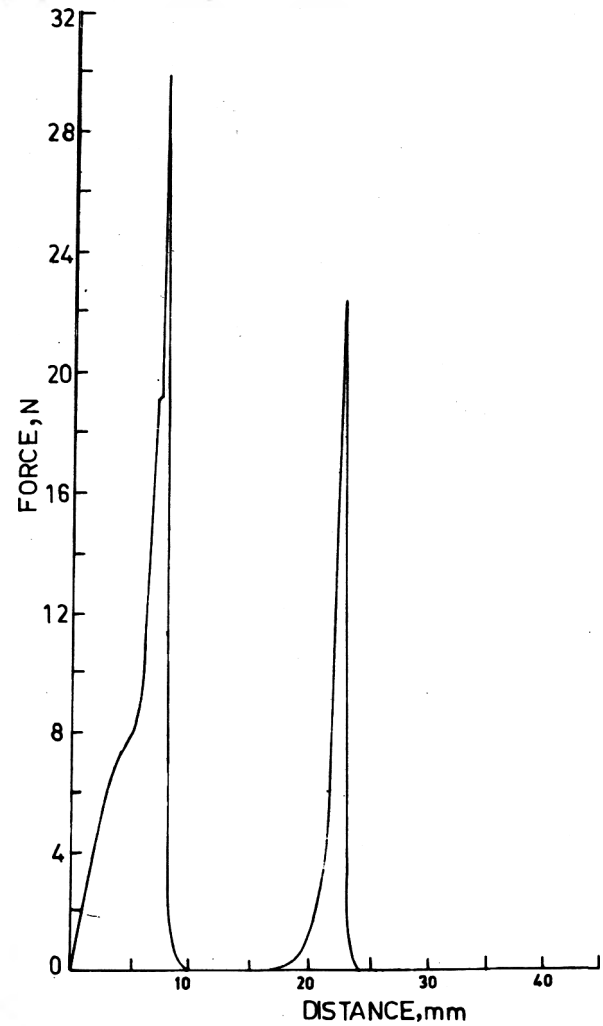

Fig. 1. Typical texture profile curve for soybean curd (Acetic acid coagulation)

TABLE 1. TEXTURE PROFILE ANALYSIS OF SOYBEAN CURD PREPARED BY DIFFERENT COAGULANTS

Parameter	Coagulant			
	Citric acid	Acetic acid	Magnesium sulphate	Calcium sulphate
Hardness (Newtons)	37.4	30.15	14.70	12.25
Cohesiveness (A_2/A_1)	0.38	0.36	0.40	0.39
Springiness (cm)	1.3	1.6	1.1	0.09
Gumminess (Newtons)	4.21	10.85	5.88	4.77
Chewiness (Newton-cm)	18.47	17.36	6.46	4.29

cut to a length of 10 mm. Four samples of each product were tested on Instron-6021 machine. The crosshead was cycled at a constant speed of 50 mm per minute with a stroke length of 7.5 mm. The maximum clearance between the moving cross head and the stationary bed was 10 mm to enable placing of the sample vertically, and the minimum clearance was 2.5 mm resulting in 75 per cent compression. Two cycles of compression were conducted on the sample to give first and second bites at room temperature. The textural parameters: hardness, cohesiveness springiness, gumminess and chewiness, were derived from the TPA curves as defined by Bourne[6]. A typical texture profile analysis for soybean curd is presented in Fig. 1. The mean values of the texture parameters for different soybean curds are tabulated in Table 1.

The acid coagulated curds exhibited significantly greater hardness, springiness, gumminess and chewiness than salt coagulated curds. The acid and salt coagulated curds had mean hardness values of 33.8 and 13.5 Newton, mean springiness of 1.5 and 1.0 cm, mean gumminess of 12.5 and 5.3 Newton, and mean chewiness values of 17.9 and 5.4 Newton-cm, respectively. The acid coagulated curds had slightly less cohesiveness than the salt coagulated curds, although the difference is rather insignificant. The cohesiveness ranged between 0.36 and 0.40 with a mean cohesiveness of 0.38.

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CHEMICAL EVALUATION OF OLIVE FRUITS OF NINE CULTIVARS OF HIMACHAL PRADESH

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Some exotic varieties of olives have recently been introduced in Himachal Pradesh to fulfil country's olive oil requirements. The mesocarp of the nine varieties of olive fruits under study contained oil from 27-45% on moisture free basis. Aglandean, Ascolano, Frantio and Groseena varieties are specifically rich in oil content (41.6-45.2%). Oils showed lower iodine value (64-70) and free fatty acid percentage (0.67-1.44%) in comparison with the oil produced in some European countries. Oleic acid constitutes a major component of olive oil ranged from 65.5 - 76.4%. The oil contained unsaturated fatty acids from 71.9 - 84.5% while saturated fatty acids constitute 15.5 - 28.1%. Chemical characteristics of Himachal Pradesh olive oil show the greater potentiality of acceptance in dietary and trade.

India's requirements of olive oil are met by imports, mainly from European countries. Unlike other vegetable oils, good grade olive oil can be obtained without any refining[1]. Olive oil is used for edible purposes and for medicinal uses[2,3]. In addition, it is used in the manufacture of soaps, textile lubricants and sulphonated oils. To fulfil the country's requirements, some exotic Italian and Spanish varieties of olives (*Olea europaea*) have been introduced and are under trial in Himachal Pradesh, Uttar Pradesh and Jammu & Kashmir States. Cultivation of exotic varieties of olives in Himachal Pradesh has been introduced in Mandi, Solan, Kulu and Chamba districts. This study was undertaken for appraising the suitability of olive oils extracted from some varieties grown under the agro-climatic conditions of Himachal Pradesh.

The fruits of nine varieties of olives viz. 'Aglandean' 'Ascoiterana', 'Ascolano', 'Canino', 'Carnicobra', 'Frantio', 'Groseena', 'Hozeiblanka' and 'Mission' of 1985-86 season were obtained from the Government Horticulture farm located at Panarsa in Mandi district of Himachal Pradesh and assessed for their physico-chemical characteristics and fatty acid composition of oils. Physical characteristics of the fruits included the average weight of the fruit, the kernel and fruit pulp weight ratio were recorded. Crude protein, petroleum ether extract (fat) and ash were determined in the mesocarp of the fruits on moisture free basis according to AOAC methods[4]. and sodium, potassium and calcium were estimated by flame photometrically whereas phosphorus and iron were assayed by using the methods of Fiske and Subba Row[5] and Andrews and Felt[6] respectively. Three independent replicates were taken for chemical analysis and mean values were reported with standard deviation values.

Five prominent oil rich varieties i.e. 'Aglandean', 'Ascolano', 'Frantio', 'Groseena' and 'Hozeiblanka' were selected for study of their fatty acid composition as the relative quantity of different fatty acids decides the quality of the oil. The oils from the moisture-free mesocarps were extracted by petroleum spirit (60-80°C) and purified according to Folch *et al.*[7]. Physical characteristics were studied by AOAC methods[4]. Fatty acids in the form of their methyl esters were analysed by gas liquid chromatography following the procedure of Kates[8] using a Pye Unicam 204 series chromatograph equipped with hydrogen flame ionization detector and fitted with a 200cm × 0.6 cm glass column packed with Reoplex, 15 per cent on chromosorb W, 80/100 mesh; oven temperature 190°C, injection port and detector temperatures 270°C and 300°C respectively and carrier gas; nitrogen, 35 ml/min.

The retention times of different methyl esters were compared with those of authentic samples and the amounts were calculated as the average of triplicate analysis with S.D. values. Peak areas of various fatty acids were measured by triangulation. Significance of difference of oleic acid and total unsaturated fatt acids have been determined by Student's 't' test.

The total ash, oil and crude protein contents varied from 2.4-4.0, 27.4-45.2 and 3.4-6.8 per cent respectively in the mesocarp of the nine olive varieties studied. The varieties 'Aglandean' 'Ascolano' 'Frantio' 'Groseena' and 'Hozeiblanka' contained higher content of oil. The ranges of mineral contents are shown in Table 1.

The refractive indices of the oils are comparably higher than those reported by Ockerman[9] and in British Pharmacopeia[10]. The iodine value which indicates the degree of unsaturation was found lower in Hozeiblanka fruit oil. These ranged from 64.5 to 70.7. It was observed that iodine values of olive oils obtained from Himachal Pradesh are lower than the values reported by others[11-13]. According to Woodman[14], lower the iodine value, greater the acceptability of oil. The range of unsaponifiable matter (0.7-0.8 per cent) is within the acceptable limits[13].

TABLE 1. COMPOSITION OF FRUITS OF NINE OLIVE VARIETIES GROWN IN HIMACHAL PRADESH

Constituents	Algandian	Ascoiterana	Ascoana	Canino	Carnicobra	Frantio	Groseena	Hozeiblanka	Mission
Moisture (%)	32.9 ± 2.3	34.9 ± 3.0	32.7 ± 3.8	39.5 ± 2.0	32.8 ± 3.1	28.3 ± 2.6	33.7 ± 3.7	50.2 ± 3.1	36.0 ± 2.2
Pulp (%)	75.7 ± 5.2	73.0 ± 4.4	75.8 ± 3.7	76.8 ± 3.9	75.3 ± 2.0	68.4 ± 2.4	70.2 ± 2.0	83.6 ± 2.2	63.2 ± 3.2
Kernel (%)	24.3 ± 1.4	27.0 ± 2.0	24.2 ± 2.1	23.2 ± 1.8	24.7 ± 2.1	31.6 ± 2.0	29.8 ± 1.5	16.4 ± 1.0	36.8 ± 2.1
Ash in (%) mesocarp	2.7 ± 0.2	2.8 ± 0.1	3.0 ± 0.1	2.7 ± 0.1	2.9 ± 0.2	2.4 ± 0.1	4.0 ± 0.1	3.5 ± 0.2	3.7 ± 0.1
Crude protein (%)	3.4 ± 0.1	4.9 ± 0.1	6.8 ± 0.2	4.5 ± 0.1	4.1 ± 0.2	4.6 ± 0.1	4.1 ± 0.1	6.4 ± 0.2	3.6 ± 0.1
Crude fat (%)	45.2 ± 1.8	33.9 ± 2.1	41.6 ± 1.5	36.5 ± 1.2	28.8 ± 1.3	45.2 ± 2.2	44.5 ± 2.1	39.5 ± 1.2	27.4 ± 1.0
Sodium (mg/100 g)	175 ± 4	70 ± 2	15 ± 1	80 ± 2	80 ± 2	200 ± 4	910 ± 6	15 ± 1	230 ± 4
Potassium (mg/100 g)	756 ± 4	990 ± 7	1050 ± 8	1000 ± 9	360 ± 5	640 ± 3	1080 ± 6	1200 ± 5	1810 ± 7
Calcium (mg/100 g)	895 ± 5	590 ± 4	150 ± 2	660 ± 3	670 ± 3	800 ± 4	1300 ± 6	150 ± 3	980 ± 4
Phosphorus (mg/100 g)	65 ± 3	34 ± 2	35 ± 3	124 ± 5	104 ± 4	89 ± 3	96 ± 4	79 ± 3	134 ± 3
Iron (mg/100 g)	32 ± 2	24 ± 1	31 ± 2	32 ± 3	21 ± 1	27 ± 2	24 ± 2	29 ± 2	39 ± 3

Values are mean ± S.D. (n=3)

TABLE 2. CHARACTERISTICS AND FATTY ACID COMPOSITION OF PROMISING OLIVE VARIETIES

Parameters	Hozeiblanka	Ascolano	Aglandean	Groseena	Frantio
Refr. index $n_d30°$	1.482 ± 0.001	1.481 ± 0.002	1.472 ± 0.001	1.474 ± 0.001	1.480 ± 0.001
Iodine value	64.5 ± 1.1	70.3 ± 0.5	70.7 ± 0.7	67.0 ± 0.6	68.6 ± 1.0
Sapon. value	201.6 ± 2.2	198.7 ± 2.0	199.2 ± 2.1	200.1 ± 1.8	198.8 ± 1.9
Unsapon. matter (%)	0.8 ± 0.01	0.8 ± 0.01	0.7 ± 0.01	0.8 ± 0.01	0.7 ± 0.01
Free fatty acids (%)	1.23 ± 0.02	1.43 ± 0.02	1.44 ± 0.03	0.67 ± 0.01	0.95 ± 0.01
Fatty acids (%)					
12:0	0.3 ± 0.01	Traces	--	--	0.5 ± 0.01
14:0	2.1 ± 0.1	1.4 ± 0.03	0.7 ± 0.01	1.2 ± 0.02	1.6 ± 0.02
16:0	4.8 ± 0.3	5.7 ± 0.3	8.4 ± 0.4	9.2 ± 0.6	7.3 ± 0.4
18:0	13.7 ± 0.7	15.0 ± 1.0	5.9 ± 0.4	5.6 ± 0.4	7.0 ± 0.8
18:1	65.5 ± 4.0	69.6 ± 3.8	76.4 ± 4.1	73.1 ± 3.2	76.0 ± 3.3
18:2	2.7 ± 0.2	2.1 ± 0.2	5.7 ± 0.8	6.5 ± 0.7	3.1 ± 0.4
18:3	8.1 ± 0.9	6.0 ± 8.7	2.4 ± 0.2	3.4 ± 8.3	4.5 ± 0.5
20:0	1.4 ± 0.1	—	0.5 ± 0.02	1.0 ± 0.05	—
20:1	1.4 ± 0.1	—	—	—	—
Total saturated fatty acids (A)	28.1 ± 1.2	22.2 ± 0.8	15.5 ± 0.6	17.0 ± 0.8	16.4 ± 0.5
**Total unsaturated fatty acids (B)	71.9 ± 2.1	77.8 ± 2.0	84.5 ± 2.3	83.0 ± 1.9	83.6 ± 3.0

*The value of Oleic acid in different olive cultivars is significantly different from other fatty acids ($P \leq 0.001$) according to Student's 't' test.
**Values are significantly different (A Vs B) at $P < 0.001$ according to Student's 't' test. Values are mean ± SD (n=3)

Olive oil shows the presence of free fatty acids (FFA) content well below the acceptable limit i.e. 0.67 to 1.44 per cent. For nutritive purpose the FFA content should not exceed 3 per cent as advised by PFA[15] and also undesirable for storage.

Among the various fatty acids, oleic acid (C_{18d}) is significantly predominant over the other fatty acids ($P \leq 0.001$). The quality of oil, however, can be affected adversely by the procedure of collection of the fruits as the fruits are very delicate in nature. Unfavourable conditions of storage can also bring deterioration in the quality of oil[16]. Other important fatty acids are also shown in Table 2. Eicosenoic acid is found only in Hozeiblanka variety (1.4 per cent). The contents of total unsaturated fatty acids in different cultivars are significantly different from total saturated fatty acids ($P < 0.001$).

It is concluded that oils extracted from the olives grown in Himachal Pradesh show characteristics similar to those of oils obtained from European countries. However, since the iodine value and free fatty acid percentage of the Himachal Pradesh olive oil are lower than oils from other regions, it has greater potentiality of acceptance for edible purposes as well as for trade.

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PYRUVATE KINASE ACTIVITY IN RIPENING MANGO (*MANGIFERA INDICA* L.) FRUIT*

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Pyruvate kinase (PK), pyruvate ATP phosphotransferase, a regulatory enzyme of glycolysis was studied at four ripening stages in seven mango cultivars. The results have indicated that, in general, the respiratory climacteric was accompanied by an increased level of PK activity. Higher relative PK activity during ripening was observed in cvs. Banganapalli, Langra and Suvarnarekha.

The marked increase in post-harvest respiration, known as the 'climacteric' is recognised as an essential event of the ripening process in a number of fruits. The climacteric rise in respiration is reported to be associated with enhanced glycolysis[1-3] and the glycolytic intermediates showed a pattern which reflected the activation of phosphofructokinase (PFK) and pyruvate kinase (PK), the regulatory enzymes of glycolysis[4]. We report in this communication pyruvate kinase (E.C. 2.7.1.40) enzyme activity which catalyses the conversion of phosphoenol pyruvate (PEP) to pyruvate in ripening mango.

Mango fruits of seven cultivars were collected from trees grown at the experimental orchard, Hessaraghatta. Fruits collected at harvest maturity stage were kept at ambient temperature (25±2°C) and at 70±5 per cent relative humidity for ripening. Each cultivar was analysed at four ripening stages viz., at harvest maturity, ½ ripe (pulp colour turning stage), ¾ ripe (pulp colour fully yellow but not ripe) and eating ripe. Each sample consisted of 10 fruits of same maturity stage. There were 2 independent samples for each maturity stage. Respiration measurements were made from whole fruits using Pettenkofer method[5].

Edible pulp after the removal of peel and stone was composited and a sample size of 1kg pulp was used for acetone powder preparation. Acetone powder was prepared by homogenizing fruit pulp with five volumes of chilled acetone, filtered through a Buchner funnel and washed with excess chilled acetone. The residue was spread on filter paper to remove traces of acetone and stored in sealed polythene covers below 0°C. PK activity was measured in extracts prepared from acetone powder. Five hundred mg of acetone powder was suspended in 10 ml 5mM Tris HCl buffer pH 7.4 and kept overnight at 0 to 4°C. It was homogenized, squeezed through four layers of muslin cloth and centrifuged at 20,000 **g** for 10 min. at 2 to 4°C. The supernatant was used as crude enzyme extract. PK activity was assayed by determining the ADP dependent formation of pyruvate from PEP[6]. The pyruvate formed by phosphatase in the absence of ADP was subtracted and the PK activity was expressed as μ mole of pyruvate formed/mg protein/min. Protein in the enzyme extract was measured by the method of Lowry *et al.*,[7] using bovine serum albumin as standard.

The mango fruits of seven cultivars during post-harvest ripening at ambient conditions exhibited climacteric pattern of respiration (Table 1). The climacteric peak occurred 2 days after harvest in cv. Alphonso, 4 days after harvest in cvs. Banganapalli, Fazli and Totapuri and 5 days after harvest in cvs. Dasheri, Langra and Suvarnarekha. High respiration rate with sharp rise was observed in cv. Alphosno, cvs. Banganapalli, Dasheri, Fazli, Langra and Suvarnarekha had intermediate values and cv. Totapuri lowest value. PK activity (Table 1) decreased from harvest maturity to ½ ripe and increased at ¾ ripe and declined in ripe stage in cvs. Banganapalli, Dasheri and Fazli. However, in cvs. Alphonso, Langra and Totapuri, the PK activities increased from harvest maturity to ½ ripe and/or ¾ ripe and then declined at ripe stage. Suvarnarekha registered a decreased activity pattern from harvest maturity to ½ ripe stage. The activity, thereafter increased until ripe stage. Though the PK activities declined at ripe stage in mango cultivars (except Suvarnarekha), they remained fairly high in cvs. Alphonso, Banganapalli, Dasheri, Fazli and Langra. Higher relative PK activities during ripening were observed in cvs. Banganapalli, Langra and Suvarnarekha as compared to the other four cultivars.

The respiratory behaviour of ripening mango is typical of a climacteric fruit. With the commencement of climacteric, a host of changes in physical, physico-chemical and biochemical characteristics are reported[8]. The ethylene induced surge in respiration

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was ascribed to increase in glycolytic substrates mediated by a five fold increase in PFK and PK activity[9]. The results have indicated that, in general, the respiratory climacteric is accompanied by an increased level of PK activity in mango. Of all the glycolytic enzymes studied in the banana fruit during the climacteric, PFK activity was reported to have increased considerably[1]. ATP and citrate inhibit PK activity leading to the accumulation of PEP and 3 phospho-glycerates, However[10] in grape a non-climacteric fruit, glycolysis was reported to operate steadily upto 6 weeks after anthesis and then the rate declined[11].

TABLE 1. RESPIRATION AND PYRUVATE KINASE ACTIVITY IN RIPENING MANGO FRUIT (VALUES ARE THE AVERAGE OF 2 INDEPENDENT DETERMINATIONS)

Cultivar	Days after harvest	Respiration[a]	Pyruvate kinase[b]
Alphonso	0	170.5	0.0079
	1	230.0	
	2	251.3	0.0101
	3	179.3	
	4	175.9	0.0244
	5	148.3	
	6	141.6	0.0205
Banganapalli	0	102.4	0.0348
	1	109.4	
	2	115.3	0.0267
	3	121.7	
	4	142.6	0.0482
	5	117.0	
	6	113.3	
	7	108.6	0.0442
Dasheri	0	81.6	0.0152
	1	—	
	2	100.9	0.0054
	3	104.6	
	4	149.1	0.0125
	5	172.7	
	6	136.6	
	7	132.4	0.0114
Fazli	0	65.5	0.0201
	1	73.9	
	2	90.8	0.0073
	3	103.8	
	4	148.0	0.0231
	5	125.5	
	6	84.2	
	7	75.1	0.0112
Langra	0	69.4	0.0189
	1	—	
	2	105.3	0.0342
	3	111.3	
	4	140.3	0.0319
	5	175.2	
	6	169.5	
	7	162.8	0.0197
Suvarnarekha	0	63.7	0.0344
	1	65.9	
	2	67.7	0.0291
	3	92.5	
	4	98.8	0.0318
	5	110.1	
	6	70.9	
	7	64.9	0.0450
Totapuri	0	67.3	0.0072
	1	70.2	
	2	73.2	0.0204
	3	81.2	
	4	117.2	0.0073
	5	94.5	
	6	91.7	
	7	83.2	
	8	59.8	0.0031

a) mg of CO_2/h/kg fruit.
b) μ mole pyruvate formed/mg protein/min
2 days and 4 days after harvest represent ½ and ¾ ripe stages respectively.

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DRYING STUDIES ON BLACK PEPPER (*PIPER NIGRUM* L)

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Three drying methods viz open drying, polyethylene solar drying and solar cabinet drying were compared for their performance of pepper drying. The spreading densities were kept as 5, 12 and 18 kg/m^2 respectively. The drying time in polysolar dryer could be reduced when first day drying was done in the open with frequent stirring. The performance indices were 1, 1.98 and 2.88 for open, polydryer and cabinet dryer respectively. The colour was also found to improve in the dryer due to temperature build up. The use of solar dryer for pepper drying therefore offers advantages like quick drying, good quality pepper free from dirt and dust contamination, higher capacity and very good natural black colour.

Pepper "King of Spices" is the dried fruit of a perennial climbing vine. India is the largest producer and exporter of black pepper with an estimated annual production of 30,397 tonnes from 1,08,039 ha[1].

When berries are fully mature and a few start turning yellow to red in each spike, the bunches are nipped off and spikes are further dried in sun for 4-5 days to get black pepper. In black pepper industry, a lot of importance is given to a glossy finish. However in the coastal region where pepper is grown, due to unsatisfactory preliminary drying, a thin layer of fungus appears on the finally dried product.[2] The solar dryers developed by the author[3] for copra drying had temperature rise of 6 to 16°C over ambient. The heating and effective air circulation in solar dryers therefore helps in reduction in drying time and improvement in colour. This paper presents the performance and evaluation of these dryers for pepper drying compared to open drying.

The fully mature pepper berries separated from spike were taken for experiment. Open sun-drying conducted on two surfaces viz black painted palmyra mat and jute cloth at spreading density of 5 kg/m^2. The low cost polyethelene solar dryer and solar cabinet dryer[3] were used for other methods. The polyethylene solar dryer, was a low cost "do it yourself type dryer" where black painted palmyra mat was a drying surface. The metallic frame kept on it was used to hold double layered polyethylene sheet. The angle of inclination was kept at 27° for maximum penetration of radiation. The inclined surface was kept facing south. The solar cabinet dryer was made of jack wood, GI corrugated sheet, glass and acrylic sheet and aluminium foil as reflector. The cabinet dryer was provided with castor wheels for manual sun tracking throughout the day (Fig 1 and Fig 2). The spreading densities were 18 kg/m^2 and 12 kg/m^2 in cabinet and poly dryer respectively. The moisture content of black pepper at the start of each day was measured. The material was turned over every one hr. The temperature of drying air in the dryer was recorded. The colour of the dried black pepper was assessed by comparison with Munsell colour chart. Since most colours are not found in the spectrum, the non spectral colours can be regarded as intermediate between spectral colours. The most widely used scheme which describes colours in terms of their hue, saturation and lightness is that of Albert Henry Munsell[4].

The initial moisture content of the green berries was found to be 72 per cent wet basis. Open sun-drying either on black painted mat or on jute bag required the same time of about 5 days. In polysolar dryer at 12 kg/m^2 spreading density, 5.5 days were required compared to 5 days in open sun. On the first day, the rate of moisture removal is faster and hence large amount of air is required to carry away saturated air. Therefore in polysolar dryer, first day drying was done without cover similar to open drying, which resulted in reduction in drying time to 4 days compared to 5.5 days required earlier. The drying time required in

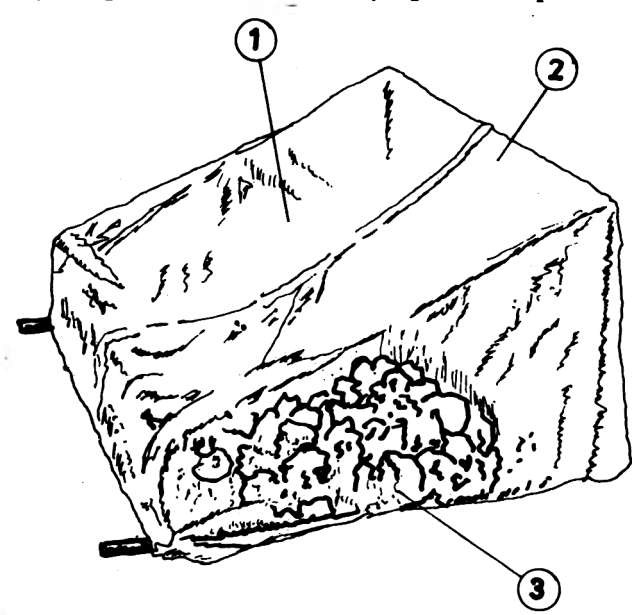

Fig. 1. Low cost poly solar-dryer

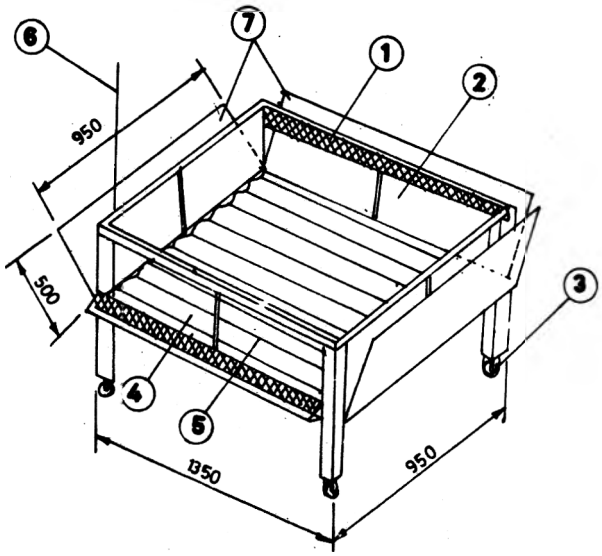

Fig. 2. A solar cabinet dryer to dry copra and other plantation crops

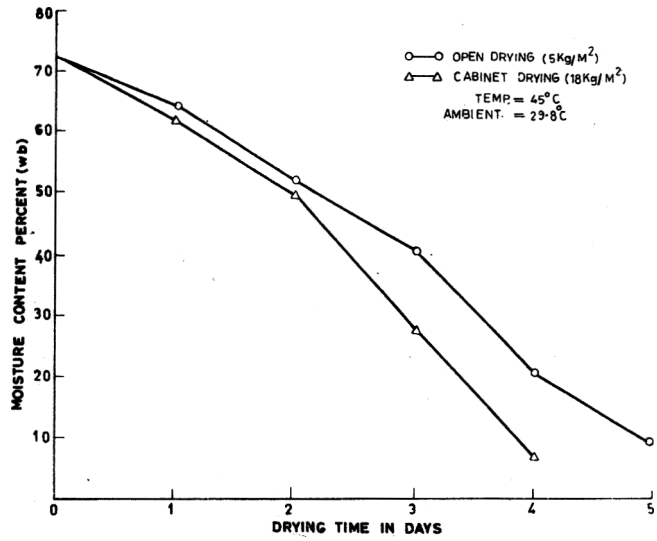

Fig. 3. Drying curves for black pepper in solar dryer and in open

cabinet dryer was only 4 days at 18 kg/m^2 spreading density. The ambient air temperature was 29.8°C, where as it was 37°C and 45°C in polysolar and solar cabinet dryers. The drying performance indices were 1, 1.92 and 2.88 in open, polydryer and in solar cabinet dryer respectively.

The moisture content variation during drying in open and in solar cabinet dryer is shown in Fig 3. The drying was faster for first two days in both the cases. After that, drying was faster in solar cabinet dryer mainly due to higher temperature build up. However, the spreading density in the dryer was 3.6 times than in open drying, hence overall moisture removal per square meter was faster in cabinet dryer for all four days.

Due to higher temperature of air in the dryers, it gave the effect of mild heating, which resulted in better colour development. Due to protective cover during drying, the deterioration in colour due to adhering dust was also not noticed in the product dried in the dryers. The colour of the black pepper dried in open was dull, the unit of measurement was 58 mild brown (5.6 VR/3.5/3.9) whereas in solar dried product, the colour was 65 br. black (7.8 YR/0.6/0.9)

Solar drying with these types of low cost dryers is advantageous due to the fact that it saves drying time, requires less space due to higher spreading density, the product and its colour do not get spoiled due to adhering dirt and dust and the higher temperature build up results in dark glossy natural black colour of the pepper which can fetch a better price.

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BOOK REVIEWS

Adulteration of Fruit Juice Beverages: by Steven Nagy, John A. Attaway and Martha E. Rhodes, Marcel Dekker, Inc. New York and Basel: 1988; PP: 563; Price: Bound Illustrated $ 136 (US & Canada) $ 150 (All other Countries).

With the increase in production and consumption of fruit juices and concentrates, the tendency for adulteration has gone up. Hence this book has come timely to awaken the persons concerned and it is a welcome addition to the series of books on food science and technology by Marcel Dekker publications. It has 23 chapters in 6 parts covering various aspects of juice adulteration and its control measures in different countries. Chapters are contributed by specialists from different countries. Part 1 includes the first chapter with a brief introduction on adulteration, highlighting the experience of the authors in their own state of Florida, which is known for maximum production of orange juice in USA. Part two comprises of 2 to 5 chapters wherein the role of chemical markers like amino acids, flavonone glycoside profile, aroma and flavour components, and trace elements in identifying the adulteration of different pure juices and also in defining the geographical origin are discussed thoroughly, and well illustrated by charts, tables and figures. Part three, comprises of chapters 6 to 10 dealing with the adoption of different physical and chemical methods to detect adulteration. Application of stable isotope ratio analysis, and natural variations in $^{13}C/^{12}C$ ratios are discussed in chapters. 6 and 7 Methodology for authenticity of cranberry and apple products are discussed in chapters 8 and 9 using several indicators like organic acids, sugars, anthocyanins, cations, chlorogenic acid, etc. Possibility of using visible, ultraviolet absorption and fluorescence spectral characteristics for clearcut identification of adulteration is discussed in chapter 10.

In part four, with chapters 11 to 14, statistical procedures for detection of adulteration like the effect of heterogenity, statistical model sequence list, directional test and the validity of new tests are discussed. Detection of adulteration in citrus juices using multivariate statistical methods showing empirical histograms of 300 orange juices is an excellent addition. Pattern recognition analysis using data generated with several analytical techniques could be used to distinguish authentic from adulterated orange juice with multivariate character. Simulation modelling system to assess the probability of orange juice adulteration is a highly flexible and adaptable approach.

Part 5 comprises of 15 to 18 chapters wherein adulteration of 5 individual commodities are discussed. If, detection of adulteration in fruit wines, regulation and enforcement problems, uses of latest techniques for detection are discussed in chapter 15, adulteration of selected fruit juices and its detection by chemicals and isotopes are discussed in chapter 16. After a detailed study of chemical compounds present at different maturity stages and under different storage conditions , estimating sugar, organic acids, amino acids and minerals, have been recommended for detection of apple juice adulteration as presented in 17th chapter. For fruit berry drinks, the need for establishing a statistical data base for authentic juice based on improved methodology is suggested in chapter 18.

In part 6, international evaluation of fruit juice adulteration in 5 countries is presnted in 19-23 chapters.

Guidelines and tolerances for specific constituents like minerals, acids, sugars and volatiles in fruit juices, standard values and the ranges of certain values termed as RSK values for different products, as prevalent in Germany are discussed in chapter 19.

As per the Australian experience, true juice content is no longer a consideration on fruit juice trading due to technological developments in fruit juice concentrate. The concentration reconstitution anomaly (CRA) and its effect on adulteration are discussed. In the Netherlands, detailed authenticity criteria for juices based on various chemical components is included in the legal regulations, but these criteria are applied in a flexible way. In Spain, possibility of using methoxylated flavones for accurate detection of fruads of dilution or addition of other juices is mentioned. In Israel, the quality of control process for fruit juices is based on several statistical tests and these tests are followed by analysis of many samples.

This book is a comprehensive coverage of all kinds of adulteration in fruit beverages and its detection. It is very useful as a reference book for food scientist, technologist, research scholar and industrialist.

SHANTHA KRISHNAMURTHY
I.I.H.R., BANGALORE.

Food Toxicology: by Jose M. Concon, Marcel Dekker, INC, 270, Madison Avenue, New York, N.Y. 10016; 1987; pp: 1371; Part A: Principles and Concepts, xiii + 675; Part B: Contaminants and Additives, xiii + 696). Price; US$ 250 (US & Canada); $300 (All other countries).

A series of monographs and text books have been published by Marcel Dekker in the area of Food Science and Technology. One of the latest in this series is the pioneering, mammoth 1371 pages, two part work entitled Food Toxicology. As mentioned by the author, this book had its genesis during a personal conversation between the author and one of the speakers at the meeting of the American College of Nutrition regarding the absence of a comprehensive book on Food Toxicology so that students of nutrition could study the subject. Inspite of Professor Concon's unfortunate demise after he had finalised the text, his wife Jayne and a few students and colleagues brought the manuscript to the stage of publication. The fact that 7 years of hard work has gone into the making of the book in which more than 9000 references have been cited, is indicative of the extensive and in-depth coverage of the subject matter.

Part A entitled 'Principles and Concepts' comprises TWELVE chapters dealing with: general principles, the role of the GI tract and intestinal microflora, metabolism of non-nutritive components, manifestation of toxic effects, carcinogenesis, toxicants/antinutritive substances occurring in plant and marine foods and toxicants derived during processing of foods.

Part B entitled 'Contaminants and Additives' embodies NINE chapters covering mold and mycotoxin contamination, bacterial contaminants, toxic plant food contaminants, chemical contaminants including radionuclides and food additives. The subject index at the end of part B helps the reader to readily refer to the topic of his choice.

Each of the Chapters begins with an introduction which gives the background to the subject matter and prepares the reader. This is followed by an in-depth discussion of the subject along with presentation of relevant data in the form of tables, figures and wherever necessary, the picture of a toxic plant or a mushroom or of the experimental animal indicating the manifestation of toxicity. The chapter ends with concluding remarks and an extensive bibliography.

Whether it is the absorption of toxic components, factors affecting the metabolic transformation of foreign compounds, the α-adrenergic blocking ability of berberine, the toxic effect of protopine type alkaloid or the transfer of pyrolizidine alkaloids into the milk of lactating cows and goats after administration of tansy ragwort (*S. jacobaea*), not only is mention made at the appropriate place, but adequate data are presented and discussed to bring the point to focus. Even specialised chapters like 'Carcinogenesis' have been covered enough adequately and the role of food toxicants focussed in such a manner as to enable even an uninitiated reader understand the subject, appreciate the interrelationship between them and to enthuse him to study further. Remarks like "..... it is highly probable that this mycotoxin (aflatoxin) poses a serious carcinogenic hazard to humans" and "bacterial contamination is a public health problem even in developed countries like USA" are examples of the author's opinion regarding toxicity arising out of foods and his concern about safety of the consumer.

The book has been brought out well and is an everlasting monument to the *late* author's efforts. It will not only serve as a text book to students of Nutrition but also as a reference work to food science and researchers in these and related areas. While it is quite costly for an individual to purchase, it will be a valuable addition to institutional libraries.

N. CHANDRASEKHARA
C.F.T.R.I., MYSORE

Handbook of Complete Statistics on Processed Fruits and Vegetables Exported from India during 1977-85: by S. Mokshapathy, No. 71, Gokulam Road, Jayalakshmipuram, Mysore - 570 012, Karnataka (India) pp. 173; Price Rs.500 in India US.$ 60.00 outside India, Packing and postage extra: Rs.20 within India and US $ 15.00 for other countries.

Fruit and vegetable processing industry in India is now undergoing a rapid transformation and it is all set for a big leap into domestic as well as export markets. It is imperative to Exporters, Importers, Processors, Policy makers, Planners, and Promoters of the industry to equip themselves with accurate and up-to-date data to give it a definite dimension and direction. In fact, one of the big problems that India's food processing industry being faced with, is the virtual absence of authentic and reliable data, which makes it impossible to plan with any degree of certainty, a new venture. The data constraints that are being faced by those users in India, can only be experienced but not told. Against this background, the emergence of this Handbook is most welcome one as it forms very valuable contribution to the most important but neglected area of research. It fills an important gap in the data base relating to fresh and processed fruits

and vegetables produced and exported from India. It is for the first time that a detailed analytical effort has been made to project production and export policy parameters in a very systematic and scientific manner in terms of very meaningful and easily understandable tables and diagrams. It is a monumental effort on the part of the author spanning six years. It is indeed a pioneering work in the field.

This Handbook consists of FOUR sections. SECTION-I. contains statistical data on area, production, yield, ranking per cent share of fruits and vegetables grown in different states and Union territories. For comparison, similar data on major fruits and vegetables grown in principal growing countries of the world are also included. The data are presented in 18 tables and 5 figures. Information on loss of storage in developing countries, cost of cultivation per hectare of fruits and vegetables, with employment potential, net income, season of availability have also been given.

Section-II. contains data on production of processed fruits and vegetables in India. It presents FPO licences (distribution of) by sector, category, by states/Union territories/ Regions; production data by-products, items, groups, state and region. Information of percentage utilisation of major fruits and vegetables for processing is also given.

Section-Ill - It is devoted to statistics exclusively on Exports of processed fruits and vegetables from India during 1977-85. The data are presented in 54 tables and 19 figures which include (a) product-wise statistics: by types, by groups and by items,; (b) Importer-wise by covering 58 countries grouped into 9 Regions (c) Exporter-wise statistics covering all exporters numbering about 500. It gives co-relation of Products Vs. Importers and Exporters; Importers Vs. Products and Exporters and Exporters Vs. Products and Importers with quantity, value, unit value, percent share Ranking of each product, importer and exporter and also Product/Importer and Exporter trend over the period.

Section-IV contains useful statistics on Export and import of processed fruits and vegetables of world and some selected countries like U.S.A., U.K., E.E.C., countries and Middle East Countries along with India's share of trade, presented in 30 tables. Data on world trade in fresh fruits and veegetables, percapita consumption of fresh and processed fruits and vegetables, percapita expenditure on fruits and vegetables in some selected countries are also given.

In the Annexure data on cost of production of selected fruit and vegetable products for domestic and export market, farmer's share in landed cost of selected fruit products, FPO specifications for different fruit and vegetable products and list of ISI specifications are also included.

In short, this compendium includes the analysis of 14 types of fruits 13 types of vegetables, 25 products groups, 65 product items, This has been related to export to 145 seaports in 58 countries grouped into 9 Regions with which about 500 exporting companies have carried out the trade during 1977-85.

The massive and fascinating collection of data on production, processing and export marketing of fresh and processed fruits and vegetables contained in this book will be immensely useful to Exporters, Importers, Processors, Planners, Policy makers, export promotional agencies, development and marketing strategists, research scholars, foreign trade students and academicians in the area. It should definitely find a place in book shelf of all the libraries particularly food research Institutes, Horticulture research Institutes, Agricultural Universities, Development and marketing research institutes. Planning cells of Central and State Governments and Export Houses and other organisations.

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

Food Processing Technology - Principles and Practice: by P. Fellows Ellis Horwood Ltd., Chichester, England, VCH Verlagsgisellschaff, Weinheim F.R.G., pp: 505; 1987 price: D.M. 185.

This is an introductory text book for undergraduate students of Food Science & Technology and for those studying nutrition, catering or agriculture. This is an understatement, a typical affliction of British and, therefore, comprehensible. The book attempts to encompass all facets of food processing technology, an endeavour fraught with all chances of failure but succeeds admirably. The book is divided into five sections. The first section (one chapter) describes important basic concepts in the area of nutrition, fluid flow, heat transfer, water activity and batch and continuous process. Second section describes operations that operate at ambient temperature (seven chapters). Third and fourth sections deal with heating and cooling of foods (12 chapters) and in the final fifth section, post processing operations (4 chapters) are handled. 24 chapters in all, more than 500 pages.

Professor Dr. Fellows strikes a rare balance between theory and application and neither of these is permitted to over-shadow the others. The writing style emphasizes the unity of material presented with frequent, but in no way jarring, references to other

parts of the book. An introduction to the use of engineering principles for solving problems without the intimidating presence of integral and differential calculus is refreshing: for the intrepid, however, sufficient references are provided to delve deeper into the subject. A number of solved numerical examples are also provided. The production values of the book are excellent; illustrations, a plenty and the book is eminently readable. One thing missing is the review questions and unsolved problems at the end of the chapters, an oversight perhaps, which will, I hope, be corrected in the subsequent editions. This book is worthy of possession by students and all the practising Food Scientists and Technologists and every library in the country.

J. S. SIDDHU
P.A.U., LUDHIANA

AFST(I) News

Annual General Body Meeting 1988

The Annual General Body Meeting of the Association for the year 1988 was held on 5th May 1989 at CFTRI, Mysore. The following are the office bearers for the year 1989-90.

President	: Dr. L.V. Venkataraman
President-designate	: Dr. V. Sreenivasa Murthy
Vice-President HQ	: Dr. S.P. Manjrekar
Vice-Presidents (Chapters)	: Dr. P.G. Adsule Dr. C.L. Nagarsekar Dr. A.S. Bawa Mr. S.K. Sood
Hon. Joint Secretary	: Mr. P. Ramakrishna
Hon. Treasurer	: Mr. N.S. Singh

The membership of the Association at the end of the year 1988 was 2,229 which included all category of members.

AFST(I) Activities for the year 1989

A National Symposium on 'Impact of Pollution In and From Food Industry and Its Management' was held on 4-5, May 1989. Mr. R.P. Shavi, Chairman, Karnataka Pollution Control Board inaugurated the Seminar, Dr. R.P. Ray, Director, ITRC, Lucknow, delivered Presidential and Key Note address, Prof. V. Chandrasekhar, Principal (former), Engineering College, Manipal, reported the theme and relevance of the Pollution Control. The Seminar was well attended by over 200 delegates.

Bombay Chapter had conducted a Seminar-cum-Exhibition on Foods and Beverages on 2-3 January 1989, Bangalore Chapter organised a one-day Symposium on the 'Processed Foods for Metabolic Disorders', Nagpur Chapter conducted a Seminar-cum-Exhibition on 'Prospects of Processed Foods' on 15th January 1989. Calcutta Chapter organised a Conference on Convenience Foods' on 17-18, February 1989.

New Editorial Board

Dr. J.R. Rangaswamy with a new Editorial Board has taken over as Editor of the Journal of Food Science and Technology from Dr. N. Chandrasekhara. Dr. V.H. Potty has taken over as the Chief Editor of the Indian Food Industry journal with a new Editorial Board.

AFST(I) Awards for the year 1988

Prof. V. Subrahmanyan Industrial Achievement Award was given to Dr. A.G. Naik Kurade, a well known Food Consultant.

Laljee Godhoo Smarak Nidhi Award was jointly awarded to Dr. M. Mahadevaiah, Mrs. R.V. Gowramma and Mr. R. Naresh of the Central Food Technological Research Institute (CFTRI), Mysore for their outstanding Research and Development contribution in the field of Food Science and Technology.

Young Scientist Award was awarded to Dr. P.K. Rajendra Kumar of CFTRI, Mysore.

Gardner's Award was given jointly to Mr. Dharam Pal and Mr. Munir Cheryan of National Dairy Research Institute, Karnal for their paper entitled 'Application of Reverse Osmosis in the Manufacture of Khoa. Process Optimisation and Product Quality', published in the Journal of Food Science and Technology, Volume 24, Number 5, pages 233-238.

Best Student Award was awarded to Ms. Ashima Jain of Haryana Agricultural University, Hissar.

AFST(I) Fellowship:

The following past Presidents of the Association were conferred with the honour of Fellowships: 1) Dr. V. Subrahmanyan, 2) Dr. H.A.B. Parpia, 3) Dr. K.K. Iya, 4) Dr. B.L. Amla, 5) Dr. J.V. Bhat, 6) Dr. P.K. Vijayaraghavan, 7) Dr. A.N. Bose, 8) Dr. D.V. Rege, 9) Dr. H. Nath, 10) Dr. T.N. Ramachandra Rao, 11) Dr. P.K. Kymal, 12) Mr. M.R. Chandrasekhara, 13) Mr. C.P. Natarajan, 14) Dr. B.P. Baliga, 15) Mr. Dayanand, 16) Dr. K.T. Achaya, 17) Mr. M.K. Panduranga Setty, 18) Mr. S.K. Majumder, 19) Lt. Col. O.P. Kapur, 20) Mr. Laljeet Singh, 21) Dr. A.G. Naik Kurade, 22) Dr. T.R. Sharma, and 23) Dr. V.H. Potty. Dr. M.S. Pochkhanwala, Industrial Consultant, Bombay and Dr. M.S. Swaminathan, Honorary Director, Centre for Research on Sustainable Agricultural and Rural Development, India were bestowed with the honour of Fellowship of the Association of Food Scientists and Technologists.

Bangalore Chapter

The Annual General Body Meeting of the above Chapter was held on 20th April 1989 and the following office bearers were unanimously elected for the year 1989-90

President	: Mr. S.N. Prahlad
Vice-President	: Mr. Varadu Seshamani
Hony. Secretary	: Mr. Srikanth M. Chatrapathy
Hony. Treasurer	: Mr. A.G. Huddar

Delhi Chapter

The Annual General Body Meeting of the Chapter was held and the following office bearers were elected for the year 1989-90.

President	: *Dr. S.K. Roy*
Vice-Presidents	: Dr. S.M. Ilyas
	: Dr. M.M. Krishna
	: Sh. O.P. Gera
	: Sh. Parkash Nath
Hon. Secretary	: Dr. D.S. Khurdiya
Hon. Treasurer	: Sh. P.N. Narang
Hon. Jt. Secretary	: Sh. D. Nag.

Jabalpur Chapter

The Annual General Body Meeting of the Chapter was held on 4th May 1989. The office bearers for the year 1989-90 are as follows:

President	: Prof. Y.K. Sharma
Vice-Presidents	: Dr. D.S. Singh
	: Dr. Suman Kumar
Hon. Secretary	: Prof. L.P. Rajput
Hon. Jt. Secretary	: Miss Mamta Bargale
Hon. Treasurer	: Prof. S.K. Sharma

Ludhiana Chapter

The Annual General Body Meeting of the above Chapter was held on 12th May 1989. The following office bearers have been elected for the year 1989-90.

President	: *Dr. J.S. Sidhu*
Vice-President	: Dr. O.P. Beerh
Hon. Secretary	: *Dr (Mrs) S. Vadhera*
Hon. Jt. Secretary	: Dr. E.P. Singh
Hon. Treasurer	: Dr. K.S. Sandhu
Councillors	: Dr. S.K. Gupta
	: Dr. J.S. Sital

Publications of the Association of Food Scientists and Technologists (India)

CFTRI Campus, Mysore – 570 013, India

Title	India		Foreign	
	Price	Postage	Price	Air Mail
	Rs.	Rs.	US$	US$
Ist Indian Convention of Food Scientists and Technologists, 1978 (Proceedings)	25	9	12	6
Symposium on the Status and Prospects of the Confectionery Industry in India, 1979 (Proceedings)	30	13	12	8
Symposium on By-products from Food Industries: Utilization and Disposal, 1980 (Proceedings)	30	9	12	6
2nd Indian Convention of Food Scientists and Technologists, 1981 (Proceedings)	40	13	15	7
3rd Indian Convention of Food Scientists and Technologists, 1983 (Proceedings)	25	9	15	5
4th Indian Convention of Food Scientists and Technologists, 1984 (Proceedings)	35	9	25	6
Symposium on Recent Developments in Food Packaging, 1986 (Proceedings)	65	13	35	8
Prof. V. Subrahmanyan Commemorative Issue, 1980	30	13	12	8
Production and Processing of Meat and Poultry Products, 1986 (Proceedings)	100	9	45*	
2nd International Food Convention & Exhibition (IFCON'88) – Food Technology Overview	100	13	45*	
2nd International Food Convention & Exhibition, (IFCON' 88) – Abstract of Papers	100	13	45*	
Trends in Food Science & Technology IFCON'88 Proceedings, 1988	300*		95 £50	

* including Postage

INSTRUCTIONS TO AUTHORS

1. Manuscripts of papers (in triplicate) should be typewritten in double space on one side of bond paper. They should be complete and in final form. The paper should not have been published or communicated for publication anywhere else. Research Notes should clearly indicate the scope of the investigation and the salient features of the results. Only *invited* review papers will be published.

2. The typescript should be arranged in the following order: Title (to be typed in capital and small letters for Research Papers and all capitals for Research Notes), Authors' names (all capitals) and Affiliation (capitals and small letters). Also give a short running title not exceeding 10 words as a footnote.

3. **Abstract:** The abstract should indicate the principal findings of the paper and typed in single space. It should not be more than 200 words and in such a form that abstracting periodicals can readily use it.

4. Use names of chemical compounds and not their formulae in the text. Methods of sampling, number of replications and relevant statistical analyses should be indicated. Footnotes especially for text should be avoided as far as possible.

5. **Tables:** Tables as well as graphs, both representing the same set of data, should be avoided. Tables should be typed on *separate* sheets. 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 not bigger than 20 cm (OY axis) × 16 cm (OX axis). The lettering should be twice the size of the printed letter. Photographs must be on glossy paper and must have good contrast; **three copies** should be sent.

7. **References:** Names of all the authors along with title of the paper should be cited. Abbreviations such as *et al.*, *ibid*, *idem* should be avoided. References should be serially numbered as superscripts in the order they are cited in the text and the same order should be maintained in the reference list. The titles of all scientific periodicals should be abbreviated in conformity with the World List of Scientific Periodicals, Butterworths Scientific Publication, London, 1962.

   Citation should be as follows (note the underlines also):

   (*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.

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

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Research Papers

Research Notes

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