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Studies on the Improvement of Quality of Karnal Bunt Infected Wheat. III. Minerals Composition, Chapati and Cookie Making Properties[1]

NARPINDER SINGH, K.S. SEKHON
Department of Food Science & Technology,
Punjab Agricultural University, Ludhiana - 141 004, India.

AND

RAJVIR SINGH
Department of Veterinary Physiology,
Punjab Agricultural University,
Ludhiana - 141 004, India.

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The effect of debranning and lye peeling on the minerals composition and chapati and cookie making properties of good and bunt infected wheat was studied. Most of the minerals, significantly increased with the increase in bunt infection. Debranning and lye peeling significantly lowered the minerals in whole wheat meal and flours. The spread of cookies decreased with the increase in bunt infection. Debranning and lye peeling significantly improved the spread factor of 10% infected wheat. Overall acceptability of cookies and chapaties progressively decreased with the increase in the level of infection. Debranning and lye peeling produced as good quality cookies and chapaties from a wheat having 5% infected wheat as those from good wheat.

Karnal bunt, a fungal disease caused by *Neovossia indica* imparts black colour and fishy odour to the infected grains of wheat. It, thus, severely affects the quality and acceptability of wheat products[1,2]. The disease has also harmful biological effects[3-5]. In our previous studies, we have reported simple methods to overcome the adverse effects of the disease on the quality of wheat and biological system[2,5]. In the present study, the effects of treatments on minerals composition and cookies and chapaties making properties of infected wheat are reported.

Materials and Methods

Karnal bunt (*Neovossia indica*) infected wheat, 'WL-711' was obtained from Regional Research Station, Kheri of the Punjab Agril. University from the 1986-87 harvest. Severely infected grains which were partially black were separated by hand picking. These grains were added to the sound wheat sample in proportions of 5 and 10 per cent to constitute the study material.

Debranning followed by washing: The debranning was accomplished with the help of McGill polisher in two steps. The 900 g samples were abraded for 20 sec each time after 10 min of tempering, first by adding water 4 per cent and then 1 per cent. The resulted grains were soaked in water for 20 min with stirring at intervals, then washed thoroughly and dried to original moisture content in a forced air laboratory cabinet drier at 35°C.

Lye peeling: The samples were treated with 15 per cent sodium hydroxide solution (lye), 30 per cent by weight of sample at 65°C for 6 min and washed in running water. The residual alkali on the kernels was neutralized by dipping in 2.5 per cent acetic acid and dried as described above.

Conditioning and milling: Samples were conditioned to 14 per cent moisture and milled in Quadrumat Junior experimental mill. An experimenttal stone grinder was used for preparation of whole wheat meal. The granulation was so adjusted as to pass the meal through 40 mesh sieve.

Minerals were estimated through atomic absorption spectroscopy (Model-AA6, MIS Varian Techtron Pvt. Ltd. Melbourne, Australia) by the method of Ludmilla[6].

Cookie making propeties: Cookies were prepared according to the method of AACC[7] and sensory qualities were evaluated by a team of ten semi-trained panelists. The cookies were arranged on white plates, those prepared from sound wheat flour taken as reference sample and test cookies were presented in randomized order. Panelists were asked to

[1]Contribution No. FTR-15, Dept. of Food Sci. & Technology, Punjab Agricultural University, Ludhiana - 141 004.

score the cookies with respect to appearance, aroma, taste, texture, colour and overall acceptability using a 9-point Hedonic scale, 9 as excellent and 1 very poor.

Chapati making properties: Chapaties were made from whole meal according to the procedure described by Austin and Ram[8]. The chapaties were evaluated for acceptability by a panel of 10 judges. Code numbers were given to different types of chapaties and each type repeated thrice during the course to evaluate the scores. The judges were asked to evaluate chapaties for colour, taste, aroma and overall acceptability using 7-point Hedonic scale, 1-strongly unfavoured and 7-strongly favoured.

Statistical analysis: The analytical data reported are average of three replications. The results were statistically analysed using two factors in randomixed block design and least significance differences (LSD) were calculated as described by Steel and Torrie[9].

Results and Discussion

Mineral composition of flour! The contents of K, Mg, Fe and Mn in flour increased with the increase in infection while those of Ca and Zn significantly decreased (Table 1.) Debranning resulted in reduction of all the minerals. Lye peeling also reduced the mineral content and the decrease was more when compared to debranning in most of the cases. The increases in K, Mg, Fe and Mn contents in the infected wheat flours might be due to more contamination of branny layers which is also reported to increase the ash and colour grade values of these flours[5]. The reduction in mineral content in debranned wheat flour is due to removal of mineral rich branny layers prior to milling which resulted in lesser contamination of flour with bran. The pattern of changes in mineral composition of flours was almost similar to that observed for whole wheat meal.

Cookie making properties: Thickness of cookies increased and the width decreased thereby reducing the spread factor progressively with increase in infection in the flours. Debranning and lye peeling improved the spread factor in 10 per cent infected wheat. All the sensory attributes of cookies evaluated by the panelists showed progressive deterioration with the bunt infection (Table 2). The severely affected attributes were taste, aroma and colour. The overall acceptability score of 9 for the control, declined to 4.2 and 2.4 in 5 and 10 per cent infected samples, respectively. Debranning and lye peeling significantly improved the quality of cookies prepared from infected samples thereby improving the overall acceptability of the product appreciably. The acceptability of cookies prepared from debranned or lye peeled infected wheat was as good as for the cookies prepared form control samples. The deterioration in the quality attributes and overall acceptability of the products with bunt infection was due to the contamination of fungal mass in such flours along with increased amounts of phenolics, free fatty acids and trimethylamine[2,3].

Mineral composition of wheat meal: Calcium content was found to decrease from 45 in control to 36.2 and 34.0 mg/100g in 5 and 10 per cent infected samples, respectively (Table 3). Potassium, magnesium and iron contents showed progressive increases as the per cent infected grains increased but zinc showed a consicerable decrease. Debranning reduced almost all the minerals significantly. Lye peeling also had similar effect. The increase in mineral content with the increase in bunt infected grains was also reported [10,11]. The changes in minerals composition with the increase in fungal infection may be due to the change in the endosperm to non-endosperm ratio and the differential composition of these parts with respect to the minerals, However, the contribution of fungal mass and changes in physiology of plant as a result of infection cannot be ruled out. The reduction due to debranning and lye peeling treatments is self explanatory as both remove a major part of the branny layer rich in minerals as evidenced by the work of Peterson *et al.*[12].

Chapati making properties: The dough prepared from infected wheat was blackish and the extent of blackening depended on the degree of infection. Debranned and lye peeled sound wheat meal produced wheatish dough. Dough prepared from debranned or lye peeled 5 per cent infected wheat had wheat-like and moderately white colour,

TABLE 1. EFFECT OF PRETREATMENTS ON MINERALS COMPOSITION OF SOUND AND BUNTED WHEAT FLOUR

Minerals (mg/100g) (d/b)	Karnal bunt infection (%)								
	0			5			10		
	Untreated	Debranned washed	Lye peeled	Untreated	Debranned washed	Lye peeled	Untreated	Debranned washed	Lye peeled
Ca	19.0	14.2	13.0	16.0	14.0	12.7	15.0	14.0	12.7
K	108	70	85	124	70	85	132	80	84
Mg	30.2	20.4	25.3	32.2	20.8	26.0	34.8	22.5	24.5
Fe	2.5	1.6	1.3	2.9	1.75	1.9	3.8	1.8	1.45
Mn	1.12	0.9	1.0	1.15	1.0	1.12	1.18	1.02	1.1
Zn	1.30	0.78	0.85	0.95	0.7	0.85	0.72	0.95	0.90

LSD (0.05) Ca 0.8; K 5.5; Mg 2.3; Fe 0.5; Mn 0.02 and Zn 0.03

TABLE 2. EFFECT OF PRETREATMENTS ON THE SPREADING AND SENSORY CHARACTERISTICS OF COOKIES PREPARED FROM SOUND AND BUNTED WHEAT FLOUR

	Karnal bunt infection (%)								
	0			5			10		
Characteristics	Untreated	Debranned washed	Lye peeled	Untreated	Debranned washed	Lye peeled	Untreated	Debranned washed	Lye peeled
Cookies spread factor	6.55	6.00	5.15	5.45	5.10	5.10	4.75	5.05	5.15
Appearance	9.0	8.8	8.7	5.2	8.6	8.5	3.5	8.2	8.3
Aroma	9.0	8.5	8.8	3.3	8.4	8.5	1.5	7.5	6.8
Taste	9.0	8.6	8.6	3.1	8.3	8.3	1.2	7.6	7.2
Texture	9.0	8.5	8.6	6.2	8.5	8.4	4.8	7.8	7.8
Colour	9.0	8.6	8.5	3.2	8.4	8.5	1.2	7.6	8.0
Overall acceptability	9.0	8.6	8.6	4.2	8.4	8.4	2.4	7.7	7.6

LSD (0.05) Cookie spread factor 0.5; Appearance 0.4; Aroma 0.3; Taste 0.3; Texture 0.3; Colour 0.3 Overall acceptability 0.4

TABLE 3. EFFECT OF PRETREATMENTS ON MINERALS COMPOSITION OF SOUND AND BUNTED WHEAT MEAL

	Karnal bunt infection (%)								
	0			5			10		
Minerals (mg/100g) (d/b)	Untreated	Debranned washed	Lye peeled	Untreated	Debranned washed	Lye peeled	Untreated	Debranned washed	Lye peeled
Ca	44.8	26.2	22.1	36.2	28.5	25.0	34.2	28.0	24.0
K	412	232	310	429	240	310	440	250	310
Mg	115	92	100	117	94	102	118	96	104
Fe	4.9	3.5	2.8	5.0	3.5	2.9	5.2	3.5	3.2
Mn	3.7	3.2	2.8	3.5	3.2	3.2	3.6	3.3	3.1
Zn	4.0	2.0	2.9	2.9	1.7	2.3	2.8	1.7	2.3

LSD (0.05) Ca 2.5; K 10.5; Fe 0.4; Mn, Ns and Zn 0.5

TABLE 4. EFFECT OF PRETREATMENTS ON THE SENSORY CHARACTERISTICS OF CHAPATIES PREPARED FROM SOUND AND BUNTED WHEAT MEAL

	Karnal bunt infection (%)								
	0			5			10		
Characteristics	Untreated	Debranned washed	Lye peeled	Untreated	Debranned washed	Lye peeled	Untreated	Debranned washed	Lye peeled
Appearance	6.2	6.8	7.0	3.5	6.5	6.7	2.0	5.4	5.6
Colour	5.5	6.5	7.0	2.0	6.3	6.7	1.2	5.6	5.9
Texture	6.2	6.4	5.5	4.3	6.1	5.2	3.0	5.6	5.7
Taste	6.7	6.3	6.0	2.8	6.2	6.0	1.0	5.4	5.5
Chewing	6.7	6.8	6.5	5.2	6.4	6.2	4.7	5.9	6.0
Overall acceptability	6.3	6.6	6.4	3.6	6.4	6.2	2.2	5.7	5.7

LSD (0.05) Appearance 0.4; Colour 0.4; Texture 0.4; Taste 0.4, Chewing 0.3; and Overall acceptability 0.4

respectively. Dough prepared from 10 per cent infected wheat meal was slightly sticky which turned into non-sticky upon debranning and lye peeling.

The puffing quality of chapaties from infected samples improved with debranning and lye peeling, which otherwise was poorer than that for the sound wheat samples. The sensory attributes of chapaties deteriorated with increase in bunt infection. The overall acceptability was considerably reduced by the bunt infection but was significantly improved by debranning and lye peeling (Table 4). The factors responsible for deteriorating the acceptability of chapaties were the same as earlier discussed for cookies.

The adverse effects of bunt infection on acceptability of cookies and chapaties can be overcome by debranning and lye peeling. However, debranning is commercially more feasible for the utilization of Karnal bunt infected wheat.

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Effect of Treatments Environment (Temperature, pH, Water Activity (a_w) on the Heat Resistance of Yeasts

M.A. AGAB* AND M. COLLINS
Queen's University of Belfast, Department of Agricultural and Food Bacteriology, Newforge Lane BT9 5PX

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Yeast cultures of *Debaromyces hansenii* Y-7268 *Kluyveromyces bulgaricus* SG 120, *K. fragilis* NCYC 587, *Saccharomyces cerevisiae* SG 271, *S. cerevisiae* NCYC 716, *S. chevalieri* SG 65 and *S. uvarum* PS 22 were used in this study. The highest survival levels in buffer occurred at pH 6 or occasionally at pH 5.4 and the lowest at pH 7, whilst in a_w reduced menstruum highest survivor levels at pH 6 and 7 and the lowest at pH 5.4, Plasmolysis of yeast cells conferred a higher degree of resistance to heat treatment especially where 60% sucrose was used as a plasmolysing agent enabling ⅔ yeasts used to survive 5°C higher temperatures than normal.

Whilst the temperature of the heat treatment will determine its lethality, the nature of the conditions during heating will affect the extent and expression of the heat resistance of a yeast strain. Cerny[1] found that the pH of the medium in which an organism is heated, has a profound effect on heat resistance. The resistance of bacteria is generally greatest when cells are suspended in a solution of pH 7. Yeasts and moulds behave similarly although, in general, lower pH values are optimal for the growth[2] of several strains of *Saccharomyces cervisiae* and *S. cerevisiae* var. *ellipsoideus* which are found to be more heat tolerant when heated in pH 4 buffer than in apple juice[3]. At a given pH and temperature, the heat sensitivity of yeasts was related to media composition. In *Saccharomyces cerevisiae*, citric acid exerted a protective effect, whereas rapid heat induced cell death in the presence of acetic acid[1].

The majority of studies on the relationship between heat resistance and water activity (a_w) have used bacteria[4]. However, a more detailed investigation using two strains of osmophilic yeasts suspended in solutions of sucrose or sucrose-glucose mixtures, showed an overall increase in heat resistance at lower a_w values although the relationship was not linear[5]. Lower levels of sugar (< 30 g/l) were found not to affect the heat resistance of *S. acidifaciens* and *S. oviformis*[6]. However, the tolerance of *S. rouxii* and *S. pombe* to temperature of 65°C was enhanced in phosphate buffer (pH 6.5) solutions containing sugars or polyols (a_w 0.95). Heat tolerance was maximal in solutions of glucose, fructose and glycerol[7]. The weight of evidence would seem to suggest that reduced a_w due to the presence of sugars does lead to an increase in heat resistance in a variety of microbes.

The severity of a heat treatment depends on both the temperature and time for which this temperature is applied[8]. *S. cerevisiae* var. *ellipsoideus* survived temperatures 58°C for 10 min in beer[9], whereas one strain of the same yeast species was killed by a temperature of 65°C applied for 20 min in a same heating menstruum[10].

Materials and Methods

Cultures used in this study were *Debaromyces hansenii* Y-7268, *Kluyveromyces bulgaricus* SG 120, *Kluyvermyces fragilis* NCYC 587, *Saccharomyces cerevisiae* SG 271, *Saccharomyces cerevisiae* NCYC 16, *Saccharomyces chevalieri* SG 65 and *Saccharomyces uvarum* PS 22.

All the yeast cultures were stored at 4°C on slopes of YM medium (Difco) contained in universal bottles. These storage slopes were subcultured every three months onto fresh CBS medium incubated at 25°C for 5 days before, returning them to storage at 4°C.

Yeast cultures were prepared as discussed before. Sorensen's phosphate buffer at pH 4, pH 5.4, pH 6 and pH 7 were used as heating menstruum in the heat treatment.

Effect of cell plasmolysis prior to heat treatment: Cells of Y-7268, SG 120 and SG 65 were placed in a series of concentrations of sucrose (Hopkins and Williams), glycerol (Koch light laboratories) or lactose (Hopkins and Williams) in YM broth (Difco). These sugars have been shown previously to plasmolyse yeast cells[4] and also in investigations on the effect of water activity (a_w) on heat resistance of microorganisms[8].

The water activities (a_w) of these media were measured at room temperature (20-22°C) using a humidity meter (Vaisala model HMP 140). This meter was calibrated to give a direct

**Present address:* Department of Microbiology and Industrial Fermentations, Food Research Centre, Khartoum North, P.O. Box 213, Sudan.

read out of broths containing glycerol and lactose, the a_w of sucrose broths had to be calculated using the meter readings and Tables[11]. Glycerol and lactose were calculated using the formula,[55.51] $\log a_w = Vm$.[11,12]

Plasmolysis: Yeast cells were plasmolysed using a series of sugar concentrations (e.g. sucrose, glycerol and lactose) in YM broth. Yeasts were incubated at 25°C for 48 hr in broths contained in universal bottles. A Durham tube had been introduced into each universal bottle to collect any gas produced, should the yeasts prove able to grow at these high sugar concentrations. After incubation, samples of the cells were examined microscopically and measured using an eye piece micrometer. Five fields were examined under the microscope and twenty plasmolysed cells and twenty normal cells were measured.

These concentrations were 60 per cent sucrose, 40 per cent glycerol and 45 per cent lactose, whilst other lower concentrations 10 and 40 per cent for sucrose, 10 and 25 per cent for glycerol and 10 and 20 per cnet for lactose. These sugar solutions were adjusted to pH 4, pH 5.4, pH 6 and pH 7 respectively as preheating menstrua.

Standard method for heat treatment used in this study was described in our previous paper[1].

Results and Discussion

Percentages 60 sucrose, 40 glycerol and 45 lactose in solution ensured that all the yeast cells became plasmolysed and so these levels of the compounds were incorporated into both the preheat treatment medium and the heating menstruum (Table 1). Under the microscope, plasmolysed cells showed shrinkage, although the exact nature of the shrinkage differed from cell to cell (Table 2).

Interaction between temperature, pH and time: The effect of pH of the heating menstruum on the interaction between temperature and time can be observed when the cultures were heated to 50°C as at higher temperatures the number of survivors were not significant. *K. Bulgaricus* SG 120 survived 50°C heat treatment in significantly greater numbers when heated for 10 or 20 min at pH 6 and 30 min at pH 5.4 (Table 3). Significantly, less numbers survived at pH 7 for three durations of heat treatment[11]. This marked effect due to temperature is hardly surprising when the relative lethalities of the processes were calculated. Taking 60°C as reference temperature and Z=5°C as a median typical value for yeasts[2], the lethality of the processes increased by an order of magnitude for each 5°C rise in temperature[8], whereas an increase in the time factor only created a linear increase in lethal value. For NCYC 587, survivor levels were significantly greater at pH 7 or pH 6 heated at 50°C for 10 and 20 min, while after 30 min, only a percentage survivors at pH 6 and pH 5.4 were significantly greater than those at pH 7 and pH 4 (Table 3). Whilst these optimal pH levels for heat tolerance are lower than those observed in bacteria[13-15], they are rather higher than the pH 3-5 range previously stated to be optimal for yeast[1,15]. In *S. cerevisiae* NCYC 716, significantly less numbers of yeasts survived in 50°C heat treatment at pH 7 (Table 3). A similar pattern occurred in *S. cerevisiae* SG 271 although in this case significantly higher numbers of yeasts were recovered at pH 6 after 50°C heat treatment at pH 4 after 55°C heat treatment (Table 3). *S. chevalieri* SG 65 again displayed a similar survivor pattern in that significantly less numbers of yeasts survived the 50°C heat treatment at pH 7 (Table 3). In this case, the highest survival rate occurred at pH 6 or at pH 5.4 after longer heat treatment. In *S. uvarum* PS 22 significantly higher number of yeasts survived the 50°C heat treatment at pH 5.4 or 4, and no difference in survival rates at pH 6 or 7.

Interaction between heating menstruum a_w and pH with the temperature and duration of heat treatment: Only very less number of *Debaromyces hansenii* Y-7268 survived even the mildest heat treatment in buffer or glycerol solution (Table 4). Significantly greater ($P > .05$) numbers survived the 50°C heat treatment in this solution; only in the mildest heat treatment (50°C for 10 min) did significantly more yeast survive in glycerol solutions than in the buffer. Differences in pH of the heating menstruum did not alter this picture (Table 5). In glycerol solution subjected to 50°C heating, significantly greater numbers of survivors were recovered from pH 4 menstruum. However, at the same temperature in sucrose solutions significantly different numbers of yeasts survived in the order pH 7>6 4>5.4. A slightly different pattern of survival occurred when heat treatments were done in menstrua of different pH values (Table 5). Significantly more yeasts survived 50°C when heated in buffer at pH 5.4 than other pH values, whilst the highest survivor levels came from glycerol solutions at pH 6 and sucrose solutions at pH 6 or 7 for the same temperature treatment. A reduction in the water availability (a_w) of the heating menstruum did lead to an increase in the heat tolerance of the yeasts tested.[1,3-5,13-15]. Significantly larger number of cells survived

TABLE 1. SUGARS PERCENTAGES AND THEIR WATER ACTIVITY

Sucrose percentage (% W/V)	Water activity (a_w)	Glycerol percentage (% W/V)	Water activity (a_w)	Lactose percentage (% W/V)	Water activity (a_w)
10	0.990	10	0.980	10	0.994
40	0.970	25	0.950	20	0.986
60	0.960	40	0.922	45	0.983

TABLE 2. MEAN CELL SIZES OF NORMAL AND PLASMOLYSED CELLS AFTER PLASMOLYSATION AND HEAT TREATMENT.

Organisms	SG 65 Cell size (μm)	Y-7268 cell size (μm)	SG 120 cell size (μm)
Normal cells ($\bar{x}$)	3.03 × 1.17	1.9 × 1.2	2.77 × 1.17
Plasmolysed cells ($\bar{x}$)	1.93 × 0.83	1.23 × 0.9	2.17 × 0.69
Heated 60°C/10 min/ plasmolysed cells ($\bar{x}$)	1.7 × 0.73	0.9 × 0.73	1.53 × 0.63

TABLE 3. EFFECT OF HEATING MENSTRUUM, pH AND DURATION OF HEAT TREATMENT ON THE ABILITY OF YEAST TO SURVIVE TEMPERATURE STRESS (SURVIVAL PERCENTAGE)

Time (min)	50°C				55°C				60°C			
	pH 7	pH 6	pH 5.4	pH 4	pH 7	pH 6	pH 5.4	pH 4	pH 7	pH 6	pH 5.4	pH 4
					K. bulgaricus (SG 120)							
10	23.597	86.183	64.447	33.623	0.850	6.623	1.877	0.990	0.000	0.010	0.001	0.017
20	18.843	70.593	59.877	30.980	0.497	1.120	2.020	0.227	0.000	0.007	0.000	0.010
30	10.990	30.867	45.260	20.083	0.170	0.543	0.397	0.090	0.000	0.000	0.000	0.010
SED = 4.32; LSD = 8.91; (0.05)												
					K. fragilis (NCYC 587)							
10	35.390	43.727	12.013	18.227	0.999	0.210	0.010	0.000	0.000	0.000	0.000	0.000
20	24.663	29.900	7.540	11.680	0.000	0.033	0.003	0.000	0.000	0.000	0.000	0.000
30	12.660	18.110	2.290	4.490	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SED = 5.97; LSD = 13.00; (0.05)												
					S. cerevisiae (NCYC 716)							
10	41.110	68.857	59.390	63.603	3.023	4.013	21.677	25.093	1.153	0.017	0.000	0.000
20	20.953	49.807	50.967	52.645	2.050	2.107	17.033	16.433	0.000	0.007	0.000	0.000
30	13.887	25.163	40.043	32.987	1.503	1.607	14.540	13.010	0.000	0.000	0.000	0.000
SED = 7.85; LSD = 16.16; (0.05)												
					S. cerevisiae (SG 271)							
10	15.643	83.203	78.500	54.810	1.477	7.223	10.070	26.043	0.130	0.000	0.000	0.000
20	9.310	65.037	52.957	50.673	0.833	2.633	6.257	14.571	0.000	0.000	0.000	0.000
30	4.517	55.583	45.020	36.860	0.600	1.188	2.430	12.993	0.000	0.000	0.000	0.000
SED = 3.96; LSD = 8.15; (0.05)												
					S. chevalieri (SG 65)							
10	13.230	82.410	67.310	44.289	1.093	2.947	9.543	3.303	0.000	0.007	0.001	0.001
20	9.113	52.323	50.063	34.573	0.093	0.493	0.450	1.230	0.000	0.000	0.001	0.000
30	6.357	38.463	42.200	21.730	0.047	0.273	3.620	0.467	0.000	0.000	0.000	0.000
SED = 2.91; LSD = 5.99; (0.05)												
					S. uvarum(PS 22)							
10	49.263	49.573	66.220	75.950	6.570	3.393	4.232	4.337	0.000	0.000	0.000	0.000
20	41.747	45.087	61.137	55.573	1.693	1.677	1.647	0.913	0.000	0.000	0.000	0.000
30	29.659	36.237	46.700	47.640	0.237	0.800	0.767	0.430	0.000	0.000	0.000	0.000
SED = 4.99; LSD = 10.86; (0.05)												

TABLE 4. EFFECT OF MENSTRUUM A_w AND DURATION OF HEAT TREATMENT OF THE ABILITY OF *DEBAROMYCES HANSENII* Y-7268 TO SURVIVE TEMPERATURE STRESS (SURVIVAL PERCENTAGE)

Time (min)	Buffer 0.2 M		Sucrose (60%)		Glycerol (40%)	
	50°C	55°C	50°C	55°C	50°C	55°C
10	0.145	0.000	15.680	0.020	5.040	0.000
20	0.110	0.000	11.387	0.001	0.507	0.000
30	0.600	0.000	7.176	0.000	0.040	0.000
SED = 1.33; LSD = 2.89; (0.05)						

50°C heat treatment in buffer at pH 5.4, glycerol solution at pH 6 and sucrose solution at pH 7 than that of other pH values (Table 5). However, more cells survived the 55°C treatment in sucrose solutions at pH 6 and 60°C treatment in pH 4. In *K. bulgaricus* SG 120, there was no significant difference between the numbers of yeast, surviving heat treatments in buffer or glycerol solutions (Table 6). Significantly ($P > 0.05$) higher numbers survived the 50°C heat treatments in the sucrose solutions compared to the other heating menstrua and low levels of yeasts even survived the highest temperature treatment.

TABLE 5. INTERACTION BETWEEN pH, TEMPERATURE AND HEATING MEDIUM a_w ON THE SURVIVAL (PERCENTAGE) OF YEAST

Heating temp (°C)	Buffer 0.2 M				Sucrose (60%)				Glycerol (40%)			
	pH 7	pH 6	pH 5.4	pH 4	pH 7	pH 6	pH 5.4	pH 4	pH 7	pH 6	pH 5.4	pH 4
					D. hansenii Y-7268							
50	0.227	0.000	0.160	0.033	22.333	14.530	0.060	8.733	0.343	0.297	1.137	5.673
55	0.000	0.000	0.000	0.000	0.001	0.023	0.000	0.003	0.000	0.000	0.000	0.000
SED = 1.53; LSD = 3.34; (0.05)												
					K. bulgaricus (SG 120)							
50	2.970	47.220	75.827	17.940	82.943	89.237	19.297	28.480	36.360	68.237	27.033	10.463
55	0.103	0.230	7.200	0.270	23.800	28.660	0.535	22.793	1.127	1.757	1.390	0.287
60	0.000	0.017	0.000	0.001	2.963	2.523	0.080	11.423	0.047	0.015	0.123	0.043
65	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.057	0.000	0.000	0.000	0.000
SED = 4.56; LSD = 9.25; (0.05)												
					S. chevalieri (SG 65)							
50	3.017	50.713	85.127	50.303	85.013	58.177	17.997	36.617	29.433	54.293	28.867	30.287
55	0.113	0.110	15.610	1.373	4.373	62.220	3.387	27.207	0.260	0.777	1.877	1.293
60	0.000	0.000	0.002	0.001	1.423	2.080	0.047	13.633	0.002	0.015	0.080	0.123
65	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.035	0.000	0.000	0.000	0.000
SED = 3.15; LSD = 6.40; (0.05)												

TABLE 6. EFFECT OF MENSTRUUM a_w AND DURATION OF HEAT TREATMENT ON THE ABILITY OF YEAST TO SURVIVE STRESS (PERCENTAGE SURVIVAL)

Time (min)	Buffer 0.2 M				Sucrose (60%)				Glycerol (40%)			
	50°	55°C	60°C	65°C	50°C	55°C	60°C	65°C	50°C	55°C	60°C	65°C
					K. bulgaricus (SG 120)							
10	46.998	4.867	0.008	0.000	68.098	26.375	7.373	0.028	47.675	2.140	0.085	0.000
20	40.183	0.908	0.005	0.000	55.208	17.393	3.153	0.010	34.093	0.735	0.055	0.000
30	20.788	0.077	0.077	0.000	41.663	13.070	2.217	0.005	24.802	0.545	0.032	0.000
SED = 3.95; LDS = 8.02; (0.05)												
					S. chevalieri (SG 65)							
10	55.335	6.927	0.002	0.000	57.692	27.288	6.468	0.023	46.425	1.845	0.084	0.000
20	48.350	3.340	0.001	0.000	48.203	25.585	4.000	0.005	36.260	0.770	0.050	0.000
30	38.185	2.637	0.000	0.000	42.458	20.018	2.420	0.001	24.475	0.543	0.032	0.000
SED = 2.73; LSD = 5.54; (0.05)												

At higher temperature treatments, significantly higher numbers survived in sucrose than the other two heating menstrua, but the pH values at which maximum survival occurred did alter, being pH 7, 6 or 4 for the 55°C heat treatment and pH 4 for the 60°C treatment. Whilst significantly greater numbers of *S. Chevalieri* SG 65 survived in sucrose solution following the 50, 55 and 60°C (10 min only) heat treatments (Table 5) than in the other heating menstrua, in this case a significantly larger number survived the 50°C treatment in buffer solution as compared to glycerol solution. As with SG 120, at least some cells of SG 65 survived the 65°C heat treatments in sucrose solution.

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Effect of Heat Treatment on Aerobically and Anaerobically Grown or Starved Yeast Cell in Different pH Menstrua

M.A. AGAB* AND M. COLLINS
Queen's University of Belfast Department of Agriculture and Food Bacteriology, Newforge Lane BT9 5PX

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Yeasts used in this study were *Hansenula subpelliculosa* Y-1096, *Kluyveromyces bulgaricus* SG 120, *Kluvyveromyces lactic* Y-8279, *Saccharomyces cerevisiae* NCYC 716 and *Saccharomyces uvarum* PS 22. Yeasts grown anaerobically before heat treatment displayed higher levels of survival only at the lowest treatment temperature used (50°C). This might be explained by either changes in membrane lipid composition or the reduction in levels of cytochrome oxidase in cells grown under anaerobic conditions. Cell starvation prior to heat treatment only enabled yeasts to withstand the same heat treatements as normally grown cells although in 2/3 of the yeasts tested a significant ($P > 0.05$) higher proportion of heat treated starved cells survived any one heat treatment.

Saccharomyces cerevisiae when grown under anaerobic conditions, the cells become auxotrophic for a sterol and unsaturated fatty acid[1], thus reflecting the oxygen membrane components[2]. Molecular oxygen is required both in the cyclization of squalene[3], to form lanosterol and for the demethylation and desaturation reaction[4] involved in the conversion of lanosterol to ergosterol, the principle yeast sterol[5].

Sterols are essential components of functional yeast membranes, where they serve a structural role. Studies of model membranes[6] have revealed that they exert a condensation effect which increases order and rigidity in the membrane structure[7]. The observation that the levels of sterols and fatty acids in a cellular membrane are important in determining the degree of membrane integrity available to protect the cell from heat stress[1] highlights the importance of aerobic growth conditions in contributing to the degree of heat tolerance in yeast cells. Procaryotic organisms are not affected in the same way as they have the ability to synthesize unsaturated fatty acids under anaerobic conditions[8].

Other metabolic processes in yeasts are affected by the redox level of the growth environment, even the control of respiratory activity itself. The respiratory activity of yeast was under the control of catabolic repression. Tustanoff and Bartley[9] demonstrated that yeasts grown anaerobically on galactose retain their ability to respire, the activity of cytochrome oxidase being about one-third that of an aerobic inoculum. Cells grown anaerobically on glucose contained virtually no cytochrome oxidase and could not immediately respire prior to induction of this enzyme. A similar catabolic repression has been described for the formation of succinate dehydrogenase in yeasts[10]. As respiratory activity has been shown to be important in the recovery of cells from heat shock[11], these changes induced by anaerobiosis may prove important in determining the heat resistance of yeast cells.

Materials and Methods

The following yeast cultures were used in this study which were presumed to show some degree of tolerance to heat treatment: *Hansenula subpelliculosa* NRRLY-1096, *Kluyveromyces bulgaricus* SG 120, *Kluyveromyces lactis* NARRLY-8279, *Saccharomyces cerevisiae* NCYC 716 and *Saccharomyces uvarum* PS 22.

All yeast cultures were stored at 4°C on slopes of YM Agar (Difco)[12] contained in universal bottles. These storage slopes were subcultured every three months onto fresh YM Agar (Difco) incubated at 25°C for 5 days before returning them to storage at 4°C. Yeast cultures in late log phase and old cells were taken for heat treatment.

Aerobic or anaerobic growth prior to heat treatment: Yeast (SG 120, NCYC 716, PS 22) were grown in aerobic conditions at 25°C for 4 days using a shake culture media. All cultures of yeasts were grown in 100 ml YM broth in 500 ml conical flasks and shaken on an orbital shaker (L H Engineering MKV) at 300 r.p.m. for 4 days at 25°C. Anaerobic growth conditions were achieved by placing the inoculated YM broth in conical flasks and incubating them under an atmosphere of nitrogen in an anaerobic cabinet (Forma scientific anaerobic system model 1024) for 4 days at 25°C.

Preparation of starved yeast cells prior to heat treatment: Shaken cultures of Y-8279, Y-1096 and SG 120 grown at 25°C

Present address: Department of Microbiology and Industrial Fermentation, Food Research Centre, Khartoum North, P.O. Box 213, Sudan.

for 48 hr were harvested by centrifuging at 2500×g for 15 min at room temperature. The supernatant medium was decanted and the yeast pellet re-suspended in sterile distilled de-ionised water and re-centrifuged under the above conditions. Again, the supernatant was decanted and the pellet re-suspended in physiological saline and incubated at 25°C for 24 hrs before use.

Standard method for heat treatment: Yeast cells were recovered from growth media or pre-treatment solutions by centrifugation (2500×**g**) for 15 min at room temperature. The cells were washed by re-suspending them in sterile distilled water and recentrifuging. The cells were then re-suspended in the required heating menstruum. The cell concentration was checked using a haemocytometer and adjusted to give $10^6 ml^{-1}$. Aliquots (10 ml) of this suspension of four different pH 4, 5, 6 and 7 were transferred to sterile 16×150 mm medium wall bacteriological rimless glass test tubes closed with aluminium caps. Three replicate tubes were transferred to each water bath and heated at 50, 55, 60, or 65°C for 10, 20 and 30 min. The relevant come up times were allowed for, in each case, times and temperatures being checked during each experiment using a thermocouple thermometer. After each time interval, one tube was removed from each bath and the numbers of survivors determined using the standard recovery procedure. Each experiment was repeated three times.

Standard recovery method: The tubes containing the suspension of yeasts were removed from the heat water baths after the required tine interval and allowed to cool at room temperature (18-20°C) for one hour. Serial dilutions were made with physiological saline as required and aliquots (0.1 ml) were removed aseptically from the tubes and spread onto the surface of the plates of Malt Extract Agar (Oxoid) in triplicate. These plates were then incubated at 25°C for 5 days before counting.

Results and Discussion

Effect of growth under aerobic or anaerobic conditions: A significantly higher ($P > 0.05$) percentage of cells of (NCYC 716) survived heat treatment at 50°C for 10 and 20 min when cultures were grown anaerobically prior to heat treatment (Tables 1 and 2) at pH values, although the observations for *K. bulgaricus* SG 120 and *S. uvarum* PS 22 were complicated by the interaction of pH with the heat treatment. The results from experiments in which the interaction between incubation in aerobic or anaerobic conditions prior to heat treatment in menstrua of different pH values present a more complex picture. PS22 anaerobically grown demonstrated a significantly ($P > 0.05$) higher survival rate at pH 7 and pH 6, while at pH 4 the opposite effect was observed (Table 2). In SG120, anaerobically grown cells showed a higher survival rate to heating (50°C) only at pH 6 (Table 2). One possible explanation for the observed heat tolerance may be the differences in the compositions of the cell membrance. Under anaerobic conditions, yeasts become auxotrophic for sterols. Thus, it is probable that the fatty acid composition of lipids in cellular membranes especially the cell membrane would be altered, which give rise to an increase in structural rigidity and stability of the cell membrane[1].

TABLE 1. EFFECT OF AEROBIOSIS OR ANAEROBIOSIS ON THE SURVIVAL OF YEAST SUBJECTED TO VARIOUS HEAT TREATMENTS (PERCENTAGES).

Time (min)	Aerobically grown yeast heated to indicated temp. 50°C	55°C	60°C	Anaerobically grown yeast heated to indicated temp. 50°C	55°C	60°C
			S. cerevisiae (NCYC 716)			
10	25.948	0.440	0.000	77.305	0.132	0.002
20	5.010	0.205	0.000	45.165	0.110	0.000
30	3.990	0.095	0.000	12.608	0.078	0.000
SED = 4.580; LSD = 11.220; (0.05)						
			S. uvarum (PS 22)			
10	61.890	0.860	0.000	74.160	0.737	0.000
30	49.218	0.175	0.000	58.943	0.595	0.000
30	36.010	0.010	0.000	26.005	0.050	0.000
SED = 6.530; LSD = 16.020; (0.05)						
			K. bulgaricus (SG 120)			
10	46.998	4.869	0.008	60.520	0.768	0.035
20	41.133	0.908	0.005	46.715	0.258	0.030
30	20.338	0.077	0.000	33.545	0.098	0.017
SED = 6.310; LSD = 13.770; (0.05)						

Effect of starving cells prior to heat treatment: Both normal and starved cells of *K. bulgaricus* SG 120 failed to survive heat treatment at 60 and 65°C. However, considerable numbers survived heat treatments at 50°C (Fig. 1 a) and 55°C (Fig. 1 b). Significantly higher numbers ($P > 0.05$) of starved cells survived as compared to normal cells for all treatment lines at these temperatures. A somewhat different explanation

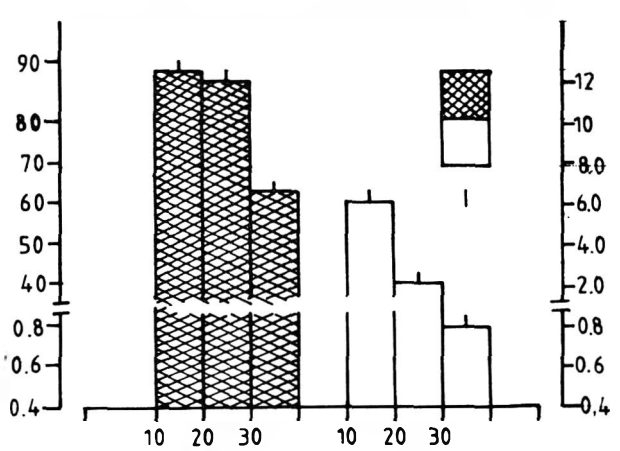

Fig. 1 a. Percentage of starved and normally grown cells of *K. bulgaricus* SG 120 surviving heat treatment at 50°C for several time periods.

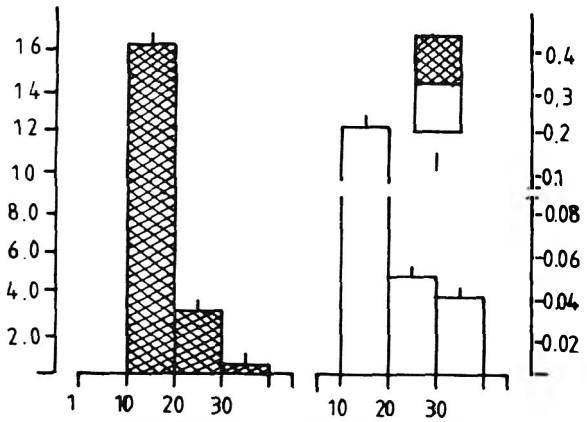

Fig. 1 b. Percentage of starved and normally grown cells of *K. bulgaricus* SG 120 surviving heat treatment at 55°C for several time periods.

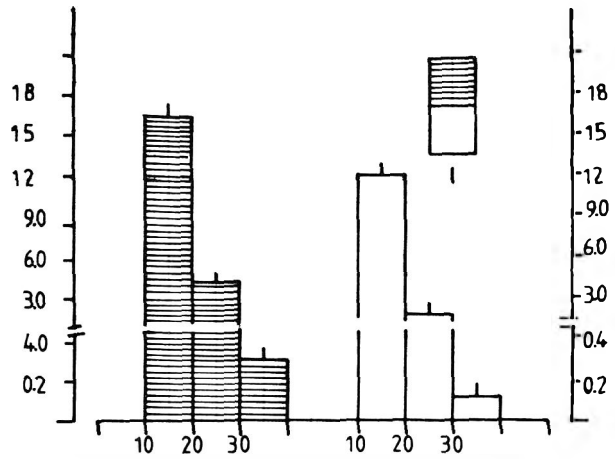

Fig. 2. Percentage of starved and normally grown cells of *K. lactis* Y-8279 surviving heat treatment at 50°C for several time periods.

is based on the difference in metabolic activity between aerobically and anaerobically grown cells. Yeasts grown anaerobically in the presence of glucose (present in YM broth) contain extremely low levels of cytochrome oxidase and thus cannot respire immediately upon return to aerobic conditions[9]. Thus, resting cells have been found to be more resistant to heat stress[15]. Significantly higher numbers of *K. lactis* Y-8279 starved cells survived 50°C heat treatment (Fig. 2). Although starved cells of *H. subpelliculosa* Y-1086 survived the lowest temperature (50°C) of heat treatment for 10 min only, there were no differences between the percentage survival of normally grown or starved cells after longer heat treatments (Fig. 3). However, respiration is necessary for recovery from heat shock[11] and so such a delay in active respiration may only confer a limited increase in heat tolerance of yeast cells.

Although starved cells of SG 120 and Y-8279 withstood the same heat treatments as normally grown cells, the proportion of cells surviving was significantly ($P > 0.05$) higher. The opposite effect was observed for the mildest heat treatment (50°C, 10 min) on Y-1096. That starved cells should show some form of increased resistance to heat shock was not unexpected as resting cells have been shown to be more resistant to heat than active cells[12] as have stationary phase cells[13-15]. However, while the cells used by these workers may have been relatively inactive they may not necessarily have been starved. These starved cells are likely to have used up their carbon reserves normally stored in the form of glycogen and trehalose[16]. As relatively high concentrations of the carbohydrate trehalose have been correlated with the

TABLE 2. EFFECT OF HEATING MENSTRUM pH ON THE SURVIVAL (%) OF AEROBICALLY AND ANAEROBICALLY GROWN YEAST CELLS SUBJECTED TO VARIOUS HEAT TREATMENTS.

Heating temp. (°C)	Aerobically grown cells				Anaerobically grown cells			
	pH 7	pH 6	pH 5.4	pH 4	pH 7	pH 6	pH 5.4	pH 4
				S. cerevisiae (NCYC 16)				
50	10.877	25.697	6.067	3.957	28.143	50.393	59.817	41.750
55	0.273	0.353	0.190	0.170	0.053	0.187	0.143	0.034
60	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001
				SED = 5.290; LSD = 11.530; (0.05)				
				S. uvarum (PS 22)				
50	6.420	39.063	71.233	79.440	46.960	77.217	61.817	26.150
55	0.000	0.680	0.703	0.013	0.417	0.503	0.590	0.333
				SED = 7.540; LSD = 18.490; (0.05)				
				K. bulgaricus (SG 120)				
50	2.970	47.220	76.493	17.940	10.013	75.307	72.183	30.203
55	0.103	0.230	7.200	0.270	0.107	0.457	0.300	0.633
60	0.000	0.017	0.000	0.001	0.020	0.030	0.000	0.060

SED = 7.290; LSD = 15. 900; (0.05)

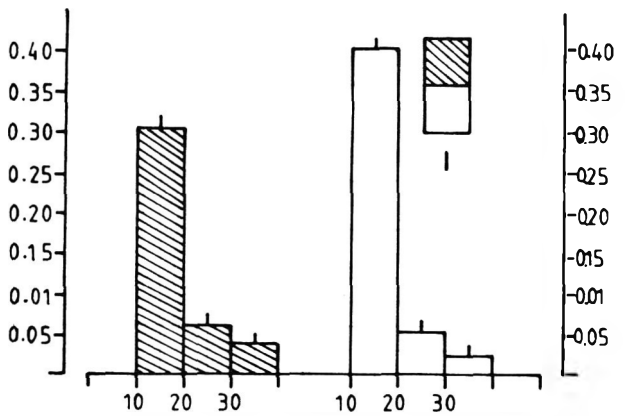

Fig. 3. Percentage of starved and normally grown cells of *Hansenula subpelliculose* Y-1096 surviving heat treatment at 50°C for several time periods.

level of heat tolerance in *Dictyostelium discoideum*[17], it is possible that both the degrees of inactivity of the yeast cells and the relative amounts of storage compounds remaining in the cells could explain differences in heat tolerance between the three yeasts tested after treatment.

Thus, it can be seen that the conditions under which yeast cells have been grown, their nutritional and water status all affect the extent to which any particular genus, species or strain are able to survive heat treatment.

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Effect of Grain Texture on Various Milling and End Use Parameters of Newly Bred Advanced Triticale (Wheat × Rye) Lines

A. K. SAXENA, A.K. BAKHSHI, K.L. SEHGAL AND G.S. SANDHA
Quality Evaluation Section, Department of Plant Breeding,
Punjab Agricultural University, Ludhiana, India

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With the increase in grain hardness, there was a significant decrease in ash content of flour. Soft textured triticales contained a significantly higher amount of protein in the flour. With increase in hardness, a significant decrease was observed in loaf as well as specific volumes. The cookies prepared from soft and medium hard textured triticales recorded significantly higher cookie spread as compared to cookies from hard textured triticales. The soft and medium hard textured triticales recorded significantly higher break fraction B_1 & break fraction B_2 as also flour yields. The reduction fraction C_3, finished flour and shorts were significantly higher in hard triticales which recorded significantly lower bran recoveries.

Grain texture plays an important role in various milling and baking characteristics such as the degree of grain hardness, water requirements for tempering the grains before milling, damaged starch produced during milling, flour yield and various changes in baking properties of flour. It has been observed that hardness is inherited separately[1,2]. A change in gene for hardness causes a change in type of protein stored within the grain. The protein matrix which entraps the starch granules, determines the degree of grain hardness[3]. A large number of practical tests are used to assess the degree of hardness of the grains[4–7].

Triticale lines generally have shrivelled kernels which are soft and are easily attacked by insects during storage. This limits its commercial acceptability by milling and baking industry. However, with long lasting efforts some triticales have been developed by breeders at Punjab Agricultural University, Ludhiana which contain plump grains with higher test weights and good baking potentials, ranging from soft to hard in texture. The studies were thus conducted to determine the effects of grain hardness on various processing properties of newly developed triticale lines.

Materials and Methods

Approximately 3 kg each of triticale samples were procured in 1990 from the Department of Plant Breeding, PAU, Ludhiana. These samples were cultivated under State trials using RB design. The recommended package of practices of the University i.e. 6 irrigations, 50 kg N, 25 kg P and 12 kg K fertilizer per hectare were used. The statistical analysis was performed using analyses of variance technique[8]. The hardness was determined by the pearling method[9], using a barley pearler (Scott, 7810 model). Based on pearling index values, triticales were categorised as follows:

Hard : TL 1217, TL 1417, TL 1714, TL 1750, TL 1750, TL 1771, TL 2088 and TL 2089 with pearling index values below 29. 0 per cent.

Medium Hard : TL 419, TL 688, TL 1012, TL 1957, TL 2078, TL 2091 and TL 2222 with pearling index values between 29.1 and 40.0 per cnt.

Soft : TL 1210, TL 1414, TL 2161, TL 2313, TL 1368, TL 1772 and TL 1762 with pearling index values of 40.1 per cent and above.

For milling, the triticales were conditioned to 14 per cent moisture for 24 hr and milled in the Buhler, pneumatic experimental mill (MLU-202). The feed rate was adjusted to about 100 g/min. The shorts were dusted in the Buhler bran finisher. The break (B_1, B_2, and B_3), reduction (C_1, C_2 and C_3) and bran dusted flour fractions (FF) were combined homogeneously to obtain straight-run flour which was sifted through a 40 mesh sieve twice to ensure uniformity of the lots. The yield of straight run flour, bran and shorts were expressed on the basis of the milled products weight (14 per cent moisture basis). The milling value was calculated by dividing flour yields by ash per cent and multiplying the figure by 100.

The chemical constituents such as moisture, protein (N×5.83), ash, sugars, diastatic activities, glutens and cookie as well as bread characteristics were estimated by the AACC methods[10], with slight modifications in fermentation schedule as followed at CIMMYT[11]. Chapati making characteristics were evaluated according to the method of Austin and Ram[12].

Results and Discussion

Grain and flour characteristics: As the grain hardness increased, the ash content of flour decreased significantly

(Table 1), The hard triticales contained the least amount of ash (0.44 per cent) while that in the flour varied from 0.39 to 0.47 per cent (Table 2). In hard category 'TL 1771' recorded the least ash (0.39 per cent) indicating its good milling quality. Significantly higher flour protein values were observed in the soft textured triticales, which could be attributed to passage of more bran into flour during milling. Amaya *et al.*[13] attributed the higher protein values of flour of some of the soft triticales to large pericarp to endosperm ratios: the pericarp contributing more protein than that of the plump grain. The differences in grain weight, grain protein, sugars, diastatic activities, gluten and water absorption amongst triticales of soft, medium hard and hard texture were non-significant.

Milling characteristics: The soft and medium hard textured triticales recorded significantly higher flour yields as compared to hard textured triticales (Table 2). The flour recoveries ranged from 64.5 to 70.6 and 51.2 to 67.4 per cent in soft and medium hard categories respectively. The flour recoveries of above 65 per cent were recorded by 'TL 1210' 'TL 2313', 'TL 1398' and 'TL 1792' in soft category and by 'TL 688', 'TL 1012' in medium hard category. In hard category, flour yields ranged from 39.3 to 54.6 per cent with mean being 48.4 per cent (Tables 1 and 2). The recoveries of above 50 per cent in hard group were recorded by 'TL 2088'. 'TL 2089' and 'TL 1417', Obunchawski and Bushak[14] also stated that hard triticales resemble more to durum wheat than bread wheats as both durum and hard triticales produce lower flour yields due to difficulty to mill endosperm. Similar conclusion was also drawn by Amaya *et al.*[13], from evaluation of triticales having pearling index values between 13 and 20. However, the flour yield values in triticale in the present studies were lower as compared to hard wheat flour recoveries (72.4 per cnet). Similar results were also reported by Bakhshi *et al.*[15], Farrel *et al.*[16], Lorenz[17] and Stringfellow *et al.*[18], Amaya[19] and Skovand *et al.*[20], reported that flour yields of some triticales increased from 50 to 68 per cent by appropriate tempering and roll adjustment.

Amongst the break flour fractions, the B_1 and B_2 fractions were significantly higher in soft and medium hard textured

TABLE 1. PHYSICO-CHEMICAL CHARACTERISTICS OF DIFFERENT TEXTURED TRITICALES

Characters	Hard			Medium			Soft			C.D. at	
	Mean	Range	CV	Mean	Range	CV	Mean	Range	CV	5%	5%
100 grain wt. (%)	40.2	35.5–43.5	5.9	41.62	35.5–45.5	7.4	41.25	39.3–43.5	3.6	NS	NS
Flour ash (%)	0.44	0.39–0.47	6.8	0.50	0.49–00.57	6.0	0.59	0.45–00.70	15.0	0.068	0.095
Grain protein (%)	12.47	11.4–13.9	7.6	11.41	11.8–14.3	8.4	12.91	11.4–13.6	5.6	NS	NS
Flour proteins (%)	10.74	9.8–11.7	7.0	11.18	10.7–11.7	3.2	11.96	11.2–12.8	5.5	0.78	1.09
Reducing sugars (mg)	45	25–65	28.8	51	36–65	14.0	46	36–60	15.8	NS	NS
Non-reducing sugars (mg)	170	157–218	17.2	170	138–209	15.0	160	123–204	77.2	NS	NS
Diastatic activity (units)	503	445–558	7.8	502	465–527	4.1	517	485–542	4.0	NS	NS
Dry gluten (%)	6.65	4.2–9.1	8.6	6.77	3.2–8.0	7.2	6.44	5.5–7.8	5.0	NS	NS
Wet gluten (%)	20.7	12.4–27.4	7.9	20.9	18.0–22.6	22.2	17.94	15.8–21.8	46.6	NS	NS
Water absorption (%)	62.6	61.0–64.5	1.6	62.71	61.0–65.0	2.5	63.57	61.0–66.0	2.6	NS	NS

CV = Coefficient of variation.

TABLE 2. MILLING CHARACTERISTICS OF DIFFERENT TEXTURED TRITICALES.

Characters	Hard			Medium			Soft			C.D. at	
	Mean	Range	CV	Mean	Range	CV	Mean	Range	CV	5%	5%
Break fractions											
B_1 (g)	21.71	17–30	23.5	51.29	40–65	16.6	56.00	48–61	8.6	7.89	11.06
B_2 (g)	49.10	17–63	30.7	70.10	62–89	14.8	69.57	62–75	7.4	9.60	13.49
B_3 (g)	14.00	12–18	15.7	17.90	14–22	17.3	22.30	15–54	6.2	NS	NS
Reduction fractions											
C_1 (g)	225.9	200–263	10.6	423.6	311–494	14.0	948.7	397–490	7.9	54.88	76.92
C_2 (g)	163.4	142–187	10.3	183.1	124–200	16.7	197.0	162–216	8.7	NS	NS
C_3 (g)	148.7	133–175	9.4	104.7	74–132	19.0	105.9	32–133	36.2	30.40	42.60
Finished flour (g)	119.4	78–142	16.8	64.9	41–115	36.5	55.4	37–70	22.3	22.72	31.83
Straight grade flour (g)	738.7	677–819	7.6	937	755–1011	9.4	762	213–1058	50.4	NS	NS
Milling value	57.4	51.5–66.7	10.3	58.8	44.9–67.7	12.7	58.4	45.2–71.7	15.9	NS	NS
Bran (%)	182.3	123–300	33.1	268.9	208–300	4.2	252.4	159–330	21.7	81.80	72.89
Shorts (%)	561.3	495–618	7.2	205.3	165–357	33.3	189.1	165–315	29.5	74.18	103.96
Flour yield (%)	48.4	39.3–54.6	20.9	63.0	51.2–67.4	8.8	67.1	64.5–70.6	4.6	6.45	9.04

CV = Coefficient of variation

TABLE 3. BAKING CHARACTERISTICS OF DIFFERENT TEXTURED TRITICALES.

Characters	Hard			Medium			Soft			C.D. at	
	Mean	Range	CV	Mean	Range	CV	Mean	Range	CV	5%	1%
Loaf vol (ml)	483.6	450–525	6.2	572.85	500–630	6.4	576.4	520–705	10.5	60.73	93.51
Special vol (ml/g)	3.3	2.9–3.7	7.8	3.9	3.4–4.5	10.2	3.82	3.7–4.5	9.3	0.408	0.571
Score	15.0	10–18	18.0	21.28	18–26	14.0	19.28	15–29	24.8	4.76	6.67
Cookie width (cm)	5.0	4.9–5.2	2.0	5.14	4.9–5.3	1.9	5.14	5.0–5.3	1.9	0.12	0.17
Cookie thickness (cm)	1.2	1.1–14	8.3	1.27	1.2–1.4	5.5	1.23	1.1–1.4	7.3	NS	NS
W:T	4.16	3.7–4.5	7.2	4.07	3.7–4.5	7.3	4.29	3.6–4.7	6.9	NS	NS
Chapati score	16.0	14–18	9.4	16.85	14–22	16.6	16.57	12–22	20.5	NS	NS

CV = Coefficient of variation

triticales. Out of the reduction streams, the soft and medium hard categories recorded significantly higher C_1 yields. The C_3 and finished flour yields were however, significantly higher in hard textured triticales. The shorts recoveries increased significantly with increase in hardness, whereas, bran recoveries were significantly lower in hard triticales. The differences amongst B_3, C_2, straight grade, flour and milling values were however, non-significant.

End use characteristics: As the hardness of grains increased in triticales, the loaf volumes and specific volumes decreased signifincantly (Table 3). In soft and medium hard categories, loaf volumes ranged between 520 and 705 ml (mean 576 ml) and 500-603 ml (mean 572 ml) respectively than hard category 450-525 ml (mean 483 ml). 'TL 1210' and 'TL 1792' recorded more than 600 ml loaf volumes. Amaya *et al.*[13], also reported a variation of 460-685 ml in different categories of triticale. The breads from soft (19.2) and medium hard categories (21,3) obtained significantly higher scores as compared to hard textured (15) triticales. The cookies spread ranged from 4.9 to 5.3 mm in soft triticales and this was significantly higher compared to that in hard category. 'TL 1210' produced cookies with maximum width of 5.6 mm. Amaya *et al.*[13], found that triticales from hard and semi-hard classes produced compact cookies with low spread factor values, as well as cakes with low volume and unsatisfactory crumb characters. In contrast, soft triticales resulted in good spread factor, satisfactory cookie quality and produced cakes with large volume and moist and open crumb. The variations were also observed for cookies thickness, width and chapati score. These differences were, however, non-significant.

It could thus be concluded that some of the newly developed lines of triticale are promising with respect to grain hardness, various quality parameters as well as end use characteristics. With an increase in hardness of triticales, various milling and baking characteristics are inversely affected. Hence from the point of view of quality improvement in triticales, efforts should be made to develop medium hard textured triticales so that admixture of triticale and wheat in commercial channels does not affect the milling and baking industry.

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Studies on Selected Functional Properties of Defatted Whole and Processed Kenaf (*Hibiscus cannabinus* L.) Seed Flour

D.R. MORE, V.D. PAWAR, H.W. DESHPANDE AND D.J. NIMKAR
Department of Biochemistry and Applied Nutrition,
Marathwada Agricultural University, Parbhani-431 402, India.

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Selected functional properties of defatted whole and processed kenaf seed flour were studied. The dehulled flour contained highest protein (39.8%), lowest fibre (3.3%) and phytic acid (3.04%) compared to flours of cake and whole seed. The dehulled flour exhibited strikingly better functional properties and was comparable with those of soybean. The removal of seed coat fractions including fibre and phytic acid in dehulled flour improved the functional properties. The dehulled expeller press cake flour although showed improvement in some functional properties than whole flours, it was poor in nitrogen solubility, foaming and emulsion properties due to heat denaturation of proteins.

The kenaf (*Hibiscus cannabinus* L.) is a crop grown throughout the world, primarily for fibre production. However, the seeds contain 21.0 per cent oil and 25.0 per cent protein[1] and therefore can be exploited as a potential source of protein and energy. In India, kenaf seeds are traditionally pressed in an expeller to remove a major part of oil and the pressed cake is widely fed to the animals. This cake, being rich in protein, can be used as one of the unconventional sources of plant proteins, provided the protein should ideally possess several desirable characteristics referred to as functional properties.

The oil expelled from kenaf seeds is found safe for human consumption[2,3]. However, no work has been done on kenaf seed flour as source of protein and also on the effects of dehulling and oil expelling in an expeller at elevated temperature on the functional properties of flour. The seed coats containing carbohydrates including fibre and phytic acid also play a role in functional properties. The major objective of the present study was to find out the influence of dehulling, heating during oil expelling and the phytic acid on the functional properties of seed flour.

Materials and Methods

Whole seeds of kenaf and edible grade soybean (*Glycine max*) were obtained from the local market, cleaned and stored in refrigerator until use.

Dehulling of seeds: The seeds were conditioned by using water, dried to an optimum moisture content and then coarse ground by stone chakki. The hulls were separated by aspiration.

Oil expelling of seeds: The seeds were crushed by screw press, (mini Arun 4 bolt expeller) to obtain expeller cake. The temperature of expeller during oil expelling was $90 \pm 2°C$ and transit time was 30 sec. The residual oil from expeller cake was extracted with n-hexane in Soxhlet apparatus for 8 hr.

Defatting of seeds: The whole and dehulled seeds were ground to a meal and defatted as above. Edible grade soybean as reference standard was ground and defatted as above. The solvent was removed in a vacuum dryer at 40°C for 6-8 hr, finely ground and passed through a 0.25 mm sieve to obtain defatted flour.

Chemical analysis: Moisture, protein (N×6.25) and crude fibre were determined as per the procedures of AOAC[4]. The extraction and precipitation of phytate phosphorus were performed according to the method of Wheeler and Farrel[5] and its estimation was carried out according to the method of Makower[6]. The iron content was estimated by AOAC[4] method using O-phenanthroline reagent. Contents of iron and phosphorus were assumed to be in 4:6 ratio in order to calculate phytate phosphorus content.

Functional properties: Water and oil (Saffola vegetable cooking oil, Bombay Oil Industries) absorption capacities of flours were determined by the method of Beuchat[7]. Bulk density of flours was determined by the method of Wang and Kinsella[8]. Nitrogen solubility was determined according to the method of Narayana and Rao[9] in the pH range of 2 to 12 using 1 g flour with meal: water ratio of 1:20 (w/v) and shaking for 30 min. Least gelation concentrations were evaluated according to the method of Coffmann and Garcia[10], employing the modifications described by Deshapande *et al.*[11] Foaming capacity and foam stability were evaluated as per the methods of Dev and Mukherjee[12]. Emulsifying activity and emulsion stability of the samples

were studied by the method of Yasumatsu *et al.*[13] with slight modifications as described by Dev and Mukherjee[12]. Emulsifying capacity of the samples, however, was studied by the method of Beuchat *et al.*[14] The emulsion stability determinations were carried out as per the procedure of Thompson *et al.*[15] using oil. In all functional properties, the observations were recorded in triplicate at room temperature (ᔕ 28°C) and means are reported.

Results and Discussion

Chemical analysis: The data presented in Table 1 show that the dehulled flour contained 39.8 per cent protein which was more than approximately one and half times that the raw and cake flours but less than that of soybean flour. The crude fibre content was the least (3.3 per cent) in dehulled flour which was decreased by about 83.0 per cent on dehulling and by about 10 per cent during oil expelling compared to whole flour. The seed kernel constitutes about 71.5 per cent of kenaf and the hull fraction of kenaf contains about 20.5 per cent protein. Therefore, defatting the seeds and rejecting the hulls by aspiration and then grinding to a meal resulted in defatted flour having a considerable higher protein and lower crude fibre contents compared to whole flour. During the process of sieving after grinding the cake, some portion of hulls was rejected and this also resulted in a defatted flour with higher protein content. However, removal of crude fibre was much less in this flour compared to dehulled one. The phytic phosphorus and calculated phytic acid were minimum (0.085 and 0.304 per cent, respectively) in dehulled flour followed by cake and flour. However, these were less in whole flour than soybean meal. Since phytic acid was associated with the hulls , it was eliminated with hulls during dehulling. Some quantity of phytic acid was also lost during oil expelling and sieving of ground meal. The observations in the present study are broadly consistent with those on rapeseed[12] and sesame[16].

Functional properties: The data presented in Table 2 reveal that kenaf flours either whole or processed, absorbed less water than soybean, but absorbed more oil than soybean.

TABLE 1. PROTEIN, FIBRE, PHYTIC PHOSPHOROUS AND PHYTIC ACID CONTENTS OF KENAF AND SOYBEAN FLOURS[a]

Flour	Crude protein (N×6.25) (%)	Crude fibre (%)	Phytic phosphorus (mg/g)	Phytic acid[b] (mg/g)
Whole	24.7 ± 1.24	19.5 ± 0.87	3.89 ± 0.16	13.82
Dehulled	39.8 ± 1.61	3.3 ± 0.12	0.85 ± 0.08	3.04
Cake	27.2 ± 0.96	17.5 ± 0.60	3.19 ± 0.13	11.34
Soybean	46.8 ± 1.78	8.2 ± 0.17	3.92 ± 0.19	14.00

a. Expressed on dry weight basis and mean of three independent replicates.

b. Calculated phytic acid assuming 28.20 per cent phosphorus in the molecule.

When compared on protein basis, water and oil absorption were found more than the soybean reference. The cake sample was however, heat treated during oil expelling and this treatment might have caused the favourable effect on water and oil absorption. During heating, storage proteins would have dissociated into sub-units and crude fibre would have swollen and these may be responsible for increased water absorption. The non-polar residues of the protein during heating would have also masked the oil and this ultimately led to increase in the oil absorption. However, the cake flour was found to be the best in water absorption but was poor in oil absorption compared to whole flour. This suggested that the non-protein components of kenaf, especially the carbohydrates and crude fibres, might have exhibited similar water binding capacity as proteins. In dehulled flour, about 78.0 per cent of the phytic acid was lost along with the hulls and this could be responsible for making more protein available for holding the water. Although soybean contains more protein, it also contains more phytic acid which may be responsible for the lowered functional properties. The phytate-protein interactions in several foodgrains including oilseeds[17] have been reported and phytic acid was found to interact with protein making it unavailable for holding the water. Dehulled and cake flours of kenaf though contained less protein than soybean flour (Table 1) they showed strikingly higher water and oil absorption.

The bulk density was observed highest in cake flour followed by whole and dehulled flour (Table 2). The negative correlation between oil absorption and bulk density was observed. The interactions between the proteins and lipids occur at non-polar side chains of protein molecules which are considered as primary sites. However, oil absorption estimated by the centrifuge method would obviously be influenced by the capacity of the sample to physically trap oil in its bulk volume. The negative correlations between oil absorption and bulk density were observed by several workers[12,18].

The data presented in Table 2 show that dehulled flour had the maximum value of least gelation followed by whole and cake flours. This improved gelling ability as a result of dehulling may be attributed to the higher protein content and the removal of seed coat fractions. The results are in good agreement with those on dry beans[11]. The cake flours, although contained more protein than whole flour, failed to show improved gelling property because of protein denaturation during heating.

The nitrogen solubility of all the samples was found minimum in the pH range of 4.0 to 5.0 (Table 3). Solubility increased on either side of this pH and this was due to more binding sites on proteins. The increase in nitrogen solubility of dehulled flour over the whole flour found at all pH's under investigation may be, due to decreases in crude fibre and phytic acid contents. The decrease in this property in cake

TABLE 2. WATER ABSORPTION, OIL ABSORPTION, BULK DENSITY AND GELATION OF KENAF AND SOYBEAN FLOURS[a]

Flour	Water absorption (g/g)		Oil absorption (g/g)		Bulk density (g/ml)	Least gelation conc (%, w/v)
	Flour	Protein[b]	Flour	Protein[b]		
Whole	2.20	8.94	2.45	9.75	0.503	12
Dehulled	2.50	6.28	2.50	6.53	0.465	10
Cake	2.75	10.04	2.36	8.69	0.638	14
Soybean	2.86	6.11	2.10	4.48	0.578	10
SE±	0.226	–	0.327	–	0.530	0.53
CD (P = 0.05)	0.703	–	0.813	–	0.218	1.64

a. Each value is the mean of three independent replicates.

b. Expressed on protein basis.

TABLE 3. NITROGEN SOLUBILITY, FOAMING CAPACITY AND EMULSIFYING CAPACITY OF KENAF AND SOYBEAN FLOURS AT VARYING pH

Flours	Values at indicated pH						
	2.0	4.0	5.0	6.0	8.0	10.0	12.0
	Nitrogen solubility (%)						
Whole	40.40	16.60	21.54	32.35	67.30	91.15	94.06
Dehulled	42.12	18.10	23.51	34.16	69.12	93.63	96.54
Cake	18.85	13.46	17.50	26.93	56.56	86.19	92.90
Soybean	43.17	19.81	25.89	74.07	87.54	94.27	99.60
	Foaming capacity (% vol increase)						
Whole	25.00	8.00	15.50	23.00	27.00	32.00	34.50
Dehulled	27.00	9.00	18.75	30.00	32.00	37.00	41.00
Cake	20.00	4.00	12.28	20.00	22.00	28.00	36.00
Soybean	32.00	14.00	22.52	36.00	42.00	48.00	53.00
	Emulsifying capacity (g of oil emulsified/g protein)						
Whole	56.50	25.00	30.20	52.45	72.00	79.00	82.20
Dehulled	81.10	48.20	53.00	75.30	95.36	102.40	105.00
Cake	54.40	22.10	26.30	51.30	91.20	78.20	80.30
Soybean	86.44	56.34	62.74	80.21	100.00	108.75	116.56

Values are the average of three independent replicates.

may be due to protein denaturation during heating resulting in dissociation into sub-units and its insolubility.

The data on foaming and emulsifying capacity (Table 3) show a similar pattern suggesting that these properties were minimum at pH 4.0 and these increased on either side of this pH indicating thereby that these properties were dependent on solubilized proteins. Most oilseed proteins have their iso-electric pH between 4.0 and 5.0 and therefore these remain maximally insoluble at these pH values. Among the processed samples, the dehulled sample was found best as regards to these properties. The probable reasons may be due to the presence of more protein and less phytic acid contents.

The data on foaming properties of 1 per cent (w/v) aqueous dispersion of flour samples determined at neutral pH (Table 4) show that dehulled flour was found best followed by raw and cake flours. The decrease in foam volume over 120 min was maximum in cake followed by whole, dehulled and soybean flours. The foam stability is dependent on the amount of native proteins. During heating, the sample for cake making the proteins get denatured and registered less foam stability. Compared to soybean, the kenaf flour showed distinctly higher foam stability by virtue of its good quality proteins. The increased concentration of flour from 1 to 8 per cent (w/v) in aqueous dispersions increased the foam volume in all the flours. This unique property of kenaf observed was most remarkable among the oilseeds, because in most of the oilseeds such an increase was observed only upto 2 per cent concentration[12]. The decrease in foam volume over 120 min was maximum in whole kenaf and minimum in soybean. The decrease in foam volume of cake was comparatively more than dehulled but less than whole flour.

Addition of NaCl upto 0.50 M concentration increased the foam capacity of dehulled and whole flours. However, such an increase was observed only upto 0.25 M NaCl concentration in cake and soybean flours (Table 5). The

TABLE 4. FOAMING PROPERTIES OF KENAF AND SOYBEAN FLOURS (AT pH 7.0).

Flour type	Vol after whipping (ml)	Vol (ml) at 28°C after indicated time (hr)				Decrease over 2 hr (%)	Increase in vol (ml) after whipping sample concen (% w/v)		
		0.5	1.0	1.5	2.0		2.0	4.0	8.0
Whole	125	110	109	107	106	18.40	38	46	57
Dehulled	130	125	120	116	114	16.17	44	52	63
Cake	121	106	104	102	102	19.04	36	42	60
Soybean	138	133	128	123	119	15.37	48	56	67
SE ±	0.39	–	–	–	0.87	–	0.53	0.59	0.69
CD (P = 0.05)	1.21	–	–	–	2.70	–	1.64	1.83	2.10

Expressed on 1% (w/v) slurries and mean of three independent replicates.

TABLE 5. FOAMING CAPACITY OF KENAF AND SOYBEAN FLOURS AS INFLUENCED BY ADDITIVES.

	Foaming capacity (% vol increase) at pH 7.0			
	Whole	Dehulled	Cake	Soybean
NaCl (M)				
0.00	25.0	31.1	25.5	38.5
0.25	30.0	34.2	24.3	41.6
0.50	32.5	36.4	23.8	40.2
0.75	32.7	36.8	21.0	37.5
1.00	31.2	34.0	20.6	35.5
Sucrose (%)				
0.00	25.0	31.1	21.5	38.5
2.00	27.4	32.7	23.7	40.1
4.00	27.1	31.7	23.5	40.0
6.00	26.5	32.0	23.0	39.2
8.00	25.5	31.7	25.5	37.0
10.00	25.0	31.3	20.2	35.0

Expressed on 1% (w/v) slurries and mean of three independent replicates.

beneficial effect of low concentration of NaCl on foam capacity of these flours has been reported to be due to increased protein solubility. Narayana and Rao[9] observed an increase in foam capacity of winged bean and soybean flours on addition of 0.2 M NaCl. Dev and Mukherjee[12], however, observed such increase in rapeseed meal on addition of 0.5 M NaCl. Such variations may be due to nature of protein content of different oilseeds. The decreased foaming capacity in cake flour compared to the others[19] may be due to protein denaturation. The decreases in this property in all the samples at higher NaCl concentrations may be due to decreased protein solubility. Addition of sucrose (2 per cent) led to a slight increase in foaming capacity of all the flours. However, beyond this level it was decreased. The results are broadly consistent with those of Dev and Mukherjee[12] who observed an increase in foam capacity of rapeseed meal even with 1 per cent sucrose concentration. However, the results are contradictory to those of Kabirullah and Wills[20] who reported decrease in foam capacity of sunflower seed protein on addition of 2 per cent sucrose. In most cases, the effect of sucrose was to decrease in foaming capacity even at lower concentration.

The data presented in Table 6 show that emulsifying activity was highest in soybean meal and lowest in cake with intermediate values in rest of the flours. When expressed on protein content, more or less the same trend was observed. The emulsion stability was observed to be more than 50 per cent on flour basis. The proportions of soluble proteins in flours seem to influence their emulsion characteristics significantly. Thus, dehulled flour having a high nitrogen solubility at pH 7.0 and low phytic acid content showed better emulsion characteristics than rest of the flours. The emulsion stability was found higher than emulsion activity.

TABLE 6. EMULSION PROPERTIES OF KENAF AND SOYBEAN FLOURS[a].

Flour	Emulsifying activity (%)		Emulsion stability[b]		Emulsion capacity at pH 7.0, (ml of oil/100 g)	Aqueous phase separated at 28°C after indicated days (%)			
	Flour	Protein[c]	Flour	Protein[c]		1	2	3	4
Whole	36.20	146.00	54.80	221.00	21.0	65	67	70	72
Dehulled	38.70	97.23	57.62	144.75	17.0	60	62	66	68
Cake	32.55	119.00	50.16	184.00	24.3	62	65	67	70
Soybean	49.13	104.97	60.33	128.91	31.5	15	18	20	22
SE ±	0.646	–	0.397	–	0.63	–	–	–	–
CD (P = 0.05)	1.99	–	1.21	–	1.96	–	–	–	–

a. Each value is the mean of three independent replicates.

b. Per cent of the original emulsifying activity after heating at 80°C for 30 min.

c. Expressed on protein basis.

The variations in the values of emulsifying activity and emulsion stability were primarily due to water losses during centrifugation. The emulsion capacity values determined by a titration method show a somewhat different pattern compared to emulsifying activity and emulsion stability. The emulsion prepared with soybean did show the marginal separation of water upto 4 days. In comparison to this, the raw and processed kenaf flour had poor emulsion stability with 70-72 per cent of the water phase of its emulsion being separated within 4 days. This indicated that kenaf flours exhibit distinctly poor emulsion stability. The emulsion capacity was, however, found not related to the soluble proteins content. A decrease in an emulsion capacity with increase in concentration of proteins observed in the present investigation may be due to change in the dependence of soluble proteins upon the hydrophillic-lipophillic balance. The data on kenaf flours fairly agree with those on groundnut[21]. However, it exhibited distinctly better emulsion stability than most of the other oilseeds .

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Studies on Canning of Apricot

T. R. SHARMA, K.S. SEKHON* AND S.P.S. SAINI*
Department of Post-harvest Technology,
University of Horticulture and Forestry,
Solan (HP), India.

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Drained weight in canned apricot increased with storage and had an inverse relationship with cut-out syrup. Varieties and treatments had their pronounced effects on drained weight and texture. Acidification and addition of calcium chloride had a stabilizing effect on ascorbic acid content. Inclusion of calcium chloride in covering syrup greatly improved the texture and organoleptic scores. Varieties suitable for canning are in the order of: 'Kaisha', 'Charmaghz', 'Suffaida' and 'Chuli', - the last one a wild variety had the maximum acidity and was found unsuitable for canning due to its textural unstability.

Apricot (*Prunus armeniaca* L.) is an important fruit of North India. This stone fruit is extensively grown in Himachal Pradesh, Jammu and Kashmir and hilly areas of Uttar Pradesh and to some extent in the North Eastern India including Manipur, Arunachal Pradesh, Meghalaya, Mizoram and Nagaland. Suitability of wide range of agro-climatic conditions ranging from temperate to sub-tropical regions has made apricot cultivation possible even in States like Punjab. Blenheim, Charmaghz, Kaisha, Ladakhi, New Castle, Shippley Early, St. Ambrose and Suffaida are the important cultivars of apricots of North Western Himalayan States.

Apricot fruit has limited storage life under ambient conditions. Its shelf life even under low temperature storage conditions (0°C) and high RH (90-95 per cent) is only about 2-4 weeks. Unless handled properly, the fruit is rendered unfit for local marketing within a short span of 4-5 days after harvesting. Apricot preservation in one form or the other provides most useful alternative[1]. The present investigation discusses the optimum conditions for canning of important commercial varieties of apricots grown in Himachal Pradesh.

Materials and Methods

Four apricot cultivars namely, 'Charmaghz', 'Chuli', 'Kaisha' and 'Suffaida' from Rekong Peo and Moorang area of Kinnaur district of Himachal Pradesh were used for canning. Maturity was determined using visual colour index. Only firm, fully mature apricots free from blemishes were selected . Over ripe fruits were rejected during mannual sorting.

Washed fruits were cut around the suture to remove stone. Apricot halves were packed in previously sterilized 301×411 78×119 mm) plain cans and covered with syrup media comprising of 38° Brix syrup (T_1), acidified syrup containing 0.1 per cent citric acid (T_2) or acidified syrup having 0.1 per cent calcium chloride (T_3), steam exhausted (7 min) and seamed. The cans were sterilized (16-18 min) in boiling water, cooled, labelled and stored under ambient conditions (20-40°C) and analysed periodically for various physical and chemical parameters[2-3].

Canned product was presented to a panel of 5 judges for evaluating sensory attributes as described by Amerine[4] on a numerical scoring system of Excellent (9-10), Very good (7-8), Good (5-6), Poor (3-4) and Very poor (1-2). The parameters used were colour, flavour and texture. The panel of judges were selected among the persons having sensitive perception and knowledge of fruit product evaluation. The average scores were expressed out of a possible maximum of 10 and results were statistically analysed following the procedure of Snedecor and Cochran[5].

Results and Discussion

Physical and chemical characteristics of apricots (Table 1) show that 'Charmaghz' pulp had higher total soluble solids, total sugars, Brix/acid ratio and ascorbic acid followed by 'Kaisha' and 'Suffaida'. 'Chuli' – a wild variety had the lowest total soluble solids (TSS), sugars and Brix/acid ratio and was quite sour in taste having a maximum acidity of 0.83 per cent. Physical and chemical composition of the fresh fruit revealed that variety is a major factor influencing the composition of apricot.

Cut out analysis of canned stored apricots revealed that external can conditions remained satisfactory throughout the storage period. Vacuum (kg cm^{-2}) in cans showed significant differences among varieties, treatments and storage periods

**Present address:* Department of Food Science & Technology, Punjab Agricultural University, Ludhiana.

TABLE 1. PHYSICO-CHEMICAL CHARACTERISTICS OF APRICOT FRUIT VARIETIES*

Variety	TSS (°Brix)	Moisture (%)	Titrable acidity (% citric acid)	Reducing sugars as dextrose (%)	Total sugars as dextrose (%)	Brix/ acid ratio	Ascorbic acid (mg %)
Charmaghz	14.5	85.0	0.37	2.46	12.18	39.19	8.5
Chuli	11.5	85.7	0.83	2.03	9.20	13.06	7.3
Kaisha	13.5	85.2	0.35	3.45	11.75	38.57	7.9
Suffaida	12.5	84.5	0.38	2.82	10.10	32.89	7.0

*Average of two determinations

(Table 2). Existence of sufficient vacuum and its retention throughout the storage showed the adequacy of exhausting process during canning of the fruit. Vacuum noticed during storage in all the cans were well above the recommended levels[6,7].

Significant variations were found in drained weight among varieties, treatments and storage periods. Fruit drained weight increased slowly upon prolonged storage due to the diffusion of sugars into the fruit until an equilibrium was established. Increase in drained weight was more pronounced in fruits covered with acidified syrup containing calcium chloride (T_3) as compared to covering syrup (T_1) in all the cans and there was progressive increase in drained weight with storage. Values for drained weight of acidified syrup covered fruits (T_2) were intermediate to other two treatments (Table 2).

Lower values for drained weight in 'Chuli' may be attributed to the highly acidic nature of the fruit causing the hydrolysis of large pectin molecules into smaller units and solubilization of cementing materials between cell walls[8]. In the present study, our values for drained weight conform to the reports of BIS[7] and FPO[9].

Total soluble solids of cut out syrup declined during storage and such a decline was also reported by Luh *et al.*[10]. Statistically, the differences for reducing sugars were significant among varieties and treatments. 'Chuli' recorded the highest reducing sugars (11.99 per cent) followed by 'Kaisha', 'Suffaida' and 'Charmaghz' (Table 3). Reducing sugars increased due to treatment, the increase being more in calcium syrupped fruits (T_3). Such sugars also increased with extending of storage period and the increase is attributed to hydrolysis of sucrose[11,12]. Significant variations were also recorded for total sugars among varieties. Higher values of total sugars were observed in 'Charmaghz' and 'Kaisha'. Increases were due to the sugar diffusion into the fruit halves covered with sugar till a final equilibrium was established. Similar observations on increases in sugar contents in canned apricots have been made[11]. Data on ascorbic acid contents indicate that there were significant variations among varieties and treatments with respect to ascorbic acid retention. The increases being more in fruits covered with acidified syrup (T_2). The results are in good agreement with those of Kayumov *et al.*[13]. Gradual decline in ascorbic acid was

TABLE 2. EFFECT OF VARIETY, TREATMENT AND STORAGE ON VACUUM AND DRAINED WEIGHT OF CANNED APRICOTS AT ROOM TEMPERATURE

Variety	Treatment				Storage period (days)					CD (0.05)	
	T_1	T_2	T_3	Mean	50	100	150	200	Mean		
					Vacuum (kg cm^{-2})						
Charmaghz	1.282	1.308	1.362	1.318	1.313	1.337	1.311	1.310	1.318	Varieties (V)	0.010
Chuli	1.309	1.247	1.327	1.294	1.323	1.299	1.290	1.266	1.294	Storage (S)	0.090
Kaisha	1.346	1.372	1.354	1.357	1.410	1.348	1.359	1.313	1.357	Treatments (T)	0.009
Suffaida	1.346	1.337	1.327	1.336	1.383	1.337	1.312	1.373	1.336	V×T	0.017
Mean	1.321	1.316	1.342		1.357	1.330	1.318	1.301		S×T	0.017
										V×S	0.020
					Drained wt (% of net wt.)						
Charmaghz	58.05	56.75	60.27	58.36	57.22	57.30	58.80	60.10	58.36	V	0.313
Chuli	55.05	53.92	56.15	55.04	53.90	55.10	55.47	55.70	55.04	S	0.313
Kaisha	57.50	56.65	57.47	57.21	55.40	57.27	57.77	58.40	57.21	T	0.271
Suffaida	56.12	55.45	58.77	56.78	54.50	56.63	57.47	58.53	56.78	V×T	0.628
Mean	56.68	55.69	58.17		55.26	56.57	57.37	58.18		S×T	0.544
										V×S	0.544

T_1 = Sugar syrup (38°B); T_2 = Syrup with 0.1 per cent citric acid; T_3 = Syrup with 0.1% citric acid & 0.1 per cent $CaCl_2$; Values are means of three independent replications.

TABLE 3. EFFECT OF VARIETY AND TREATMENT ON REDUCING AND TOTAL SUGARS AND ASCORBIC ACID CONTENT OF CANNED APRICOTS AT ROOM TEMPETATURE (STORAGE PERIOD 200 DAYS).

Variety	Treatment				CD 0.05%	
	T_1	T_2	T_3	Mean		
	Reducing sugars as dextrose (%)					
Charmaghz	4.00	6.00	5.80	5.28	Varieties(V)	0.55
Chuli	10.76	12.37	12.83	22.99	Treatments(T)	0.47
Kaisha	7.61	6.85	7.98	7.48	V×T	0.95
Suffaida	6.66	7.05	7.92	7.21		
Mean	7.26	8.08	8.63			
	Total sugars as dextrose (%)					
Charmaghz	16.60	17.47	16.59	16.88	Varieties(V)	1.2
Chuli	14.82	15.23	16.28	15.44	Treatments(T)	NS
Kaisha	17.97	17.10	18.31	17.79	V×T	2.08
Saffaida	14.80	17.53	16.53	16.32		
Mean	16.07	16.84	16.93			
	Ascorbic acid (mg %)					
Charmaghz	8.25	9.03	8.13	8.47	Varieties(V)	0.12
Chuli	4.73	5.39	5.16	5.09	Treatments(T)	0.30
Kaisha	6.51	6.80	6.77	6.70	V×T	0.61
Saffaida	5.57	5.91	5.70	5.75		
Mean	6.80	6.44				

T_1 = Sugar syrup (30°B); T_2 = Sugar syrup with 0.1 per cent citric acid, T_3 = Sugar syrup + citric acid (0.1% + $CaCl_2$ (0.1%).

TABLE 4. EFFECT OF VARIETY, TREATMENT AND STORAGE ON MEAN COLOUR, FLAVOUR AND TEXTURE SCORES* OF CANNED APRICOT AT ROOM TEMPERATURE.

Variety	Treatment								CD (0.05)	
	T_1		T_2		T_3		Mean			
	S	S_2	S_1	S_2	S_1	S_2	S_1	S_2		
	Colour score									
Charmaghz	8.33	8.17	8.50	7.83	8.33	8.33	8.39	8.11	Var	0.55
Chuli	5.83	5.00	6.00	4.50	6.17	5.17	6.00	4.89	Storage	0.39
Kaisa	9.00	8.17	9.17	8.67	9.00	8.17	9.07	8.33	Treat	NS
Suffaida	7.50	7.17	7.17	6.67	7.50	6.50	7.39	6.78	Inter	NS
Mean	7.67	7.13	7.71	6.92	7.75	7.00				
	Flavour score									
Charmaghz	6.50	6.17	7.84	7.50	8.50	8.00	7.61	7.22	Var.	0.53
Chuli	7.67	3.67	4.17	3.33	5.00	4.17	4.61	3.72	Storage.	0.37
Kaisha	8.67	7.50	8.83	7.67	8.83	8.00	8.78	7.72	Treat	0.37
Suffaida	5.83	4.83	6.50	4.83	6.33	5.00	6.22	4.89	Int.	NS
Mean	6.42	5.54	6.83	5.83	7.17	6.29				
	Texture score									
Charmaghz	8.17	7.67	7.83	7.50	8.50	7.83	8.17	7.67	Var.	0.49
Chuli	5.17	3.83	4.67	3.33	6.17	4.67	5.33	3.94	Storage	0.35
Kaisha	8.83	8.17	8.83	7.50	8.83	8.17	8.83	7.94	Treat	0.35
Suffaida	6.17	4.67	5.67	4.17	6.50	6.60	6.11	4.78	Inter.	Ns
Mean	7.08	6.08	6.75	5.63	7.50	6.54				

T_1, T_2 & T_3 as per Table 3; S_1 & S_2 stored at room temperature (20-40°C) for 100 and 200 days respectively.

*On 10 point basis.

observed with storage. The observations in the present investigation are supported by the studies of Cameron[14].

Sensory evaluation scores are presented in Table 4. Varieties differed significantly with respect to colour of canned product. 'Kaisha' earned the highest colour score of 9.07 while 'Chuli' was awarded the lowest score of 6.0 on 10 point rating scale. Storage periods were found to have significant effect on colour. The colour of canned fruits darkened progressively with increased storage period and thus scored poorly[15]. Treatments did not differ significantly with respect to the colour of canned fruits.

There were notable differences in flavour scores of canned product which were significant among cultivars. 'Kaisha' and 'Charmaghz' were awarded higher scores while 'Chuli' was given the lowest score. Statistical analysis of treatments and storage periods showed significant differences in flavour scores of samples at 5 per cent level. With the increase in shelf life, there was a decline in the flavour rating because volatile reducing substances (VRS) responsible for flavour are lost because of their unstability[16]. Samples with higher VRS contents were rated better in aroma and these volatile substances impregnate into the media and affect the flavour of the product. Progressive decrease in VRS has been demonstrated in canned apricots[11]. Differences in mean scores were significant due to varieties, storage periods and treatments. Kaisha ranked best in terms of texture scores among the varieties tested. Calcium chloride has been used to improve the texture of many canned products[17]. Poor texture of "Chuli" can be attributed to the higher acidity in the fruits and high acidity of the apricot could be correlated to the fruit softening[18].

From this study, it is concluded that incorporation of acid and calcium chloride in the covering syrup could greatly improve the quality parameters of canned apricots and the product could be found acceptable upto one year at ambient temperature without any type of quality damage except for slight colour change.

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Browning and Aggregation of Milk Proteins

P.P. GOTHWAL* AND M.K. BHAVADASAN
Southern Regional Station,
National Dairy Research Institute,
Bangalore-560 030, India.

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Heating of milk was found to change the separation pattern of casein through Sephadex G-200 gel chromatography. Generally, the proportion of high molecular weight protein fraction increased with a concomitant decrease in low molecular weight protein fraction on increasing the severity of heat treatment. The study showed that heating conditions which resulted in higher browing in milk would also lead, to increased polymerisation of proteins. Like browning, polymerisation of casein was considerably higher in buffalo milk than in cow milk under identical conditions of heating. Gel filtration studies showed that polymerisation of casein during heating of milk increased with increased levels of proteins or lactose or increase in pH. These factors also enhanced browning in milk. The extent of polymerisation of casein caused by these factors was higher in buffalo milk than in cow milk.

Heating milk causes a number of changes in milk proteins. Heating milk to temperatures about 90°C causes substantial aggregation of whey proteins but produces only minor changes in dimensions of casein micelles[1,2]. However, more drastic heat treatments such as UHT sterilization, cause aggregation of casein micelles[3]. The changes in molecular sizes of proteins as a result of different heat treatments have been studied[4-7]. Aggregation of proteins using gel permeation chromatography was investigated by a number of workers[8-10]. These investigations showed that casein micelles underwent heat induced molecular changes on severe heat treatment. Milk heat treatment did not cause noticeable changes in gel filtration pattern of milk proteins. As severe heat treatments to milk result in browning mainly by lactose-protein interactions[11], these reactions are likely to bring about futher changes in molecular size of proteins. The present investigation reports the effect of heat treatment on browning and the changes in molecular size of milk proteins.

Materials and Methods

Milk samples: Pooled cow and buffalo milk samples, drawn from 10 to 12 animals, were obtained from the Institute's herd in the morning, their temperature adjusted to 35°C and separated using Alfa-Laval cream separator. The skim milk obtained was used fresh or after storage at 4°C.

Preparation of acid casein and whey: Acid caseins were prepared by the method described by Gupta and Ganguli[12]. The acid whey obtained after precipitation of casein by 1N HCl at pH 4.6 was adjusted to 6.8 with 1N NaOH.

Reconstitution of casein micelles: The casein micelles were isolated by centrifuging skim milk at 105,000 × g in a IEC/B-60 ultracentrifuge for 30 min at room temperature. The wet micelles were ground using mortar and pestle. Phosphate buffer, pH 6.8 (0.1M), or water was added little by little during grinding to form a fine paste followed by addition of buffer or water for dispersion.

Dialysed acid whey: The acid whey obtained after precipitation of casein followed by adjusting the pH to 6.8 was placed in cellophane tubes and dialysed against large volume of distilled water for 24 hr at around 5°C with constant stirring and twice changing the distilled water.

Preparation of milk systems with varied levels of protein/lactose: A mixture of casein and whey proteins (4:1) was ground in a mortar to a fine paste. Phosphate buffer, pH 6.8 (0.1M) was added to the paste to obtain a dispersion of a mixture of casein and whey proteins. Separate protein dispersions were prepared from cow and buffalo milk. The respective dispersion was added to cow milk (initial protein, 3.2 per cent) and buffalo milk (initial protein, 3.6 per cent) to get milk systems with 6.5 and 9.5 per cent final protein level respectively.

α-lactose monohydrate crystals, (Sigma Chemical Company) were added to milk to obtain samples with 7.0 and 9.0 per cent lactose levels.

Preparation of milk systems with different initial pH: Milk was adjusted to 6.8 and 7.5 pH by addition of 1N NaOH.

Heat treatment: The milk samples taken in test tubes and capped with cotton plugs were heated at 0.84 and 1.05 kg/cm^2 for 15 min.

Estimation of protein and lactose: Protein was estimated by the method of Lowry *et al.*[13] and lactose was estimated by polarimetric method[14].

*Present address: CFTRI Regional Centre, Chinnhut Deva Road, Lucknow-227105, India.

Measurement of browning: The browning in milk/milk systems was estimated spectrophotometrically after pronase digestion as suggested by Palombo *et al.*[15] with slight modification. Three ml of milk were pipetted into a tube and to this 0.8 ml enzyme (Type xxv, Pronase E from Sigma Co., USA) solution (3 mg enzyme / 0.8 ml Tris-HCl buffer, pH 7.0) was added. The contents were incubated for 120 min at 45°C in a water bath. After incubation, the tube was cooled in ice water and 150 µl trichloroacetic acid (100 per cent TCA) added, and was centrifuged at 5000 × g. It was then filtered through Whatman No. 1 filter paper. The optical density of the clear filtrate was measured on a Gilford spectrophotometer. Samples were read in a 5 ml cuvette with 1 cm pass length. Water was used as blank. Browning index, (OD) was calculated as follows:

$$OD = A_{420\ nm} - A_{550\ nm}$$

For practical purposes, the browning index was expressed as OD/g dry milk solids.

Gel filtration pattern of casein on Sephadex G-200: Gel filtration of casein from heated and unheated milk was carried out by the method of Andrews and Cheeseman[16] on Sephadex G-200 (Pharmacia) column (22 mm × 560 mm). Thirty five mg of casein were dissolved in 1 ml of tris-HCl buffer, 0.02M (pH 7.0), containing 0.0001 MEDTA and 0.02M 2-mercaptoethanol and eluted with the same buffer. Void volume of the column was 60 ml. Four ml of effluents were collected by means of an automatic biochem fraction collector and the optical density was read on Gilford spectrophotometer at 280 nm.

Gel filtration pattern of whey proteins on Sephadex G-100: Molecular sieving of the unheated and heated whey proteins was carried out by the method of Morr *et al.*[4] and as modified by Majumdar and Ganguli[17] on Sephadex G-100 (Pharmacia) column (28 mm × 500 mm). Ten ml of whey protein solution having a concentration of 60 mg were layered on the column. Five ml of sodium phosphate buffer, pH 6.9 (0.01M), containing 3.02 g sodium chloride per litre were added to carry the proteins into the gel bed. The proteins were eluted with the buffer and four ml of the effluents were collected by means of an automatic biochem fraction collector and optical density was read on Gilford spectrophotometer at 280 nm.

Results and Discussion

Effect of heat treatment on browning in milk: Analysis of browning in heated cow and buffalo skim milk samples showed that browning was higher in buffalo milk than in cow milk (Table 1) under the two conditions of heating used in the study. Severity of heat treatment also enhanced browning.

Effect of heat treatment of milk on gel filtration pattern of casein: Casein from heated (0.84 and 1.05 kg/cm^2 for 15 min) cow and buffalo milk resolved mainly into two fractions on Sephadex G-200 gel permeation chromatography. Casein from corresponding raw milk samples was found to be continuously eluted. The linear portions of the peaks extrapolated to the base line gave three portions. The first portion corresponded to higher molecular weight polymers and was eluted at or close to the void volume of the column (60 ml). The second portion corresponded to intermediate molecular weight material and was considered as partially polymerised. The third portion was the major one and represented unpolymerised casein molecule. The percentage distribution of unpolymerised, partially polymerised and polymerised caseins from cow and buffalo milk are shown in Table 2. The proportion of polymerised casein in buffalo milk heated at 0.84 and 1.05 kg/cm^2 for 15 min was much higher than in corresponding cow milk samples. Generally, the proportion of polymerised casein fraction increased with concomitant decrease in unpolymerised casein fraction.

TABLE 1. BROWNING INDEX IN COW AND BUFFALO MILK HEATED UNDER DIFFERENT CONDITIONS

Samples	Browning index (OD/g dry milk solids)*	
	0.84 kg/cm^2	1.05 kg/cm^2
Cow milk	0.294 ± 014	0.471 ± .023
Buffalo milk	0.381 ± .013	0.689 ± .027

*Mean ± SE of 4 samples.

As caseins were treated with mercaptoethanol, EDTA and urea prior to gel filtrations, the increase in the proportion of polymerised fraction in severely heated samples suggests that polymerisation could be due to the formation of permanent covalent linkage between protein molecules. Andrews and Cheeseman[16] noted that aggregation of proteins was due to polymerisation in heated milk. Interaction between lactose and casein has been reported to lead to the formation of polymerised casein[18]. As browning was more in milk heated at 1.05 kg/cm^2 than in milk heated at 0.84 kg/cm^2 and the proportion of polymerised casein was also higher in the former, it could be concluded that interaction of lactose with casein has a role in polymerisation of the casein.

Effect of heat treatment of milk on gel filtration pattern of whey proteins: Fig 1 shows the separation pattern of whey proteins through Sephadex G-100. Whey proteins from

TABLE 2. EFFECT OF HEAT TREATMENT ON FRACTIONATION OF TOTAL PROTEINS BY GEL FILTRATION ON SEPHADEX G-200

Casein source	Heat treatment	Unpolymerised protein (%)	Partially polymerised protein (%)	Polymerised protein (%)
Cow milk	0.84 kg/cm^2	76.2 ± 0.9	13.3 ± 0.9	10.8 ± 0.4
	1.05 kg/cm^2	67.8 ± 1.5	11.7 ± 0.4	19.6 ± 1.1
Buffalo milk	0.84 kg/cm^2	65.3 ± 1.3	13.8 ± 0.7	21.2 ± 1.1
	1.05 kg/cm^2	43.8 ± 1.4	18.7 ± 0.7	37.4 ± 0.5

Mean ± S.E. of quadruplicates
All heat treatments were done for 15 min.

unheated milks resolved into three fractions. Out of these fractions, Fractions II and III were major ones. Fraction I accounted for only a small proportion of total whey proteins. The gel filtration pattern of whey proteins from milk samples heated at 0.84 and 1.05 kg/cm^2 showed only one fraction. This observation suggests that low molecular weight whey proteins aggregate when milk is subjected to heat treatments. Gel filtration patterns of whey proteins from unheated and heated buffalo milk were very similar to those corresponding to cow whey proteins. Hence, the gel filtration pattern of whey proteins from buffalo milk is not shown in the Figure.

Effect of protein level on gel filtration pattern of casein from heated milk using Sephadex G-200: Casein from heated milk systems having three different levels of protein were fractionated through Sephadex G-200. The percentage representing polymerised, partially polymerised and unpolymerised caseins is shown in Table 3. Proportion of polymerised casein increased with protein level in both cow and buffalo milk. Browning also increased with increase in protein level. Hence, the lactose - protein interaction appears to be important in influencing the degree of polymerisation of casein in heated milk.

Effect of lactose on gel filtration of casein from heated milk: The data obtained from Sephadex G-200 gel filtration of casein from heated milk samples having three levels of lactose are shown in Table 4. Increased lactose levels in both cow and buffalo milk increased the proportions of polymerised casein with a concomitant decrease in unpolymerised casein. Increased levels of lactose were also found to enhance the browning in heated milk; so the degree of polymerisation of casein appears to have a direct relationship with degree of browning.

Effect of initial pH of milk on gel filtration of casein from heated milk: The data obtained on Sephadex G-200 gel filtration of casein from heated milk having initial pH of 6.8 and 7.5 are shown in Table 5. Milks having higher initial pH had higher proportions of polymerised casein as well as more browning. The higher browning in milk samples having higher pH could be due to higher number of unprotonated amino groups which can combine with lactose. Whitelaw and Weaver[19] have reported that only unprotonated amine can combine with sugars. The higher interaction between lactose and proteins in milk having higher pH value could lead to more Maillard reaction products as well as more

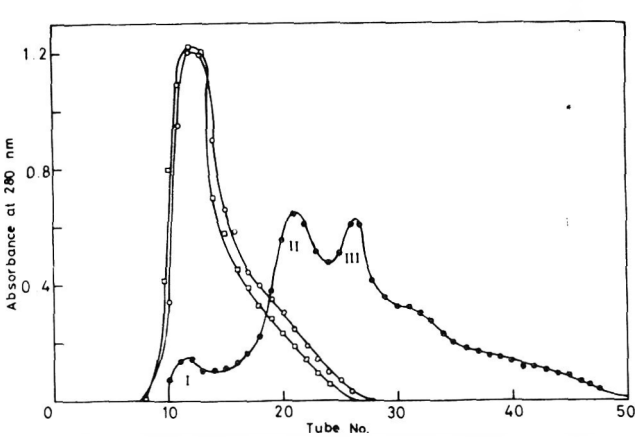

Fig. 1. Effect of heat treatment on gel filtration of whey proteins isolated from heated cow milk. ●—● Raw milk; o—o milk heated at 0.84 kg/cm^2, 15 min; □—□ milk heated at 1.05 kg/cm^2, 15 min.

TABLE 3. EFFECT OF TOTAL PROTEIN CONCENTRATION ON FRACTIONATION OF PROTEINS FROM HEATED MILK BY GEL FILTRATION ON SEPHADEX G-200.

Samples	Protein level (%)	Browning index (OD/g dry milk solids)	% of total protein		
			Unpolymerised	Partially polymerised	Polymerised
Cow milk*	3.2	0.286 ± .012	73.8 ± 0.7	14.3 ± 0.4	11.5 ± 0.6
	6.5	0.443 ± .016	50.0 ± 0.7	13.7 ± 0.3	35.8 ± 0.7
	9.0	0.529 ± .018	30.9 ± 0.4	24.2 ± 0.2	44.8 ± 1.0
Buffalo milk*	3.6	0.390 ± .013	64.1 ± 1.1	12.5 ± 0.5	23.3 ± 0.2
	6.5	0.643 ± .017	51.4 ± 1.2	16.0 ± 0.7	32.1 ± 0.4
	9.0	0.741 ± .019	23.8 ± 0.8	21.0 ± 0.4	54.8 ± 0.4

Mean ± S.E of quadruplicates.
*Heated at 0.84 kg/cm^2 for 15 min.

TABLE 4. EFFECT OF LACTOSE LEVEL IN MILK ON FRACTIONATION OF PROTEINS FROM HEATED MILK BY GEL FILTRATION ON SEPHADEX G-200.

Samples	Protein level (%)	Browning index (OD/g dry milk solids)	% of total protein		
			Unpolymerised	Partially polymerised	Polymerised
Cow milk*	4.8	0.302 ± .014	72.1 ± 0.9	14.8 ± 0.4	12.9 ± 0.5
	7.0	0.347 ± .016	51.3 ± 0.6	19.8 ± 0.2	28.8 ± 0.7
	9.0	0.573 ± .018	41.7 ± 1.0	17.7 ± 0.6	40.1 ± 0.9
Buffalo milk*	5.2	0.399 ± .016	62.6 ± 0.8	14.3 ± 0.4	23.2 ± 0.5
	7.0	0.498 ± .018	43.7 ± 0.6	21.4 ± 0.3	35.3 ± 0.6
	9.0	0.817 ± .023	26.9 ± 0.4	21.7 ± 0.5	50.8 ± 0.8

*Mean ± S.E of quadruplicates.
*Heated at 0.84 kg/cm^2, 15 min.

TABLE 5. EFFECT OF pH OF MILK ON FRACTIONATION OF PROTEINS FROM HEATED MILK BY GEL FILTRATION ON SEPHADEX G-200

Samples	pH	Browning index (OD/g dry milk solids	% of total protein		
			Unpolymerised	Partially polymerised	Polymerised
Cow milk*	6.8	0.481 ± .017	66.1 ± 0.7	14.0 ± 0.3	20.1 ± 0.6
	7.5	1.101 ± .023	50.8 ± 0.6	14.8 ± 0.5	33.9 ± 0.7
Buffalo milk*	6.5	0.697 ± 0.19	49.2 ± 0.5	14.3 ± 0.4	37.2 ± 0.6
	7.5	1.310 ± .026	38.0 ± 0.8	14.4 ± 0.3	47.9 ± 0.7

*Mean ± S.E of quadruplicates.
*Heated at 1.05 kg/cm^2 for 15 min.

polymerisation of proteins. Burton[20] has also reported that milk samples having higher pH undergo more browning.

The present study showed that severity of heating conditions, higher protein and lactose levels and higher initial pH lead to polymerisation of casein. All these factors were found to enhance browning in milk. Therefore, this study supports that interaction between lactose and protein has a major role in aggregation and polymerisation of casein in heated milk or milk products[18].

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Textural Properties of Market Chhana

H.K. DESAI, S.K. GUPTA, G.R. PATIL AND A.A. PATEL
Division of Dairy Technology, National Dairy Research Institute, Karnal-132 001, India.

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Instron hardness, cohesiveness, gumminess and chewiness varied significantly in chhana samples collected from different suppliers. Correspondingly, significant variations were also noted in sensory firmness, crumbliness, chewiness and smoothness. Chhana having sensorily most acceptable textural properties was fairly smooth but sticky, and low in firmness, elasticity, crumbliness and chewiness. Variations in textural characteristics appeared to be related, to some degree, to significant variations in pH, and to a lesser extent, to the moisture content.

With the progressive increase in the volume of milk being handled by the organized sector of the dairy industry, more and more commercial interest in chhana and other indigenous dairy products has been witnessed in recent times[1]. Production of chhana and chhana-based sweets has so far been largely confined to the cottage scale. The quality of chhana in the market greatly varies from trader to trader and from day to day with the same trader. This is particularly true of the texture aspects of the product. The texture of chhana is very important to its applications in the preparation of sweets and is governed by compositional factors (i.e. moisture and fat levels) which, in turn, are influenced by quality of milk used and the coagulation procedure employed. Chhana of a fine texture with velvety body is considered desirable[2]. A compact, close knit smooth texture and a soft body are believed to ensure satisfactory manufacture of good quality *Rasogolla*, but a slightly less soft body together with smooth texture is desirable for making good quality *Sandesh*[3,4,5]. While several attempts have been made to standardize the procedure for preparation of chhana suitable for sweet-making[2-4,6-8], little work has been directed towards systematic characterization of chhana texture. Gera[9] determined the pitching number, cone penetration value, viscosity and springiness of laboratory-made channa in relation to its texture. The objective of this study was to elucidate the textural properties of market chhana in terms of Instron texture profile (TP) parameters and sensory texture descriptors.

Materials and Methods

About 750 g of fresh chhana was purchased from shops in Delhi market and packed in stainless steel containers with tightly closing lids. These containers were held in a plastic ice-box and brought to the laboratory. After about 6 hr, the samples were transferred to an incubator at 15°C and held overnight before doing chemical and texture evaluations.

For texture profile analysis, a cylindrical sample of channa (19 mm dia, 20 mm ht, 2.84 cm sq. cross sectional area) was subjected to two-bite deformation employing Instron Universal Testing Mechine Model 4301 fitted with a 100 N load cell attached to compression anvils (linear compression to 80 per cent of the original cylinder height). The force-distance curve obtained for a cross head speed of 50 mm/min and chart speed of 100 mm/min was used to derive various TP parameters as per Bourne[10]. Each determination was carried out in duplicate.

Chhana samples, in identical form as employed for Instron texture measurement were presented to a panel of six trained judges (selected from the Division) for assessing sensory firmness, elasticity, crumbliness, stickiness, chewiness, smoothness and overall texture quality. A 14-cm horizontal dotted straight line with its left end indicating one parametric extreme (score-0) and the opposite end indicating the other extreme (score-100) was used as the scale for each attribute[11]. Scoring was done to indicate the perceived intensity by means of a small vertical line along the scale (100 dots) which directly indicated the numerical value of the sensory texture descriptor. Sensory evaluation was carried in a specialized laboratory meant for the purpose and six samples were given at a time for sensory evaluation.

Representative samples of market chhana were made homogeneous by grinding them, separately, in a mortar and pestle. The moisture content of chhana was determined by using well ground, weighed sample in a tared aluminium dish and drying it in an electric oven at 102+1°C to a constant weight[12]. Fat and total protein were determined by using standard methods[12,13]. The total ash content was determined by drying in an oven at 105°C, igniting gently on a flame

and ashing in a muffle furnace (at 550+20°C) for 3 hr before weighing. The calcium content of chhana was determined titrimetrically as per BIS[14] whereas the phosphorus content was determined by the method of Fiske and Subba Row[15]. The pH of chhana was measured at 20°C with a digital pH meter.

The data on compositional parameters were analysed using the randomized block design and the instrumental data by using factorial design[16]. The data on sensory textural properties were transformed into arc-sine values and then subjected to factorial analysis.

Results and Discussion

The moisture contents ($P \leq 0.05$) and pH ($P \leq 0.01$) of channa varied significantly among the suppliers (Table 1). Chhana from all suppliers except the supplier 1 met the legal requirement for moisture (i.e. not more than 70 per cent) but none of the samples met the requirement for the fat content of not less than 50 per cent in dry matter.

As shown in Table 2, chhana from different suppliers differed significantly ($P \leq 0.01$) in respect of all TP parameters except springiness. Chhana showing greater hardness generally appeared to be more cohesive, gummy and chewy. Further, the replicate samples from individual suppliers of chhana exhibited significant variations ($P \leq 0.01$) in all parameters except cohesiveness. However, no differences were noticed between the duplicate determinations of different TP parameters, which indicated that the chhana samples used were fairly homogeneous.

It is evident from Table 3 that sensory firmness, crumbliness, chewiness, smoothness and overall texture quality varied significantly ($P < 0.01$) among suppliers of the product. Lower firmness generally corresponded with lower crumbliness and lower chewiness but no definite relationship

TABLE 1. COMPOSITION OF MARKET CHHANA

Constituent	Sample source[a]						F-ratio	CD
	1	2	3	4	5	6		
Moisture (%)	71.63	68.08	69.16	66.51	69.17	68.88	2.71*	2.96
Fat(%)	9.98	12.94	12.96	14.27	12.31	13.39	1.96	-
Protein(%)	14.90	15.23	14.32	15.16	14.76	14.25	1.22	-
Ash (%)	1.44	1.48	1.41	1.53	1.53	1.44	2.19	-
Calcium (%)	0.45	0.48	0.44	0.47	0.46	0.42	1.98	-
Phosphorus (%)	0.25	0.26	0.22	0.25	0.25	0.20	1.30	-
pH	5.79	5.83	6.11	5.83	5.93	6.02	8.54**	0.12

Average of six replicates; a = refers to the supplier of chhana; *$P < 0.05$, **$P < 0.01$.

TABLE 2. INSTRUMENTAL TEXTURAL PROPERTIES OF MARKET CHHANA

Attribute	Sample source[a]						F-ratio	CD
	1	2	3	4	5	6		
Hardness (mN)	3.08	3.87	2.52	3.71	2.39	2.16	4.91**	9.91
Cohesiveness	0.61	0.67	0.57	0.65	0.57	0.55	4.62**	0.06
Springiness (mm)	6.13	6.21	6.25	6.50	6.38	6.08	0.28	–
Gumminess (mN)	1.89	2.58	1.44	2.43	1.36	1.20	6.80**	0.63
Chewiness, (mN.mm)	12.73	16.90	9.19	16.35	8.80	7.71	5.05**	5.04

Average of six replicates; a = refers to the supplier of chhana; **$P < 0.01$

TABLE 3. SENSORY SCORE (max, 100) FOR TEXTURAL CHARACTERISTICS OF MARKET CHHANA

Attribute	Sample source[a]						F-ratio[b]	CD[b]
	1	2	3	4	5	6		
Elasticity	36.37	35.80	32.03	36.03	34.95	32.57	0.53	–
Firmness	35.83	36.76	28.41	34.95	28.03	29.95	3.72**	3.49
Crumbliness	53.30	49.90	43.21	47.09	38.62	34.18	6.56**	4.49
Stickiness	47.17	46.04	51.45	46.98	54.44	54.55	1.96	–
Chewiness	37.53	33.80	27.21	34.77	28.27	27.44	4.28**	3.65
Smoothness	55.99	66.72	69.47	64.99	69.25	56.25	7.42**	3.72
Overall texture quality	58.29	65.28	68.80	67.35	70.10	70.48	5.70**	3.17

Average of six replicates; a=refers to the supplier of chhana; b based on arc-sine values; **$P < 0.01$.

was observed between firmness and smoothness. Further, softer and smoother chhana was, to some extent, considered more acceptable as it had good texture.

Sensory firmness of the product was correlated with Instron hardness ($r=0.88$, $P < 0.05$). Although the moisture content also varied significantly among the suppliers as did sensory firmness and Instron hardness of chhana, little definite relationship was evident between the moisture content and textural properties. However, pH of chhana showing lower firmness (and hardness) values was apparently higher than that of the product with higher firmness (Tables 1 and 3).

It was, thus, evident that market samples of chhana had a varying textural characteristics such as firmness, crumbliness, chewiness and smoothness, which, in turn, affected their overall sensory texture quality. Sensory data were generally supported by instrumental texture measurements. Highly desirable chhana texture corresponded with low firmness (or high softness), crumbliness, elasticity and chewiness, moderate stickiness and high smoothness. Of various compositional parameters, only pH appeared to bear some relationship with firmness and to some extent, with the overall texture quality of the product.

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Studies on the Formulation and Quality Attributes of Milk Protein Based Vermicelli *(Seviah)* for *Kheer*-like Product.

P.D. NITURKAR, V.S. DOKE, N.V. JOGLEKAR AND S.G. ROTTE
Marathwada Agricultural University, Parbhani-431 402.
Maharashtra, India.

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Studies on the formulation and evaluation of quality attributes of vermicelli with 2, 4 and 6% milk protein fortification in semolina and white flour were conducted. As the level of milk protein fortification was increased, the water required for dough formation got decreased and time for dough development and extrusion increased. Fortification of milk protein increased the vermicelli thread length with improvement in colour and texture. An improvement in sensory qualities of vermicelli was brought about with 4% milk protein fortification in either of the wheat flour fractions. Higher scores for sensory attributes including flavour, taste and acceptability were recorded. An increase in the protein level by 15.77 and 16.18% in semolina and white flour vermicelli at 6% milk protein fortification resulted in a decrease of 70.34 and 69.63% respectively in the total carbohydrate content.

Milk and dairy products serve as useful ingredients in food industry. Diversified uses of milk and derived products play major roles in baking, soft drinks, confectionery, ice-cream desserts, etc[1]. There has been a substantial increase in the growth and sale of ready-to-eat and ready-to-cook products.

Indian desserts including *Kheer* are prepared by partial dehydration of whole milk together with sugar and cereals like rice or wheat semolina, or vermicelli *(Seviah)*. Altschus[2] reported that protein-based foods with dairy products processed along with oil seeds or cereal foods would provide excellent nutrition at reasonable price. Schoppet *et al.*[3] reported that for raising the protein content of pasta to 20 per cent the whey protein was essentially to be insolubilised by heat denaturation to avoid stickiness. Addition of insoluble lactalbumin and whey products to the semolina resulted in functional advantages[4]. Salunkhe[5] observed that *Triticum durum* (hard wheat) had high protein content and hard texture needed for the production of semolina, macaroni and pasta products. The present work was undertaken for utilizing skim milk solids in the production of cereal-based food, vermicelli *(Seviah)*.

Materials and Methods

Formulation of Seviah *(Vermicelli)*: The formulation of vermicelli *(Seviah)* was done by using the raw material wheat semolina (−25, +30) white flour (−45+60) and skim milk powder. Hand driven extrusion machine brass did (make KMB-special quality 8) with the disc number B medium with 0.5 mm outer diameter was used. The process conditions were well defined as the addition of salt at 1 per cent and the pressure cooking conditioning of the dough were carried out in the pressure cooker.

Formulations of vermicelli fortified with dried skim milk proteins at levels of 2, 4 and 6 per cent were tried. Sensory attributes were evaluated and the results were statistically analysed[6].

Chemical analysis of vermicelli: The fresh vermicelli samples were air-dried for first two days and then at 105°C for 4 hr before analysis.

The total solids were determined by AOAC official method[7]. Moisture was determined by toluene distillation method[8]. The ash content was determined by method as recommended by ISI (IS-1479)[9] and (IS-1547)[10]. Protein contents were estimated by micro-Kjeldahl method as described under AOAC[8]. For making accurate estimation of fat in skim milk, special butyrometers graduated to read 0.01 per cent were used. The Gerber's method was employed as per IS-1478[9] and IS-1547[10].

Results and Discussion

The average length of vermicelli threads notably occurred in three ranges namely 35 to 40 cm as short, 40 to 45 cm as medium, and 45 cm and above as long. The vermicelli obtained from semolina fractions incorporated with milk proteins occurred in the range of 40 to 42 cm, whereas those obtained from white flour combinations exhibited thread length in the range of 47 to 50 cm indicating a longer thread length. In general, a reduction in the maximum thread length was noticed with the addition of milk proteins at the rate of 6 per cent in either flour fractions (Table 1).

The thread thickness ranged from 0.082 to 0.098 cm. with the maximum at 0.098 cm in case of semolina with 2 per cent milk protein type vermicelli. A reduction in the thread thickness resulted with incorporation of skim milk proteins.

TABLE 1. PHYSICAL CHARACTERS OF VERMICELLI OBTAINED WITH MILK PROTEIN FORTIFICATION (SEMOLINA/WHITE FLOUR).

Main ingredient	Milk protein (%)	Thread length Max (cm)	Thread length Average (cm)	Thread thickness (cm)	Colour	Thread texture	General remarks
Semolina	2	42	41	0.098	White	Slightly coarse	Medium and brittle
Semolina	4	42	40	0.089	Slightly white	Feathery	Medium long and brittle
Semolina	6	40	35	0.085	Cream white	Feathery	Medium short and brittle
White flour	2	50	40	0.091	Bright	Feathery	Longer but brittle thread
White flour	4	48	43	0.087	Creamy	Feathery	Longer and brittle
White flour	6	47	45	0.082	Creamy	Feathery	Average thread and very brittle

Salt was added at 1% to all the flour combinations.

The process condition involved the use of hot water and steam cooling.

Further, it is interesting to note that an improvement in the colour of product could be brought about by process alteration namely milk protein, use of salt, addition of hot water and steam conditioning of dough. As a result, the colour of the vermicelli changed from white to creamy white in the finished product.

The thread texture was slightly coarse to feathery in all the treatment combinations with semolina, suggesting thereby that the addition of milk proteins could lead to such a product. An increasing trend with regard to brittleness of vermicelli was noticed in case of either type of flours. This was, however, more in case of semolina incorporated with milk proteins at 6 per cent and very brittle/fragile thread was noticed in case of white flour with milk proteins at the same level.

Sensory evaluation of vermicelli: Data on sensory evaluation of vermicelli are presented in Table 2. Texture and brittleness were differentiated on standard score card for various vermicelli.

TABLE 2· SENSORY EVALUATION OF VERMICELLI FORMULATION.

Vermicelli formulation	Texture	Brittleness
VOR	31.693	10.070
V_1	32.191	10.300
V_2	33.119	11.796
V_3	32.298	10.504
VOM	31.547	10.467
V_4	31.985	11.376
V_5	33.002	11.823
V_6	32.985	11.633
SE	±0.146	±0.0822
CD (at 5%)	0.406	0.227

VOR, V_1, V_2 and V_3 represent semolina with 0, 2, 4 and 6% skim milk powder.

VOM V_4, V_5 and V_6 represent white flour with 0, 2, 4 and 6% skim milk powder.

*Max score 40, + Max score 15.

Texture: The formulations V_2 (4 per cent skim milk protein with semolina) V_5 (4 per cent skim milk protein with white flour) and V_6 per cent skim milk protein with white flour) were significantly superior over the rest with scores being 33.119±0.146, 33.002±0.146 and 32. 985±0.146, respectively and were at par. The formulations V_1 (2 per cent skim milk protein in semolina), VOR (all semolina) VOM (all white flour) got low ratings. In general, the treatments V_4 (2 per cent skim milk protein in white flour) to V_6 (6 per cent skim milk protein in white flour) were rated as superior over those from semolina with respect to texture. On the contrary, the treatments V_2 (4 per cent milk proteins in semolina) and V_5 (4 per cent milk proteins in white flour) were found best.

Brittleness: The ratings for brittleness of V_2 (4 per cent skim milk proteins in semolina) and V_5 (4 per cent skim milk proteins in white flour) were good. The values were 11.796 for V_2. 11.823 for V_5 whereas, the highest value of brittleness was 19.50 for the combination (6 per cent skim milk protein in semolina). Fortification of milk proteins at 4 per cent gave a better product.

Proximate composition of vermicelli: It is clear from Table 3, that the mean dry matter content was 88.708±0.089 per cent. The higher dry matter contents were observed in higher level of milk protein fortification in V_3 (6 per cent skim milk protein fortified semolina) (89.12 per cent) and V_6 (6 per cent skim milk protein fortified white flour) (88.85 per cent). The protein levels of 10.22 per cent in case of VOR (all semolina) changed gradually to 15.77 in case of V_3 (6 per cent skim milk protein in white flour) whereas, the corresponding values for VOM (all white flour) changed from 10.33 to 16.18 per cent in case of VOM and V_6 (6 per cent skim milk protein in white flour) respectively. The fibre content exhibited a gradual decrease with the subsequent increase in milk proteins. The fat content ranged from 0.690 to 0.790 per cent. The total carbohydrate levels tended to decline with the increase in the protein levels of vermicelli and the values decreased from 75.59 to 69.63 per cent. The

TABLE 3· PROXIMATE COMPOSITION OF VERMICELLI

Vermicelli formulations	Dry matter (%)	Moisture (%)	Protein (N×6.25) (%)	Crude fibre (%)	Fat (%)	Total carbohydrate (by diff) (%)	Ash (%)
VOR	88.57	11.47	10.22	0.238	0.726	75.83	1.55
V_1	88.58	11.42	11.83	0.202	0.774	74.25	1.73
V_2	88.58	11.42	13.76	0.181	0.720	71.97	1.94
V_3	89.12	10.87	15.77	0.153	0.690	70.34	2.16
VOM	88.25	11.75	10.33	0.244	0.776	75.57	1.33
V_4	88.71	11.29	12.01	0.220	0.790	74.19	1.49
V_5	88.78	11.22	14.13	0.168	0.790	71.88	1.81
V_6	88.85	11.15	16.18	0.152	0.760	69.63	2.12
Mean	88.708	11.25	13.03	0.194	0.753	72.95	1.766
SE±	0.0895	0.09	0.810	0.012	0.013	0.827	0.105

ash content was higher in V_3 (6 per cent, skim milk protein in semolina and V_6 (6 per cent skim milk protein in white flour) being 2.16 and 2.12 per cent, respectively, suggesting thereby that there could be an improvement in the mineral levels with the addition of milk proteins. The values obtained in the present investigation are comparable with the ISI specification[11] of moisture content as 12 per cent and protein content as 12 per cent.

It is concluded that 4 per cent protein fortification is the optimum level of milk protein incorporation in preparation of vermicelli. The product could be a satisfactory food source to meet the dietary needs.

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Factors Affecting Compositional Quality of Cheddar Cheese from Buffalo Milk

S.K. KANAWJIA AND S. SINGH
Dairy Technology Division, National Dairy Research Institute,
Karnal-132 001, India.

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Among the casein/fat ratios studied, 0.65 to 0.70 was found to be optimum to enhance the moisture retention in cheddar cheese made from buffalo milk. The yield, moisture and total solids retention in cheese were higher as compared to those obtained from highest C/F ratio (0.75) milk. Maximum yield, moisture retention and total solids recovery were obtained at a higher temperature of 165°F. Homogenization improved yield, moisture retention and recovery of total solids in cheese. Among the different additives, pectin gave a superior product. The yield and moisture retention were maximum in pectin added cheese.

The flavour development in buffalo milk cheddar cheese is considerably slower than that of cow milk cheese and it takes a prolonged ripening period of 8-12 months[1]. The prolonged ripening period and lack of full flavour development in buffalo milk cheddar cheese appears to be due to inherent qualitative and quantitative differences amongst major and minor constituents of buffalo and cow milk[2]. Syneresis of buffalo milk curd is considerably faster than that of cow's, probably due to high calcium content and different kind of casein micelles[3]. This poor retention of moisture, in turn, manifests itself in slower acidity development during manufacture and ripening accompanied by relatively slower rate of proteolysis and lipolysis. As a result of these slow biochemical changes, the cheese tends to be dry, hard and crumbly in body and texture and bland in flavour. In this study, efforts were made to enhance the moisture retention in cheese using various processing treatments.

Materials and Methods

Manufacture of cheddar cheese: Buffalo milk was procured from experimental dairy of the Institute. The cheddar cheese was manufactured as per the method described by Singh and Kanawjia[4]. The effects of different casein to fat ratio, (0.60, 0.65, 0.70 and 0.75), heat treatments, 62.8°C, 65.3°C and 73.9°C for 30 min, homogenization 1000 and 2500 p.s.i, and incorporation of certain additives like lecithin (0.02 and 0.05 per cent), starch (0.25 and 0.50 per cent) and pectin (0.10 and 0.20 per cent) were studied.

Coagulating enzyme: Modilase produced from *Mucor miehei* in liquid form was procured from Christen Hansen's Laboratory, Inc. Wisconsin, USA and used at 14.07 ml per 100 l of milk.

Lecithin: Lecithin was procured from BDH chemicals, England for cheese trials.

Starch: Pre-gelatinized potato starch was procured from M/S G.S. Chemical Testing Lab. & Allied Industries, New Delhi.

Pectin: Pectin was procured from M/S Hi Media Laboratories Pvt. Ltd., Bombay.

Chemical analysis: The milk was analysed for fat and casein, cheese for its fat, moisture and salt as per the methods of ISI[5]. The protein content of cheese was determined by the semi-micro Kjeldahl method, suggested by Meneffee and Overman[6].

Results and Discussion

Effect of casein/fat ratio on composition of cheese: The composition of cheese as influenced by casein/fat ratio is presented in Table 1. The yield of cheese is defined chiefly by the fat and casein contents of milk, but other aspects are also of considerable importance. The ratio of casein to fat affects the body and texture of the cheese, and it is, therefore, desirable to standardize it. The yield of cheddar cheese from buffalo milk ranged from 12.78 to 14.10 per cent being directly related to increase in fat content of milk. This yield of over 13 per cent is considerably higher than the yield reported for cheddar cheese from cow milk (about 10.50 per cent)[7-9].

The fat also helps in the retention of moisture in the curd and contributes to the better development of body, texture, and flavour[10-12]. Our findings showed that the cheese made with the lower C/F ratio resulted in higher yield. This increased yield was due to the additional fat used in the milk as well as due to the enhanced moisture retention. The fat content increased in cheese in proportion to its increase in milk. However, the retention of moisture was not that

TABLE 1. EFFECT OF CASEIN/FAT RATIO ON THE COMPOSITION OF CHEDDAR CHEESE.

C/F ratio	Yield (%)	Moisture (%)	Fat (%)	Protein (%)	MFFS (%)	FDM (%)	S/M (%)	T.S. recovery (%)
0.60	14.10	36.10	35.20	24.66	55.70	55.08	4.12	63.65
	(0.464)	(0.328)	(0.241)	(0.232)	(0.422)	(0.124)	(0.058)	(0.622)
0.65	13.86	36.70	33.89	25.41	55.20	53.53	4.34	63.27
	(0.398)	(0.366)	(0.198)	(0.248)	(0.516)	(0.180)	(0.062)	(0.518)
0.70	13.14	37.26	32.49	25.89	55.19	51.78	4.47	60.78
	(0.421)	(0.382)	(0.188)	(0.312)	(0.469)	(0.166)	(0.032)	(0.496)
0.75	12.78	38.48	29.35	27.16	54.46	47.91	4.61	58.68
	(0.418)	(0.318)	(0.179)	(0.286)	(0.477)	(0.131)	(0.044)	(0.488)

Average of 4 replicates.

MFFS: Moisture in fat-free substance., FDM: Fat in the dry matter., S/M: Salt in moisture., T.S.: Total solids., Figures in parentheses indicate standard error of mean.

apparent. The total moisture in cheese decreased as the fat content in milk increased. But moisture obtained on the basis of fat-free substance (MFFS) increased from 54.46 to 55.70 per cent, as the fat content in milk increased. Thus, the maximum retention of moisture was in cheese made from milk with minimum C/F ratio.

As expected, the protein content in cheese increased from 24.66 to 27.16 per cent with the increase in C/F ratio from 0.60 to 0.75. On the other hand, the fat in the dry matter (FDM) decreased from 55.08 to 47.91 per cent with increase in C/F ratio. It is quite obvious that for the enhanced flavour development and improved body and texture, a relatively higher fat content in the product is helpful. Thus, C/F ratios ranging from 0.60 to 0.70 were superior from the standpoint of the development of flavour, body and texture. The corresponding FDM for these C/F ratios ranged from 51.78 to 55.08 per cent. Thus, to get cheddar cheese of satisfactory quality from buffalo milk, the FDM above 50 per cent is essential. This is further substantiated by our study on samples of process cheese obtained from Indian market where all the samples had FDM above 50 per cent[13]. The minimum FDM prescribed by PFA for cheddar cheese is 42 per cent and that for process cheese is 40 per cent as against the International standard of not less than 50 per cent FDM for cheddar and process cheese. Thus, the Indian standards for cheddar and process cheese require urgent review particularly in case of buffalo milk.

The proper salt in moisture (S/M) is very important to control the system of cheese in combination with optimum level of acidity and oxidation reduction potential. The optimum level of salt in moisture recommended in cheddar cheese from cow milk is between 4-6 per cent. This level controls the proper growth of microflora in cheese. Our study showed that S/M level ranged from 4.12 to 4.61 per cent being inversely related to C/F ratio. As the salt content became lower, better was the flavour development. Since this level was always less than 5.0 per cent, it shows a marked distinction from that of cow milk cheese where the minimum level of salt prescribed is 5.0 per cent.

The total solids recovery ranged from 58.68 to 63.65 per cent, being directly related to the increase in fat content in milk and cheese. Thus, it can be presumed that the increase in fat content of milk does not necessarily entail increased loss of fat in whey. The total solids recovery of over 63 per cent is quite impressive. The literature value for TS recovery in cheddar cheese manufactured from cow milk is considerably lower (56.43 per cent)[9].

Effect of heat treatments: The effect of heat treatments on yield and composition of cheddar cheese is shown in Table 2. Yield and moisture increased with increase in

TABLE 2. EFFECT OF HEAT TREATMENT ON COMPOSITION OF CHEDDAR CHEESE

Heat treatment (°C/30 min)	Yield (%)	Moisture (%)	Fat (%)	Protein (%)	MFFS (%)	FDM (%)	S/M (%)	T.S. recovery (%)
62.8	13.20	37.48	32.56	25.51	55.57	52.08	4.34	60.71
	(0.522)	(0.620)	(0.244)	(0.362)	(0.660)	(0.242)	(0.068)	(0.762)
68.3	13.98	38.09	32.09	25.09	56.09	51.83	4.04	61.32
	(0.540)	(0.594)	(0.232)	(0.410)	(0.618)	(0.184)	(0.091)	(0.664)
73.9	14.88	40.05	31.68	24.68	58.61	52.84	3.53	62.05
	(0.666)	(0.662)	(0.210)	(0.428)	(0.516)	(0.216)	(0.082)	(0.684)

Average of 4 replicates.

MFFS: Moisture in fat-free substance., FDM: Fat in the dry matter., S/M: Salt in moisture., T.S.: Total solids., Figures in parentheses indicate standard error of mean.

temperature of heat treatment. The moisture in fat-free substances (MFFS) in cheese increased with the increase in temperature. The S/M in cheese ranged from 3.53 to 4.34 per cent, the lowest being in cheese made at 62.8°C and highest at 73.9°C. The total solids recovery was positively related and it ranged from 60.71 to 62.05 per cent. The maximum recovery was in cheese made from milk heated to higher temperature. The pasteurization and other heat treatments of milk caused prolonged renneting time[14,15] and higher moisture retention in the curd. The pasteurization also reduced the curd firmness as compared to raw milk system[16,17].

Effect of homogenization: The effect of homogenization on composition of cheddar cheese is shown in Table 3. The lower pressures had marginal improvement on the yield of cheese. The moisture retention in cheese increased with the increase of pressure and it ranged from 37.28 to 39.13 per cent. There were no appreciable differences observed in fat content of cheese. The protein content in cheese ranged from 24.85 to 25.63, the lowest being in control and highest in cheese made with 2500 p.s.i pressure. The higher protein content in homogenized milk cheese may be due to higher retention of whey protein along with the moisture. The moisture in fat-free substance (MFFS) ranged from 55.73 to 58.45 per cent. The homogenization also helped in retention of fat in cheese The fat in moisture-free substance ranged from 52.78 to 54.32 per cent, the lowest being for control and the highest for cheese homogenized at 2500 p.s.i pressure. The salt in moisture ranged from 3.92 to 4.53 per cent, being inversely related to homogenization pressure. The total solids recovery also increased. It may be due to more retention of fat and soluble solids. It ranged from 60.53 to 62.92 per cent the lowest being in case of control and the highest in case of cheese obtained at 2500 p.s.i. homogenization pressure.

TABLE 3. EFFECT OF HOMOGENIZATION ON COMPOSITION OF CHEDDAR CHEESE.

Homogenization pressures (p.s.i.)	Yield (%)	Fat (%)	Protein (%)	MFFS (%)	FDM (%)	S/M (%)	T.S. recovery (%)
Control	13.13 (0.624)	33.10 (0.262)	25.63 (0.468)	55.73 (0.662)	52.78 (0.246)	4.53 (0.044)	60.53 (0.724)
1000	13.89 (0.588)	32.94 (0.241)	25.02 (0.388)	56.63 (0.716)	53.11 (0.310)	4.24 (0.029)	62.40 (0.788)
2500	14.69 (0.572)	33.06 (0.244)	24.85 (0.422)	58.45 (0.684)	54.32 (0.224)	3.92 (0.022)	62.92 (0.648)

Average of 4 replicates.

MFFS: Moisture in fat free substance., FDM: Fat in the dry matter., S/M: Salt in moisture., T.S.: Total solids.,
Figures in parentheses indicate standard error of mean.

TABLE 4. INCORPORATION OF ADDITIVES ON COMPOSITION OF CHEDDAR CHEESE.

Additives (%)	Quantity (%)	Yield (%)	Moisture (%)	Fat (%)	Protein (%)	Salt (%)	MFFS (%)	FDM (%)
Control	–	13.15 (0.522)	37.44 (0.624)	32.48 (0.242)	25.64 (0.286)	1.66 (0.024)	55.45 (0.726)	51.92 (0.262)
Lecithin	0.02	13.28 (0.496)	37.53 (0.720)	32.54 (0.310)	25.39 (0.246)	1.70 (0.018)	55.63 (0.766)	52.00 (0.188)
	0.05	13.35 (0.466)	37.70 (0.635)	32.48 (0.362)	25.36 (0.268)	1.71 (0.032)	55.83 (0.870)	52.13 (0.242)
Starch	0.25	13.84 (0.662)	37.98 (0.588)	32.34 (0.388)	25.58 (0.310)	1.56 (0.036)	56.13 (0.620)	52.14 (0.314)
	0.50	13.90 (0.710)	38.12 (0.610)	32.16 (0.410)	25.51 (0.296)	1.47 (0.039)	56.19 (0.645)	51.97 (0.322)
Pectin	0.10	14.16 (0.486)	38.68 (0.596)	31.31 (0.420)	24.81 (0.322)	1.50 (0.040)	57.14 (0.743)	52.69 (0.310)
	0.20	14.32 (0.520)	38.81 (0.540)	31.80 (0.428)	24.65 (0.310)	1.43 (0.042)	56.91 (0.724)	51.96 (0.334)

Average of 4 replicates.

MFFS: Moisture in fat-free substance., FDM: Fat in the dry matter., S/M: Salt in moisture., T.S.: Total solids.,

Figures in parentheses indicate standard error of mean.

The benefits of homogenized milk in the manufacture of cheese are soft rennet curd, reduced fat loss in whey, higher yield, lower shrinkage during ripening and reduced fat leakage at higher temperature of curing room. It was observed that the homogenization had a beneficial effect on yield and composition of cheddar cheese. Similar findings were reported by Neogi and Jude[18], Peters[19], Humbert *et al.*[20] and Rao *et al.*[21]. The salt in moisture of cheese was reduced by the pressures of homogenization.

Effect of additives: The effect of starch (0.25 and 0.50 per cent), pectin (0.10 and 0.02 per cent and lecithin (0.02 and 0.05 per cent) on the composition of cheddar cheese is given in Table 4. The yield of cheese increased due to the additives. The addition of starch and lecithin had only marginal effect whereas pectin had maximum effect on moisture retention in cheese, consequently on the yield. These additives have been reported to enhance moisture retention in different varieties of cheeses by various workers[22-24]. The fat content in cheese ranged from 31.80 to 32.54 per cent and the protein content ranged from 24.65 to 25.64 per cent in cheese. The fat and protein contents in experimental cheeses were lower than the control. The salt content ranged from 1.43 to 1.71 per cent being minimum in cheese made with 0.20 per cent pectin and maximum in cheese made with 0.05 per cent lecithin. The MFFS in cheese increased with the addition of additives.

This study revealed that the yield, moisture retention and total solids recovery in cheese could be enhanced by using 0.65 to 0.70 C/F ratio milk, higher heat treatment, homogenization and incorporation of certain additives. The addition of pectin (0.10 per cent) to milk was the best for manufacture of cheddar cheese from buffalo milk.

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Effect of Heat Processing on Refrigerated Shelf-life of Concentrated Soymilk Beverage

LESLIE M. NSOFOR AND KELECHI B. ANYANWU
School of Food Science and Technology, Imo State University,
P.M.B. 2000, Okigwe, Nigeria

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The refrigerated shelf-life of concentrated soymilk beverage processed with different heat treatments was evaluated. Visible coagulation time (self-life) of beverage decreased with increased concentration of its total solids. Heat sterilization alone or in combination with simmering generally produced instant coagulation in soy beverage of 32% total solids and short shelf-life in beverages of 16 and 21% solids content. Combination of simmering and pasteurization produced visible coagulation time of 10 weeks in 32% solids beverage stored in air-tight container. Linear correlation coefficient of -0.89 was deduced between visible coagulation time and pH of freshly coagulated beverage. Simmering plus pasteurization generally produced lower pH at coagulation compared to other heat treatment combinations.

The adoption of soymilk as a substitute for milk in parts of the world where milk production is low and dairy products' prices are exhorbitant, has been receiving the attention of different workers[1-3]. A foreseeable limitation is its unavailability in shelf-stable forms for widespread use. Eventhough, it is desirable to produce low-cost soy beverage that is shelf-stable in ambient tropical conditions, immediate development of a beverage that would keep for more than 3 days is necessary.

Appreciable resentment for home preparation of soymilk is due to its short shelf life[4], although a refrigerated shelf-life of 2 months has been reported for regular strength soymilk[5], and an equivalent keeping time for sweetened concentrated soy beverage during ambient storage[6]. Moreover, the low solids concentration of the regular strength soymilk produced by Illinois process[7], and the high viscosity of sweetened condensed milk, do not satisfy the popular food uses of evaporated cow milk (ECM) by the people of sub-Saharan Africa. In a previous report[4], it was indicated that the use of concentrated milk varieties, especially ECM, had become an important food culture in Nigeria. For the preparation and utilization of soy beverage of high solids as an inexpensive substitute for ECM, prolongation of the product's shelf-life at both refrigerated and ambient tropical storage is necessary. This work summarizes the investigations of the effects of heat processing treatments on the refrigerated shelf-life of concentrated soymilk beverage.

Materials and Methods

Preparation of concentrated soymilk beverage (CSB): The preparation of CSB was as described by Nsofor and Anyanwu[4]. Five hundred g of whole soybean were utilized for the production of one litre of beverage which had 32 per cent total solids (TS) and an overall mean 9-point Hedonic sensory score of 5.7.

Variation in total solids concentration: Three concentrations of CSB corresponding to (i) full strength (FS) as described above (ii) half strength (HS), that is, 1:1 dilution of CSB with boiled and cooled tap water, and (iii) two-third strength (TTS) made by diluting 2 parts CSB with 1 part water, were freshly prepared. The original CSB stock from which the dilutions were made, was not simmered during its preparation as was done in the previous work[4]. One hundred ml aliquots of each concentration of CSB were then pipetted into Erlenmeyer flasks to provide eight complete sets of duplicates of each concentration. All flasks were stoppered with cotton wool.

Heat processing of beverage: The effect of single heat processing such as simmering (boiling at low heat for 20 min), pasteurization (holding in water bath at 65°C for 30 min), and sterilization (autoclaving at 121°C for 15 min) were investigated with each set of duplicate CSB samples. Combined heat processing such as simmering and pasteurization, simmering and sterilization, pasteurization and sterilization, and simmering, pasteurization and sterilization were also evaluated with duplicate CSB samples. Samples with no post CSB preparation heat treatment served as control.

Evaluation of shelf-life: All samples were then stored in the refrigerator at 5 ± 2°C and observed for clot formation after a gentle tilt for every 12 hr for visible coagulation time (VCT). Coagulated samples were immediately analyzed for pH and viscosity.

Statistical analysis: A two-factor (CSB strengthxheat processing treatment) analysis of variance[8] was utilized for evaluating the variations occurred in VCT. Tukey's test of multiple comparison was used to compare mean VCTs of different heat processing treatments and different strengths of CSB. Linear regression was used to calculate simple correlation coefficients between VCT, pH and viscosity. Coefficient of determination between VCT and pH also was calculated.

Results and Discussion

The variations that occurred in VCT of refrigerated CSB are shown in Table 1. Significant variations (α =0.01) in VCT were observed for the three strengths of CSB and the various heat treatments. Interaction between strength and heat treatment was insignificant. Tukey's multiple comparison of mean VCTs for three strengths of CBS showed that FS-CSB and TTS-CSB had insignificantly different (α =0.01) VCTs of 3.3 and 6.3 days respectively and the corresponding TS contents of the strengths were 32 and 21 per cent respectively. The HS-CSB that had 16 per cent TS produced mean VCT of 11.5 days which was significantly different (α =0.01) from FS-CSB and TTS-CSB. The mean VCTs in days produced by single and combined heat processing treatments are summarized as follows:– no heat (NH)=2.6, simmered (S_t)=4.3 pasteurized (P)=12.3, sterilized (S_t)=3.8; and S_tP=16.8, PS_t=7.3, S_tS_t=5.6 and S_tPS_t=3.5. Tukey's multiple comparison of heat treatment means produced the grouping as S_tP^a P^a PS_t^b $S_tS_t^b$ S_t^b S_t^b $S_tPS_t^{bc}$ NH^{bc}, in which treatments with same superscript(s) produced means which were not significantly different at α =0.01. The combined heat processing treatment S_tP produced the longest mean VCT of 16.8 days which was insignificantly different from P alone which was 12.3 days. Despite this insignificant difference, S_tP is preferred to P because P_t inactivates trypsin inhibitor[7]. The shortest mean VCT of 2.6 days was produced by the control sample, (NH). This however, was insignificantly different from the 3.5 days produced by samples which had combined triple heat treatment S_tPS_t. The latter observation indicates that whereas microbial deterioration could be implicated for the short shelf life of NH samples, heat denaturation of soy proteins resulting from the excessive heat treatment S_tPS_t was responsible for the short VCT of the latter. Insignificant differences occurred between mean VCTs of samples that were S_t or S_t alone, and those which received a combination of S_t and another heat treatment. Mean VCTs of 4.3 days observed with samples which were S_t alone agree with the range of VCT of 2 to 5 days commonly observed when home prepared soymilk is refrigerated. Several people who are involved with home preparation of soymilk usually simmer it in a sauce pan as the last processing step before dispensing into clean but neither sterilized nor pasteurized containers, followed by refrigerated storage. It is strongly suspected that relatively high microbial numbers present in the storage containers mediate the relatively rapid spoilage of the soymilk.

TABLE 1. ANALYSIS OF VARIANCE OF VISIBLE COAGULATION TIME OF CONCENTRATED SOYMILK BEVERAGE DURING REFRIGERATED STORAGE

Source of variation	Sum of squares	D.F.	Mean square	F-ratio[1]
Soymilk concn (A)	546.1	2	273	19.5*
Heat treat (B)	1057.5	7	151.1	10.8*
A×B	158.3	14	11.3	0.8
Error	335.6	24	14	
Total	2097.5	47		

[1]F-ratio* was significant at P = 0.01.

Interaction of heat processing and soybeverage solids concentration: The interactive effects of heat processing treatment and soymilk concentration on VCT are illustrated in Fig 1. Single heat treatment produced a mixture of linear and curvilinear relationships, while combined heat treatment generally produced curvilinear relationships only. A weakly significant interaction (=0.10) existed between soymilk solids concentration and single heat treatment (Fig 2). While NH, and S_t treatments produced similar effect on VCTs of CSBs, P and S_t produced widely varying effects. The longest VCT of 22 days was produced by S_tP in 16 per cent TS CSB while S_t alone or in combination with other heat treatments generally produced instant coagulation in 32 per cent TS CSB (Fig 1). It appeared that pre-heat treatment of 21 per cent TS CSB by S_t or P before S_t produced longer VCT than when the same milk analogue was only S_t or when the S_tPS_t combination was applied. Pre-heat treatment of ECM improved heat stability of the product during S_t[9]. These observations strongly indicate that sterilization of CSB at concentrations of 21 per cent and greater would not extend shelf-life. The longest mean VCT produced in 16 per cent TS CSB and the shortest in the 32 per cent variety strongly established the existence of a concentration effect on the shelf-life of heat processed soymilk. Soymilk with lower solids concentration than those utilized in this study is expected to keep longer even when heat sterilized. Nelson *et al.*[5] observed a refrigerated shelf-life of at least 2 months without separation of the colloidal phase in pasteurized soymilk of 12 per cent TS prepared by the Illinois process.

The overall short shelf-life of CSB samples observed in this study may be partly attributed to gaseous exchange between GSB and atmosphere, with consequent post-heat treatment contamination of samples by micro-organisms. The Erlenmeyer flasks that contained CSB stoppered with cotton wool may not have provided air-tight environment. A new 32 per cent TS CSB sample that was S_tP processed in air-

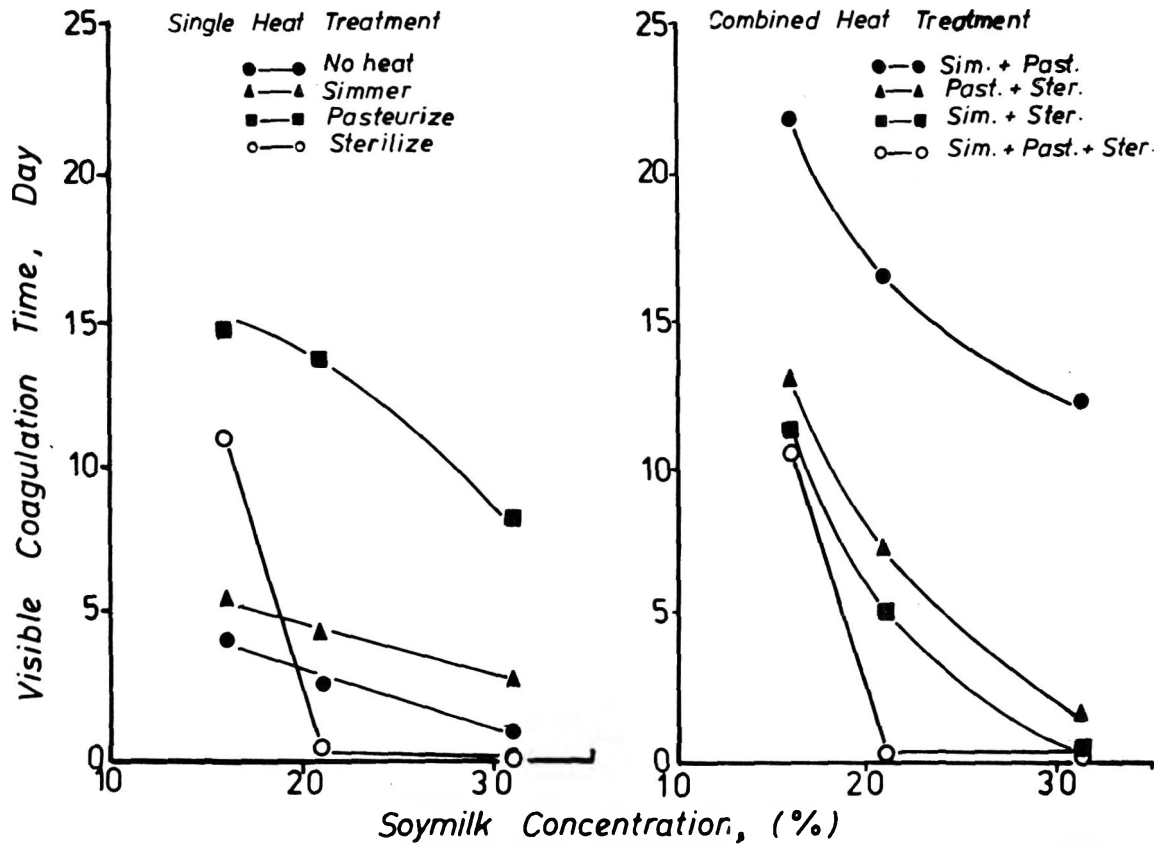

Fig. 1. Effect of heat treatments on visible coagulation time (shelf-life) of concentrated soymilk beverage during refrigerated storage

tight bottles, and stored in the refrigerator, yielded VCT of 10 weeks.

Correlation coefficients: Linear regression of VCT on pH of CSB at coagulation, produced a correlation coefficient r=0.89 indicating a strong relationship between pH and shelf-life (Fig 3). Coefficient of determination, r^2=0.80 showed that 80 per cent of the variation in VCT was explained by pH at coagulation, and the remainder 20 per cent was probably due to heat denaturation of soy protein. An interplay of microbial activity and heat denaturation of soy proteins could be implicated for the coagulation of CSB. The

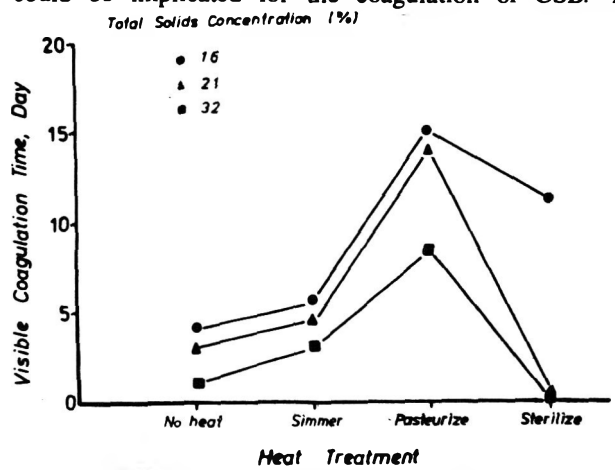

Fig. 2. Interactive effects of single heat processing treatment and total solids concentration of soymilk beverage on refrigerated shelf-life.

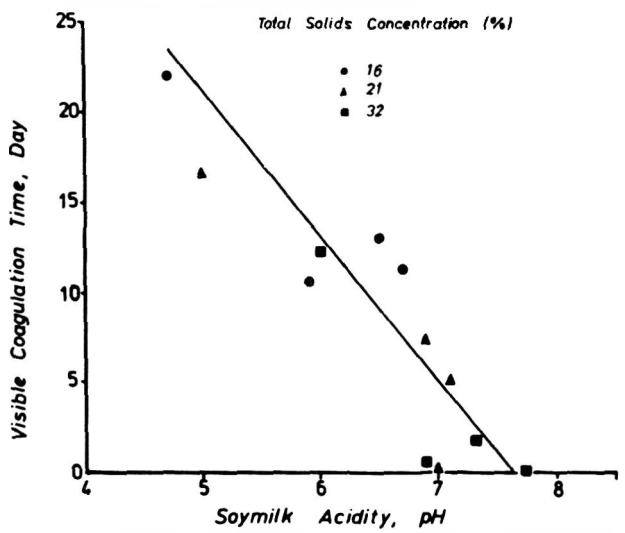

Fig. 3. Linear regression of visible coagulation time on acidity of freshly coagulated concentrated soymilk beverage processed with combined heat treatments.

correlation coefficient shown is for data obtained with combined heat processing treatment only. Correlation coefficient for single heat treatment data was insignificant. Shelf-life data for both single and combined heat processing treatments are shown in Table 2. Significant correlations r=−0.47 and 0.40 were calculated between VCT and viscosity, and pH *versus* viscosity for CSB processed with combined heat treatments.

TABLE 2. SHELF-LIFE PARAMETERS OF CONCENTRATED SOYMILK BEVERAGE STORED AT REFRIGERATED TEMPERATURES[1]

Heat treatment	Values at indicated total solids concn. (%)								
	16			21			32		
	pH	VCT[2] (days)	Viscosity (CP)	pH	VCT (days)	Viscosity (CP)	pH	VCT (days)	Viscosity (CP)
No heat	5.0	4.0	29.1	5.2	2.8	32.4	5.8	1.0	69.6
Simmer (S_1)	5.1	5.5	46.5	5.7	4.5	41.7	6.0	2.8	99.6
Pasteurize (P)	5.7	14.8	26.1	5.9	13.8	27.9	6.0	8.3	56.1
Sterilize (S_2)	4.7	11.0	34.5	7;3	0.3	29.4	8.0	0	38.1
S_1P	4.7	21.8	25.5	5.0	16.5	31.5	6.0	12.3	33.5
PS_1	6.5	13.0	25.5	6.9	7.3	29	7.3	1.8	33.0
SS_1	6.7	11.3	28.5	7.1	5.0	32	6.9	0.5	35.5
S_1PS_1	5.9	10.5	25.5	7.0	0	26	7.7	0	34.0

[1]Mean values of duplicate readings are shown.

[2]VCT = visible coagulation time.

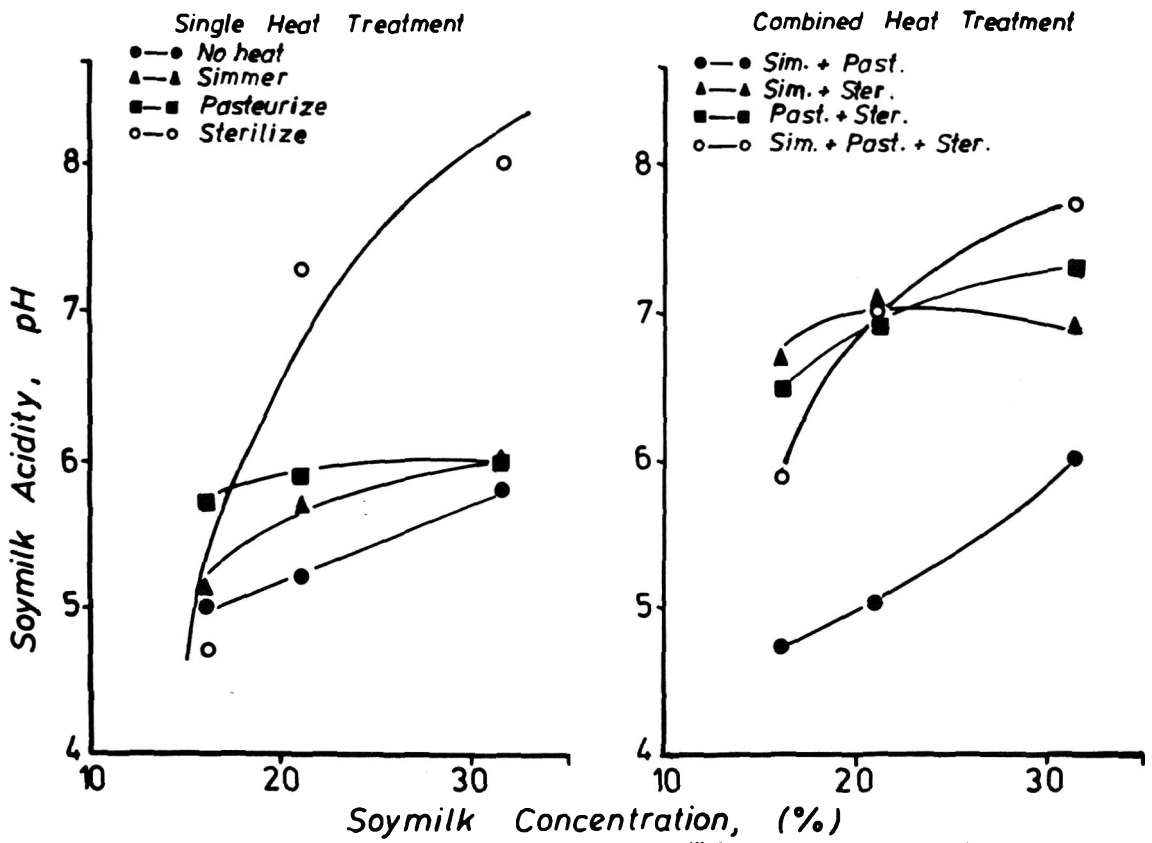

Fig. 4. Effect of heat treatments on the pH of freshly coagulated concentrated soymilk beverage stored at refrigeration temperatures.

Effect of heat treatment on cogulation pH: The pHs of GSB at coagulation produced by single and combined heat treatments are shown in Fig 4. The pHs of samples processed by S_1P were distinctly lower than those of other combined heat treatments. The lower heating temperature of S_1P compared with other heat treatment combinations minimized heat denaturation of soyproteins and therefore prolonged their precipitation. It, however, did not eliminate viable microorganisms which subsequently caused pH reduction through metabolic activities. The other three heat treatment combinations produced approximate pH of 7.0 at coagulation in 21 per cent TS CSB. Metabolic activity of microorganisms results in production of organic acids, for example lactic acid, and this causes pH reduction and consequent protein precipitation thereby reducing shelf-life. Precipitation of soyproteins increases viscosity of soy beverages. Visual perception of spoilage of refrigerated soymilk occurs when there is an apparent increase in viscosity. The significant correlation coefficients deduced in this study between VCT, pH and viscosity indicate strong relationships between shelf-life and these parameters. Newer method of soy processing involving non-heating techniques for inactivating soybean

enzymes[10,11] may minimize heat denaturation of soyproteins and prolong shelf-life of CSB.

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Effect of Relative Concentration of Different Sugars on the Freeze-Drying Properties of Grape Juice

T.S. VASUNDHARA, H.S. PHANINDRA KUMAR AND K. JAYATHILAKAN
Defence Food Research Laboratory, Siddartha Nagar, Mysore-570 011, India.

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The juice from blue grapes varied considerably in its total sugar content during a two year period from 8° to 19° Brix in which the reducing sugar amounted to 85-90%. When made up as 20° Brix juice, these samples exhibited various problems during freeze-dehydration. When the sucrose to glucose ratio was equal or lower than 1.0:0.47 or sucrose to fructose ratio was equal or lower than 1.0:0.27; the juice could be satisfactorily freeze-dried and stored without exhibiting hygroscopicity for several months. With higher initial Brix, of greater than 8° these values were much higher and led to drying problems. Method adopted for preparing juice for freeze-drying when the ratio were altered to increase the total non-reducing portion by incorporating cane sugar to a level of 30°, 35° and 40° Brix, the same juice samples dried satisfactorily. The ratio of the total reducing sugar to sucrose rather than the ratio of glucose or fructose to sucrose individually was found to be more important in determining the freeze-dried characteristics of grape juice.

Previous studies had shown that fruit juices such as pineapple, mango, citrus and watermelon[1-3] could be freeze-dried at 20° Brix and different acidity levels (0.3-1.0 per cent). The freeze-dried juice powders remained flavoursome, chemically stable and in the free-flowing form for several months when suitably packed and stored. The successful freeze-drying of grape juice (from Bangalore Blue variety) was recently reported[4] where the authors employed a juice preparation adjusted to 20° Brix and 1.5 per cent acidity. In the succeeding years, during the freeze-drying of grape juice at pilot scale levels, for no apparent reason, it was noticed that in certain batches either the drying was incomplete (sticky or leathery mass) or that the resultant dried powders did not have the expected shelf stability unlike the other fruit juice powders.

The grape powder was highly hygroscopic, was difficult to handle even under low humidity (20 per cent relative humidity) and the packed powders caked early in storage. The freeze-drying of liquid extracts containing large quantities of reducing sugars have reportedly presented problems[5]. Since fruit juices also contain large amounts of sugars, it was of interest to understand whether the problems associated with the freeze-drying of grape juice in particular resulted from its total sugar content and/or its constituent sugars. In this paper, the results of a study carried out to establish whether the initial and the final juice solids which are largely sugars as well as the relative content of the non-reducing sugars influenced the drying properties of the juice and its storage stability in the dried form are reported.

Materials and Methods

All the chemicals used in this investigation were of the highest purity commercially available. Cane sugar was obtained in retail as available commercially; citric acid (AR grade) was of 99 per cent titratable acidity. Corn syrup solids (Anil Starch Company, Bombay) and malto-dextrins (Laxmi Starch Ltd., Bombay) were added to the juice in different concentrations (on w/v basis) along with cane sugar to increase the total solids content of juice. Trimethyl silyl derivatives of α-D glucose, β-D glucose, sucrose, trichloromethyl silane and hexa methyl disilazane were products of Sigma Co., USA. Pyridine (A.R) was freshly distilled and dried before use. Blue grapes of variety 'Bangalore Blue' were procured in retail in quantities of 50-100 kg during the period of investigation (about 19 months). Juice was prepared as described by Radhakrishna *et al.*[4] which involved (a) extraction from the crushed grapes in a screw type extractor, (b) heating the juice to enhance the colour, (c) enzyme clarification, (d) pasteurisation followed by (e) Brix and acidity adjustment. Brix was adjusted at 20°, 30°, 35° and 40° with cane sugar and acidity with citric acid (to 1.5 per cent). Freeze-drying was carried out in a pilot scale freeze-dryer (Hull Corporation, USA) to a final moisture content of approximately 1 per cent or less. When the trays were unloaded and taken to a humidity controlled chamber (20% relative humidity) the dried juice (large flakes or blocks) was scraped off the tray, powdered and packed in paper-aluminium foil-polyethylene laminated pouches. This powder served as a base for compounding the ready-to-serve beverage formulation[6].

Chemical analysis: Moisture content, Brix, acidity, total and reducing sugars were determined as per standard procedures used in the analysis of fruit product[7]. Gas liquid chromatographic analysis of the individual reducing sugars (glucose and fructose) present in the juice was carried out by the method of Kline[8] in a gas chromatograph (CIC, Baroda) equipped with flame ionisation detector.

Results and Discussion

The total solids content or Brix is an indirect measure of the total sugars in fruit juices[9]. Effect of the initial Brix of grape juice on its freeze-drying properties is shown in Table 1, where five juice samples varying in natural Brix (8°-14°) and acidity (0.82-1.02 per cent) were all uniformly adjusted to a final Brix of 20° and final acidity of 1.5 per cent. Only where the initial Brix was 8° did the juice appear to dry properly. At higher Brix, drying problems were encountered as well as hygroscopicity and instability of the dried powder was observed as depicted in Table 1. Chemical analysis of these five juice samples showed the corresponding sucrose to glucose (S:G) and sucrose to fructose (S:F) ratios to be greater than 1:0.47 and 1:0.27 respectively, corresponding to 8° Brix juice which dried perfectly. The composition of juice samples with higher initial Brix i.e. between 15° and 19° were also determined because these samples also exhibited poor drying properties. Of the total sugar found in grape juice, the non-reducing sugars constituted less than 5 per cent (on dry weight basis) whereas the reducing sugars comprised the rest (85-90 per cent on dry weight basis). This seemed to be a notable difference between grape and pineapple juice composition in which though the glucose and fructose were present in equal amounts, collectively, the reducing sugar content was less than that of the non-reducing sugars initially in the juice, to dry satisfactorily. Similar observations with respect to higher non-reducing sugar content was made in mango[10]. Therefore, the reason for poor drying of grape juice may be attributed not to the relative glucose and fructose contents but possibly to the total non-reducing sugar content. It was, therefore, hypothesised that if the relative concentration of sugars could be altered on par with pineapple or mango, then better drying properties could be introduced into grape juice. One could achieve this by diluting with water, but it would lower the total solids content below what is desirable for economic freeze-drying. Additives such as malto-dextrins and corn syrup solids incorporated into the juice to increase the total solids content after diluting with water did not have the desired effect. Therefore, the effect of direct addition of a further quantity of cane sugar was examined in the case of juice samples with higher initial Brix (viz. 16° Brix in the hot extracted form) which hitherto did not dry well at 20° Brix. The altered S:G and S:F ratios determined for 30°, 35° and 40° Brix juice and their corresponding drying characteristics were compared with those of the 20° Brix juice as control (Table 2). It is clear from the data presented that except at 20° Brix the S:G and S:F values were lower than 1.0:0.47 and 1.0:0.27 respectively corresponding to the satisfactory drying observed earlier (Table 1).

These experiments have revealed that the practice of topping up with cane sugar to a final Brix of 20° irrespective of either the initial Brix or the constituent sugar ratio of the juice would not always lead to successful drying. Due to the inherent variations in total solids content and the three sugars : glucose, fructose, sucrose present in the grape juice, as has been brought out in this study, it would be more appropriate to increase the final Brix to 30° with cane sugar so that it

TABLE 1. EFFECT OF INITIAL SUGAR CONCENTRATION OF THE FREEZE DRYING CHARACTERISTICS OF GRAPE JUICE

Fresh Juice		After hot extraction		Properties of juice for drying[a]		Drying properties	
°Brix	Acidity (%)	°Brix	Acidity (%)	S:G	S:F	Heating phase (37° under vacuum)[b]	End phase (unloading)
8	1.02	10.50	1.15	1:0.47	1:0.27	No melting and puffing	Fully dries, easily removable from trays[c], can be powdered[d] and packed and held for several months at room temp.
10	0.82	12.30	0.86	1:0.81	1:0.52	Puffing, melting	No uniform drying, wet patches, not easily scraped, from tray, difficult to powder, hygroscopic.
12	0.72	14.60	0.79	1:1.40	1:0.83	High melting and puffing	
13	0.92	15.76	1.02	1:1.85	1:1.15	-do-	-do-
14	0.95	16.85	1.08	1:2.75	1:1.61	-do-	-do-

(a) In all cases Brix and acidity were adjusted to 20° and 1.5% respectively after hot extraction: (b) behaviour of frozen juice after heat is applied under vacuum: (c) unloading and handling at 20% RH; (d) paper foil polyethylene laminated pouches.

S:G = Sucrose to glucose; S:F = Sucrose to fructose.

TABLE 2. THE EFFECT OF THE CONCENTRATION OF REDUCING SUGARS IN RELATION TO NON-REDUCING SUGARS ON DRYING AND STABILITY OF GRAPE JUICE POWDER

°Brix	Acidity	Non reducing : reducing sugars		Juice drying behaviour	Quality and storage stability of juice power
		S:G	S:F		
20°	1.5	1:0.75	1:0.40	Improper drying if original Brix is $\geqslant$ 10.	
30°	1.5	1:0.33	1:0.18	Slight puffing, but dried satisfactorily if the original Brix is 10°-16°.	No change in colour, flavour, easily rehydratable, free flowing, stable for 1 yr at RT.
35°	1.5	1:0.26	1:0.14	Puffing occurs but dries satisfactorily if original Brix is $>$ 16°.	-do-
40°	1.5	1:0.21	1:0.11	-do-	-do-

S:G = Sucrose and glucose; S:F = Sucrose to fructose.

compensates for the low initial sucrose content and alters the S:G and S:F ratios which are more favourable for drying. Glucose and fructose concentrations play important role in determining the final drying properties though not in their individual capacity but only in relation to sucrose (as S:G and S:F) as has been substantiated by the data presented. Since the 'Bangalore Blue' variety of grapes used in this study (1987-1989) varied considerably during the 2 year period in the concentration of its constituent sugars from one season to another and within the same harvest season as well. It is imperative that both parameters, i.e. the initial Brix as well as the S:G ratios be determined before topping up with cane sugar. However, the rule of the thumb emerging from our experiments would be that when the Brix is 10 or above in the hot extracted juice (easily determined by the simple method adopted), the final Brix should be made upto 30° and not 20° to obviate any drying difficulties.

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STUDIES ON THE UTILISATION OF MANGO PROCESSING WASTES FOR PRODUCTION OF VINEGAR

S. ETHIRAJ AND E.R. SURESH

Microbiology Laboratory, Indian Institute of Horticultural Research, Hessaraghatta, Bangalore - 560 089. India.

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The possibilities of utilizing mango peels and stones for production of vinegar were explored. Direct fermentation yielded slightly more alcohol as compared to fermentation of cold or hot water extracts. Since the alcohol content in the base wine was less (2.5 to 3.5%) for vinegar production, it was raised to 5% either by fortification with alcohol or by secondary fermentation by addition of cane sugar. A good quality vinegar with 4.5 to 5.0% acetic acid and characterised by mild mango flavour was obtained. The simple batch type process required 3 to 12 days for completion depending upon the base wine.

Mango is one of the most important fruit crops of India and is processed into various products. Peel and stones which account for nearly 20-30 per cent of the fruit are the major waste materials available during mango processing. The fermentable sugars adhering to the fruit processing waste materials are ideal substrates for fermentations. Several reports suggest the possibilities of alcohol and vinegar production from various fruit processing wastes. Production of alcohol from apple pomace[1] and damaged guava or banana fruits[2] has been reported. Similarly, utilization of waste mango pulp and peel[3], pineapple processing wastes[4], reject sub-standard banana[5] and few other tropical fruits[6] for vinegar production has been studied. The present study was undertaken to find out the possibility of using mango peel and stones for production of alcohol and vinegar and the results are reported in this communication.

'Totapuri' mango peels and stones used in this study were obtained from a local processing factory during 1988 and 1989. Alcohol fermentation of these wastes was carried out by two methods. In the first method, 5 to 10 kg lots of peels or stones were mixed with 50 per cent (w/w) of cold or hot water and the saccharine extracts were obtained by manual washing. These extracts were treated with 50 p.p.m. SO_2 and fermented for 72 hr at ambient temperature (24 ± 4°C) by inoculation with *Saccharomyces cerevisiae* var. *ellipsoideus*, Montrachet strain. In the other method, 5 to 10 kg lots of peels or stones were mixed with 50 per cent (w/w) of cold water, treated with 50 p.p.m. SO_2, fermented as described above and drained after 48-72 hr. Acidity and total sugars were analysed by standard A.O.A.C. methods[7]. Alcohol and tannin were estimated as described by Amerine and Ough[8]. The yields of sugar and alcohol were calculated for 100 kg waste material. The base wine from peel and stone washings contained 2.5 and 3.0 per cent alcohol respectively. The corresponding values for tannin contents were 2020 and 600 mg/l. In an efficient acetification process, 1 ml of ethyl alcohol yields about 1 g acetic acid[9]. Hence, the base wine should contain a minimum of 5 per cent alcohol in order to get 5 per cent acetic acid in vinegar. Since the base wine contained only 2.5 to 3.0 per cent alcohol, the desirable level of alcohol (5 per cent) was obtained either by fortification with alcohol or by secondary fermentation with the addition of 4 per cent cane sugar. Yeast extract at 0.1 per cent level was used as a nutrient to initiate fermentation. At the end of fermentation, the wine samples were racked, bottled and stored at low temperature for subsequent use in vinegar production.

A batch type fermentation process as described by Adams[5] was used for acetification process. A strain of acetic acid bacteria isolated from beetroot in this laboratory and identified as *Acetobacter rancens* was used. Starter culture for acetification was developed by inoculating this culture into 25 ml of medium containing glucose, 10 per cent; yeast extract, 3 per cent and calcium carbonate, 3 per cent. Acetification was initiated by mixing 48 hr old starter culture with 200 ml base wine and placing in 2 l aspirator bottle for development as mother culture. After 7 days, 800 ml of base wine was mixed with this mother culture and allowed to undergo fermentation at ambient temperature (26 ± 3°C). The acetic acid production and drop in alcohol content were measured at 2 day intervals. When the acidity reached about 4.5 to 5 per cent, 500 ml of vinegar was drawn from the bottom of the bottle and replaced by the same quantity of fresh base wine without disturbing the film growth of acetic acid bacteria. This procedure was repeated for five times separately for fortified and secondary fermented base wines.

The data presented in Table 1 indicate that the cold or hot water extraction method had no significant effect on the total sugar available for fermentation. However, mango peel washings obtained during 1989 had slightly more sugar as compared to 1988 samples probably due to the seasonal variations in the sugar contents of mango fruits or due to process variation. The calculated value for alcohol yield indicated that an average of 2.40 l of absolute alcohol can be obtained from 100 kg peel by direct fermentation as compared to 1.39 to 1.45 l by hot or cold water extraction. Similarly, an yield of 2.5 l of absolute alcohol can be obtained

Contribution No. 58/90.

TABLE 1. YIELD* OF SUGAR AND ALCOHOL FROM TOTAPURI MANGO PEEL AND STONES BY DIFFERENT METHODS

Treatment method	Year of exp.	Peel washings		Stone washings	
		Sugar (kg)	Alcohol (lit)	Sugar (kg)	Alcohol (lit)
Cold water extraction	1988	2.40	1.10	3.51	1.62
	1989	3.99	1.79	3.64	1.94
Hot water extraction	1988	2.28	1.04	3.72	1.74
	1989	3.62	1.73	3.39	1.56
Direct Fermentation	1988	–	2.75	–	2.47
	1989	–	2.05	—	2.06

*The sugar and alcohol yield figures are recalculated for 100 kg of waste based on the experimental results obtained during the respective years.

TABLE 2. BATCH TYPE VINEGAR FERMENTATION OF BASE WINE FROM TOTAPURI MANGO PEEL AND STONES

Batch No.	Mango peel base wine			Mango stone base wine		
	% acidity*		Acetification period (days)	% acidity*		Acetification period (days)
	Initial	Final		Initial	Final	
Fortified base wine						
I	1.75	4.65	12	1.68	4.26	8
II	2.58	4.68	11	2.76	4.32	5
III	2.64	4.75	12	2.74	4.68	4
IV	2.64	4.59	11	2.96	4.56	3
V	2.64	4.68	12	2.82	4.68	3
Secondary fermented base wine						
I	2.40	4.40	8	2.79	4.62	4
II	2.58	4.74	8	2.70	4.54	4
III	2.76	4.80	10	2.54	4.53	4
IV	2.64	4.92	9	3.00	4.02	3
V	3.24	5.28	5	1.98	4.16	3

*Expressed as g acetic acid/100 ml

from 100 kg of stones by direct fermentation as compared to 1.65 to 1.78 l by hot or cold water extraction. Since hot or cold water extraction yielded a thick pulpy slurry which was difficult to handle during fermentation and the saccharine extract yielded less alcohol, direct fermentation of peel or stones can be adopted as a standard method for fermentation.

Vinegar fermentation by simple batch type process is generally slow and requires 4 to 5 weeks for completion of fermentation[10]. In the present study, it was observed that acetification period ranged from 11 to 12 days and 3 to 8 days for fortified base wine from mango peel and stones respectively (Table 2). A slightly faster rate of acetification was noticed in secondary fermented base wine. The variation observed in acetification period in different batches could be due to the differences in temperature as the fermentation was carried out at ambient conditions. Wine from peel washings required more period for acetification probably due to higher tannin content. Since the alcohol yield is low, it may not be feasible to use this waste for alcohol production. However, good quality vinegar can be obtained from mango peel or stones. The possibility of commercial production needs to be worked out.

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EFFECTS OF HEAT TREATMENT ON LIPID DEGRADATION IN BAJRA FLOUR DURING STORAGE

K.V. PATEL AND M. PARAMESWARAN
Department of Biochemistry, B.A., College of Agriculture, Gujarat Agricultural University, Anand - 388 110, India

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Moisture content and peroxide value increased while lipase activity and free fatty acids fluctuated in bajra flour during storage. Gas liquid chromatographic profile of free fatty acids showed a fall in the proportions of oleic, linoleic and palmitic acids with storage. Heating the flour prior to storage at 50 or 100°C for two hours lowered the rate of lipid degradation.

In spite of greater availability, low cost and comparatively good nutritional value, use of bajra in food industry is very low compared to that of wheat and maize. The main reason is its poor keeping quality. Bajra flour develops unpleasant odour and often a bitter taste when stored for more than 7-10 days[1]. Bajra contains a greater amount of fat (5-7 per cent) and its fatty acid composition indicate presence of higher proportions of unsaturated fatty acids[2]. Both hydrolytic and oxidative rancidities occur in bajra flour resulting in release of free fatty acids and formation of peroxides[3]. The hydrolytic and oxidative changes in the flour lipids during storage of bajra flour and the effect of heat treatment of bajra flour on lipid degradation were examined and the results are presented here.

Bajra (variety 'BJ-104') obtained from the plant breeding farm of Gujarat Agricultural University, Anand was cleaned to remove extraneous material. It was ground in small quantities (20 g each) in the small container of Braun mixie at maximum speed setting four to five times each time for one minute allowing (sufficient interval) to keep the container cool.

The flour was then passed through 60 mesh sieve (recovery 90 per cent). The flour samples were stored in four separate aluminium tins (250 g capacity filled to the rim and closed with lid) for 21 days. The average minimum and maximum room temperatures were 25° and 31°C respectively during this period while the relative humidity of the storage room fluctated from 65 to 90 per cent. The flour samples were withdrawn and analyzed for moisture, lipase activity, free fatty acids, peroxide value and fatty acid profile as per standard methods[4-7]. In another experiment, the flour samples prepared as described above, were heated in a hot air oven at 50 or 100°C for two hr, cooled in a desiccator and later stored in four separate aluminium tins (filled to the rim and closed with lid) for 45 days. Control (unheated) and heat treated samples were withdrawn at 0, 15, 30 and 45 days and analyzed for moisutre, lipase acitvity, free fatty acids and peroxide value.

The moisture content of bajra flour increased continuously during storage, except for the value on the 6th day (Table 1). Though the relative humidity of the room was in the range of 65-90 per cent, the humidity in the storage tin must have been much lower (not measured). The flour did not develop off-flavours possibly because the moisture was less than 12 per cent, the critical moisture content reported for development of off-flavour[8].

The lipase activity as well as free fatty acid levels not only increased during storage but also showed high fluctuations as observed in lipase activity during storage of oats[9] and wheat[10]. With progress in storage time, a continuous increase in peroxide levels was seen. The flour deterioration appeared to be more rapid in the third week from the greater rate of increase in peroxide value during this period.

The profile of free fatty acids extracted with alcohol from bajra flour at intervals of storage showed a decline in the proportion of palmitic, oleic and linoleic acids (Table 2). During the later stages of storage, there were unidentified peaks in the gas liquid chromatographic separation profile of methylated fatty acids which may correspond to 18:2 fatty acid derivatives resulting from isomerization and peroxidation reactions reported to occur during storage[11].

Correlation coefficients were calculated among the various parameters in stored flour. Significant positive correlations were observed between (i) FFA and moisture ($r = 0.43$) (ii) peroxide value with moisture ($r = 0.70$) and FFA ($r = 0.61$). The absence of any correlation between lipase and moisture or FFA is due to the fluctuations in the lipase activity.

If the flour is heated prior to storage, the lipid degradative changes would be much lower. In Table 3, the data on

TABLE 1. CHANGES IN MOISTURE, LIPASE ACTIVITY AND LIPID DEGRADATIVE PRODUCTS IN STORED BAJRA FLOUR

Period (days)	Moisture (%)	Lipase activity (μm/FFA/min/g flour)	FFA (as % oleic acid)	Peroxide value (m.eq./kg fat)
0	8.61	12.69	0.63	4.72
3	8.91	42.06	1.15	7.37
6	10.00	108.70	1.88	9.36
9	8.90	32.06	2.10	15.08
12	9.00	109.53	2.47	20.36
15	9.30	59.97	2.73	28.74
18	9.60	8.70	1.83	57.39
21	10.90	12.49	2.99	100.49
S.Em	0.26	1.70	0.66	3.00
C.D. (0.05)	0.75	4.94	0.17	8.73

TABLE 2. FREE FATTY ACID COMPOSITION (%) OF BAJRA FLOUR DURING STORAGE

Storage period (days)	16:0	18:0	18:1	18:2	18:3	Others	(r=4)
0	18.98	1.71	25.32	46.49	3.26	1.3 – 5.91	(1–2)*
3	15.01	1.35	18.97	34.25	4.50	1.4 –19.77	(3–5)
6	14.49	1.32	19.32	37.22	3.44	1.22–19.69	(3–4)
9	18.88	2.07	24.71	44.72	3.07	1.98–23.52	(1–3)
12	13.07	1.48	17.51	32.03	3.76	2.80–16.84	(1–6)
15	12.74	1.34	15.43	30.61	5.70	1.23–20.70	(1–7)
18	14.23	1.77	20.56	35.94	2.65	1.57–20.48	(1–5)
21	14.04	2.31	20.38	36.90	3.07	1.58–25.27	(1–5)
C.D. (0.05)	2.44	0.70	4.06	7.78	1.25		

r = Number of replications
* = Number of extra peaks.

moisutre, lipase, free fatty acids and peroxide value are expressed as percent of untreated control at the start of the storage. The data at the beginning (zero day) clearly showed that heat treatment at 50 and 100°C reduced the moisture content, lipase activity and formation of free fatty acids. Peroxides were lower only in flour heated at 100°C.

TABLE 3. EFFECT OF HEAT TREATMENT PRIOR TO STORAGE ON LIPID DEGRADATION* IN BAJRA FLOUR

Heating temp. (°C)	Degradation (%) after indicated days of heat treatment			
	0	15	30	45
	Moisture			
Control	100	109	119	123
50	85	90	91	107
100	59	80	94	84
	Lipase			
Control	100	125	155	197
50	64	79	121	140
100	67	71	108	106
	Free fatty acids			
Control	100	103	195	331
50	84	102	122	217
100	88	80	74	108
	Peroxide value			
Control	100	319	429	492
50	96	237	329	452
100	87	247	328	345

Values are derived from mean of four replicates
* Values as per cent of untreated control at start.

Compared to the untreated control, moisture and lipase activity were lower in heated samples and the reduction appeared to be more in flour heated at 100°C. This was true for both free fatty acids and peroxide value. On the whole, it may be said that bajra flour heated at 100°C appeared to keep better than flour unheated or heated at 50°C.

Heat treatment is, thus, beneficial for extended shelf life of bajra flour. However, changes in nutritive value in response to heat treatment need to be ascertained by further studies.

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EFFECT OF POST-HARVEST TREATMENTS ON BIOCHEMICAL CHANGES IN SAPOTA CV, 'CRICKET BALL'

S.K. GAUTAM AND B.S. CHUNDAWAT
Aspee College of Forestry & Horticulture, G.A.U.
Navasari Campus - 396 450, Gujarat.

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Treatments with gibberellic acid 300 p.p.m., kinetin 100 p.p.m. and silver nitrate 40 p.p.m. slowed down ripening by retarding the pre-climacteric respiration rate and ethylene production and through postponement of their activity peaks. These changes lead to reduced degradative metabolism in terms of catalase and PME activities and thus helpful in extending shelf life of sapota fruits.

The sapota (*Manikara achras* Mill Forsberg) is sensitive to cold temperature, and the total produce in India is handled at high tropical ambient temperature. Under these conditions fruits ripen within 3 or 4 days and become over ripe and spoiled within 5 days causing about 25-30 per cent loss. To overcome this loss by extending the shelf life, investigation was conducted to evaluate the influence of various post-harvest dips.

Fruits were harvested at colour change stage when slightly yellow surface colour developed denoting optimum maturity. After 30 min of harvesting, fruits were given dip treatments of gibberellic acid 300 p.p.m. dip for 20 min (T_1), kinetin 100 p.p.m. dip for 20 min (T_2) and silver nitrate 40 p.p.m. dip for 20 min (T_3) and all batches were ripened at ambient conditions (minimum and maximum temperature 28.2-39.2°C, RH 72-100 per cent). Control (T_4) with no treatment ripened at ambient conditions. Treatments were replicated five times in a split plot design (SPD). Each replicate consisted of 20 fruits. Respiratory activity[1], rate of ethylene production[2], relative activity of catalase and pectin methyl esterase[3] were estimated.

The treatments retarded the pattern of respiratory activity and also postponed its peak by 2 days as compared to control (Table 1). Similar retardation was also recorded by Vendrell[4], Gautam and Chundawat[5], Wade and Brady[6] and Raghava Rao and Chundwat [7] by gibberellic acid and kinetin. Silver nitrate regulated respiration through ethylene metabolism being an ethylene scavanger or by forming complexes with silver ion[8].

Various treatments retarded the pattern of ethylene production. The lowest average activity of ethylene production was recorded in T_1 followed by T_3, T_2 and T_4 treatments (Table 1). Gibberellic acid[9] and kinetin[10] are known to counteract the production of ethylene and silver nitrate regulated ethylene production by formation of silver ion complexes with the metal receptor site of ethylene binding[11].

The treatment of sapota fruits with GA, kinetin and silver nitrate retarded the activity (average) of pectin methyl esterase enzyme and postponed its peak by 1 day in gibberellic acid and silver nitrate treated fruits and by 2 days in kinetin treated fruits as compared to control (Table.1). Reduced oxidative metabolism and pectin breakdown through reduced PME activity is responsible for the extended shelf life of fruits under the influence of these treatments. Hashimoto and Rappaport[12] speculated that some active form of GA opposes the action of ethylene during growth and as GA declines with maturation, the fruit becomes more and more sensitive to induction of ripening by ethylene. Similar observations were also made by Gautam and Chundawat[5] in sapota and Khudairi[13] in tomato.

Therefore, this investigation clearly implies that post-harvest dip treatments of sapota fruits in GA, kinetin and silver nitrate countered the ethylene production and reduced the rate of oxidative metabolism and pectin hydrolysis through declined catalase and PME activities and finally, slow rates

TABLE 1. EFFECT OF VARIOUS TREATMENTS ON DAYS TO ATTAINMENT OF CLIMACTERIC PEAK AND AVERAGE ACTIVITY OF VARIOUS BIOCHEMICAL COMPONENTS

Treatments	Days to attainment of peak activity				Average activity			
	Catalase	PME	Respiration	Ethylene production	Catalase (μl H_2O_2 (oxidised/ min/ml of enzyme)	PME (units/ g/min)	Respiration (μl of O_2 consumed/ hr/g pulp)	Ethylene production (μg/kg fr. wt./hr)
T_1	8	4	6	4	1782.58	2.73	244.012	5.0
T_2	8	5	6	4	1973.69	2.80	217.006	7.0
T_3	8	4	6	6	2516.27	3.27	215.542	6.0
T_4	6	3	5	4	3332.44	4.16	272.091	12.0
C.D. at 5 %	–	–	–	–	96.57	0.04	11.900	NS

of these biochemical attributes are helpful in extending the shelf life of fruits and low post-harvest losses in these fruits under ambient conditions.

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INFLUENCE OF PACKAGING AND TYPES OF CHHANA ON THE WATER VAPOUR TRANSMISSION RATE OF FLEXIBLE PACKAGES

G.K. GOYAL
Dairy Technology Division, National Dairy Research Institute, Karnal 132 001, India.

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Water vapour transmission rate (WVTR) of flexible packages increased with the increase in storage temperature. The change in WVTR of the packages was significantly affected by the duration of storage and the type of chhana packaged.

Chhana is rich in moisture content and quality of the product during storage is significantly influenced by the change in moisture barrier property of the package during storage. Hence, the packages after emptying out the contents were tested for the changes in water vapour transmission rate (WVTR) at the end of different storage periods and the results are delineated in this communication.

The methods used for the preparation of chhana samples from cow or buffalo milk, the procurement of commercial chhana have already been reported[1]. The flexible packages used are P1 : 60 gsm poster paper/0.02 mm foil/150 gauge polyethylene, P2 : 60 gsm poster paper/0.009 mm foil/150 gauge polyethylene and P3 : 300 MST cellophane/150 gauge polyethylene. The chhana samples were packed in the 3 types of pre-sterilized flexible packages by following the suggested procedures[2]. Immediately after filling, all the packages were sealed and stored at 37±0.5°C and 60±5% RH (condition A) and at 4-5°C and 90±5% RH (condition B).

The packaging materials were tested for WVTR before filling the product and after emptying out the contents at the end of storage periods of 1,2 and 3 days for the packages stored under condition A, and after 10, 20 and 30 days for the packages stored under condition B using prescribed method[3]. The technique described by Snedecor[4] was adopted for the statistical analysis of the data.

The values for WVTR of the 3 types of flexible packages (P1, P2 and P3) after storage of 3 types of chhana samples for 0,1,2, and 3 days under condition A; and for 0, 10, 20 and 30 days under condition B are given in Table 1. The analyses of variance of the WVTR data for the packages stored under the two conditions are presented in Table 2.

Storage at 37±0.5°C/60±5 per cent R.H.: On storage of chhana from cow milk at condition A for 1,2 and 3 days, the mean values for WVTR (g/m^2/24 hr) of P1 increased from 0.21 to 0.38, 0.41 and 0.44 respectively; in case of P2, the values increased from 0.26 to 0.31, 0.36 and 0.39 respectively; while in case of P3, the values increased from 11.52 to 11.63, 11.82 and 11.89 respectively (Table 1). After storage for 3 days, the package P1 showed 109 per cent increase in WVTR, while P2 had 50 per cent increase and P3 registered only 3 per cent increase in WVTR. Thus, the changes in WVTR values are much more in the case of packages having aluminium (Al) foil as compared to P3 without Al foil. This is likely due to the formation of pores in the Al foil[5] and/or in other constituents of the packages or may be also due to the probable creasing of foil during the normal course of handling of the packages resulting in

TABLE 1. WATER VAPOUR TRANSMISSION RATE (G/M^2/24 Hrs AT 38°C AND 90% RH) OF FLEXIBLE PACKAGING MATERIALS AFTER STORAGE OF CHHANA AT 37±0.5°C & 60±5% RH AND 4-5°C & 90±5% RH.

Source of chhana	Storage period (in days)	37±0.5°C & 60±5% RH			Storage period (in days)	4-5°C & 90±5% RH		
		P_1	P_2	P_3		P_1	P_2	P_3
From cow's milk	0	0.21	0.26	11.52	0	0.21	0.26	11.52
	1	0.38	0.31	11.63	10	0.53	0.55	11.83
	2	0.41	0.36	11.82	20	0.64	0.66	12.55
	3	0.44	0.39	11.89	30	0.73	0.79	12.73
From buffalo milk	1	0.35	0.37	11.73	10	0.52	0.53	11.87
	2	0.39	0.45	11.90	20	0.61	0.65	12.49
	3	0.42	0.52	11.98	30	0.71	0.81	12.84
Market samples	1	0.34	0.35	11.76	10	0.49	0.54	12.10
	2	0.39	0.44	11.85	20	0.62	0.70	12.68
	3	0.43	0.49	11.89	30	0.71	0.83	13.04
Overall package*	1	0.36	0.34	11.70	10	0.51	0.54	11.93
	2	0.40	0.42	11.85	20	0.62	0.67	12.57
	3	0.32	0.47	11.92	30	0.72	0.81	12.87

*Values calculated taking into account variations due to the packages only.

TABLE 2. ANOVA TABLE FOR CHANGES IN WVTR OF FLEXIBLE PACKAGES STORED AT 37±0.5°C & 60±5% RH AND 4-5°C & 90±5% RH

Source of variation	AT 37±0.5°C & 60±5% RH			AT 4-5°C & 90±5% RH		
	df	mss	F-value	df	mss	F-value
Among packages	2	1556.638	518879.33**	2	1638.067	204758.37**
Among types of chhana	2	0.014	4.67*	2	0.040	5.00*
Among intervals of storage	3	0.403	134.33**	3	3.371	421.38**
Packages × types of chhana	4	0.008	2.67*	4	0.037	4.63**
Packages × intervals of storage	6	0.237	79.00**	6	0.479	59.88**
Intervals × types of chhana	6	0.002	0.67^{NS}	6	0.006	0.75^{NS}
Packages × intervals × types of chhana	12	0.003	1.00^{NS}	12	0.006	0.75^{NS}
Error	72	0.003	–	72	0.008	–

**Significant at 1% level of probability
*Significant at 5% level of probability
NS Not significant

the formation of pin holes. Results also suggest that handling abuse of filled packages cause more damage to the packages having thicker foil, eventhough the overall WVTR of thicker foil packages are still less than the packages having thinner foil. A similar trend was noticed for WVTR of flexible packages with the other two types of chhana (Table 1). Statistically, the three types of packages had significantly ($P < 0.01$) different values for WVTR (Table 2). Intervals of storage significantly ($P < 0.01$) affected the WVTR of flexible packages.

Storage at 4-5°C/90±5 per cent R.H.: The data in Table 1 indicate that the initial WVTR value of 0.21 in case of P1 increased to 0.53, 0.64 and 0.73 respectively after 10, 20 and 30 days of storage of chhana from cow milk at 4-5°C and 90±5 per cent R.H. The changes in WVTR of flexible packages used for storing buffalo milk chhana also showed the similar trend, where the initial figure of 0.21 for P1 escalated to 0.52, 0.61 and 0.71 g/m^2/24 hr at 38°C and 90% R.H. In case of P2, the initial WVTR of 0.26 increased to 0.53, 0.65 and 0.81, and in P3 the increase had been from 11.52 to 11.87, 12.49 and 12.84 g/m^2/24 hr, respectively after 10, 20 and 30 days of storage. The packages used for commercial samples of chhana also gave similar results.

The overall package values (Table 1) indicate that after 10 days of storage, the packaging P1 showed maximum increase in WVTR (124 per cent) followed by P2 (107 per cent) and P3 (3.56 per cent) respectively. After 20 days of storage, the WVTR in case of P1 increased by 195 per cent, in P2 by 157 per cent and in P3 by 9 per while after 30 days of storage, the figures in P1, P2 and P3 packagings escalated by 343 per cent, 211 per cent and 12 per cent, respectively showing that the change in WVTR had been minimum in case of P3, followed by P2 and P1 in ascending order.

The Anova Table 2 shows that three types of packaging materials had highly variable WVTR values ($P < 0.01$). The effect of duration of storage was observed to be highly significant ($P < 0.01$) towards the changes in WVTR. The chhana samples obtained from three different sources significantly affected ($P < 0.05$) the vapour transmission rate of the flexible packagings. Interactions between packages × intervals and packages × type of chhana were observed to be highly significant ($P < 0.01$). This suggests that the conditions of storage of chhana do play a significant role in affecting the WVTR of the flexible packaging material, which in turn, affects the chemical characteristics, body, texture and flavour and microbial growth of the packaged chhana during storage. At lower temperature and high humidity storage, the chances of slight delamination of the packaging material may not be also ruled out, in addition to role of acid producing microorganisms and the enzymes present/liberated in the product. The observations are in harmony with the corresponding changes in the sensory, microbiological and chemical qualities of the product reported in earlier communications[1,2,6].

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EFFECT OF COAGULATION TEMPERATURES AND TOTAL SOLID LEVELS ON QUALITY OF PANEER MADE FROM WHOLE MILK POWDER

S. SINGH AND S.K. KANAWJIA
Division of Dairy Technology,
National Dairy Research Institute,
Karnal - 132001, India.

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Whole milk powder was utilized to prepare paneer of acceptable quality, so that this acid coagulated milk product is available around the year. Acceptable quality paneer was obtained from milk having 15 per cent total solids and coagulated at 85°C. Experimental paneer compared well with the control.

Paneer is an important acid coagulated milk product, used primarily for a number of culinary dishes. Buffalo milk is known to result in good quality paneer[1]. Recently, Singh and Kanawjia[2] standardized the manufacturing technique for paneer from cow milk. It is reported[3] that recombined and reconstituted milk yield inferior paneer. The paneer is very soft, weak and loses the identity of cubes on frying and cooking. The present study was, therefore, carried out to develop a suitable technology for paneer from reconstituted buffalo whole milk powder, so as to meet the demands during lean season.

Preparation of paneer: Buffalo whole milk powder was dissolved (15, 18, 20 and 25 per cent total solids (TS)) in potable water at 50°C, allowed for about 3-4 hr and then converted into paneer following the method suggested by Chawla. *et al.*[4] with slight modifications. The coagulations temperatures tried were 80, 85, and 90°C. The levels of TS in milk were adjusted to 15, 18, 20 and 25 per cent. As a control, paneer was prepared from buffalo milk following the method of Bhattacharya *et al.*[1].

Sensory evaluation of paneer: Paneer samples were evaluated for flavour, body and texture and appearance by a panel of 5 trained judges using Hedonic scale.

Chemical analysis: Fat and total solid contents of milk were determined by the method outlined in IS:SP:I8 (Part XI)[5]. Moisture content in paneer was determined gravimetrically using Majonnier test as per method described in Laboratory Manual[6]. The fat content of paneer was determined by the method described in IS:SP:18 (Part XI)[5]. Protein content of paneer was determined by the method of Meneffee and Overman[7].

Effect of temperature of coagulation on sensory characteristics of paneer: The effect of coagulation temperatures on sensory qualities of paneer is presented in Table 1. It is apparent from the Table, the flavour scores of experimental paneer did not differ significantly from those of control. Among the coagulation temperatures tried, 85 and 90°C gave the better flavoured paneer. The flavour scores of experimental paneer ranged between 8.0 and 8.2. The temperature of coagulation had tremendous effect on body and texture of paneer.The lowest temperature resulted in a weak and soft body whereas, the highest temperature resulted in a hard paneer. The best paneer was obtained at 85°C. The body and texture scores ranged between 6.5 and 8.2. Singh and Kanawjia[2] reported that to obtain a good quality paneer from cow milk, coagulation at 85°C was optimum. However, coagulation at 70°C was optimum to obtain a good quality paneer from buffalo milk[1,8,9]. The appearance of experimental paneer improved while increasing the temperature of coagulation. However, no difference was observed between the paneer obtained at coagulation temperature of 85 and 90°C. At the lower temperature, a moist and open texture was observed, which disappeared at higher temperature of coagulation.

Effect of TS levels in milk on sensory characteristics of paneer: The purpose of increasing the TS levels in milk was to reduce, the bulk handling and also to reduce the requirements of coagulant, water, energy and labour for manufacture of paneer. The sensory characteristics of MPP (Table 1) as influenced by the levels of TS in reconstituted milk show that the flavour score decreased with an increase in the level of TS in milk. The flavour scores of MPP ranged between 7.5 and 8.2. The maximum score was observed in paneer made from 15 per cent TS and was rated as liked very much. The body and texture scores also followed the similar trend. The appearance scores were unaffected by the levels of TS in milk. In terms of sensory qualities, the study revealed that the MPP made from 15 per cent TS was very close to BMP.

Effect of temperature of coagulation on yield and composition of paneer: The effect of coagulation temperatures on yield and composition of paneer is presented in Table 2. The yield of milk powder paneer (MPP) ranged from 21.60 to 22.10 per cent, being minimum at 90° and maximum at 85°C. The yield of MPP was well within the range of buffalo milk paneer (BMP). Similar yield from buffalo milk was reported by earlier workers[1,8,9]. The moisture retention in paneer decreased with increase in coagulation temperature. The moisture content of MPP ranged from 57.10 to 58.70 per cent being the lowest in paneer obtained at 90°C. It is apparent from the Table that MPP retained more moisture as compared to BMP. The fat content in experimental paneer ranged between 16.58 and 17.31 per cent and these values were much lower to those of BMP. This is due to lower fat content of milk powder. The fat content on dry matter basis ranged from 40.16 to 40.74 per cent which was quite lower to that of control. According to PFA, the fat content in paneer on dry matter basis should not be less than 50 per cent. To meet

TABLE 1. EFFECT OF TEMPERATURE OF COAGULATION AND TOTAL SOLIDS IN MILK ON SENSORY CHARACTERISTICS OF PANEER

Type of paneer	Temp. of coagulation (°C)	TS in milk (%)	Flavour	Body & texture	Appearance	Remarks
Buffalo milk	70	–	8.5 (0.022)	8.5 (0.024)	8.5 (0.022)	Normal
Milk powder	80	–	8.0 (0.024)	6.5 (0.028)	7.0 (0.023)	Weak, Soft
	85	–	8.2 (0.026)	8.2 (0.024)	8.0 (0.023)	Normal
	90	–	8.2 (0.035)	7.0 (0.047)	8.0 (0.025)	Slightly hard
Buffalo milk	–	15	8.5 (0.022)	8.5 (0.024)	8.5 (0.022)	Normal
Milk powder	–	15	8.2 (0.024)	8.2 (0.028)	8.0 (0.037)	Normal
	–	18	8.0 (0.036)	8.0 (0.029)	8.0 (0.024)	Normal
	–	20	7.7 (0.043)	7.5 (0.031)	8.0 (0.027)	Slightly hard
	–	25	7.5 (0.061)	7.2 (0.036)	8.0 (0.037)	Slightly hard

Average of 5 replicates.

Figures in parentheses indicate standard error.

TABLE 2. EFFECT OF TEMPERATURE OF COAGULATION AND TS IN MILK ON YIELD AND COMPOSITION OF PANEER

Type of paneer	Temp. of coagulation (°C)	TS in milk (%)	Yield (%)	Moisture (%)	Fat (%)	FDM (%)	Protein (%)	T.S recovery (%)
Buffalo milk	70	–	22.00 (0.318)	55.19 (0.614)	23.80 (0.344)	53.11 (0.516)	17.99 (0.242)	64.43 (0.763)
Milk powder	80	–	21.80 (0.296)	58.70 (0.814)	16.58 (0.246)	40.16 (0.422)	21.22 (0.266)	60.02 (0.672)
	85	–	22.10 (0.431)	57.30 (0.805)	17.40 (0.292)	40.74 (0.466)	21.80 (0.272)	62.92 (0.720)
	90	–	21.60 (0.522)	57.10 (0.905)	17.31 (0.316)	40.36 (0.415)	22.10 (0.254)	61.78 (0.742)
Buffalo milk	–	15	22.00 (0.318)	55.19 (0.614)	23.80 (0.344)	53.11 (0.516)	17.99 (0.242)	64.43 (0.763)
Milk powder	–	15	22.10 (0.294)	57.30 (0.801)	17.40 (0.242)	40.74 (0.416)	22.80 (0.262)	62.92 (0.658)
	–	15	26.10 (0.412)	57.10 (0.810)	17.85 (0.348)	41.60 (0.641)	22.35 (0.282)	62.20 (0.721)
	–	15	28.30 (0.566)	57.80 (0.814)	18.44 (0.416)	42.69 (0.662)	22.10 (0.269)	61.12 (0.762)
	–	15	34.00 (0.582)	55.40 (0.822)	19.12 (0.518)	42.86 (0.679)	21.94 (0.268)	60.65 (0.769)

Average of 5 replicates.

Figures in parenthesis indicate standard error.

PFA standards for fat, it is reported that the milk should contain 5.5 to 6.0 per cent fat [1,4,8,10]. Generally, the fat content of milk is standardized to about 3.5 per cent during manufacture of whole milk powder, so as to meet the PFA standards of not less than 26 per cent for whole milk powder. Therefore, on reconstitution, whole milk powder should give 3.5 per cent fat in milk. The protein content of MPP ranged from 21.22 to 22.10 percent and these values were higher than those of MBP, and these values were within the range of those reported by Chawla *et al*[4] for low fat paneer. The TS recovery was the highest in case of MPP obtained at 85°C of coagulation and the lowest at 80°C.

Effect of TS levels in milk on yield and composition of paneer: Table 2 shows that the yield of paneer increased tremendously with increased TS levels in milk. The yield ranged from 22.10 to 34.00 per cent, the maximum being obtained from 25 percent TS milk. The moisture content in paneer was inversely proportional to the TS of milk. The fat and protein contents in MPP ranged from 17.40 to 19.12 per cent and 21.94 to 22.80 per cent, respectively. The TS recovery in MPP ranged from 62.92 to 60.65 per cent. The maximum in case of paneer made from 15 per cent TS milk and the minimum from 25 per cent TS milk. Upto 18 per cent TS milk could be used for manufacture of paneer without losing much solids in whey.

Since, the end use of paneer is an ingredient of certain culinary preparations which involves frying and cooking with spices, this may neutralize the effect of low fat content in paneer to a great extent. The high fat content in paneer may not be an absolute requirement for cooking purposes. Chawla *et al.*[9] reported that satisfactory quality paneer could be manufactured from low fat milk (3.5 per cent). A product from defatted soy flakes known as "Nutrinugget" contains only 0.5 per cent fat but serves as a good ingredient for vegetable curry. By the same way, the whole milk powder paneer proved to be as good as high fat paneer for culinary purposes.

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INFLUENCE OF SODIUM TRIPOLYPHOSPHATE (STPP) TREATMENT ON FRACTIONATION OF JAPANESE QUAIL (*COTURNIX COTURNIX* - JAPONICA) MUSCLE PROTEINS*

K. PRABHAKARA REDDY[1],
D. NARAHARI AND I. ALFRED JAYAPRASAD
Department of Poultry Science,
Madras Veterinary College,
Madras - 600 007, India

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Ready-to-cook Japanese quail carcasses of either sex were dipped in 0, 3 and 6% STPP for 3 and 6 hr and stored at 4±1°C for 0, 72 and 144 hr or were frozen (−18±1°C) and stored for 30 and 60 days. STPP dip of Japanese quail carcasses significantly increased the water and salt soluble protein fractions and had no effect on changes in the non-protein nitrogen content. Different storage periods had also significantly influenced the water and salt soluble protein fractions, but not the non-protein-nitrogen content of the quail meat. Dipping of carcasses for 6 hr in STPP solution increased the water soluble protein.

The myofibrillar and sarcoplasmic protein contents of turkey[1] and chicken muscles[2,3] have been shown to decrease during frozen storage. Sreenivasaiah[4] and Kenny *et al*[5] noticed increased solubility and extractability on proteins in polyphosphate treated chicken and turkey meats. Chowdary[6] found no significant differences in the protein content of refrigerated and frozen stored Japanese quail. This study reports on the influence of sodium tripolyphosphate (STPP) treatment, duration of chilling and storage, storage temperature and sex on the extractability and fractionation of muscle proteins of spent Japanese quail meat.

Spent Japanese quails of 25 weeks of age, belonging to the same batch were slaughtered and dressed conventionally in four batches of 60 birds each with equal number of males and females. The ready-to-cook carcasses were dipped in 0,3 and 6 per cent STPP solutions for 3 or 6 hr. After treatment, the carcasses were drained for 10 min, vacuum packed and stored either at 4±1°C for 72 and 144 hr or at −18±1°C for 30 and 60 days. For each treatment, equal number of male and female carcasses were allotted. At the end of the respective storage periods, representative samples of breast muscles were taken and the muscle proteins were fractionated according to the method described by Kang and Rice[7]. Various fractions of the muscle proteins were quantitatively estimated colorimetrically using Biuret method as described by Gornall *et al*[8]. The data on the water soluble and salt soluble proteins and non-protein nitrogen contents of muscles were statistically analysed[9].

The levels of sarcoplasmic or water soluble protein (WSP) fractions in the Japanese quail muscle (Table 1) show highly significant ($P < 0.01$) variations between STPP levels, significant ($P < 0.05$) variations between dipping period and storage periods and no significant differences between sexes. Both 3 and 6 per cent STPP treatments had significantly increased the WSP values over the untreated carcasses. Similarly, treating for 6 hr had significantly increased the WSP levels over 3 hr treated muscle irrespective of the STPP levels, sex and storage periods. These findings agree with the results of Sreenivasaiah[4] and Kenny *et al*[5]. in polyphosphate treated poultry. Contrary to these observations, Khan and Vandenberg[2] noticed decreased extractability of Sarcoplasmic proteins in chicken meat during long frozen storage and attributed for denaturation of myofibrillar protein fraction and proteolysis.

The myofibrillar (salt soluble-protein, SSP) content of quail muscle (Table 1) also showed significant ($P < 0.05$) variations with STPP levels and with storage periods. Treatment with STPP at both 3 and 6 per cent levels extracted more SSP than the untreated carcasses. Similar increased extraction of SSP was also noticed by Kenny *et al*[5]. in minced poultry meat.

TABLE 1. INFLUENCE OF STPP LEVELS, DURATION OF TREATMENT, STORAGE PERIOD AND SEX ON THE PERCENT WATER SOLUBLE, SALT SOLUBLE PROTEINS AND NON PROTEIN NITROGEN CONTENT OF THE QUAIL MEAT

% extractable proteins	STPP levels (%)			Dipping periods (hr)		Storage periods (hr)			Storage period (days)		Sex	
	0	3	6	3	6	0	72	144	30	60	Male	Female
WSP (%)	16.14^{a}	17.26^{b}	17.26^{b}	16.59^{a}	17.16^{b}	16.52^{ab}	16.13^{a}	16.92^{abc}	17.78^{c}	17.04^{bc}	17.12^{a}	17.72^{a}
SSP (%)	24.12^{a}	28.21^{b}	28.63^{b}	27.00^{a}	27.06^{a}	26.76^{b}	24.37^{a}	24.10^{a}	30.69^{c}	29.00^{c}	27.01^{a}	26.97^{a}
NPN (%)	2.65^{a}	2.46^{a}	2.43^{a}	2.61^{a}	2.42^{a}	1.83^{a}	2.89^{a}	2.73^{a}	2.24^{a}	2.76^{a}	2.46^{a}	2.53^{a}

WSP: Water soluble proteins; SSP: Salt soluble proteins.

Means bearing atleast one common superscript within each factor do not differ significantly ($P < 0.05$).

Present address: [1]Department of Poultry Science, College of Veterinary Science, Tirupati-517 501.

*Correspondance is to be done with the first author.

The non-protein nitrogen (NPN) content of quail meat was not significantly influenced by STPP treatment, dipping periods, storage periods and sex of the carcasses. Even though 3 and 6 per cent STPP treated, 6 hr treated, fresh and male carcasses recorded slightly lower NPN values than the zero percent STPP treated, 3 hr treated, stored and female carcasses respectively; these values did not differ statistically. Further storage either in refrigerator or in freezer did not influence significantly the NPN content of quail meat. Similarly, Khan and Vandenberg[2] also noticed no significant changes in the chicken meat. Slight but non-significant increase in the NPN content of stored meat might be attributable to the denaturation of meat during storage, resulting in the production of simpler non-protein nitrogenous compounds. Contrary to the present findings, Moinuddin[3] recorded significantly reduced NPN content during storage in spent chicken meat.

Lower values of WSP and SSP observed in the 72 hr refrigerated than in the fresh quail meat were comparable with the observations made by Adamcic and Clark[10] who opined that extractable nitrogenous materials in chicken muscles decreased during the early log phase of bacterial growth corresponding to the period of rapid increase in the pH values.

Sex of the carcasses had no influence in the extractability of WSP, SP and NPN contents of quail meat.

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A STUDY ON CERTAIN QUALITATIVE CHANGES IN GLYCEROL, GLYCERO-NITRITE AND NITRITE BASED INTERMEDIATE MOISTURE MEATS

K. PRABHAKAR*, C.V. GOVINDARAJAN AND A.M. SHANMUGAM
Department of Meats, Madras Veterinary College,
Madras-600 007, India.

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Three types of intermediate moisture (IM) meats based on (i) glycerol (ii) glycerol-nitrite and (iii) nitrite were prepared by equilibration in their respective infusion solutions followed by oven heating and air-drying. Certain qualitative changes were studied in the IM samples during two-month ambient temperature storage along with frozen-stored unprocessed samples. Higher pH was noticed in nitrite and glycerol-nitrite based IM samples. Frozen-stored samples recorded a water activity of 0.98 compared to 0.85 in IM samples with non-significant changes during storage. Frozen-stored samples and IM samples revealed total water of 73.98 and 41.10 to 43.91% before cooking and 60.51 and 57.12 to 57.17% after cooking and bound water of 43.28 and 30.29 to 34.76% before cooking and 48.76 and 46.05 to 46.61% after cooking respectively.

Intermediate moisture (IM) meats offer an effective and economical preservation system with the potential to process ready-to-cook and ready-to-eat products suitable for ambient temperature storage. Some of the undesirable changes in IM meats were attributed to the presence of higher levels of glycerol[1]. Hence, a study was planned to prepare IM meats with lower glycerol levels and without glycerol and to study certain quality parameters to help in the development of new generation IM meat products.

Three types of IM meats were prepared using market buffalo meat in post-rigor stage viz. glycerol based, glycerol-nitrite based and nitrite based, by a 24 hr equilibration in their respective infusion solutions followed by oven-heating (80°C for 1 hr) and surface drying under an electric fan. Composition of infusion solutions (per cent, w/w) is as follows;

Glycerol based: Sodium chloride (10), glycerol (2), trisodium citrate (2), sodium benzoate (0.2) and potable water (85.8).

Glycerol-nitrite based: Sodium chloride (10), glycerol (2), trisodium citrate (2), sodium benzoate (0.2), sodium nitrate (0.1), sodium nitrite (0.01), sodium ascorbate (0.05) and potable water (85.64)

Nitrite based: Sodium chloride (10), trisodium citrate (2), sodium benzoate (0.2), sodium nitrate (0.1), sodium nitrite (0.01), sodium ascorbate (0.05), and potable water (87.64).

After processing, IM samples were packaged in polypropylene bags to study quality changes during ambient temperature storage and compared with unprocessed samples under frozen storage. The parameters were studied after completion of processing and at 15-day intervals during a storage period of two months.

pH and water activity were recorded as per procedures described by Prabhakar and Ramamurthi[2].

Moisture content was estimated according to the standard procedure of AOAC[3] and assumed as total water content of the samples.

Expressible water in the samples was determined as per the procedure outlined by Sanderson and Vail[4] with slight modifications. Samples weighing 0.2 to 0.4 g in duplicate were pressed between a pair of aluminium foils (pre-weighed along with the sample) with a piece of Whatman filter paper No.42 under a weight of 4 kg for two min. After pressing, the samples were peeled off the filter paper, replaced between the same two foils as before and weighed. The difference between the two weights was expressed as per cent expressible water.

The difference in total water content and expressible water content was assumed as bound water[4] and taken as an indicator of water holding capacity[5].

Frozen-stored unprocessed samples and rehydrated IM samples[2] were weighed, packaged in polypropylene bags and cooked in a pressure cooker at 15 lb pressure for seven min. After cooling to room temperature, fluid released during cooking in each package was drained off and weights were recorded to calculate per cent cooking loss by difference in weights and a blotting paper was used to dry the surfaces of samples before weighing.

Total, expressible and bound water in the cooked samples were recorded as done for raw samples.

Data were analysed statistically as per the procedure of Snedecor and Cochran[6] by analysis of variance and comparison of mean values for statistical significance. The data pertaining to pH, water activity and cooking loss are furnished in Table 1 and those of total, expressible and bound water in Table 2.

Mean values (Table 1) indicate a gradual increase in pH as storage period progressed in frozen-stored unprocessed samples and in glycerol-nitrite and nitrite based IM samples. But, in glycerol-based IM samples, it was almost constant. Frozen-stored samples recorded the lowest mean pH (5.65) as compared to IM samples. Among the latter, glycerol-based samples revealed lower mean pH values (5.75) than glycerol-nitrite and nitrite-based IM samples (6.15 to 6.16). Obanu *et al.*[7] reported pH values of 5.6 to 5.7 in glycerol desorbed IM beef which remained constant throughout the

**Present address:* Dept. of Meat Science & Technology, College of Veterinary Science, Rajendra Nagar, Hyderabad-500 030.

TABLE 1. MEAN VALUES OF pH, a_w AND COOKING LOSS IN IM AND FROZEN STORED MEATS

Parameter	Storage period (days)	Frozen stored	Intermediate moisture samples		
			Glycerol based	Glycerol-nitrite based	Nitrite based
pH	0	5.60	5.79	6.11	6.12
	15	5.63	5.73	6.12	6.15
	30	5.64	5.74	6.13	6.17
	45	5.68	5.74	6.15	6.18
	60	5.70	5.75	6.24	6.20
	Overall	5.65[c]	5.75[b]	6.15[a]	6.16[a]
Water activity (a_w)	0	0.98	0.86	0.86	0.85
	15	0.98	0.85	0.85	0.85
	30	0.98	0.85	0.85	0.85
	45	0.98	0.85	0.85	0.84
	60	0.99	0.85	0.85	0.85
	Overall	0.98[a]	0.85[b]	0.85[b]	0.85[b]
Cooking loss (%)	0	38.20	29.15	30.25	31.22
	15	37.17	34.21	34.60	32.24
	30	36.09	32.00	32.88	31.70
	45	35.87	31.75	30.40	31.12
	60	37.13	32.07	32.32	32.09
	Overall	36.89[a]	31.84[b]	32.09[b]	31.67[b]

Mean values with the same superscript along rows within each parameter do not differ significantly. ($P>0.05$)

TABLE 2. MEAN VALUES OF WATER RELATED PARAMETERS IN IM AND FROZEN STORED MEATS DURING STORAGE

Parameter	Storage period (days)		Frozen stored	Intermediate moisture samples		
				Glycerol based	Glycerol-nitrite based	Nitrite based
1. Total water (%)	0	R	74.80	42.61	37.90	41.66
		C	61.66	59.66	58.59	59.71
	15	R	74.88	42.50	37.46	39.15
		C	61.14	59.16	59.48	58.83
	30	R	73.96	42.32	37.69	43.65
		C	60.37	56.72	58.07	57.76
	45	R	73.44	46.55	47.09	44.65
		C	60.14	56.09	56.04	56.48
	60	R	72.83	45.56	45.34	43.17
		C	59.23	53.96	53.43	53.07
	Overall	R	73.98[a]	43.91[b]	41.10[c]	42.46[bc]
		C	60.51[a]	57.12[b]	57.112[b]	57.17[b]
2. Expressible water (%)	0	R	33.91	9.93	11.03	11.15
		C	11.21	11.42	13.38	13.21
	15	R	28.97	8.41	11.70	12.91
		C	11.08	9.94	10.78	10.82
	30	R	25.67	9.42	10.91	13.02
		C	10.87	12.47	9.57	11.23
	45	R	29.45	8.72	10.77	13.32
		C	12.88	13.25	13.07	13.35
	60	R	35.54	9.27	9.63	9.36
		C	12.71	7.01	6.83	7.05
	Overall	R	30.71[a]	9.15[c]	10.81[b]	11.95[b]
		C	11.75[a]	10.82[c]	10.73[c]	11.13[b]
3. Bound water (%)	0	R	40.89	32.69	26.88	35.51
		C	50.45	48.24	45.21	46.49
	15	R	45.91	34.09	25.75	30.52
		C	50.06	49.22	48.70	48.02
	30	R	48.29	32.90	26.78	30.63
		C	49.50	44.25	48.56	46.59
	45	R	44.00	37.84	36.32	31.33
		C	47.26	43.25	42.97	43.12
	60	R	37.30	36.29	35.71	33.82
		C	46.53	46.90	46.61	46.02
	Overall	R	43.28[a]	34.76[b]	30.29[c]	32.36[bc]
		C	48.76[a]	46.37[b]	46.41[b]	46.05[b]

R: raw C: cooked samples. Mean values with the same superscript along rows within each parameter do not differ significantly ($P > 0.05$).

storage period. However, Webster *et al.*[8] observed a decrease in pH after 6 weeks and a subsequent increase after 15 weeks during storage. The earlier decrease was attributed to cross-linking and decreased solubility of proteins and the subsequent increase to higher level of protein breakdown. In glycerol-based IM samples of this study, pH values which remained almost constant suggest limited cross-linking in proteins. As low levels of glycerol were used in this study, cross-linking in proteins could not have occurred on a larger scale, thereby reducing or almost eliminating a significant disadvantage.

A higher pH in the glycerol-nitrite and nitrite-based IM samples indicated the occurrence of a higher level of protein breakdown in these samples. Protein breakdown in the absence of microbial spoilage is desirable as it softens the structure leading to greater tenderness[8].

Water activity was around 0.98 in frozen-stored samples and 0.85 in the IM samples. No significant changes were observed in water activity during storage.

Frozen-stored samples recorded higher values of total water, expressible water and bound water than IM samples in the raw state and differences among the three IM samples are not large (Table 2). The IM samples in this study revealed total water content (per cent) in the range of 37.46 to 46.55. Obanu *et al.*[7] reported moisture level of 37.43 and Ledward *et al.*[9], a range of 41.9 to 42.8 in IM meat products. Based on the mean values in raw samples, it can be interpreted that IM samples, on an average, contained, (in percentages) 57.4 of total water, 34.7 of expressible water and 75.0 of bound water in frozen-stored unprocessed samples.

Cooking loss was higher in frozen-stored samples than in IM samples (Table 1). This is expected as some portion of free water had been removed during processing in the preparation of IM meats.

Comparison of mean values (Table 2) indicates that the rehydrated and cooked IM samples, on an average, contained (in percentages), 94.4 of total water, 92.7 of expressible water and 94.9 of bound water in cooked frozen-stored unprocessed

samples. This data revealed that IM samples after cooking, closely approximated the water content and water holding capacity of frozen-stored unprocessed samples. Evidently, the protein denaturation effects associated with heating and drying may be limited in the processing procedure adopted in this study.

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COLOUR AND RELATED QUALITY CHANGES IN INTERMEDIATE MOISTURE MEATS

K. PRABHAKAR*, C.V. GOVINDARAJAN, V.R. KOSALARAMAN AND A.M. SHANMUGAM

Department of Meats, Madras Veterinary College, Madras-600 007, India.

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Gylcerol, glycerol-nitrite and nitrite based intermediate moisture (IM) meats were prepared by 24 hr equilibration, oven-heating and air-drying to evaluate colour and related qualitative characteristics during storage at ambient temperatures for two months in comparison to unprocessed frozen samples. Frozen stored samples recorded the lowest Munsell hue values (colour towards red hue). Glycerol and glycerol-nitrite based IM samples revealed higher hue values (19.57 and 19.0 respectively) indicating a change in sample colour towards yellow hue after processing. Munsell value was higher in the frozen-stored and glycerol-based IM samples than in glycerol-nitrite and nitrite based IM samples. Among cooked samples, hue was lower (towards red range) in nitrite based IM samples than others (towards yellow range). Total pigment content and solubility in pyridine were highest in frozen stored samples followed by nitrite, glycerol-nitrite and glycerol based IM samples in that order.

Intermediate moisture (IM) meats offer several unique advantages for meat preservation and new product development suitable for ambient temperature storage[1,2]. A processing procedure was standardised by infusion soaking of meat samples in an aqueous solution containing glycerol (2 per cent), sodium chloride (10 per cent), trisodium citrate (2 per cent) and sodium benzoate (0.2 per cent) followed by mild heat treatment and air drying[3].

No evidence of spoilage in the IM samples was reported during storage for two months at ambient temperatures. However, the colour of glycerol-based IM meat changed to yellow hue during storage. Similar changes were observed in glycerol-salt desorbed IM meats with higher proportions of glycerol (10 to 30 per cent) and were attributed to destruction of haematin content of myoglobin[4,5]. The colour and appearance of meat and meat products are primary factors in consumer choice. The bright red colour of fresh meats and the attractive heat stable pink colour of cured meats are preferred by the consumers. The colour of meat is due to the reaction of muscle pigment myoglobin with oxygen in fresh meats and nitrite in cured meats. So, it was planned to improve the colour in glycerol-based IM product by incorporating curing ingredients and adjuants. Muguruma *et al*[6]. also prepared IM cured meat products with 10 per cent glycerol and 6 per cent sodium chloride. The present study involves preparation of IM meat using infusion solutions containing glycerol and nitrite and study of colour and related quality characteristics during storage.

About 6 kg of meat from the thigh muscles of a buffalo *(Bos bubalis)* carcass in post-rigor stage was collected for processing into IM meat.

The sample was made into uniform cubes of approximately 2.5 cm and after random mixing were processed into IM meats. Three types of IM meats were prepared viz. glycerol based (seven replicates), glycerol-nitrite based (five replicates) and nitrite-based (seven replicates) by a 24 hr equilibration in their respective infusion solutions followed by oven heating (80°C for 1 hr) and surface drying under an electric fan. The composition of infusion solution for glycerol-based IM samples was according to the procedure described by Prabhakar and Ramamurthi[3]. The infusion solution for glycerol-nitrite based samples included in addition, sodium nitrate (0.1 per cent), sodium nitrite (0.01 per cent) and sodium ascorbate (0.05 per cent). The infusion solution for nitrite-based samples contained all the ingredients except glycerol.

After completion of processing, IM samples were packaged in polypropylene bags to study colour and related quality changes during ambient temperature storage in comparison with frozen-stored unprocessed samples. The following parameters were studied in the IM meats and frozen-stored meats before processing, immediately after processing and at fortnightly intervals during storage for two months.

Colour of the samples as such and after pressure cooking[3] was assessed in terms of Munsell hue, value (lightness) and chroma (saturation) by comparison with standard chips of a Munsell book of colour under standard conditions[7].

Total pigment (myoglobin) content of the samples was estimated according to the acetone extraction procedure of Hornsey[8].

The procedure described by Obanu and Ledward[4] was utilised to arrive at the solubility in pyridine.

Non-enzymic browning (NEB) was estimated by the trypsin digestion method[9].

Data were analysed by analysis of variance to study the effects of treatments, cooking effect and storage periods. Overall mean values were compared for significant differences with the help of critical difference values as per the procedures of Snedecor and Cochran[10].

Table 1 indicates the analysis of variance of colour parameters. Mean values and comparison of overall mean values of colour parameters and colour related objective parameters are presented in Tables 2 and 3, respectively.

**Present address:* Department of Meat Science and Technology, College of Vety. Science, Rajendra Nagar, Hyderabad-500 030

TABLE 1. COMPARISON OF MEAN VALUES FOR FROZEN STORED AND IM MEATS

Treatment	Munsell hue	Munsell value	Munsell chroma
Frozen stored	14.36[b]	3.30[a]	3.47[a]
Glycerol based	19.67[a]	3.34[a]	2.89[b]
Glycerol-nitrite based	19.00[a]	2.44[b]	3.06[ab]
Nitrite based	15.46[b]	2.59[b]	3.07[ab]
Cooking effect			
Raw	15.77[B]	3.19[A]	2.60[B]
Cooked	18.19[A]	2.72[B]	3.65[A]

Mean values in columns with the same superscript do not differ significantly ($P > 0.05$)

Treatments revealed highly significant ($P < 0.01$) influence on Munsell hue and value and significant ($P < 0.05$) influence on chroma (Table 1). Variation due to cooking was highly significant ($P < 0.01$) in all the three colour parameters hue, value and chroma. Cooked samples recorded higher hue and chroma and lower value. (Table 1).

Among raw samples, frozen stored samples recorded the lowest hue values (10.28) suggesting the colour in the red range (Table 2). Glycerol and glycerol-nitrite based IM samples gave the highest hue values (19.57 and 19.0 respectively) indicating a change in sample colour to yellow hue after processing.

Obanu and Ledward[4] and Webster *et al.*[5] also reported similar colour changes in glycerol-salt desorbed IM meats containing 10 to 30 per cent of glycerol and attributed this to haemoprotein breakdown. Nitrite based IM samples recorded lower mean hue values (15.14) because of the formation of the heat stable cured pigment nitrosohaemo-chromogen.

Munsell value was highest in the frozen stored and glycerol based raw IM samples (Table 2) indicating their being lighter in colour. The values in the glycerol-nitrite and nitrite IM samples were lower suggesting darker colour. It was further noticed that Munsell value increased with storage period in case of glycerol based IM samples (Table 2) while in others, it declined. Haemoprotein breakdown occurring in the glycerol based IM samples at a higher level would have contributed to this fading of colour. Colour of meat and meat products is a primary factor in consumer choice and hence glycerol based IM meat products suffer from this disadvantage. Addition of nitrite and other curing agents lowered the yellow hue and colour fading during storage. In the absence of glycerol, curing agents could bring the colour into red-yellow range which was retained to a greater extent during storage in the nitrite based IM samples. Mean values revealed that the colour darkened during storage probably due to surface evaporation and denaturation. Chroma was higher in the frozen stored samples as compared to IM samples indicating that colour was more saturated in the former.

Among cooked samples, hue was more towards red (15.78) in nitrite based samples (Table 2) whereas in the other samples, it was almost in the yellow range (18.43 to 19.79). Loss of red colour in cooked frozen stored meats is expected as cooking imparts greyish tinge to meat due to precipitation of the less stable proteins. However, cured IM product without glycerol had retained the red-yellow hue even after cooking as a result of the heat stable nitrosohaemochromogen. The glycerol based IM samples after pressure cooking were observed to have almost similar hue, value and chroma as those of cooked frozen stored unprocessed samples. Since the nutritional availability of iron in these samples is also not

TABLE 2. COLOUR PARAMETERS IN IM AND FROZEN STORED SAMPLES DURING STORAGE

Storage period (days)		Munsell hue				Munsell value				Munsell chroma			
		Frozen stored	Glycerol based	Glycerol-nitrite	Nitrite based	Frozen stored	Glycerol based	Glycerol-nitrite	Nitrite based	Frozen stored	Glycerol based	Glycerol-nitrite	Nitrite based
0	Raw	10.71	20.00	19.00	14.64	4.00	3.57	3.20	3.14	4.57	1.57	2.20	2.00
	Cooked	17.50	20.00	19.00	14.64	2.43	2.86	2.00	2.86	4.00	3.34	3.60	3.71
15	Raw	10.00	19.64	19.00	15.00	4.43	3.57	3.20	3.14	4.00	2.29	2.40	2.00
	Cooked	18.21	20.00	19.00	15.71	5.14	4.14	2.00	2.57	3.86	4.43	4.00	3.43.
30	Raw	10.00	19.64	19.00	15.00	3.57	3.43	2.20	2.43	3.43	2.00	2.40	2.00
	Cooked	18.93	19.64	19.00	17.14	2.57	2.71	2.20	2.43	4.14	3.29	3.00	3.57
45	Raw	10.00	19.64	19.00	15.00	3.14	3.00	2.60	2.86	2.86	2.00	2.60	1.71
	Cooked	18.93	19.29	19.00	15.36	3.14	2.57	2.00	2.29	3.14	3.43	3.60	3.43
60	Raw	10.71	18.93	19.00	16.07	2.57	4.14	3.00	2.14	2.86	2.14	2.80	2.00
	Cooked	18.57	20.00	19.00	16.07	2.14	3.43	2.00	2.00	2.86	4.29	4.00	4.86
Means	Raw	10.28[c]	19.57[a]	19.00[a]	15.14[b]	3.54[a]	3.54[a]	2.84[b]	2.74[b]	3.54[a]	2.00[c]	2.48[b]	1.94[c]
	Cooked	18.43[a]	19.79[a]	19.00[a]	15.78[b]	3.08[a]	3.14[a]	2.04[b]	2.43[b]	3.60[a]	3.77[a]	3.64[a]	3.80[a]

Mean values in the same row with the same superscript do not differ significantly ($P > 0.05$).
The replications for glycerol - nitrite was 5 and for others 7.

TABLE 3. COLOUR RELATED PARAMETERS IN IM AND FROZEN STORED SAMPLES DURING STORAGE

Parameters	Replication	Values at indicated storage period (days)					Mean
		0	15	30	45	60	
		Total pigment content					
Frozen stored	7	200.40	233.11	232.86	232.17	241.46	228.00[a]
Glycerol based	7	125.11	99.26	57.97	44.20	33.93	72.09[d]
Glycerol Nitrite	5	127.49	156.72	116.08	111.96	100.98	122.64[c]
Nitrite based	7	147.97	220.31	151.77	142.57	119.50	156.44[b]
		Solubility in pyridine					
Frozen stored	7	0.277	0.186	0.166	0.154	0.150	0.187[a]
Glycerol based	7	0.098	0.093	0.111	0.108	0.107	0.103[d]
Glycerol Nitrite	5	0.134	0.144	0.115	0.121	0.121	0.127[c]
Nitrite based	7	0.131	0.129	0.139	0.134	0.126	0.132[b]
		Non-enzymic browning					
Frozen stored	7	0.008	0.007	0.007	0.005	0.006	0.007[c]
Glycerol based	7	0.009	0.010	0.010	0.013	0.013	0.011[b]
Glycerol Nitrite	5	0.009	0.010	0.012	0.012	0.015	0.012[b]
Nitrite based	7	0.008	0.010	0.014	0.015	0.026	0.015[a]

Mean values with the same superscript in the last column under each parameter do not differ significantly (P = 0.05).

affected[11], proper education of consumers may overcome the problem of undesirable colour in glycerol based IM samples. Nitrite based IM samples had retained the red colour even after cooking and so are easily marketable.

Total pigment content extractable with acetone was highest in frozen stored samples followed by nitrite based, glycerolnitrite based and glycerol based IM samples in that order (Table 3). Solubility in pyridine, a solvent with a great affinity for haematin indicates the extent of insolubilisation of haematin during storage in processed meats[4]. It was highest in the frozen stored samples, followed by nitrite based, glycerol-nitrite based and glycerol based IM samples (Table 3). These changes confirmed the trend in visual colour changes and greater insolubilisation of haematin in glycerol based IM samples. Non-enzymic browning was slightly higher in nitrite based IM samples than other (Table 3) but the values observed in this study (0.008 to 0.026) were lower than the values of 0.260 to 0.266 reported by others[9].

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CAROTENE RETENTION IN PALM OIL BY MECHANISED AND TRADITIONAL PROCESSES

V.A.E. JIDEANI*
Department of Food Technology, Federal Polytechnic P.M.B. 0231, Bauchi, Nigeria.

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Samples collected at various stages during mechanised and traditional palm oil production processes were cold saponified. The rate of β-carotene destruction was more in mechanical process. Hence, palm oil by traditional process retained about three times more carotene than that processed mechanically. The thermal destruction rate of carotene doubled for every 20°C rise in processing temperature.

Palm oil is an important vegetable oil in the diet of many Nigerians and other West African countries. Palm oil is very rich in carotenoids with α-and β-carotenes as the principal pigments. It has about 40,000-80,000 I.U. of carotene in 100g of red palm oil[1]. About 10 per cent of more than 500 known carotenoids have pro-vitamin A activity[2]. Carotenoids content in photosynthetic tissues and other tissues is known to be affected by a multitude of environmental factors[3]. It has been shown that the amount of β-carotene in palm oil decreased with an increase in temperature[4]. Concentration of carotenes in such plant materials during growth and to some extent during processing can be assayed[5]. As the mechanised method of palm oil production is fast replacing the traditional method, an assessment of the effect of processing method on the product quality is necessary to maintain nutritional quality.

Two methods of palm oil production studied were the mechanised method as devised by NIFOR Oil Company, Benin City and the local method as commonly applied in Gbogan town, Oyo state. Samples were collected at each stage of processing the fresh palm fruits into palm oil. A known weight of each sample was dried in vacuum at 60°C and 50 cm Hg pressure for 3 to 6 hr prior to β-carotene determination. Samples from mechanised process used for the study of thermal effect on carotene were heated to 160°, 180° and 200°C and held at that temperature for various periods and cooled before analysis. The saponification procedure designed by NIFOR[6] was adopted. One hundred millilitres of methanol and 25 ml hexane were added to palm oil or fruits or heated palm oil (12.50g). Potasium hydroxide (12.50g) in 21 ml of water was added to the mixture and left in the dark at room temperature for 24 hr. One hundred and fifty millilitres of distilled water was added and the mixture was transferred to a separating funnel. A known volume of petroleum spirit was used for extraction for one hour. The petroleum spirit extracts were filtered through a Whatman No 1 filter paper, washed with about 20 ml of water to remove the last traces of soap. It was dried with anhydrous sodium sulphate and filtered. The filtrate served as the extract of pigment. α-and β-carotenes were separated from other carotenoids by TLC using dichloromethane:petroleum spirit (19:1) as solvent system. The plates were removed and air dried for 5 min. The bands suspected to be α - and β-carotene based on their R_f values (0.69 and 0.84 respectively) were scraped off and the pigment re-extracted with a known volume of petroleum ether. Their absorbance was read in spectrophotometer at 450 nm and the concentrations of carotenes were calculated[7]. The values of the β-carotene content obtained agreed well with the reported figures; their values ranging from 42,420-168,800 μg-100g[8,9].

β-carotene concentration in the palm fruit decreased at every stage during palm oil production (Table 1). Destruction of β-carotene (Table 2) at the sterilisation stage was about 5.9 per cent due to very high temperature of super heated steam and oxidation by air if the sterilizer is not properly

TABLE 1. CHANGES IN β-CAROTENE CONTENT AT VARIOUS PROCESSING STAGES OF PALM FRUIT TO PALM OIL

Sample	Mechanical β-carotene (μg/100g)	Traditional β-carotene (μg/100g)
Fresh fruit	180,971	59,822
Sterilized fruit	170,380	–
Digested fruit	118,887	–
Crude oil	102,985	49,978
Clarified oil	84,811	–
Pure oil	76,482	48,464
Cooked fruit	–	56,973
Pounded fruit (mash)	–	53,764

TABLE 2. PER CENT DESTRUCTION OF β-CAROTENE AT VARIOUS PROCESSING STAGES IN MECHANICAL AND TRADITIONAL PROCESSES

Stages	Mechanical process	Traditional process
Fresh fruit	–	–
Sterilized/Cooked fruit	5.9	5.0
Digested/Pounded fruit	30.2	5.3
Crude oil	13.4	7.0
Clarified oil	17.6	–
Pure oil	9.8	3.0
Total destruction	76.9	20.3

**Present address:* C/o. Procter Dept. of Food Science, University of Leeds, Leeds LS2 9JT.

vented. Greater destruction (30.2 per cent) of β-carotene occurred at the digestion stage. This was as a result of oxidation and localised overheating. Digestion requires a high temperature for liberating the oil from the mesocarp cells and for efficient running[10]. Pressing and passage of the oil through crude oil tank and clarifier subjected the oil to wear, liberating potential pro-oxidants into the system[10]. These processes contributed to the decrease in β-carotene concentration of palm oil produced by the mechanised method.

The palm fruits used in the traditional process showed a lower β-carotene content (Table 1). This could be as a result of heaping the palm fruits for about three days before processing, to loosen the mesocarp from the kernels. This is contrary to the procedure in mechanical process where a shorter period between harvesting a processing is maintained. Hence, the β-carotene content is affected adversely by heat, light or oxidation reactions[11] due to longer exposure. Table 1 shows a decrease in β-carotene concentration during traditional processing but the rate was not as high as that in mechanically processed samples. This could be due to the relatively low temperature (95°-100°C) used in boiling the fruits. Moreover, no additional heat was applied apart from that given to crude oil to obtain the pure oil. The slight increase in the destruction (7.0 per cent) of β-carotene shown in Table 2 at the crude oil stage could be due to loss during separation of kernels and fibre by washing and inadequate loosening of the mesocarp cells from the fibre during pounding. Less destruction of carotene in the oil was as a result of a high moisture content which appeared to 'protect' hot oil.

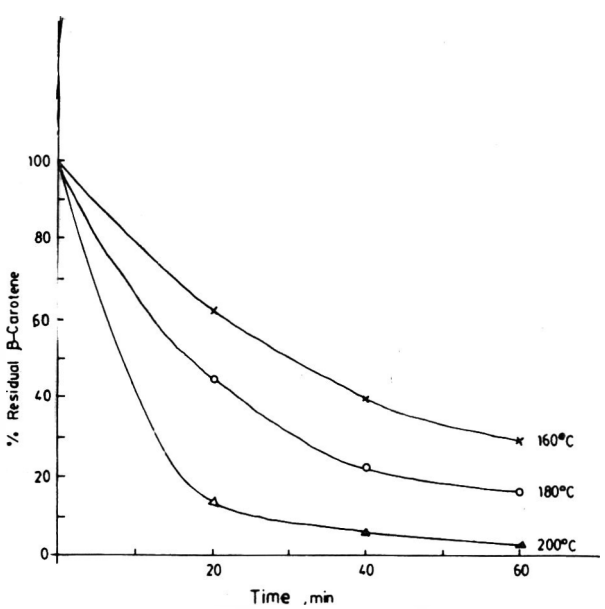

Fig. 1. Thermal destruction of β-carotone at 160°, 180° and 200°C.

The traditional method of palm oil production retained more β-carotene (79.7 per cent) in the palm fruit than the mechanised process (23.1 per cent). This was because the palm fruits in the traditional method were not exposed to very high temperatures during processing.

The progressive loss of β-carotene in palm oil when heated to 160, 180 and 200°C and held at these temperatures for 20, 40 and 60 min are presented in Fig. 1. The destruction was more at 200°C, reducing the β-carotene content by more than 85 per cent in the first 20 min and a more gradual reduction subsequently. At lower temperatures such as 160°C for 20 min, the β-carotene content was reduced by more than 35 per cent.

It would be difficult to ensure that temperature of as low as 160°C (when the retention of β-carotene is more than 50 per cent) is maintained during frying operations. Thus, though palm oil is a rich source of β-carotene, it would be reasonable to assume that very little of it would be available from fried foods.

The β-carotene retention in palm oil produced traditionally was about three times more than in the palm oil mechanically produced.

The destruction rate of β-carotene by heat doubles at every 20°C. When palm oil is used as a frying medium, only a very small fraction of the β-carotene is retained in the food.

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SENSORY EVALUATION OF FOODS PREPARED IN CRUDE PALM OIL

R MANORAMA AND C RUKMINI
National Institute of Nutrition,
Indian Council of Medical Research, Hyderabad, India.

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Crude palm oil (CPO) produced in India has been evaluated for its nutritional quality and safe edibility. As it is one of the richest natural sources of β-carotene, it is an ideal vehicle for vitamin A supplementation programmes to pre-school and school children. Hence, foods prepared in CPO were evaluated for quality by a selected panel of judges. Mean scores by 15 judges for different quality attributes indicated that CPO was found suitable in the preparations of *suji halwa* and *muruku*. Although it is known that continuous deep-fat frying for long periods results in destruction of β-carotene due to oxidative degradation, the first fried product *muruku* was found to have high β-carotene retention, and in this product, CPO was also found to be highly suitable by the panel. Preparations made in a 1:1 blend of refined groundnut oil (GNO) and crude palm oil also showed good quality.

The search for new sources of β-carotene for use in supplementary feeding programmes to combat vitamin A deficiency coupled with severe edible oil shortage during the late eighties, has led to the consideration of the possibility of using crude palm oil (CPO) *(Elaeis guineensis)* as an edible oil in India[1]. Preliminary nutritional and toxicological evaluation of CPO has been completed and it was found to be nutritionally adequate and toxicologically safe for human consumption[2,3]. CPO has high carotenoid content[4,5] which is bleached and removed during refining. The presence of carotenoids results in certain physical and chemical changes during heating which may alter the sensory properties of the oil[6]. Therefore, before attempting to evaluate the efficacy of CPO as a vitamin A supplement, it was found imperative to assess the quality of the products cooked in CPO. Analytical in-house laboratory testing, which represents a controlled environment to conduct studies for finding quality difference of products, was used to evaluate CPO products.

CPO is an unconventional cooking medium having unique properties. Hence, it was considered essential to try it out in different recipes and ascertain its suitability. Recipes were selected on the basis that CPO did not alter the colour and appearance of the product compared to controls made in refined goundnut oil (GNO). The five recipes used were (1) *muruku* (2) *suji halwa* (3) tamarind rice (4) *upma*, and (5) cake. These recipes were prepared in four oils namely, (a) 1:1 blend of CPO and GNO (b) CPO (c) GNO (butter was used for cake instead of GNO) and (d) refined palmolein oil (RPO).

Sensory evaluation: Fifteen panel members who were a mixture of males and females between the age group of 25 and 45 years, were selected from the Institute staff for evaluation of all the products. All four samples of one recipe were presented at a time. One small serving of each sample was given and the judges were asked to evaluate after consuming as much of the sample as possible without reaching the saturation point of satiety. Puffed rice was provided as a palate clearing agent. The sessions were conducted during mid-morning and mid-afternoon periods in the dining room adjacent to the metabolic kitchen of the Institute where samples were prepared. Conditions of temperature, humidity and illumination were adequate. Panel members were asked to rate different quality attributes by assigning scores specified ranging from 1 to 5 namely, 1 = very poor. 2 = poor, 3 = fair, 4 = good and 5 = very good.

Statistical analysis was done using one way analysis of variance to test the differences between mean scores allotted. Suitable log transformations were done wherever heterogenicity of variances was found. Probability was tested at 5 and 1 per cent levels of significance. Least significant difference was used to compare means wherever F-ratios were found significant.

Mean scores assigned to the five different food items tested and their statistical comparisons are presented in Table 1. Regarding individual food products, cake made with butter (control) was rated higher than the other three with regard to colour and appearance but obtained similar scores for other attributes. A 1:1 blend of CPO and butter increased the rating when compared to CPO alone, though this increase was not statistically significant. With respect to *muruku*, there were no significant differences found in the scores given. *Muruku* fried in CPO was rated equally with control. Since the preparation of *muruku* used for quality testing was fried in a fresh batch of oil within 15 min of heating at 180° ± 3°C, it did not obtain any unacceptable flavour and taste. However, if the heated oil were to be reused, the same degree of palatability would not have been achieved, as it was observed in earlier studies[6,7] that repeated heating results in an unacceptable oil with regard to its physical and chemical properties. It would be appropriate to suggest that CPO be used only for single frying of foods, without reusing the oil. A 1:1 blend of CPO and GNO, which is still an adequate source of β-carotene, would be a good frying medium for such snacks, as it may not undergo as many oxidative changes as CPO alone.

Suji halwa is normally coloured light orange with saffron. As CPO imparts a pleasant orange colour similar to saffron, it can be observed from the Table that *halwa* with CPO has

TABLE 1. MEAN SCORES ASSIGNED TO PRODUCTS PREPARED USING CRUDE PALM OIL

Oils used	Colour	Appearance	Texture	Aroma	Taste	After taste	Overall quality
			Cake				
Butter+CPO (1:1)	3.0[a]	2.8[a]	2.8	2.6	2.3	2.0	2.4
CPO	2.2[b]	2.6[a]	2.8	2.1	1.8	1.9	2.2
Butter (Control)	3.9[a]	3.9[b]	2.6	2.9	2.9	2.5	2.5
RPO	2.2[b]	2.4[a]	2.6	2.6	2.0	2.0	2.2
SEM (d.f.=3, 56)	0.26	0.26	0.34	0.21	0.34	0.32	0.34
			Muruku				
GNO+CPO (1:1)	3.6	3.6	3.3	3.4	3.8	3.4	3.6
CPO	4.0	4.0	3.9	3.7	3.6	3.5	3.8
Control	4.1	4.1	4.0	3.9	3.9	3.6	3.9
RPO	3.7	3.8	4.0	3.9	3.9	3.9	3.9
SEM (d.f.=3, 56)	0.19	0.22	0.22	0.17	0.22	0.23	0.23
			Halwa				
GNO+CPO (1:1)	3.8	3.8	3.6	3.7	3.9	3.7	3.3
CPO	4.2	4.1	3.8	3.9	4.0	3.9	4.0
Control	3.8	3.7	3.6	3.7	3.6	3.5	3.6
RPO	3.8	3.8	4.0	3.8	3.9	3.4	3.6
SEM (d.f.=3, 56)	0.19	0.22	0.20	0.16	0.21	0.17	0.21
			Tamarind rice				
GNO+CPO (1:1)	3.6	3.6	3.7[a]	3.8	4.1[a]	3.8[a]	3.9[a]
CPO	3.3	3.3	2.8[b]	3.0	2.9[b]	2.6[b]	3.1[b]
Control	3.4	3.6	3.5[a]	3.5	3.5[a]	3.4[a]	3.6[a]
RPO	3.6	3.8	3.2[a,b]	3.0	2.9[b]	2.7[b]	2.8[b]
SEM (d.f.=3, 56)	0.24	0.25	0.22	0.24	0.29	0.22	0.24
			Upma				
GNO+CPO (1:1)	3.3[a,b]	3.9[a]	3.7	3.6[a]	3.4[a,b]	2.9[a]	3.5[a]
CPO	2.6[a]	2.8[b]	3.6	2.6[b]	3.1[a]	2.7[a]	2.6[b]
Control	3.7[b]	3.7[a]	3.6	3.4[a]	3.6[b]	2.4[a]	3.6[a]
RPO	3.9[b]	3.9[a]	3.9	4.1[a]	4.1[b]	3.9[b]	4.0[a]
SEM (d.f.=3, 56)	0.19	0.20	0.26	0.26	0.26	0.32	0.24

Figures with different superscript differ under each item significantly ($P < 0.05$ & 0.01) in each column.

obtained the highest scores for colour and appearance. However, statistically no significant differences were observed in all quality attributes, indicating the suitability of CPO in this preparation.

With respect to both the seasoned items tamarind rice and *Upma*, CPO did not fair as well as controls. This could probably be due to a smaller amount of CPO being exposed to a larger surface area of heat (frying pan), thereby resulting in rapid chemical changes and imparting slightly undesirable flavours.

In conclusion, *muruku* among the savouries and *suji halwa* among the sweets were found to be suitable items for CPO incorporation. A 1:1 blend of CPO and GNO which tones down the effect of CPO alone, at the same time providing sufficient β-carotene, could be an ideal way of using CPO in cooking. In our earlier studies[7] it was reported that all the food items tested here were found to retain 70-88 per cent of β-carotene. Hence, any of the sweet or snack items, preferably prepared by blending with other commonly used edible oils, would be suitable vehicles for vitamin A supplementation in school feeding programmes.

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ANNOUNCEMENT

Members are hereby informed about the recent decision of the Central Executive Committee with respect to the validity of membership fee.

i) The validity of the membership fee will be only upto 31st March of every year. This is done to bring the membership year in line with the financial year ending in March,

ii) In view of the escalation in the cost of printing the Journals, the membership fee has been revised as follows:

Life member	:	Rs. 600=00
Corporate member	:	Rs. 1000=00
Affiliate member	:	Rs. 80=00
Full member	:	Rs. 50=00

There will not be any change in the Student Membership fee.

This will come into effect from 1 April 1992.

Members are requested to renew their membership on or before 31 March 1992, so as to enable the secretariat to keep their names in the mailing list. Kind cooperation of all the members is solicited.

Hony. Exec. Secretary
AFST(I), Mysore

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The Acceptance, Control of and Trade in Irradiated Food, International Atomic Energy Agency, Wagramerstrasse, 5, PB.No. 100, A-1400, Vienna, Austria, 1989, pp:229; Price: not indicated.

The recent publication from International Atomic Energy Agency, Vienna (1989) records the proceedings of conference jointly organised by FAO, WHO, IAEA, ITC-UNCTAD/GATT, to discuss "The Acceptance, Control of and Trade in Irradiated Food", and to draft a document on food irradiation. The book comprises 5 sections (I) Opening Addresses, (II) Keynote Addresses, (III) International Document on Food Irradiation, (IV) Statements of Official Participants and (V) Closing Remarks.

Section I includes a set of introductory talks by the various representatives of the organisations who have sponsored the conference. The talks also highlight the activities of these organisations as well as their specific interest in this conference. The need to develop improved methods of food preservation to combat the spoilage of food due to infestation, contamination and deterioration, is stressed. As the world population is rapidly increasing, there is also an urgent need to ensure that sufficient food is made available. Food irradiation, thus, could be used (i) to reduce food loss by extending the shelf-life, (ii) to replace fumigants whose safety has been questioned and (iii) to eliminate or reduce food-borne pathogens, thereby promoting public health. However, some people oppose the use of food irradiation due to sheer misunderstanding of the safety, benefits and limitations of this technology. Therefore, it is necessary to change this public perception through education and demonstration. In addition, appropriate government agencies should have access to accurate technical data to facilitate development of policy decisions about food irradiation and to provide their citizens with factual information about these policies. In connection with world trade in food, it would be desirable if regulations in major trading nations, related to food saftey could be harmonized.

Section II comprises a series of keynote addresses, reviewing the safety of food irradiation, its effect on public health and food security and its impact on international food trade. This section also discusses the regulatory control of the food irradiation process and the views of consumers' on acceptance of irradiated food.

The section introduces the technology of irradiation and reviews the advantages and limitations of irradiation over other food processing methods. The major advantages are an extension of the shelf-life of food by inhibiting sprouting, destroying insect pests, reduction of microbial load and desruction of pathogens. In addition, no unwanted residues are left in the food. The nutritional quality of irradiated foods remains unimpaired and no toxic or harmful effects are observed with application of effective dosages. Another advantage is that irradiation of food can be done even after the food has been packed. Food irradiation, if applied at levels upto 10 kGy and energies not exceeding 10 Mev for accelerated electrons or 5 Mev for x-rays and gamma irradiation, will not lead to any significant change in the natural radio-activity or prejudice the safety and wholesomeness of the food.

The disadvantages include the high cost involved in the installation and maintenance of irradiation equipment as well as difficulty in finding an agreed protocol for testing the wholesomeness of irradiated foods. Irradiation of some food products like meat and poultry to eliminate pathogens, may require the food to be irradiated at low temperatures to prevent the production of unacceptable changes in colour and flavour. This also leads to an increase in the cost of the treated food.

Various tests and experiments conducted on irradiated food and their results have also been discussed and the optimum doses for various food commodities have been listed.

The effect of irradiation on the nutrient content of foods is discussed. Oxidation of polyunsaturated fats, peroxide formation, decrease in vitamin C and thiamin content, are some of the changes observed. However, these are not very significant and are also observed in foods treated by other processes.

The effect of irradiation on various food products has been mentioned and irradiation seems to be the most suitable for cereals, spices, onions and potatoes.

The importance of dosimetry for radiation control has been highlighted in addition to use of proper packaging material and need for labelling of irradiated products.

The last talk of this section discusses the views of consumers on irradiated food and the need to educate and convince them of the benefits of food irradiation.

Section III contains the "International Document on Food Irradiation" which was adopted by consensus on 16th Dec. 1988 by the members and participants of the conference. The document is a summary of the discussions by the participants at the conference and includes (a) an introduction to irradiation and the need for food processing, (b) consumer attitudes to irradiated food, (c) government policies regarding irradiated food, (d) process control (maintenance of safety during assembly of equipment as well as transport of sources, together with proper application of effective dose) and (e) trade in irradiated food (need for labelling of irradiated food and the harmonization of standards and codes of practice

for regulating irradiated food and irradiation facilities by public authorities, in addition to training of inspectors, plant operators and food control officials).

Section IV includes the reactions of official participants and observers to the International document and decisions of their governments with respect to food irradiation.

Section V includes the closing remarks of the President and Vice-President of the conference wherein they summarise the discussions at the conference and thank the participants. It was concluded that there was a need for food security, disease precaution and adequate nutrition for 1 billion consumers and food irradiation technology was found to be suitable for developing countries. The conference helped to promote the establishment and development of food irradiation technology in the world and to expand co-operation among various countries in their respect. The book has been edited ably to project very important factors such as overall acceptability of the technology, wholesome safety and control, and norms for international trade. Those who are concerned with this new technology should have this compilation on their shelf for ready reference.

S.R. PADWAL DESAI
B.A.R.C., BOMBAY

Analytical Instrumentation Handbook: by Galen Wood Ewing (Ed.) Marcel Dekker Inc. 270, Madison Avenue, New York, 1990; pp:1008; Price:US $195 (USA and Canada), $234 (all other countries).

The book is a good handbook for Analytical Chemists, who have to decide the suitable approach to solve a specific problem.

The book contains instrumentation for spectrochemical, electrochemical, chromatographic and miscellaneous methods. Some of the most important modern spectrochemical tools; such as Atomic Emission, Atomic Absorption and Flame Emission, UV and visible, Infrared, Molecular Fluorescence and Phosphorescence, Raman, Chiroptical, Laser, Nuclear Magnetic Resonance, Electron Paramagnetic Resonance and X-ray Photo electron employed in analytical chemistry have been precisely described in the II part. The role and the Instrumentation for potentiometry, Voltametry, Stripping Analysis, Electrolytic conductance and Coulometry form the contents of the III part. Various Chromatographic tools such as gas chromatography, High Performance Liquid Chromatography. Supercritical Fluid Chromatography have been described in IV part. Miscellaneous methods such as Mass Spectrometry, Thermo analytical, Automatic Titration and Continuous-Flow have been grouped in V part. Elementary methods such as use of balance, Computer and Organic elemental analysis are described in I part.

It is always important to make a correct decision about the analytical tool to adopt for a specific analysis. For this purposes, this book acts like a good guide. Different Instruments such as PE-2400 CHN analyser of Perkin-elmer, Carlo Erba Analyser 1106, Heracus Elemental Analyser and Yanaco Coxler MT-3 and their principles for CHN analysis have been described.

Spectrochemical analysis by Atomic Emission Spectroscopy is based on the measurement of electro-magnetic radiation emitted by electronically excited atoms and ions. The energy distribution of the radiation is unique to each element. This Instrumentation required for such measurement is described in a simplified form, through a series of processes which convert information from elemental domain to observation domain.

Atomic absorption and flame emission spectrometry have been the mainstays in the area of trace elemental analysis as their detection can be done even at 1 ppm level. Instruments with two simultaneous measurement channels are commercially available.

A vivid description of uv-vis spectrochemical analysis of the compounds is followed by a list showing various brands of uv-vis spectrophotometers.

The Chapter on Infrared (IR) instrumentation traces the history of its development from 1940 to 1980. The modern Fourier transform infrared (FT-IR) spectrometer with new methods of sampling and data preparation from 1970 to 1980 form the rebirth of the modern IR Spectrophotometry. The first FT-IR was manufactured by JEOL.

Nuclear Magnetic Resonance (NMR) now known as Proton Magnetic Resonance has kept pace with the explosion in instrumental techniques. In virtually every area of chemical research, it has become an essential tool in the identification of substances and in the study of their structures.

X-ray Photo Electron (XPS) and Auger Electron Spectroscopy (AES) have been used to analyse the composition of the outermost few atomic layers of solid surfaces. Both XPS and AES have been used in numerous areas such as catalysis, corrosion, lubrication, electrodes, biological surfaces and polymers in addition to, in many other important technology. The principles and application of these instruments have been well described.

The principle and application of instruments used in potentiometry, voltametry, coulometry used in electrochemical analyses have been ably described.

After a good detailed account to modern gas chromatographic methods and to instrumentation, details about the principle and instrumentation of HPLC, supercritical fluid chromatography, Mass spectrometry, Thermoanalyses, Automatic titration, continuous-Flow analyses have been described.

At the end of every chapter, a good reference section comes in handy for cross reference checking. It will be a good addition to Libraries of Research Institutes and Universities.

J.R. RANGASWAMY,
CFTRI, MYSORE.

Carbohydrates as Organic Raw Materials: VCH Publishers, Weinheim, Germany, 1991. Price. DM 148, pp 367.

It was a pleasure for me to go through the book, which is the outcome of a workshop conference - *Progress and Prospects in the use of Carbohydrates as Organic Raw Materials*, held on April 11-12, 1990 at Darmstadt, Germany. It comprises 16 papers on various aspects of simple sugars such as glucose and sucrose. The topics range from a simple chemistry of glucose/sucrose, through their many specialised-functionalised derivatives and their application potentialities to complex polymeric substances such as dextran, xanthan, etc. It is amply justified to call this branch of research - "Sucrochemistry".

Sucrose, a naturally occurring disaccharide, may be considered as a ready-to-manipulate, tailor-made chemical intermediate for the manufacture of a number of value-added products. It is a raw material of very high purity and availability at moderately low prices from easily dependable - replenishable sources. Application of a wide variety of chemical - biochemical reactions has led to the preparation, on an industrial scale, of many novel sucrose derivatives, which are of high commercial value.

Papers 1 and 2 describe the historical developments of the chemistry and structural representation of sucrose. In the first paper by Prof. Lichtenthaler *et al.* the evolutionary aspects of the various structural formulae for sucrose molecule are provided. The computer generated molecular models in the usual atomic colour-code are really good. The sweetness - hydrophobicity of fructose region of sucrose molecule is exquisitely dealt with many examples. However, an article of similar title and information by the same authors just recently has appeared in Staerke, Vol.43 (1991), p, 121-132.

Papers 3,7,8 and 9 report on the enzymatic modification of sucrose to new aligo – and polymeric substances. Polyfructans, natural polymers of fructose, have received little attention so far and have never been exploited for any industrial applications.

The papers 4 through 6, 11 and 15 deal with various synthetic approaches for sucrose modification and also their applications. The use of sucrose sulfates as antiulcer and antipeptic agents (in paper 5) is interesting in that these derivatives are easily prepared. The regioselectivity of sulfation at the primary alcoholic group (0-6) has nicely been exemplified.

In paper 10, Prof. J.N. BeMiller has given an up-to-date account of sugar beet carbohydrates – their prospects for industrial utilization. Information is also given on their oligo and polymeric constituents.

The use of hydrogen fluoride as an efficient solvent and reagent for carbohydrate conversion – reactions forms the subject matter of paper 12. The versatility of HF in these reactions and their mechanisms are beautifully described. In HF medium, the sugar glycoside readily forms internal anhydride – type compounds, the fatty ester derivatives of them are useful as surfactants, fat substitutes and thickeners.

Selective oxidation of D-glucose at different hydroxyl groups (C-1 to C-6) by chemical and biochemical reactions to a number of value-added products is discussed in paper 13. However, this article had seen the light of publication in 1990 by the same author, vide Staerke, Vol. 42 (1990), p. 342-349, and I wonder why this paper is again reproduced verbatum in this volume? I think there was no need for this repeat publication of the same data! Nevertheless, the scientific compilation of data in this review is worthy of reading and understanding. Some of the derivatives mentioned have potential to be used for specialised application areas. The next paper (No. 14) is more or less on a similar reaction sequence, but carried out catalytically using platinum, rhodium, etc.

In the last paper (No. 16) an attempt is made to present the utility of sucrose for the production of several colourants, dyes and pigments. These substances find applications in electronics and opto-electronics. Starting from 5-hydroxymethyl-2-furfural, which is obtained in quantitative yields by acid catalysed dehydration of glucose, a number of chromosphoric – heterocyclic compounds, which are capable of electron transfers are produced.

The Editor has done a commendable job in compiling these different papers and bringing out this volume. Contribution by different specialist authors for the individual chapters has resulted in a high quality of writing and discussion. The subject matter discussed in here is pertinent to all chemists, technologists, and industrialists too. An active carbohydrate researcher finds wealth of information in this book. Except for a few minor printing errors, the overall format and production of the book are excellent, and the subject retains a good deal of cohesion all through. The chapters are well organised, easy to read, and are supplemented with an extensive coverage of up-to-date references. The cover illustration showing the computer-generated colour-coded molecule is appealing.

Scientific libraries would be incomplete without a copy of this book. The Editor and the Publishers are thanked for bringing us a very resourceful book.

R.N. THARANATHAN
CFTRI, MYSORE.

Evaluation of Certain Veterinary Drug Residues in Food: World Health Organisation of the U.N., Geneva, 1990; pp 67: Price: Sw fr.9/-.

The annual per capita consumption of animal foods has tremendously increased in recent times both in developed and developing countries. The frequent use of a large number of veterinary drugs in animal disease control has led to the accumulation of certain quantities of these drugs in animal tissues and thereby become responsible for public health

hazards. Knowledge on the residue content in animal foods and the probable implications due to consumption of such products is very limited. A book on 'Evaluation of Certain veterinary Drug Residues' is a timely publication by FAO/WHO.

The publication is a result of expert opinions emanated from FAO/WHO Expert Committee on food additives. The report outlined the principles governing the safety evaluation of residues, microbiological risk due to residues of antimicrobial drugs in food and allergy potential of residues. The report included the comments on residues of specific veterinary drugs.

Attention has been focussed on residues of specific veterinary drugs –I. Anthelminthic drugs –Closantel, Vermectin and Levamisole. II Antimicrobial agents – Benzyle penicillin and Oxytetracycline, III Growth promoters – Carbadox and Olaquindox. The committee has critically evaluated the available scientific data on the above mentioned drugs and provided results of toxicological data (on metabolism, carcinogenicity, genotoxicity and effects on reproduction and development) and residue data. The need for growth promoters is increasing in order to boost up milk or meat production. The committee has evaluated for the first time on the toxicological and residue content of the growth promoters and provided valuable data.

The committee has suggested Maximum Residue Limits (MRL) based on toxicological and residue data. The data are also extremely useful for establishing Acceptable Daily Intake (ADI) for humans.

The committee has presented critically the information on evaluation of certain veterinary drug residues in food in the report. The book is highly valuable as a source of information and reference materials for research workers, veterinary and medical professionals and public health personnel.

D. NARASIMHA RAO,
CFTRI, MYSORE.

Oilseeds in India Perspectives for 2000 A.D. by P.C. Agarwal, Oxford & IBH Publishing Co., Pvt. Ltd., 66, Janpath, New Delhi-110 001, 1990; pp:346; Price: Rs.130/-.

The book containing an excellent preface aims to highlight the past, present and future trends of oilseeds production in India based on the demand and consumption pattern of oilseeds and oils, various constraints in oilseeds cultivation, and the methodologies to be adopted for enhanced production and yield of oilseeds.

Presentations are made in great detail on the individual seeds covering area, production and yield and their growth rates in each State district-wise and also percentage share of India in the World. The statistical approaches and use of computers have been adapted extensively. An excellent picture has been projected also on the export and import scenarios of India's oilseeds and oils and fats. The projections of oilseeds upto 2001 A.D. covering the major oilseeds have been included in the text in great detail.

The author has included as many as ten chapters and large numbers of Tables providing categorical projection of the past, present and future situation of oilseeds and oils and fats in India.

The quality of each chapter is high and the text book would be of practical use to the scientists and technologists working in the fields of oilseeds and fats and oils. The book would be an useful addition in the libraries of the Indian Universities and Research Institutes which offer courses in agriculture and in oil technology and where a great deal of R & D activities are pursued in the area of oilseeds and oils/fats.

D.K. BHATTACHARYA,
CALCUTTA UNIVERSITY, CALCUTTA.

AFST(I) NEWS

Headquarters

In the lecture series of the Association, Dr. S.S. Arya, Additional Director, Defence Food Research Laboratory, Mysore gave a talk on 'Philosophy of Designing Ration Scale for Armed Forces' in the Assembly Hall of CFTRI, Mysore on 20 December 1991.

Bhopal Chapter

A lecture was arranged under the Chairmanship of Dr. N.S.L. Srivastava, Director, Central Institute of Agricultural Engineering, Bhopal on 6 December 1991. Dr. N. Ali, President, welcomed the gathering. Dr. A.S. Aiyar, Technical Director, Godrej Foods Ltd., Bhopal delivered a lecture on 'Random Thoughts on Indian Food Industry', Dr. V. Kawalkar, Executive member, proposed a vote of thanks.

ERRATA

In Volume 26, No. 6, the sentence on page 343, 1st column last two lines should read as "Equation 4 was used for predicting the moisture content of paddy soaked after evacuation and within the range of this study".

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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