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(INDIA)

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Dear Authors and Referees,

I am laying down the office of the Editor of Journal of Food Science and Technology on 30th June 1992. Many authors have expressed that my Editorial Pen has been extremely sharp. If it is a sin, friends I have committed it during these three and a half years, and if it is a virtue, I have got my humble control over it. I am expressing my profound gratitude to all the authors, who cooperated with me inspite of the sharpness of my pen. I am highly indebted to all the referees for their prompt response without which bringing of the Journal on time would have been impossible. I cherish the kind cooperation and help of the members of the Editorial Board. I must mention the name of Mr. R. Shivaram, who has been my second wife in up keep of Editors House.

Thanks to one and all.

J.R. Rangaswamy

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Effect of Different Cooking Methods on β-Carotene Content of Vegetables

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β-carotene contents of 12 raw vegetables and 35 cooked preparations were estimated by column chromatography and spectrophotometry. The effect of different cooking methods was investigated by calculating the % loss in the cooked preparations. The extent of loss was lower when processing/heating was kept to a minimum. Cooking methods when used cumulatively such as grinding, chopping plus cooking for long periods or prolonged cooking resulted in progressive losses of β-carotene. Deep-frying resulted in twice the amount of loss that occurred during shallow-frying.

Deficiency of vitamin A leads to impaired cellular functioning since it has a role in numerous physiological processes in animals[1]. Carotenoids are the precursors of vitamin A and those commonly occurring in nature include α-, β-and γ-carotene, lycopene and cryptoxanthin[2]. Among these precursors, a major proportion of vitamin A activity is accounted for by β-carotene which is widely distributed in green leafy vegetables, yellow-orange fruits and some other vegetables.

Nutrient composition of vegetables varies not only due to factors such as season, variety, stage of maturity, storage and geographical location, but also during its transformation from the raw to its cooked form. In most cases, cooking causes a reduction in the nutritive value of foods[3]. Several attempts have made in the past to determine the nutrient composition of different foods, but these were mainly for raw foodstuffs[4].

A major constraint faced by nutritionists in India for evaluating nutrient intakes of population and their nutritional status is that reference is generally made to food value tables in which the nutrient composition of only raw foodstuffs is available.

While calculating the dietary intakes, the losses of several nutrients which occur during food processing and cooking cannot be accounted for. This may sometimes result in gross errors in estimates of actual dietary intakes and in interpreting the results of dietary surveys. It is vital that such data are available. This study was, therefore, conducted to determine the β-carotene content of commonly consumed vegetables and to study the effect of different cooking methods used in the preparation of various vegetable preparations on the β-carotene content.

Materials and Methods

Twelve raw vegetables as listed in Table 1 and 35 preparations made from these vegetables as listed in Table 2 were analysed for β-carotene content. The samples were 9 leafy vegetables and 3 yellow orange/red vegetables, namely carrot, yellow pumpkin and ripe tomatoes. β-carotene measurement was done by open column chromatography and spectrophotometry after extracting it from the plant materials, according to the standard procedure of AOAC[5].

A known weight of the food sample (2 - 12g) was homogenized in a Waring blender and the pigment was extracted using 50 ml aliquots of acetone:hexane (4:6 v/v) containing 0.1 per cent butylated hydroxy toluene. The β-carotene was eluted by column chromatography and determined by measurement of colour intensity at 436 nm using a Systronics spectrophotometer Model 106. β-carotene concentrations were calculated per 100 g of the raw vegetables and per serving of the cooked preparations. Per cent losses were calculated by comparing the values estimated by analysis on the basis of the amount of the raw vegetable that had been used in one serving of each preparation.

All analyses were carried out in duplicate. Recoveries were performed and found to be 99 per cent for β-carotene. The entire process of extraction, separation and spectrophotometric measurement was carried out in subdued light.

Estimation of β-carotene by HPLC: The steps for extraction and concentration were similar to those used for open column chromatography. The concentrated extract was saponified by adding 10 ml ethyl ether and 10 ml of I N methanolic potassium hydroxide and was allowed to stand under nitrogen with constant stirring for 2 hr. The unreacted

potassium hydroxide was neutralized with 5 per cent hydrochloric acid and transferred to a separating funnel. The solvent containing the pigment was washed twice or thrice with deionized water. The separated ether layer was dried with sodium sulphate, filtered and evaporated on a rotary vacuum evaporator. The residue was dissolved in the least amount of hexane required, containing 0.1 per cent butylated hydroxy toluene. From this, 20-30 μl was used for chromatographic separation.

The HPLC system was a Hitachi 655-A-11 liquid chromatograph model equipped with a Hitachi D-2000 chromatointegrator and 655-A autosampler unit. An RP C-18 VYDAC column was used. The unit was connected to a 655 -A variable UV detector set which was adjusted to 280 nm. The mobile phase used was a mixture of acetonitrile and chloroform at a flow rate of 1.0 ml/min. A programmed gradient elution system was used which consisted of t-0, 0 chloroform and 100 acetonitrile to t-20, 10 chloroform and 90 per cent acetonitrile i.e. the concentration of chloroform increased from 0 to 10 per cent in 20 min.

Thirty μl of the extract was injected and the chromatograms developed. Standard solutions of pure β-carotene with concentrations ranging from 0.06 mg per 30 μl to 0.3 mg per 30 μl were also injected to obtain the calibration curve. The entire analysis was computer regulated. The peak area, peak height as well as concentrations were obtained by the use of a chromatointegrator. The pigment peaks (fractions) from the samples were identified on the basis of retention times. Retention time ranged from 14.06 to 14.77 min. From these concentration, the β-carotene content was calculated per 100 g of the raw vegetable and per serving of the cooked preparations.

Results and Discussion

The α-and β-carotene contents of the raw vegetables are presented in Table 1. The contents estimated thus were compared with published values of the ICMR [4]. α-carotene was absent in most vegetables and detected only in carrots and tomatoes. The β-carotene contents of some vegetables were comparable to those given by the ICMR, whereas for others, the values differed quite widely. For colocasia leaves, the values obtained in the present study were slightly higher. Dikshit[6] reported a lower β-carotene content of 9.081 mg/100g of the vegetable.

Similarly, for carrots and fenugreek leaves, the β-carotene contents were almost two-fold higher than the ICMR reported values. In case of fenugreek leaves, the levels obtained in the present study were higher than those reported in the literature[6,7]. Not many studies are reported on the β-carotene content of foods which are commonly considered as sources of vitamin A in Indian diets. Yellow pumpkin was found to have a much higher β-carotene i.e. 665 mg/100g as compared to 50 mg/100g reported by the ICMR. Mayalu contained approximately half the levels reported by the ICMR[4].

The β-carotene content per serving for the 35 cooked preparations is shown in Table 2. Among the various preparations, curries or 'bhajis' prepared from leafy vegetables, were better sources of the provitamin than preparations such as pakodas or soups.

The preparations were evaluated from the point of view of fulfilling the provitamin requirements. The RDA for an adult for provitamin A is 3000 mg[8]. From Table 2, it can be seen that one serving of preparations such as aloo palak, palak

TABLE 1. β-CAROTENE CONTENT OF VEGETABLES

Common name	Botanical name	α-carotene (mg/100g)	β-carotene (mg/100g)	Published (ICMR) (mg/100g)
Amaranth	*Amaranthus gangeticus*	Not detected	5.291	5.520
Colocasia (green var)	*Colocasia antiquorum*	Not detected	11.627	10.278
Coriander	*Coriandrum sativum*	Not detected	7.632	6.918
Curry leaves	*Murraya koenigii*	Not detected	12.261	7.560
Fenugreek	*Trigonella foenum greceum*	Not detected	7.450	2.340
Gogu	*Hibiscus cannabinus*	Not detected	4.363	2.898
Mayalu	*Basella rubra*	Not detected	3.424	7.440
Mint	*Mentha spicata*	Not detected	3.752	1.620
Spinach	*Spinacia oleracea*	Not detected	5.027	5.580
Carrots	*Daucus carota*	0.5845	3.352	1.890
Tomatoes, ripe	*Lycopersicon esculentum*	2.78	0.539	0.351
Yellow pumpkin	*Cucurbita maxima*	–	0.666	0.050

Values represent average of duplicate samples

TABLE 2. LOSS OF β-CAROTENE IN VEGETABLES DURING DIFFERENT METHODS OF PROCESSING.

Processing method	Product	Wt of preparation per serving (g)	Wt of vegetable used per serving (g)	β-carotene content (μg/serving)	% loss of β-carotene (%)	Mean ± SD
Minimum processing (Salads)	Tomato Salad (pieces)	100	100	0.507	6.0	
	Carrot Salad (pieces)	100	100	3.056	8.8	11.3±6.6
	Carrot Salad (grated)	100	100	2.900	11.1	
	Tomato Raita	100	130	0.327	19.1	
Short time cooking-chopping, sauteeing	Carrot Bhaji	70	50	0.313	18.5	
	Methi Chanadal Bhaji	82	30	1.595	28.6	
	Palak Bhaji	74	100	3.775	29.3	
	Palak Paneer	138	100	3.354	29.6	44.6± 17.7
	Mayalu Bhaji	124	100	2.845	33.2	
	Aloo Methi	93	30	1.257	43.7	
	Aloo Palak	142	100	2.500	50.3	
	Yellow Pumpkin Bhaji	98	100	0.257	61.3	
	Amaranth Curry	150	100	1.784	66.3	
	Colocasia Patal Bhaji	100	50	2.095	63.8	
	Methi Dal	147	15	0.381	65.9	
Chopping + steaming + shallow frying	Coriander Vadi	35	13	0.916	7.6	37.8±22.6
	Methi Muthia	41	10	0.419	43.7	
	Colocasia Patra	75	50	2.205	62.1	
Chopping + deep-frying	Mayalu Pakoda	48	30	0.803	61.0	
	Palak Bhaji	70	25	1.403	72.1	73.1±7.7
	Palak Pakoda	75	35	1.279	74.5	
	Coriander Vadi (deep-fried)	32	13	0.708	71.3	
	Methi Muthia (deep-fried)	46	10	0.189	74.5	
	Patra (deep-fried)	78	50	0.874	85.0	
Chopping and roasting	Methi Thepla	100	20	1.616	9.5	
Maceration/grinding	Coriander Chutney (blender)	6	3	0.264	13.3	
	Curry leaves chutney	6	2	0.598	18.7	24.9± 10.1
	Mint Ratia	70	6	0.346	18.7	
	Gongura Chutney	6	1.1	0.097	25.8	
	Mint Chutney (Stone grinder)	8	2	0.256	32.7	
	Mint + Coriander Chutney (Stone grinder)	6	2	0.248	40.2	
Prolonged cooking + grating/grinding	Pumpkin Halwa	125	150	0.201	69.4	
	Cream of Carrot Soup	200 ml	50	0.499	70.2	75.9±5.7
	Palak Soup	175 ml	50	1.047	79.2	
	Carrot Halwa	70	50	0.313	80.4	
	Tomato Chutney	30	100	0.054	80.6	

paneer, carrot salad (grated or whole) could fulfil almost the day's RDA.

Some preparations like colocasia patra (shallow fried) and bhaji provide 75 per cent of the day's allowance for β-carotene while preparations such as amaranth curry, spinach soup, etc provide almost 50 per cent of the RDA in one serving. Preparations such as carrot halwa, tomato chutney etc do not contribute as much since considerable losses would occur during their preparation. Rao[9] analysed 14 foodstuffs using chromatographic and spectrophotometric methods. Losses of β-carotene were found to occur due to storage and cooking.

The effect of cooking and per cent loss was calculated in the present study according to the level of processing and the cooking method used (Table 2). Salads which usually undergo the least amount of processing were found to have a mean loss of 16.3 per cent. Dikshit[6] reported similarly a loss of 15 per cent β-carotene for carrot salad.

Losses of β-carotene ranged from 18 to 61 per cent, with an average of 37.5 per cent when foods were chopped and sauteed. When the foods were chopped, macerated further and cooked for relatively longer periods, the losses increased; the average loss being 60 per cent. These results clearly demonstrated the lability of β-carotene to heat and the

adverse effects. Grinding in a blender/mixer was found to be more favourable for preparation of chutneys than the use of a traditional grindstone. (Table 2). This may be because maceration would take longer on a stone grinder and the loss of β-carotene through oxidation would be greater.

Use of a combination of methods led to progressive losses of the provitamin, whereas when preparation time was optimal and exposure to heat and air was minimal, the loss was lower.

The β-carotene content estimated by HPLC in the 7 preparations is compared with the spectrophotometric estimation in Table 3. For all preparations except the first values obtained by the spectrophotometric method were lower than the values obtained by HPLC. The results of this study indicated that although in almost all preparations, β-carotene loss occurred, as far as possible the length of cooking time should be minimized and combinations of different cooking procedures should be minimized in order that the losses of β-carotene should be less. Procedures like deep-frying should be avoided since it would lead to extensive losses of the fat soluble β-carotene.

TABLE 3. COMPARISON OF β-CAROTENE CONTENT OF SEVEN PREPARATIONS ESTIMATED BY HPLC AND SPECTROPHOTOMETRIC METHOD

Products prepared	β-carotene (mg/100g)	
	HPLC	Spectrophotometric method
Aloo Methi	0.828	1.257
Methi Muthia (Shallow fried)	4.916	4.196
Palak Pakoda	1.412	1.279
Coriander Vadi	8.621	7.046
Palak Bhajia	1.856	1.705
Palak Soup	1.486	1.047
Patra (Shallow fried)	6.928	4.409

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Response Surface Modelling of Extrusion Texturing of Defatted Soya Grits

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Effects of barrel temperature (die end), die temperature, screw compression ratio, screw speed and feed moisture on expansipn ratio, per cent water absorption, breaking strength, density and colour of extrudates including extruder mass flow rate during single-screw extrusion of defatted soya grits were studied using response surface methodology (RSM). Results were graphed as response surfaces showing areas of optimum extrusion processing parameters. A combination of high barrel and die temperature not favoured expansion. Low feed moisture level provided good expansion. It is evident that RSM is an useful technique in extrusion modelling.

Extrusion cooking is one of the most economic and effective means of converting defatted plant proteins into wide range of textured products. Atkinson[1] succeeded in texturing defatted soya flour using single-screw extruder.

Response surface methodology (RSM), a statistical method, describes the change of the dependent variable while changing the independent process parameters. The use of RSM in extrusion cooking of defatted soya meal was first reported by Aguilera and Kosikowski[2]. RSM has been applied successfully in the extrusion of different food materials by various authors[3-9].

The objective of this study, therefore, was to find out the optimum regions for extrusion texturing of defatted soya grits, restricted to the process factors like extrusion temperature, screw compression ratio, screw speed and feed moisture.

Materials and Methods

Soya grits: Defatted soya grits (50.5 per cent protein, 9.9 per cent moisture and 2.1 per cent fat) was used throughout the experimental work. Screen analysis showed that the mean particle size of the soya grits was 0.42 mm.

Preparation of soya grits for extrusion: For extrusion cooking, samples were moistened with distilled water to a selected moisture level (including endogenous moisture), mixed in a variable speed mixture for 10 min, sealed in polyethylene bags and refrigerated overnight at 5°C for equilibration. They were stored for 120 min at room temperature prior to extrusion.

Extrusion texturization: A Brabender single-screw food extruder (model 20 DN) was used in this study. The temperature of the first section was maintained at 125°C, while the second section and die head were controlled according to the temperature profile necessary for the definite experiment (Table 1). During extrusion feeding, screw speed was fixed at 100 r.p.m. to provide optimum feeding[3]. The die was of a 5 mm diameter cylindrical type.

Extruder output: Extruder mass flow rate was determined with the help of a stopwatch and balance. Extrudates were collected during steady state of each extrusion run.

Expansion ratio: Expansion ratio was calculated as extruder diameter/die exit diameter. A mean value of 20 measurements was taken into consideration.

TABLE 1. RESPONSE SURFACE MODEL

Independent variable	Upper limit $Z_j^u(X_j^u)$	Lower limit $Z_j^l(X_j^l)$	Centre point $Z_j^\circ(X_j^\circ)$	Interval ΔZ_j	Star points R
Barrel temp (die end) Z_1 (X_1), °C	160 (+1)	140 (−1)	150 (0)	10	+R=165 −R=134
Die temp Z_2 (X_2), °C	160 (+1)	140 (−1)	150 (0)	10	+R=165 −R=134
Screw compression ratio Z_3 (X_3)	4:1 (+1)	2:1 (−1)	3:1 (0)	1	+R=5:1 −R=1:1
Screw speed Z_4 (X_4), min^{-4}	220 (+1)	150 (−1)	185 (0)	35	+R=240 −R=130
Feed moisture Z_5 (X_5), %	26 (+1)	14 (−1)	20 (0)	6	+R=30 −R=10

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Product density: Extrudate density was determined in the following way:

The mass and the average diameter of ten replicate sample segments from each equilibrium extruder run were determined. Assuming that the shape of the extrudate approximated a cylinder, the volume of each sample segment was calculated in cubic centimetres. The sample mass (M) can be defined by:

$$M = M_o - M_w = M_o - M(W/100) \quad (1)$$

Where M_o and M_w are the mass of dry material and the mass of water respectively and W is the product moisture content.

From formula (1) it can be written as follows:

$$M_o = M\ (1 - W/100) \quad (2)$$

Again the sample volume (V) can be written as:

$$V = V_o - V_w \quad (3)$$

$$V_o = V - V_w \quad (4)$$

Where V_o is the volume of dry material.

Therefore, density of each extrudate on dry basis can be determined as:

$$\rho_e = M_o/V_o = \{M(1 - W/100)\} / (V - V_w) \quad (5)$$

Assuming a density of 1 g/cm^3 for water (ρ_w), the volume of water present in the sample (V_w), will be:

$$V_w = M_w/\rho_w \{M(W/100)\} / 1 = M(W/100) \quad (6)$$

Substituting the value of V_w, the formula (5) takes the following shape:

$$\rho_o = \{M(1 - W/100)\} / \{(V - M(W/100)\} \quad (7)$$

Water absorption: Ten replicates of extrudates were weighed and allowed to rehydrate in an excess (10:1) of distilled water for 5 min. After draining, they were reweighed and water absorption WA, per cent was calculated as:

$$WA = \{(M_2 - M_1) / M_1\}\ 100 \quad (8)$$

Where M_1 is the weight of dry extrudate and M_2 is the weight of wet extrudate.

Product colour: The colour of the extrudates and that of the raw material were measured with the help of a device "Pye Unicam PU 8000" using Lab system after milling the extrudates and the raw material with the help of disc mill to an average particle size of 280 μm. The colour difference (ΔE) can be defined as follows:

$$\Delta E = (\Delta L^2 - \Delta a^2 - \Delta b^2)^{1/2} \quad (9)$$

where $\Delta L = L_o - L_e$; $\Delta a = a_o - a_e$; $\Delta b = b_o - b_e$; "o" – for raw material (standard); "e" – for extrudates (here e = 1 to 27); Standard values : $L_o = 72.33$, $a_o = 4.14$, $b_o = 22.95$.

L – Intensity of light in L* a* b* colour space; a – Green-red axis in L* a* b* colour space; b – Blue - yellow axis in L* a* b* colour space.

Experimental design: A central composite response surface experimental design[10] of type 2^{5-1} was used to examine the combined effects of five independent process variables as barrel temperature at the die end, die temperature, screw compression ratio, screw speed and feed moisture.

TABLE 2. RESULTS FROM THE TRIALS

Trial No.	G (kg/h)	ER	P (N)	ρ (g/cm^{-3})	WA (%)	ΔE
1	12.05	1.14	48.40	0.99	97.09	11.65
2	9.38	1.09	79.90	0.95	213.49	10.49
3	8.30	1.02	41.75	0.77	270.52	10.91
4	12.95	1.26	30.06	0.86	281.63	6.55
5	7.10	0.77	61.80	0.69	189.03	12.32
6	12.07	1.17	62.80	1.00	92.42	9.28
7	11.17	1.12	42.97	0.94	58.07	9.28
8	5.22	1.17	40.77	0.77	184.40	9.51
9	5.17	1.03	41.30	0.68	138.66	11.34
10	13.03	1.15	47.12	0.98	74.56	13.81
11	15.34	1.18	51.55	0.99	108.24	8.23
12	9.91	1.19	40.22	0.97	153.56	8.65
13	14.36	1.16	42.53	0.94	142.73	9.11
14	6.05	1.16	43.41	0.95	144.81	10.68
15	8.45	0.82	40.87	0.69	172.09	12.41
16	14.34	1.25	40.21	0.96	125.43	9.75
17	12.55	1.14	60.55	0.94	244.59	8.85
18	13.05	1.20	41.13	0.89	222.81	7.27
19	12.95	1.25	31.17	0.85	269.35	8.16
20	12.78	1.21	40.08	0.94	230.38	10.26
21	13.27	1.12	92.92	1.10	43.83	10.97
22	7.13	1.19	71.09	0.86	262.24	11.61
23	7.54	1.12	80.02	0.90	136.33	9.68
24	5.17	1.10	63.00	0.95	94.78	8.96
25	4.76	1.14	20.41	0.80	170.15	9.89
26	4.82	1.16	79.77	1.05	35.04	9.49
27	8.33	1.17	41.80	0.94	165.94	9.20

Table 1 shows the real (Z_j) and the coded (X_j) values of the independent variables.

The response surface design was used to evaluate the dependent variables as extruder mass flow rate (G, kg/hr); expansion ratio (ER); breaking strength (P, N); product density (ρ, g/cm^3); water absorption (WA, per cent); colour difference between the extrudate and the raw material (ΔE)

The whole design was composed of 27 extruder runs, replicated thrice in random order and the average values are shown in Table 2. The first 16 points in the design were the usual factorial points for fitting a first order model. The 27th point was the centre of the design in order to test the model for lack of fit. Ten axial points were added in order to estimate second order coefficients.

Results and Discussion

The primary results obtained are the regression equations from the coefficients calculated by using computer. The following significant ($p < 0.05$) equations explain the importance and significance of each independent variable and their interactions.

$$G = 9.9 - 2.2\ X_5 + 0.77\ X_2 X_4 + 1.78\ X_1^2 + 1.8\ X_2^2 - 0.92\ X_4^2 - 1.57\ X_5^2 \quad (10)$$

$$ER = 1.13 - 0.062\ X_1 + 0.027\ X_3 - 0.053\ X_5 - 0.035\ X_1 X_3 - 0.029\ X_2 X_4 - 0.042\ X_4^2 \quad (11)$$

$$P = 51.02 - 5.41\ X_2 + 6.0\ X_2X_4 - 11.79\ X_2^2 + 7.6\ X_3^2 \quad (12)$$

$$\rho = 0.902 - 0.032\ X_1 - 0.076\ X_5 - 0.026\ X_1X_2 - 0.03\ X_2^2 \quad (13)$$

$$WA = 160.04 + 15.42\ X_2 - 27.21\ X_3 - 12.67\ X_4 + 33.41\ X_5 + 13.85\ X_1X_4 + 19.89\ X_2X_3 + 28.11\ X_3X_4 + 20.6\ X_1^2 + 27.36\ X_2^2 - 28.8\ X_4^2 - 34.22\ X_5^2 \quad (14)$$

$$\Delta E = 10.07 + 0.46\ X_1 - 0.77\ X_2 - 0.67\ X_1X_4 + 0.82\ X_2X_2 + 0.79\ X_3^2 + 0.61\ X_4^2 \quad (15)$$

Effect on extruder mass flow rate: Extruder output was found to be primarily a quadratic function of screw speed and feed moisture content (Eq 10). Fig 1a and 1b describe the effect of process variables on extruder output. Extruder output was decreased at high and low feed moisture contents and at high and low screw speeds, thus giving rise to a target-shaped contour plot with a central point of optimum extruder output. It is quite clear that the barrel temperatures (die end) did not have any effect on the extruder output (Fig. 1).

Higher extruder output within the experimental area occurred when die temperature was at its higher level (160°C) and at screw speed of about 195 min^{-1} with feed moisture content 17 - 17.5 per cent. A combination of high feed moisture and high screw speed predicted to give very low output (Fig. 1). The significant role of moisture is probably related to flow characteristics of the feed material. Increasing moisture level produced caking of the material reducing feed rate and hence extruder output.

Effect on expansion ratio: It is easy to predict from regression equation (11) that the process variables play a significant role on product expansion. According to Fig.2. an increase in screw speed at low screw speed level increased the expansion ratio, until a certain speed, which depends on screw compression ratio, was reached. At still higher speed levels, the expansion ratio was again decreased. An increase

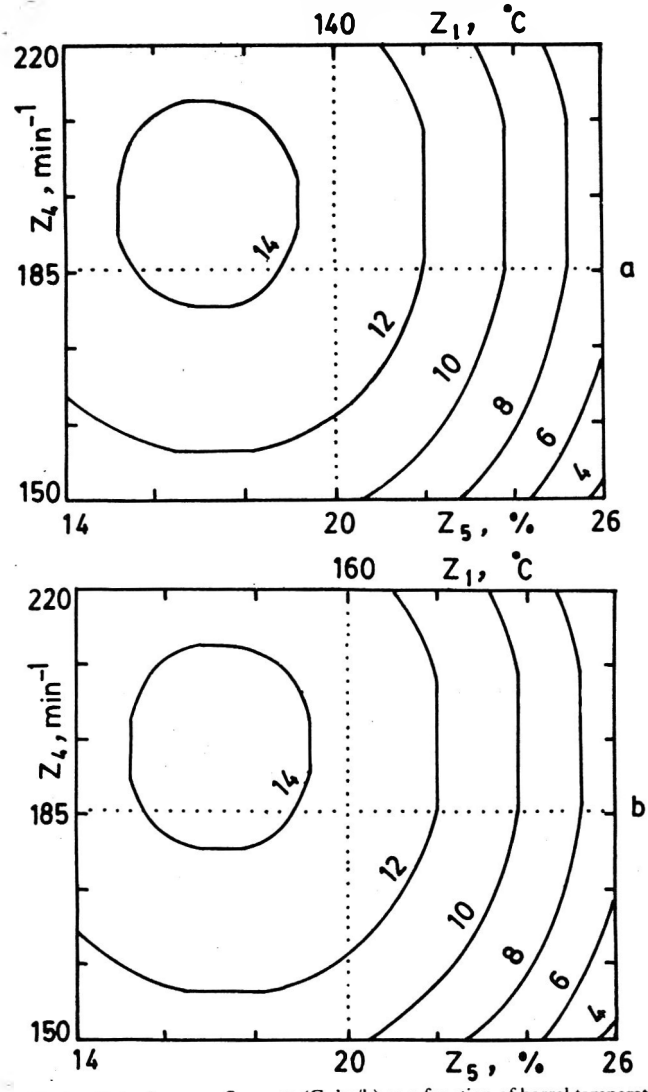

Fig.1. Extruder mass flow rate (G. kg/h) as a function of barrel temperature (die-end) (Z_1) screw speed (Z_4) and feed moisture (Z_5): Z_1 in a = 140°C: Z_1 in b = 160°C: (Z_2 = 160°C).

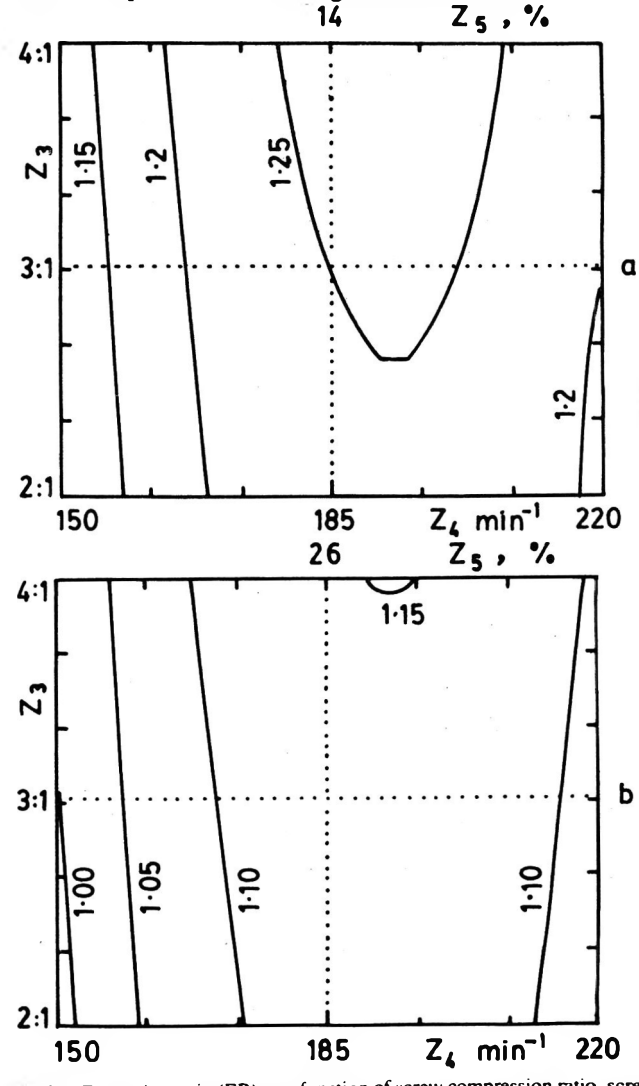

Fig.2. Expansion ratio (ER) as a function of screw compression ratio, screw speed (Z_4) and feed moisture (Z_5): Z_5 in a = 14%; Z_5 in b = 26%; (Z_1 = 140°C, Z_2 = 140°C).

in screw speed increased the expansion ratio faster at lower screw speed and at higher screw compression ratio. An increase in screw compression ratio usually increases expansion ration as found also by Frazier *et al*[11].

Fig 2a and 2b also indicate that expansion increases with decreasing feed moisture content. A decrease in extrusion-moisture resulted in improved moisture distribution and a more elastic dough, which favoured expansion[12].

In fact, in this study defatted soya grits did not show good expansion. Anyhow, highest expansion within the experimental limits was achieved at extrusion temperature of 140°C, screw speed about 175 – 200 min^{-1} and feed moisture of 14 per cent with screw compression ratio 3:1 to 4:1 (Fig. 2a).

Effect on breaking strength: Breaking strength of the extrudates must be minimum as most of the extrudates are consumed directly as ready-to-eat foods. On the basis of equation (12), the breaking strength of the extrudates was plotted as contour lines (Fig.3). The surfaces shown in the Fig 3a and 3b are generally complex as the surfaces are saddle-shaped having a broad, relatively flat middle area, rising at the opposite sides at high screw compression ratio and at low screw compression ratio and falling at the other two sides at lower die temperature and at higher die temperature. Because of the saddle shape, breaking strength was decreased as screw compression ratio was increased to 3:1. At still higher compression ratio levels, the breaking strength was again increased.

With the increase of die temperature, breaking strength was also increased until die temperature, reached about 145 to 150°C, when screw compression ratio was 3:1. Still with higher die temperature, breaking strength was decreased again. Fig 3a and 3b show that high screw speed level shifted

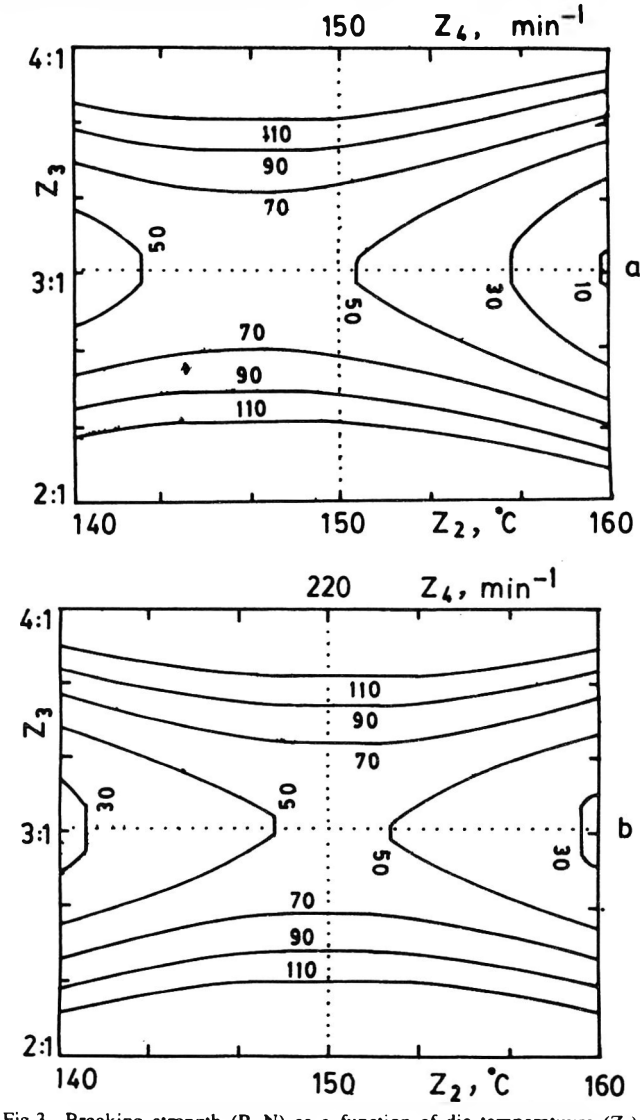

Fig.3. Breaking strength (P, N) as a function of die temperatuyre (Z_2), screw compression ratio (Z_3) and screw speed (Z_4): Z_4 in a = 150 min^{-1}; Z_4 in b. = 220 min^{-1}.

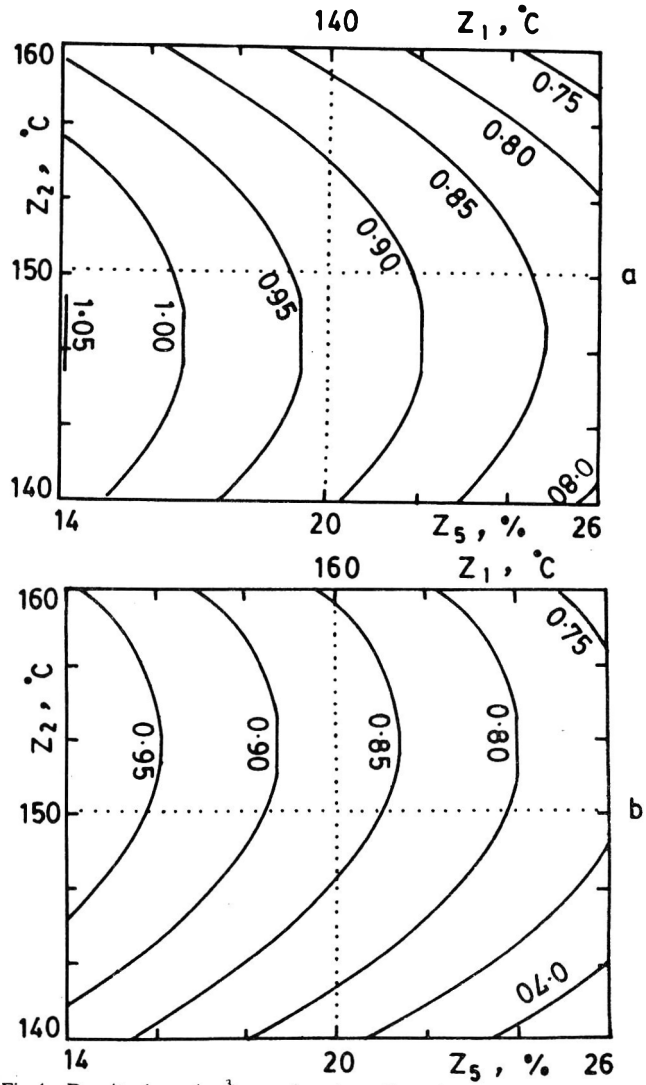

Fig.4. Density (ρ, g/cm^3) as a function of barrel temperature (die end) (Z_1, die temperature (Z_2) and feed moisture content (Z_5): Z_1 in a = 140°C; Z_1 in b = 160°C.

the optimum minimum towards higher die temperature side, while this zone was more near to low die temperature at lower screw speed level.

Thus, within the experimental area, at low screw speed level (150 min^{-1}), optimum texture was found to occur at die temperature of 147°C with screw compression ratio 3:1 (Fig, 3a).

In the other case, within the experimental area at high screw speed level (220 min^{-1}), optimum texture was found to occur at die temperature of 150°C with screw compression ratio 3:1 (Fig. 3b).

Effect on product density: Equation (13) shows the quadratic effect of die temperature on product density. Increasing moisture content from 14 to 20 per cent resulted in a less dense product (Fig. 4). Added moisture reduced the viscosity of texturized dough at the die allowing it to expand at a given discharge temperature.

Fig 4 illustrates that an increase in die temperature at low temperature level increased the product density, until a certain die temperature, which depends on barrel temperature (die end), was reached. At still higher die temperature level, the density was again decreased. An increase in barrel temperature (die end) decreased density.

Lowest product density within the experimental area was reached at a barrel temperature (die end) of 160°C and at a die temperature of 150 – 160° C with feed moisture content of 26 per cent (Fig. 4b).

Effect on product water absorption: Among the process parameters affecting water absorption, feed moisture level, screw speed and process temperature showed quadratic relationship (Eq 14).

Water absorption was decreased at high or low feed moisture contents and at high or low screw speeds, thus giving

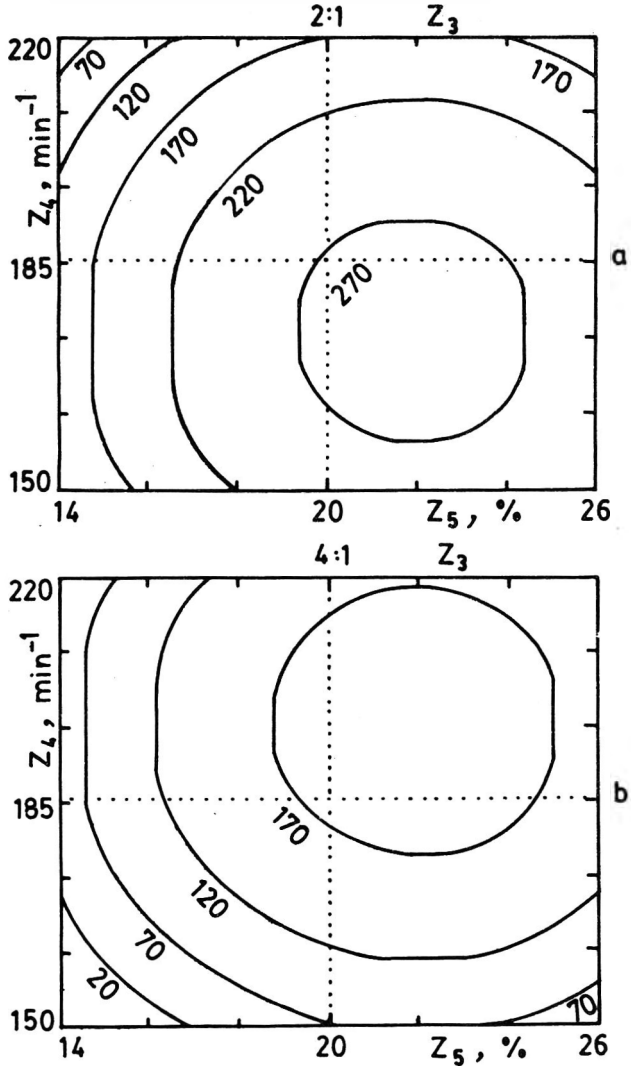

Fig.5. Water absorption (Wa, %) as a function of screw compression ratio (Z_3), screw speed (Z_4) and feed moisture content (Z_5; Z_3 in a = 2:1; Z_3 in b = 4:1; (Z_3 = 160°C, Z_2 = 160°C).

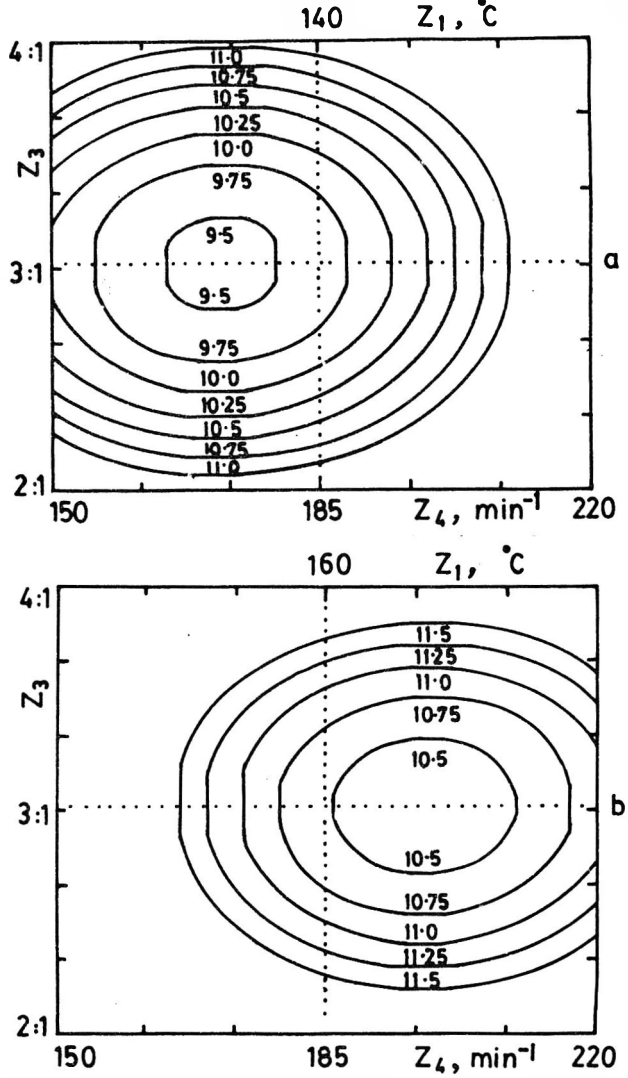

Fig.6. Colour difference between the extrudates and the raw material (ΔE) as a function of barrel temperature (die end) (Z_1), screw compression ratio (Z_3) and screw speed (Z_4): Z_1 in a = 140°C; Z_1 in b = 160°C; (Z_2 = 150°C).

rise to a target-shaped contour plot, at low screw compression ratio (2:1), with a central point of optimum water absorption (Fig. 5a). As screw compression ratio was increased to 4:1 the optimum water absorption area was shifted towards higher screw speed side keeping feed moisture unchanged (Fig. 5b).

Higher water absorption occurred at screw speed of 175 min^{-1}, feed moisture of 22 per cent, barrel (die end) and die temperature of 160°C respectively with screw compression ratio of 2:1 (Fig.5a).

Effect on product colour: Colour formation during processing can provide important information about the degree of thermal treatment. Colour is also an important quality characteristic of extruded foods.

Fig 6 describes overall extrusion process in terms of colour difference between extruded product and the raw material (the standard) i.e. the deviation of extrudate colour from the standard colour of the raw material. The colour difference was increased at high or low screw speeds and at high or low screw compression ratios, thus giving rise to a target-shaped contour plot, at low barrel temperature (die end), with a central point of optimum colour difference. As barrel temperature (die end) was increased, the optimum colour difference area shifted towards higher screw speed keeping screw compression ratio unchanged.

Equation (15) shows the significant quadratic effects of screw speed and screw compression ratio on colour difference between the product and the standard.

It is also clear from the Fig 6 that an increase of barrel temperature (die end) increased the colour difference between the product and the raw material.

Lowest colour difference within the experimental zone was occurred at a barrel temperature (die end) of 140°C with screw speed of 175 min^{-1} and with screw compression ratio of 3:1 (Fig. 6a).

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Studies on the Use of Garlic in Bread

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Dough properties of wheat flour with the addition of 2, 4, 6 and 8% garlic extract showed a gradual adverse effect on the strength of the dough. As the garlic extract increased from 0 to 8%, farinograph dough stability decreased from 5.0 to 3.0 min and mixing tolerance index increased from 80 to 160 BU while mixograph and extensograph area values decreased from 69.6 to 52.5 cm^2 and 192 to 53 cm^2 respectively. Bread with garlic flavour and without any deleterious effect on its quality could be made with 2% addition of garlic extract.

Bakery industry is one of the largest organized food industries in India. The bread constitutes almost 50 per cent of the total bakery products and it is equally popular both in urban and rural regions.[1] Though number of varieties of bread are available in the developed countries, the bread produced in the country is mainly white pan bread. However, there is a vast scope to diversify the production of bread with the introduction of variety breads to suit the Indian palate. This will augment the sustained growth of the industry. Use of vegetables and spices in bread formulation would help in the production of bread which can be consumed without any adjuncts.

Addition of garlic in bread formulation can result in a bread with familiar taste of the spice.

In this paper, studies relating to the effect of garlic on dough and bread making properties of wheat flour are presented.

Materials and Methods

Commercial refined wheat flour (*maida*) and garlic were procured from the local market.

Moisture, total ash, dry gluten, Hagberg's falling number, Zeleney's sedimentation value and damaged starch were estimated using standard AACC procedures.[2] Crude protein (N × 5.7) was determined by micro-Kjeldahl method. The flour colour was determined using Kent-Jones Flour Colour Grader.

Garlic extract was prepared by mixing 100 g of garlic and 100 ml of water in a Waring blender and filtering to remove fibrous material. The effects of garlic extract at levels of 2,4,6 and 8 per cent on rheological and bread characteristics of wheat flour were studied.

Farinograph, mixograph and extensograph characteristics were determined according to standard AACC procedures.[2]

Breads were prepared according to remix procedure of Irvine and McMullan[3] with a reduced fermentation period of 90 min for the dough instead of 165 min. Loaf volume was measured using rapeseed displacement method of Malloch and Cook[4]. Evaluation of breads was carried out for crust and crumb characteristics after 24 hr by a panel of six judges.

Results and Discussion

Chemical characteristics: The wheat flour had 0.49 per cent ash content, 8 per cent gluten, 477 falling number, 19 ml sedimentation value, 10.7 per cent damaged starch and 2.5 colour grade value. The values showed that the flour was of medium strength quality which fell in the range of typical values reported for Indian wheat flour by Shurpalekar *et al.*[5]

Farinograph characteristics: The data (Table 1) on dough properties indicated that increase in garlic extract from 0 to 8 per cent decreased water absorption by 0.4 per cent, while dough development time decreased marginally by 0.5 min. The dough stability decreased by 2.0 min and mixing tolerance index increased by 80 to 90 BU. However, the Valorimeter value decreased by only 4. The results indicated a decrease in the strength of the dough.

TABLE 1. EFFECT OF GARLIC EXTRACT ON FARINOGRAPH CHARACTERISTICS OF WHEAT FLOUR.

Garlic extract (%)	Water absorption (%)	Dough development time (min)	Dough stability (min)	Mixing tolerance index at 10 min (BU)	Valorimeter value
–	55.6	4.0	5.0	80	44
2	57.7	3.5	3.5	140	44
4	55.6	3.5	3.0	170	42
6	55.4	3.5	3.0	170	42
8	55.2	3.5	3.0	160	40

Mixograph characteristics: The results presented in Table 2 show decrease in peak time by 0.5 min and area by 17.1 cm^2. However, weakening angle increased by 25 to 29° and peak height by 0.7 cm with the addition of garlic extract by 2 to 8 per cent. The reduction in dough strength was comparatively higher due to severe mixing in mixograph compared to the gentle mixing in farinograph.

Extensograph characteristics: The dough properties (Table 3) during resting for 135 min showed that at 2 per cent level, resistance to extension increased from 375 to 580 BU initially and decreased thereafter to 200 BU as the extract increased to 8 per cent. Concurrently, the extensibility decreased from 160 to 106 mm and later on increased to 177 mm. However, the area decreased from 192 to 53 cm^2 showing gradual reduction in strength of the dough. The results indicated stiffening of the dough at 2 per cent addition of garlic extract and slackening at higher addition of the extract.

TABLE 2. EFFECT OF GARLIC EXTRACT ON MIXOGRAPH CHARACTERISTICS OF WHEAT FLOUR

Garlic extract (%)	Peak time (min)	Peak height (cm)	Weakening angle (°)	Area (cm^2)
–	3.5	6.0	5	69.6
2	3.0	6.1	35	62.7
4	3.0	6.2	34	59.6
6	3.0	6.5	32	57.8
8	3.0	6.7	30	52.5

TABLE 3. EFFECT OF GARLIC EXTRACT ON EXTENSOGRAPH CHARACTERISTICS OF WHEAT FLOUR

Garlic extract (%)	Resistance to extension-R (BU)	Extensibility E (mm)	Ratio figure R/E	Area (cm^2)
–	375	160	2.3	192
2	580	106	5.5	103
4	370	138	2.7	68
6	210	162	1.3	60
8	200	177	1.1	53

The reduction in strength of the dough with the addition of garlic extract recorded by different rheological instruments, may be attributed to the interchange reactions of thiols contributed by garlic with disulphide bonds of wheat flour proteins. The reduction in consistency and strength of dough due to thiol compounds was discussed by Bloksma[6]. Further, the derivatives of cysteine present in garlic could cause the reduction of wheat flour proteins thereby decreasing the strength of the dough. L. cysteine is used as a reducing agent in the bread production for lowering the mixing time[7]. Frater *et al.*[8,9] reported similar effect of cysteine on dough properties.

Bread making characteristics: The data (Table 4) on baking studies show that with the increase in the addition of garlic extract from 0 to 8 per cent, the specific loaf volume decreased from 3.53 to 2.95 ml/g. The crust shape gradually became flat and crumb grain turned to coarse and non-uniform. The texture changed from soft to hard. The garlic flavour was too pronounced beyond 6 per cent. At 2 per cent addition of garlic extract, the characteristics of bread namely, specific volume, crust shape, golden brown colour, fine and uniform crumb grain, soft texture were comparable to those of control. The bread had a typical garlic flavour.

The results indicated that bread having a typical garlic flavour and aroma and without any adverse effect on crust or crumb characteristics could be prepared with addition of 2 per cent garlic extract.

TABLE 4. EFFECT OF GARLIC EXTRACT ON THE QUALITY OF BREAD

Garlic extract (%)	Specific loaf vol (ml/g)	Crust shape	Crumb		Texture	Flavour	Eating quality
			Grain	Score			
–	3.53	Normal	Fine uniform	7.0	Soft	Normal	Normal
2	3.52	Normal	Fine uniform	7.0	Soft	Garlic	Normal
4	3.14	Normal	Coarse non-uniform	5.0	Slightly hard	Garlic	Normal
6	2.97	Slightly flat	Coarse non-uniform	4.0	Slightly hard	Pronounced garlic	Normal
8	2.95	Slightly flat	Coarse non-uniform	4.0	Hard	Pronounced garlic	Normal

The crust colour was golden brown in all treatments.

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Effect of Onion Extract on the Rheological and Bread Making Characteristics of Wheat Flour

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Effect of adding 5, 10, 20, 30 and 40% onion extract to wheat flour on rheological and bread making characteristics has been studied. In general, dough properties with respect to strength and gas retention capacity were adversely affected gradually as the onion extract content increased in the dough from 0 to 40% as was evident from decrease in dough stability from 5.5 to 3.5 min, valorimeter value from 40 to 36 and increase in the mixing tolerance index from 80 to 160 BU of farinograph and the decrease in area values of mixograph and extensograph from 70.6 to 60.5 cm^2 and 111 to 85 cm^2 respectively. Consequently, the specific loaf volume of bread decreased from 3.4 to 3.0 ml/g. Bread with onion taste can be prepared with 20% incorporation of onion extract as the specific loaf volume (3.3 ml/g), the medium fine crumb grain and soft crumb texture were comparable to those of control bread.

The bread industry in India has shown a sustained growth with increase in the production at the rate of 9.7 per cent per annum[1]. The steady increase in consumption of bakery products is due to their ready-to-eat convenience. The bakery products are popular in urban as well as rural regions among all sections of population. However, the bread produced in the country is mostly sandwich bread. Hence, diversification with the introduction of number of varieties will help in sustaining the growth of the industry.

Vegetables and spices are commonly used in various dishes and onion (*Allium cepa* L) is one of the most widely utilised ingredients in a number of Indian food preparations. The major value of onion lies in its flavour. With a view to introduce familiar flavour and bring in convenience so that bread can be consumed without any adjuncts, onion extract was used in the bread preparation. The studies on the effect of onion extract on the rheological and bread making characteristics of wheat flour are presented in this paper.

Materials and Methods

Commercial refined wheat flour (maida) and onions procured from the local market were used.

Total ash, Hagberg's falling number, Zeleny's sedimentation value and damaged starch were determined according to AACC procedures[2]. Crude protein (N x 5.7) was estimated by micro-Kjeldahl method. The flour colour was determined using a kent-Jones Flour Colour Grader.

The rheological and bread making characteristics of the flour, as influenced by the addition of onion extract replacing water at levels of 5, 10, 20, 30 and 40 per cent were studied. Onion extract was made by mixing the onion in a Waring blender and filtering to remove fibrous material. Farinograph, mixograph and extensograph characteristics were determined according to AACC procedures[2].

Breads were prepared according to remix procedure of Irvine and McMullan[3] with a reduced fermentation period of 90 min for the dough instead of 165 min. Loaf volume was measured using rapeseed displacement method of Malloch and Cook[4]. Evaluation of breads was carried out for crust and crumb characteristics after 24 hr by a panel of six judges.

Results and Discussion

Chemical characteristics: The chemical characteristics indicated that the flour used was of medium strength as shown by the values of protein (9.6 per cent), ash (0.58 per cent), sedimentation value (21.5 ml), damaged starch (10.8 per cent), falling number (233) and K.J. colour grade value (3.4).

TABLE 1. EFFECT OF ONION EXTRACT ON FARINOGRAPH CHARACTERISTICS OF WHEAT FLOUR.

Onion extract (%)	Water absorption (%)	Dough development time (min)	Dough stability (min)	Mixing tolerance index at 10 min (BU)	Valorimeter value
–	61.2	2.0	5.5	80	40
5	60.1	2.0	5.5	80	36
10	61.4	2.0	4.0	120	36
20	62.0	3.0	3.5	150	36
30	62.3	3.0	3.5	160	36
40	62.6	3.0	3.5	160	36

Farinograph characteristics: The dough properties studied using farinograph (Table 1) showed that with increase in onion extract from 0 to 40 per cent, water absorption and dough development time increased marginally from 61.2 to 62.6 per cent and 2.0 to 3.0 min respectively showing increase in mixing time requirements of dough. However, the decrease in stability from 5.5 to 3.5 min, valorimeter value from 40 to 36 and drop in consistency by 80 BU as shown by increase in mixing tolerance index from 80 to 160 BU indicated that the dough strength had decreased with the incorporation of onion extract.

TABLE 2. EFFECT OF ONION EXTRACT ON MIXOGRAPH CHARACTERISTICS OF WHEAT FLOUR*

Onion extract (%)	Peak time (min)	Peak height (cm)	Weakening angle (°)	Area (cm^2)
–	2.0	6.4	7	70.6
5	2.0	6.5	8	69.5
10	2.5	6.9	20	67.0
20	2.5	6.9	30	61.4
30	2.5	6.8	30	60.8
40	2.5	6.9	30	60.5

*Doughs based on farinograph water absorption.

TABLE 3. EFFECT OF ONION EXTRACT ON EXTENSOGRAPH CHARACTERISTICS OF WHEAT FLOUR

Onion extract (%)	Resistance to extension R (BU)	Extensibility E (mm)	Ratio figure R/E	Area (cm^2)
–	480	156	3.08	117
5	720	138	5.22	104
10	700	120	5.83	96
20	660	115	5.74	93
30	510	112	4.55	89
40	460	106	4.34	85

Mixograph characteristics: The data in Table 2 indicate that similar to farinograph dough properties, the mixing time requirement increased as shown by increase in peak time from 2.0 to 2.5 min and peak height from 6.4 to 6.9 cm. The strength of the dough decreased as shown by increase in weakening angle from 7 to 30° and decrease in area value from 70.6 to 60.5 cm^2 as the onion extract increased from 0 to 40 per cent.

Extensograph characteristics: The results (Table 3) show extensograph resistance to extension increased from 480 to 720 BU with 5 per cent and thereafter gradually decreased to 460 BU as the onion extract increased to 40 per cent. This indicates that dough exhibited short dough properties at lower levels and slackened afterwards with higher levels of onion extract in the dough. The extensibility and area values gradually decreased from 156 to 106 mm and 117 to 85 cm^2 respectively showing reduction in the strength of the dough.

The adverse effect on dough properties with increase in the level of onion extract may be attributed to the presence of thiols and derivatives of L-cysteine and their interaction with proteins of wheat flour. The effect of thiol compounds in reducing consistency and strength of dough was discussed by Blocksma[5]. Frater *et al.*[6,7] described the reducing effect of L-cysteine on the dough properties. Similar adverse effect on mixing stability was earlier reported by Shroeder and Hoseney[8] with the addition of compounds with activated double bond in the dough.

Bread making characteristics: The baking studies (Table 4) show that spectific loaf volume of bread decreased from 3.4 to 3.0 ml/g as onion extract increased from 0 to 40 per cent. However, at 20 per cent level the specific loaf volume was 3.3 ml/g. The normal crust shape, medium fine crumb grain, crumb score of 6.5 and soft crumb texture of bread were not affected upto 20 per cent incorporation of onion extract. The onion flavour was distinct at 10 per cent and increased further at 20 per cent level of addition of onion extract. Both at 30 and 40 per cent addition of onion extract, the crust shape

TABLE 4. EFFECT OF ONION EXTRACT ON THE QUALITY OF BREAD

Onion extract (%)	Specific loaf vol (ml/g)	Crust shape and colour	Crumb grain	Crumb score (Max. 8)	Crumb texture	Flavour	Eating quality
–	3.4	Normal and dark brown	Medium fine	6.5	Soft	Normal	Normal
5	3.4	Normal and dark brown	Medium fine	6.5	Soft	Normal	Normal
10	3.4	Normal and dark brown	Medium fine	6.5	Soft	Slightly onion	Normal
20	3.3	Normal and dark brown	Medium fine	6.5	Soft	Onion	Normal
30	3.2	Slightly flat and brown	Coarse	5.5	Slightly hard	Pronounced onion	Gummy
40	3.0	Slightly flat and brown	Coarse	5.5	Slightly hard	Pronounced onion	Gummy

was slightly flat, crumb grain was coarse, crumb score was 5.5 and crumb texture was slightly hard. The onion flavour was pronounced and crumb became gummy.

It can be concluded from the results that bread with onion flavour can be prepared without any deleterious effects on crust and crumb characteristics with 20 per cent addition of onion extract.

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Characteristics of *Puri* Dough and *Puri* Based on Wheat and Composite Flours

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Brabender farinograph, General Food texturometer and WB shear press have been successfully adapted for the first time to study objectively the quality characteristics of *puri* dough and *puri* based on *atta* (whole wheat flour)/*maida* (refined wheat flour) with or without upto 33% of flours from maize (*Zea mays*), Bengalgram (*Cicer arietinum*) and jowar (*Sorghum vulgare*). Optimum processing conditions for the preparation of dough of desired consistency and *puri* arrived at were: (1) water requirement of the dough based on (i) *atta*:67±2% (ii) *maida*: 52-54% and (iii) blends of *atta* and (a) maize or jowar flour: 63±1% and (b) Bengalgram flour *(Besan)* 60±1% (2) rolling of dough sheet to 2 mm thickness and 12.5 cm diameter yielding *puri* with full puffing (3) frying temperature and time: 180±2°C and 25-30 sec respectively. The texture and eating quality of *maida* based *puri* was inferior to that based on *atta*, but improved on incorporation of 5-10% bran; however its puffing was affected adversely. *Puri* of good overall acceptability could be prepared from composite flours based on wheat *atta* blended with maize / jowar flours at 15% level or with Bengalgram flour at 20% level.

Among the traditional wheat based meal or snack items of the Indian subcontinent, *puri* ranks second to *Chapati* or *roti*. As compared to baked *chapati* or *roti*, *puri* being a deep-fat fried product, has better keeping quality as well as acceptability, because of its lower moisture content and slower staling changes affecting the texture adversely. As such, *puri*, specially in spiced form, offers convenience to people travelling long distances by rail or road.

In general, *puri* is made from *atta* (whole wheat flour) dough containing small quantity of table salt. The dough pieces are made into round balls and rolled into circles of varying diameters and deep-fat fried in a convenient edible oil. In some regions, *maida* (refined wheat flour), processed in roller flour mills, is also used for *puri* making; but unless consumed hot, its texture as well as eating quality are considered inferior to that of *puri* based on *atta*.

Though extensive work has been carried out in several countries, on wheat based bakery products, such as bread, biscuit and cake, very scanty literature was available till eighties on the characteristics of traditional food item *chapati* and its dough[1-4]. However, scientific information on *puri*, is conspicuous by its absence.

Further, in many regions of the world, where *puri* is consumed, but wheat is not grown, blends of imported wheat flour with flours from locally grown maize (*Zea mays*), jowar *(Sorghum vulgare)* and Bengal gram *(Cicer arietinum)* can be used with advantage, more so, as *puri* cannot be made from any cereal / pulse flours other than wheat. With this background, the results of studies carried out on the characteristics of *puri* dough and *puri* based on wheat flour *(atta / maida)* and possibilities of using composite flours based on wheat flour blends with other cereal / pulse flours for *puri* making are presented in this paper.

Materials and Methods

Commerical varieties of medium hard wheat ('Bhojan samrat' — commonly used for chapati making), jowar, maize and Bengal gram were procured from local market and after manual cleaning were ground in a disc mill (*Chakki*) to obtain flours passing through 60 mesh (250 μ) sieve in case of wheat, jowar and Bengal gram; maize being harder grain yielded flour of only 40 mesh (420 μ). Different composite flours were prepared by blending 90, 85, 80, 75 and 67 parts of wheat *atta* 10, 15,20,25, and 33 parts of other cereal / pulse flours respectively.

Maida used was milled from 'Bhojan samrat' wheat, conditioned overnight to 15.5 per cent moisture, in a laboratory roller mill (Model: Buhler MLU 302). Wheat bran obtained from a local roller flour mill was toasted at 105°C for 1 hr and finely ground to 60 mesh in laboratory Kamas mill (Model: Slaggy 200 A) using a sieve of 0.8 mm aperture. A commercial brand of refined groundnut oil and table salt were procured locally.

Chemical characteristics of flours: Standard AACC[5] methods were used for the estimation of moisture and ash. Micro - Kjeldahl method was used to estimate total nitrogen.

Ether extractives were estimated by Soxhlet extraction, using petroleum ether (B.P. range: 60 - 80°C).

Sieve analysis: Sieve analyses of different flours were carried out in a Buhler Plansifter (Model MC 41 K8) to determine yields of desired particle size flours suitable for blending into composite flours.

Characteristics of puri *dough:* Dough forming characteristics of *atta, maida* and composite flour blends based on maize, Bengal gram and jowar were studied using Brabender farinograph according to AACC procedure with minor modification (using lever position 1:3, instead of 1:1). Based on preliminary trials using Hobart mixer (Model N-50, position 1 i.e 58 rpm, period 2-3 min), water level used for making the *puri* dough, which could be rolled easily, ranged from 60 to 71 per cent. Since the sigma type blade of farinograph mixer brings about more intimate mixing, as compared to Hobart mixer with planetary motion of the beater arm, all the farinograph dough characteristics of composite flours with respect to development time, stability and consistency were carried out using 60 - 63 per cent water (on the basis of preliminary trials) to avoid stickiness.

Preparation of puri: The ingredients used for preparation of *puri* were 200 g *atta* or *maida* or composite flours (on 14 per cent moisture basis) and 2 g table salt with varying quantities of water: (i) *atta* 65 - 71 per cent , (ii) *maida* 48-60 per cent (iii) *atta* with maize / jowar flour 63 per cent, and (iv) *atta* with Bengal gram flour 60 per cent.

The consistency of different *puri* doughs prepared in the Hobart mixer was measured on a General Food Texturometer (Model GTX) under the optimised conditions (Plunger - 20 mm, cup-aluminium, voltage - 1 volt, clearance - 2 and speed - low). The texturometer curves were evaluated for hardness (compressibility) and stickiness.

Rolling and frying of puri: Dough was cut into 20 - 25 g pieces, rounded and placed in the centre of a specially fabricated square shaped aluminium platform[6]; aluminium frames of varying thicknesses were used for maintaining uniform thickness; 1.5 and 2.0 mm thick frames found optimum, were chosen for further studies. The dough piece rolled into 1.5 or 2.0 mm sheet with a wooden rolling pin was cut into a circle of 8.5-9.0 or 12.5 cm diameter respectively, using a sharp disc cutter and was removed from the platform by a stainless steel spatula.

Frying trials of *puri* were carried out in an aluminium pan using refined groundnut oil in the temperature - time ranges of 170-195°C and 20-40 sec to arrive at optimum conditions.

Evaluation of puri: The puris were evaluated for different quality parameters, such as height on puffing, moisture content, oil pickup, WB shear value and also sensory parameters like appearance (based colour, oiliness and shape), texture, eating quality and overall acceptability by a panel of six experienced judges.

WB shear values: Fried *puri* was folded to have four layers and placed in the centre of single conical blade provided on the WB shear press and the shear values were recorded in triplicate.

Overall acceptability: The panel members were requested to grade the samples of *puris* as +, ++ and +++ on the basis of puffing height, appearance, texture, eating quality and overall acceptability (Table 5).

Results and Discussion

Proximate composition and sieve analysis: The results presented in Table 1 highlight the low, medium and high protein contents of jowar/maize, wheat and Bengal gram flours respectively. Bengal gram flour, when used for blending, improves qualitatively as well as quantitatively the nutritive value of foods based on cereals flours. Such blend is being used for *roti* making in some North Indian States, while use of jowar/maize for blending has considerable scope for *puri* making in several African countries, where wheat is not grown.

The data collected on the sieve analysis of different flours showed that nearly 87-97 per cent of wheat, Bengal gram and jowar flours passed through 60 mesh, which is generally considered as desired fineness for their utilisation in foods or for easy blending. In contrast, over 40 per cent of flour from the hard grain of maize was retained over 60 mesh. However, for economic utilisation, 88 per cent of maize flour passing through 40 mesh was used for blending.

1. *Puri* based on *atta/maida*

Preparation of puri *based on* atta: On the basis of preliminary frying trials to study the effect of (i) water level used for the preparation of different doughs based on *atta* and (ii) thickness of dough sheet used for rolling *puri*, the optimum conditions of time and temperature were in the range of 25-30 sec and 180±2°C.

Results of the preliminary trials showed that *puris* with thickness of 2.0 and 1.5 mm and with diameters of 12.5 and 8.5-9.0 cm respectively had satisfactory puffing, caused by instant conversion of moisture into steam and its consequent expansion between the layers of the *puri*.

It can be seen from Table 2 that, as the quantity of water used for preparation of *atta* dough increased (65-71 per cent), the oil pick-up by *puris* also increased (29.1-34.4 per cent),

TABLE 1. PROXIMATE COMPOSITION OF DIFFERENT FLOURS

Flours	Moisture (%)	Total ash (%)	Protein* (%)	Ether extractives (%)	Carbohydrates (by diff.) (%)
Wheat (*atta*)	11.50	1.64	12.56	1.72	72.58
Maize	8.82	1.72	8.02	3.64	77.80
Jowar	8.35	1.91	8.23	1.85	79.66
Bengal gram	7.53	1.32	22.37	1.23	67.55

*N x 5.7 for wheat and N x 6.25 for maize, jowar and Bengal gram

TABLE 2. EFFECT OF WATER USED IN THE DOUGH AND SHEET THICKNESS ON THE QUALITY OF *PURI*[1] BASED ON *ATTA*

Water used (%)	Thickness of dough sheet (mm)	Height on puffing (cm)	Moisture in *puri* (%)	Oil pickup in *puri* (%)
65	2.0[+]	5.2	25.40	29.72
67	2.0[+]	5.5	22.64	29.75
69	2.0[+]	5.5	22.50	32.47
71	2.0[+]	5.6	20.51	34.37
65	1.5[@]	4.0	25.57	29.11
67	1.5[@]	4.0	20.56	31.17
69	1.5[@]	4.2	19.67	32.61
71**	–	–	–	–

[1]Frying-temperature: 180±2°C; time 25-30 sec.

[+]Diameter of *puri* 12.5 cm; [@]Diameter of *puri* 8.5-9.0 cm

**Continuous dough sheet of 1.5 mm thickness could not be obtained.

while the moisture content of the *puri* decreased (25.6-19.7 per cent). This contributes to crisp texture and better eating quality of *puri*. A level of 65-67 per cent of water was considered as optimum for making a dough yielding highly acceptable *puris*. Further, puffing was better, when the dough sheet thickness was 2.0 mm as compared to 1.5 mm. At the same level of water used for dough making, thickness of the dough sheet (1.5-2.0 mm) had no marked effect on the oil pick-up of *puris*. (Table 2). On the other hand, the oil pick-up of *puris* showed significant diffrences (29.1-34.4 per cent), when water level used, varied from 65 to 71 per cent.

Preparation of puri *based on* maida: The data presented in Table 3 show that for dough making, addition of water in the range of 48-56 per cent had no marked effect on the moisture content (19.1-21.2) per cent) or the oil pick-up (25.5-28.7 per cent) in *puris* of same thickness. However, puffing was lesser in 1.5 mm thick *puris*, as compared to *puris* of 2.0 mm thickness. It is interesting to note that water required for dough making as well as the oil pick-up in *atta* based *puris* (Table 2) were comparatively higher than those based on *maida*. This may be attributed to the presence of most of the wheat bran retained in *atta*, unlike in case of roller milled *maida*.

TABLE 3. EFFECT OF WATER USED IN THE DOUGH, SHEET THICKNESS AND INCORPORATION OF BRAN ON THE QUALITY OF *PURI** BASED ON *MAIDA*.

Water used (%)	Bran added (%)	Thickness of dough sheet (mm)	Height on puffing (cm)	Moisture in *puri* (%)	Oil pickup in *puri* (%)
48	–	2.0	5.3	20.6	26.72
52	–	2.0	5.3	19.7	27.01
56	–	2.0	5.4	19.2	28.72
48	–	1.5	4.3	21.2	25.50
52	–	1.5	4.4	20.2	26.41
56	–	1.5	4.7	19.1	27.01
54	5	2.0	4.3	26.2	28.1
60	10	2.0	4.8	27.5	29.7
54	5	1.5	3.4	26.7	28.6
60	10	1.5	3.7	27.8	30.2

*Frying-temperature: 180 ± 2°C; time : 25-30 sec.

As traditionally *atta* is used for *puri* making, it was considered worthwhile to study the effect of incorporation of 5-10 per cent bran in the *maida* based dough on the quality profile of *puri*. The results (Table 3) indicated adverse effect on puffing and increase in the oil pick-up (28.1-30.2 per cent). Also, the moisture content of *puris* based on *maida* (19.1-21.2 per cent) was markedly lower than that of the *puris* containing added bran (26.2-27.8 per cent).

2. Effect of incorporating maize/Bengalgram/jowar flours on the characteristics of *puri* dough based on *atta*

Farinograph consistency: The results presented in Table 4 and Fig.1 and 2 highlight the following: As the level of

TABLE 4. EFFECT OF INCORPORATING MAIZE, BENGALGRAM AND JOWAR FLOURS ON THE CHARACTERISTICS OF *PURI* DOUGH[a] BASED ON *ATTA*

Flour (%)	Farinograph			Texturometer		Sheeting[1]
	Consistency (BU)	Dough development time (min)	Dough stability (min)	Hardness (kg/volt)	Stickiness (kg/volt)	
			Atta			
100	550	5.5	0.5	3.45	1.05	+++
			Maize			
10	480	6.5	6.0	3.35	1.05	+++
15	455	8.0	9.0	2.95	1.10	+++
20	410	10.5	10.5	2.85	1.25	+++
25	390	9.5	9.5	2.80	1.30	++
33	370	9.0	9.0	2.75	1.35	++
			Bengalgram			
10	550	4.5	6.50	2.80	1.30	+++
15	610	2.5	1.25	3.40	1.45	+++
20	720	2.0	1.50	3.15	1.55	++
25	710	2.0	1.50	2.90	1.55	++
33	700	1.5	1.75	2.70	1.65	+
			Jowar			
10	475	6.5	3.5	2.35	1.10	+++
15	450	7.0	4.5	2.25	1.20	+++
20	410	7.5	5.0	2.10	1.25	+++
25	380	7.5	6.5	2.00	1.35	++
33	370	8.0	7.5	1.90	1.40	+

[a]Water used for dough based on *atta* (control): 67% and *atta* blended with maize/jowar/flours: 63% and with Bengalgram flour: 60%

+++ Easy
++ Somewhat difficult
+ Difficult

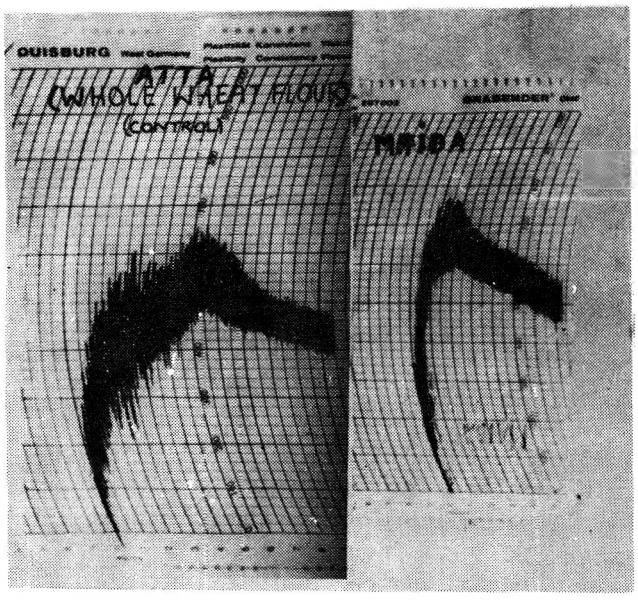

Fig 1. Farinograph characteristics of *atta* (whole wheat flour) and *maida* (refined wheat flour) based *puri* doughs containing 67 and 54% water, respectively.

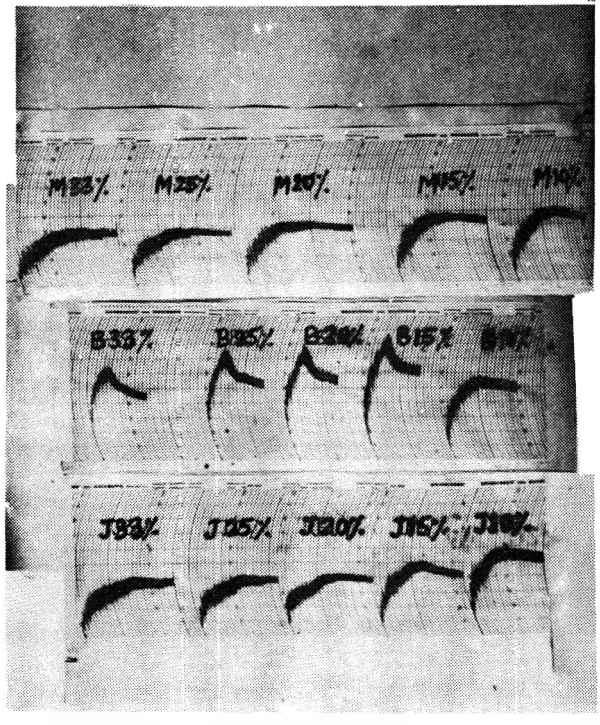

Fig 2. Farinograph characteristics of *atta* based *puri* doughs containing 63% water and varying levels (10-33%) of maize, Bengalgram and jowar flours.

blending with *atta* increased from 10 to 33 per cent of different flours, the farinograph consistency of doughs containing jowar or maize decreased considerably from 480 to 370 BU, while in doughs with Bengal gram, it increased from 550 to 700 BU.

In maize flour blends, the dough development time as well as stability changes were somewhat erratic (values increasing upto 20 per cent level of blending and then decreasing), possibly due to its relatively coarse and non-uniform particle size distribution. However, the dough development time recorded steady but lower increases, while the stability improved markedly in jowar flour blends. Such changes were significant with marked decrease in values for the blends containing 15-33 per cent of Bengal gram flour. In both the cases of jowar and maize blends, the dough stability was markedly higher as compared to Bengal gram flour blends.

Texturometer characteristics: As regards texturometer hardness of dough expressed as Kg/volt, the values were somewhat comparable in case of doughs containing maize (3.35-2.75) and Bengal gram (3.40-2.70) flours and were considerably lower in case of jowar (2.35-1.90) based doughs. In contrast to the pattern of hardness, stickiness pattern was comparable in doughs containing jowar (1.10-1.40) and maize (1.05-1.35) flours, while doughs containing Bengal gram flour recorded higher values (1.30-1.65) and were comparatively difficult to roll.

Sheeting characteristics: Dough containing upto 20 per cent of maize or jowar flour and upto 15 per cent of Bengal

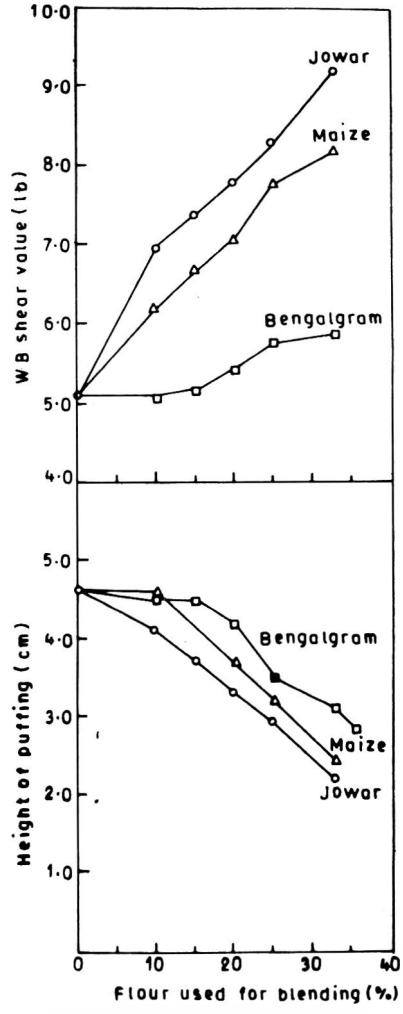

Fig 3. Puffing quality (height) and texture (WB shear value) characteristics of *puris* based on composite flour doughs containing varying levels (10-33%) of maize, Bengalgram and jowar flours.

gram flour could be rolled easily, while those with 33 per cent Bengal gram or jowar flour were difficult to roll.

3. *Puris* based on composite flours

Quality profile: The data on the effect of incorporating 10-33 per cent of maize, Bengal gram and jowar flours in wheat *atta*, on the puffing quality (Fig.3) and sensory parameters of *puri*, as evaluated by the panel of judges are presented in Table 5.

Puffing quality: Puffing of *puris* is an important quality parameter, as it improved appearance and consumer appeal. Puffing quality was rated as very good, satisfactory and fair for puffing height values of 5.0, 4.0 and 3.0 cm respectively. Incorporation of maize, Bengal gram and jowar flours in *atta* at 15, 20 and 10 per cent levels respectively yielded fully puffed *puris* with a rating of very good. Puffing was satisfactory upto 20 per cent level of incorporation of maize or jowar flours.

Appearance: Appearance of *puris* was rated as good or very good in case of all *puris* except those containing 33 per cent maize or jowar flour. Texture of all *puris* containing upto 20 per cent of different flours was soft and good. Bengal gram flour at 20 per cent level and maize and jowar flours at 15 per cent levels yielded *puris* of good eating quality. Beyond 25 per cent level of incorporation, *puris* were unacceptable, because of the prominent flavour of the flour used.

Texture: A comparison of texture values, as recorded on WB shear press indicated that *puris* containing Bengal gram flour varied in the narrow range (5.1-5.9 lb) and had better texture than that of *puris* containing maize (6.43-8.16 lb) or jowar (7.02-9.20 lb) flour respectively.

Overall acceptability: Finally, taking into consideration the comparative grading of different quality parameters, it could be concluded that *puris* of good overall acceptability could be obtained from composite flours based on wheat *atta* incorporated with maize/jowar flours at 15 per cent level and Bengal gram flour at 20 per cent level.

The findings of the studies on utilisation of composite flours have considerable scope for *puri* consuming population in some regions of the world, when wheat products are imported.

TABLE 5. EFFECT OF INCORPORATING MAIZE, BENGALGRAM AND JOWAR FLOURS ON THE QUALITY AND ACCEPTABILITY OF *PURI*[1] BASED ON *ATTA*

Flour (%)	Height on puffing (cm)	Puffing[2]	Appearance[3]	Texture[4]	Eating quality[3]	Overall acceptability[5]	WB shear value (lb)
			Atta				
100	5.6	+++	+++	+++	+++	+++	5.12
			Maize				
10	5.6	+++	+++	+++	+++	+++	6.43
15	5.1	+++	+++	+++	+++	+++	6.70
20	4.7	++	+++	+++	++	++	6.92
25	4.1	++	++	++	++	+	7.80
33	3.3	+	+	++	+	+	8.16
			Bengal gram				
10	5.5	+++	+++	+++	+++	+++	5.13
15	5.4	+++	+++	+++	+++	+++	5.22
20	5.1	+++	+++	+++	+++	+++	5.43
25	4.3	++	+++	++	++	++	5.61
33	3.9	+	++	++	+	+	5.93
			Jowar				
10	5.1	+++	+++	+++	+++	+++	7.02
15	4.9	++	+++	+++	+++	+++	7.41
20	4.7	++	+++	+++	++	++	7.75
25	3.8	+	++	++	++	++	8.25
33	3.1	+	+	+	+	+	9.20

[1]Frying-temperature: 180±2°C; time 25-30 sec
Water used for dough based on *atta*: 67% and *atta* blended with maize/jowar flours: 63% and with Bengal gram flour: 60%

[2]+++ Full
++ Partial
+ Non uniform and somewhat flat

[3]+++ Very good
++ Good
+ Fair

[4]+++ Soft
++ Somewhat soft
+ Slightly hard

[5]+++ Highly acceptable
++ Acceptable
+ Just acceptable/ Not satisfactory.

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Quality Characteristics of Pork Sausage Containing Mushroom *(Pleurotus tuber-regium)* and Local Spices

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The effects of incorporating *usu* mushroom (*Pleurotus tuber-regium*) flour and local spices [*uziza* or West African black pepper (*Piper guinensis*) *ehuru* or West African nutmeg (*Monodora myristica*) and *uda* or Ethiopian pepper (*Xylopia aethiopica*)] on the quality of cooked pork sausage were studied. Cooked pork sausages supplemented with 0-25% of *usu* mushroom flour were evaluated. Results revealed that *usu* mushroom incorporation increased cooking yield and ash content but decreased fat, protein, juiciness, colour, flavour and cohesiveness slightly. Objective textural evaluation with the Instron corroborated sensory results. The local spices did not affect sausage composition but produced acceptable and specific sausages. *usu* mushroom incorporation up to 25% produced acceptable sausage.

With shortage of animal protein, vegetable products have continued to be incorporated into processed meat products to reduce cost and to generate products with specific characteristics. *Usu* mushroom which is widely grown is much cheaper than meat and thus makes its incorporation into meat meaningful. Soybean, potato, sunflower and melon seeds have been used in sausage production with success[1-5]. Some of these extenders possess unique functional properties relating to increased emulsion capacity, cooking yield, flavour, and slicing characteristics[6,7]. Food proteins play essential functional role in sausage manufacture when they form stable emulsions[8]. When vegetable protein products are incorporated into sausages, they play functional as well as nutritional roles.

Mushrooms have been used by man for generations. *Usu* mushroom *Pleurotus tuber-regium* is widely grown in South-eastern Nigeria. Unlike common mushrooms, it grows underground and has no stem. In this part of Nigeria, *usu* mushroom is used in soup and *egusi* or melon seed ball preparations.

In food product development, cultural food selection has often restricated the use of spices to culturally accepted commodities. Tested local flavours have an edge over 'foreign' flavours in improving the acceptability of new products. The purpose of this work was to investigate the effects of incorporating *usu* mushroom and some local spices on the quality of cooked pork sausage.

Materials and Methods

The pork meat from the rump was purchased from a local slaughter house. The skin was trimmed off and frozen to facilitate grinding. The pork meat was then ground initially to pass through 4.8 mm plate and finally through 3.2 mm plate.

Fresh *usu* mushroom (*Pleurotus tuber-regium*) was procured from the local market, peeled and ground to pass sieve apperture of 90 microns. The spices (*uziza)* seed or West African black pepper (*Piper guinesis,*) *ehuru* or West African nutmeg (*Monodora myristica*) and *uda* Ethiopian pepper (*Xylopia aethiopica)* were purchased from the local market. The *ehuru* was first roasted before grinding to pass through sieve of 312 microns. The other spices (*uziza* seed and *uda*) were separately ground into same particle size. Onions and paprika were ground with Kenwood kitchen centre.

Pork sausages containing 0,5,10,20 and 25 per cent *usu*, 3 g salt, 1 g paprika, 4 g onion, and 0.5 g of appropriate spice per 100 g meat and varied amounts of ice were formulated for each flavour. The water absorption capacity was determined according to the methods of Akobundu *et al*[9]. The amount of ice was based on 3.2 ml/g absorption capacity for *usu* mushroom flour. The other ingredients were added to the ground pork and blended for 10 min. The blend was then stuffed into artificial casing (U.A.C Foods, Lagos) and water cooked at 105°C for 2 hr using the All-American pressure cooker (Model 915) at low flame setting on a gas cooker. The sausages were cooled with cold water and stored in a refrigerator prior to analyses while samples for sensory evaluation were served warm.

Proximate composition of sausage samples were determined[10]. The percentage cooking yield was evaluated according to the method of Akobundu[5].

Objective textural measurement using the Instron Universal Testing instrument (Model 1122) was performed on 7 x 7 x 1 cm sausage samples at 18°C without the casing. A load cell of 50 kg, crosshead speed of 50 mm per min and a chart speed of 100 mm per min was used. The sample was placed lengthwise on a base plate and first compressed by a plunger before being extruded through the base plate holes of 6 mm diameter. The steel plunger had a square base 7.0 x 7.0 cm. The extrusion was taken as the shear action. The strain was calculated from the force-extension curve. The extension (mm) was divided by the original sample thickness and defined as the strain, while the stress was defined as the corresponding force divided by the area. The slope of the stress-strain curve was defined as the modulus.

Sensory evaluation of the sausages was performed using a 30-number untrained panel. The sausages were served warm with 50 g sample presented to the panelists at random. Quality attributes of colour, flavour, juiciness, and texture were examined on a 7-point scale where 7 = excellent, 6 = very good, 5 = good, 4 = fair, 3 = poor, 2 = very poor, and 1 = unacceptable.

Results and Discussion

Results indicated a drop in both the moisture and fat contents of pork sausages extended with *usu* mushroom (Table 1). There was reduction of both moisture and fat as the level of *usu* mushroom increased. The reduction in moisture level was related to the low water absorption capacity of 3.2 ml/g determined for *usu* mushroom. Similarly, the drop in fat content of the supplemented sausage was due to the low fat content of *usu* mushroom. The lower fat content of supplemented pork sausage confirmed earlier reports that incorporation of low-fat meals into processed meat products reduced their fat content[1,11].

Protein content of the extended pork sausage decreased as the level of *usu* mushroom flour increased but the decrease was not appreciable. The all-pork sausage contained 12.66 per cent protein but the supplemented samples had slightly lower values (Table 1). The decrease in protein content was due to dilution effect of *usu* mushroom which was reported to contain 10.5 per cent protein[12]. The ash content of the *usu* mushroom supplemented pork sausage increased progressively to 4.51 in the 25 per cent mushroom supplemented sample. (Table 1). The results are in agreement with those of some researchers who observed decreased shrinkage and increased product yield when vegetable products replaced meat[8,13,14].

Sensory properties of *usu* mushroom supplemented pork sausages are presented in Table 2. Generally, the quality attributes of supplemented samples decreased as the level of *usu* mushroom increased. However, the reduction for most attributes was slight. The reduction in juiciness of supplemented sausages was related to the reduced fat content observed in Table 1. The results reinforced the observations of other investigators[5,15] who reported that juiciness of processed meat products was influenced by fat content.

The panel observed that texturally, the *usu* mushroom supplemented sausages were progressively harder than the all-pork control. Similarly, Slinde and Martens[16] reported increased hardness and less juiciness when blood replaced meat in sausages. Perception of texture or tenderness in meat products is dependent on juiciness[17]. It is, therefore, not surprising that the texture followed the pattern of juiciness (Table 2). Results of *usu* mushroom incorporation made the pork sausage drier and less cohesive. Samples with 25 per cent *usu* mushroom incorporation were appreciably different from the control.

TABLE 1. MEAN VALUES* FOR PROXIMATE COMPOSITION AND YIELD OF SAUSAGES

Sausages Pork : 'Usu'	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	% yield
100 : 0	64.03	12.66	21.03	1.01	42.9
95 : 5	63.20	12.50	20.70	2.00	45.3
90 : 10	67.80	12.34	20.10	2.75	64.3
85 : 15	62.30	12.25	19.95	3.10	73.4
80 : 20	60.90	12.20	19.80	3.80	81.4
75 : 25	60.50	12.02	19.60	4.51	90.7

*Average of three determinations.

TABLE 2. MEAN ACCEPTANCE LEVEL (%) OF MUSHROOM IN PORK SAUSAGE

Mushroom level (%)	Colour	Flavour	Texture	Juiciness
West African black pepper flavoured (uZ:Za)				
0	5.30	5.80	5.00	5.63
5	5.20	5.60	5.13	5.50
10	5.81	5.17	5.07	5.33
15	5.21	4.27	4.97	5.43
20	5.13	4.00	4.97	5.30
25	5.87	3.80	4.93	5.27
West African nutmeg flavoured (eburu)				
0	5.77	6.13	5.87	5.73
5	4.83	5.53	5.47	5.40
10	5.10	5.03	5.03	5.43
15	5.13	5.00	5.00	5.30
20	5.17	5.13	4.77	5.00
25	5.17	4.67	5.13	5.20
Xylopia aethiopica flavoured				
0	5.33	6.00	5.60	5.83
5	5.03	5.07	5.37	5.30
10	5.07	5.00	5.17	5.20
15	5.00	4.97	5.07	5.33
20	5.00	4.97	5.00	5.33
25	5.37	4.97	4.33	5.27

The flavour of sausages supplemented with *usu* mushroom decreased slightly as the level increased. However, the supplemented sausages were still acceptable up to 25 per cent *usu* mushroom supplementation. The bland taste of *usu* mushroom accounted for the lower scores at higher levels of supplementation.

The local spices contributed positively to the acceptance of the finished product. Although the flavour scores were not significantly different, *uziza* (Table 2) scored highest, closely followed by *uda* and *ehuru*. The important contribution of these local spices was the production of specific and distinct sausage products.

The colour of processed meat is influenced by the level of red pigments initially present[18]. In sausages supplemented with *usu* mushroom, the colour score was lower than the all-pork sample. The lighter colour of supplemented pork sausage was caused by the dilution effect of white *usu* mushroom flour. Similar results were reported for processed meat supplemented with vegetable products[19].

Both the compressive and shear moduli as measures of texture increased as the level of *usu* mushroom increased in the sausage (Table 3). In other studies[5,20], incorporation of non-meat components in sausage yielded products with lower textural scores. Although the taste panel that evaluated the samples was untrained, the result on texture was in agreement with objective measurement (Table 3). The effect of incorporating non-meat material on the texture of processed meat could be product-specific with materials of low fat content yielding harder and less cohesive product. To prepare products that do not differ substantially from the control only small quantities of non-meat materials should be incoporated into processed meat products.

It is concluded that *usu* mushroom can replace meat in pork sausage manufacture but not about 25 per cent supplementation. Local spices can also be incorporated to produce acceptable and specific sausages.

TABLE 3. CHANGES IN MODULI OF SAUSAGES

Sausages Pork : *Usu*	Compressive modulus (N/m^2)	Shear modulus (N/m^2)
100 : 0	37.778	18.056
95 : 5	58.824	20.313
90 : 10	71.429	23.108
85 : 15	77.778	25.000
80 : 20	85.185	29.545
75 : 25	86.667	31.667

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Effects of Two Skinning and Curing Methods on the Quality of Rabbit Meat

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Thirty two rabbit carcasses were assigned to four treatment groups to study the effect of skinning and curing methods on quality and yield of cured rabbit meat. No significant difference was observed in weight loss between unskinned non-injected and skinned injected cuts after aging except in the leg cut. Loss in weight was greatest during the first week of aging and was least during salt equalization and, during the last week of aging. Both skinning and curing methods significantly affected the proximate composition and chloride content of the aged meat but had no effect on the final pH. Brine injection significantly affected the salt content and tenderness of the rabbit meat. However, differences were not discernible in the other sensory indices.

The preservation of meat by curing has been reported to be particularly useful in the tropical developing countries especially in the dry rural areas[1]. Preservation of meat by curing was originally effected by sprinkling salt on the meat surface and later by brine immersion. More recently vascular pumping, stitch pumping and multiple needle injection of salt solution has been employed to hasten the curing process. Kemp and Fox[2] as well as Kemp *et al*[3] have reported that needle tenderization of ham accelerated salt absorption and shortened curing time. Skinning has also been employed as a means of reducing curing time. However, skinned hams have significantly higher weight losses and salt content than unskinned hams on processing[4]. Although little information is available concerning the use of rabbit meat for processing by curing and smoking, it has been reported that an acceptable product could be obtained by hot curing of pre-rigor rabbit carcasses without the need for refrigeration in the processing stage[5]. Large scale production of herbivores such as rabbit has been suggested for rapidly increasing meat demand in developing countries and widespread distribution to urban and rural areas can be carried out cheaply and more efficiently following the curing and smoking processes.

The effects of two methods of dressing and two methods of curing rabbit meat on its chemical composition as well as physical and sensory properties are reported in this paper.

Materials and Methods

The 32 New Zealand white rabbits used in this study were between 2.0 and 2.5 kg live weight. They were slaughtered in groups of eight rabbits in each of four replications. They were scalded and the fur was removed. The rabbit carcasses were eviscerated, washed and chilled overnight at −1°C. The chilled carcasses were randomly assigned equally to the following four treatments.

Skinned non-injected (SNI): The rabbit carcasses were skinned, then cut into four primal cuts including the leg, shoulder, loin and rib cuts. A dry curing mixture containing salt (78 per cent), sugar (20 per cent), sodium nitrate (1.3 per cent) and sodium nitrite (0.7 per cent) was applied uniformly to the cuts at the rate of 80g per kg meat (8 per cent W/W) per application in three applications at two days intervals. The total curing time was for seven days at −1°C.

Unskinned non−injected (UNI): This treatment was essentially the same as the first treatment except that the carcasses were not skinned before cutting into primal cuts and dry salting.

Skinned injected (SI): The rabbit carcasses were skinned and fabricated into the four primal cuts. The skinned cuts were first injection-pumped 8 per cent by weight with a curing brine containing salt (50g), sugar (15g) and sodium nitrite (2g) per litre of solution followed by a dry curing process as in the first treatment.

Unskinned injected (UI): This treatment was the same as the third treatment; but that the carcasses were not skinned before cutting into primal cuts brining and dry salting.

Processing yields: After curing for seven days at −1°C, all primal cuts were rinsed of excess salt and held an

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additional two days at −1°C for salt equalization. All cuts were subsequently smoked at 40−44°C for 6 hr in an experimental smoke chamber. After smoking, cuts from one of the two carcasses in each replicated treatment were evaluated for proximate composition, pH and shear values.

Cuts from the other rabbits in each group were held at room temperature (27±2°C) for four weeks in an open wooden box protected with wire gauze for drying. At the end of four weeks of aging, these cuts were evaluated for proximate composition as well as for physical and chemical properties. Cuts were weighed at each processing step to determine respective weight losses.

Physical and proximate properties: Proximate analysis was carried out on meat from the *Longissimus dorsi* on one side of the loin. Total moisture content was measured by weight difference after drying[6]. Fat, protein and ash were also determined while salt accumulation was determined as chloride[7]. For pH measurement, 10g of ground meat sample was homogenized in 100 ml of distilled deionised water. The pH was measured with the MINISI pH meter, model 8000.

Shear force measurement: Tenderness score was measured on a 1.27 cm diameter core sample of *Longissimus dorsi* taken in the fibre direction from the other half of the loin using a Warner Bratzler meat device[8].

Sensory evaluation: Meat from the aged rabbit legs from each treatment was cut into bite size samples and were subsequently evaluated by a ten − member sensory evaluation panel. Samples were scored on a 9-point Hedonic scale ranging from 1 for dislike extremely (flavour, overall acceptability), extremely dry (juiciness), extremely tough (tenderness), extremely white (colour), extremely salty (saltiness) and abundant (smokiness) to 9 for like extremely for flavour and overall acceptability, extremely juicy, extremely tender, extremely pink, extremely tasteless and devoid of smokiness respectively. Reconstituted whole powdered milk was used to rinse the month after each evaluation to avoid carry over flavour.

The data collected were subjected to analysis of variance[9] and Duncan's Multiple Range test [10] was used to determine mean differences for the various treatments.

Results and Discussion

In all the treatment groups, the weights of the various rabbit cuts decreased remarkably starting from the curing step to the end of the aging period. Data presented in Tables 1 and 2 are the percentage weight losses at each processing step and the total per cent loss in weight of each cut at the end of the aging period. Extensive dehydration was observed during the curing and smoking and during the first week of aging. The least loss in weight was during salt equalization and during the last week of aging. While loss in weight during curing was due to osmotic withdrawal of water from the interior of the meat cuts, subsequent loss in weight was due to evaporative water loss from the surface. The leg and shoulder cuts containing the largest amount of meat[11] lost more weight during the curing process than the loin and rib cuts with a trend reversal during the salt equalization process.

The skinned cuts within the same series of sub-treatments significantly lost more weight ($P < 0.05$) than the unskinned cuts at each processing step probably due to more rapid dehydration during the curing stage and increased evaporative losses in subsequent stages. Similar results were observed in skinned dry cured country hams than in unskinned ones[4]. It would, therefore, appear that a shorter curing time or reduced amount of salt might be advisable in curing fully skinned rabbit meat.

At the end of the aging period, the injected cuts within each skinning sub-treatment significantly lost less weight ($P < 0.05$) compared to the non-injected cuts. This might be due to an uptake of additional brine resulting from the curing process. The result is in agreement with findings that injected turkey had the greater cooked yields than non-injected turkey[12]. Kemp *et al*[3], however, reported that injected hams absorbed salt faster but had more weight losses than non-injected hams.

There was also no significant difference in percentage weight losses between the unskinned non-injected and the skinned injected cuts at the end of four weeks of aging. The exception was in respect of the leg cut in which the percentage weight loss was significantly higher ($P < 0.05$) in the unskinned non-injected cut. It, therefore, appears that while the skin acted as a physical barrier in preventing osmotic dehydration from uninjected rabbit cuts, brine injection achieved the same result by reducing the osmotic gradient between the meat surface and its interior.

The rib cuts had the least per cent weight losses in all the treatments at the end of the aging process, a feature that is attributable to its higher bone content which makes it less susceptible to both osmotic and evaporative water losses than the other cuts which had more soft tissue content.

Means for proximate analysis, sodium chloride content and pH are shown in Table 3. The moisture content and meat pH were unaffected by the various treatments after smoking while only the pH remained unaffected after four weeks of aging. However, slight increases in moisture contents were observed in unskinned samples when compared with skinned samples and in injected samples when compared with un-injected samples after four weeks of aging. Both fat and protein contents were affected in a reverse order to that of moisture at the end of the aging period.

The slightly high ash content of injected loins over those of non-injected loins and of skinned samples over the unskinned ones was expected and attributable to the different concentrations of salt in the different samples. Owen *et al*[1], reported that the mean ash content of processed cured chicken was significantly higher ($P < 0.05$) than that of the fresh uncured chicken. In this study, salt contents of salted rabbit

TABLE 1. LOSS IN WEIGHT (PER CENT) OF THE LEG AND SHOULDER CUTS AT EACH PROCESSING STEP

Processing step	S N I		U N I		S I		U I	
	Leg	Shoulder	Leg	Shoulder	Leg	Shoulder	Leg	Shoulder
Cured	15.28[a] (1.40)	13.33[a] (0.92)	14.85[a] (1.56)	12.81[a] (1.04)	11.83[b] (1.18)	10.83[b] (1.24)	10.48[a] (1.19)	10.00[b] (1.69)
Salt equalization	2.52[a] (1.44)	2.54[a] (0.64)	1.84[b] (0.98)	2.10[a] (0.75)	1.84[b] (0.62)	1.73[b] (0.90)	1.24[c] (0.65)	1.05[c] (0.68)
Smoked & cooled	11.03[a] (1.15)	9.80[a] (1.21)	9.86[b] (1.10)	8.03[b] (0.95)	7.64[c] (1.53)	9.52[a] (1.10)	6.64[c] (1.25)	8.21[b] (1.12)
Aged (1 wk)	18.73[a] (0.85)	15.09[a] (1.62)	13.88[b] (1.10)	12.81[b] (0.90)	13.68[b] (1.70)	13.85[b] (1.60)	13.91[b] (1.18)	11.50[c] (1.20)
Aged (2 wk)	6.66[a] (1.41)	9.80[ab] (1.80)	5.20[b] (0.77)	8.41[c] (1.12)	6.65[a] (0.58)	10.38[a] (1.20)	4.56[b] (0.98)	9.31[b] (1.25)
Aged (3 wk)	5.05[a] (0.80)	6.07[ab] (1.40)	3.57[c] (0.90)	6.69[a] (1.40)	4.56[b] (0.70)	5.19[c] (1.12)	3.53[c] (0.75)	5.47[bc] (0.95)
Aged (4 wk)	2.18[a] (0.70)	2.74[a] (1.20)	2.06[a] (0.70)	2.10[b] (0.65)	1.72[b] (0.60)	1.73[b] (0.95)	1.66[b] (0.85)	0.90[c] (0.68)
Total	61.45[a] (0.70)	59.37[a] (0.73)	51.26[b] (0.70)	52.95[b] (0.79)	47.92[c] (0.80)	53.22[b] (1.32)	42.02[d] (1.31)	45.85[c] (0.90)

[1]Data are means and standard deviation (in parentheses)
Means with the same superscript in each column do not differ significantly ($P < 0.05$).

TABLE 2. PER CENT LOSS IN WEIGHT OF THE LOIN AND RIB CUTS AT EACH PROCESSING STEP

Processing step	S N I		U N I		S I		U I	
	Loin	Rib	Loin	Rib	Loin	Rib	Loin	Rib
Cured	11.61[a] (1.80)	9.78[a] (0.76)	9.69[b] (1.06)	8.40[b] (1.12)	9.65[b] (1.72)	7.62[b] (0.71)	7.98[c] (1.36)	6.20[c] (0.94)
Salt equalization	3.22[a] (1.31)	4.25[a] (1.22)	2.42[b] (0.70)	2.80[b] (1.12)	2.41[b] (1.25)	2.24[bc] (0.67)	2.07[c] (1.17)	1.93[c] (1.36)
Smoked & cooled	10.96[a] (1.62)	13.19[a] (1.42)	9.69[b] (1.15)	12.00[b] (0.60)	9.65[b] (1.18)	12.55[b] (1.30)	8.87[c] (0.70)	12.40[b] (1.35)
Aged (1 wk)	15.48[a] (1.48)	13.19[a] (1.65)	13.03[c] (1.20)	10.00[b] (0.87)	14.48[b] (1.80)	8.52[c] (0.80)	13.62[c] (0.98)	19.30[b] (0.78)
Aged (2 wk)	9.35[b] (1.26)	8.51[a] (1.40)	9.69[ab] (1.15)	6.80[b] (6.85)	10.34[a] (1.46)	6.72[b] (0.78)	8.28[c] (0.72)	4.65[c] (1.02)
Aged (3 wk)	5.80[b] (1.12)	4.25[a] (0.98)	5.45[b] (1.10)	3.20[c] (0.90)	6.20[a] (0.98)	4.03[ab] (0.92)	6.21[a] (1.10)	3.87[b] (0.98)
Aged (4 wk)	4.83[a] (1.30)	2.97[a] (0.94)	3.03[c] (1.25)	2.40[b] (0.80)	1.37[d] (1.25)	1.79[c] (0.35)	3.84[b] (1.30)	1.55[c] (0.95)
Total	61.25[a] (1.75)	56.14[a] (0.60)	53.00[b] (0.94)	45.60[b] (0.81)	54.10[b] (0.95)	43.47[b] (1.96)	50.87[c] (1.42)	39.90[c] (1.13)

[1]Data are means and standard deviation (in parentheses)
Means with the same superscript in each column do not differ significantly ($P < 0.05$).

ranged from 9.55 to 11.52 per cent after smoking and from 13.49 to 17.57 per cent after four weeks of aging. Although salt content ranging from 2.0 to 2.5 per cent has been judged to be acceptable by the taste panel members in cured pork[13], the high salt content of rabbit meat in the present study should not be a great problem. Such meat could be used for stewing or cooking without putting any additional salt or after desalting with water.

Shear force values for meat from the skinned non-injected (SNI) samples were 10.09 ± 2.10 after smoking and 11.37 ± 1.93

TABLE 3. CHEMICAL CHARACTERISTICS OF CURED RABBIT MEAT[1]

Treatment	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	NaCl (%)	pH
			After smoking			
Skinned non-injected (SNI)	53.85 (1.23)	4.58^{a} (0.56)	28.27^{c} (1.51)	13.46^{a} (1.03)	10.34^{ab} (0.64)	5.72 (0.05)
Unskinned non-injected (UNI)	54.32 (0.76)	5.48^{b} (1.00)	27.38^{bc} (1.45)	12.95^{a} (2.01)	9.55^{a} (0.60)	5.63 (0.17)
Skinned injected (SI)	54.40 (0.92)	4.90^{ab} (0.41)	26.78^{b} (1.31)	14.26^{b} (0.79)	11.52^{c} (0.86)	5.65 (0.12)
			After 4 wk aging			
Skinned non-injected (SNI)	32.90^{a} (1.32)	8.14^{c} (0.85)	40.65^{c} (2.08)	18.40^{a} (1.55)	14.48^{a} (1.54)	6.12 (0.26)
Unskinned non-injected (UNI)	33.89^{b} (1.50)	7.50^{bc} (0.91)	39.28^{bc} (1.40)	18.66^{a} (0.03)	13.49^{a} (0.94)	6.27 (0.30)
Skinned injected (SI)	34.34^{b} (1.83)	7.11^{ab} (0.54)	38.10^{ab} (1.26)	19.73^{b} (1.84)	17.57^{b} (1.63)	6.30 (0.38)
Unskinned injected (UI)	36.25^{c} (1.92)	6.52^{a} (0.77)	37.36^{a} (2.04)	19.42^{b} (1.66)	16.50^{b} (1.39)	6.20 (0.21)

[1]Data are means and standard deviations (in parentheses)
Means with same superscript in each column do not differ significantly ($P \leq 0.05$)

after four weeks of aging. Equivalent values for the remaining treatments were 9.30 ± 2.18 and 11.29 ± 2.57 for the unskinned non-injected (UNI) samples, 6.21 ± 1.60 and 9.80 ± 1.73 for the skinned injected (SI) samples as well as 4.51 ± 1.71 and 8.79 ± 1.75 for the unskinned injected (UI) samples respectively.

The lower shear values obtained in injected cuts when compared with non-injected ones both after smoking and after four weeks of aging (Table 4) could be due primarily to the slight though insignificantly higher moisture content of the injected cuts or the slight denaturation effect of dehydration in the non-injected cuts. Previous reports of Janky *et al*[14] have shown the use of a 5 per cent sodium chloride brine soak prior to cooking to greatly improve tenderness in cornish hens.

TABLE 4. SHEAR FORCE VALUES OF CURED RABBIT MEAT AFTER SMOKING AND AGING

Treatments	After smoking	4 wk of aging
SNI	10.09 $\pm$ 2.10^{b}	11.37 $\pm$ 1.93^{b}
UNI	9.30 $\pm$ 2.18^{b}	11.29 $\pm$ 2.57^{b}
SI	6.21 $\pm$ 1.60^{a}	9.80 $\pm$ 1.73^{a}
UI	4.51 $\pm$ 1.71^{a}	8.79 $\pm$ 1.75^{a}

Means $\pm$ standard error

Means on column with different superscripts are significantly different ($P < 0.05$)

Panel evaluation for flavour, juiciness, colour, saltiness and smokiness did not reveal any significant difference due to the various treatments. The inability of the taste panel members to discern any difference in the level of saltiness probably arose from the saturation effect of the high salt content of the meat on the taste buds.

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Effect of Buffalo Fat Premix on the Quality of Patties

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There was no significant difference in emulsion stability, cooking yield, shear force value, cooking shrink diameter of patties made with or without fat premixes. Patties containing fat premix made in bowl chopper had significantly ($P < 0.01$) lower mouth coating and higher acceptability compared to those containing fat premix prepared using meat mincer. Patties containing fat premix having equal proportions of meat, fat and whole egg liquid (WEL) had significantly ($P < 0.01$) lower mouth coating and higher acceptability. There was no significant difference between fat premix with or without WEL in reducing mouth coating.

In India, the demand for buffalo meat is increasing due to its leanness and high price of the other traditional meats. Buffalo meat obtained from old and unproductive animals is being consumed as fresh or in the form of processed and convenience meat products. Addition of fat improves the juiciness and palatability of the products, but higher levels of beef or mutton fat in frankfurters resulted in waxy or tallowy taste[1]. Poor dispersibility of sheep and goat fats resulted in low quality meat emulsions[2]. Incorporation of buffalo fat significantly contributed to mouth coating and lowered the palatability of the patties because of its poor dispersion in the emulsion due to higher content of saturated fatty acids[3]. Further, significant quality improvement has been achieved by incorporating whole egg liquid (WEL) to the product formulations as it decreased the mouth coating problem[3].

An attempt was made in the present study to reduce the mouthcoating problem contributed by buffalo fat in meat products by incorporating fat premix in place of fat. So, the effects of fat premixes prepared using meat mincer and bowl chopper, containing different levels of WEL and with or without WEL on the quality of patties were evaluated.

Materials and Methods

Buffalo meat and fat from a carcass of medium finish were procured from local meat shop, slaughtered by traditional halal method. The meat chunks were stored at -10°C for 48 hr and thawed at 4-5°C for 12 hr before using in product formulation. Fat samples chilled (4-7°C) for 2 days were used. Similar meat and fat samples as far as possible were obtained for each trial of the experiments. They were coarse and/or fine minced by passing through 8 mm followed by 3 mm plates respectively of a meat mincer (Electrolux).

Fat premix preparation using bowl chopper or meat mincer: Minced meat together with salt (2 per cent) and tetra-sodium pyrophosphate (0.3 per cent) was chopped for 1-2 min in a bowl chopper (Model 64181 D, Hobart) and equal quantity of coarsely minced fat was added and chopping continued till the formation of fine and smooth consistency batter. Minced meat was mixed with salt and phosphate followed by equal quantity of fat and passed through 3 mm plate of mincer to get a homogeneous fat premix.

Fat premix containing different levels of WEL: Fat premixes I, II and III were prepared using bowl chopper with meat, fat and WEL in the ratio of 1:1:1, 2:3:2 and 2:2:1 respectively. After chopping lean meat with salt, phosphate followed by fat, WEL was added and chopping continued till a fine consistency batter was formed. Salt (2 per cent) and phosphate (0.3 per cent) were added to fat premix on the weight basis of meat, fat and WEL. Addition of fat premixes I, II and III contributed buffalo fat 15 per cent as well as WEL 15, 10, 7.5 per cent to the respective formulations which replaced the lean meat.

Fat premix with or without WEL: A fat premix with WEL containing equal quantity of meat, fat and WEL (1:1:1) and other fat premix without WEL consisting equal quantity of meat and fat (1:1) were prepared as above for comparing their effect on the quality of patties. Formulations of control and fat premix without WEL had 15 per cent buffalo fat whereas fat premix with WEL had also 15 per cent buffalo fat and 15 per cent WEL.

Preparation of meat emulsion: To the finely minced meat, salt (2 per cent) and phosphate (0.3 per cent) were added and chopped for 1-2 min in a bowl chopper, after addition of ice flakes (10 per cent); chopping was continued for another 1-2 min. Then, required amount of fat premix as per the above experiments was added to contribute buffalo fat 15 per cent as in control and chopping was continued till a good dispersion of fat was observed. Control formulation consisted of 85 per cent lean meat and 15 per cent buffalo fat. Spices (1.5 per cent) and condiments (5 per cent) were added and chopping was continued for their proper blending with

emulsion. Seasonings and ice flakes were added on the weight basis of meat and fat/fat premix.

Patties preparation: Seventy five grams of meat emulsion were hand moulded using a petri dish (80×19 mm size), kept on perforated oven trays and cooked in pre-heated hot air oven at 180°C for 15 min. Then, the patties were turned over and cooked for another 10 min. Internal temperature of cooked patties was 77±2°C as recorded by Wahl probe thermometer.

Analyses of samples: Emulsion stability was determined according to Kondaiah *et al*[4]. Moisture, protein and fat contents of patties were estimated as per AOAC[5]. The cooking yield was expressed in percentage. The sensory attributes of the patties were evaluated using a 8-point descriptive scale (8= extremely desirable, 1= extremely undesirable). The shear force value and the diameter of the patties were determined using Warner-Bratzler shear press and Vernier calipers respectively. The data obtained were statistically evaluated using analysis of variance and critical difference tests of significance[6].

Results and Discussion

Addition of fat premix prepared using meat mincer or bowl chopper instead of fat to the formulation did not significantly affect the emulsion stability as indicated by per cent cooking loss and yield of cooked patties (Table 1). However, addition of fat premix in place of fat to the formulation contributed proper dispersion of fat in the emulsion resulting in slightly higher yield of patties. Differences in texture of patties as indicated by shear force values and dimensional changes of patties diameter during cooking were not significant between control and other treatments.

Moisture, protein, fat, sensory scores for appearance, flavour, juiciness and texture of the patties did not differ significantly (values not presented). Control patties had higher smeary and greasy mouthcoating as indicated by lower score for mouthcoating as compared to patties with fat premixes (Table 1). Similar mouthcoating problem of patties prepared with buffalo fat was reported possibly due to its poor dispersion and higher contents of saturated fatty acids[3,7]. Patties prepared with fat premix had significantly lower mouthcoating resulting in better overall acceptability of the product possibly due to better dispersion of fat in premix and in subsequent emulsion. Fat premix prepared by using bowl chopper resulted in lower mouthcoating and higher acceptability of the patties compared to those containing fat premix prepared by using meat mincer.

TABLE 1. EFFECT OF FAT PREMIX ON THE QUALITY OF BUFFALO MEAT PATTIES

Parameters*	Control	Fat premix– meat mincer prepared	Fat premix– bowl chopper prepared
Emulsion stability (%)	14.39 ± 1.48	13.77 ± 1.22	14.56 ± 1.39
Patties yield (%)	81.32 ± 1.98	81.85 ± 2.21	81.74 ± 2.79
Shear force value/ (kg/2 cm cubes)	2.40 ± 0.24	2.18 ± 0.23	2.24 ± 0.17
Reduction in patties diam (%)	18.00 ± 1.04	17.08 ± 0.99	17.21 ± 1.29
Sensory attributes@ :			
Mouthcoating	5.34 ± 0.17[a]	6.43 ± 0.15[b]	6.69 ± 0.14[b]
Overall acceptability	5.57 ± 0.18[a]	6.46 ± 0.14[b]	6.60 ± 0.11[b]

*n = 5;@ Mean of 35 sensory scores based on 8-point descriptive scale 8 = Extremely desirable; 1 = Extremely undesirable.

Means with same superscripts in each row do not differ significantly ($P < 0.05$)

Addition of fat premix containing different levels of WEL to the formulations did not significantly affect the stability of emulsion (Table 2). However, the emulsion containing fat premix III was slightly higher in stability resulting in greater yield of patties. These results are in agreement with Swift *et al*[8]. Further, patties containing fat premix III had lesser dimensional changes during cooking. Texture of the patties did not vary significantly as indicated by the shear force values. However, the patties with fat premixes I and II had relatively lower shear force values due to higher level of WEL which is in agreement with the results of Kulkarni *et al*[9].

Incorporation of fat premix with WEL slightly improved the appearance, flavour and juiciness of patties. Irrespective of level of WEL in the fat premix, the mouthcoating decreased significantly and resulted in significantly higher acceptability scores (Table 2). Fat premix containing the combination of WEL and buffalo fat facilitated in better dispersibility of fat. Anjaneyulu *et al*[3]. reported that incorporation of 3 per cent WEL in the formulation reduced the mouthcoating of the products and increased the acceptability.

Emulsion containing fat premix having WEL had slightly higher stability than control and other treatments without WEL (Table 3). It is due to good functional properties and emulsifying capacity of WEL in food systems[10]. It is also possibly due to combination of hard and saturated buffalo fat with that of WEL resulting in formation of stable emulsion. There was no significant difference in the yield and shear force values of patties between control and treatments.

Histological studies showed that the fat was distributed in large number of small sized fat globules and occasionally bigger size fat globules which were well enclosed in protein matrix in the patties made with fat premixes while for control patties, fat was dispersed in relatively larger globules with a frequent coalescence of fat globules in comparison to other treatments.

Sensory scores indicated that the appearance of the patties having fat premix containing WEL was markedly better than the control. The flavour, juiciness and texture of the patties were not significantly different between control and treatments. Incorporation of fat premix with or without WEL had significantly lower mouthcoating as indicated by higher

TABLE 2. EFFECT OF FAT PREMIX CONTAINING WHOLE EGG LIQUID (WEL) ON THE QUALITY OF PATTIES

Parameters	Control*	Premix I*	Premix II*	Premix III**
Emulsion stability (%)	10.95 ± 0.85	12.06 ± 1.16	11.52 ± 0.94	10.65 ± 1.03
Patties yield (%)	88.65 ± 1.13	88.35 ± 1.23	88.45 ± 1.14	89.92 ± 0.06
Shear force (kg/2 cm cubes)	1.94 ± 0.05	1.79 ± 0.15	1.78 ± 0.13	2.08 ± 0.16
Reduction in diameter (%)	14.04 ± 0.51	14.43 ± 0.93	14.79 ± 0.91	13.69 ± 1.61
Sensory attributes				
Mouthcoating	5.62 ± 0.16^{a}	6.71 ± 0.13^{b}	6.53 ± 0.11^{b}	6.43 ± 0.18^{b}
Overall acceptability	5.62 ± 0.14^{a}	6.78 ± 0.12^{b}	6.42 ± 0.10^{cd}	6.43 ± 0.16^{bd}

Means with same superscripts in each row do not differ significantly ($P < 0.05$)

* n = 6; sensory scores 45.

** n = 3; sensory scores 21.

TABLE 3. EFFECT OF FAT PREMIX WITH AND WITHOUT WHOLE EGG LIQUID (WEL) ON THE QUALITY OF PATTIES

Parameters*	Control	Fat premix	
		With WEL	Without WEL
Emulsion stability (%)	15.99 ± 1.67	14.28 ± 2.06	14.74 ± 1.56
Patties yield (%)	87.82 ± 1.42	88.45 ± 0.23	88.17 ± 1.99
Shear force value (kg/2 cm cubes)	1.89 ± 0.12	1.60 ± 0.12	1.84 ± 0.14
Sensory attributes** :			
Mouthcoating	6.00 ± 0.25^{a}	6.95 ± 0.05^{b}	6.84 ± 0.12^{b}
Overall aceptability	5.68 ± 0.22^{a}	6.53 ± 0.16^{b}	6.68 ± 0.13^{b}

Means with same superscripts do not differ significantly ($P<0.05$)

* n = 3; **sensory scores 19.

sensory scores resulting in significant increase of acceptability of the products (Table 3). However, patties prepared with fat premixes did not differ significantly in mouthcoating as well as overall acceptability of the product.

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Moisture Adsorption Isotherms of Ground Turmeric at Different Temperatures

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Moisture adsorption characteristics of turmeric powder were evaluated at 15, 25, 35 and 45°C. The adsorption isotherms were sigmoid and represented the Type II isotherms according to the BET classification scheme. An upward temperature shift from 15 to 45°C led to a shift of isotherm towards the right side indicating that at any constant moisture content, water activity increased with increasing temperature. Of the six mathematical equations, BET equation was unsatisfactory as it gave very high relative mean square root of error (RMS %) values. Oswin, Smith, Halsey, Henderson and Chung-Pfost equations described well the data at low temperatures but became less satisfactory at higher temperatures as evidenced by the RMS (%) values. Free energy change of adsorption decreased exponentially at all temperatures as the moisture content of the sample increased. Binding energy of sorption calculated at three mean temperatures (20, 30 and 40°C) also decreased with increasing moisture content. The calculated values of isosteric heats of adsorption ranged from about 11 kcal/mole to 19 kcal/mole.

Water sorption isotherms of foods are useful in dehydration, storage and packaging. An important factor affecting the stability of dehydrated foods is water activity (a_w). Due to complexity of food composition, theoretical prediction of the isotherm is not possible and hence experimental measurements are necessary for the prediction of quality of stored foods[1]. Wide variations in sorption properties of foods are reported[2]. Most of the sorption data in the literature were obtained at only one temperature representing normal storage conditions. However, sorption properties over a wide temperature range are essential for modelling dehydration and rehydration processes and storage stability of dehydrated foods.

Processing of turmeric involves a series of steps like boiling in water or brine, steaming and drying[3]. In India, the dry turmeric rhizomes are largely sold as such or powdered. For export also, the dry rhizomes are powdered and packaged in suitable packaging materials, before being shipped. Like many other powdered food materials, turmeric powder is also hygroscopic in nature and will gain or lose moisture depending on the relative humidity of the surrounding air and make it susceptible to deteriorative biological and chemical reactions including discolouration. Even though processing aspects of turmeric have been reported in the literature, no published work on temperature dependence of moisture adsorption and desorption characteristics of turmeric powder could be found. The present investigation was, therefore, undertaken with this objective in mind.

Materials and Methods

Dry turmeric rhizomes were purchased from the local market, ground and passed through a 150 μm ISS sieve. The turmeric powder so obtained was filled in an airtight glass bottle with glass stopper and stored in a refrigerator at 5°C.

Moisture equilibrium studies: Glass desiccators (16 cm dia × 25 cm height) containing about 200 ml saturated salt solutions were employed to provide constant relative humidities varying from 12 to 97 per cent[4]. The desiccators were kept in BOD incubator at 15, 25, 35 and 45°C and the temperature was maintained to an accuracy of ± 1°C during the period of study.

Samples (approximately 2 g) of the test material was weighed into 5 cm diameter petri dishes and placed over the saturated salt solutions in triplicate in desiccators. The weight was recorded at two days intervals and it was observed that equilibrium was attained in all the samples after 12-14 days. Water activity associated with each temperature was assumed to be that of saturated salt solution and the values were taken from literature[5]. The initial moisture content of the samples were determined by drying in an air oven at 70°C for 6 hr. The gain or loss of moisture after equilibrium was calculated and equilibrium moisture content (per cent EMC) at each of the relative humidities was computed on dry weight basis by adding or subtracting the per cent gain or loss of moisture.

Analysis of data: Each set of sorption data were fitted to six mathematical equations relating equilibrium moisture content and a_w with least square method using an EC

computer. The adequacy of the fit was checked by calculating the relative mean square root of error (RMS per cent) as per the method of Iglesias and Chirife[6] as follows,

$$\text{RMS (per cent)} = 100\sqrt{\Sigma\frac{[X\ exp - Xcal) / X\ exp]^2}{N}}$$

Where Xexp and Xcal are the experimental and calculated moisture contents, respectively, N is the number of experimental points. The mathematical equations relating equilibrium moisture content and a_w used were those of Oswin[7], Smith[8], Halsey[9], Henderson[10], Chung-Pfost[11] and BET[12] as follows;

Oswin $$M=A\left[\frac{a_w}{1-a_w}\right]^B \quad \ldots\ldots (1)$$

Smith $$M=A-B\ \ln(1-a_w) \quad \ldots\ldots (2)$$

Halsey $$M=\left[-\frac{A}{T\ \ln a_w}\right]^{1/B} \quad \ldots\ldots (3)$$

Henderson $$M=\left[-\frac{1}{\ln(1-a_w)}\right]^{1/B} \quad \ldots\ldots (4)$$

Chung-Pfost $$M=\frac{1}{B}\left[\ln\frac{A}{RT}-\ln(-\ln a_w)\right] \quad \ldots\ldots (5)$$

BET $$M=\frac{A.B.\ a_w}{(1-a_w)\ [1+(B-1)\ a_w]} \quad \ldots\ldots (6)$$

Notations; A, B are moisture gain and loss, respectively, M is equilibrium moisture content per cent dry basis, a_w is water activity, T is absolute temperature, °K, and R is universal gas constant, 1.987 cal/mole °K.

Results and Discussion

Adsorption isotherm: The adsorption isotherms of turmeric powder at 15, 25, 35 and 45°C are shown in Fig 1. The isotherms are sigmoid and belong to type II isotherms according to the classification of Brunauer *et al.*[12] An upward temperature shift from 15°C through 45°C led to a shift of isotherms towards the X-axis indicating that at any constant moisture content, a_w increases with increasing temperature. Balasubramanyam *et al*[13], studied the humidity moisture relationship of turmeric power at 27°C and 11-92 per cent RH. They found that 12 per cent moisture (dry basis) was critical for free flowing characteristics.

Fitting of sorption data in equations: A number of theoretical and empirical equations found in literature were tested for fitting the adsorption data of turmeric powder. Table 1 shows the results of calculations for the water adsorption of turmeric powder at temperatures of 15 to 45°C. The BET equation was found unsatisfactory as it gave very high RMS (per cent) values. In general, BET equation is known to be suitable for polymeric materials, of starchy or proteinaceous food products. Besides, BET equation deviates from its straight line form beyond a_w of 0.5. All the other five equations were found to describe adequately the relationship between a_w and moisture content of turmeric

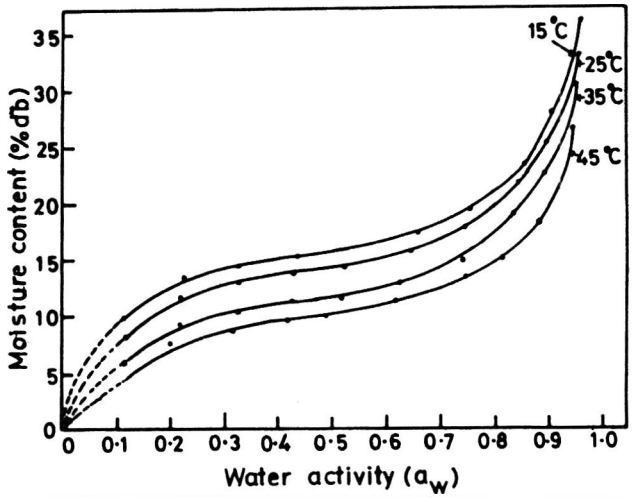

Fig. 1. Moisture adsorption isotherms of turmeric powder at four different temperatures.

TABLE 1. RELATIVE MEAN SQUARE ROOT OF ERROR (RMS %) AND PARAMETERS OF THE EQUATIONS OBTAINED BY FITTING MOISTURE ADSORPTION DATA OF TURMERIC POWDER

Equation	T (°C)	R.M.S. (%)	Parameters of the equation	
			Moisture gain	Moisture loss
Oswin	15	5.16	16.12	0.22
	25	5.19	14.46	0.24
	35	7.24	11.71	0.28
	45	9.83	10.21	0.34
Smith	15	6.62	10.49	7. 11
	25	7.69	9.15	6.85
	35	10.83	6.65	6.78
	45	14.23	4.85	7.36
Halsey	15	5.72	6.69×10^{-5}	−5.79
	25	7.27	1.94×10^{-4}	−5.65
	35	11.15	3.51×10^{-4}	−5.99
	45	15.20	1.94×10^{-3}	−5.70
Henderson	15	9.83	4.04×10^{-4}	2.90
	25	9.21	4.37×10^{-4}	2.68
	35	9.92	5.39×10^{-4}	2.24
	45	11.19	6.27×10^{-4}	1.93
Chung-Pfost	15	7.14	4.89×10^{-12}	−2.31
	25	6.70	1.68×10^{-10}	−2.30
	35	8.19	6.18×10^{-8}	−2.30
	45	10.56	0.00	−2.50
BET	15	76.15	2.07	−2.43
	25	75.76	1.94	−2.48
	35	78.20	1.74	−2.58
	45	91.65	1.98	−3.20

powder. All these models describe the data well at low temperatures but become less satisfactory at higher temperatures, as evidenced by the RMS (per cent) values. The Oswin equation gave the most satisfactory results over the entire range of temperature investigated. The experimental adsorption and the theoretical isotherm based on the best fitted Oswin equation are shown in Fig.2.

Thermodynamic considerations: Free energy change of adsorption: The values of free energies of adsorption investigated were calcul ,d by equation

$$-\Delta F = RT \ln \frac{P}{P_o}$$

as per the method of Chung-Pfost[14] using test data and plotted against moisture content on a semilog scale (Fig.3). The free energy of adsorption decreased continually with increasing moisture content. Similar results have been reported by Chung-Pfost[14]. The results indicate that

$$-\Delta = A e^{-Bx}$$

Where A and B are constants depending on temperature and the type of adsorbent and X is moisture content. Constants A and B can be evaluated from the intercept (In A) and slope (B) of the ΔF versus X plots.

Heats of adsorption: A good measure of the interaction of water vapour with the solid substrate is the binding energy of sorption (ΔH_B)[14], defined as the difference ($Q_{st} - \Delta H_O$) where Q_{st} is the isosteric heat of sorption and H_O is the heat of condensation of water vapour at the given temperature (H_O = 10.53 kcal/mole at 25°C). At a given moisture content, H_B can be estimated from sorption data at two different temperatures (T_1, T_2). The sorption data of turmeric powder were used to estimate the binding energy (ΔH_B) and isosteric heat of sorption, Q_{st} ($\Delta H_B + \Delta H_O$) as a function of moisture content at three mean temperatures i.e., 20, 30 and 40°C. The data are presented in Table 2. The binding energy as well as isosteric heat of sorption decreased with increasing moisture content at all temperatures. The calculated values of isosteric heat of adsorption ranged from about 11 to 19 kcal/mole and are comparable with those obtained for other products[14]. Since

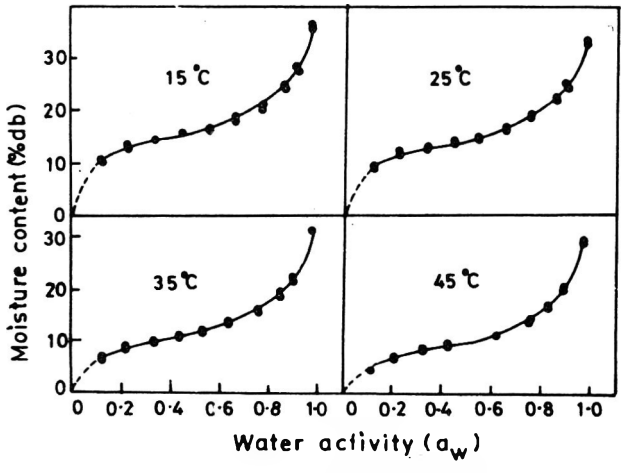

Fig. 2. Experimental sorption data (+) and the theoritical isotherm (−) based on best fitted Oswin equation.

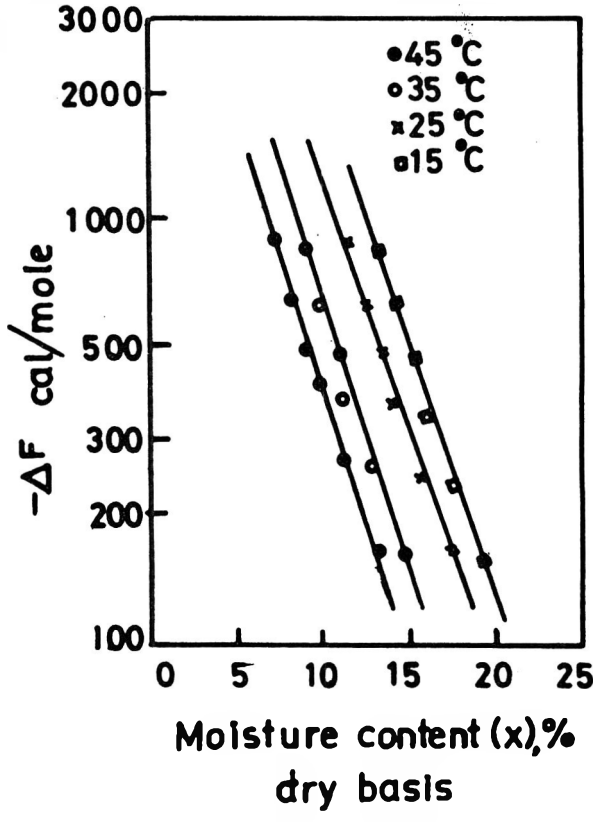

Fig. 3. Variation of free energy (ΔF) as a function of moisture content (X) of turmeric powder.

TABLE 2. BINDING ENERGY OF SORPTION (ΔH_B AND ISOSTERIC HEAT OF SORPTION (Q_{st} IN kcal/mole[14])FOR TURMERIC POWDER AT DIFFERENT MEAN TEMPERATURES

Moisture content (% dry basis)	20°C		30°C		40°C	
	ΔH_B	Q_{st}	H_B	Q_{st}	H_B	Q_{st}
5	7.71	18.24	8.40	18.93	8.28	18.81
10	5.48	16.81	9.38	18.91	7.71	18.24
15	4.43	15.96	3.72	14.25	1.54	12.07
20	0.64	11.17	1.02	11.55	0.96	11.49
25	0.24	10.77	0.78	11.31	0.46	10.99
30	0.18	10.71	0.31	10.84	—	—

the heats of sorption can be considered as indicative of intermolecular attractive forces between sorptive sites and water vapour. The values of ΔH_B and Q_{st} at various moisture contents show the magnitude of binding energy or the availability of polar sites to water vapour as sorption proceeds. The binding energy of sorption (ΔH_B) approaches zero as the moisture content increases, indicating that adsorbed water vapour on the adsorbent may behave like pure water at higher equilibrium moisture contents corresponding to higher relative humidity.

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Effect of Insect Infestation on the Proximate Composition and Functional Properties of Flour Samples and Protein Isolates from Bambarra Groundnut and Cowpea

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The proximate composition of flour samples obtained from infested and unifested cowpea *Vigna unguiculata* and bambarra ground nut *Voandzeia subterranea* seeds were determined. The results reveald that infested flour sample from both seeds had lower protein and fat contents but higher ash content than unifested samples. The emulsion capacity, foam capacity and foam stability of the flour, protein isolates and protein fractions of unifested cowpea demonstrated better emulsification and foaming characteristics than those of bambarra groundnut. In all cases, insect infestation seeds reduced the foaming and emulsification properties of flours.

Functional properties constitute the major criteria for the adoption and acceptability of proteins in food system. The physical and chemical characteristics and interactions of proteins with other components in the food are the major contributors to the usefulness and success of proteins in food systems. These characteristics influence processing, preparation and quality attributes of foods[1]. Ability to form foams and emulsions is important and results from intermolecular interactions and cohesiveness. Foaming ability is useful in food systems that require aeration for textural and leavening properties while emulsification property is an indispensable tool in food systems requiring cohesiveness and stabilization.

This study investigated the effect of bruchid infestation on the proximate composition and functional properties of cowpea and bambarra groundnut flour samples. The functional properties of bambarra groundnuts were also compared with those of the cowpea.

Materials and Methods

Unifested seeds of bambarra groundnut *(Voandzeia subterranea)* and cowpea (*Vigna unguiculata*-black eye, kano white variety) seeds were obtained from the International Institute for Tropical Agriculture, Ibadan, Nigeria. Five hundred gram portions in each seed type were infested with fifty adults of *Callosobruchus maculatus* (F) and left for two months while the remaining portions of each were maintained free of infestation for the same period. At the end of two months, the infested seeds were segregated based on insect bored holes on them. Seeds having at least 5-7 emergent holes were used for further study.

Legume seeds were cleaned, conditioned by soaking for about 15 min and dried to a moisture content of 10-15 per cent. The tempered seeds were cracked in a hammer mill and detached hulls were winnowed off. The seeds were further pulverized in a sample mill (Cyclotex 1053, Tecator instruments) to produce flour samples used for the experiments. The protein, moisture, ash and fat contents of flour samples were determined using standard A.O.A.C. methods[2].

Protein isolates were prepared by the methods of Rhee *et al*[3]. Flour samples were equilibrated in 0.1M NaOH (10 volumes) for about 30 min after which they were filtered through cheese cloth. The pH of the extract was adjusted to 4.5 using IM HCl. The resulting protein curd was separated by centrifugation at 5000 r.p.m. for 20 min. This precipitated protein was washed several times with distilled water and subsequently centrifuged. A slurry containing 10 per cent solids was prepared and neutralized to pH 7.0 using 0.1M NaOH. This slurry was regarded as the protein isolate and was frozen until further use.

For the determination of protein solubility, the Lund Sandstrom method of classification[4] was used. (i) Ten g of flour sample was equilibrated with 50 ml distilled water for 30 min and centrifuged at 5000 r.p.m. for 30 min. The supernatant was regarded as the albumin fraction. (ii) The sediment was re-slurried in 50 ml of 5 per cent NaCl and equilibrated for 30 min. It was subsequently centrifuged at 5,000 r.p.m. for 30 min. The supernatant from this, was regarded as the globulin fraction while the sediment was used for the preparation of subsequent fractions. (iii) The sediment from (ii) was equilibrated in 50 ml of 70 per cent alcohol for

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30 min. This was followed by subsequent centrifugation at 5,000 r.p.m. for 30 min. The supernatant from this step was used as the prolamin fraction. (iv) The sediment from (iii) was re-slurried in 50 ml of 0.2M NaOH and treated as described above, to produce the glutelin fraction.

Foam capacity and stability were determined according to the method of Coffman *et al*[5]. Ten g of sample was dispersed in 50 ml of distilled water and the total volume noted. The suspension was homogenized for 5 min and the mixture was poured into a 100 ml measuring cylinder. The foam volume was recorded at 10 min intervals for a total period of 420 min. The foam capacity was expressed as percentage increase in volume.

The emulsion capacity was determined for infested and unifested bambarra groundnut and cowpea protein isolates using the method of Sathe and Salunkhe[6]. Fifty ml of a thirty per cent dispersion of the sample in distilled water was blended for 30 min. Soyabean oil was added in 5 ml portions during blending. A drop in consistency was taken as an indication of a decrease in resistance to blending and was considered to be the point of discontinuation of oil addition. The quantity of oil added up to this point was noted and expressed as the quantity of oil emulsified.

TABLE 1. PROXIMATE COMPOSITION OF FLOURS

Sample type	Moisture (%)	Crude protein (%)	Ether extract (%)	Ash (%)
Bambarra groundnut flour				
Infested	10.0	18.5	9.0	2.5
Unifested	10.0	22.1	10.5	1.0
Cowpea flour				
Infested	11.5	21.7	2.3	4.0
Uninfested	15.0	26.3	2.5	3.5

Each value is the mean of duplicate determinations.

Results and Discussion

Results of proximate composition indicate that insect infestation reduced the nutrient content and increased the ash content of bambarra groundnut and cowpea flour samples (Table 1). Insects are known to decrease the nutritive value of foods by altering the biochemical composition of the grain as a result of feeding or other metabolic activities of the insect[7].

Cowpea flour was found to exhibit better foaming property than bambarra groundnut flour. Maximum foam volume produced as well as the rate of decrease of foam volume with time is shown in Table 2. Protein isolates from both the seeds demonstrated better foaming characteristics than the corresponding flour samples. This may suggest that interaction of proteins with other food components lowered foam formation in the isolates. Insect infestation of cowpea flour samples resulted in a product with poor foaming characteristics. Infested bambarra groundnut flour showed very little foaming property (not measurable). These results indicate that foaming is adversely affected by insect infestation (Table 3).

TABLE 2. CHANGE IN FOAM VOLUME OF BAMBARRA GROUNDNUT AND COWPEA WITH TIME

Sample	Foam vol. (ml) at indicated times (min)								
	0	10	30	60	90	120	180	290	360
	I UI	I UI	I UI	I UI	I UI	I UI	I UI	I UI	I UI
Cowpea									
Flour	14 10	2 6	1 4	0 4	0 1	0 0	0 0	0 0	0 0
Protein isolate	10 13	5 10	3 8	2 7	1 5	1 4	05 2	0 0	0 0
Protein fractions									
Albumin	9 15	9 12	5 11	3 10	2 8	2 7	2 7	1 8	0 0
Globulin	—	—	—	—	—	—	—	—	—
Prolamin	12 15	11 14	9 12	8 10	7 9	6 7	7 5	2 3	0.5 1
Glutelin	31 35	15 20	1 10	0 1	0 0	0 0	0 0	0 0	0 0
Bambarra groundnut									
Flour	0 2	0 1	0 1	0 1	0 0	0 0	0 0	0 0	0 0
Protein isolate	0 8	0 6	0 5	0 4	0 3	0 2	0 1	0 0	0 0
Protein fractions									
Albumin	6 15	4 12	3 9	2 6	7 5	3 4	0 1	0 0	0 0
Globulin	2 7	1.8 6	1.5 5	1 2	0 1	0 0	0 0	0 0	0 0
Prolamin	—	—	—	—	—	—	—	—	—
Glutemin	—	—	—	—	—	—	—	—	—

I = Infested samples
UI = Unifested samples

TABLE 3. FOAM CAPACITIES AND STABILITIES OF BAMBARRA GROUNDNUT AND COWPEA FLOURS AND PROTEIN ISOLATES

Sample	Foam stability (min)	Foam capacity (%)
Uninfested bambarra groundnut flour	15.0	3.5
Infested bambarra groundnut flour	Negl	Negl
Uninfested bambarra groundnut protein isolate	90.0	10.0
Infested bambarra groundnut protein isolate	Negl	Negl
Uninfested cowpea flour	60.0	16.7
Infested cowpea flour	15.0	7.1
Uninfested cowpea protein isolate	120.0	21.7
Infested cowpea protein isolate	60.0	16.7

Each value is the mean of triplicate determinations.
Negl: Negligible

TABLE 4. FOAM CAPACITIES/STABILITIES OF BAMBARRA GROUNDNUT AND COWPEA FLOURS AND PROTEIN FRACTIONS

Protein fraction	Foam stability min		Foam capacity (%)	
	Infested	Unifested	Infested	Unifested
	Cowpea flour			
Albumin	120	120	60	36
Globulin	Negl	Negl	Negl	Negl
Prolamin	180	180	60	48
Glutelin	30	5	140	124
	Bambarra groundnut flour			
Albumin	120	60	60	24
Glubulin	30	30	28	8
Prolamin	Negl	Negl	Negl	Negl
Glutelin	Negl	Negl	Negl	Negl

Evaluation of the foaming characteristics after fractionation of the proteins based on their solubility indicates that the water and salt soluble fractions of bambarra groundnut seeds were primarily responsible for its foaming properties (Table 4). The water and alkali soluble protein fractions of cowpea on the other hand demonstrated good foaming properties. Albumins (water soluble proteins) are known to form thick adhering cohesive layers of protein films that resist compression and rupture. Globulins (salt-soluble proteins) are rather noted for rapid formation of large foam volume that are better stabilized after thermal coagulation. The foaming properties of the glutelin (alkali-soluble proteins) is considered rather superior in terms of foam volume and stability[1]. It is therefore, not surprising that the cowpea food system in which the glutelin fraction contributes significantly to foam formation should possess superior foaming properties.

Uninfested cowpea flour samples showed better emulsification properties than their bambarra groundnut counterparts (Table 4). Protein isolates from both legumes showed higher emulsification capacities than the corresponding flour samples. Insect infestation reduced the emulsification capacities of all flour samples and protein isolates. It is not surprising that protein isolates were found to be better emulsifiers than flour samples since other components of flour would obviously affect the emulsion and proteins are known to be good emulsifiers. The higher protein content of cowpea may at least, partially account for its better emulsification properties.

The percentage oil emulsified by bambarra groundnut flour was found to be comparable to that of lentil flour (19 per cent); but lower than most other legume flours[8]. Cowpea flour, on the other hand, emulsified a much higher percentage of the oil (73 per cent). The percentage oil emulsified by cowpea flour is lower than that of soybean (82 per cent) and lima bean (80 per cent); but much higher than that of other legume flours[8]. The types of oils used to form emulsions may, however, account for minor differences. Emulsifiers are known to lower the interfacial tension between two immiscible phases and thereby facilitate the emulsification process. They develop steric and electrical barriers at the interface and hinder the dispersed particle from coalescing. The stability of an emulsion is known to be affected by the type and concentration of protein as well as other factors such as pH, ionic strength, viscosity of the system etc[9].

In conclusion, a comparative evaluation of the oil emulsification and foaming properties of bambarra groundnut and cowpea flours indicate that in food systems that require these properties, cowpea flour may be more useful. Insect infestation reduces effectiveness of these functional properties in food systems.

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STUDIES ON THE MECHANICAL ROASTING OF SAGO

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An electrically heated mechanical sago roaster with an output of 100 kg/hr was developed. The roasting of sago was carried out at 12 temperature levels from 110 to 220°C with roasting time of 2 to 5 min. Stability, clustering, moisture and swelling were determined. A roasting at 170°C for 3 min was found to be most satisfactory as it had less clustering and high stability.

The process of manufacturing of sago (granulated, roasted tapioca starch) came into being many decades ago as a home industry in India. Eventhough the total number of sago manufacturing factories in the country has increased to more than 1000[1], still many of the unit operations in the process are being carried out by the age old methods. Roasting of the sago granules is one of such operation which is controlled manually and thereby resulting in poor quality product.

The non-uniformity of the roasting temperature and the unhygienic conditions of the surrounding also contribute for the inferior quality. In the processing of tapioca starch, it is vital to complete the whole process within the shortest time possible, since it is subjected to enzymatic reactions[2]. In order to quicken the process of roasting and to increase the quality of sago by eleminating the manual operation, a mechanical system for roasting of sago has been developed. The studies on important process parameters such as temperature and time of roasting were conducted and results are reported.

In conventional practice, the starch granules are roasted over a pan of 2 m × 2 m by women labourers. The temperature of the pan varies from 120 to 180°C and the time of roasting ranges from 8 to 10 min. The starch granules of 'Malabar' variety of tapioca which is available in and around Salem (Tamil Nadu) was used in the present study. The gelatinization temperature of the sample was determined as described by Watson[3] and was between 67 and 80°C. Accordingly, the temperature of roasting surface was selected above 100°C for designing the sago roaster.

A mechanical roaster consisting of feed hopper, roasting cylinder, heating coil and driving mechanism was developed (Fig.1). The hollow cylinder was provided with a mild steel screw auger throughout its length to transport the starch granules inside the roaster. Eight 1.5 kW electric heating coils

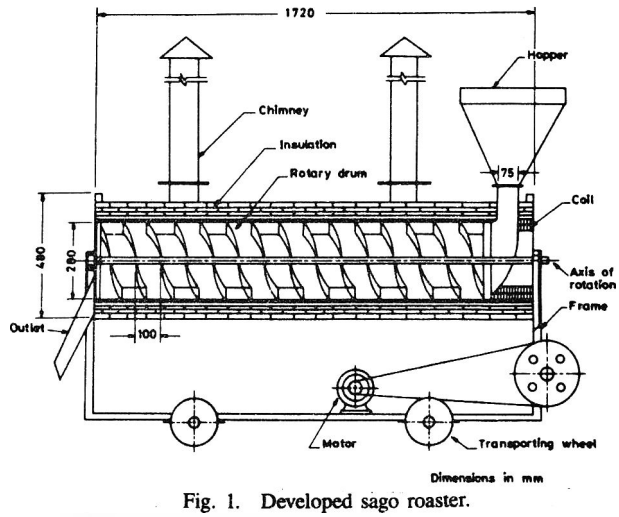

Fig. 1. Developed sago roaster.

were fixed longitudinally in the periphery of the outer drum. The insulation cover was made with the mixture of plaster of paris and fire clay: minute holes were made in the outer drum for the exhaust of water vapour through the chimney. A thermostat of 0-300°C range (Temtrol make) was fixed in the electrical circuit to maintain the desired temperature and the roaster was connected with a 3 phase, 10 H.P. variable speed motor (Greaves Cotton make) to achieve different time of roasting. A fluted roller was fixed in the feed hopper to feed sago into the roasting drum at the rate of 100 kg/hr. All the parts of the roaster were fabricated with mild steel sheets and rods.

The temperature of roasting cylinder was kept at 12 different levels viz., 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210 and 220°C and the time of roasting was 2, 3, 4 and 5 min. The moisture contents of sago before and after roasting were determined by standard AOAC method[4] and the swelling of granules was determined by the method suggested by Mohsenin[5].

Stability of roasted sago (500 g) was determined by shaking ISS – 200 sieves on a vibratory shaker at a speed of 120 strokes per min. The weight of the sago retained in the sieve was expressed as the per cent of original weight.

Clustering of roasted sago (500 g) was determined by separating the individual and clustered granules, the latter was expressed as per cent of original weight.

All the experiments were conducted in duplicate and the mean values were taken for analysis. The sago roasted in the conventional method was treated as control for comparison.

Gelatinization temperature of sago was between 67 and 80°C. It is in good agreement with the values (60 – 80°C) reported by Grace[5]. The effect of stability at different temperature and time of roasting is presented in Fig. 2. As the temperature of roasting increases, the stability also ncreases for all the duration of roasting. In the case of 2 min

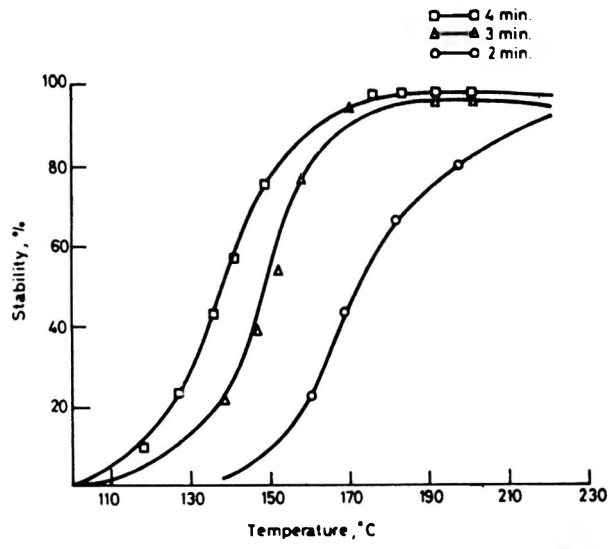

Fig. 2. Effect of time and temperature of roasting on stability of sago.

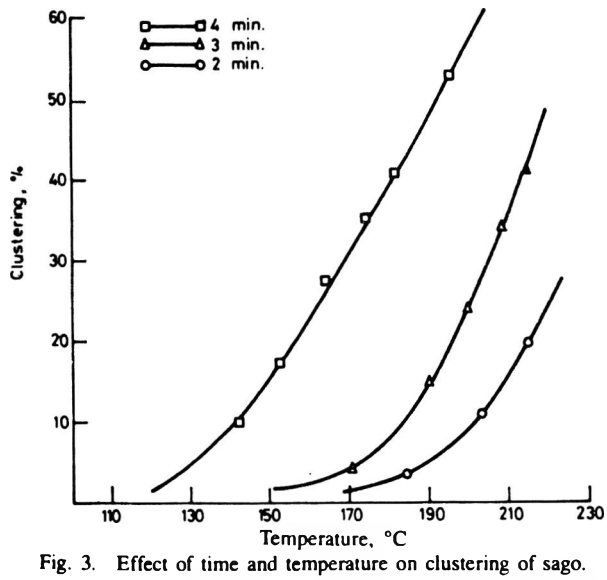

Fig. 3. Effect of time and temperature on clustering of sago.

treatment, the stability is only 93 per cent even at 220°C. The stability reaches a maximum of 98 per cent at 170°C in 3 min treatment and slightly more at 170°C in 4 min treatment. The stability remains same for all treatments above 180°C with 3 min and 4 min roasting. This implies that in these treatments, the starch granules are attaining the temperature more than that of gelatinization temperature slowly.

The relationship between roasting temperature and time of roasting on clustering of sago is depicted in Fig.3. It indicates that the clustering increases with temperature and time of roasting. It is observed during the trials that at higher temperatures of 190°C and above with more time of 3 and 4 min., the sago granules started consolidating into solid mass. Since the samples of the 170°C for 3 min treatment were found to be of less clustering and more stable, further experiments of the granules were carried out only with this treatment. The percentages of swelling in conventional roasting and mechanical roasting are 7.7 and 9.3 per cent respectively. The increase in swelling by 20 per cent in mechanical roasting over the control (conventional roasting) may be due to thorough mixing of sago in the mechanical roaster. The roasting time varies between 8 and 10 min in the conventional process whereas it is only 3 min in the mechanical system. The uniform temperature given to the product with the help of a thermostat control throughout the roasting period and thorough mixing due to helical screw auger, in the roaster have attributed for the reduction in the roasting time. The high roasting time in the conventional process is due to variation in the roasting temperature (120–180°C) of the pan.

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GLYCOLIPID COMPOSITION OF SUBABUL, RITHA AND KUSUM SEED OILS OF VIDARBHA REGION

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The chloroform–methanol (2:1, v/v) extracted lipids from Subabul, *(Leucaena lecocephala)* Ritha *(Sapindus mukorossi)* and Kusum *(Schelchera trijuga)* seeds were subjected to silicic acid column chromatography. The glycolipids obtained by acetone elution were separated by TLC into monoglucosyl diacylglycerol (MGDG) 22 to 28%, diglucosyldiacyglycerol (DGDG) 42 to 43%, steryl glucoside (SG) 13 to 16%, acylatedsterylglucoside (ASG) 14 to 17% and unidentified components 1 to 3%. The predominant fatty acids of individual glycolipids were found to be palmitic, stearic, oleic and linoleic acids. Glucose was identified as the sugar moiety in all the fractions. The ratio of sugar: sterol was 1:1 for SG and that of sugar : sterol : fatty acids was 1:1:1 for ASG.

Although fatty acid composition of Subabul, Ritha and Kusum seed oils has been reported[1,2], no work has been done on the glycolipid composition of these seed oils. This piece of investigation reports for the first time, the composition of total glycolipids, the fatty acid composition of total and component glycolipids and sterol composition of sterylglucoside (SG) and acylatedsterylglucoside (ASG) together with the molecular ratio of their components.

Subabul *(Leucaena lecocephala)*, Ritha *(Sapindus mukorossi)* and Kusum *(Schelchera trijuga)* seeds were procured from forest department of Nagpur region. Standard glycolipids and methyl esters were obtained from Applied Science Laboratory, State College, Pennsylvania, USA. All the chemicals were of chromatographic grade. The crushed seeds were extracted with chloroform-methanol (2:1, v/v) by the procedure of Folch *et al.*[3] The total lipids so obtained were fractionated on a silicic acid column by eluting successively with chloroform, acetone and methanol. The acetone elute yielded the total glycolipids. The latter were separated into individual components by preparative TLC (Table 1). The bands were visualised with iodine vapours. Appropriate areas were scrapped off and weighed. The nature of each fraction was confirmed with authentic compounds on TLC[4] using periodate–benzidine reagent. MGDG, DGDG, SG and ASG were further analysed for their components. The sterols in SG and ASG were analysed by GLC[5] after their conversion into trimethyl silyl (TMS) derivatives.

Methyl esters of fatty acids of total as well as component glycolipids were prepared by the method of Christie[6]. These methyl esters were analysed by GLC having a flame ionization detector at 280°C. The column used was packed with 15 per cent EGSS–X on chromosorb – W (40–60 mesh size). The column and injection port temperatures were 200°C and 300°C respectively. Nitrogen was used as a carrier gas with a flow rate of 60 ml/min. The chart speed was 60 cm/hr (Table 2).

Glycerol in the glycolipid fraction was also identified by the method of Malkin and Poole[7].

Glycolipid composition of Subabul, Ritha and Kusum seed oils is given in Table 1. The component glycolipids identified were MGDG 22 to 28 per cent, DGDG 42 to 43 per cent. ASG 14 to 17 per cent, SG 13 to 16 per cent and unidentified 1 to 3 per cent.

The fatty acid composition of total and component glycolipids is given in Table 2. The major fatty acids present are palmitic, stearic, oleic, linoleic and linolenic acids along with minor amounts of 12:0, 14:0, 20:0, 22:0 and 24:0 acids. The 20:0 acid which was present in the Kusum oil (21.2 per cent) was present in the glycolipids only in minor amounts of the same oil. The sterol compositions of SG and ASG components were found to be similar, β – sitosterol

TABLE 1. GLYCOLIPID COMPOSITION OF SEED OILS*

Oil source	Glycolipid (%)	Glycolipids (wt %)				
		MGDG	DGDG	SG	ASG	Unidentified components
Subabul	0.28	23.8	42.8	15.8	16.3	1.3
Ritha	0.26	25.7	42.5	14.5	15.2	2.1
Kusum	0.30	28.2	42.1	13.2	14.1	2.5

*All values are means of triplicate analysis

MGDG: monoglucosyl diacylglycerol; DGDG: diglucosyldiacylglycerol; SG steryl glucoside, ASG: acylated steryl glucoside.

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TABLE 2. FATTY ACID COMPOSITION OF TOTAL AND COMPONENT GLYCOLIPIDS*

Glycolipid components	Fatty acids (wt %)					
	16:0	18:0	18:1	18:2	18:3	Others[a]
Subabul oil						
GL	29.2	2.0	26.2	40.2	1.3	—
MGDG	30.1	2.5	23.1	43.1	1.2	—
DGDG	30.5	2.1	23.3	43.2	0.9	—
ASG	32.2	3.7	23.5	40.1	0.5	—
Ritha oil						
GL	30.1	5.7	20.1	38.2	2.5	3.4
MGDG	32.4	4.2	22.1	38.9	1.0	1.4
DGDG	31.5	5.0	21.3	39.4	1.5	0.8
ASG	36.1	19.0	21.0	18.4	4.5	—
Kusum oil						
GL	36.3	11.0	22.0	16.1	10.4	4.2
MGDG	35.9	8.0	24.1	15.3	7.3	9.4
DGDG	34.2	8.9	22.6	18.7	8.5	7.1
ASG	38.5	11.1	20.0	14.0	11.1	5.3

*All values means of triplicate analysis
[a]Others include 12:0, 14:0, 20:0, 22:0 and 24:0 fatty acids.

TABLE 3. STEROL COMPOSITIONS OF SG AND ASG COMPONENTS*

Oil source	Sterols (wt %)							
	Steryl glucoside component[a]				Acylated sterylglucoside component			
	I	II	III	IV	I	II	III	IV
Subabul	70.4	5.3	19.2	5.1	71.3	3.1	20.4	5.2
Ritha	70.1	5.2	19.8	4.9	72.0	4.1	19.3	4.6
Kusum	71.0	5.3	18.5	5.2	70.0	4.0	20.4	5.6

*All values are means of triplicate analysis
[a] I– β– sitosterol (RRT = 1.00), II – stigmesterol (RRT = 0.88), III – campesterol (RRT = 0.81), [a]IV – brassicasterol (RRT = 0.71) and RRT – relative rentention times.

TABLE 4. MOLECULER RATIO OF SG AND ASG COMPONENTS

Oil source	Steryl glucoside		Acylated steryl glucoside		
	Sterol	Sugar (glucose)	Sterol	Sugar (glucose)	Fatty acids
Subabul	1.02	1.01	1.02	1.00	1.02
Ritha	1.01	1.00	1.01	1.02	1.00
Kusum	1.00	1.02	1.00	1.01	1.01

being the major component. Glucose was identified as a sugar moiety (Table 3). Molecular ratios of sugar : sterol was 1:1 for SG and that of sugar : sterol : fatty acids was 1:1:1 in ASG components (Table 4). Infra–red spectra of SG and ASG showed strong absorption bands at 1735 cm^{-1} for the carbonyl group.

The glycolipid composition of these seed oils agree rather well with the general glycolipid pattern of other seeds like Karanja[8], Behada[9], *Briza spicata*[10], Rice bran[11] and Palm oils[12].

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EFFECT OF CONVENTIONAL AND NON-CONVENTIONAL GREEN LEAFY VEGETABLES ON HAEMATOLOGICAL INDICES AND BLOOD CONSTITUENTS OF RATS

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Haematological studies revealed significant reduction in haemoglobin red blood corpuscles (RBC) and white blood corpuscles (WBC) in rats fed with different dry vegetables as sole protein source (T_1). Significant reduction in RBC was also observed when diet was supplemented (5g fresh/day) with fresh colocasia, drumstick, fenugreek and pumpkin (T_3) leaves. Differences in haemoglobin, RBC and WBC between male and female rats were significant. Relative neutrophilia and lymphocytopenia were observed in drumstick fed group (T_1). On the other hand, there were relative neutropenia and lymphocytosis in rats fed with dry drumstick vegetable contributing 2% protein in the diet (T_2). A significant increase in plasma protein in amaranth fed group and decrease in blood glucose in amaranth, colocasia and drumstick (T_3) fed groups was observed.

Green leafy vegetables, such as amaranth, chenopodium, fenugreek, Kale, cabbage, spinach and others are widely consumed in the country[1]. Better growth of rats when alfalfa was fed along with casein, while poor growth with amaranth have been reported[2]. Olatunbosum[3] reported dramatic effect of leaf protein supplementation in children's diets. Gestetner *et al.*[4], Birk[5] and Cheeke[6] reported haemolysis of RBC in poultry and animals fed saponin in diets. Literature, on the effect of leafy vegetables on haematological indices is very scanty. Since the vegetables are known to have adverse effects also, the present investigation was undertaken.

Feeding trial was conducted with Wistar strain albino rats, procured from Haryana Agricultural University, Hisar. The animals were kept individually in separate screen bottomed cages placed in a well ventilated room. Food was made available *ad libitum* and the rats had free access to water. The rats of the treated groups were maintained at 10 per cent protein. Leafy vegetables were used to get a particular protein per cent in the diet. The treatments consisted of T_1: Dry leafy vegetables as the sole protein source, T_2: Dry leafy vegetables, milk and wheat, contributing 2, 3 and 5 per cent protein respectively, T_3: 5g fresh leafy vegetable along with wheat and milk contributing 7 and 3 per cent protein respectively. Each treatment was designated of following diets: D_1: Amaranth, D_2: Colocasia, D_3: Drumstick, D_4: Fenugreek, D_5: Neem, D_6: Pumpkin, D_7: Wheat and milk contributing 7 and 3 per cent protein, D_8: Milk (Skimmed). Isocaloric diets were prepared by adding vitamin mixture (1 per cent), salt mixture (4 per cent), oil (10 per cent), glucose (5 per cent). After 28 days of feeding, the rats were anaesthetized with ether and blood was collected directly from heart in separate vials having one per cent ethylene-diamine tetra-acetate (EDTA) disodium salt for haematological studies. 0.05 ml whole blood was taken into 1.85 ml isotonic sodium sulphate-copper sulphate solution in centrifuge tubes. Sodium tungstate (0.1 ml) (10 per cent) was added, mixed, centrifuged and glucose was estimated by colorimetric method[7]. Differential leucocytic counts (DLC) was done according to Coles[8], and WBC, RBC and haemoglobin contents were determined by the improved Neubauer haematocytometric and acid haematin methods as described by Schalm *et al*[9]. Plasma protein was estimated by modified Biuret method[10].

Significant differences in haemoglobin content, WBC and RBC were observed between treatments and diets. Between sex, significant differences were noticed only in haemoglobin and WBC. Haemoglobin contents in all the leafy vegetable fed groups (T_1) were significantly lower as compared to control (D_8 and D_7). Significant reductions in haemoglobin contents were observed in colocasia, neem and pumpkin fed groups (T_2) while the differences were not significant in all leafy vegetable fed groups (T_3) when compared with control group. There could be some principle or saponin present in leafy vegetables which affects the synthesis/destruction of haemoglobin in the body[10,4-6]. When leafy vegetables were reduced in the diet, the effect of that principle was lessened. When given as garnishing the principle might be having beneficial effect on the haemoglobin content. The results on haemoglobin content of rats indicated that male rats fed on fenugreek and pumpkin diets had significantly higher haemoglobin contents than those of female rats. Moreover, male rats of T_1 had higher haemoglobin contents as compared to female rats (Table 1A, B).

As in haemoglobin, RBC in different vegetable fed groups (T_1) was also significantly lower as compared to control groups. WBC also showed decreasing trend but significant differences over control were observed in fenugreek, neem and pumpkin fed groups. Nitrate and saponin ranged from 0.1 to 56.9 (m mol/100 g) and 0.9 to 3.1 per cent respectively. Neem contains the maximum amount of saponin followed by pumpkin and amaranth[10]. Gestetner *et al*[4]., Birk[5] and Cheeke[6] reported that the hamolysis of red blood cells in poultry and animals was attributed primarily to its saponin

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TABLE 1A. INFLUENCE OF LEAFY VEGETABLES ON HAEMATOLOGICAL INDICES IN RATS

Source	Haemoglobin (g/100 ml)	RBC counts ($\times 10^6$/mm^3)	WBC counts (per mm^3)	Plasma protein (g/100 ml)	Blood glucose (mg/100 ml)
T_1	9.15	3.60	2865.36	5.07	94.08
T_2	14.33	7.00	4128.12	5.75	93.87
T_3	14.92	6.55	4841.67	5.99	84.97
SEm	± 0.16	± 0.12	± 147.51	± 0.11	± 3.1?
C.D. (P< 0.01)	0.65	0.52	620.96	0.47	13.15
C.D. (P< 0.05)	0.47	0.37	447.62	0.34	9.48
D_1	13.13	5.60	3947.22	5.86	99.41
D_2	12.75	5.48	4502.78	5.83	93.06
D_3	12.87	5.33	381 6.67	5.98	85.41
D_4	13.17	5.91	3324.31	6.23	96.32
D_5	9.62	4.59	3094.44	3.83	55.89
D_6	1 1.71	4.14	3819.44	5.48	92.01
D_7	14.58	8.13	4608.33	5.65	107.28
D_8	14.55	6.56	4447.22	5.96	98.42
SEm	± 0.25	± 0.20	± 240.89	± 0.18	±5.10
C.D. (P<0.01)	1.07	0.84	1014.02	0.77	21.48
C.D. (P<0.05)	0.77	0.60	730.97	0.55	15.48
S_1	13.09	5.89	4099.83	5.60	90.85
S_2	12.50	5.54	3790.28	5.61	91.10
SEm	±0.13	±0.10	±120.44	±0.09	±2.55
C.D. (P<0.01)	0.53	0.42	665.48	0.38	10.74
C.D. (P<0.05)	0.39	0.30	507.01	0.28	7.74

D_1: Amaranth, D_2: Colocasia, D_3: Drumstick, D_4: Fenugreek, D_5: Neem,
D_6: Pumpkin, D_7: Wheat & skimmed milk contributing 7 & 3% protein respectively.
D_8: skimmed milk contributing 10% protein. S_1: Male, S_2: Female
T_1: Dry leafy vegetables as the sole protein source (10% protein)
T_2: Dry leafy vegetables, milk and wheat contributing, 2, 3 and 5% protein respectively.
T_3: 5g fresh leafy vegetables daily along with D_7 diet.

content present in the diet. Significant reductions in WBC were observed only in neem and amaranth fed groups (T_2), while with RBC, significant reductions were noticed in amaranth, colocasia, drumstick, neem and pumpkin fed groups. RBC showed significant reduction in colocasia, drumstick, fenugreek and pumpkin fed groups when compared with control (T_3). When male and female rats were compared, RBCs of male rats in neem fed groups were significantly higher than those of female rats. It was also seen that RBC (T_2) and WBC (T_3) of male rats were significantly higher in comparison to those of female rats. Ketkar[12] reported reduction in total RBC and haemoglobin contents, rise in total WBC counts in chicken fed neem cake.

Effect of leafy vegetables on plasma protein and blood glucose: Significant differences in plasma protein and blood glucose were observed within treatments, diets and their interaction (diet × treatment) (Table 1A, B). Total plasma protein contents in the vegetable fed groups (T_1) varied from 4.46 to 6.35 g/100 ml. However, no significant difference could be observed in any of the vegetable fed groups when compared with that of control group. Plasma protein ranged from 5.29 to 5.90 g/100 ml (T_2) and difference was not significant. Significant difference in plasma protein was observed in amaranth fed group (T_1). There were no significant differences in plasma protein of male and female rats with respect to treatments and diets. The differences observed in blood glucose contents in all vegetable fed groups, when compared with control (T_1), were not significant. Blood glucose levels in different vegetable fed groups except amaranth fed group (T_2) were less than those of control. However, significant reduction was observed only in neem fed group. Blood glucose decreased significantly in amaranth, colocasia and drumstick fed groups (T_3). There were no significant differences in blood glucose levels of male and female rats.

Effect of leafy vegetables on differential leucocytic count: A significant difference in percentage neutrophils and lymphocytes was observed among treatments and diets, but not significant between sex. Drumstick fed group of (T_1) showed significant increases in per cent neutrophils and decrease in per cent lymphocytes when compared with those of D_8 (skimmed milk group). On the other hand, there was significant decrease in per cent neutrophils and increase in per cent lymphocytes in colocasia fed rats (T_2) when compared with the control (Table 2). No significant differences in percentage neutrophil and lymphocyte counts of male rat fed on drumstick diet (T_3) were observed when compared with counts of female rats. No such variations were observed in rats of other treatments, when sexes were compared. Percent values of monocytes, eosinophil and

TABLE 1B. MEAN VALUES OF INTERACTIONS ON HAEMOGLOBIN, RBC AND WBC COUNTS

Treatments x diets	Haemoglobin (g/100 ml)	RBC counts (x 10^6/mm^3)	WBC counts (per mm^3)	Plasma protein (g/100 ml)	Blood glucose (mg/100 ml)
T_1D_1	9.33	3.18	3066.66	5.46	120.45
T_1D_2	9.80	3.99	3125.00	5.74	115.99
T_1D_3	10.27	3.00	4158.33	5.94	101.78
T_1D_4	10.07	3.64	2356.25	6.37	108.04
T_1D_5	0.00	0.00	0.00	0.00	0.00
T_1D_6	6.86	1.86	1900.00	5.46	103.24
T_1D_7	14.58	8.13	4608.33	5.65	107.28
T_1D_8	12.27	5.01	3708.33	5.94	95.89
T_2D_1	14.33	6.67	3100.00	5.29	102.38
T_2D_2	13.90	6.97	4833.33	5.85	99.49
T_2D_3	14.20	6.59	3700.00	5.90	87.70
T_2D_4	15.16	8.68	3508.33	5.30	92.27
T_2D_5	13.13	5.78	4325.00	5.43	72.15
T_2D_6	13.64	5.84	4123.33	5.56	90.05
T_2D_7	14.58	8.13	4608.33	5.65	107.28
T_2D_8	15.70	7.33	4816.66	6.02	99.69
T_3D_1	15.83	6.97	5675.00	6.84	75.41
T_3D_2	14.56	5.48	5550.00	5.90	63.70
T_3D_3	14.13	6.40	3591.66	6.10	66.76
T_3D_4	14.28	5.40	4108.33	6.04	88.64
T_3D_5	15.72	7.98	4958.33	6.07	95.50
T_3D_6	14.63	4.72	5425.00	5.43	82.75
T_3D_7	14.58	8.13	4608.33	5.61	107.28
T_3D_8	15.70	7.33	4816.66	5.94	99.69
SEm	±0.44	±0.35	±417.23	±0.32	±8.84
C.D. (P<0.01)	1.85	1.46	1756.33	1.33	37.20
C.D. (P<0.05)	1.33	1.04	1266.07	0.96	26.81

Treatment (T) and diet (D) details are as under Table 1A

TABLE 2. MEAN OF INTERACTIONS ON DIFFERENTIAL LEUCOCYTIC COUNTS IN RATS (CELLS/100 CELLS)

Diet × treat	Neutrophils	Lymphocytes	Monocytes	Eosinophils	Basophils
T_1D_1	18.83	78.83	0.49	1.83	0.00
T_1D_2	12.00	87.00	0.49	0.50	0.00
T_1D_3	28.00	68.67	1.33	1.00	0.00
T_1D_4	19.00	79.75	0.29	0.83	0.66
T_1D_5	0.00	0.00	0.00	0.00	0.00
T_1D_6	15.16	83.33	0.91	0.75	0.00
T_1D_7	26.66	71.33	0.83	0.16	0.00
T_1D_8	16.16	81.50	1.33	0.66	0.33
T_2D_1	26.00	76.50	0.67	0.33	0.00
T_2D_2	17.33	81.50	0.50	0.66	0.00
T_2D_3	22.50	76.16	0.67	0.66	0.00
T_2D_4	22.16	76.66	0.50	0.66	0.00
T_2D_5	20.16	78.83	0.83	0.16	0.00
T_2D_6	19.67	79.33	0.67	0.33	0.00
T_2D_7	26.66	71.33	0.83	0.16	0.00
T_2D_8	23.16	75.66	0.67	0.50	0.00
T_3D_1	18.33	80.16	0.41	0.53	0.00
T_3D_2	22.50	77.00	0.50	0.00	0.00
T_3D_3	30.00	59.16	0.50	0.33	0.00
T_3D_4	20.17	77.66	0.83	1.33	0.00
T_3D_5	24.66	73.75	0.83	0.25	0.00
T_3D_6	22.00	75.83	1.17	1.00	0.00
T_3D_7	26.66	71.33	0.83	1.16	0.00
T_3D_8	23.16	81.50	1.33	0.66	0.33
SEm	±2.82	±3.10	±0.20	±0.31	±0.07
C.D.(P≤0.01)	11.88	3.07	0.86	1.31	0.29
C.D. (P≤0.05)	8.56	9.42	0.62	0.95	0.20

Treatment (T) and diet (D) details are as under Table 1A

basophil did not reveal any significant differences among treatments, diets, sex and any of other interactions. Increases in lympocytic counts in chicken were also observed when neem cake was fed[12].

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EFFECT OF COOKING ON FIBRE CONTENT OF VEGETABLES

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The fibre fractions of raw and cooked vegetables namely, neutral detergent fibre (NDF), acid detergent fibre (ADF), hemicellulose, cellulose and lignin were determined. The NDF, ADF and cellulose contents of raw and cooked vegetables were found to be significantly ($P < 0.05$) different. Further, in order to find out an alternate method to freeze-drying, two drying temperatures viz. 50°C and 100°C were used to dry the samples. Lignin content significantly increased ($P < 0.05$) in the samples when dried at 100°C as compared to 50°C thus resulting in higher value of total fibre.

The amount of dietary fibre consumed in the daily diet in developed and developing countries is varying. The intake of dietary fibre in Punjabi diets has been reported as 29.4 g by Sadana *et al*[1]. Majority of our population depend on vegetables which are rich sources of dietary fibre. Since majority of the vegetables are cooked before consumption, the present investigation has been undertaken in order to find out the effect of cooking on fibre content. Moreover, heat drying of plant material, at temperature above 70°C has been reported to increase the fibre fraction[2] whereas according to AOAC[3], the drying temperature of vegetables is 100°C. The recent recommendation is to freeze-dry the samples for fibre estimation. Since the facility of freeze-drying is not available at this Institute, an attempt has been made to find out an alternative drying temperature, especially for cooked vegetables which contain more of moisture. So, the two main objectives of this study are to observe the effect of cooking vegetables on their fibre content and drying as alternative to freeze-drying of vegetables for fibre estimation.

The vegetables used for the study were cabbage *(Brassica oleracea)*, fenugreek *(Trigonella foenum-grecum)*, spinach *(Spinacia oleracea)*, carrot *(Daucus carota)*, onion *(Allium cepa)*, potato *(Solanum tuberosum)*, radish *(Raphanus sativus)*, bitter gourd *(Memordica charantia)*, bottle gourd *(Lagenaria vulgaris)*, brinjal *(Solanum melogena)* and cauliflower *(Brassica oleracea botrytis)*.They were purchased from the market, cleaned, washed and grated except for cabbage, fenugreek and spinach which were chopped. All these vegetables were divided into two parts. One part of each vegetable was cooked in pressure cooker. The pressure was raised to 15 lb within 8-10 min, after which further cooking was done for 2-3 min. These were again divided into two parts which were dried at 50°C and 100°C for about 8 hr. The other part of each vegetable was dried as such at 50°C in the hot air oven. The dried vegetables were ground finely in a grinder and stored in polythene bags for analysis. These vegetables were analysed for NDF, ADF, hemicellulose, cellulose and lignin by the method of Goering and Vansoest[2].

Effect of cooking: The data on NDF and ADF contents of raw and cooked vegetables are given in Table 1. The values are based on moisture free basis. The NDF and ADF contents

TABLE 1. NDF AND ADF CONTENTS OF RAW AND COOKED VEGETABLES (G/100G OF EDIBLE DRY MATTER BASIS) DRIED AT 50°C AND 100°C

Vegetables	Neutral detergent fibre			Acid detergent fibre		
	Raw	Cooked		Raw	Cooked	
	50°C	50°C	100°C	50°C	50°C	100°C
Cabbage	17.48	19.72	19.85	13.07	15.62	15.84
Fenugreek	18.11	19.67	19.21	14.31	15.74	15.56
Spinach	19.55	22.11	21.99	15.52	18.60	18.43
Carrot	14.10	15.88	15.45	12.76	14.19	14.00
Onion	7.93	9.32	8.74	6.93	8.10	7.30
Potato	4.21	5.25	4.77	3.41	4.35	3.93
Radish	17.39	20.12	18.42	10.74	12.91	11.49
Bitter gourd	16.53	18.54	18.94	13.54	15.51	15.92
Bottle gourd	17.57	20.73	20.48	14.85	17.75	17.36
Brinjal	18.89	21.15	21.23	15.18	17.20	17.82
Cauliflower	21.17	24.05	23.82	16.11	18.68	18.48

Each value is mean of two replicates
C.D. at 5% (for treatments) : NDF = 0.834, ADF = 0.917.

TABLE 2. HEMICELLULOSE, CELLULOSE AND LIGNIN CONTENTS (G/100 G OF EDIBLE, DRY MATTER BASIS) OF RAW AND COOKED VEGETABLES DRIED AT 50°C AND 100°C.

Vegetables	Hemicellulose			Cellulose			Lignin		
	Raw	Cooked		Raw	Cooked		Raw	Cooked	
	50°C	50°C	100°C	50°C	50°C	100°C	50°C	50°C	100°C
Cabbage	4 41	4.10	4.01	11.93	14.40	14.60	1.14	1.22	1.24
Fenugreek	3.80	3.93	3.65	12.11	13.43	13.00	2.20	2.31	2.56
Spinach	4 03	3.51	3.56	13.00	16.25	15.74	2.52	2.35	2.69
Carrot	1.34	1.69	1.45	10.57	11.75	11.48	2.19	2.44	2.52
Onion	1.00	1.22	1.44	6.21	7.30	6.17	0.72	0.80	1.13
Potato	0.80	0.90	0.84	2.81	3.54	2.84	0.60	0.81	1.09
Radish	6.65	7.21	6.93	9.12	10.98	9.06	1.62	1.93	2.43
Bitter gourd	2.99	3.03	3.02	11.17	12.88	12.75	2.37	2.63	3.17
Bottle gourd	2.72	2.98	3.12	12.30	14.79	14.01	2.55	2.96	3.35
Brinjal	3.71	3.95	3.41	12.12	14.25	14.70	3.06	2.95	3.12
Cauliflower	5.06	5.37	5.44	13.93	16.38	15.43	2.18	2.30	2.95

Each value is mean of two replicates
C.D. at 5% (for treatments) : Hemicellulose = 0.340, Cellulose = 1.022, Lignin = 0.295

were maximum in raw cauliflower and minimum in potato. There was significant ($P < 0.05$) increase in the contents of NDF and ADF in cooked vegetables. The hemicellulose, cellulose and lignin contents (Table 2) were maximum in raw radish, cauliflower and brinjal, respectively and minimum in potato. On cooking, the hemicellulose content increased significantly except for carrot and radish. The cellulose content increased significantly (P 0.05) on cooking. There was no effect of cooking on lignin content of the vegetables except in radish and bottlegourd. Matthee and Appledorf[4] have also reported that NDF, ADF and cellulose tended to increase on cooking while hemicellulose and lignin values are affected much. The starch resistant to hydrolysis may also be responsible for slightly higher values of fibre contents in some vegetables especially the cellulose fraction.

Effect of drying temperature on fibre content: The results of drying temperature (50°C and 100°C) of samples for estimation of fibre fraction in the cooked vegetables are given in Tables 1 and 2. There was no significant difference in the NDF, ADF, cellulose and hemicellulose contents when dried at two different temperatures in almost all the vegetables whereas the lignin content increased significantly ($P < 0.05$) in spinach, onion, radish, bittergourd and cauliflower when dried at higher temperature. This increase can be accounted for largely by the production of artifact lignin in non-enzymic browning reaction during drying of cooked vegetables at higher temperature.

It may be concluded that even the pressure cooking of vegetables may result in an increase in dietary fibre. Secondly, the drying of cooked samples at 100°C resulted in an additional increase especially in lignin content and that cooked vegetables may be preferably dried at 50°C as an alternative to freeze-drying for dietary fibre estimation.

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FIBRE CONTENT AND ITS COMPOSITION IN COMMONLY CONSUMED INDIAN VEGETABLES AND FRUITS

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Mean percentage of dietary fibre as neutral detergent fibre (NDF) on dry matter basis was highest in green leafy vegetables (22%) followed by other vegetables. Fruits which are eaten with outer peel and seed were rich in cellulose (63–71%). Vegetables and fruits which are eaten without outer peel and seed had high contents of hemicellulose (51.79%).

Consumption of dietary fibre (DF) has been found to cause non-infective degenerative diseases such as ischaemic heart diseases, diabetes, diverticular diseases of the colon, cancer of the colon and other diseases of gastro-intestinal tract[1]. High intake of DF reduces the absorption of nutrients and DFs from different sources have a wide range of properties of hydration[2], fermentation and digestibility[3]. In spite of such direct impacts, information on the DF and its components of commonly grown and consumed Indian vegetables and fruits is meagre. In the present study, the level of fibre and its components in commonly consumed Indian fruits and vegetables were determined.

The vegetables used for the study included cabbage *(Brassica oleracea* var *capitata)*, coriander *(Coriandrum sativum)*, fenugreek *(Trigonella foenum-grecum)*, mint *(Mentha spicata)*, mustard *(Brassica campestris)*, spinach *(Spinacia oleracea)*, carrot *(Daucus carota)*, onion *(Allium cepa)*, potato *(Solanum tuberosum)*, radish *(Raphanus sativus)*, turnip *(Brassica rapa)*, bitter gourd *(Momordica charantia)*, bottle gourd *(Lagenaria vulgaris)*, brinjal *(Solanum melongena)*, cauliflower *(Brassica oleracea botrytis)*, cucumber *(Cucumis sativus)*, chillie *(Capsicum annum)*, Lady's finger *(Abelmoschus esculentus)*, and ridge gourd *(Luffa acutangula)*.

Fruits used for the study included apple *(Malus sylvestris)*, banana *(Musa paradisiaca)*, gooseberry *(Emblica officinalis)*, guava *(Psidium guajava)*, lemon *(Citrus limon)*, mango *(Mangifera indica)*, papaya *(Carica papaya)*, peach *(Amygdalus persica)*, pear *(Prunus persica)*, plum *(Prunus domestica)* and tomato *(Lycopersicum esculentum)*.

Vegetables and fruits procured from the market, were cleaned, washed, edible portion sorted out and homogenized for analysis. Neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin were determined in triplicate by the method of Georing and Van Soest[4] from the edible portion of vegetables and fruits. The difference between NDF and ADF values was taken as hemicellulose. Content of cellulose was calculated by the difference between ADF and lignin. The results of NDF and its components were expressed on dry matter basis. Dietary fibre contents as NDF concentration of vegetables and fruits are given in Tables 1 and 2 respectively.

Green leafy vegetables: The mean concentration of NDF in green leafy vegetables was 21 per cent. The highest content

TABLE 1. NDF AND ITS CHEMICAL COMPOSITION ON DRY MATTER (DM) BASIS IN VEGETABLES.

Vegetables	NDF (%)	Composition of NDF		
		Cellulose (%)	Hemi-cellulose (%)	Lignin (%)
Green leafy vegetables				
Cabbage	14.80	66.21	22.29	11.50
Coriander	26.50	65.40	21.50	12.10
Fenugreek	17.00	65.50	21.00	13.50
Mint	20.00	66.00	22.00	12.00
Mustard	28.80	66.00	21.50	12.50
Spinach	20.00	65.80	21.50	12.70
Mean	21.18	65.82	21.63	12.55
S.D.	±5.43	±0.30	±0.52	±0.73
Root & tubers				
Carrot	14.86	71.70	13.05	15.25
Onion	10.00	12.00	79.70	9.10
Potato	5.00	29.00	70.80	0.20
Radish	19.00	50.00	38.10	11.90
Turnip	12.00	64.60	25.49	10.00
Mean	12.1	45.46	45.41	9.29
S.D.	±5.24	±24.83	±29.82	±5.60
Other vegetables				
Bitter gourd	14.00	69.00	18.00	13.10
Bottle gourd	13.11	70.30	15.00	14.70
Brinjal	16.29	62.20	22.00	15.58
Cauliflower	20.31	62.90	26.80	10.30
Cucumber*	14.30	69.70	16.30	14.00
Gaint chillies	13.80	33.48	61.52	5.00
Lady's finger	15.30	65.00	24.00	11.00
Ridge gourd*	13.51	70.00	17.00	13.00
Mean	15.08	62.82	25.08	12.09
S.D.	±2.35	±12.30	±15.29	±3.36

*Peeled samples were taken.

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TABLE 2. NDF AND ITS CHEMICAL COMPOSITION ON DRY MATTER (DM) BASIS IN FRUITS

Fruits	NDF (%)	Composition of NDF		
		Cellulose (%)	Hemi-cellulose (%)	Lignin (%)
Apple	8.00	67.00	31.00	2.00
Banana	5.66	21.00	65.00	14.00
Gooseberry	13.00	60.00	37.00	3.00
Guava	19.80	28.00	46.30	25.70
Lemon	20.64	45.90	6.10	48.00
Mango	6.30	24.50	52.00	23.50
Papaya	7.50	22.00	55.00	23.00
Peach	15.50	14.00	66.00	20.00
Pear	15.19	26.00	56.00	18.00
Plum	10.00	16.00	63.00	21.00
Tomato	20.10	39.30	48.00	22.70
Mean	12.83	40.13	47.76	20.08
S.D.	±5.74	±19.97	±17.71	±12.24

of NDF was in mustard (28 per cent) and lowest in cabbage (14.80 per cent). The values of NDF obtained for coriander and fenugreek were close to the values reported by Prema *et al*[5]. The chemical composition of NDF for green leafy vegetables showed that they contained a higher concentration of cellulose than that of hemicellulose. The mean lignin content as per cent of NDF was about half that of hemicellulose and one fifth that of cellulose. Southgate[6] also recorded the same proportion among different components in spinach, cabbage and mustard leaves. Although, no values seem to be available for mint and fenugreek, the values found in the present investigation are very close to the values reported for other green leafy vegetables.

Roots and tubers: Among the roots and tubers, potato had the lowest (5 per cent) and carrot had the highest (14.86 per cent) NDF content. The values of NDF in radish and onion recorded in our study are close to those of Prema *et al*[5]. Southgate[6] reported that carrot, onion, potato and radish had 9.2, 7.60, 25.00 and 14.3 per cent NDF respectively. The values obtained in the present investigation for carrot, onion and potato are higher and for radish lower than those reported by Southgate[6]. This variation can be attributed due to the maturity stage and genetic make up of the plants.

Like green leafy vegetables all the tubers evaluated were rich in cellulose excluding onion and potato which contained 12 and 29 per cent cellulose as a per cent of NDF respectively. On the other hand, a high concentration of hemicellulose as per cent of NDF was found in potato and onion (70.0 to 79.7 per cent). The ratio between cellulose and hemicellulose was not the same in all tubers.

Other vegetables: Concentration of NDF in other vegetables was found maximum in cauliflower and minimum in ridge gourd. Southgate[6] reported the values for cauliflower and peeled cucumber to be 20.31 and 14.30 per cent respectively. The value of NDF for cauliflower in the present study was also found to be very close to the values reported by Prema *et al*[5]. Like green leafy vegetables, other vegetables with the exception of gaint chillie were also rich in cellulose.

Fruits: Composition of NDF among fruits too showed variation, and the concentration of cellulose was found to be high in gooseberry and apple followed by citrus fruits. Hemicellulose as per cent of NDF was high in banana, peach, pear, papaya and mango. The corresponding values were comparatively low in citrus fruits. In tomato and guava the concentration of hemicellulose was intermediate. Lignin content was higher than cellulose in citrus fruits but was minimum in gooseberry and apple. Southgate[6] recorded slightly lower values than found in the present study. This may be due to variations in locality and maturity of fruits.

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NUTRIENTS IN WILD MUSHROOM *CLITOCYBE MULTICEPS* (PECK)

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Nutrients such as proteins, amino acids, sugar, vitamins and fat were estimated during the peak growing season from June to August in *Clitocybe multiceps*. The analyses were done separately on pileus and stipe which contain more of the nutrients. Pileus contains higher amounts of proteins, amino acids, ascorbic acid, thiamine and fat than the stipes, while sugar content is higher in stipes. Though the contents of nutrients in pileus and stipes are different, total contents of nutrients in mushroom are higher than other edible wood-rotting mushrooms of Manipur.

Clitocybe multiceps (Peck) is one of the rare mushrooms found in Manipur. It grows at the humidity range of 70-90 per cent and temperature of 21°C−28°C. It is a white spored agaric and world wide in distribution. It is found growing on decaying wood, tree branches, trunks and roots. This species is cream or white and consists of two parts, stipe (stalk) and pileus (cap). The length of the stipe varies from 2.5 to 13 cm and the stipe is elastic in texture, spongy within and fibrous outside. The fibres are bound each other completely even when the stipe is twisted or broken. Thickness of the stipe varies from species to species and the pileus is soft while the stipe is fibrous. Due to its fibrous structure, people at Thanglon, about 70 km from Imphal prefer to consume only pileus. However, most people consume the whole mushroom and consider it to be one of the most delicious mushrooms. The present paper deals with the determination of nutrients such as proteins, amino acids, sugars, fat and vitamins.

Mature *Clitocybe multiceps* was collected from the decaying host wood, *Mangifera indica*, and pileus and stipes of the mushroom were separately analysed. Protein was analysed by the method of Lowry *et al*[1]. Total amino acid estimation was done by ninhydrin method of Moore and Stein[2]. For the estimation of reducing sugars, Nelson's modification of Somogy's method[3] was employed. Determination of non-reducing sugars was done according to Malhotra and Sarkar[4]. The method of analysis of fat was determined by A.O.A.C. method of Leslie Hart and Fisher[5]. Extraction of thiamine was according to Paech and Tracey[6] and ascorbic acid was estimated by visual titration method based on the reduction of 2-6 dichloroindophenol dye[7].

The data given in Table 1 indicate that there is a significant difference in nutrient content of pileus and stipes and that the contents of proteins, amino acids, fat, thiamine and ascorbic acid were higher in pileus than stipes while reducing and non-reducing sugars were found higher in stipes than pileus. Though there are differences in the nutrient contents of pileus and stipes, the mushroom is found to show high nutritional value.

Total amino acids and proteins of pileus of *C. multiceps* were found significantly higher than stipes. Similar observations were made by Paranjpe *et al*[8]. in *Agaricus bisporus*. High level of total amino acids and proteins in the edible mushrooms including *Clitocybe nebularis* and *Agaricus campestris* have also been reported by some workers[9-12]. Presence of different amounts of proteins in pileus and stipes of *C. multiceps* have shown that this mushroom is a good source of proteins.

Difference in the concentration of sugar in the pileus and stipes of *C. multiceps* has been reported by Yoshida[13]. He reported that in the pileus and stipes of *Lentinus edodes*, the content of each component varied independently during development and thus bringing a marked difference between pileus and stipes.

The present analysis also showed the presence of more fat in the pileus than stipes. Higher fat content in the pileus might

TABLE 1. NUTRIENT CONTENTS OF *CLITOCYBE MULTICEPS*

Mushroom part	Sample	Proteins (g%)	Amino acids (g%)	Reducing sugars* (g%)	Non-reducing sugars (g%)	Fat* (g%)	Thiamine (g%)	Ascorbic acid (mg/100 g)
Pileus	1	4.902	4.891	0.597	0.309	33.6	0.447	14.7
	2	4.900	4.792	0.582	0.311	34.0	0.449	14.0
Stipe	1	2.110	2.373	0.606	0.459	27.4	0.394	5.88
	2	2.100	2.360	0.611	0.445	27.5	0.401	5.78

Average of pentareplicate determination of 2 samples of each of pileus and stipe.

*On dry wt basis.

be due to the accumulation of fat globules in the spores present in the gills of pileus[14]. The total fat in *C. multiceps* was found to be 61.0 per cent on dry basis. Such high accumulation of total fats in mushrooms was reported to be poisonous[15]. However, toxicity of *C. multiceps* has never been reported by many consumers. It might be containing a high percentage of linoleic acid since Ofenbeher and Miric[16] reported that edible mushrooms had a high linoleic acid content. It was also reported that the nutritional value of mushroom fat is very high because of a high content of the essential fatty acids and ergosterol[17].

Mushrooms are good sources of thiamine, riboflavin, niacin, vitamin B_6 and folic acid[18]. According to the present analysis, the relative amounts of thiamine varied slightly in pileus and stipes. The pileus of *C. multiceps* showed slightly higher thiamine than stipes and this agrees with the data of various workers[19-21]. Though pileus has more of thiamine, *C. multiceps*, on the whole may be regarded as one of the vitamin B_1 rich mushrooms. Pileus of this mushroom is found to have higher per cent of ascorbic acid than stipes and this finding has also been supported by Yokokawa[21]. Presence of ascorbic acid in some edible mushrooms has been reported earlier by some workers[22,23].

Hence, the above studies revealed that *C. multiceps* is one of the nutritious edible mushrooms.

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BLENDING OF SOY MILK WITH BUFFALO MILK FOR PREPARATION OF SOY CURD*

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Soymilk (SM) was blended with buffalo milk (BM) with 6% fat in different combinations viz. 100% BM, 25% SM, + 75% BM, 50% SM + 50% BM, 75% SM + 25% BM and 100% SM. The average values for specific gravity ranged from 1.019 to 1.036, for viscosity from 1.3943 to 2.5337 cp and for fat from 1.02 to 6.00%. However, curd strength ranged from 6.40 to 39.40 g, total solids 7.91 to 16.38%, pH 4.24 to 5.00 and acceptability of product scored from 3.12 to 7.24 points out of 9 points. All the properties except pH showed decrease in the average values with the increase in the proportion of soymilk in blends. The quality evaluation expressed that 25% SM + 75% BM curd was at par with the curd from 100% BM and superior over other blends. The curd evaluation score for 50% SM + 50% BM, 75% SM+ 25% BM and 100% SM was statistically at par.

Bovine milk is a good source of dietary protein but its use is restricted among persons with heart disease and those who are prone to allergy. Due to the high cost of this protein, it is out of reach of economically weaker sections of society.

Soymilk can be used as a milk extender. It is recommended for lactose intolerant infants and malnourished children. It is a cheaper source of high quality protein and its usefulness was proved for treatment of protein deficiency among under-nourished pre-school children[1]. The weight gains in rats fed on rice and SM were equal to those fed on rice and CM[2]. However, main objection for utilization of SM as supplementary food among Indians was its characteristic beany flavour. Utilization of SM in combination with BM for preparation of khoa, channa and soft ice cream[3], flavoured milk[4] and dahi-like products[5] was investigated.

In our country, 7 per cent of total milk produced is utilized for curd preparation[6] in rural and urban areas. The biological value of protein in curd being high is easily absorbed in the body. In our country, curd is extensively prepared from BM as compared to CM due to its high fat and total solids content as well as it gives firm curd. Various workers prepared fermented milk products such as Yoghurt[7], acidophillus milk and soymilk. The latter was sterilized at 120°C for 30 min, cooled and inoculated with *L. acidophillus* NRRL B-269 and incubated at 37°C for 24 hr. The resulted fermented soybean milk tasted good after addition of sugar and vanilla flavouring[8]. Earthen pots were used for curd preparation under laboratory conditions. With this in view, the use of SM and BM blends for preparation of curd was explored.

BM was procured from University dairy farm and standardised to 6 per cent fat level with Pearson's formula using BM skim milk. It was then pasteurized at 72°C for 15 min and cooled to room temp. (30 to 31°C). The plain sterilized SM was obtained from M/S Soyghurt Food Products, Nagpur and stored in refrigerator. SM contained 2.70-3.70 per cent protein 0.30-1.20 per cent fat, 2.00-3.00 per cent carbohydrates, 5.50-8.60 per cent total solids and 0.13 to 0.16 per cent acidity. The fat, SNF and TS contents of BM ranged from 6.58 to 8.40 9.60 to 10.35 and 16.30 to 18.68 per cent, respectively. Blending of SM and BM was made on volume basis. viz. 100 per cent BM (T_1), 25 SM + 75 per cent BM (T_2), 50 SM + 50 per cent BM (T_3), 75 SM + 25 per cent BM (T_4) and 100 per cent SM (T_5). Specific gravity of blends was estimated by AOAC method[9]. Hoppler rolling ball method was used for determining viscosity as described by Tambat and Srinivasan[10] whereas the fat was estimated by ISI method[11].

These blends were used for curd preparation in earthen pots (2 l capacity) dipped in 10 per cent chlorine solution for 5 min. Fresh culture of *Streptococcus lactis* and *Lactobacillus bulgaricus* (mixed type 1:1) was procured from dairy bacteriology laboratory of this department and inoculated at the rate of 0.1 per cent of milk and incubated at 37 ± 1°C, for 12 hr in incubator.

Curd strength was estimated as per Rao *et al.*[12] Total solids and pH were determined as per the methods detailed in ISI.[13-14] Overall acceptability of curd was evaluated on a 9- point Hedonic scale[15] by five judges. Five treatments were replicated five times and results were statistically analysed under randomised block design as per Snedecor and Cochran[16].

It is seen from Table 1 that with the increase of SM proportion in the blends, specific gravity and viscosity decrease. This is corroborated with the proportion of fat and total solids of SM which was directly affecting these two parameters. Kothari[17] reported average specific gravity for SM ranging from 1.012 to 1.022. Chandra and Roy[18] obtained positive correlations between viscosity and fat content. Similar trend is also observed in the present study.

The highest fat (6 per cent) was obtained in T_1 and lowest (1.02 per cent) in T_5 treatment. This shows that fat content in SM and BM played a vital role in respect of specific gravity and viscosity of different blends.

It is seen that the average values of curd strength ranged from 6.40 to 39.40 g for T_5 and T_1, respectively. It is

*Part of research work was carried out by first author for M.Sc. (Agri.)

TABLE 1. EFFECT OF SOYMILK AND BUFFALO MILK COMBINATIONS OF VARIOUS PARAMETERS OF BLENDED MILK* AND CURD PREPARED FROM THE BLENDS

Soymilk (%)	Buffalo milk (%)	Blended milk			Curd from blends			
		Sp gr	Viscosity (cp)	Fat (%)	Curd strength (g)	Total solids (%)	pH	Acceptability score+
–	100	1.036	2.5337	6.00	39.60	16.38	4.24	7.24
25	75	1.033	2.2943	4.73	13.40	14.32	4.44	6.16
50	50	1.029	2.0148	3.50	9.40	12.04	4.62	4.92
75	25	1.023	1.8557	1.80	8.40	10.01	4.78	3.52
100	–	1.019	1.3943	1.02	6.40	7.91	5.00	3.12
CD	–	0.002*	0.271*	0.196*	1.440*	0.335*	0.133*	1.578

*Significant at 1% level +Maximum score is 9

observed that with the increase in the proportion of SM in the combinations, there was decrease in curd strength, the reason being the lower fat and total solids contents in SM. Ismail and Salam[19] reported that with the increase in the total solids content of curd, there was an increase in curd tension values of 32.25 and 29.05 g for pasteurized and unpasteurized buffalo milk curd, respectively. They also reported that higher the fat, SNF and TS contents in milk higher was the curd tension.

The highest (16.38 per cent) total solids were found in T_1 and lowest (7.91 per cent) in T_5 curd. It was revealed that with the increase in SM, there was decrease in total solids. This is attributed to lower total solids in SM. This is also the reason for lowering curd strength as SM was increased in the blends.

The highest (5.00) and lowest (4.24) pH values were recorded in T_5 and T_1 treatments, respectively. The acidity content of SM used in the present study ranged from 0.13 to 0.16 per cent. This has contributed to the pH values of the curd prepared from various blends. Angles and Marth[20] reported the pH values of 5.93 and 5.40 for curd prepared from SM and cow milk, respectively. The values recorded in the present study are slightly lower due to SM, culture variations and incubation period used in the study. Rangappa and Achaya[21] reported that good quality curd should have pH values of 4.60 to 5.02.

The acceptability score showed diminishing trend for curd with the increase of soymilk in the combinations. The T_1 scored maximum (7.24) while T_5 scored minimum (3.12) points. During the study, it is observed that, the use of SM above 50 per cent proportion with BM imparts beany flavour to the curd. There is also whey separation with the increase in SM in the curd. Thus, it is revealed from above observations that, the BM can be substituted with SM upto 25 per cent for good quality curd preparation, although Duragkar[22] reported that BM can be substituted with SM to the extent of 50 per cent. Deka and Rajor[5] reported high acceptability of Dahi-like product prepared from soy solids and butter milk in the ratio of 1:1.5.

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PHYSICAL AND CHEMICAL CHARACTERISTICS OF SOY MILK

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The physical and chemical characteristics of soy milk prepared from different varieties of soybean were determined. The colour of milk prepared from different varieties ranged from whitish to greyish white. The ranges of different characteristics for various soy milk samples were: total solids 5.16–5.96%, protein 2.38–2.95%, pH 6.3–6.7, % titratable acidity 0.13–0.17, specific gravity 1.01–1.03, viscosity 4.5–5.0 cp, surface tension 102.10–111.79 dynes/cm and freezing point −0.7 to 0.8°C.

Soy milk is a popular drink of East Asian countries. It is becoming popular in many countries of the world[1,2]. It was introduced in India in mid seventies to supplement and/or extend milk supply. At present, 8-10 brands of soy milk are marketed in the country. Soy milk is not a standardized product. Varietal differences[3] and processing conditions such as method of hydrating beans[4,5], bean to water ratio[6], extraction temperature[7,8] influence the composition and quality characteristics of soy milk. There is very limited information on quality parameters of soy milk. In the present paper, physical and chemical characteristics of soy milk prepared from different varieties are reported.

Dry mature seeds of varieties-'PK 308' 'PK 416', 'Alankar Ankur' and 'Kalitur' were obtained from the Department of Plant Breeding of this University. The seeds were cleaned, graded and dehulled. Soy milk was prepared according to the procedure described by Nasim *et al.*[9] with the modifications that beans were blanched for 5 min in boiling water and 125 g of soy dhal per litre of water was used for grinding.

Moisture and protein (N×6.25) in soy milk were determined according to AOAC procedures[10]. Colour of soy milk was recorded visually. Specific gravity of soy milk was estimated at 25±2°C according to the method described by Ranganna[11] using specific gravity bottle. Viscosity was measured in centi poise at 25±2°C with Brookfield synchro-Lectric viscometer using spindle No.1 and speed of 60 r.p.m. A factor of 1.0 as specified by the manufacturer was used. Surface tension was determined using capillary rise method[12]. Freezing point was estimated using Hortvit Cryoscope according to AOAC procedure[10]. The pH of the samples was determined using a systronics pH meter.

Soy milk samples prepared from different varieties differed in their physical and chemical characteristics (Table 1). The colour of milk prepared from varieties 'PK 308' and 'PK 416' was whitish as against yellowish white for 'Ankur' and greyish white for 'Kalitur'. The milk prepared from 'Alankar' variety exhibited a slight greenish taint. The total solids and protein in soy milk obtained from different varieties ranged from 5.16 to 5.96 and 2.38 to 2.95 per cent respectively. Variety 'PK 308' contained maximum total solids and proteins, whereas the variety Kalitur contained the minimum.

The pH and per cent titratable acidity values for different soy milk samples were in the range of 6.30-6.70 and 0.13-0.17, respectively. More or less similar values for these characteristics have been reported earlier[13-15]. The specific gravity values (1.010–1.030) recorded in this investigation for different soy milk samples are within the range (1.008–1.110) reported earlier[16,17]. Soy milk obtained from variety 'PK

TABLE 1. PHYSICAL AND CHEMICAL CHARACTERISTICS OF SOY MILK PREPARED FROM DIFFERENT VARIETIES[1] OF SOYBEAN

Variety	Colour	Total solids (%)	Protein (%)	pH	% titratable acidity	Sp. gr	Viscosity (Cp)	Surface tension (dynes/cm)	Freezing point (°C)
PK 308	Whitish	5.96	2.95	6.4	0.13	1.030	5.0	109.40	−0.7
PK 416	Whitish	5.40	2.42	6.2	0.14	1.020	5.0	107.02	−0.7
Alankar	Greenish white	5.79	2.81	6.7	0.17	1.020	4.5	111.79	−0.7
Ankur	Yellowish white	5.44	2.77	6.3	0.16	1.010	5.0	104.54	−0.7
Kalitur	Greyish white	5.16	2.38	6.7	0.17	1.010	4.5	102.10	−0.8

[1]Average of two determinations

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308' showed higher specific gravity presumably because of its higher total solids as compared to soy milk prepared from other varieties.

The viscosity of different soy milk samples ranged from 4.5 to 5.0 cp. Nelson *et al.*[8] have reported a higher value of 6.3 cp for soy milk. The surface tension of different soy milk samples ranged from 102.10 to 111.79 dynes/cm. Soy milk prepared from variety 'Alankar' exhibited maximum surface tension, whereas the variety 'Kalitur' showed the minimum. The freezing po:nt of different soy milk samples was −0.7°C with the exception of soy milk prepared from variety 'Kalitur' which exhibited a freezing point of −0.8°C.

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EFFECT OF PROCESSING ON NATIVE PROTEINASES IN MILK

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The activity of native proteinases in aseptically drawn milk was studied in relation to the processing treatments of milk. The increase in non-protein nitrogen (NPN) content of milk during incubation at 37°C was chosen as a measure of proteinase activity. The breakdown of proteins leading to increase in NPN was estimated by micro-kjeldhal technique. The milk proteinases appeared to be partly resistant to certain processing treatments like chilling, homogenization and pasteurization. These enzymes can, therefore, cause proteolysis in processed milks. Heat processing above 80°C completely inactivated this enzyme.

In milk, native proteinases (plasmin and plasminogen) are responsible for the hydrolysis of β-casein to γ-casein[1]. Although proteinases hydrolyse solutions of αs_2 and αs_1 caseins, only few specific proteolysis products have been characterized[2]. Relatively little is known on the effect of heat treatments such as pasteurization on proteinase activity and on their activators and inhibitors in milk. A 30-40 per cent increase in the endogenous proteolytic activity of pasteurized milk was attributed to inactivation of trypsin inhibitors as a result of pasteurization[3]. In our observations[4] on native proteinases, it was noticed that milk from crossbred cows contained very high native proteinase activity as compared to the values reported elsewhere. In this investigation, the changes in endogenous proteinase activity that occurs as a consequence of pasteurization and other normal processing treatments to which milk was subjected are examined.

Cow and buffalo milk samples were obtained under sterile conditions and were treated with 0.02 per cent merthiolate to avoid microbial interference. The samples were skimmed by centrifugation at 4°C and 7000 rpm for 15 min. The skim milk thus obtained was subjected to various processing treatments like chilling (4°C for 48 hr), homogenization (60°C for 10 min.) pasteurization (71.5°C for 15 sec), forewarming (80°C for 10 min), and sterilization (120°C for 15 min). Native proteinase activity that occurs as a conseqence of the above processing treatments was estimated using an assay developed for determination of proteinase activity where increase in non-protein nitrogen (NPN) during incubation of milk at 37°C for 5 days was used as a measure of proteinase activity[3,5].

TABLE 1. EFFECT OF DIFFERENT PROCESSING TREATMENTS ON NON-PROTEIN NITROGEN CONTENT OF MILK DURING INCUBATION AT 37°C FOR 5 DAYS (Mg/l)

Treatment	Cow milk+	Buffalo milk+
Control	70.2	55.0
Chilling	28.2	22.2
Homogenization	35.5	42.6
Pasteurization	18.3	18.9
Forewarming	0.2	0.4
Condensation	0.0	0.0
Sterilization	0.0	0.0
(F test) C.D. at 5%	7.601**	9.164**

\+ Mean values of 5 replications
** Significant at 1% level

The native proteinase activity as measured by increase in NPN in milk after subjecting to processing treatments and incubation for 5 days at 37°C is presented in Table 1. The results indicate that forewarming (80°C for 10 min) almost completely inactivates native proteinase activity in milk. Similarly, sterilization of milk ensured total inactivation of native proteinase activity in milk, as indicated by no increase in NPN during incubation of these samples.

However, in case of homogenized milk and pasteurized milk only partial inactivation of native proteinase was noticed. About 50 and 73 per cent (as that of control which is raw milk without any processing treatment) increase in NPN for cow and buffalo milk in case of homogenization (60°C for 10 min) was noticed during incubation at 37°C. The increase in NPN in case of pasteurised milk was comparatively less than that of homogenized milk. As seen from the results in Table 1, the increase in NPN was about 25 per cent and 35 per cent of that in control, for cow and buffalo milk respectively. The reduced proteinase activity corresponded well with increase in temperature. Moreover, other workers[6] in their study on kinetics of inactivation of native proteinases in milk observed that denaturation of β-lactoglobulin, releasing free SH groups would lead to formation of β-lactoglobulin-kappa casein complex which does not allow the proteinase to act on caseins and so causes reduced activity in heated milks. They also concluded that heat treatment may unfold the major native proteinases plasmin and plasminogen leading to progressive inactivation of these enzymes. Pasteurization will cause partial denaturation of β-lactoglobulin while forewarming denatures it to a greater extent. Heating upto 90°C for 10 min and sterilization temperature will completely denature β-lactoglobulin and release maximum SH groups. Thus, native proteinase activity is completely inhibited at these higher heat processing conditions. Interestingly, chilling of milk (5°C for 48 hr)

showed reduced proteinase activity, about 40 per cent of the control raw skim milk. This could be due to proteinase inhibitors being very active to chilling conditions, thus restricting the conversion of less active plasminogen to more active plasmin and reducing the native proteinase activity. Reports further indicate that dissociation of β-casein by proteinases to form γ-casein is minimum under chilling conditions compared to that at room temperature (37°C)[7].

Our findings[4] on native proteinase activity in milk showed that both cross-bred cow milk and buffalo milk possessed very high native proteinase activity as compared to that reported in Western breeds. Hence, it is very uncertain whether the conditions used for UHT processing of milk in Indian dairies is enough to inactivate all the native proteinases in milk. This aspect needs to be further studied in depth.

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DEVELOPMENT AND EVALUATION OF WEANING FOOD FORMULATIONS

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Four weaning foods namely, RGB – Rajkeera: green gram: Bengal gram dhal, BRB - bajra : rice flakes: Bengal gram dhal, JSB – Jowar: Soy bean: Bengal gram dhal, JPG–Jowar: puffed Bengal gram: green gram mixes were formulated and evaluated for sensory parameters. The weaning foods supplied 349 to 362 kcal and 12.6 to 17.2 g of protein per 100g. Among the four weaning foods RGB had the highest calcium and iron contents and the maximum per cent digestibilities of proteins and carbohydrates.

Malnutrition is widespread in most developing countries and the condition is particularly serious in children below three years of age[1]. It is estimated that between 30 and 50 per cent of the children in this group are malnourished.

Breast milk is adequate to meet energy and nutrient requirements of an infant upto the first six month of age. Thereafter, breast milk is insufficient to sustain normal growth of an infant and needs to be supplemented with other foods such as weaning foods. Therefore, there is a need to develop weaning foods. The present study was undertaken to develop and to evaluate the weaning foods using locally available foodstuffs.

Jowar *(Sorghum vulgare)*, bajra *(Pennisetum typhoideum)*, rajkeera *(Amaranthus peniculatus)*, green gram *(Phaseolus aureus* Roxb), Bengal gram *(Cicer arietinum)* dhal, soybean *(Glycine max)* and rice *(Oryza sativa)* flakes were the selected foodstuffs for the development of weaning foods. These foodstuffs were cleaned and processed as shown in flow chart (Fig. 1).

Twelve weaning foods were formulated using different proportions of the processed foods. From these, four namely, RGB-Rajkeera: greem gram: Bengal gram dhal (2:0.5:0.5), BRB - Bajra: rice flakes: Bengal gram dhal (0.5:0.5:1.0), JSB - Jowar: soybean: Bengal gram dhal (2.0:0.5:0.5), and JPG - Jowar: puffed Bengal gram dhal: green gram (2.0:0.5:0.5) were selected on the basis of specific sensory quality. The panel members were selected by conducting threshold test[2]. The selected weaning foods were evaluated for the sensory quality using numerical scoring test[3] by the panel members.

Energy value of the weaning foods was calculated as per the values reported for different foods by ICMR[4]. The protein and the total iron contents of the weaning foods were estimated by the standard methods of AOAC[5]. Titrimetric method given by NIN[6] was used to estimate total calcium content of the weaning foods. Non-protein nitrogen (NPN) was estimated by the method of Lees[7]. *In vitro* digestibilities of proteins and carbohydrates were assessed by the method of Akeson and Stahmann[8] and by dinitrosalicylic acid method of Bernfeld, respectively. The results were subjected to analysis of variance of one way classification and critical difference test[10].

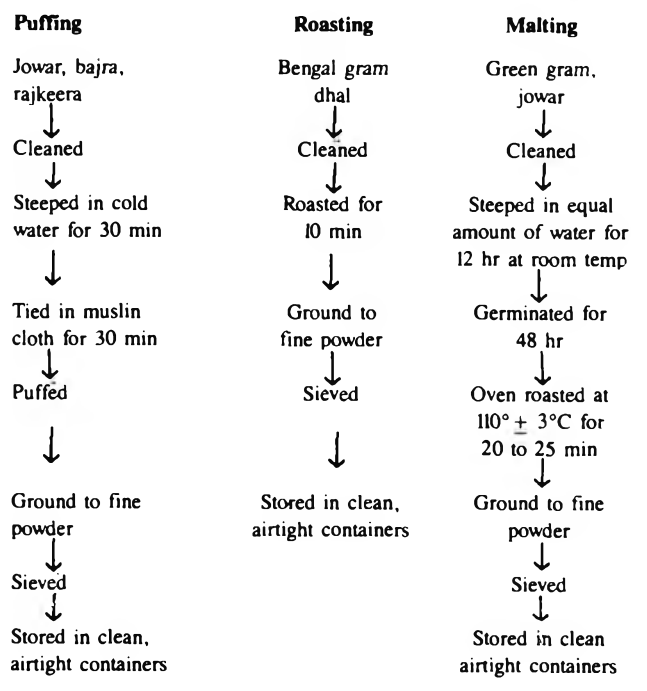

Fig. 1. Flow chart showing different steps followed in processing of foods.

The mean scores of different sensory parameters of the weaning foods are shown in Table 1.

Among the four weaning foods, JSB was found to be significantly superior to other three by its higher scores for colour, taste, and texture, next in order was RGB mix. BRB and JPG mixes had obtained the least scores for all the

TABLE 1. SENSORY SCORES OF THE WEANING FOODS

Weaning food	Colour	Flavour	Texture	Average scores
RGB	3.50	3.50	3.37	3.45
BRB	2.47	2.91	3.30	2.89
JSB	3.53	3.50	3.50	3.51
JPG	2.92	2.70	2.99	2.87
S.E.	0.005	0.01	0.01	—
C.D. at 0.05%	0.017	0.025	0.025	—

Scale

Excellent – 4, Good – 3, Fair – 2, Poor – 1.

characteristics and hence were considered to be least acceptable.

The results of nutritional evaluation of the weaning foods are presented in Table 2. The calories supplied by 100 g of weaning foods varied from 349 to 362 kcal. BRB and JSB were found to have the same calorific value. The protein content of RGB was highest (17.2 g per cent), JPG recorded the lowest protein content (12.6 g per cent). With regard to the calcium content, RGB mix markedly differed from the other three mixes and had the highest calcium content (184 mg per cent). The amount of total iron provided by the weaning foods varied from 7.73 to 13.23 mg per 100g. The iron content was maximum in RGB (13.23 mg per cent) and minimum in JPG (7.73 mg per cent). Every form of damage to the protein during processing is the transformation of non-protein nitrogen to other forms[11]. The low non-protein nitrogen (NPN) contents (0.9 to 0.58 per cent) of the weaning foods suggest that processing did not damage the proteins. In general, it was observed that the weaning foods had good calorific value and their protein content was adequate to fulfil the requirements set by ICMR[12].

In vitro digestibility of true proteins of the weaning foods is given in Table 3. The protein digestibility of the weaning foods varied from 53.48 to 86.07 per cent. Among the four developed weaning foods, RGB registered the highest per cent digestibility of proteins (86.07) and JPG the lowest (53.48).

Carbohydrate digestibility of the weaning foods as judged by the release of maltose ranged from 14.4 to 17.8 mg per cent (Table 4), with RGB showing the highest value (17.8 per cent) and BRB the lowest (14.4 per cent).

TABLE 2. NUTRITIVE VALUE OF THE WEANING FOODS, (PER 100 G)

Weaning food	Energy (kcal)	Protein (g)	Calcium (mg)	Total iron (mg)
RGB	359	17.2±0.02	184±0.03	13.28±0.01
BRB	362	12.9±0.02	56±0.03	9.48±9.48
JSB	362	15.3±0.02	23±0.03	10.53±0.01
JPG	349	12.6±0.02	25±0.03	7.73±0.01

*Values calculated as per theoretical values.

Values are means of six replications with ± S.E.

TABLE 3. *IN VITRO* DIGESTIBILITIES OF PROTEINS AND CARBOHYDRATES OF THE WEANING FOODS

Weaning food	Digestibility of proteins (%)	Digestibility of carbohydrates (mg %)
RGB	86.07 ± 0.11	17.8 ± 0.01
BRB	78.68 ± 0.11	14.4 ± 0.01
JSB	65.00 ± 0.11	16.8 ± 0.01
JPG	53.48 ± 0.11	17.1 ± 0.01

Values are means of six replications with ± S.E.

These values were higher than those reported by Chandrsekhar *et al*[13].

Thus, Rajkeera: Green gram: Bengal gram weaning food was found to be superior to other three weaning foods.

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The present book is part of the three volume proceedings containing the papers and posters presented at the Fifth International Congress on Engineering and Food held at Cologne FRG, during 28 May -3rd June 1989. The Congress was organized by a working group of the Federal Research Centre for Nutrition, Karlsruhe, Germany. The third volume, which is the book under review, comprises of advanced technologies such as extraction, membrane separation, extrusion, bio-techniques, fermentation and recycling of waste.

In the extraction category, most of the papers are product specific such as oil extraction from flaked soybeans, soybean oil extraction, separation processes for spirulina, to name a few. There are also very interesting papers on the equipment aspects, notably effects of axial dispersion during solid-liquid extraction, aroma loss and recovery during falling film evaporation and flavour recovery using the Austalian Spinning Cone Column. Super critical extraction has accounted for a number of other contributions.

Membrane processes viz; ultrafiltration electro-dialysis and pervaporation constitute a very thought provoking segment of the book. Membrane techniques also form a significant grouping among papers in the wastewater treatment category. The major segment of the book has been devoted to fermentation including treatment of food processing wastes. There are a number of interesting papers highlighting novel reactor engineering such as modelling of the dialysis membrane reactor and RTD of twin screw extruder as a reactor. The other articles mostly deal with more conventional process related topics like enzymatic and cocoa bean fermentation and the use of aerobic and anaerobic processes for wastewater treatment.

The most significant aspect of the book is that it provides a spectrum of modern food processing but only as a valuable exposure for a researcher. It is well edited and is recommended for libraries devoted to Food Processing R&D.

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REGIONAL RESEARCH LABORATORY
TRIVANDRUM

Drug Biotechnology Regulation — Scientific Basis and Practices: Edited by Yuan-yuan H. Chiu and John L. Gueriguian). Marcel Dekker Inc. New York; 1991; pp:592, Price: $ 135 (USA) & Canada), $ 155 (All other countries).

In recent years, the area of Molecular Biology and Biotechnology is expanding at an unprecedented scale. The discoveries and perfection attained in recombinant DNA technology have provided impetus to the application of biotechnological tools into almost all spheres of scientific activities — be it agriculture, health, industry or environment. Of all these, the greatest impact is being realized in the area of pharmaceuticals. Consequently, a number of recombinant DNA technology based drugs are already available in the market and many more are in the pipeline. Since these activities directly have a bearing on human health, it is understandable that greater care must be taken in commercializing these products. Obviously, therefore, this would need formulation of rules and regulations which must be scrupulously followed by the manufacturer, distributor and health departments for monitoring the impact of these drugs.

The present compilation, provides latest indepth coverage of various processes involved in the use of recombinant DNA technology for the production of drugs and an account of rules and regulations framed by Food and Drug Administration (FDA) USA for manufacture and marketing of such drugs. The book is divided into two main parts. The first part deals with "Experiences of the Past" and embodies sections such as 'Biological Production System', 'Production Facilities', 'Drug Manufacture', 'Characterization of Proteins from Recombinant DNA Manufacture', 'Food and Drug Administration Inspection and Licensing of Manufacturing Facilities', 'Safety and Efficacy Evaluation of Recombinant DNA Products', and 'Industry's View on Government Regulatory Activities'. Each section contains a number of chapters written by scientists directly involved in practising the art of Biotechnology. The second part of the book deals with 'Future Prospects' and covers the areas of 'Potentially Useful Biological Production Systems', 'Second Generation Products', 'International Harmonization Among Worldwide Regulatory Agencies', 'A Scenario for the Future: Biotechnology and Pharmacogenesis', Again, each section has different chapters on various facets concerning these areas. Besides these, there is an Appendix 'A compilation of Government Regulation of Biotechnology'.

The editors, Dr. Chiu, a Supervisory Chemist and Dr. Gueriguian, a Medical Officer, in the Centre for Drug Evaluation and Research at the FDA, Rockville, Maryland, should be complemented for compiling basic information covering systems ranging from prokaryotes to human cells and lab bench technology to large scale fermentors; production of insulin, human growth hormone, antibiotics and vaccines through recombinant DNA technology. In my view, the information available in this book can be fruitfully utilized by the research workers and the students working in these areas. But the single most important beneficiary of this compilation can be the pharmaceutical industry who are currently engaged or are contemplating to enter in this rapidly

progressing and revolutionary field of bio-drugs. Besides, those in the Government, responsible for screening and monitoring the bio-safety of such drugs, can also obtain current information on the rules and regulations being framed for the use of Biotechnologically derived products.

R.P. SHARMA
I.A.R.I., NEW DELHI

Handbook of Cereal Science and Technology: Edited by Klaus J. Lorenz and Karel Kulp, Marcel Dekker Inc. New York, N.Y. 10016; 1991: pp:896, Price: $185 (US and Canada), $222 All other countries.

This Handbook is a collection of comprehensive and up to-date information on important cereal grains. It has been possible now to find the scientific information on so many cereals in one book. Besides looking at these basic physical, chemical and biochemical aspects of these cereals, it looks at the changes that take place during their processing. It is very important for the food technologists and engineers to see that undesirable changes in foodgrains do not take place during the various processes. The desirable changes, however, noted by the scientists had been able to give energy conservation and easy processes to the industry which is very important.

The figures, tables of data, flow diagrams, formulae, microphotagraphs, instrumentation, processing machinery diagrams etc have made the up-to-date scientific text further interesting to read. The main assest of the book, besides its information, is that it has been presented in a simple manner which even a processor who is not an academician could understand. It is a very good attempt.

Could the data base have been still wider? A lot of work has been done and published in the third world countries on cereals as they form their basic food. Some more references could have possibly been included.

The Handbook will certainly be a valuable text and reference book for the cereal science students, researchers, food technologists and food engineers and processors alike.

N.G. BHOLE
I.I.T., KHARAGPUR

High Dose Dosimetry for Radiation Processing: Proceedings of an International Symposium held in Vienna, Austria, November 5-9, 1990; pp:500 (Text). International Atomic Energy Agency, Vienna, Austria, 1991; Price : not mentioned.

Dosimetry is one of the most important parameters in radiation process because accuracy of measurements of absorbed dose and absorbed dose rate is the basic condition needed for quality assurance of radiation processing and irradiated products. The proceedings constitute excellent papers illustrating recent developments in this particular field. Scientists from 38 countries have contributed 41 papers.

The symposium had eight sessions grouped in 4 headings as follows : (i) general aspects on radiation dosimetry (Session I) (ii) development of dosimetry techniques (Sessions II, III and IV), (iii) reference dosimetry and review of dosimetry techniques (Session V), and (iv) quality control and assurance of dosimetry (Sessions VI, VII and VIII).

The first session (4 papers) elaborates various high dose dosimetry systems, their development and their implications in radiation processing and irradiated products including foods advocating issues to obtain international consensus on dosimetry standards in harmonising trade regulations.

The three independent sessions (II, III and IV) under the heading "Development of dosimetry techniques" include alltogether 17 papers. Each paper highlights different dosimetry system such as white perspex, lyoluminescence, thermoluminescence, glass detectors, graphite colorimeter, electron spin resonance, rhodamine dyes, Fricke etc. being used in radiation processing and their improvement in measurement techniques with illustrations. Further, experiences and development of dosimetry in Chile and Cuba are documented.

Session V (3 papers) deals on "Reference dosimetry and review of dosimetry techniques" for quality assurance in the radiation processing. The use of computer programme and regression analysis is discussed. The development of standard and precision equipment for measurements of dosimetric parameters has been highlighted in one of the invited papers. Experiences and development of high dose dosimetry in USSR, Hungary and France are recorded.

The section under the heading "Quality control and assurance of dosimetry" covers 17 papers presented in three independent sessions (VI, VII and VIII). These papers enlighten the factors involved in dosimetric measurements using various dosimeters in radition processing. Ways of conducting high dose measurements, methods and means of obtaining the required accuracy are described and inter-comparison studies for standardization of high dose measurements are discussed. Further, experiences of high dose dosimetry in Thailand, Philippines, Argentina, Iran, IAEA service programme, Canada and Malaysia are presented.

The proceedings include highly valued information on recent developments in high dose dosimetry for radiation processing and certainly fulfil the purpose for which it was prepared. It is a useful reference book for all radiation processing laboratories and industries.

C. BANDYOPADHYAY
B.A.R.C., BOMBAY

The Technology of Dairy Products: Edited by R. Early VCH Publishers Inc. New York; 1991: Price: £65.

The science concerned with man's food supply is of obvious importance. Dairy science is experiencing a substantial scientific revolution and glamour of some of the advances made in this atomic era. The dairy science must be pressed forward through research, new findings must be integrated with established facts and advances in knowledge must be brought into light in a concentrated form.

Milk has the significance in agriculture and in human health. Its importance has been demonstrated in various ways.

The dairy industry is, in many countries, a major contributor to the manufacturing capacity of the food sector and more components of milk are utilized in processed foods. The success of dairy industry depends on the derivation of accurate process controls, through automation and through improved procedures for quality control.

Improved methods of product control have also been instrumental in raising the efficiency of the various manufacturing procedures.

A partial and condensed table of contents follows. Chapter headings are given followed by example of important sub-titles.

1. Liquid milk and cream
   i) Liquid milk: products, processing and packaging.
   a) Raw milk quality, b) Pasteurized milk, c) Sterilized milk, d) UHT milk.
   ii) Cream: products, processing and packaging.
2. Milk chemistry and nutritive value.
   i) Milk fat. ii) Milk protein. iii) Lactose, iv) Minerals in milk, v) Minor components and micro-nutrients.
3. Cheese
   i) History and classification of varieties of cheeses.
   ii) Raw materials and micro-organisms ivolved in cheese manufacture. iii) Flavour and texture in cheese.
   iv) Traditional and recent techniques of manufacture.
4. Clutured milk products
   i) Classification, shelf life, food values of yoghurt.
   ii) Manufacture of different varieties of yoghurt.
   iii) Manufacture of quarg and fromage frais.
5. Butter, margarine and reduced fat spreads
   i) Physical properties of butter. ii) Butter making process. iii) Procucts based on blends of milk fat and other reduced and low fat spreads.
6. Concentrated milk fat products
   i) Flavour and properties of milk fat, ii) Manufacturing processes for milk-fat products, iii) Products and applications.
7. Milk concentrated
   i) The concentration process, ii) Manufacture of milk concentrates, iii) Recombined concentrates.
8. Milk powder
   i) Milk powder manufacture, ii) Spray-dryer developments, iii) Milk powder properties, iv) Milk powder types and uses.
9. Ice-cream and aerated desserts
   i) Ice-cream composition, raw materials and processing.
   ii) Aerated desserts composition, manufacture and processing.
10. Milk-based desserts
   i) Use of starches and hydrocolloids in dairy desserts;
   ii) Dairy desserts types and ingredients; iii) Manufacturing processes of ready-to-eat milk desserts;
   iv) Process parameters and their influence on dessert properties.
11. Laboratory control in milk product manufacture
   i) Microbiological aspects of laboratory control, and
   ii) Chemical aspects of laboratory control;
12. Hygiene in milk product manufacture
   i) Assessment of hygiene requirements,
   ii) High risk foods, iii) HACCP outline examples,
   iv) Pasteurization, v) Factory hygiene, vi) Services,
   vii) Cleaning
   a) Clean-in place (CIP) systems, b) Typical CIP clean,
   c) Manual cleaning, d) Environmental cleaning,
   e) Wet process areas, f) Dry process areas,
   g) Monitoring.

The book is an attempt for it is presumptuous in this age of science to provide readers a greater understanding on milk and method of milk product manufacture and the technology involved. The authors are experts in their fields with many years of experience as food scientists and technologists. This book will be useful for scientists, technologists and students of Dairy Science and Technology.

S.R. CHAKRABARTI
B.C.K.V., MOHANPUR

ASFT (I) News

Headquarters

Under the auspices of the Association of Food Scientists and Technologists (India), CFTRI and CFTRI Alumini Association, a one day National Meet of Food Scientists and Technologists was held at CFTRI, Mysore on April 10, 1992. It was inaugurated by Prof. M. Madaiah, Vice-Chancellor, University of Mysore, under the chairmanship of Dr. S.R. Bhowmik, Director, CFTRI, who also inaugurated the poster session. Sri. R. Guru, President, Mysore Chamber of Commerce and Industry, released a souvenir on the occasion. Dr. B.L. Amla, Former Director, CFTRI, delivered the key note address. Earlier, Dr. P.J. Dubash, President, AFST(I) welcomed the gathering. Dr. M.S. Prasad, Secretary, AFST(I), proposed a vote of thanks.

More than 100 participants including academicians, scholars, entrepreneurs, researchers and students took part in the Meet. Poster Sessions attracted over 144 posters from various disciplines. The colloquium provided a forum for the interaction between academicians involved in Food Science and Technology training and personnel from industry on the type of curriculum most suited to the development of Food Industry in the third world countries.

Lecture series

In the lecture series of the Association, Dr. H. Ramaswamy, Associate Professor, Food Science Department, McDonald College, McGill University, Canada gave a talk on 'Retort Pouch Processing' in the Assembly Hall of CFTRI on 22nd April 1992.

Bhopal Chapter

A lecture was arranged under the chairmanship of Dr. M.P. Saxena, Managing Director, Apex Bank, Bhopal on 22nd February 1992. Dr.N.Ali, welcomed the gathering, Dr. A.V. Bakre, Dy. General Manager, NABARD, Bhopal delivered a lecture on 'Refinance Facilities from the National Bank for Setting-up of Agro-Industries with Specific Reference to Agro-Processing', Dr. S.D. Kulkarni, Hon. Secretary proposed a vote of thanks.

Kharagpur Chapter

The Annual General Body Meeting of the above chapter was held on 28th January 1992. The following office bearers were elected for the year 1992-93.

President	:	Prof. R.K. Mukherjee
Vice-president	:	Prof. H. Das
Hony. Secretary	:	Prof. Suresh Prasad
Hony. Jt. Secretary	:	Dr. P.P. Srivastava
Hony. Treasurer	:	Dr. H.N. Mishra

ERRATA

Ref: Research Note entitled 'Effect of Mango Ginger (*Curcuma amada* Roxb) on Lipid Status in Normal and Hypertriglycerimedic Rats' by M.R. Srinivasan and N. Chandrasekhara, appeared in Vol. 29, No. 2 March/April '92 issue of the JFST.

On page 131, in Table 1, the first row values should correspond to liver wt (g/100g BW) and not liver (mg/g).

Liver (mg/g) should have come as heading to the other three parameters in BOLD LETTERS.

INSTRUCTIONS TO AUTHORS

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

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

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

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

5. **Tables:** Tables as well as graphs, both representing the same set of data, should be avoided. Tables should be typed on *separate* sheets. Nil results should be indicated and distinguished clearly from absence of data, which is indicated by '——' sign. Tables should not have more than *nine* columns.

6. **Illustrations:** Graphs and other line drawings should be drawn in Indian ink on tracing paper or white drawing paper preferably art paper not bigger than 20 cm (OY axis) × 16 cm (OX axis). The lettering should be twice the size of the printed letter. Photographs must be on glossy paper and must have good contrast; **three copies** should be sent.

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

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

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

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

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

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

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

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

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

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Research Papers

Research Notes

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