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(INDIA)

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JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

Volume 28 Number 5 Sept./Oct. 1991

CONTENTS

Research Papers

Heat Transfer During Concentration of Whey in Thin Film Scraped Surface Heat Exchanger 267
V. Kapil, A. K. Dodeja and S.C. Sarma

Inhibition of Growth of Pathogenic Bacteria During Production and Storage of Acidophilus Milk 271
C. D. Khedkar, J. M. Dave and S. S. Sannabhadti

Effect of Variety, Parboiling and Aging of Rice on the Texture of *Idli* 274
C. M. Sowbhagya, L. K. Pagaria and K. R. Bhattacharya

Studies on the Utilization of Sunflower Kernels in Bakery Products 280
K. Leelavathi, P. Haridas Rao and M. C. Shamanthaka Sastry

Studies on the Storage Characteristics of Khakra 285
Maya Prakash, Sarojani K. Dastur and Suvendu Bhattacharya

Effect of Storage Temperatures on Sensory, Chemical and Rheological Characteristics of Mozzarella Cheese 288
Bikash C. Ghosh and S. Singh

A Study of Certain Functional Properties of Chicken and Duck Eggs 293
L. Satyanarayana Reddy, M. Sreenivas Reddy and S. M. Siddiqui

Effect of Frozen Storage and Extenders on the Quality of Meat Tikkas from Culled Hens and Broiler Breeder Males 296
K. S. Sekhon and A. S. Bawa

Effect of Maida, Potato and Textured Soya as Binders on the Quality of Chicken and Mutton Kababs 301
Mir Salahuddin, N. Kondaiah and A. S. R. Anjaneyulu

Studies on the Quality Characteristics of Buffalo Skeletal, Offal Meats and Their Combinations 304
K.R. Krishnan and N. Sharma

Flow Behaviour of Peach and Apricot Pulps and Concentrates of Some Indian Varieties 308
G. H. Shah and G. S. Bains

Nutritional Evaluation and Cooking Quality of Dry Cowpea (*Vigna sinensis* L.) Grown Under Various Agricultural Conditions. 1. Effect of Soaking and Cooking on the Chemical Composition and Nutritional Quality of Cooked Seeds 312
A.A. Bakr and R. A. Gawish

Research Notes

The Microbiological Quality of Ice Creams Sold in Bangalore City 317
M. Sarada and J. Mushtari Begum

Screening for Popping Quality in Popcorn 319
R. P. Singh, K. L. Sehgal and A. K. Bakhshi

Studies on the Quality of Casein-Soya Protein Incorporated Rennet Curd (Coagulum) 321
T. Madhava Rao, B. T. Jairam, M. Laxminarayana and N. Krishna

Studies on Preparation of Mutton Sausages 323
N. S. Shaikh, A. T. Sherikar, K. N. Bhilegaonkar and U. D. Karkare

Nutritional Evaluation of *Euryale ferox* Salisb (Makhana) 326
Vidyanath Jha, G. K. Barat and U.N. Jha

Proportionate Incidence of Mycotoxic Fungi-*Fusarium* and Its Effect on Ingestion by Poultry 329
H. K. Beri, D. V. Vadehra and J. K. Gupta

Book Reviews 332

AFST(I) News 335

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Heat Transfer During Concentration of Whey in Thin Film Scraped Surface Heat Exchanger

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Thermal performance of thin film scraped surface heat exchanger was evaluated for concentrating deproteinized paneer whey to high solids with process variables such as mass flow rate, steam temperature, rotor speed, number of blades, etc. Appropriate correlation was developed in the form of box Wilson Model to predict overall heat transfer coefficient. The effect of process variables on overall heat transfer coefficient is discussed.

Whey that separates during manufacture of cheese, casein and paneer, contains approximately 6 per cent total solids of which more than 70 per cent is lactose and about 0.7 per cent whey proteins. Since whey represents approximately 80-85 per cent of the initial milk volume used for manaufacture of these products, its mere disposal problem as effluent and economic utilization poses a serious problem for large plants. It has a biological oxygen demand (BOD) ranging from 32,000 to 60,000 p.p.m. depending primarily on specific cheese making process used[1]. This value is 100-200 times that of domestic sewage[2]. Thus, from economics and environmental view points, it has become essential to utilize whey solids.

Manufacture of lactose from whey solves both the problems of improving economics of whey utilization and of environmental pollution as lactose itself can reduce BOD of whey by about 70-80 per cent as compared to 20 per cent reduction by manufacture of protein concentrate alone[2].

Manufacture of lactose is basically a four step process: deproteinization of whey, concentration, crystallization and recovery of lactose. Many problems have been encountered by many workers during concentration in conventional equipments[3-5]. To confront these problems associated in handling whey in the conventional evaporators and to increase steam economy, an application of thin film scraped surface heat exchanger (SSHE) seems to be a better proposition because of its unique performance characteristics[6].

The available literature reveals that Angell and Baird[7] conducted a study to concentrate radioactive wastes in SSHE. Abichandani and Sarma[8] also evaluated thermal performance of SSHE to concentrate milk. Dodeja[9] established that thin film SSHE can be used effectively for manufacturing milk products leading to high total solids. In the present study, attempts have been made to evolve the capability of thin film SSHE for concentrating paneer whey to manufacture lactose.

Materials and Methods

(a) *Experimental set-up:* The experimental set-up consisted of a feed tank, feed pump, a SSHE made of 304 SS material having ID 34 x 10^{-2} m, thickness 0.7 x 10^{-2} m and 76 x 10^{-2} m overall length (55 x 10^{-2} m effective heating length), variable speed drive (0-20 r.p.s. speed range) and a condenser (pipe in pipe). The schematic diagram of experimental set-up is shown in Fig. 1.

(b) *Experimental procedure:* The feed tank was filled with whey. The steam was admitted to the jacket of feed tank and was maintained at atmospheric pressure. Simultaneously, the agitator was started to ensure uniform mixing and heating. When the whey reached a temperature of 95-96°C, the feed pump was switched on to permit flow of whey into SSHE. The temperature of steam in jacket of SSHE was adjusted to a desired level by operating valves (V_2) and (V_3). Sufficient flow of water was maintained to condense vapours. The condensate was collected to determine the rate of evaporation. When steady state attained, all the process variables were recorded. The experiments were repeated with various mass flow rate, steam pressure, rotor speeds and number of blades. The samples of concentrated whey and fresh whey were recorded for total solids in accordance with the standard procedure[5].

(c) *Theoretical considerations:* The thermal performance of thin film SSHE can be evaluated in terms of overall heat transfer coefficient. Therefore, it was proposed to develop a correlation for overall heat transfer coefficient (Uo) involving all process variables:

$$U_o = F (S, V_c, B, M, \Delta t) \quad \text{.....(1)}$$

Where, Uo is overall heat transfer coefficient
S is average total solids, per cent
V_c is circumferential velocity
B is number of blades

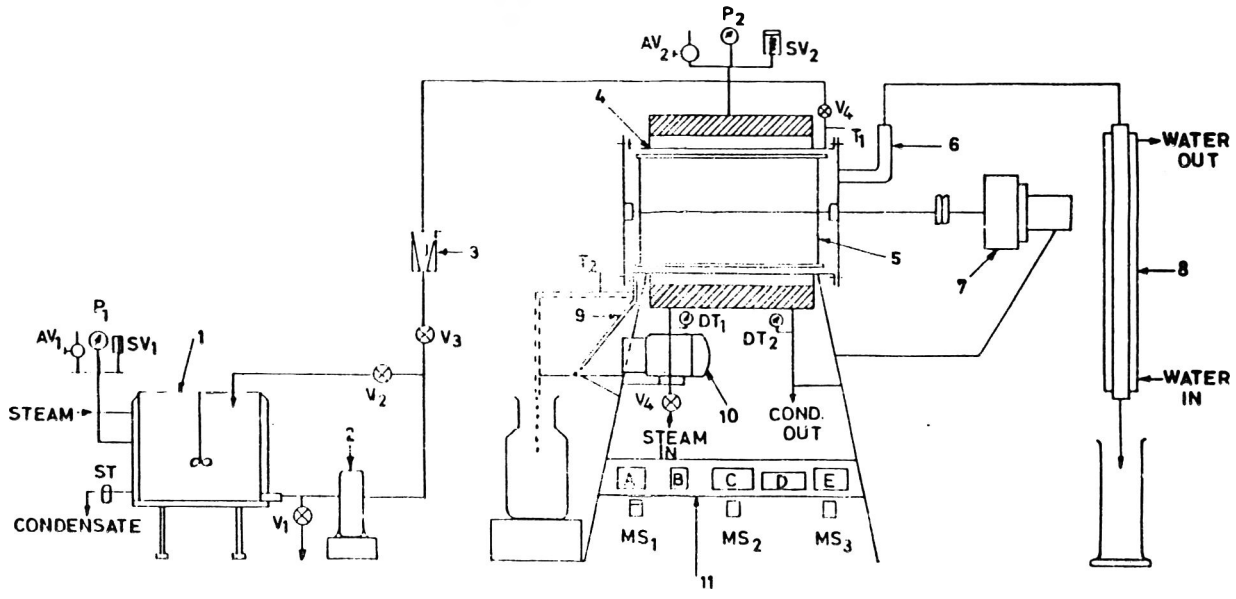

Fig.1. Schematic diagram of experimental set-up for whey evaporation.

1. Feed Tank. 2. Feed Pump. 3. Rotameter. 4. Heat Exchanger. 5. Scraper. 6. Vapour Outlet. 7. Variable Speed Drive. 8. Condenser. 9. Screw Conveyor. 10. Variable Speed Geared Motor. 11. Instrument Panel. V_1, V_2, V_3, V_4 - Flow Regulating Valve. St - Steam Trap. T_1, T_2 - Inlet and Outlet Thermo-Wells. MS_1, MS_2, MS_3 - Motor Starters. AV_1, AV_2 - Air Vents. P_1, P_2, - Pressure Gauges. DT_1, DT_2 - Dial Thermometers. SV_1, SV_2 - Safety Valves. A - Electronic Regulator. B - Manual Speed Controller. C - Selector Switch D. - Millivolt Meter. E - Watt Meter.

M is mass flow rate

t is temperature difference

Selecting a polynomial model (Box-Wilson Model)[10], the overall heat transfer coefficient can be correlated as

$$Uo = a_0 + a_1(S) + a_2(V_c) + a_3(B) + a_4(M) + a_5(\Delta t) + a_6(S)^2 + a_7(V_c)^2 + a_8(B^2) + a_9(M)^2 + a_{10}(\Delta t)^2 + a_{11}(S)(V_c) + a_{12}(S)(B) + a_{13}(S)(M) + a_{14}(S)(\Delta t) + a_{15}(V_c)(B) + a_{16}(V_c)(M) + a_{17}(V_c)(\Delta t) + a_{18}(B)(M) + a_{19}(B)(\Delta t) + a_{20}(M)(\Delta t) \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Results and Discussion

In order to study the thermal performance of thin film SSHE, various process parameters were selected. These are given in Table 1.

Experiments on evaporation of paneer whey (deproteinized) were carried out and data were collected for different operating conditions of SSHE. Whey was concentrated from 6 per cent total solids (TS) to about 50 per cent TS. Data on average heat transfer coefficient, circumferential speed of rotor, number of blades, percentage average total solids, temperature difference and mass flow rate were fitted in Box Wilson model. The prediction equation coefficients obtained are given in Table 2.

Fig. 2 presents the deviation of $(Uo)_{PRED}$ obtained from equation (2) developed through this study from those

TABLE 1. SELECTION OF PROCESS PARAMETERS

Sl. No.	Parameter	Values
1.	No. of blades	2, 4, 6
2.	Mass flow rates	2.43×10^{-2}, 2.03×10^{-2}, 1.73×10^{-2} kg/s
3.	Steam temperature	118.6°C, 126.8°C and 132.9°C
4.	Rotor speed	1.67, 2.5, 3.33, 4.17 rps

TABLE 2. VALUES OF COEFFICIENTS

Coefficient	
a_0	+281.09
a_1	−28.67
a_2	+219.91
a_3	+31.47
a_4	+81638.11
a_5	−13.50
a_6	−0.58
a_7	−16.19
a_8	−3.12
a_9	−890365.00
a_{10}	+0.18
a_{11}	−1.29
a_{12}	−0.08
a_{13}	+1688.25
a_{14}	+0.93
a_{15}	+2.09
a_{16}	−1556.10
a_{17}	+0.38
a_{18}	+179.43
a_{19}	+1.20
a_{20}	−896.29

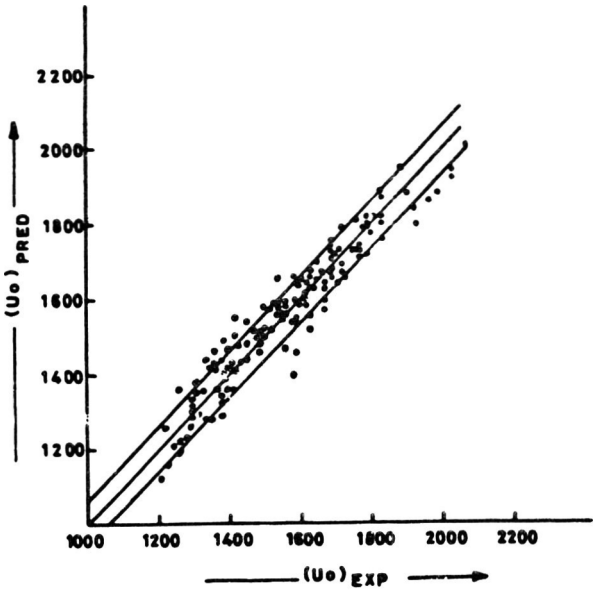

Fig.2. Comparison between $(Uo)_{exp}$ and $(Uo)_{pred}$

determined experimentally $(Uo)_{EXP}$ The eq(2) seems to be very good as large number of data are within the range of standard error.

The equation (2) is also valid for horizontal thin film SSHE having different wall thickness or material. The overall heat transfer coefficient Uo for any other thin film horizontal SSHE can be obtained by multiplying the overall heat transfer coefficient Uo predicted by eq(2) with a factor[11].

$$\frac{A_o}{A_o'}\ \frac{t}{t'}\ \frac{km'}{km}$$

Where, km is thermal conductivity of exchanger's material

A_o is outside area of exchanger

t is the thickness of exchanger's wall

In order to explain the effect of various operating parameters, viz., mass flow rate, rotor speed, number of blades and temperature difference on overall heat transfer coefficient various graphs were plotted and explained as follows:

(i) Fig. 3 illustrates the effect of mass flow rate on overall heat transfer coefficient at various rotor speeds. It was observed that increase in M from 0.017 to 0.024 kg/s caused Uo to increase from 1350 to 1625 W/m^2k at rotor speed of 1.67 r.p.s. Similar trend was also observed in other speeds. This was explained with a reason that increase in mass flow rate caused the fluid fillet volume in front of blades to increase only after the film had attained steady thickness corresponding to rotor speed. As mass flow rate was increased from 0.017 to 0.024 kg/s, increasing amount of super heated fluid from film joined the fillet at saturation temperature. This maintained increasing trend of evaporation rates. A similar trend was also reported in case of milk, cream and water[8,9].

(ii) Fig. 4 shows the effect of Δ t on Uo. It is seen from figure that U decreased with increasing Δt, at all rotor

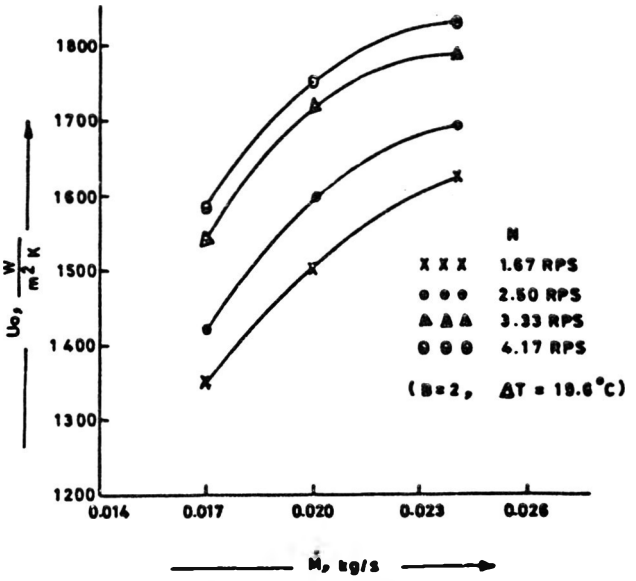

Fig.3. Effect of Mon Uo.

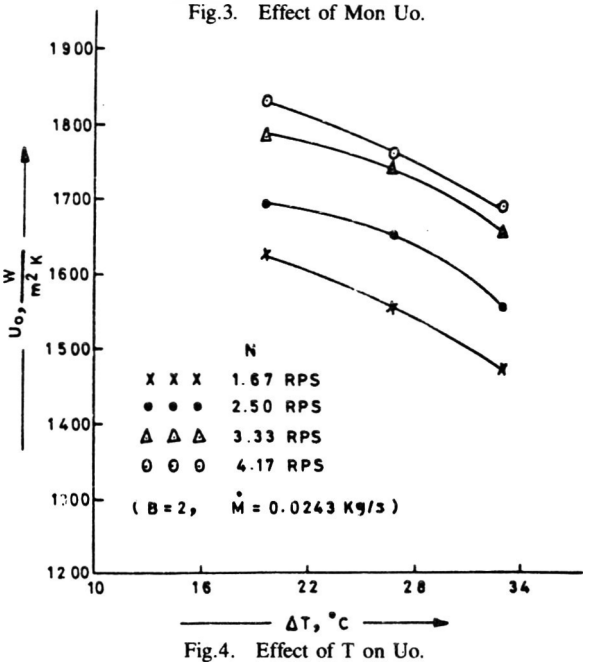

Fig.4. Effect of T on Uo.

speeds. The overall heat transfer coefficient depends upon the steam and scraped film coefficient as the metal wall resistance remains unchanged. The steam film coefficient always decreased with increase in Δ t. Though scraped film coefficient increases with increase in Δt, the decrease in steam film coefficient is always offset with increase in scraped film coefficient and finally resulted in decrease in Uo with increasing Δ t[9].

(iii) Fig. 5 shows the effect of rotor speed (N) on the overall heat transfer coefficient (Uo). In general, the Uo increased with increasing rotor speed and in particular its change was rapid when the speed was increased from 2.50 to 3.33 r.p.s. For instance, Uo increased from 1350 to 1540 W/m^2k for a mass flow rate of 0.0173 kg/s in the above speed range. A similar trend was reported for milk and cream[8].

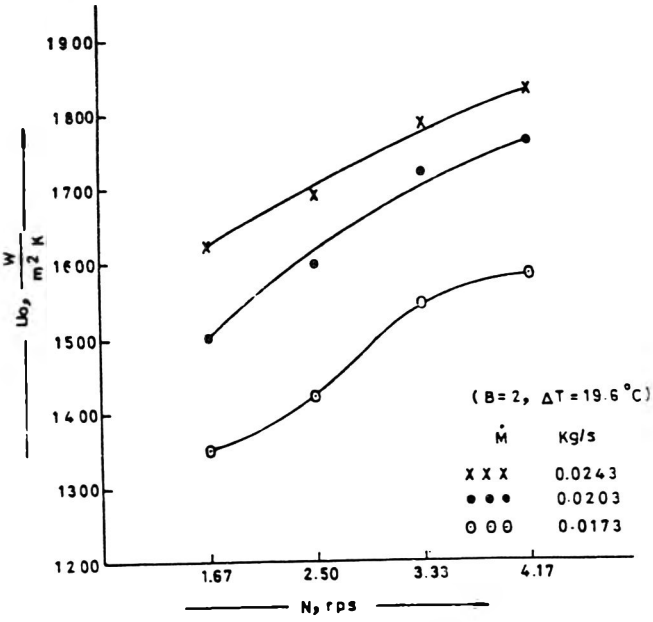

Fig.5. Effect of N on Uo.

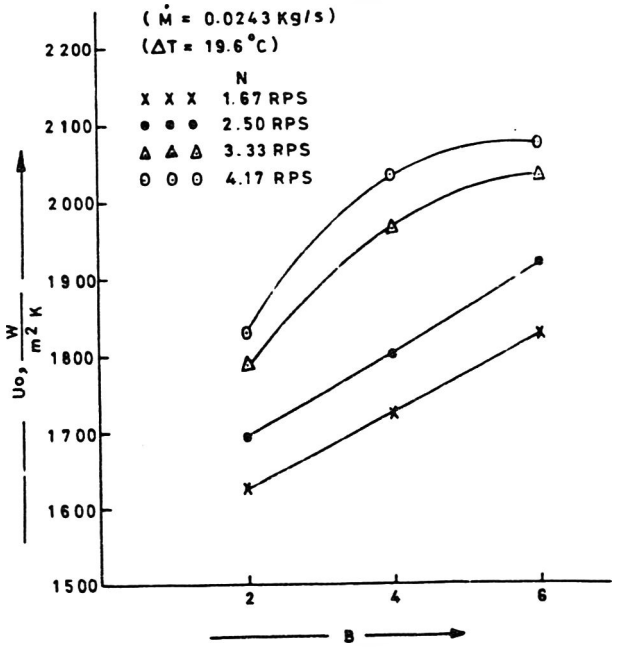

Fig.6. Effect of B on Uo.

The increase in rotor speed caused higher turbulance and mixing of the superheated liquid from the film at much higher frequency. These factors enhanced the rate of evaporation.

(iv) Fig. 6 illustrates the effect of number of blades (B) on overall heat transfer coefficient (Uo) for whey at various rotor speeds. The diagram indicates that Uo increases with increase in number of blades. The effect of increasing number of blades is similar to that of increasing rotor speed. However, at higher speeds of 4.17 r.p.s. and above, increasing number of blades to 6 had little effect on Uo. Thus, there is no advantage in increasing number of blades beyond 4 at 3.33 r.p.s. and above.

The study demonstrated that thin film scraped surface exchanger can be successfully employed for concentration of whey to high solids for lactose manufacture.

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Inhibition of Growth of Pathogenic Bacteria During Production and Storage of Acidophilus Milk

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Enterotoxigenic *Staphylococcus aureus* and mastitic *Escherichia coli* were grown individually in milk in the presence of *L. acidophilus* $LBKV_3$ at 37°C. *L. acidophilus* restricted the growth of *Staph. aureus* after 16 hr and that of *E. coli* after 60 hr. When the cultures were subsequently stored at 15°C after incubation for 12 hr at 37°C, the inhibition of *Staph. aureus* was observed after 4 hr while the inhibition of *E. coli* was observed after 36 hr.

Potential for contamination of milk with *Staph. aureus* and *E. coli* and subsequent hazard associated with the possibility of growth and enterotoxin production in fermented products like yoghurt and acidophilus milk is mentioned[1]. However yoghurt and acidophilus Yoghurt cultures possess factors such as lactic acid, hydrogen peroxide and bacteriocin which inhibited the growth of *Staph. aureus*[1]. Price and Lee[2] also specified that the observed inhibition of pathogens was resulted from H_2O_2 produced by lactobacilli. Shahani *et al.*[3], obtained lactic acid free preparation 'acidophilin', an antibiotic substance from acidophilus milk using silica gel method. They indicated that it is the combined effect of lactic acid and other metabolites. From the studies on factors affecting the viability of pathogens in fermented milks, it is indicated that, at the beginning of fermentation the decrease in growth of pathogens is probably due to antimicrobial compounds, peroxide and decrease in redox potential. Later on, the low pH, lactic acid, lower fatty acids and perhaps diacetyl contribute to the inhibition of pathogens in fermented dairy products[4].

We report here the influence of human strain of *L. acidophilus* and mixed lactic culture, LF-40 on enterotoxigenic strain of *Staph. aureus* and mastitic strain of *E.coli* when they are grown with association in milk.

Materials and Methods

Source of cultures: *L. acidophilus* strain $LBKV_3$ is a vaginal isolate from an adult woman. *Staph. aureus* and *E. coli* used in the study were obtained from Department of Veterinary Bacteriology of Gujarat Agricultural University, Anand Campus, Anand. LF-40, the mixed lactic streptococci culture is a culture combination procured from Hansen's laboratory, Denmark.

Both the lactic cultures were activated through two consecutive transfers in sterilized skim milk at 37°C for 24 hr. The lactic cultures were then inoculated into sterilized skim milk flasks containing 300 ml milk at the rate of 2 per cent (V/V). Subsequently, one set of flasks was inoculated with nutrient broth cultures of *Staph. aureus* (24 hr old culture) in 0.1 ml quantity to give a count of approximately 10^3 cfu/ml of milk. Initial Staphylococcal and coliform counts were recorded on Staphylococcal (S-110) and MacConkey's agars, after incubating the plates for 36 and 24 hr respectively at 37°C.

The contents of the flasks were thoroughly mixed by Cyclomixer and aseptically distributed into sterilized test tubes in equal quantities of 15 ml per tube. After 12 hr of incubation at 37°C, half the number of the tubes from both the sets were stored at 15°C and the rest were stored at 37°C.

Enumeration of pathogenic counts: At selected time intervals during preparation and storage at 37° and 15°C, 1 ml quantity was taken from each of the two cultures and appropriately diluted using phosphate buffer (IS:1479, Part III)[5]. Suitable dilutions were poured into petri dishes and then melted *Staphylococcus* agar (S-110, Difco)[6] was added to plates in which dilutions of cultures containing *Staph. aureus* were placed. Those plates after solidification of media were incubated at 37°C for 36 hr and the number of typical Staphylococcal colonies were counted. In other set of plates in which dilutions of cultures containing *E. coli* were placed, melted MacConkey's agar was poured and allowed to set. After solidification, they were overlayered with 4-5 ml un-inoculated MacConkey's agar and after setting, plates were incubated at 37°C and typical coliform colonies were counted after 24 hr.

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Titratable acidity of the inoculated milk samples as per cent lactic acid was determined at the various periods of production and storage according to method Specified in part-I of IS: 1479[7] using 10.0g of sample. Similar procedure was followed in reference of mixed lactic culture LF-40.

Results and Discussion

The observations on the effect of *L. acidophilus* and mixed lactic culture against enterotoxigenic *Staph. aureus* and mastitic *E. coli* at 37°C and 15°C are shown in Tables 1 and 2.

It could be seen from Table 1 that there was a steady increase in Staphylococcal counts upto 16 hr in *L. acidophilus* $LBKV_3$ cultured milk at 37°C and thereafter there was a gradual decline in the counts upto 60 hr of incubation.

At this temperature, the counts were lower than those present initially after 60 hr. In milk inoculated with LF-40, the Staphylococcal counts were increased upto 24 hr but the counts remained higher than those inoculated initially upto 72 hr indicating that there was no inhibitory effect of this culture. There was a steady increase in *E. coli* counts upto 48 hr of incubation in $LBKV_3$ which was followed by a sudden drop leading to tremendous decrease in number of *E. coli* by 72 hr. But in the case of LF-40, inhibition of *E. coli* was observed upto 72 hr of storage.

The inhibitory effect observed in case of $LBKV_3$ was parallel to that obtained from this culture during *in vitro* inhibitory studies using cup-well assay technique[8]. As there was a steady increase in acidity in *L. acidophilus* and mixed

TABLE 1. MEAN LOG SURVIVORS* OF *STAPHYLOCOCCUS AUREUS* AND *ESCHERICHIA COLI* DURING PRODUCTION AND STORAGE OF ACIDOPHILUS MILK AT 37°C.

Cultures	Incubation period								
	0 hr	12 hr	16 hr	20 hr	24 hr	36 hr	48 hr	60 hr	72 hr
				Staphylococcus aureus					
L. *acidophilus* $LBKV_3$	3.45 (0.24)**	6.34 (0.44)	6.42 (0.66)	6.15 (0.89)	4.66 (1.13)	4.28 (1.45)	3.66 (1.64)	3.26 (1.78)	2.99 (1.88)
Mixed lactic culture LF-40	3.4 (0.20)	6.55 (0.49)	6.68 (0.55)	7.32 (0.69)	7.77 (0.72)	6.62 (0.81)	5.47 (0.83)	4.27 (0.85)	4.03 (0.87)
				Escherichia coli					
L. acidophilus $LBKV_3$	3.1 (0.2)	5.55 (0.54)	6.53 (0.7)	7.47 (0.98)	7.82 (1.24)	7.91 (1.37)	8.62 (1.53)	8.05 (1.76)	3.49 (1.81)
Mixed lactic culture LF-40	3.1 (0.22)	5.62 (0.49)	6.48 (0.57)	7.45 (0.73)	7.64 (0.76)	8.64 (0.82)	8.71 (0.83)	8.77 (0.85)	8.80 (0.90)

*Average of five replications
**Figures in parantheses indicate TA values.

TABLE 2. MEAN LOG SURVIVORS* OF *STAPHYLOCOCCUS AUREUS* AND *ESCHERICHIA COLI* DURING STORAGE OF ACIDOPHILUS MILK AT 15°C

Cultures	Storage period						
	4 hr	8 hr	12 hr	24 hr	36 hr	48 hr	60 hr
			S. aureus				
L. acidophilus $LBKV_3$	6.46 (0.57)**	6.01 (0.62)	5.37 (0.63)	5.29 (0.64)	4.55 (0.64)	4.42 (0.66)	3.56 (0.68)
Mixed lactic culture LF-40	6.54 (0.53)	6.61 (0.53)	6.68 (0.54)	6.68 (0.55)	6.46 (0.56)	6.03 (0.56)	5.45 (0.57)
			E. coli				
L. acidophilus $LBKV_3$	5.91 (0.55)	6.02 (0.58)	6.28 (0.59)	6.32 (0.62)	6.42 (0.69)	6.37 (0.65)	5.76 (0.66)
Mixed lactic culture LF-40	5.63 (0.51)	5.73 (0.53)	5.79 (0.54)	5.80 (0.55)	5.82 (0.55)	5.99 (0.57)	6.39 (0.58)

*Average of five replications.
**Figures in parantheses indicate TA Values.

cultures used during incubation at 37°C, it is evident that the inhibitory effect was not totally due to the increase in acidity in case of milk cultured with $LBKV_3$. Konecny[9] also made similar observations.

It could be observed from Table 2 that the milk inoculated with $LBKV_3$ and LF-40 have shown reduction in staphylococcal counts after 8 and 36 hr respectively on storage at 15°C after an initial incubation for 12 hr at 37°C. At the temperatures of 37 and 15°C, $LBKV_3$ had much more higher antibacterial activity against *S. aureus* than LF-40.

However, *E. coli* counts have shown decline after 36 hr. storage at 15°C in $LBKV_3$ but there was a steady increase in LF-40. Tables 1 and 2 indicate that at 37 and 15°C there was inhibition of *E. coli* in $LBKV_3$ but inhibition was not observed in LF-40. Rate of acid production by both the cultures was significantly different.

The results obtained in an earlier study[1] for acidophilus-yoghurt are comparable with those observed in case of $LBKV_3$ in the present study. The highest inhibitory activity of *L. acidophilus* observed by earlier workers[9] among lactic cultures tested is in agreement with the results of present investigation. The results obtained on effect of different storage temperatures on inhibitory activity are similar to those of earlier reports, where it has been indicated that the higher storage temperature had a greater inhibitory effect than lower one[9].

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Effect of Variety, Parboiling and Aging of Rice on the Texture of *Idli*

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Of the 16 varieties of rice, representing eight different cooking quality types, those having 22% amylose or more, either raw or parboiled were suitable for the preparation of *Idli* and gave the desired soft and spongy texture. Low amylose and waxy rice yielded hard and sticky textured *Idli*. Sensory analysis corroborated with the results of objective tests. *Idlis* from aged rice had better appearance and texture compared to fresh rice *idlis*.

Idli is a popular Indian fermented breakfast food[1,2], prepared from milled rice and black gram dhal. The product has a spongy texture with a characteristic odour. The effect of processing variables like, soaking time, grinding condition, proportion of ingredients, temperature and time of fermentation and extra adjuncts have been studied in detail[3]. Rice as commonly available in India is generally used, without any specific varietal preferences for making *idli*. However, aged parboiled rice, or a mixture of raw and parboiled rice, is usually preferred. Nothing is known about the effect of rice variety, its processing and aging on *ildli* quality. The present paper reports the effect of variety, parboiling, conditions of parboiling and of aging of rice on the quality of *idli* prepared by a simplified composite dry mix method.

Materials and Methods

'IR 20' variety of paddy stored for about a year under ambient conditions was collected from Karnataka State Seed Corporation Depot, Mysore and was used for the standardization of *idli* preparation and also for testing the different parboiling conditions. Another 16 varieties of paddy (Table 1) obtained from a nearby Agricultural Research Station and stored for 2 years at 5°C were used for varietal studies both as raw and parboiled rices. The samples comprised of 2 varieties each (varietal study) and one variety each (aging study) from the eight quality types of rice described earlier[4]. Black gram dhal was procured from the local market. Both paddy and dhal were cleaned, fumigated and stored in the cold room (about 5°C) till further use. For aging study, paddy was preserved as 'new' by storing it at 5°C for 6 months and another half of the same was aged by keeping it at room temperature (RT) in a closed container for 6 months.

Normal and mild parboiled rice were prepared by soaking paddy in warm water (RT) overnight, draining the excess water and steaming the paddy at atmospheric pressure for 15 min and 3 min respectively as described by Bhattacharya and Indudhara Swamy[5]. For severely parboiled rice, soaked padddy was steamed at 1 kg/cm^2 for 10 min. The total amylose content was determined in the defatted powder after solubilization of the rice powder in sodium hydroxide solution as reported earlier[6]. Water-soluble amylose content was determined after heating the rice powder in boiling water. The insoluble amylose content was calculated as the difference between total and soluble amylose as reported by Shanthy *et al*[7].

Paddy was shelled and milled in a McGill sheller and a McGill miller No. 3, to 6-8 per cent polish using standard methods. The milled rice was ground in a Buhler disc grinder (MLI204) and then sifted to obtain −16 +44 mesh semolina.

TABLE 1. THE EXPERIMENTAL RICE VARIETIES AND THEIR AMYLOSE CONTENTS

Rice quality type	Variety*	Amylose content (% d.b.)** Total	Insoluble
I	Jaya	28.2 ±0.25	17.2 ± 0.21
	T(N)1	28.1 ± 0.21	17.3 ± 0.26
II	Co32	26.5 ± 0.30	13.0 ± 0.20
	Mahsuri	26.5 ± 0.10	13.9 ± 0.21
III	S317	29.9 ± 0.26	11.1 ± 0.10
	SR26B	29.7 ± 0.26	11.5 ± 0.17
IV	NIOB	24.5 ± 0.38	9.7 ± 0.17
	Pankhali 203	26.5 ± 0.36	10.0 ± 0.06
V	Intan	25.6 ± 0.26	7.4 ± 0.06
	Aborted A	24.3 ± 0.20	9.6 ± 0.21
VI	Sukanandi	24.6 ± 0.32	8.4 ± 0.17
	Baok	24.5 ± 0.35	8.9 ± 0.20
VII	Changlei	19.2 ± 0.20	6.6 ± 0.11
	Chainan8	18.6 ± 0.06	7.1 ± 0.10
VIII	Asm44	4.8 ± 0.15	3.9 ± 0.06
	Purple puttu	5.2 ± 0.12	

*All varieties were used for studies on varietal effect and the first variety listed in each quality type was used for studies on effect of aging.

**The values reported are means ± standard deviation of 4 replicates in this and all other tables.

Preparation of idli batter: *Idli* batter is traditionally prepared by wet grinding of previously soaked rice and black gram dhal. However in the present studies, the composite dry mix method with yeast, as suggested by Desikachar *et al.*[4] was adopted for convenience. Concentration of the ingredients and the methodology for the preparation of *idli* were first standardized to give *idli* with acceptable texture.

Idli batter was prepared by mixing (2:1) the rice semolina and black gram dhal flour. For each 100 g of the mixed flour 2 g salt, 5 mg baker's yeast and 220 ml tap water were added. All ingredients were mixed with hand and transferred to a one litre beaker and covered. The initial volume was marked and the batter allowed to ferment for 18 hr at 29°C. After fermentation, the volume was noted again and the contents were mixed mildly for about half a minute with a stainless steel spoon. Acidity in the batter was determined by titration with 0.1 *N* NaOH and expressed as per cent acidity (as lactic acid)[3].

Preparation of idli: About 50 ml of batter was transferred to a petri dish (9 cm diameter), kept over a stainless steel plate, in a rice cooking stand[8] and steamed at atmospheric pressure in an autoclave for 15 min. The petri dish was taken out and covered and left for one hour at RT for equilibration and the lids were wiped occasionally with filter paper.

Properties: *Idli* was cut into pieces (2.6 cm diameter) for determination of bulk density. The pieces were waxed by dipping in hot wax, to plug the air pockets on surface. Bulk density was determined by water displacement of the waxed *idli* piece in a graduated cylinder. For penetrometer readings, *idli* was prepared as above but in a 50 ml beaker with its top portion cut. The measurements were made using a Lab-line Hi-accuracy penetrometer with an aluminium plunger which was allowed to penetrate the *idli* for 5 sec in the container. The penetration distance was noted in mm. Firmness and elastic properties of *ildi* were determined using a Chopin-INRA viscoelastograph by a slight modification of the method of Laignelet and Feillet[9]. Pieces of *idli* (12 mm diameter, 5 mm thick) were cut using a metal cork borer, and compressed in the viscoelastograph under a load of 200g for 35 sec, and allowed to recover for 20 sec after removal of the load. The measurement was replicated 10 times with fresh piece of *idli* each time. Firmness and elastic recovery were calculated from the average values as described[9].

Sensory test: *Idli* samples kept covered in petri dishes for one hour after preparation were code numbered and presented to a panel of 10 judges selected randomly for sensory scoring. Samples were scored for hardness, stickiness, appearance, odour and taste according to a numerical scoring system as defined in the score card (Table 2).

Results and Discussion

The different rice quality types, the different rice varieties and their total and insoluble amylose contents are presented in Table 1. Rice has been classified into eight distinct quality types by Bhattacharya *et al.*[4], depending on the total and insoluble amylose contents and the relative breakdown BD_r value (calculated from the paste viscosity curves obtained using Brabender viscograph). The first three quality types belong to high amylose group which are distinguished on the basis of differences in their insoluble amylose contents. The intermediate amylose group form the quality types IV, V and VI. The low amysose group form the quality type VII. Waxy rices belong to the quality type VIII. The relative breakdown, BD_r and stickness is least in the quality type I and increases gradually and becomes highest in the quality type VIII.

From Table 2, it is seen, as expected, that amylose content was high in rice quality types I, II and III, medium in quality types IV, V and VI, low in quality type VII and least in quality type VIII. The insoluble amylose content was also high in quality type I and decreased gradually and became low in quality type VIII. These results are in accordance with the values reported earlier[4]. Bearing this in mind, the varietal difference with respect to *idli* making quality was studied both in raw and parboiled rices.

Effect of varietal differences-raw rice: The results are presented in Tables 3 and 4. The increase in batter volume due to fermentation was highest for the rice of type I, intermediate for types II, III and VI, low for type VII and the least for type VIII. Apparently, the total as well as insoluble amylose content influences the rise in batter volume by affecting stickiness. The acidity value did not show any appreciable difference due to variety (0.38-0.40). Penetrometer reading, reflecting the softness of *idli* was almost same in the first six rice types but lower than the last two. The bulk density of *idlis* was similar in rice types I, II, III, IV, V and VI (0.88-0.93) but increased slightly in types VII

TABLE 2. SCORE CARD FOR *IDLI* EVALUATION*

Score	Hardness	Stickness	Appearance	Odour	Taste
1	Very hard	Very sticky	Smooth	Off-odour	Too sour
2	Rather hard	Rather sticky			
3	Medium	Medium	Slightly porous	Slight off-odour	Slightly sour
4	Rather soft	Rather fluffy			
5	Very soft	Very fluffy	Porous	Good odour	Bland

**Idlis* having a score of 3 or more for all the parameters seemed to have acceptable texture and appearance

TABLE 3. PHYSICOCHEMICAL PROPERTIES OF *IDLI*

Rice quality type	Increase in fermented batter vol. (%)		Softness* (mm)		Firmness (%)		Elastic recovery (%)	
	Raw	Parboiled	Raw	Parboiled	Raw	Parboiled	Raw	Parboiled
I	73 ± 7.93	110 ± 8.16	14.2 ± 0.26	13.5 ± 0.26	54.4 ± 0.67	38.7 ± 0.67	38.0 ± 0.39	14.1 ± 0.83
II	66 ± 4.08	84 ± 7.70	15.0 ± 0.26	14.2 ± 0.08	54.6 ± 0.49	39.6 ± 0.75	37.0 ± 1.63	15.3 ± 0.84
III	66 ± 3.65	83 ± 11.40	14.1 ± 0.15	15.7 ± 0.17	52.4 ± 2.04	38.2 ± 0.64	32.0 ± 0.66	13.8 ± 0.22
IV	63 ± 3.37	70 ± 14.70	14.7 ± 0.30	16.1 ± 0.10	50.1 ± 0.59	35.8 ± 0.23	30.0 ± 1.44	10.8 ± 0.22
V	70 ± 5.12	80 ± 6.24	14.1 ± 0.22	15.4 ± 0.33	52.3 ± 0.45	42.2 ± 2.84	33.0 ± 0.57	18.1 ± 0.66
VI	62 ± 1.29	152 ± 28.00	14.2 ± 0.26	13.8 ± 0.18	44.0 ± 0.57	47.0 ± 2.39	23.0 ± 0.31	20.8 ± 0.91
VII	52 ± 16.30	190 ± 33.98	15.6 ± 0.34	15.0 ± 0.41	37.0 ± 1.13	36.6 ± 0.65	15.0 ± 0.9i	12.0 ± 1.44
VIII	39 ± 2.45	48 ± 7.50	20.0 ± 1.64	15.8 ± 0.36	19.0 ± 2.16	17.0 ± 1.15	0.0 ± 0	0.5 ± 0.17

*Penetration of plunger in 5 sec.
Means ± S.D.

TABLE 4. SENSORY SCORES OF *IDLI*

Rice quality type	Hardness		Stickness		Appearance		Odour		Taste	
	Raw	Par-boiled	Raw	Par-boiled	Raw	Par-boiled	Raw	Par-boiled	Raw	Par-boiled
I	2.7ab±0.30	3.0ab±0.26	3.0ab±0.15	2.6a±0.30	2.5a±0.30	2.1a±0.25	2.1a±0.40	1.6a±0.36	2.5a±0.38	1.8a±0.15
II	2.9a±0.26	3.1ab±0.25	3.2a±0.15	2.8ab±0.26	2.7a±0.30	2.6ab±0.40	2.2ab±0.38	3.1c±0.30	2.3a±0.40	2.2a±0.26
III	2.7a±0.25	3.0ab±0.30	2.3cd±0.36	3.2b±0.26	2.7a±0.25	2.4ab±0.26	2.9c±0.38	3.3c±0.06	2.3a±0.38	2.2a±0.36
IV	2.1b±0.23	3.0ab±0.15	2.6bc±0.40	3.1ab±0.05	2.6a±0.30	2.1a±0.21	2.7bc±0.26	3.2c±0.26	2.8a±0.06	2.7a±0.30
V	1.5c±0.62	2.8a±0.56	2.1d±0.23	2.8ab±0.40	1.9bc±0.26	2.5ab±0.35	2.2ab±0.06	4.0d±0.10	2.7a±0.46	2.4a±0.06
VI	1.2c±0.15	3.0ab±0.06	1.9de±0.10	2.8ab±0.44	2.3ab±0.17	3.5c±0.15	2.3b±0.12	1.7a±0.30	2.7a±0.10	2.1a±0.40
VII	1.4c±0.06	3.4b±0.10	1.5e±0.12	3.0ab±0.10	1.5c±0.10	2.9b±0.36	2.3b±0.35	2.4b±0.10	2.2a±0.46	2.2a±0.57
VIII	1.2c±0.10	4.7c±0.26	1.0f±0.10	1.2c±0.10	1.0d±0.10	1.1d±0.20	2.0a±0.21	3.4c±0.40	1.9a±0.15	2.1a±0.20
SEm (16df)	±0.17	±0.16	±0.13	±0.16	±0.14	±0.17	±0.17	±0.15	±0.19	±0.19

Means of the same column followed by different letters differ significantly as per Duncan's New Multiple Range Test.

Means ± S. D.

and VIII (1.0 and 1.1). The firmness and elasticity values, especially the latter gave better gradation for type I to type VIII, the former being the most firm or hardest and the latter the least. Evidently, the amylose and insoluble amylose content (Table 1) has some influence on the *idli* texture. Thus, the increase in batter volume was high, the penetrometer reading (softness) and the bulk density values low and the firmness and elastic recovery values were high for high amylose varieties as compared to low amylose and waxy rices. The sensory properties also showed a parallel gradation from rice of type I to type VIII except for the score for taste which remained statistically insignificant (Table 4). *Idlis* made from high and intermediate amylose rice (types I, II, III, IV, V and VI) had acceptable texture according to both instrument and sensory data compared to those from low amylose and waxy rice (types VII and VIII).

Effect of varietal differences-parboiled rice: Parboiled rice is widely used for preparation of *idli*. Effect of parboiling of different varieties of rice on *Idli* properties was studied. In general, parboiled rice gave higher values for batter volume (110 to 365 per cent higher as compared to raw) and acidity (0.49-0.60) on fermentation and *idlis* had lower bulk density, firmness and elasticity (Table 3) as compared to raw rice. The increase in batter volume was unusually high in type VI and VII rice, unlike in raw rice, where these types gave lower values for unknown reasons.

The softness of *idli* as indicated by penetrometer reading was more or less same for all rice types except for type VIII which was softer. This is in contrast to the raw rice *idli* where types VII and VIII gave unacceptably soft *idlis*. The bulk density (0.78-0.84) was slightly less for all rice types as compared to raw rice except for waxy (1.10) which did not

change. Firmness and elasticity values also showed lower values for types I, II, III, IV and V as compared to raw rice, while those for types VI, VII and VIII were more or less same. Sensory scores (Table 4) for various parameters of the *idli* showed that there was no sigificant difference statistically between the rice types, except that, type VIII, was more sticky. These results would suggest that *idlis* could be made from any parboiled rice other than waxy rice. Probably parboiling reduces varietal difference, but a clear difference between waxy and nonwaxy varieties still persisted. However, *idli* prepared from parboiled rice seemed slightly softer than those from raw rice.

Effect of parboiling conditions: Parboiled rices of different severity were tested for their effect on *Idli* quality (Tables 5 and 6). Usually, only the normal parboiled rice is available in the market. However, very light coloured parboiled rice is preferred by some consumers traditionally accustomed to eating raw rice while severely parboiled rice having darker colour is preferred by certain sections of parboiled rice eaters. The effects of severity of parboiling was, therefore, included in the study. The batter volume increased significantly from raw to parboiled rices with increasing severity of the parboiling. Batter acidity, however, did not change. Softness of the resultant *idlis* from mild parboiled rice was least and similar to raw rice while *idlis* from normal and severely parboiled rice showed similar and significantly higher softness than the former. Bulk density of the *idlis* from mild parboiled was significantly lower than that from raw, normal and severely parboiled rices gave *idlis* with similar but significantly lower bulk density than that of mild parboiled rice. The firmness and elastic recovery were highest for raw rice and least for the severely parboiled rice and the mild and normal parboiled rice fell in between. Although the sensory scores did not show significant differences according to statistical analysis, there is a clear indication that the normal parboiled rice is best suited for making *idli* as shown by its higher scores for softness, firmness and elastic recovery values.

Effect of aging: Eight rice varieties representing the eight quality types were selected. *Idli* was made after parboiling new (stored at 5° for 6 months) as well as aged (stored for 6 months at RT) paddy. Aged rice showed higher increase in the batter volume after fermentation over new rice (Table 7). Acidity was more in new than in aged rice. Softness and fluffiness as shown by penetrometer reading, bulk density, firmness and elastic recovery showed a tendency to slightly

TABLE 5. EFFECT OF DIFFERENT PARBOILING CONDITIONS ON THE QUALITY OF *IDLI*

Parboiling condition	Increase in fermented batter vol (%)	Acidity (%)	Softness* (mm)	Bulk density (g/ml)	Firmness (%)	Elastic recovery (%)
Raw	40a ± 5.00	0.36a ± 0.04	11.6a ± 0.15	0.91a ± 0.03	52.9a ± 2.75	32.9a ± 1.05
RT': 0 kg-3 min (mild-parboiled)	63b ± 3.51	0.40a ± 0.04	11.2a ± 2.95	0.84b ± 0.01	46.2b ± 2.20	23.0b ± 3.00
RT': 0 kg-15 min (normal-parboiled)	80c ± 3.00	0.40a ± 0.04	16.3b ± 0.06	0.78c ± 0.04	39.6c ± 3.95	17.1c ± 1.85
RT' 1 kg-10 min (severely-parboiled)	88d ± 3.00	0.40a ± 0.03	15.6b ± 0.95	0.79c ± 0.01	31.3d ± 2.10	7.5d ± 1.10
SE_m(8df)	±2.15	±0.02	±0.90	±0.01	±1.54	±1.11

*Penetration of plunger in 5 sec.

Means of the same column followed by different letters differ significantly according to Duncan's New Multiple Range Test.

IR20 variety was used

Means ± S.D.

TABLE 6. EFFECT OF DIFFERENT PARBOILING CONDITIONS ON THE SENSORY SCORES OF *IDLI*

Parboiling condition	Hardness	Stickiness	Appearance	Odour	Taste
Raw	3.1 ± 0.55	2.9 ± 0.15	3.0 ± 0.30	3.7 ±0.10	3.6 ± 0.90
RT': 0 kg-3 min	3.2 ± 0.95	3.0 ± 0.45	3.2 ± 0.56	3.4 ± 0.56	3.5 ± 0.30
RT': 0 kg-15 min	3.9 ± 0.60	3.7 ± 0.30	3.8 ± 0.50	3.7 ± 0.35	4.0 ± 0.15
RT': 1 kg-10 min	3.2 ± 0.30	3.1 ± 0.36	3.4 ± 0.15	4.2 ± 0.30	4.0 ± 0.40
SE_m(8 df)	± 0.37	± 0.19	± 0.24	± 0.21	± 0.30

No significant ($P < 0.05$) differences were found between the four conditions for all the sensory characteristics.

IR20 variety used

increase upon aging, except in rice types VII and VIII. (All the elastic recovery values shown in Table 7 were a little lower than those in Table 3 for unknown reasons).

The sensory data (Table 8) showed that the differences among various attributes were not significant between new rice and old rice. However, *idlis* made from aged rice had significantly better appearances as compared to those from fresh rice.

As per the present results, it would seem that *idlis* could be made from either raw or parboiled rice of any variety other

TABLE 7. EFFECT OF AGE ON THE PHYSICOCHEMICAL PROPERTIES OF *IDLI*

Rice quality type	Age	Increase in fermented batter vol. (%)	Acidity (%)	Softness* (mm)	Bulk density (g/ml)	Firmness (%)	Elastic recovery (%)
I	New	68 ± 3.00	0.50 ± 0.04	16.3 ± 0.50	0.82 ± 0.01	39.8 ± 3.10	13.9 ± 0.36
	Old	111*** ± 5.51	0.36** ± 0.01	18.0* ± 0.35	0.83^{NS} ± 0.01	35.4^{NS} ± 2.80	10.4*** ± 0.21
II	New	77 ± 4.51	0.46 ± 0.04	15.8 ± 0.60	0.84 ± 0.05	34.3 ± 1.95	10.0 ± 0.35
	Old	152*** ± 6.51	0.36* ± 0.02	17.2^{NS} ± 0.70	0.84^{NS} ± 0.04	31.6^{NS} ± 0.80	8.0** ± 0.40
III	New	135 ± 11.00	0.36 ± 0.02	16.0 ± 0.35	0.81 ± 0.02	34.3 ± 0.12	9.9 ± 0.25
	Old	158* ± 2.52	0.22** ± 0.02	17.0* ± 0.46	0.89** ± 0.01	30.5*** ± 0.23	5.2*** ± 0.35
IV	New	171 ± 5.57	0.36 ± 0.03	16.2 ± 0.53	0.80 ± 0.02	32.4 ± 0.60	8.0 ± 0.50
	Old	187* ± 5.29	0.27** ± 0.02	16.6^{NS} ± 0.32	0.82^{NS} ± 0.02	30.3** ± 0.30	7.4^{NS} ± 0.40
V	New	113 ± 3.06	0.36 ± 0.04	16.2 ± 0.20	0.85 ± 0.03	32.1 ± 0.95	8.4 ± 0.21
	Old	132* ± 6.51	0.22** ± 0.02	17.0** ± 0.21	0.89^{NS} ± 0.02	30.9^{NS} ± 1.06	7.2** ± 0.21
VI	New	110 ± 4.58	0.36 ± 0.03	16.9 ± 0.36	0.86 ± 0.03	32.1 ± 0.21	8.4 ± 0.20
	Old	125* ± 4.04	0.20** ± 0.02	17.0^{NS} ± 0.25	0.85^{NS} 0.04	29.1*** ± 0.12	7.4** ± 0.15
VII	New	180 ± 3.78	0.35 ± 0.03	17.0 ± 0.21	0.84 ± 0.02	24.9 ± 0.96	3.3 ± 0.12
	Old	206** ± 8.14	0.22** ± 0.03	17.0^{NS} ± 0.26	0.84^{NS} ± 0.04	26.1^{NS} ± 0.30	4.2** ± 0.30
VIII	New	164 ± 5.86	0.35 ± 0.05	20.3 ± 1.10	1.0 ± 0.06	14.7 ± 0.36	1.0 ± 0
	Old	190* ± 7.81	0.22* ± 0.03	17.8* ± 0.60	0.98^{NS} ± 0.01	16.6** ± 0.53	1.0^{NS} ± 0

+Penetration of plunger in 5 sec.

NS, *, **, *** indicates not significant, singnificant at 5%, 1% and 0.01% levels between new and old rice, in this and the next table.

New: Freshly harvested paddy stored for 6 months at 5-6°C;
Old: Freshly harvested paddy stored for 6 months at RT.

Means ± S.D.

TABLE 8. EFFECT OF AGE ON THE SENSORY SCORES OF *IDLI*

Rice quality type	Age	Hardness	Stickiness	Appearance	Odour	Taste
I	New	2.2 ± 0.25	3.4 ± 0.10	2.2 ± 0.15	4.6 ± 0.42	2.5 ± 0.30
	Old	2.5^{NS} ± 0.21	3.8^{NS} ± 0.75	3.4** ± 0.42	4.6^{NS} 0.21	2.7^{NS} ± 0.30
II	New	2.6 ± 0.40	3.2 ± 0.25	2.2 ± 0.15	4.0 ± 0.21	2.2 ± 0.23
	Old	3.0^{NS} ± 0.10	3.8^{NS} ± 0.32	3.6* ± 0.60	3.4* ± 0.30	2.6^{NS} ± 0.46
III	New	3.0 ± 0.15	3.5 ± 0.06	2.8 ± 0.29	4.3 ± 0.25	2.2 ± 0.12
	Old	3.2^{NS} ± 0.26	3.8^{NS} ± 0.60	3.3^{NS} ± 0.35	3.3** ± 0.21	2.4^{NS} ± 0.38
IV	New	3.3 ± 0.35	3.0 ± 0.06	3.0 ± 0.30	4.3 ± 0.21	2.2 ± 0.21
	Old	3.5^{NS} ± 0.55	3.2* ± 0.10	3.5^{NS} ± 0.47	3.7^{NS} ± 0.61	2.9^{NS} ± 0.49
V	New	2.8 ± 0.56	2.9 ± 0.55	2.4 ± 0.30	4.5 ± 0.36	2.5 ± 0.56
	Old	3.2^{NS} ± 0.12	3.2^{NS} ± 0.26	2.8^{NS} ± 0.30	3.8^{NS} ± 0.46	2.2^{NS} ± 0.26
VI	New	3.0 ± 0.21	2.8 ± 0.60	2.0 ± 0.06	3.8 ± 0.42	2.5 ± 0.21
	Old	3.8^{NS} ± 0.70	3.0^{NS} ± 0.06	2.9* ± 0.38	3.7^{NS} ± 0.46	2.5^{NS} ± 0.35
VII	New	3.5 ± 0.21	1.8 ± 0.56	1.9 ± 0.21	3.2 ± 0.30	2.1 ± 0.21
	Old	3.9^{NS} ± 0.51	2.0^{NS} ± 0.26	2.7* ± 0.40	3.0^{NS} ± 0.30	2.3^{NS} ± 0.10
VIII	New	5.0 ± 0.38	1.0 ± 0.06	1.3 ± 0.30	2.3 ± 0.60	1.6 ± 0.10
	Old	4.5^{NS} ± 0.15	1.3^{NS} ± 0.20	1.7^{NS} ± 0.46	2.3^{NS} ± 0.21	1.8^{NS} ± 0.21

Means ± S.D.

than low amylose (22 per cent or less) and waxy rice. *Idlis* from aged rice of any variety except the low amylose and waxy type had a better appearance and texture than those from fresh rice.

However, these results have to be interpreted in the context of the composite dry mix method of *idli* preparation adopted here. It is quite possible that additional differences might have been revealed between varieties and between raw and parboiled rice, had the normal method of *idli* preparation been adopted. This aspect needs further study.

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J. Fd. Sci. Technol., 1991, Vol. 28, No. 5, 280—284

Studies on the Utilization of Sunflower Kernels in Bakery Products

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Studies on the incorporation of roasted sunflower grits showed that the overall quality of bread was not changed upto 10% level, while at the same level defatted sunflower flour significantly lowered the overall quality. Use of roasted grits improved the taste of biscuits and it could be used upto 20% level without affecting the overall quality. On the other hand, sunflower flour lowered the overall quality even at 10% level of incorporation. Incorporation of either defatted flour or roasted grits improved the taste of cakes while the overall quality improved with increase in the level of roasted grits even upto 30% level. Roasting decreased chlorogenic acid by 58% and available lysine by 22%.

Studies are reported on the use of composite flours in bakery products[1-3] either to extend the wheat availability or to improve the nutritional quality. Most of the studies so far reported for the preparation of bakery products of improved nutritional quality make use of flours from groundnut or soya[4,5]. Sunflower kernel and its defatted meal have several advantages over other oilseed meals as human protein food, because of the absence of antinutritional or toxic factors, flavour and of its high digestibility and biological value[6]. Sunflower kernel is also a good source of B-complex vitamins, β-carotene, calcium, iron and phosphorous[7-9]. The sunflower protein is well balanced in all essential amino acids except lysine and compares favourably with soya and cottonseed proteins[10].

Very little information is available on the utilization of sunflower grits as a source of protein to enrich the bakery products. Talley *et al.*[11] observed that acceptable quality bread could be made by incorporating 3 per cent sunflower meal. Rooney *et al.*[12] reported that functional characteristics of sunflower flour with respect to bread making could be improved by heat treatment. D'Appolonia and Mac Arthur[13] showed that removal of chlorogenic acid from sunflower kernel produced superior quality bread.

Studies were undertaken to find out the possibilities of using it in bakery products. The objectives of the work reported here were to study the effects of using sunflower grits after roasting or defatted sunflower flour on the quality of doughs, bread, biscuits and cakes.

Materials and Methods

Refined wheat flour (Maida): Commercially available medium hard and soft wheats were milled in a Buhler laboratory flour mill (Model: MLU^2 02) after conditioning them overnight at moisture levels of 15.5 and 14.5 per cent respectively. The maida obtained from medium hard wheat was used for bread making trials while that obtained from soft wheat was used for biscuit and cake making trials.

Sunflower grits and defatted flours: Sunflower kernels ('Mordon' variety) was obtained from Karnataka Agro Industries Corporation, Mysore. The seeds were cleaned, graded and dehulled in a sheller according to the method of Sastry[14]. Part of the kernels was roasted with sodium chloride (1:1) in an electrical roaster at 120 $\pm$ 2°C for 5 min. The mixture was cooled and sieved through 30 mesh to remove the salt. These roasted kernels were made into grits (5 mesh) in a blender and used in the bakery products. Remaining kernels were flaked to 0.01 in. thickness in a flaker and extracted with food grade hexane for the removal of fat. The defatted meal was desolventised at 40°C for 4-6 hr and milled in an Apex mill to pass through 60 mesh sieve.

Chemical characteristics: Proximate composition of kernels and defatted flours was carried out according to AOCS procedures[15]. Chlorogenic acid was estimated according to the procedure of Pomenta and Burns[16]. Amino acid composition of sunflower proteins was determined in the LKB amino acid analyser. Available lysine content was estimated according to the method of Carpenter[17].

Rheological characteristics: Farinograph characteristics of flour as affected by the incorporation of roasted sunflower grits and sunflower flour at various levels were determined by the standard method of AACC[18]. The farinograms were evaluated for water absorption capacity, dough development time, dough stability and mixing tolerance index.

The extensograph characteristics of the doughs containing differently processed sunflower kernels were carried out by the standard method[19]. The extensograph curves were evaluated for resistance to extension, extensibility, ratio figure and strength as indicated by the area under the curve.

Bread making trials: Breads containing different levels of sunflower flour and sunflower grits were made as per the

method of Irwine and McMullan[19]. Loaf volume of bread was determined using loaf volume meter and other characteristics such as crust colour shape, crumb texture, taste, etc., were determined by adopting the scoring system as described by Pyler[20].

Biscuit making trials: Biscuits containing different levels of sunflower flour and sunflower grits were made according to the procedure described by Haridas Rao and Shurpalekar[2]. The biscuits were evaluated as per the standard procedure[18] by giving a score for each quality parameter like spread factor (30) sufrace colour (10), crispness (30) and taste (30).

Cake making trials: Cakes were made by using the following recipe and processing conditions. Maida or its blend (100 g), sugar (84 g), hydrogenated fat (84 g), whole egg (85 g) and baking powder (2 g). The cake batter was mixed and specific gravity of the batter was determined by filling completely the aluminium cup with batter and weighing it followed by weighing the cup with water.

The volume of the cake was determined by rapeseed displacement method. The sensory characteristics of cake were determined by giving a score for volume (10), crust colour (10), shape (10) crumb grain (20), crumb texture (20) and taste (30).

All the experiments mentioned above were carried out in quadruplicate and the statistical evaluation of the data was carried out by Duncan's New Multiple Range Test.

Results and Discussion

Proximate composition of roasted grits and defatted sunflower flour is given in Table 1. The roasted grits had 59.6 per cent fat, 31.5 per cent protein and low crude fibre (2.9 per cent). The defatted sunflower flour had high protein content (58.8 per cent) and chlorogenic acid (1.33 per cent). By roasting the kernels at 120°C for 5 min, chlorogenic acid decreased from 0.5 to 0.29 per cent. Milic *et at.*[21] have also shown that chlorogenic acid gets degraded at high temperature.

Amino acid composition of defatted flour is given in Table 2. Lysine is found to be the first limiting amino acid. The other amino acids are found to be well balanced and compare favourably with those of soy and cotton seed proteins[22].

TABLE 1. COMPOSITION OF ROASTED SUNFLOWER GRITS AND DEFATTED SUNFLOWER FLOUR

Constituents	Roasted grits	Defatted flour
Protein (N x 6.25) (%)	31.5	58.8
Fat (%)	59.6	0.9
Crude fibre (%)	2.9	9.6
Ash (%)	3.9	7.6
Carbohydrate (by diff.) (%)	2.7	23.7
Chlorogenic acid (%) (Sunflower grits : 0.5%)	0.29	1.33

TABLE 2. ESSENTIAL AMINO ACID COMPOSITION OF DEFATTED SUNFLOWER FLOUR

Amino acid	Content (g/16 g N)
Lysine	3.83
Available lysine*	3.50
Methionine	1.85
Cystine	1.60
Leucine	6.80
Isoleucine	6.10
Valine	5.10
Penylalanine	5.20
Threonine	3.60
Tryptophane	1.10
Tyrosine	2.65

*in roasted defatted grits 2.35 g/16 g N

Roasting of sunflower kernels at 120°C for 5 min reduced the available lysine content from 3.5 to 2.35 per cent.

Rheological characteristics: The farinograph characteristics of doughs containing different levels of defatted sunflower flour and roasted sunflower grits (Table 3) indicate that water absorption increased gradually with increase in the level of incorporation of sunflower flour. The water absorption increased to 62 per cent from 57.2 per cent when 20 per cent of the sunflower flour was incorporated. Increase in the dough development time was observed only at 5 per cent level of incorporation and further increase in the level did not affect the dough development time. Stability decreased from 6.5 to 4.5 min in dough containing 20 per cent sunflower flour. This was also reflected by the mixing tolerance index. On the other hand, incorporation of roasted sunflower grits reduced greatly the water absorption capacity, as it may affect the conformation of the sunflower protein in such a way as to reduce the interaction with water, since the water absorption capacity reflects interactions with hydrophilic groups of the protein molecule.

The maximum value for dough development time was observed with flour containing 10 per cent of grits unlike in case of sunflower flour where the same was observed at 5 per cent level of incorporation. The dough stability, on the other hand, was not much influenced except in case of dough containing 30 per cent sunflower grits wherein slight increase was observed.

The extensograph characteristics (Table 4) showed that the resistance to extension decreased in both the doughs and the decrease was more and considerable in dough containing sunflower flour (735 to 345 BU) than that containing grits (735 to 580 BU) at 20 per cent level. However, change in the extensibility was gradual in both the cases. The stiffness of the dough as indicated by the ratio figure gradually reduced in doughs containing sunflower flour and the same increased in case of dough containing sunflower grits. This is because of the greater effect of flour in decreasing the resistance to

TABLE 3. EFFECT OF INCORPORATION OF PROCESSED DEFATTED SUNFLOWER FLOUR AND GRITS SEPARATELY ON THE FARINOGRAPH CHARACTERISTICS

Flour/grit used (%)	Water absorption (%)	Dough development time (min)	Stability (min)	Mixing tolerance index (BU)
		Sunflower flour		
0	57.2	1.5	6.5	40
5	59.2	4.5	5.5	60
10	60.0	3.5	5.5	90
15	61.0	3.5	5.0	110
20	62.0	4.0	4.5	150
		Sunflower grits		
5	55.0	1.5	6.0	40
10	54.0	4.5	6.0	100
20	48.6	4.0	6.5	80
30	45.8	4.0	7.0	60

TABLE 4. EFFECT OF INCORPORATING DIFFERENTLY PROCESSED SUNFLOWER FLOUR/GRITS ON THE EXTENSOGRAPH CHARACTERISTICS

Flour/grit used (%)	Resistance to extension, R (BU)	Extensibility, E (mm)	Ratio figure (R/E)	Area (cm^2)
		Sunflower flour		
0	735	145	5.1	141.5
5	640	123	5.0	107.6
10	465	114	4.1	73.7
15	390	108	3.6	60.5
20	345	102	3.4	49.0
		Sunflower grits		
5	710	140	5.1	135.5
10	690	129	5.4	103.3
20	620	101	6.2	95.9
30	580	88	6.6	69.4

extension as compared to sunflower grits with somewhat similar changes in the extensibility in both the cases. The strength of the dough as indicated by the area under the curve was always higher in doughs containing sunflower grits than in doughs containing sunflower flour at corresponding level of incorporation, because of comparatively lesser change in the resistance to extension and extensibility.

Bread making quality: The dough containing sunflower flour was found to be sticky and was difficult to handle and had slight greenish colour particularly at higher levels, while the dough containing sunflower grits was easy to handle and machined well even at 30 per cent level of incorporation because of the high amount of fat present in it.

The loaf volume of bread containing sunflower flour decreased gradually but significantly with increase in the level of incorporation (Table 5). The colour of the crust as well as crumb changed to dull greyish brown and the crumb texture became harder and crumb grain became coarser with increase in the level of incorporation. This was reflected in the significant decrease in the bread scores for the above characteristics. Slight off-taste was also observed at incorporation levels of 15 per cent and above. The total score decreased to 43.3 for bread containing 20 per cent sunflower flour as compared to 76.7 observed for control bread made from only maida. Though the total score slightly decreased to 70.8, the bread containing 5 per cent sunflower flour was

TABLE 5. EFFECT OF INCORPORATING DIFFERENTLY PROCESSED SUNFLOWER FLOUR/GRITS ON THE QUALITY OF BREAD

Flour/ grit used (%)	Loaf Vol (ml)	Loaf Score (15+)	Crust colour (10+)	Symmetry of form (5+)	Crumb texture (20+)	Colour of crumb (10+)	Crumb grain (10+)	Aroma (10+)	Taste (20+)	Total score (100+)
					Sunflower flour					
0	540	11.0^{a}	8.0^{a}	3.5^{a}	12.5^{a}	9.0^{a}	8.5^{ab}	8.1^{abc}	16.0^{ab}	76.7^{a}
5	490	9.5^{d}	8.5^{a}	3.3^{a}	11.4^{bc}	7.5^{b}	8.0^{bc}	7.5^{ce}	15.0^{b}	70.8^{b}
10	445	7.0^{c}	7.5^{ba}	2.5^{bc}	9.5^{d}	6.9^{bc}	7.6^{c}	6.8^{e}	12.8^{c}	60.5^{c}
15	410	6.5^{cd}	6.0^{c}	2.3^{c}	8.5^{e}	6.3^{cd}	4.6^{d}	6.9^{e}	12.6^{c}	50.0^{d}
20	360	5.5^{d}	5.3^{c}	2.3^{c}	7.9^{e}	5.5^{d}	3.3^{e}	6.9^{e}	7.5^{d}	43.3^{e}
					Sunflower grits					
5	540	11.0^{a}	8.3^{a}	3.5^{a}	12.0^{ab}	9.1^{a}	8.5^{ab}	8.9^{a}	15.5^{b}	76.3^{a}
10	528	10.6^{ab}	7.6^{ab}	3.1^{ab}	11.8^{ab}	8.8^{a}	8.8^{a}	8.6^{ab}	16.0^{ab}	76.0^{a}
20	520	10.3^{ab}	7.3^{b}	3.0^{ab}	10.6^{c}	8.8^{a}	7.5^{c}	7.9^{bc}	16.0^{ab}	78.8^{f}
30	475	9.6^{b}	6.0^{c}	2.9^{abc}	7.9^{e}	7.3^{b}	6.1^{f}	8.0^{bc}	17.0^{a}	65.5^{g}
SEm (df=27)		±0.35	±0.37	±0.23	±0.31	±0.27	±0.24	±0.26	±0.35	±0.56

+Maximum score

Any two means in the same column with different superscripts differ significantly ($P < 0.05$)

quite acceptable. The protein content in such a bread was found to be higher (8.5 per cent) when compared with control bread (6.4 per cent). The adverse effect on the quality was considerably less in bread containing sunflower grits and no significant reduction in the loaf volumes was observed even at 20 per cent level of incorporation. However, in the other quality parameters such as symmetry of form, crumb colour and aroma, slight adverse change was observed at that level while the taste of bread improved. However, the total score slightly increased from 76.7 to 78.8 over the control. But at 30 per cent level, significant decrease with overall quality was observed. The studies indicated that sunflower grits could be easily incorporated upto 20 per cent in bread to increase its protein content. The protein content in such a bread was found to be 10.9 per cent.

*Biscuit making quality:*The spread of biscuits increased while thickness decreased with increase in the addition of either sunflower flour or grits, the effect being more with sunflower flour (Table 6). This was illustrated by the fact that the thickness of biscuits as well as the spread containing 20 per cent sunflower flour was comparable to that containing 30 per cent sunflower grits.

Incorporation of sunflower flour changed the colour of biscuits from golden brown to dull yellowish brown. In addition, the biscuits were slightly hard and had slight off-taste particularly at 20 per cent level. However, the biscuits

TABLE 6. EFFECT OF INCORPORATION OF DIFFERENTLY PROCESSED SUNFLOWER FLOUR/GRITS ON THE QUALITY OF BISCUITS

Flour/ grit used (%)	Width W (cm)	Thickness, T (cm)	W/T ratio	Spread factor (30+)	Surface colour (10+)	Crispness (30+)	Taste (30+)	Total score (100+)
				Sunflower flour				
0	4.91^{a}	0.84^{a}	5.85^{c}	30.0^{a}	8.4^{ab}	28.0^{a}	23.8^{a}	90.1^{a}
10	5.07^{b}	0.68^{b}	7.46^{b}	23.1^{b}	7.5^{bc}	26.3^{ab}	22.5^{b}	78.9^{b}
15	5.23^{c}	0.66^{b}	7.92^{b}	21.0^{c}	6.6^{c}	24.5^{c}	19.6^{c}	71.1^{c}
20	5.20^{c}	0.64^{c}	8.10^{c}	19.0^{d}	5.4^{d}	19.9^{d}	15.0^{d}	59.8^{d}
				Sunflower grits				
10	5.10^{b}	0.74^{d}	6.89^{d}	25.3^{e}	9.0^{a}	29.5^{e}	25.3^{j}	88.8^{a}
20	5.10^{b}	0.70^{b}	7.29^{b}	24.6^{e}	9.0^{a}	27.8^{a}	27.6^{f}	89.6^{a}
30	5.20^{c}	0.64^{c}	8.1^{c}	22.5^{b}	8.4^{ab}	25.5^{bc}	28.4^{f}	84.1^{e}
SEm	±0.10	±0.04	±0.2	±0.31	±0.30	±0.35	±0.39	±0.44

+Maximum score

Any two means in the same column with different superscripts differ significantly ($P < 0.05$).

TABLE 7. EFFECT OF INCORPORATING DIFFERENTLY PROCESSED SUNFLOWER/GRITS ON THE QUALITY OF CAKE

Flour/ grit used (%)	Sp.gr. of batter	Cake vol (ml)	Score for vol (10+)	Crust colour (10+)	Crust shape (10+)	Crumb grain (20+)	Crumb texture (20+)	Taste (30+)	Total score (100+)
					Sunflower flour				
0	0.87^{a}	137	7.5^{a}	8.5^{a}	9.3^{a}	15.7^{a}	16.6^{a}	24.4^{a}	80.9^{a}
10	0.83^{b}	143	6.8^{a}	6.9^{b}	8.8^{ab}	13.5^{b}	15.8^{ab}	25.5^{a}	77.9^{b}
20	0.80^{b}	137	7.3^{a}	5.4^{c}	7.5^{c}	12.3^{c}	15.5^{b}	26.8^{b}	74.5^{c}
					Sunflower grits				
20	0.90^{c}	135	7.6^{a}	8.4^{a}	9.3^{a}	15.0^{a}	16.5^{a}	26.8^{b}	85.0^{d}
30	0.93^{d}	136	7.1^{a}	7.6^{d}	8.3^{b}	12.5^{c}	16.8^{a}	28.0^{c}	85.1^{d}
SEm (df=15)	±0.03		±0.22	±0.21	±0.18	±0.29	±0.31	±0.38	±0.37

[+]Maximum score

Any two means in the same column with different superscripts differ significantly ($p < 0.05$).

containing upto 10 per cent of sunflower flour though slightly decreased the overall quality score, it was quite acceptable and had 10.8 per cent protein which is almost double the amount present in normal sweet biscuits. On the other hand, sunflower grits significantly improved the colour and taste of biscuits. The crispness of biscuits containing upto 20 per cent of sunflower grits was not significantly different from that of control biscuits. The taste of biscuits improved significantly with the incorporation of sunflower grits.

The overall quality of biscuits as indicated by the total score was not significantly different from control biscuits upto 20 per cent incorporation of sunflower grits. Hence, it can be inferred that sunflower grits could be used in biscuits upto 20 per cent level without any effect on its quality.

Cake making quality: Volume of the cake was not significantly affected by the incorporation of sunflower flour or grits (Table 7). The crust colour, shape and crumb grain of the cakes were affected adversely on incorporation of sunflower flour while no significant change was observed when grits were used at 20 per cent level.

Interestingly, the taste of cakes improved with addition of either sunflower flour or sunflower grits and the improvement was more in cakes containing the sunflower grits. The overall quality of cakes as indicated by the total score suggested that the cake containing sunflower grits at any levels was better than the control cake.

The above studies have shown clearly that defatted sunflower flour can be incorporated at 5 and 10 per cent levels to obtain acceptable quality bread and biscuits respectively. However, sunflower grits could be incorporated at much higher levels and the optimum level was found to be 20 per cent for both bread and biscuits. Incorporation of sunflower flour or grits improved the taste of cake. The overall quality of cake was found to be better as compared to control cake when sunflower grits were incorporated upto 30 per cent level.

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Studies on the Storage Characteristics of *Khakra*

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Khakra is a crisp wheat based flatbread, like chapati, having low moisture content (4 - 6%). Storage characteristics of _khakra_ were investigated at normal (27°C / 65% RH) and under acceleratаed (38°C / 92% RH) conditions. The sorption studies of _khakra_, exposed to different relative humidities (11 - 86%), have suggested that a moisture level of 7.8% corresponding to 44% RH is critical with respect to crispness. The product had a storage life of about 3 months under normal storage conditions, when packaged in polyethylene (65 - 70 micron) or polypropylene (32 micron) pouches. The moisture content of _khakra_ during storage could be expressed by quadratic regression equations. The sensory quality and instrumental texture of _khakra_ during storage were also determined.

Khakra is an Indian flatbread, like chapati, and is a popular traditional food in western India, particularly Gujarat. *Atta* (whole wheat flour) is kneaded with water into chapati dough consistency and rolled (flattened) to 1 - 1.5 mm thickness and 17 - 25 cm. diameter. These are toasted on a hot pan (thava), with occasional pressing to the thava to ensure uniform contact heating. Roasted *khakra* has a low moisture content of 4 to 6 per cent, in contrast to 25 to 34 per cent moisture content in chapati. The crisp texture and long storage life of *khakra* are two characteristics which make them a convenience food constituting one of the major items in lunch packs, breakfast foods, anytime snack, or food for travel. They are served accompanied by sabji (cooked vegetables), pickle and sweet or hot chutney. Thus, they can fit into any meal or snack. The price of *khakras* is also comparable to that of chapatis. Masala (spiced), bhaji (leafy vegetables), ghee (traditional Indian clarified butter), sweet and plain are the main five types of *khakras* that are available commercially. The present investigation is the first scientific study on *khakra* processing and preservation. An effort has been made to study the storage characteristics of *khakra*.

Materials and Methods

Bansi (hard) wheat, purchased from the local market of Mysore, was cleaned and milled into whole flour for use in the preparation of *khakra*.

Preparation of khakra: The plain *khakras* were prepared with 88.5 per cent whole wheat flour, 10 per cent fat, and 1.5 per cent salt. Before arriving at this composition, several combinations of flour, fat and salt were tried for obtaining good quality *khakra*. Five to six *khakras*, weighing 16 to 17 g each, could be prepared at a time. *Khakras* were preheated on an electrically operated frypan (Sunbeam, 230 - 250 V, 1150 Watts, Model no AFP - 11A, Sunbeam Corporation Ltd, Sydney, Australia) for 10 and 5 sec. on sides 1 and 2, respectively to prevent them from sticking and curling. The surface temperature of the frypan was around 160°C. The preheated *khakras* were individually processed, one after the other, in the same frypan. A steel based flattener, with a wooden handle was used for pressing the *khakras* in the same manner as described earlier[1]. The traditional processing time of *khakras* is 240 to 300 sec (150 - 160°C) and heat is applied to one side at a time. In the present study, use of the hot steel flattener reduced the processing time to 90 - 105 sec.

Sorption studies: To study the influence of moisture on the keeping quality of the *khakras*, humidity - moisture relationship of the product was studied at 27°C by exposing weighed quantities of the samples in petri dishes to relative humidities (RH) ranging from 11 to 86 per cent, built in different desiccators by using appropriate saturated salt solutions[2]. The samples were periodically weighed, till they attained practically constant weight, or showed fungal growth whichever was earlier[3]. The equilibrated samples were also subjected to sensory analysis with particular reference to texture, an essential index for *khakra* quality. The experiments were carried out in duplicate.

WVTR of packaging materials: The water vapour transmission rate (WVTR) of the packaging materials, used for storage studies, was determined according to ISI method[4] and the result was expressed in g/m^2 / day under 90 per cent RH gradient at 38°C.The WVTR studies were performed in triplicate.

Storage conditions: Unit pouches, filled with 200 g of sample were heat sealed and exposed to two sets of storage conditions, (1) 92 per cent RH and 38°C (accelerated conditions); and (2) 65 per cent RH and 27°C (normal ISI condition). The packaging materials used for storage study were 65 - 70 micron low density polyethylene (LDPE) and 32 micron polypropylene (PP). The control samples packaged in 12 micron metallised polyester / poly 38 micron was stored in refrigerated conditions (4-6°C) for sensory assessment of *khakra* during storage.

Sensory and texture evaluation: Unit packages in each condition were periodically withdrawn from the two sets and were evaluated by a panel of judges (14 to 16) for texture, flavour and overall quality. The samples were also analysed for moisture content and shear strength. The latter was determined by using Warner - Bratzler (WB) Shear Press (Model SD - 50, John Chatillon and Sons, New York). The *khakra* samples used for the determination of the shear strength were 24 - 26 mm wide and 1.35 - 1.40 mm thick. The instrument was operated at a speed of 253 mm / min; a Plexiglass shear blade, 30 mm cutting edge, 5.75 mm thick, was used in shearing experiments.

The judges were asked to assess the texture of *khakra* at intervals of one month of storage. A five point sensory scale (5-like extremely, 4-like very good, 3-like moderately, 2-dislike slightly, 1-dislike extremely), where 3 was the limit for acceptance used by the judges.

Statistical analysis: Duncan's Multiple Range Test (DMRT) was used to differentiate the sensory texture values during storage. The regression equations were developed by the technique of least squares[6] using PC-AT computer. The significance of the statistical procedures was judged at P = 0.01 or 0.05.

Results and Discussion

Sorption studies: Table 1 shows the proximate composition of *khakra* used in the present study. Table 2 shows the humidity moisture relationship for *khakra* stored at 27°C. With an initial moisture content of 4.6 per cent (dry basis), the product was in equilibrium with an RH of about 17 per cent (from sorption isotherm, not cited). Thus, it is highly moisture sensitive and absorbs moisture at normal RH conditions. The product equilibrated to RH of 32 per cent, had an EMC of 6.3 per cent and was crisp (Table 2). However, the sample which equilibrated to RH of 44 per cent had an EMC of 7.8 per cent and was slightly soft. The products which were equilibrated to 56 per cent RH and above were soft and soggy and had lost the desirable characteristics of crispness. Mould growth was noticed within 30 days in the product equilibrated to 86 per cent RH.

The sorption isotherm of the product was a typical sigmoid curve (not cited) and exhibited steep rise above 44 per cent RH suggesting probable rapid physical and chemical changes in the product above this RH. So, it was inferred that 44 per cent RH is the upper limit for acceptance with respect to crispness. Thus, it can be considered that an EMC of 7.8 per cent (db) (corresponding to 44 per cent RH) is the critical value of moisture content with respect to the acceptability of the product from the point of view of crispness.

TABLE 1. PROXIMATE COMPOSITION* OF *KHAKRA*

Characteristics	
Moisture (%)	4.4 ± 0.9
Protein (N × 5.7) (%)	14.4 ± 1.3
Fat (%)	12.5 ± 0.6
Ash (%)	2.3 ±0.1
Crude fibre (%)	2.5 ± 0.3
Carbohydrate (by diff) (%)	63.9 —

Mean ± standard deviation of triplicate determinations

TABLE 2. HUMIDITY - MOISTURE RELATIONSHIP OF *KHAKRA* AT 27°C

No	RH (%)	Eq. moisture content (EMC) (% db)	Product characteristics
1	11	3.8	Crisp, good
2	22	5.3	Crisp, good
3	32	6.3	Crisp, good
4	44	7.8	Slightly soft fair
5	56	10.8	Soft, not acceptable
6	64	12.1	Soft and soggy, not acceptable
7	75	15.6	Very soft, not acceptable
8	86	20.9	Mould growth after 30 days

Initial moisture content of *khakra* = 4.6% (db)

Water vapour transmission rate (WVTR): The WVTR values for the polyethylene (LDPR) and polypropylene (PP) were 6.22 and 8.52 g / m^2 / day at 90 per cent RH, 38°C, respectively.

Storage studies: Fig 1 shows the increase in moisture content of *khakra* during storage at 27°C / 65 per cent RH (normal storage) and 38°C / 92 per cent RH (accelerated storage). At normal storage condition, PP - packed samples gained slightly higher moisture compared to that of LDPE. The moisture content of *khakra* during storage could be explained by quadratic regression model of the form:

$$Y = A + BX + CX^2$$

Where Y = moisture content (per cent wb), X = storage

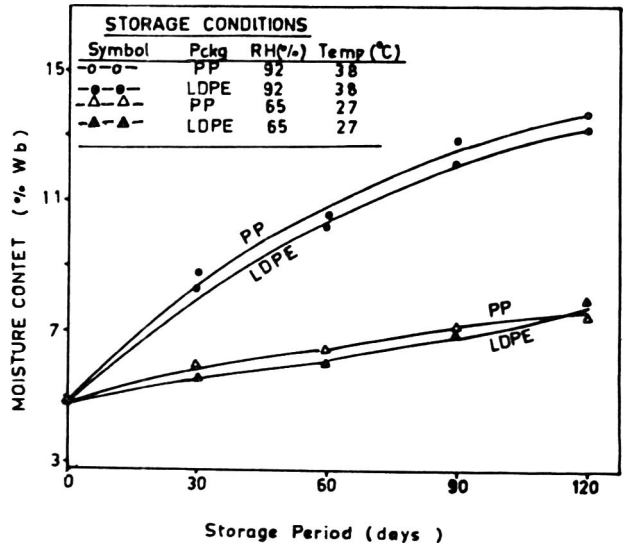

Fig.1. Moisture content of *khakra* during storage.

period (days) and A,B,C are the constants for the regression model. Table 3 shows the regression equations for moisture content of *khakra* during storage at different storage conditions in LDPE and PP packages. These regression models were found to explain the moisture content of *khakra* satisfactorily ($r \geq 0.99$, $P \leq 0.01$) during storage.

The storage life of *khakra* can be determined from Fig 1. Corresponding to critical moisture content of 7.8 per cent (db) (equivalent to 7.3 per cent, wet basis), the storage life of *khakra* will be about 20 days under accelerated storage conditions. Similarly, storage life of *khakra* under normal storage condition (65 per cent RH, 27°C) was about 95 and 105 days in PP and LDPE pouches, respectively.

Subjective and objective assessment of texture of khakra during storage: Table 4 gives a profile of the texture of *khakra* stored under different conditions. It may be observed that, in most of the cases, the texture of the *khakra*, packaged in LDPE and PP, was not significantly ($P \leq 0.05$) different when stored under similar storage temperature and relative humidity.

TABLE 3. REGRESSION EQUATIONS FOR *KHAKRA* AT DIFFERENT STORAGE CONDITIONS

Storage condition			Regression equation	r*
Temp (C)	RH (%)	Packaging material		
38	92	LDPE	$Y = 6.95 + 0.12\ X - 4.12 * 10^{-4}\ X^2$	0.998
38	92	PP	$Y = 6.97 + 0.13\ X - 4.71 * 10^{-4}\ X^2$	0.997
27	65	LDPE	$Y = 6.89 + 0.02\ X + 7.38 * 10^{-5}\ X^2$	0.998
27	65	PP	$Y = 6.88 + 0.04\ X - 1.18 * 10^{-4}\ X^2$	0.992

*Significant at $P \leq 0.01$

Moisture content (% wb) (Y) *Vs* storage period (days) (X)

TABLE 4. SENSORY EVALUATION OF THE TEXTURE OF *KHAKRA* DURING STORAGE

Storage period (months)	Sensory score for texture				
	A	B	C	D	E
0	5.00	5.00	5.00	5.00	5.00
1	4.79^a	3.79^b	3.87^b	4.39^c	4.45^c
2	4.53^a	3.08^b	2.72^c	3.93^d	4.02^c
3	4.32^a	1.70^b	1.32^c	3.03^d	3.65^e
4	4.45^a	—	—	3.01^b	2.97^b

Storage conditions:
A - Refrigerated (control)
B - 30°C / 92 % RH, PP
C - 38°C / 92 % RH, LDPE
D - 27°C / 65 % RH, PP
E - 27°C / 65 % RH LDPE

Sensory scores: 5 - Excellent; 4 - Very good; 3 - Good; 2 - Like slightly ; 1 - Dislike.

Values in the same row with same superscripts are not significantly ($p \leq 0.05$) different according to Duncan's Multiple Range Test.

TABLE 5. WARNER - BRATZLER SHEAR VALUES FOR *KHAKRAS* STORED AT DIFFERENT STORAGE CONDITIONS

Storage period (months)	W.B. shear values (kg / mm)				
	A	B	C	D	E
0	0.91	0.91	0.91	0.91	0.91
1	0.76	0.71	0.78	0.76	0.76
2	0.74	0.58	0.68	0.74	0.79
3	0.77	—	—	0.73	0.74
4	0.75	—	—	0.69	0.71

A, B, C, D, E as in Table 4.

Table 5 shows the decrease in Warner - Bratzler (WB) shear values of *khakra* during storage. The decrease in WB values was considereable in the initial phase of storage for all the samples. However, by comparing the sensory texture values (Table 4), one may conclude that acceptable limit for texture of *khakra* will be 0.73 kg/mm.

Preliminary studies on the rehydration of *khakra*, to yield ready-to-eat chapati were made. Such chapati will be very useful as convenient or instant chapati for serving in large catering establishments like railways, industrial, defence canteens etc. Wetting of *khakra* by dipping in water, followed by warming on a hot pan for a short time, gave a product similar to chapati. The problem with such reconstitution is that it is a time - consuming, laborious and each *khakra* has to be processed again individually. Detailed investigation on the rehydration of *khakra* by different methods needs to be undertaken.

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Effect of Storage Temperatures on Sensory, Chemical and Rheological Characteristics of Mozzarella Cheese

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Mozzarella cheese prepared from buffalo milk and packed in polyethylene pouches was acceptable upto a period of 14 and 90 days when stored under refrigerator (8 to 9°C) and deep-freeze (−10 to −15°C) respectively. During storage, there was a continuous moisture loss and so also a decrease in the pH levels of the cheese. The values of titratable acidity (TA) and soluble protein showed an increase during storage. The multiple regression analysis revealed that TA and soluble protein were responsible for 96% of variation in flavour characteristics of cheese stored in refrigerator. All the textural characteristics decreased with increase in storage period at both the temperatures except adhesive force.

Mozzarella cheese is being prepared increasingly in India since it forms a major constituent of fast food Pizza. The quality of cheese, however, gets affected by the conditions of manufacture, type of milk, rennet and storage temperature. The melting and stretching characteristics which are of great importance for Pizza preparation, are influenced by the breakdown of protein, fat and lactose during storage. In this background, an attempt was made to study the extent of the influence of storage temperatures on sensory, chemical and rheological characteristics.

Materials and Methods

Cheese manufacture: Mozzarella cheese was prepared from buffalo milk according to the method described by Ghosh and Singh[1]. The cheese blocks of 6 x 9 x 9 cm size were dipped in chilled water (8-10°C) for 2 hr and were dipped again for 4 hr in 20 per cent brine solution. The salted blocks were kept in the cold store for surface drying. Dried cheese blocks were packaged in food grade polyethylene pouches of 300 gauge thickness, sealed with aluminium clips and stored in the refrigerator (8-9°C) and deep-freeze (−10 to −15°C). Four replicates were taken for storage studies.

Analysis of milk: Fat, solids-not-fat, total solids (TS) and titratable acidity (TA) of milk were determined according to the ISI method[2].

Analysis of cheese: Cheese samples were selected by schematic random technique and analysed at different storage intervals for sensory, physico-chemical changes and shelf-life. Samples were sensorily evaluated for appearance, body and texture and flavour by a select panel of trained judges using an 18 - point score card[3]. Moisture was determined by the method outlined in Laboratory Manual[4] and TA by the method recommended by AOAC[5]. The pH was measured by making 10 g of cheese into a paste in a mortar by adding 10 ml of glass distilled water, An Elico-Digital pH meter (model LI-122) with combined glass electrode was used. Soluble protein was determined by the method of Kosikowski[6] with some modifications as described below.

Three g sample was taken in a mortar and a small amount of Sharps' extraction solution tempered to 50°C was added. The contents were ground into a thick paste. More solution was added to make dilute suspension and transferred to 100 ml volumetric flask. The total volume was made to 100 ml by using mortar rinse solution. The flask was kept in a water bath at 50°C for one hour with occasional shaking. The solution was filtered through Whatman No. 42 filter paper and 25 ml volume of this filtrate was transferred to a 300 ml Kjeldahl flask. It was then digested, distilled and titrated as in the determination of total protein. The soluble protein was calculated as under:

$$\text{Per cent soluble protein} = \frac{(X-Y)\ N\times 14.007\times 100}{W} \times 6.38$$

Where, X = ml of HCl used for sample, Y = ml of HCl required for blank, N = Normality of HCl used and W = wt of sample in mg.

Meltability was determined by the method of Nilson and LaClair[7] with suitable modifications. A cylindrical sample of cheese was taken with the help of a cork borer from the cheese block. The area of the base of the bored sample was 2.43 sq.cm. It was sliced into discs of 10 mm height. Three discs of each sample were placed on Whatman No. 42 filter paper, placed on the corning glass petridish and then covered

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with another plate. The whole assembly was then kept for 15 min in an atmospheric oven pre-heated to 140°C. The area of the melted cheese was then traced on a paper with the help of carbon and pencil after taking it out from the oven. The area was measured with a planimeter (Zero setting device polar compensation planimeter with optical tracer No. 75167, made in Japan). From the data, the meltability was calculated.

Meltability = A/B, where, A = Area of melted disc, B = Area of original disc. Fat leakage was determined from the same discs of cheese used for meltability measurement. As the cheese melted, the free fat leaked and soaked into the filter paper forming a grease ring around the disc of the cheese. The area of first ring was traced and measured after taking it from the oven. The fat leakage was reported as ratio of A/B where, A = area of fat ring and B = area of original disc. Stretchability test was done as described by Ghosh and Singh[1].

Electrophoretic study of Mozzarella cheese was carried out by the method outlined by deJong[8] using vertical disc gel electrophoresis technique with some modifications.

Gel buffer: Tris-HCl buffer pH 8.9 (46 g Tris dissolved in about 1 litre distilled water and the pH adjusted to 8.9 with conc. HCl and volume made to 1 litre).

Electrode buffer: Tris-glycine buffer pH 8.6 (1.4 g Tris and 5.8 g glycine per 2 l of solution).

Sample buffer: Tris-HCl-8M urea buffer, pH 8.5.

Preparation of sample: Two g of ground cheese was taken in a mortar and dissolved in 25 ml of sample buffer. Fat was removed by centrifugation (1000 r.p.m.) and subsequent filtration through Whatman No.1 filter paper. This gave 2 per cent protein in solution. The samples were stored in deep-freeze at a temperature of −10°C until analysed.

Prepared sample was subjected to polyacrylamide gel electrophoresis (PAGE). The gels were stained with amido black and destained with acetic acid. The bands formed in the gels were photographed.

Measurements of textural properties: Textural properties like hardness, adhesiveforce, cohesiveness, springiness, gumminess and chewiness of the Mozzarella cheese were measured according to the method described by Yang *et al.*[9], with an Instron Universal Testing Machine (Model 4301, Instron Corporation, Canton, MA, USA). The instrument was operated with a full scale load of 50 Newtons, 5 cm/min chart speed and 5 cm/min cross head speed (cross head recorder ratio of 1:1). Two samples of 2 cm cube were obtained from the cheese block with the help of a wire cutting device. Each cube was compressed to 50 per cent of its height and two consecutive bites were taken at 20 + 1°C.

Results and Discussion

Sensory qualities: A significant deterioration in the flavour score of cheese stored at refrigerated temperature was observed and compared to a marginal deterioration when stored at deep-freeze temperature (Table 1). The product stored in refrigerator was acceptable upto 14 days while the product in deep-freeze was acceptable even at the end of 90 days of storage. Visible fungal growth was observed at the end of 18 days of storage in cheese kept in refrigerator. Acidic, bitter and putrid flavours were noticed in cheese graded as unacceptable which is similar to the observations made earlier[10]. The body and texture scores decreased from 4.8 to 4.4 at the end of 14 days in cheese stored in refrigerator and from 4.8 to 3.5 in cheese stored in deep-freeze. The main criticisms for the decreased scores were weak, pasty and mealy for the product stored in refrigerator. The cheese stored in deep-freeze was graded as brittle, coarse and fragile. However, a marginal improvement in the body and texture scores was observed in the cheese stored in refrigerator and deep-freeze at the end of 7 and 30 days, respectively. The changes in body and texture observed may be due to the degradation of proteins during storage and equilibration of the brine salt in cheese with storage time[11].

The colour of Mozzarella cheese stored in refrigerator became dull yellow during storage and this increased with the storage period. The surface spoilage occurred due to the growth of microorganisms and a greenish slime accompanied by an off-flavour observed in the product stored in refrigerator. The frozen samples after thawing were observed to be bleached with acid flavour and free surface moisture was noticed. However, no mould growth was observed even at the end of 90 days at this temperature.

Chemical changes: The moisture content of cheese reduced gradually during storage from 51.6 to 49.9 per cent and 47.7 per cent in refrigerated and deep-frozen samples, respectively (Table 2). Rossi[12], in his study had observed a continuous moisture loss from the cheese stored in deep-freeze which depended on the moisture permeability of the wrapper, integrity of the seals, relative humidity between the atmosphere inside and outside the wrapper, storage temperature and the method of packaging.

It is observed that the pH remained unchanged upto 7 and 30 days of storage in refrigerated and deep-frozen samples

TABLE 1. SENSORY QUALITY OF CHEESE DURING STORAGE

Attributes	Scores at refrigerated temp at indicated days					Scores at deep-frozen at indicated days of storage					
	0	7	14	21	28	15	30	45	60	75	90
Flavour (10)	9.8	9.4	7.5	4.5	2.0	9.8	9.5	9.2	8.7	8.3	8.0
Body & texture (5)	4.8	5.0	4.4	3.4	2.3	4.8	5.0	4.7	4.4	4.0	3.5

TABLE 2. CHEMICAL CHANGES OF THE CHEESE DURING STORAGE

Parameters	Changes in refrigerated stored sample at indicated days					Changes in deep-frozen stored sample at indicated days					
	0	7	14	21	28	15	30	45	60	75	90
Moisture (%)	51.63	51.34	50.65	50.10	49.88	51.02	50.00	49.34	48.54	48.07	47.67
pH	5.36	5.35	5.27	5.20	5.16	5.36	5.34	5.32	5.30	5.27	5.24
TA (%)	0.73	0.74	0.85	0.96	1.06	0.73	0.74	0.74	0.77	0.80	0.85
Soluble protein (%)	1.58	1.73	2.23	2.98	3.88	1.63	1.77	1.89	2.07	2.36	2.68

Average of four replicates

and started declining thereafter. (Table 2). The final pH reached was 5.16 at the end of storage in refrigerator and 5.24 in the product stored at deep-freeze. The rate of decrease in pH was slow in the cheese sample stored at deep-freeze, an observation similar to those reported by Asperger[13] and Matteo *et al.*[14], The rate of decrease was due to the absence of micro-organisms on the surface. The storage temperature had distinct effect on the pH of the cheese.

There was negligible change in TA upto 7 days at refrigerated temperature. The acidity increased sharply thereafter reaching 1.06 per cent at the end of storage (Table 2). The increase in TA was directly related to the spoilage of the product. The spoilage may be due to the micro-organisms which would utilise lactose present in the cheese. The increase in acidity was considerably lower in frozen sample due to the adverse situation for microbial growth compared to the refrigerated samples.

The initial soluble protein of Mozzarella cheese was 1.58 per cent. The degradation of protein increased during storage and the final soluble protein was 3.88 per cent after 28 days of storage in refrigerator (Table 2). The rate of increase was closely related to the flavour deterioration which is also confirmed by regression analysis. The samples which underwent rapid proteolysis also deteriorated faster. As the proteolysis progressed, the product became soft losing its grating properties. The proteolysis was considerably slower at deep-freeze temperature though it followed a similar trend as in the case of refrigerated samples. However, the final value was considerably lesser (2.68 per cent) . The increase in proteolysis could be due to the residual coagulating enzymes or the enzymes produced by the micro-organisms[15,16]. The slower proteolysis observed in the deep-frozen sample may be due to slow enzymatic action and this observation is in agreement with the results of Melachouris and Tuckey[17]. The increase in soluble protein contributed for the bitterness of the cheese.

Regression analysis: The effect of chemical changes viz., TA, pH and soluble protein on the flavour of Mozzarella cheese packed in polyethylene pouches stored in refrigerator was studied statistically by regression equation. The chemical changes were found to relate closely to flavour deterioration. Since the flavour deterioration and changes in the above parameters in deep-frozen samples were not prominent, the multiple regression analysis was not applied on these samples. The most significant independent variable was soluble protein followed by titratable acidity and pH. The results of the stepwise regression analysis are given in Table 3. A typical regression; Flavour score = 19.110 - 7.708 (TA) −2.346 (Soluble protein) has been selected as the final equation for further interpretation. As the variables TA and pH were found to be strongly interrelated, pH was dropped from the final equation. This equation (sl.no. v in Table 3) revealed that TA and soluble protein showed a negative and significant effect on the flavour score implying that with the increase of one unit of TA, there would be a decrease in the flavour score by 7.71 units whereas in the case of soluble protein there would be a decrease in the flavour score by 2.35 units keeping other factors constant. The extent of variation explained by the two variables (TA and soluble protein) included in the multiple regression equation was of the order of 96 per cent.

Electrophoretic behaviour of casein hydrolysis during storage: It is observed that the degradation of β-casein was not much whereas α-casein degraded faster with the increase in storage period upto 28 days (Fig.1). Degradation was maximum in $\alpha\ s_T$ casein. Proportion of $\alpha\ s_T$ casein degraded to s_T-I and $\alpha\ s_T$-II fraction was more prominent on 28th

TABLE 3. MULTIPLE LINEAR REGRESSION EQUATIONS FOR FLAVOUR CHANGES OF CHEESE DURING STORAGE

	Regression equations	R^2
(i)	Y = 26.470 − 22.328 ×1** (1.99)	0.874
(ii)	Y = −183.527 + 36.170 ×2** (3.677)	0.843
(iii)	Y = 14.698 − 3.351 ×3** (0.1984)	0.941
(iv)	Y = −31.086 − 16.515 ×1* + 9.964 × 2 (7.407) (12.217)	0.879
(v)	Y = 19.110 − 7.708 ×1* − 2.346 ×3 (2.673) (0.386)	0.960
(vi)	Y = −41.462 + 10.310 ×2* − 2.545 ×3** (4.481) (0.393)	0.955
(vii)	Y = 10.733 − 6.958 ×1* + 1.459 ×2** − 2.330×3** (4.677) (7.350) (0.407)	0.960

*Significant at 5%; ** at 1% level; Y = Flavour score, ×1 = TA, (% Lactic acid); ×2 = pH, ×3 = Per cent soluble protein.

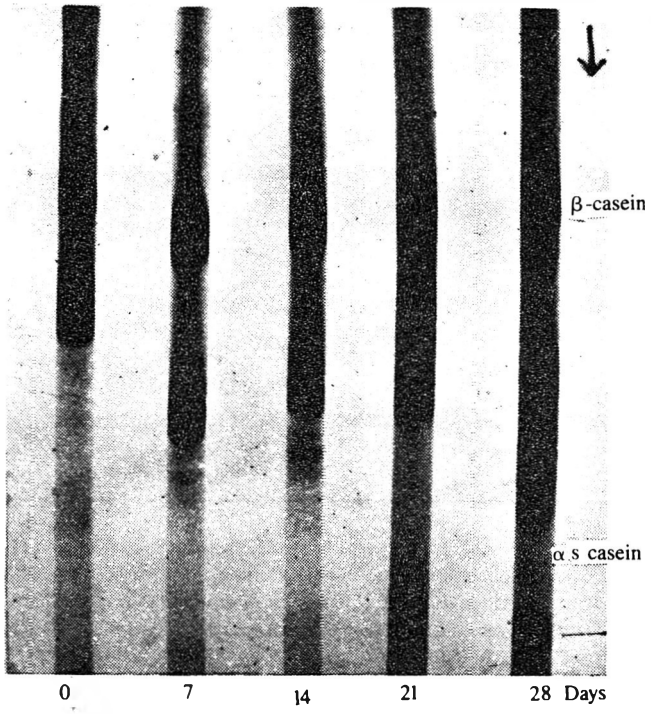

Fig.1. PAGE Pattern of casein hydrolysis of Mozzarella cheese packaged in polyethylene pouches and stored at refrigerated temperature.

day of storage but the degradation started from 14th day onwards. This additional αs_T-casein bands (αs_T-I and αs_T-II) appeared as a result of degradation by microbial rennet. Casein degradation during storage of cheese was also observed by earlier workers[13,19].

In deep-frozen sample (Fig 2), casein was not degraded upto 45 days of storage. The slight degradation in α-s casein started at the end of 60 days of storage and continued with increase in storage period. The α-s casein underwent slow degradation into faster moving compounds as indicated by the minor bands towards positive pole. The lower rate of casein degradation in Mozzarella type cheese is likely to be a consequence of temperature treatment to the curd received during manufacture[14,18]. Albonico and Resmini[20] found that Mozzarella cheese stored at −20°C for more than one month did not affect the electrophoretic properties of the casein. Matteo *et al.*[14] suggested that degradation of casein in Mozzeralla cheese can be minimised by using as little rennet as possible and by increasing the acidity of the cheese milk.

Melting and fat leakage: The melting and fat leakage of cheese increased with the increase of storage period but the

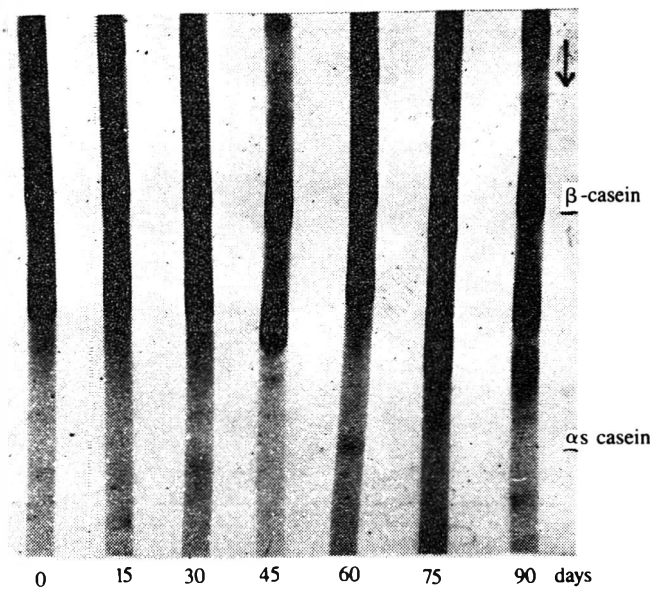

Fig.2. PAGE pattern of casein hydrolysis of Mozzarella cheese packaged in polyethylene pouches and stored in deep-freeze.

rate of increase of melting was faster in cheese stored in refrigerator than the cheese stored in the deep-freeze (Table 4). The initial average melting and fat leakage of fresh samples were 2.99 and 4.82, respectively. The increase in melting may be due to the progressive protein degradation and these results are in agreement with the results of Harvey *et al.*[21] in process cheese. However, the fat leakage was more in cheese stored in deep-freeze compared to the cheese stored in refrigerator with the same degree of melting quality. In general, the melting and fat leakage were closely related except in case of deep-frozen samples where fat leakage was disproportionately high, an observation made earlier by Olson[22]. The high fat leakage in deep-frozen samples may be due to the denaturation of protein and rupture of fat globule membrane.

Changes in textural parameters: All the textural parameters were observed to decrease during storage except for the adhesive forces (Table 5). The changes in textural characteristics were less in the frozen samples as compared to the refrigerated samples. This could be due to slow incorporation of free water into the fibrous protein sturcture of cheese. The textural characteristics of cheese as a whole changed significantly during storage due to microbiological growth, moisture loss, enzymatic activity (degradation of protein) and salt diffusion[23].

TABLE 4. CHANGES IN RHEOLOGICAL CHARACTERISTICS OF THE CHEESE DURING STORAGE

Characteristics	Changes in refrigerated storage at indicated days				Changes in deep-frozen sample at indicated days of storage			
	0	7	14	21	28	30	60	90
Melting (ratio)	2.99	3.25	3.96	4.45	4.76	3.10	3.35	3.56
Fat leakage (ratio)	4.82	5.35	6.83	7.21	7.58	5.15	5.72	6.60

TABLE 5. CHANGES IN TEXTURAL PROPERTIES OF CHEESE DURING STORAGE

Storage period (days)	Conditions of storage	Instron measures					
		Hardness (N)	Springiness (mm)	Cohesiveness —	Gumminess (N)	Chewiness (Nmm)	Adhesive force (N)
0	—	42.923	7.5	0.3782	16.233	121.748	0.6
15	Refrigerator	36.676	7.0	0.3581	13.133	91.931	0.8
	Deep-freeze	41.051	7.5	0.3697	15.178	113.828	0.6
30	Refrigerator	20.112	5.0	0.3125	6.285	31.425	1.1
	Deep-freeze	39.517	7.0	0.3501	13.835	96.845	0.7

N = Newton ; mm = millimeter

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A Study on Certain Functional Properties of Chicken and Duck Eggs*

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Foam volume and angel cake volume were high and foam drainage and albumen spread were less in chicken eggs compared to duck eggs. Oils coated refrigerated eggs recorded better functional properties in terms of foam volume, foam drainage, angel cake volume, poaching quality and sensory quality of angel cake compared to oil coated room temperature stored eggs and untreated regrigerated eggs. Flavour and tenderness scores of the angel cakes prepared from chicken egg whites were superior to those prepared from duck egg whites. There was a decrease in functional properties of chicken and duck eggs, as well as sensory qualities of angel cakes prepared from the whites of eggs of both species as storage period increased.

Several studies were carried out on the physical and chemical aspects of chicken and duck eggs[1-4]. Very few attempts were made to study the functional qualities of these eggs which help in proper use of them. This experiment was designed to study the effect of preservation method and storage periods on functional properties of chicken and duck eggs.

Materials and Methods

A total of 158 eggs from each of chicken and duck were used. From this, a sample of 14 eggs were used within six hours of collection to determine the functional qualities at fresh stage. The remaining eggs from each source were randomly devided into three lots of 48 eggs each, numbered and weighed. Two lots from each species were oil coated with a hand spray using the commercial egg coating oil. One oil coated lot from each species was stored at room temperature. The second lot of oil coated eggs was stored in a refrigerator (4 ± 2°C) along with untreated lot. Fourteen eggs from each treatment and from each species were used at 14, 28 and 42 days interval to study foam volume and its drainage, angel cake volume, poaching quality and sensory qualities of angel cake made from chicken and duck egg whites.

Fifty g of egg white drawn from two eggs was beaten for two min with a mechanical hand beater. The foam was transferred to a measuring flask and the volume measured. The amount of drainage was measured after allowing the foam to stand for one hour[5]. The drainage was expressed in ml per 100 ml of foam.

Angel cakes were made according to the method described by Slosberg *et al.*[6] with slight modification. The angel cake was prepared by using the formulation, egg white 55 g, sugar 55 g, flour 30 g, vanaspathi (hydrogenated fat) 30 g and baking powder 0.9 g. The volume of the cake was measured by rapeseed displacement method as described by Sauter *et al.*[7] The difference in the seed volume with and without the cake loaves was taken as the volume of the cake.

Poaching of the eggs was carried out as per the method of Nash *et al.*[8] Poaching quality was determined on the basis of thick albumen spread and yolk coverage. Yolk coverage was judged by the indicated coverage of yolk by albumen. A scale of 0 to 3 was used (0 - broken, 1 - poor, 2 - fair and 3 - good). Albumen spread of the poached eggs was recorded by taking the mean of two readings at right angles with the help of a vernier calipers and expressed in centimeters.

A taste panel of six trained members was used to evaluate the colour, appearance, tenderness and flavour on an eight point Hedonic scale (eight for very desirable and one for very

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undesirable). A sample of the size of one square inch was presented to each panelist.

The data were statistically analysed using the split plot (nested) design[9]. The differences between the treatments were spotted by using least significant difference. Means for periods within each species were compared with 't' values.

Results and Discussion

Functional properties of eggs as influenced by the species are presented in Table 1. Functional qualities of chicken and duck eggs as affected by preservation methods and storage periods are presented in Tables 2 and 3, respectively. Foam volume was significantly higher in chicken eggs compared to duck eggs. Baliga *et al.*[10] observed that poor foaming quality of duck eggs is due to the presence of larger content of mucin in thick white. Garewal[11] observed that albumen of duck eggs was more transluscent and watery and therefore does not beat well to give larger volume of foam. In both the species, oil coated eggs stored at refrigerated temperature gave higher foam volume and oil coated eggs held at room temperature gave least volume. A gradual decline was observed in foam volume as storage period increased from 0 to 42 days with significantly higher foam volume in fresh eggs of both the species and least in the eggs stored for 42 days. Harns *et al*[12] observed that there was definite deterioration of the egg white quality by the fourth week during room temperature storage.

Duck eggs showed significantly higher foam drainage compared to chicken eggs. Foam drainage was significantly higher in oil coated eggs stored at room temperature, when compared to the other two preservation methods. The increased storage time also had a significant deteriorating effect of egg white whipping quality probably due to lower albumen quality.

Chicken egg whites gave angel cakes of higher volume compared with duck egg whites. Duck egg whites due to their poor whipping quality do not make good angel cakes[11]. Eggs stored at refrigerated temperature gave higher cake volume, which confirmed the reports of Slosberg *et al*[6] and Harns *et al*[13]. Increased storage period of eggs decreased the angel cake volume significantly. Fresh eggs gave higher cake volume than stored eggs. Eggs held for 14 days maintained higher cake volume, but there was a definite deterioration of egg white quality by the end of fourth week storage. Some oil coated duck eggs held at room temperature for 42 days could not be utilized for the preparation of angel cakes as whites got contaminated with yolk.

There was a significant difference between the albumen spreads of poached chicken and duck eggs. This may perhaps be due to larger quantity of albumen in duck eggs. In both the species, preservation methods failed to significantly influence the albumen spreads. Storage periods showed significant effect on albumen spreads. Albumen spreads of poached eggs were not affected till the 14th day of storage in duck eggs. In both the species, significant decline in the quality was observed by 14 day of storage. Nash *et al*[8] reported that after preservation and storage, the spreads were greater in all cases. This was probably due to decreased per cent thick albumen[14].

TABLE 1. MEAN VALUES OF FUNCTIONAL PROPERTIES OF EGGS AND ANGEL CAKE QUALITIES AS INFLUENCED BY SPECIES

Characteristics	Duck	Chicken
Foam volume (ml)	181.24^a	226.04^b
Foam drainage (ml)	16.38^a	10.07^b
Angel cake volume (ml)	242.91^a	265.41^b
Poaching quality		
Thick albumen spread	10.02^a	8.86^b
Coverage scores (Yolk)	2.75^a	2.63^a
Sensory scores of angel cake		
Colour	5.58^a	5.55^a
Appearance	5.95^a	5.78^a
Flavour	5.83^a	6.49^b
Tenderness	5.42^a	6.05^b

Means with the same superscript in the same row do not differ significantly ($P < 0.01$).

TABLE 2. FUNCTIONAL PROPERTIES OF CHICKEN EGGS AS INFLUENCED BY PRESERVATION METHOD AND STORAGE PERIODS

Parameters	Preservation methods			Storage period (days)			
	Oil + room.	Oil + refrig.	Refrig	0	14	28	42
Foam volume (ml)	203.12^a	240.00^b	235.00^b	255.00^m	235.00^n	215.83^p	198.33^p
Foam drainage (ml)	13.52^a	8.39^b	8.29^b	6.66^m	8.60^{mn}	11.56^{np}	13.46^p
Angel cake volume (ml)	253.12^a	278.12^b	265.00^a	325.00^m	304.16^n	225.00^p	212.50^p
Albumen spread	8.90^a	8.82^a	8.87^a	7.88^m	8.03^n	9.41^p	10.15^q
Yolk coverage scores	12.75^a	14.75^b	12.00^a	16.00^m	13.33^n	13.00^n	10.33^p
Sensory scores of angel cake							
Colour	5.54^a	5.66^a	5.46^a	5.83^m	5.66^m	5.49^m	5.22^m
Appearance	5.66^a	5.95^a	5.74^a	6.16^m	5.88^m	5.72^m	5.40^m
Flavour	6.07^a	6.78^b	6.62^b	7.16^m	6.34^n	6.38^n	6.05^p
Tenderness	5.66^a	6.45^b	6.04^b	6.66^n	5.99^o	5.83^n	5.71^m

Means with the same supercript in the same row do not differ significantly ($P < 0.05$)

TABLE 3. FUNCTIONAL PROPERTIES OF DUCK EGGS AS INFLUENCED BY PRESERVATION METHOD AND STORAGE PERIOD

Parameters	Preservation methos			Storage period in days			
	Oil + room.	Oil + refrig.	Refrig	0	14	28	42
Foam vol (ml)	169.37^{a}	196.25^{b}	178.12^{ab}	217.50^{m}	190.83^{mn}	170.00^{np}	146.66^{p}
Foam drainage (ml)	18.67^{a}	14.56^{b}	15.92^{b}	13.33^{m}	13.52^{m}	19.68^{n}	23.43^{n}
Angel cake volume	237.50^{a}	250.00^{b}	241.25^{ab}	275.00^{m}	265.00^{n}	214.16^{n}	207.50^{n}
Poaching quality							
Albumen spread	10.12^{a}	9.94^{a}	10.01^{a}	8.90^{m}	9.16^{m}	10.07^{n}	11.95^{p}
Yolk coverage	12.75^{a}	15.00^{b}	13.50^{a}	17.00^{m}	15.33^{n}	14.00^{n}	8.66^{p}
Sensory scores of angel cake							
Colour	5.55^{a}	5.66^{a}	5.54^{a}	5.66^{m}	5.49^{m}	5.72^{m}	5.42^{m}
Appearance	5.94^{a}	5.99^{a}	5.91^{a}	6.50^{m}	5.83^{m}	5.77^{m}	5.60^{m}
Flavour	5.71^{a}	5.91^{a}	5.87^{a}	5.66^{m}	5.77^{m}	6.16^{m}	6.16^{m}
Tenderness	5.44^{a}	5.54^{a}	5.29^{a}	6.00^{m}	5.27^{m}	5.22^{m}	5.00^{m}

Means with the same superscript in the same row do not differ significantly ($P < 0.05$)

Average yolk coverage was good in fresh eggs in both the species. The coverage of yolk of oil coated eggs stored at refrigerated temperature was rated higher than the other two preservation methods. Greater spreads of albumen and poor coveragae of yolks in stored eggs observed in this study may be due to thinning of thick albumen.

No differences were observed in colour and appearence between the cakes prepared from duck and chicken egg whites. Eventhough fresh eggs gave slightly higher scores, there was no difference due to preservation methods and storage periods. Tenderness and flavour scores of the cake were significantly higher in chicken eggs as compared to duck eggs. The flavour difference in the cakes prepared from duck eggs may be due to species[11] and dietary differences[2]. The decrease in tenderness of duck egg angel cake may be due to increased firmness of cooked egg white. Preservation methods or storage periods showed no significant effect in duck eggs while they affected the chicken eggs ($p < 0.05$). In both the species, oil coated eggs held at refrigerated temperature gave higher scores, followed by untreated refrigerated eggs and oil coated eggs held at room temperature in that order. A gradual decline was observed in flavour score of angel cake quality as storage period increased[12].

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Effect of Frozen Storage and Extenders on the Quality of Meat Tikkas from Culled Hens and Broiler Breeder Males

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Meat tikkas (sausages) from spent hens and broiler breeder males in combination with refined wheat flour (maida) semolina and potato as binders were frozen stored (-18°C) as raw or pre-cooked and evaluated at monthly intervals for proximate composition and sensory quality. The cooking loss and shrinkage were significantly affected by binders, storage and meat type; while proximate composition and sensory parameters were significantly affected by cooking as well in addition to these treatments. Among the binders, potato containing samples were preferred the least. Cooking improved sensory quality of tikkas. The tikkas could be stored under frozen conditions for four months in case of raw and more than five months in case of pre-cooked samples without marked perceivable deterioration in quality.

The addition of soy protein isolate or textured soy protein increases binding of water and fat, improves adhesion/cohesion and reduces weight losses in sausages[1]. Poultry sausages have been successfully produced by blending chicken meat with vegetables[2] and binders such as dried skim milk, semolina, corn starch and pasteurized egg white[3]. Jindal and Bawa[4] concluded that meat from spent hens can be blended with soy flour upto 10 per cent level of replacement in poultry sausages without any adverse effect on the chemical composition and sensory quality. Sekhon and Bawa[5] evaluated the wheat flour, shredded potato and semolina as extenders in the preparation of poultry meat tikkas. In continuation of the same, this investigation was undertaken to evaluate the storage stability and shelf life of such tikkas under frozen conditions.

Materials and Methods

Approximately one year old 'White Leghorn' culled hens and broiler breeder males at the end of their active laying and breeding periods respectively were procured, slaughtered, dressed, packed in polyethylene bags (150 gauge) and kept in deep -reezer at — 18°C till use. On the day of preparation, the carcasses were thawed, deboned and minced in a manually operated meat mincer. Maida, semolina and potato were purchased from the local market. The potatoes were grated before use.

Four samples (with three binders and a control) weighing about 4 kg each, of hen/broiler meat tikkas were prepared as reported by Sekhon and Bawa[5].

Four tikkas from each treatment were weighed before and after cooking/deep-frying to an internal temperature of 68-70 °C. The loss in weight during cooking was expressed in terms of per cent cooking loss as follows:

$$\text{Per cent cooking loss} = \frac{\text{Initial wt} - \text{Wt after cooking}}{\text{Initial wt}} \times 100$$

The raw and cooked tikkas were packaged in 150 gauge polyethylene bags with alternate layers of butter paper and air was removed from the bag as far as possible, folded twice at the top, stapled and stored in deep-freezer at −18°C. The frozen stored tikkas were evaluated at monthly intervals.

The raw minced meat, maida, semolina, potato, tikka batter and cooked tikka samples were analysed for moisture, protein, fat and salt contents using AOAC[6] procedures. The binders and meat were also analysed for dextrose equivalent (DE) using the method of Sophianopoulos[7].

Total plate counts of raw meat, binders, batter and cooked samples were conducted by pour plate method using Agar media[8]. The tikkas were fried and sensory qualities were evaluated for colour, texture, flavour and overall acceptability with the help of a semi-trained panel using a semi-structured scale[9]. The data were statistically analysed[10].

Results and Discussion

Analysis of variance and LSD tests of comparison for individual treatment means revealed that cooking loss and shrinkage were significantly affected by storage, binders and meat type while binders, storage, cooking and meat type had significant effects on all the proximate composition and sensory evaluation parameters. The values for treatment means (averaged over the binders in case of storage and storage periods in case of binders) have been reported in Tables 1, 2, 3 and 4. The zero hr values have been reported earlier[5] and taken into account while discussing the results.

The mean cooking loss values indicate that the losses were significantly ($P < 0.05$) affected by binders and storage. The

control tikkas from hen meat gave significantly ($P < 0.05$) higher cooking loss (24.71 per cent) followed by potato samples (23.24 per cent) of broiler meat while it was minimum for semolina samples (15.90 per cent) of hen tikkas. Similarly, the storage had a significant ($P < 0.05$) effect on cooking loss. There was a significant ($P < 0.05$) increase in cooking loss as the storage progressed in case of tikkas from either meat source which can be attributed to progressive denaturation of proteins and certain other biochemical changes. At the end of five months storage, the values for hen and broiler tikkas were 30.09 and 30.91 respectively. Similar results were reported by Cook and Gill[11] and Rogov *et al.*[1]

Binders and storage had a significant ($P < 0.05$) effect on the mean per cent shrinkagae in diameter of various tikka samples. The tikkas containing semolina from both hen (18.25 per cent) and broiler (17.59 per cent) meats had a significantly ($P < 0.05$) lower shrinkage as compared to other samples. However, shrinkage values for broiler tikkas containing maida and semolina were not significantly different. There was a significant ($P < 0.05$) increase in shrinkage during storage with maximum values of 28.21 and 30.81 per cent for hen and broiler meat tikkas respectively at the end of five months storage. Similar results have been reported by Thompson *et al.*[12] for textured meat patties and Sison and Almira[13] for binders such as cassava flour and corn starch.

Proximate composition: Moisture content significantly ($P < 0.05$) decreased with the use of binders except for potato. However, the moisture contents were not much different for maida and semolina or control and potato containing raw samples. Cooking resulted in a significant ($P < 0.05$) decrease in moisture contents. Storage resulted in a significant increase in moisture content in both the raw and cooked samples as storage progressed from one to five months which may be attributed to condensation of moisture within the packages. The loss in moisture content in cooked samples may be due to evaporation.

The binders and storage had a significant ($P < 0.05$) effect on protein content of raw and cooked samples from either source (Tables 1 and 2). It decreased significantly with the use of binders in both the types of meat. Cooking resulted in a significant ($P < 0.05$) increase in protein content. During storage, the protein decreased significantly ($P < 0.05$) in raw and cooked tikkas made from both types of meat. This appeared to be corresponding with the moisture content. The lower protein content of samples with binder may be due to their starchy nature and the higher protein content of cooked samples can be attributed to moisture losses as a result of evaporation during cooking.

The samples with maida, semolina and potato were similar in fat contents while cooking resulted in significantly ($P < 0.05$) higher values which can be attributed to absorption of fat during frying. A significant ($P < 0.05$) decrease in fat contents was observed after second month of storage in case of cooked samples and after third month of storage in case of raw samples for both the meat types which can be attributed to the increase in moisture contents.

The length of storage resulted in a significant ($P < 0.05$) decrease in the salt content of various tikka samples, irrespective of the storage as raw or cooked which can be attributed to synergesis during thawing and leaching out of salt into the drip. The tikkas from hen meat containing various binders had significantly ($P < 0.05$) higher salt contents as compared to corresponding broiler samples. The hen raw tikkas containing semolina had the higher (1.61 per cent) salt content which corresponds to the lowest cooking loss

TABLE 1. EFFECT OF BINDERS ON THE MEAN* PROXIMATE COMPOSITION AND TOTAL PLATE COUNTS OF POULTRY TIKKAS

	Moisture (%)		Protein (%)		Fat (%)		Salt (%)		Dextrose (%)		TPC ($x10^3$)	
	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked
Culled Hens												
Control	68.89^{w}	58.68^{w}	13.09^{w}	17.53^{w}	6.74^{x}	8.01^{x}	1.41^{w}	1.16^{w}	4.66^{w}	5.76^{w}	2.78^{w}	2.31^{w}
Maida	67.97^{x}	64.44^{x}	12.58^{x}	17.04^{x}	6.45^{y}	7.76^{y}	1.45^{x}	1.13^{x}	6.39^{x}	6.36^{x}	2.22^{x}	2.11^{x}
Semolina	67.60^{y}	62.70^{y}	11.92^{y}	15.16^{y}	6.45^{y}	7.64^{y}	1.61^{y}	1.55^{y}	7.95^{y}	6.79^{y}	2.49^{y}	2.01^{y}
Potato	70.13^{z}	65.10^{z}	11.94^{y}	15.19^{y}	6.44^{y}	7.65^{y}	1.34^{z}	1.47^{z}	5.19^{z}	5.03^{z}	2.86^{z}	2.40^{z}
Culled Broiler Breeder Males												
Control	68.34^{w}	63.17^{w}	15.25^{w}	19.05^{w}	7.46^{x}	8.28^{x}	0.95^{w}	1.04^{w}	4.61^{w}	4.07^{w}	2.87^{w}	2.49^{w}
Maida	67.28^{x}	58.30^{x}	14.82^{x}	18.18^{x}	7.13^{y}	9.47^{y}	0.87^{x}	1.28^{x}	6.68^{x}	6.78^{x}	2.38^{x}	1.98^{x}
Semolina	66.64^{x}	62.90^{y}	14.99^{y}	17.04^{y}	7.10^{y}	8.42^{x}	0.85^{y}	1.13^{y}	7.34^{y}	6.17^{y}	2.61^{y}	2.16^{y}
Potato	68.55^{z}	63.08^{z}	13.59^{z}	15.78^{z}	7.04^{y}	9.43^{y}	0.93^{y}	1.16^{z}	5.35^{z}	5.32^{z}	2.85^{z}	2.35^{z}
C.D. (Binders)	0.025		0.017		0.25		0.013		0.027		0.013	
C.D. (Cooling)	0.03		0.03		0.36		0.019		0.039		0.018	

*Means in the same column with different superscripts differ significantly ($P < 0.05$).
n = 12.

TABLE 2. EFFECT OF STORAGE ON THE MEAN* PROXIMATE COMPOSITION AND TOTAL PLATE COUNTS OF POULTRY TIKKAS

Storage (months)	Moisture (%)		Protein (%)		Fat (%)		Salt (%)		Dextrose (%)		TPC ($X10^3$)	
	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked
Culled Hens												
1	62.32^a	61.65^a	14.20^a	17.45^a	6.85^a	8.12^a	1.87^a	1.81^a	7.11^a	7.58^a	1.85^a	1.61^a
2	67.74^b	61.78^b	13.54^b	16.11^b	6.80^{ab}	8.00^a	1.61^b	1.32^b	6.98^b	7.49^b	2.08^b	1.76^b
3	72.01^c	63.68^c	9.72^c	15.93^c	6.59^c	7.76^b	1.47^c	1.26^c	6.40^c	5.98^c	2.44^c	2.11^c
4	67.78^d	63.07^d	12.23^d	15.83^d	6.28^c	7.55^{cd}	1.17^d	1.19^d	5.43^d	4.76^d	3.10^d	2.66^d
5	63.38^e	63.47^e	12.32^e	15.84^d	6.07^c	7.40^d	1.13^e	1.04^e	4.32^e	4.13^e	3.47^e	3.14^e
Culled Broiler Breeder Males												
1	66.58^a	60.19^a	16.19^a	19.11^a	7.47^a	9.17^a	1.34^a	1.57^a	7.22^a	6.97^a	1.98^a	1.82^a
2	67.68^b	61.44^b	14.83^b	17.77^a	7.43^a	9.03^{ab}	1.13^b	1.47^b	6.77^b	6.21^b	2.28^b	1.95^b
3	70.09^c	62.53^c	14.05^c	17.56^b	7.18^b	8.86^b	0.99^c	1.24^c	6.04^c	5.39^c	2.55^c	1.98^c
4	67.22^d	61.83^d	14.49^d	16.62^c	6.96^c	8.77^b	0.54^d	0.77^d	5.23^d	4.83^d	3.11^d	2.38^d
5	67.95^e	62.32^e	13.73^e	16.44^d	6.68^d	8.68^b	0.51^e	0.74^e	4.72^e	4.52^e	3.47^e	3.08^e
C.D. (Storage)	0.023		0.015		0.23		0.012		0.024		0.011	
C.D. (Cooking)	0.03		0.03		0.36		0.019		0.039		0.018	

*Means in the same column with the different superscripts differ significantly ($P<0.05$)
n = 15

observed earlier and maida samples had the highest (1.28 per cent) salt content in case of cooked broiler tikkas.

Storage resulted in a significant (P 0.05) decrease in dextrose equivalent (DE) in all the samples. The cooking of tikkas resulted in a significant ($P < 0.05$) decrease in dextrose equivalent in almost all the samples which can be attributed to browning reactions during cooking. Tikka samples with different binders (Table 1) different significantly from each other with respect to DE. The hen and broiler tikkas with semolina had significantly ($P < 0.05$) higher dextrose contents (7.95 per cent and 7.34 per cent respectively) which can be attributed to the starchy nature of semolina.

Total plate counts: The mean total plate count (TPC) values (Tables 1 and 2) for various samples showed that storage resulted in increases in total plate counts in all the samples. This is contrary to expectations and could be due to reasons beyond control. The total plate counts decreased with the addition of binders, which may be due to lower initial total plate counts for binders reported earlier by the present authors[5]. The tikkas with potatoes as binder showed increases in TPC which can be attributed to contamination during grating of potatoes. Cooking resulted in decreases in TPC which may be caused due to destruction of micro-organisms by heat. Similar results with respect to binders[14] and heat treatment/ cooking[15,16] have been reported earlier.

Sensory panel scores: The mean sensory panel scores for colour, texture, flavour and overall acceptability (Tables 3 and 4) indicate that binders, storage and cooking had a significant ($P < 0.05$) effect. The cooked samples both for hen and broiler with semolina rated significantly better (9.25 and 9.64 cm respectively) than other samples for colour scores. Storage had a significant ($P < 0.05$) effect on colour and with increase in storage, a cecrease in sensory scores for colour was observed.

The texture scores were significantly ($P < 0.05$) higher for pre-cooked samples as compared to raw stored ones while the binders significantly improved the texture of tikkas over that of control. A decrease in texture score values was observed with the increase in storage period. This can be attributed to higher cooking losses and shrinkage.

The addition of binders resulted in significant ($P < 0.05$) decreases in flavour scores with the exception of broiler raw tikkas containing maida. The flavour scores decreased with the increase in length of storage and a slightly rancid flavour was observed after 3 months in case of broiler samples and after 4 months in case of hen samples. Bowers and Eugler[17] reported lower scores for meaty flavour and aroma in soy beef patties as compared to whole beef patties.

The mean overall acceptability scores were increased significantly ($P < 0.05$) with the use of binders as compared to control samples. Cooking also resulted in significant ($P < 0.05$) increases in overall acceptability scores. The overall acceptability was, no doubt, decreased during storage, for all the samples. However, the decreases were more in case of broiler breeder male tikkas as compared to hen tikka samples. Farthing[18] reported preference of the frozen pre-cooked patties over raw while Dagerskog *et al*[19] reported improvement in sensory properties as a result of heating of patties frozen stored at −18°C in pre-cooked (browned) form.

It is concluded that meat from culled hens and broiler breeder males can be effectively used for the preparation of meat tikkas with semolina and maida as binders. The tikkas can be frozen stored upto four months in case of raw and

TABLE 3. EFFECT OF BINDERS ON MEAN *SENSORY PANEL SCORES FOR POULTRY TIKKAS

Binders	Colour		Texture		Flavour		Overall acceptability	
	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked
Culled Hens								
Control	10.40^{w}	8.18^{w}	8.59^{w}	9.60^{w}	9.70^{w}	9.01^{w}	8.65^{x}	9.32^{x}
Maida	10.90^{x}	8.49^{x}	9.72^{x}	9.89^{x}	9.50^{x}	9.10^{x}	9.04^{y}	9.33^{x}
Semolina	10.57^{y}	9.25^{y}	9.50^{y}	10.03^{y}	8.91^{y}	9.53^{y}	8.73^{x}	9.47^{x}
Potato	9.75^{z}	8.85^{z}	9.26^{z}	9.65^{z}	8.90^{z}	9.24^{z}	8.74^{x}	8.65^{y}
Culled Broiler Breeder Males								
Control	8.56^{x}	8.96^{w}	8.36^{w}	9.04^{w}	7.79^{w}	8.39^{w}	7.63^{x}	8.09^{w}
Maida	8.84^{x}	8.71^{x}	8.74^{x}	8.84^{x}	7.81^{x}	8.82^{x}	7.74^{x}	8.60^{x}
Semolina	8.84^{x}	9.64^{y}	9.01^{y}	9.02^{y}	7.71^{y}	8.83^{y}	7.75^{x}	8.73^{x}
Potato	9.53^{y}	9.30^{y}	9.74^{z}	9.23^{z}	7.66^{z}	8.47^{z}	7.98^{x}	8.64^{z}
C.D. (Binders)	0.024		0.009		0.013		0.554	
C.D. (Cooking)	0.033		0.013		0.019		0.787	

*Means in the same column with different superscripts differ significantly ($P > 0.05$).
n = 24

TABLE 4. EFFECT OF FROZEN STORAGE ON MEAN *SENSORY PANEL SCORES FOR POULTRY TIKKAS

Storage (months)	Colour		Texture		Flavour		Overall acceptability	
	Raw	Cooked	Raw	Cooked	Raw	Cooked	Raw	Cooked
Culled Hens								
1	10.84^{a}	10.02^{a}	10.41^{a}	11.30^{a}	9.98^{a}	11.56^{a}	9.83^{a}	11.16^{a}
2	10.44^{b}	8.56^{b}	10.25^{b}	9.92^{b}	9.94^{b}	11.06^{b}	9.57^{a}	10.13^{b}
3	10.36^{c}	8.45^{c}	9.40^{c}	9.91c^{c}	9.34^{c}	8.87^{c}	8.50^{b}	8.28^{c}
4	10.25^{d}	8.36^{d}	8.34^{d}	9.34^{d}	8.86^{d}	8.38^{d}	8.37^{b}	8.20^{c}
5	10.12^{e}	8.06^{e}	7.94^{e}	8.49^{e}	8.78^{e}	7.23^{e}	7.70^{c}	8.20^{c}
Culled Broiler Breeder Males								
1	10.49^{a}	11.00^{a}	11.18^{a}	10.53^{a}	9.59^{a}	9.78^{a}	9.52^{a}	10.18^{a}
2	9.31^{b}	9.65^{b}	8.90^{b}	9.63^{b}	9.08^{b}	9.68^{b}	9.02^{a}	9.53^{b}
3	9.21^{c}	9.50^{c}	8.50^{c}	9.23^{c}	7.32^{c}	9.45^{c}	7.99^{c}	9.32^{b}
4	8.34^{d}	8.14^{d}	8.43^{d}	8.20^{d}	6.81^{d}	7.43^{d}	7.32^{c}	6.18^{c}
5	7.38^{e}	7.50^{e}	7.82^{e}	7.58^{e}	9.91^{e}	6.81^{e}	5.02^{d}	6.76^{c}
C.D. (Storage)	0.021		0.008		0.012		0.496	
C.D. (Cooking)	0.033		0.013		0.019		0.787	

*Means in the same column with different superscripts differ significantly ($P > 0.05$).
n = 30.

more than five months in case of pre-cooked samples without much perceivable deterioration in quality.

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Effect of Maida, Potato and Textured Soya as Binders on the Quality of Chicken and Mutton Kababs*

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Effect of incorporation of maida (refined wheat flour) (2.5%), potato (10% cooked mince) and textured soya (10% soya nuggets wet mince) as binders on the quality of kababs prepared from total meat components (deboned meat, skin, gizzard, heart and fat) of spent hens and mutton was studied. Emulsion type dough was prepared and kababs were moulded on skewers and charbroiled. Inclusion of maida gave significantly better emulsion and contributed to higher yield of kababs. Potato and textured soya produced a lesser but similar effect on emulsion stability and cooking yield. The yields of chicken kababs were 79.40%, 75.90% and 74.97% and mutton kababs were 83.04%, 78.75% and 79.64% in formulations of maida, potato and textured soya respectively. Sensory scores of appearance, flavour, juiciness, texture and overall palatability indicated that chicken and mutton kababs with incorporation of the above 3 binders were equally acceptable, there being no significant preferential rating for any of the sensory attributes. Potato incorporated kababs, however, were preferred. Flavour and juiciness seemed to have decided the overall palatability of kababs. The 3 binders could be incorporated in the formulations to produce kababs of good quality and acceptability from chicken and mutton.

With rapid developments in meat based fast food industry in India, the scope of production of traditional comminuted meat products like kabab has increased immensely[1]. Comminuted meat products offer several advantages over the products developed from intact meat. One of the most important advantages is that the non-meat ingredients can be easily incorporated as extenders so as to reduce the cost of production as well as to improve the yield and quality of the finished product. Several workers have studied the use of various non-meat additives in model meat systems[2,3] and in some meat and poultry products[4-8]. But much remains to be done to optimize the use of non-meat extenders in meat products[9] and the need to explore the use of various extenders and fillers in comminuted meat products has been emphasized[10].

The use of non-meat extenders in kababs has not been studied so far. The present work was, therefore, planned to find out the effect of incorporation of three binders viz. maida, potato and textured soya on the quality of kababs from chicken and mutton.

Materials and Methods

Spent laying hens and spend type of sheep of either sex (aged 5-7 years), slaughtered at the experimental slaughter house, according to the standard procedure, formed the meat source. The carcasses were hand deboned within 3 hr postmortem. Mutton sample for each trial was collected from pooled deboned meat of a carcass. Similarly, hand deboned spent hen meat along with the gizzards and hearts and natural proportions of skin, abdominal fat and yolk (ova) was collected. All materials were frozen at —10°C for 15 days and used after partial thawing at 5°C for 15 hr. Meat samples were cut into small cubes and coarse minced using an 8 mm grinder plate. Mutton fat and chicken fat, skin gizzards and hearts were cut into small pieces and fine minced using 4 mm grinder plates. To reduce the particle size, skin, gizzards and hearts were fine minced twice.

Maida (refined wheat flour) was used as such. Potatoes were boiled in water (at about 100°C for 5 to 6 min) to a softer consistency, the external coverings peeled off and were fine minced before addition. Soya nuggets were rehydrated for 30 min with double the quantity of water, then drained, hand squeezed and fine minced before addition to the formulation.

Meat emulsions were prepared in a bowl chopper (Model 8418 D, Hobart, USA) incorporating the 3 binders as per the formulations presented in Table 1.

Raw kababs were moulded according to the method described by Ahmad[11]. Forty g of emulsion were pressed on to the centre of a skewer (pointed steel rod) and gently spread evenly on it to form a cigar shaped kabab. Kababs were cooked by charbroiling at 230 ± 2°C for 3 min to an end point internal temperature averaging 75 ± 1°C.

pH of the emulsions was determined using a digital pH meter with combination glass electrode[12]. For emulsion stability test, the method of Baliga and Madaiah[13] was

*Part of the work (on chicken kababs) presented at the 2nd International Food Convention, February 18-23, 1988, Mysore, India.

TABLE 1. KABAB FORMULATIONS WITH BINDERS

Ingredients	% composition	Formulation		
		Maida	Potato	Soya
Chicken				
Deboned meat	64.9	649	649	649
SGH mix[a]	24.1	241	241	241
Chicken fat	8.0	80	80	80
Yolk	3.0	30	30	30
Mutton				
Deboned meat	85.0	850	850	850
Mutton fat	15.0	150	150	150
Maida*	2.5	25.0	—	—
Potato*	10.0	—	100.0	—
Soya*	10.0	—	—	100.0
TSPP*[b]	0.5	5.00	5.0	5.0
Salt*	1.5	15.37	16.5	16.5
Sugar*	0.5	5.12	5.5	5.5
Water (ice flakes)*	5.0	51.20	55.0	55.0
Condiment*	5.0	51.20	55.0	55.0
Spices*	1.5	15.37	16.5	16.5

[a]%composition: Skin = 77.7, Gizzard = 17.57, Heart = 4.73.
* These were added to both chicken and mutton formulations and whole egg liquid at 5% level was also added to mutton formulations.
—Calculated percentage of binders and TSPP based on weight of meat and fat components; calculated per centage of other common ingredients and whole egg liquid based on weight of meat and fat components and the binders.
b Tetrasodium pyrophosphate.

followed with slight modifications. Sealed and accurately weighed polyethylene bags each containing about 25 g of raw sample were placed in a thermostatically controlled water bath at 80°C and removed after 20 min, cut open and cook fluid drained. The samples were weighed and loss in weight after cooking was expressed (in per cent) as an index of ES. Cooking yield of each kabab was determined and expressed as per cent of raw weight. AOAC[14] procedure was used to determine moisture contents of raw and cooked samples.

A seven member semi-trained sensory evaluation panel[15] evaluated the kababs for appearance, flavour, juiciness, texture, mouth coating and overall palatability using an 8-point descriptive scale (8 = extremely desirable, 1 = extremely undesirable). Samples were presented for evaluation in warm condition soon after cooking.

Data from 3 trials were pooled and analysed[16] on a computer (Micro-32). Means were compared by using Duncan's New Multiple Range Test[16].

Results and Discussion

The mean values of various quality parameters of kababs, as affected by the incorporation of maida, potato and textured soya, are presented in Tables 2 and 3. Results have indicated no significant effect of type of binder on the pH of raw emulsion from either type of meat, the pH values being nearly

TABLE 2. EFFECT OF DIFFERENT BINDERS ON THE QUALITY OF CHICKEN KABABS

Parameter	n	Maida	Potato	Soya
pH — raw mix	3	6.10±0.06	6.09±0.03	6.13±0.03
Emulsion stability (%)	9	8.25±1.16[a]	14.20±1.34[b]	14.15±0.39[b]
Moisture-raw mix (%)	9	64.63±0.58[a]	66.43±0.27[c]	65.28±0.35[b]
Cooking yield (%)	30	79.40±0.71[b]	75.90±1.34[a]	74.97±1.02[a]
Moisture-Kabab (%)	9	56.92±0.34[b]	57.05±0.20[b]	55.84±0.25[a]
sensory scores				
Appearance	21	6.20±0.16	6.86±0.14	6.67±0.17
Flavour	21	6.48±0.15	6.81±0.18	6.52±0.20
Juiciness	21	6.48±0.18	6.71±0.16	6.52±0.19
Texture	21	6.48±0.19	6.57±0.15	6.38±0.16
Mouth coating	21	6.90±0.17	6.95±0.16	6.89±0.19
Overall palatability	21	6.57±0.11	6.90±0.14	6.62±0.15

*Means (±SE) with same superscripts in each row do not differ significantly (P>0.05).
n = No. of observations.

TABLE 3. EFFECT OF DIFFERENT BINDERS ON THE QUALITY OF MUTTON KABABS

Parameter	n	Maida	Potato	Soya
pH — raw mix	3	6.11±0.04	6.07±0.06	6.10±0.06
Emulsion stability (%)	9	7.82±0.44[a]	11.60±1.02[b]	12.18±1.16[b]
Moisture-raw mix (%)	9	66.57±0.63[a]	68.10±0.61[c]	67.64±0.69[b]
Cooking yield (%)	30	83.04±0.55[b]	78.75±0.64[a]	79.64±0.49[a]
Moisture-Kabab (%)	9	61.42±0.59[a]	62.68±0.60[c]	61.91±0.55[b]
sensory scores				
Appearance	21	6.81±0.13	6.95±0.11	6.86±0.10
Flavour	21	6.67±0.17	6.90±0.14	6.62±0.16
Juiciness	21	6.76±0.18[ab]	7.00±0.10[b]	6.43±0.15[a]
Texture	21	6.62±0.19	6.81±0.13	7.05±0.16
Mouth coating	21	7.29±0.10	6.24±0.12	7.24±0.12
Overall palatability	21	6.62±0.18	6.90±0.15	6.33±0.16

*Means (±SE) with same superscripts in each row do not differ significantly.
n = No. of observations.

similar (6.11 and 6.09 respectively) for chicken and mutton raw emulsions. Type of binder had a higher significant but similar effect on the emulsion stability (ES) of both the chicken and mutton. ES of the samples containing maida was comparatively better ($P < 0.05$) than those with potato and textured soya. The latter two did not differ significantly.

These results of ES are in agreement with the finding of Comer[17] who reported improved performance of wheat flour, which was attributed to a greater extent of gelatinization of its starch components. The possible interaction between soluble meat and vegetable proteins has been indicated[18], the fillers appearing to increase fat agglomeration while improving stability. Comparatively, the ES values indicated better performance of mutton formulation than chicken, probably due to the inclusion of chicken skin in the latter. Stabilities have been shown to decrease with increasing collagen content[17], as collagen lost much of its water holding

capacity during cooking due to shrinkagae of the fibres. However, the difference in ES between the two types of meat was not large and as mentioned by Comer[17], substantial quantities of collagen could be tolerated in comminuted meat systems.

Differences in moisture per cent of raw emulsions were highly significant for the 3 binders in both chicken as well as mutton. Emulsions incorporating potato had a higher value ($P < 0.05$) than that containing textured soya, which in turn had a value higher ($P < 0.05$) than that of maida. This was expected keeping in view the moisture per cent of the 3 binders, being highest for cooked potato (79.95 per cent) followed by textured soya (66.77 per cent) as reported by Kondaiah *et al.*[19] and least for maida (wheat flour - 12.9 per cent) as reported by Comer *et al.*[18].

It was observed that the type of binder had a higher significant effect on cooking yield (CY) of chicken and mutton kababs. Incorporation of maida resulted in higher ($P < 0.05$) yield of kababs compared to the kababs containing potato and soya. However, no significant difference in CY was observed in the latter two. Similar observations have been made on pork sausages[19]. The trend in CY was similar to ES and the yield, in general, was lower for chicken kababs indicating again that connective tissue content and other formulation differences (Table 1) might have played a role.

Results indicated a highly significant effect of binders on the moisture content of kababs from both types of meat. Moisture contents of potato incorporated chicken kababs were slightly higher than those with maida; both, however, did not differ significantly from each other, but had significantly higher ($P < 0.05$) values compared to kababs with textured soya. In mutton kababs, significant differences ($P < 0.05$) in moisture per cent were observed between the 3 types of kababs, the order being potato > soya > maida. The behaviour of the binders in chicken kababs might be explained by the findings of Comer *et al.*[18] who reported that potato starch granules absorbed large amounts of moisture when heated at 70°C, and wheat flour starch granules did not absorb moisture as rapidly as the potato starch granules, while the textured soy protein was shown to have cold absorption higher but hot absorption lower than potato and wheat flour.

Results of sensory evalution indicated that chicken and mutton kababs with 3 types of binders were equally acceptable as there was no significant preferential rating for any type of kabab for the sensory attributes studied. However, potato incorporated kababs, in general, obtained the highest scores for most of the parameters and, thus, were liked the most, followed in order by those with textured soya and maida in the case of chicken and those with maida and soya in the case of mutton. The attributes of flavour and juiciness seem to have largely decided the overall acceptability of the kababs, since the trend of scores for these 3 attributes with respect to 3 binders was similar in each type of kabab.

From the present study, it may be concluded that maida, potato and textured soya could be incorporated in the formulations to produce kababs of good quality and acceptability from chicken and mutton. It would also reduce the formulation cost and will thus contribute to a successful enterprise.

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J. Fd. Sci. Technol., 1991, Vol. 28, No. 5, 304—307

Studies on the Quality Characteristics of Buffalo Skeletal, Offal Meats and Their Combinations

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Rumen meat (RM) had significantly higher pH (6.95) followed by heart meat (HM) and skeletal meat (SM) in decreasing order. The colour score was the lowest for RM followed by SM and HM in an increasing order. The water holding capacity (WHC, 3.27 sq. cm.) and moisture content (80.93%) were significantly higher in RM than in SM and HM. The total proteins (20.32%) and extractable proteins (EP, 56.07%) were significantly higher in SM. Between offal meats, RM had higher EP and lower salt soluble proteins (SSP) than HM. Regarding the emulsifying capacity (EC), the RM and HM were almost identical. Significant differences were observed in EC ($P < 0.05$), moisture ($P < 0.01$) and total protein ($P < 0.01$) percentages in the different raw meat combinations, SM:OM. Higher EC was observed in 100:00 combination (107.17 ml/2.5 g) and lowest in 70:30 combination (100.33 ml/2.5 g) and reverse proportions of moisture percentages in 100:00 (76.92) and in 70:30 (78.07) were observed. Highest total protein percentage was registered by 100:00 followed by 90:10, 80:20 and 70:30 combinations in a decreasing order. The results indicate that buffalo SM and OM in various combinations may be commercially utilised in the preparation of comminuted meat products.

For the preparation of value added products like sausages, patties etc., raw meat possessing good quality characteristics are essential. Extensive studies on pH, water holding capacity (WHC), chemical composition, extractable proteins (EP) and emulsifying capacity (EC) of beef have been done[1-7]. But very scanty literature is available about the quality characteristics of buffalo skeletal meat (SM), offal meat (OM) and their combinations.

Kondaiah *et al.*[8,9] have reported some of the quality characteristics of buffalo meat and offal meat. The proximate composition of buffalo meat has also been reported[4,8,10-14].

Since very scanty information is available on the quality characteristics of buffalo skeletal and offal meats and further no work has been reported on the quality characteristics of ground skeletal and offal meats in different combinations, this study was undertaken.

Materials and Methods

Buffalo skeletal meat (SM) was selected from the thigh region of she buffalo carcasses of about 8-10 year old animals. Fresh rumen meat (RM) and heart meat (HM) were purchased from the Offal Meat Market. The SM, RM and HM were packed individually in clean polyethylene bags and quickly transported to the Meat Products Laboratory of the Division of Livestock Products Technology, Indian Veterinary Research Institute, Izatnagar. The HM was flushed with tap water to remove blood clots, if any, adhering to it. The RM was also washed with tap water several times to clean it. After draining the water, they were packed separately in polyethylene bags and stored with SM in a refrigerator overnight at 2-5°C.

Twenty-four hour chilled samples of SM, RM and HM were trimmed for visible fat, fascia and separately cut into 2-3 cm cube chunks. Each of these was ground once through 8 mm plate, mixed well and ground again by passing through 5 mm plate and thoroughly mixed. Representative samples of about 200 g of SM, RM and HM were collected for analysis.

The remaining ground SM and OM were then mixed in a Hobart Mixer (Model N-50) in the proportions of 70:30; 80:20; 90:10 and 100:00 respectively. The RM and HM components were mixed in equal proportions to constitute 30, 20 and 10 parts of the OM in the above combinations. The individual combination (70:30; 80:20; 90:10 and 100:00) after mixing separately in the Hobart Mixer were passed through 5 mm plate. Following grinding, individual representative sample weighing about 200 g was collected for analysis.

About 10 g of chilled ground meat sample in duplicate was homogenised with 50 ml of distilled water for 10-15 secs in waring blender. The pH was recorded by a digital pH meter

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using a combined glass electrode. The average of duplicate readings is reported as the pH of the sample.

Visual observation for colour was recorded based on a 5-point colour score.

Water holding capacity (WHC): A filter paper press method of Grau and Hamm[15] was adopted with slight modification.

The moisture, protein and ether extracts were determined as per procedures laid down in the Official Methods of Analysis of the A.O.A.C.[16].

The water soluble and salt soluble proteins (WSP and SSP) were estimated by the method of Kang and Rice[17]. The per cent total EP (WSP plus SSP) was calculated by dividing the extractable protein with the total protein and multiplied by 100. EC of meat samples was determined as per the method described by Swift *et al.*[6].

The data generated from 12 batches were subjected to statistical analysis as per the standard procedures of Snedecor and Cochran[18].

Results and Discussion

Mean values of different quality parameters of raw buffalo SM, RM and HM are presented in Table 1 and the analysis of variance in Table 2. There were significant differences ($P < 0.01$) in respect of all the physico-chemical and functional quality parameters studied in raw meats. RM had significantly ($P \leq 0.01$) higher pH value followed by HM and SM. The colourscore was found to be the lowest in RM followed by SM and was the highest in HM. The WHC was significantly ($P < 0.01$) higher in the case of RM followed by HM and SM. With respect of total proteins and extracted proteins percentages, SM had higher values than RM and HM. There was no significant difference in total proteins whereas variation in SSP was significant ($P < 0.01$) between RM and HM. Regarding EE percentage, RM was significantly ($P < 0.01$) lower than those of SM and HM, but the difference in percent WSP was not significant between SM and RM, but HM had significantly ($P < 0.01$) least WSP. The RM and HM were almost indentical in their emulsifying capacity (EC), however, SM had registered significantly ($P < 0.01$) a higher value than those of RM and HM.

The mean values of quality characteristics of raw meat combinations containing different proportions of SM and OM are presented in Table 3 and the results of analysis of variance in Table 4.

With regard to the different raw meat combinations, SM:OM, there were significant differences only in EC, moisture and total protein per centages, and none with reference to pH, colour, WHC, ether extract, WSP, SSP and EP percentages.

Highest EC was observed in 100:00 and lowest in 70:30 meat combinations followed by 80:20 and 90:10 in an increasing order. The difference in EC between 100:00 and 90:10 was not significant, whereas the difference in EC between 100:00 and 70:30 and also between 100:00 and 80:20 were significant ($P < 0.05$). Regarding moisture percentage, the differences between 100:00 and other combinations were significant ($P < 0.01$). The highest moisture percentage (78.07) was recorded in 70:30 and lowest in 100:00 (76.92) meat combinations. The total percentage of protein was found to be significantly ($P < 0.01$) the highest in 100:00 followed by 90:10, 80:20 and 70:30 in a decreasing order.

Highest pH and WHC have been recorded in RM as compared to SM and HM. The higher WHC might be due to pH (6.95, Table 1) and the presence of higher stroma proteins in it. Further, the decrease in the WHC of SM might have also been contributed by various factors such as

TABLE 1. QUALITY CHARACTERISTICS OF MEAT OF SKELETAL (SM), RUMEN (RM) AND HEART (HM)

Parameters	SM	RM	HM
pH	5.61 ± 0.03^{c}	6.95 ± 0.03^{a}	5.82 ± 0.03^{b}
Colour*	4.00^{b}	1.00^{c}	5.00^{a}
WHC (cm^2)	4.72 ± 0.22^{b}	3.27 ± 0.06^{c}	6.29 ± 0.14^{a}
Moisture (%)	76.92 ± 0.12^{c}	80.93 ± 0.12^{a}	79.75 ± 0.23^{b}
Total proteins (%)	20.32 ± 0.11^{a}	17.00 ± 0.14^{b}	17.38 ± 0.19^{b}
Ether extract (%)	1.60 ± 0.08^{a}	1.16 ± 0.05^{b}	2.04 ± 0.12^{a}
WSP (%)	5.01 ± 0.14^{a}	4.72 ± 0.16^{a}	2.93 ± 0.60^{b}
SSP (%)	6.37 ± 0.18^{a}	3.15 ± 0.35^{c}	4.86 ± 0.10^{b}
EP (%)	56.07 ± 0.14^{a}	46.32 ± 3.35^{b}	45.26 ± 0.83^{c}
EC (ml/2.5 g)	107.17 ± 2.26^{a}	101.08 ± 1.34^{b}	98.83 ± 0.89^{b}

Mean and SE of 12 replicate batches

Means bearing different superscripts in rows differ significantly ($P < 0.01$)

*Single value based on 5-point visual colour score: 5 = reddish brown colour and 1 = pale pink colour.

TABLE 2. RESULTS OF ANALYSIS OF VARIANCE OF RAW MEAT QUALITY CHARACTERISTICS OF SKELETAL, RUMEN AND HEART MEAT

Sources of variation	df	Mean squares								
		pH	WHC	Moisture	Total proteins	Ether extract	WSP	SSP	EP	EC
Between raw meats	2	6.1521**	27.4555**	24.7803**	21.2569**	9.9965**	33.0564**	62.7050**	141.120**	223.0278**
Error	33	0.0121	0.2847	0.1663	0.1563	0.4978	0.3562	0.5345	3.9055	30.7348

**$P < 0.01$

TABLE 3. QUALITY CHARACTERISTICS OF RAW MEAT COMBINATIONS CONTAINING DIFFERENT PROPORTIONS OF SKELETAL MEAT (SM) AND OFFAL MEAT (OM)

Parameters	Raw meat combinations SM : OM			
	70:30	80:20	90:10	100:00
Moisture (%)	78.07 ± 0.12^{a}	77.87 ± 0.12^{a}	77.65 ± 0.11^{a}	76.92 ± 0.12^{b}
Total proteins (%)	19.37 ± 0.10^{c}	19.67 ± 0.10^{bc}	19.90 ± 0.05^{b}	20.32 ± 0.11^{a}
EC (ml/2.5 g)	100.33 ± 0.78^{b}	102.58 ± 1.00^{b}	104.33 ± 1.62^{ab}	107.17 ± 2.26^{a}

Mean and SE of 12 replicate batches
Means bearing different superscripts in rows differ significantly ($P < 0.05$).

TABLE 4. RESULTS OF ANALYSIS OF VARIANCE OF QUALITY CHARACTERISTICS OF RAW MEAT COMBINATIONS CONTAINING DIFFERENT PROPORTIONS OF SKELETAL AND OFFAL MEAT

Sources of variation	df	Mean squares								
		pH	WHC	Moisture	Total proteins	Ether extract	WSP	SSP	EP	EC
Between raw meat combinations	3	0.0315	0.2990	3.0260**	1.0261**	0.0008	0.8549	0.5783	3.9781	99.8542*
Error	44	0.0114	0.5658	0.1750	0.0674	0.0408	0.3579	0.3986	7.1795	27.9981

*$P < 0.05$
**$P < 0.01$

isoelectric point, ATPase activity and marbling characteristics of meat.

In the present study, the moisture contents were found to be lower than those observed by Ramamohanarao[10] and Nigm *et al.*[4] as they had estimated the proximate composition of meat from young buffalo calves which tended to have more moisture percentages.

Saffle and Galbreath[5] recorded 1.43 per cent SSP in beef tripe which appears to be much lower than the value for RM (3.15 per cent) reported in this study. However, they did not indicate whether the extraction was made from raw rumen meat or from the traditionally scalded and partially cooked tripe, which is the usual practice in the western world to utilise the rumen meat. It is well known that heating denatures meat proteins and impairs the extractability of the proteins. Therefore, the lower SSP percentage observed by Saffle and Galbreath[5] might be ascribed to the use of scalded and partially cooked tripe for such studies.

EC was observed to be higher in SM than in RM and HM. The SM has more EP which is essential for the binding and emulsification of fats in the preparation of emulsion-type meat products. RM has higher pH and better WHC and HM has more myoglobin pigments which impart a deeper colour to it.

Of the various parameters studied, pH was relatively the highest in 70:30 (SM:OM) combination and the lowest in 100:00, containing only the SM. The higher pH in 70:30 can be attributed to the presence of 15 parts of each of RM and HM along with the 70 parts of SM. Relatively higher WHC was also recorded in 70:30 combination followed by 80:20, 90:10 and 100:00 in a decreasing order since 70:30 treatment contained more proportions of RM and HM which had more stromal protein (collagen) than those of other treatments. Therefore, besides pH, the collagen also might have contributed for a higher WHC.

The highest EC value was recorded in 100:00 which may be due to higher SSP in SM. The lower value of EC in 90:10, 80:20 and 70:30 combinations may be due to the presence of increased proportions of RM and HM. The highest moisture percentage was observed in 70:30 which was due to the presence of higher proportions of RM and HM in this meat combination than the rest. The total protein percentage was highest in SM (100:00) and the lowest in 70:30 combination which was also influenced by the proportions of OM present. The WSP, SSP and EP were found to increase with the increasing proportions of SM in the different combinations.

Eventhough 100:00 (SM:OM) combination contained more total proteins, more soluble proteins and higher EC value, the other meat combinations cannot be considered as inferior raw meat sources for comminuted meat products' formulations since these have registered higher pH and more WHC which are equally important desirable qualities of raw meats.

From this study, it may be concluded that the meat processors can attempt to produce emulsion-type meat products by incorporating different proportions of SM and OM (RM and HM) of buffaloes as indicated in the present study.

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J. Fd. Sci. Technol., 1991. Vol. 28. No. 5, 308—311

Flow Behaviour of Peach and Apricot Pulps and Concentrates of Some Indian Varieties

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A coaxial cylinder viscometer (Rheotest 2) was used to determine the flow behaviour of pulps and concentrates of peach and apricot cultivars. Power law values for the flow behaviour index 'n' of pulps and concentrates were in the range of 0.20 to 0.39 indicating the pseudoplastic nature of the products. Apparent viscosity 'napp' and consistency coefficient 'k' values were dependent on shear rate and temperature. Magnitude of yield stress obtained by extrapolating the shear rate-shear stress data according to Casson, depended on temperature, being higher at lower temperatures. Bolger model parameters indicated that the shear resistance of the network type structure was responsible for the higher plasticity of concentrates than those of pulps. Consistency index K_1 values determined by Herschel - Bulkley model decreased with increase in temperature.

Rheological behaviour of fluid food products has been studied by several workers for obtaining data for engineering applications[1], quality control and sensory evaluation relationships[2,3] and for better understanding of product texture[4]. For a number of fluid foods, shear rates - shear stress flow curves served the purpose for rhelogical information[5].

Flow properties of peach and apricot pulps/purees have been studied to a limited extent[6,7]. The objective of the present investigation was to study the effect of various temperatures on the rheological behaviour of peach and apricot pulps and concentrates of some Indian varieties.

Materials and Methods

Fruits of 'Elbert' and 'Quetta' cultivars of peach and 'Halman' and 'Narmoo' cultivars of apricot were obtained from orchards of Srinagar and Ladakh, respectively, of Jammu and Kashmir State. The fruit was destoned and blanched before preparation of pulp. Pulps of Quetta and Narmoo with an initial total soluble solids (TSS) content of 10.0° and 9.0° Brix, respectively, were concentrated to 21.0° and 16.5° Brix, respectively in a laboratory scale rotatory vacuum concentrator at a temperature of 70°C. Pulps of Elberta' (6° Brix) and 'Halman' (17.5° Brix) were used as such for rheo-logical studies.

Flow behaviours of pulps and concentrates were determined using the concentric cylindrical S/S_2 system of Rheotest 2 Viscometer (VEB MLW prufgerate - werk. Medingen, Sitz, Freital, East Germany). Shear rate-shear stress data were obtained for such samples at temperatures ranging from 30 to 80°C. Different shear rates were employed in the ascending and descending orders and mean values for torque were noted for computing the shear stress.

For characterization of flow behaviour from the shear rate - shear stress data according to power law expression $T = k\ \dot{\gamma}^n$, log - log plots were developed[8]. The slope of the linear plots gave the values for n, the flow behaviour index. The values of consistency coefficient, k were computed using the values for n exponent and any shear rate with the corresponding shear stress. Almost equal k values were obtained at the intercept of these plots.

Casson's model as suggested by Charm[9] was used for determinatior of yield stress. According to this model

$$T^{0.5} = Ko + Kc\ \dot{\gamma}^{0.5}$$

Where Ko and Kc are the intercepts and the slope of a plot of $\dot{\gamma}^{0.5}$ vs $T^{0.5}$, respectively. T and $\dot{\gamma}$ represent shear stress and shear rate respectively. Magnitude of yield stress T_o was determined as $T_o = Ko^2$.

Michaels and Bolger model[10] as used by Duran and Costell[7] was applied to the shear rate-shear stress data to obtain values for shear stress required for destruction of net work structure (T_o), breaking of aggregate bonds (T_b) and shear stress responsible for viscous flow at infinite shear rate (η_∞). The values of T_o was derived as the square of the intercept for the regressions line between the square root of the shear stress and the square root of shear rates. Bingham yield stress (T_b) was calculated as the intercept of the plot T vs γ when linear part of the plot was extrapolated to ordinate axis. Values of η_∞ were calculated as the square of the slope of plot 0.5 $T^{0.5}$ vs $\dot{\gamma}^{0.5}$

$T = \Gamma$

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As followed by the earlier workers[11] yield stress values (T_o) calculated from Casson's model were used in Herschel - Bulkley model;

$$T - T_o = k_1 \dot{\gamma}^{n_1}$$

where k_1 and n_1 have similar names as k and n in the simple power law model, discussed above. The magnitude of k_1 and n_1 were determined from linear regression analysis of log $\dot{\gamma}$ vs log $(T - T_o)$.

Apparant viscosity η_{app} was determined at different temperatures (30 - 80°C) by dividing the shear stress by shear rate as prescribed for the instrument. To study the relationship between apparant viscosity η_{app} and shear rate $(\dot{\gamma})$, the values were plotted on a log − log paper.

Results and Discussion

Flow behaviour: The shear rate - shear stress curves represented a typical behaviour of pseudoplastic fluid foods. At lower shear rates, the shear stress increased but not linearly. However, at higher shear rates the shear stress increased linearly. Even at different temperatures, the pulps as well as concentrates prepared from peach and apricot cultivars exhibited pseudoplastic flow (Fig.1). Using a tube viscometer Saravacos[6] reported pseudoplastic nature of flow of peach puree.

Flow behaviour index (n) values of power law model (Table 1) were < 1 which indicate shear thinning flow of pulps and concentrates of peach and apricot cultivars[12,13]. As presented in Table 1, the flow behaviour index values of pulps and concentrates were negligibly affected by temperatures, whereas consistency coefficient values decreased considerably as the temperature was increased from 30 to 80°C. The magnitude of decrease of k values for peach pulps and concentrates averaged 45.6 and 57.5 percent as compared to 53.3 and 21.8 per cent in case of apricot pulps and concentrates, respectively. Watson[14] also reported a significant decrease in K values of apricot puree and apricot concentrate when temperature was raised from 4.5 to 60°C.

Casson's model: According to Casson[15] for some fluids possessing the yield stress, the plots of $T^{0.5}$ vs $\dot{\gamma}^{0.5}$ were linear. In the present investigation (Fig. 2), it was observed that at the lower shear rate the relationship was not linear.

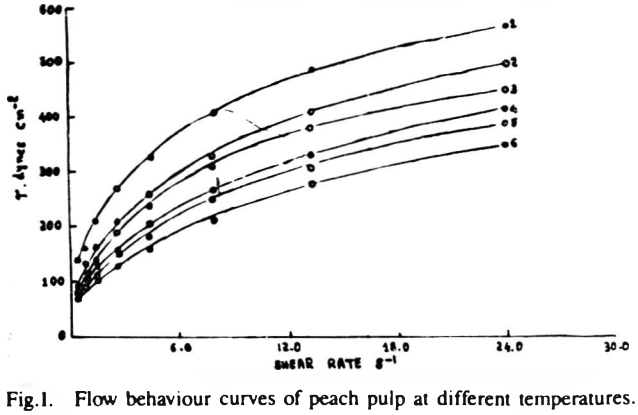

Fig.1. Flow behaviour curves of peach pulp at different temperatures.

TABLE 1. EFFECT OF TEMPERATURE ON THE POWER LAW CONSTANTS OF PEACH AND APRICOT PULPS AND CONCENTRATES.

Fruit	Var	Product	Power law constant at indicated temp. (°c)					
			30	40	50	60	70	80
			Flow behaviour index, (n)					
Peach	Elberta	Pulp	0.37	0.39	0.36	0.39	0.38	0.38
Peach	Quetta	Conc.	0.24	0.27	0.27	0.28	0.34	0.33
Apricot	Halman	Pulp	0.30	0.32	0.30	0.32	0.34	0.35
Apricot	Narmoo	Conc.	0.20	0.25	0.26	0.24	0.23	0.23
			Consistency coefficient (k) (dynes cm^{-2} sec^n)					
Peach	Elberta	Pulp	191	150	143	122	116	104
Peach	Quetta	Conc.	525	424	386	324	229	223
Apricot	Halman	Pulp	122	101	95	76	66	57
Apricot	Narmoo	Conc.	326	265	260	258	258	255

However, at higher shear rates, the relationship was linear. By extrapolating the linear segment of $T^{0.5}$ vs $\dot{\gamma}^{0.5}$ plots to zero shear rates Cassons yield stress values were obtained. The yield stress values showed a considerable decrease as the temperature of the pulp and concentrate was increased from 30 to 80°C as shown in Table 2. The yield stress values of 246.5 and 235.6 dynes cm^{-2} for peach and apricot pulps

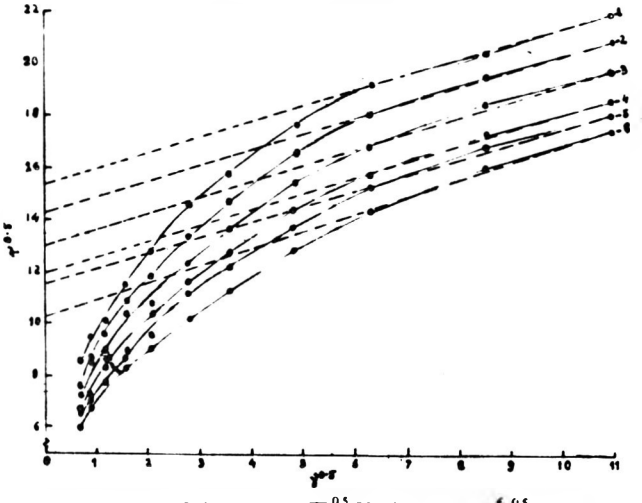

Fig.2. Casson plots of shear stress $(T)^{0.5}$ Vs shear-rate $(\dot{\gamma})^{0.5}$ for apricot pulp at different temperatures.

TABLE 2. EFFECT OF TEMPERATURE ON THE CASSON YIELD STRESS OF PEACH AND APRICOT PULPS AND CONCENTRATES

Temp (°C)	Yield stress T_o (dynes cm^{-2})			
	Peach pulp	Peach conc	Apricot pulp	Apricot conc
30	246.5	605.2	235.6	441.0
40	169.0	484.0	201.6	436.8
50	162.6	380.3	169.0	434.7
60	123.2	289.0	141.6	432.6
70	104.0	231.0	132.3	432.6
80	84.6	204.5	105.1	432.6

at 30°C decreased to 84.6 and 105.1 dynes cm^{-2}, respectively, at 80°C. Corresponding yield stress values for peach and apricot concentrates at 30°C were 605.2 and 441.0 dynes cm^{-2} compared to 204.5 and 432.6 dynes cm^{-2} respectively at 80°C. The relative decrease in yield stress was more as the temperature was raised from 30 to 60°C compared to the temperature increase from 60 to 80°C.

Michaels and Bolger model: Stuctural changes in peach and apricot pulps and concentrates caused by increasing shear rates were studied using this model[10], as elaborated by Duran and Costell[7]. The model determines the shear stress necessary for destroying the network structure T_o, to break aggregates (T_b) and for viscous flow at infinite stress (η_∞).

Both T_o and T_b values decreased when temperature was increased from 30 to 80°C, as shown in Tables 2 and 3. This was true of both pulps and concentrates. Maximum decrease of 64 per cent of T_b values was recorded in peach concentrate when the temperature was raised from 30 to 80°C. However, the corresponding decrease in the values was minimum (52 per cent) in case of apricot concentrate.

Herschel-Bulkley model: Herschel and Bulkley model is considered more suitable compared to power law as it also considers the plastic character of fruit purees[7]. The magnitude of yield stress determined with Casson model were subtracted from those of shear stress. The magnitude of the parameters k_1 and n_1 were determined from the plot of log $\dot{\gamma}$ vs $(T - T_o)$.

The consistency coefficient k_1 values decreased with increase in temperature (Table 4). One can expect this decrease to be similar in nature to that of the consistency coefficient of the simple power law. The flow behaviour index n_1 values as calculated at various temperatures using this model were also < 1.

Apparent viscosity: The relationship between apparent viscosity (η_{app}) and shear rate when plotted on log - log paper both for pulps and concentrates of peach and apricot cultivars was linear. As shown in Fig.3, the apparent viscosity decreased with increase in temperature and/or shear rate. At identical shear rate the η_{app} was different for different temperatures.

TABLE 3. EFFECT OF TEMPERATURE ON MICHAELS AND BOLGER PARAMETERS* OF PEACH AND APRICOT PULPS AND CONCENTRATES

Temp (°C)	T_b (dynes cm^{-2})				η_∞ (dynes cm^{-2})			
	Peach		Apricot		Peach		Apricot	
	Pulp	Conc	Pulp	Conc	Pulp	Conc	Pulp	Conc
30	380	582	175	450	0.81	0.81	0.40	0.64
40	300	482	138	400	0.81	0.81	0.40	0.48
50	280	390	115	390	0.79	0.81	0.40	0.45
60	210	304	100	350	0.64	0.80	0.40	0.45
70	195	268	78	300	0.59	0.80	0.40	0.41
80	175	208	67	212	0.25	0.79	0.40	0.37

*Values of T_o have been presented in Table 2.

4. EFFECT OF TEMPERATURE ON THE HERSCHEL - BULKLEY PARAMETERS OF PEACH AND APRICOT PULPS AND CONCENTRATES

Temp (°C)	Consistency coefficient k_1 (dynes cm^2)				Flow behaviour index n_1			
	Peach		Apricot		Peach		Apricot	
	Pulp	Conc	Pulp	Conc	Pulp	Conc	Pulp	Conc
30	5C	350	16	110	0.59	0.49	0.56	0.50
40	4E	340	15	92	0.58	0.48	0.58	0.47
50	47	320	14	90	0.58	0.49	0.58	0.47
60	45	300	13	89	0.56	0.46	0.57	0.47
70	37	280	13	88	0.54	0.51	0.56	0.54
80	27	260	12	84	0.69	0.49	0.58	0.53

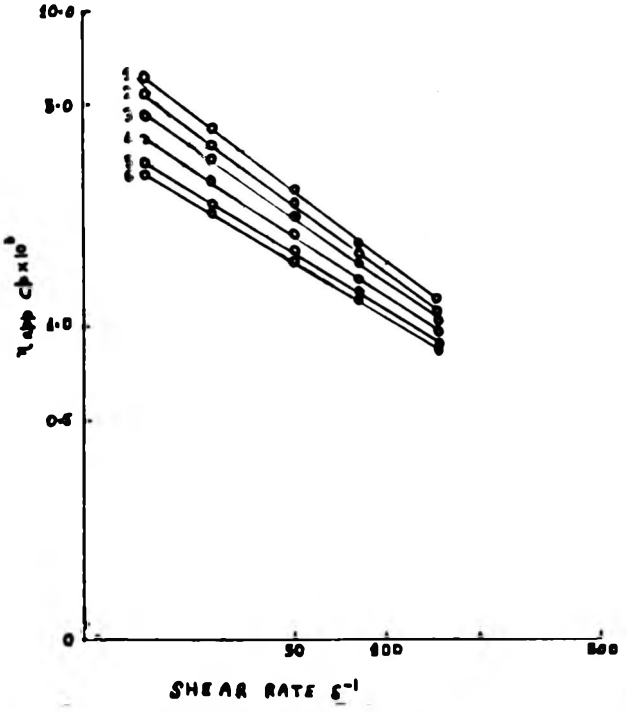

Fig.3. Relation between shear rates s' and apparent viscosity (η_{app}) of peach concentrate at different temperatures.

Curve	1	2	3	4	5	6
°C	30	40	50	60	70	80

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Nutritional Evaluation and Cooking Quality of Dry Cowpea (*Vigna sinensis* L.) Grown Under Various Agricultural Conditions. 1. Effect of Soaking and Cooking on the Chemical Composition and Nutritional Quality of Cooked Seeds

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Foliar application with gibberellic acid (GA_3) and white wash, especially under saline conditions, improved the nutritive value of raw cowpea seeds by increasing total protein, soluble carbohydrate, total free amino acids and *in vitro* protein digestibility as well as reducing antinutritional factors i.e. trypsin inhibitor activity, phytic acid and tannins. Cooking in water containing sodium chloride (2%) after soaking in hot water for 12 hr showed the lowest content of protein, carbohydrate and antinutritional factors and the highest content of fibre, ash and digested protein. Crude fat remained unaltered. Highest loss in total free amino acids was observed for the unsoaked and cooked seeds.

Vigna sinensis is grown successively in the newly reclaimed lands which are slightly to moderate saline. Both dry mature seeds and snap pods are popular as food.

Heat treatment applied to legumes improved their texture, palatability and nutritive value by destroying or inactivating heat labile toxic compounds and other enzyme inhibitors[1]. The type of cooking used varies significantly from one study to the other, and therefore, very difficult to have uniform conditions for comparison. Therefore, it is recommended to soak legume grains before cooking[2]. Moreover, it softens the seeds and cooking duration is lessened.

The main aim of the present investigation is to study the effect of some growth regulators and reflecting antitranspirant on the chemical composition and nutritional quality of raw and cooked cowpea seeds after soaking in different media.

Materials and Methods

A pot experiment was carried out at the Agricultural Experimental Station of the Faculty of Agriculture, Minufiya University, Shibin El-Kom, Egypt in two successive summer seasons of 1988 and 1989. As plants became well stabilised with 3-4 true leaves (about 40 days after sowing), they were thinned again to 3 plants per pot, and salinity, as NaCl, was applied to half the number of pots. Pot salinization was carried out gradually i.e., the total amount of NaCl was added in three equal instalments at 2-day intervals to a final concentration of 60 mM (3480 p.p.m.). On the same day, plants of all pots (salinized and unsalinized) were sprayed with three substances:1-Gibberellic acid (GA_3) as Berelex (100 p.p.m.), 2-chloroethyl trimethyl ammonium chloride (Cycocel, 1500 p.p.m.) and 3-white wash (reflecting antitranspirant which is calcium carbonate as 6 per cent suspension). Control plants were sprayed with water. Foliar application of these substances was carried out 4 times with 10 days intervals. Both surfaces of leaf were treated. One hundred g of cowpea seeds were steeped in 300 ml distilled water for 12hr at room temperature (25 $\pm$2°C). Another 100 g was soaked in boiling distilled water for 12 hr as before. Soaked seeds after rinsing were cooked under atmospheric pressure either in distilled water or in distilled water containing 2 per cent NaCl until 50 per cent of seeds split, this duration having been taken as cooking time[3]

Moisture, crude protein (total nitrogen X 6.25), crude fat, crude fibre and total ash were determined according to the methods described in A.O.A.C[4]. Soluble carbohydrates were calculated by difference. All analyses were done in triplicate and average was recorded.

Energy values of legumes and nuts were calculated according to the Atwater system and factors for ingested nutrient-

calories per g were 3.47 for protein, 8.37 for fat and 4.07 for carbohydrate.

Trypsin inhibitor was determined as described by Kakade[5]. To determine tannins, cowpea flour (1 g) was extracted in absolute methanol (50 ml) for 20 hr at room temperature (25±2°C), and centrifuged at 3000 r.p.m. for 30 min. Aliquots of the supernatants were assayed for total tannins content (as tannic acid) according to the A.O.A.C. methods[4]. Phytic acid was determined according to the method of Wheeler and Ferrel[6]. *In vitro* protein digestibility was determined using pepsin according to the method of Singh and Jambunathan[7]. Total free amino acids were determined according to Rosen[8]. The results obtained were analysed statistically according to Snedecor[9].

Results and Discussion

Effect of the interaction between salinity and foliar application substances on the proximate composition and calories of raw cowpea seeds: Data in Table 1 reveal that salinization decreases crude protein, fat and soluble carbohydrate content of raw cowpea seeds by 12.71, 25.67 and 6.17 per cent respectively. This could be related to the fact that salinity disturbed protein synthesis and reduces photosynthetic activity of plants[10]. On the contrary, salinity caused a marked increase in both fibre and total ash contents. Foliar application with both gibberellic acid and white wash brought favourable effects i.e. a significant increase on protein and soluble carbohydrate contents of seeds, especially under saline conditions. This increase may be due to the stimulative effect of both foliar substances on protein and carbohydrate synthesis by plants[11]. These results are in agreement with the results obtained by El-Nimr[12] and Khafagi[13]. On the other hand, the energy values followed the trend similar to protein, fat and carbohydrate contents.

Effect of soaking and cooking: The results shown in Table 2 indicate the variations in the proximate composition in treated cowpea seeds. The protein content was slightly decreased in seeds cooked in plain distilled water (d.w.) for 12 hr. The amount of water absorbed per unit weight of cowpea increased with the increase in soaking time and reached to equilibrium after 12 hr[14], whereas this decrease was more pronounced in those cooked in 2 per cent NaCl. Furthermore, boiling in salted water tends to extract more of soluble proteins from the cells and the interstitial spaces and therefore, the texture of the seeds increased while the firmness decreased. Results also show that the soaking before cooking interacted with 60 mM NaCl and gave the lowest protein content, especially after soaking in hot d.w. for 12 hr. It can be explained by the double effects of both salt and heat, which tend to extract more soluble substances. Soluble carbohydrates followed similar trend. Date indicate that both processes had no marked effect on ether extract content. On the contrary, crude fibre increased markedly due to both soaking and cooking in all treatments, whereas the increase was more pronounced at all foiar sprays under saline conditions. This is an apparent increase and due to the loss in the other constituents such as ash, soluble carbohydrates and total protein. Regarding the total ash, results show that soaking in salted media, cooked seeds accounted for more total ash compared to that soaked in plain water. These results are in agreement with those obtained for cowpea by El-Ashwah[15].

Interaction between salinity and foliar application substances on the nutritional quality of raw cowpea seeds: Data presented in Fig. 1 show that foliar application of gibberellic acid, cycocel and white wash decreased the contents of antinutritional factors like trypsin inhibitor, phytic acid and tannin compared to control under both saline and non-saline conditions. The reduction was more pronounced in the latter ones. Total free amino acids remarkably increased in cowpea seeds from plants sprayed with only GA_3 and white wash under non-saline conditions, the increase being 9.9 per cent. But it is 7.5 and 6.6 per cent for GA_3 and white wash respectively under saline conditions. Also, the *in vitro*

TABLE 1. EFFECT OF THE INTERACTION BETWEEN SALINITY AND FOLIAR APPLICATION SUBSTANCES ON THE PROXIMATE COMPOSITION AND CALORIES (100 g DRY WT) OF RAW COWPEA SEEDS.

NaCl mM	Foliar sprayed chemical	Crude protein		Ether extract		Soluble carbohydrates		Crude fibre		Total ash	
		%	Cal/100 g	%	Cal/100 g	%	Cal/100 g	%	Cal/100 g	%	Cal/100 g
0	Control	28.56	99.10	1.87	15.65	59.79	243.35	4.86	—	4.92	—
"	GA_3 100 p.p.m.	30.08	104.38	1.65	13.81	61.24	249.25	3.59	—	3.44	—
"	CCC 1500 p.p.m.	26.34	93.13	1.91	15.99	60.52	246.32	4.93	—	3.44	—
"	White wash 6%	31.27	108.51	1.42	11.89	61.56	250.55	2.50	—	3.25	—
60	Salanised control	24.93	86.51	1.39	11.63	56.10	228.33	7.72	—	9.86	—
"	GA_3 100 p.p.m.	26.64	92.44	1.28	10.71	59.47	242.04	4.56	—	8.05	—
"	CCC 1500 p.p.m.	25.38	88.07	1.45	12.14	58.40	237.69	6.41	—	8.36	—
"	White wash 6%	27.65	95.95	1.47	12.30	59.22	241.03	4.42	—	7.24	—
	L.S.D. at $P < 0.05$	0.27		0.10		0.22		0.35		0.01	
	$P < 0.01$	0.37		0.13		0.30		0.48		0.01	

TABLE 2. EFFECT OF SOAKING AND COOKING ON THE PROXIMATE COMPOSITION (g./100 g. DRY WEIGHT) OF RAW AND TREATED COWPEA SEEDS

NaCl (mM)	Foliar substances	Raw	A_1	A_2	B_1	B_2	C_1	C_2
				Crude protein (%)				
	Control	28.56±0.11	27.21±0.13	26.63±0.09	27.03±0.20	26.51±0.14	27.83±0.10	27 00±0.14
0	GA_3 100 p.p.m.	30.08±0.20	29.89±0.11	28.70±0.24	29.80±0.08	28.63±0.10	29.70±0.12	29.11±0.16
	CCC 1500 p.p.m.	26.84±0.09	26.40±0.13	26.02±0.09	26.17±0.18	25.93±0.10	26.61±0.22	26.22±0.06
	White wash 6%	31.27±0.14	31.01±0.10	30.88±0.08	30.96±0.06	30.66±0.24	31.19±0.10	29.97±0.11
	Salinised control	24.93±0.12	23.34±0.20	23.04±0.08	23.22±0.13	22.89±0.18	24.79±0.14	23.19±0.06
60	GA_3 100 p.p.m.	26.64±0.10	25.39±0.11	25.1±0.30	25.32±0.06	25.81±0.14	26.40±0.09	25.51±0.23
	CCC 1500 p.p.m	25.38±0.30	25.12±0.07	25.00±0.11	24.73±0.20	24.37±0.22	25.29±0.11	24.90±0.18
	White wash 6%	27.65±0.26	27.21±0.14	26.99±0.24	27.17±0.07	26.87±0.30	27.49±0.24	26.81±0.32
				Soluble carbohydrates (%)				
	Control	59.79±0.45	58.51±0.36	58.10±0.67	58.30±0.44	57.60±0.28	58.91±0.42	58.32±0.22
0	GA_3 100 p.p.m.	61.24±0.38	60.62±0.60	60.21±0.40	60.49±0.32	59.72±0.48	60.93±0.20	60.42±0.20
	CCC 1500 p.p.m.	60.52±0.60	60.22±0.44	59.89±0.39	60.04±0.36	59.53±0.65	60.40±0.50	59 88±0.49
	White wash 6%	61.56±0.52	61.40±0.38	60.77±0.46	61.17±0.56	60.73±0.48	61.46±0.46	60.98±0.70
	Salinised control	56.10±0.32	54.70±0.66	54.10±0.40	54.33±0.28	53.42±0.28	55.80±0.36	55.20±0.12
60	GA_3 100 p.p.m.	59.47±0.22	58.12±0.32	57.59±0.46	57.84±0.38	56.93±0.28	58.93±0.28	58.03±0.24
	CCC 1500 p.p.m.	58.40±0.60	57.01±0.24	56.41±0.44	56.77±0.50	55.84±0.33	57.91±0.42	57.22±0.30
	White wash 6%	59.22±0.28	57.81±0.28	57.19±0.50	57.81±0.22	56.90±0.48	58.83±0.18	58.17±0.14
				Ether extract (%)				
	Control	1.87±0.12	1.79±0.16	1.76±0.22	1.77±0.10	1.74±0.12	1.86±0.09	1.84±0.18
0	GA_3 1500 p.p.m.	1.65±0.18	1.63±0.08	1.64±0.18	1.63±0.22	1.62±0.10	1.64±0.15	1.62±0.12
	CCC 1500 p.p.m.	1.91±0.22	1.89±0.16	1.88±0.12	1.90±0.14	1.88±0.14	1.90±0.12	1.90±0.22
	White wash 6%	1.42±0.22	1.41±0.12	1.40±0.10	1.41±0.15	1.41±0.10	1.40±0.08	1.39±0.12
	Salinised control	1.39±0.16	1.38±0.12	1.37±0.18	1.30±0.02	1.38±0.14	1.37±0.12	1.38±0.13
60	GA_3 100 p.p.m.	1.28±0.12	1.27±0.16	1.25±0.14	1.26±0.12	1.25±0.22	1.28±0.09	1.29±0.15
	CCC 15000 p.p.m.	1.45±0.18	1.44±0.20	1.43±0.28	1.42±0.14	1.42±0.16	1.43±0.22	1.42±0.10
	White wash 6%	1.47±0.44	1.46±0.14	1.46±0.16	1.47±0.14	1.47±0.13	1.46±0.15	1.46±0.14
				Crude fibre (%)				
	Control	4.86±0.12	7.62±0.16	8.18±0.14	8.04±0.18	8.87±0.22	6.50±0.16	7.41±0.08
0	GA_3 100 p.p.m.	3.59±0.22	4.44±0.11	5.24±0.12	4.68±0.20	5.86±0.18	4.32±0.20	4.62±0.14
	CCC 1500 p.p.m.	4.39±0.14	5.72±0.15	6.28±0.13	6.16±0.11	6.79±0.10	5.30±0.14	6.01±0.22
	White wash 6%	2.50±0.06	2.95±0.12	3.29±0.10	3.25±0.16	3.59±0.06	2.75±0.30	3.89±0.19
	Salinised control	7.72±0.16	10.74±0.20	11.25±0.12	11.89±0.18	8.19±0.08	9.79±0.18	23.19±0.06
60	GA_3 100 p.p.m.	4.56±0.13	7.19±0.16	7.34±0.20	7.57±0.14	7.34±0.19	5.36±0.12	6.44±0.11
	CCC 1500 p.p.m	6.41±0.10	8.11±0.15	8.13±0.14	8.75±0.11	9.39±0.14	7.03±0.11	7.41±0.18
	White wash 6%	4.22±0.14	6.30±0.16	6.44±0.12	6.35±0.16	6.90±0.17	5.00±0.15	5.57±0.13
				Total ash %				
	Control	4.92±0.04	8.87±0.05	5.33±0.08	4.86±0.04	5.28±0.11	4.90±0.06	5.43±0.04
0	GA_3 100 p.p.m.	3.44±0.06	3.42±0.08	4.21±0.04	3.40±0.05	4.17±0.06	3.41±0.04	4.30±0.05
	CCC 150 p.p.m.	5.80±0.10	5.77±0.44	5.93±0.05	5.73±0.06	5.87±0.04	5.79±0.09	5 99±0.20
	White wash 6%	3.25±0.03	3.23±0.05	3.66±0.07	3.21±0.04	3.61±0.05	3.20±0.05	3.77±0.08
	Salinised control	9.86±0.04	9.84±0.03	10.41±0.04	9.82±0.04	10.33±0.04	9.85±0.04	10.44±0.05
60	GA_3 100 p.p.m.	8.05±0.06	8.71±0.08	8.71±0.05	8.71±0.05	8.67±0.10	8.03±0.05	8.73±0.08
	CCC 1500 p.p.m.	8.36±0.09	8.33±0.10	9.03±0.06	8.32±0.07	8.98±0.06	8.35±0.08	9.04±0.04
	White wash 6%	7.24±0.05	7.22±0.08	7.92±0.04	7.20±0.05	7.86±0.04	7.22±0.05	7.99±0.06

A_1 = Cooking without 2% NaCl under atmospheric pressure after soaking in distilled water for 12 hr.
A_2 = Cooking with 2% NaCl under atmospheric pressure after soaking in distilled water for 2 hr.
B_1 = Cooking without 2% NaCl under atmospheric pressure after soaking in hot distilled water for 12 hr.
B_2 = Cooking with 2% NaCl under atmospheric pressure after soaking in hot distilled water for 12 hr.
C_1 = Unsoaked, cooking without 2% NaCl under atmospheric pressure.
C_2 = Un soaked, cooking with 2% NaCl under atmospheric pressure.
Means of three determinations ±SD.

TABLE 3. EFFECT OF SOAKING AND COOKING ON THE NUTRITIONAL QUALITY OF RAW AND TREATED COWPEA SEEDS

NaCl (mM)	Foliar substances	Raw	A_1*	A_2	B_1	B_2	C_1	C_2
		Trypsin inhibitor activity (TUI/mg protein)						
	Control	22.96±0.3	21.9±0.7	20.9±0.5	21.5±0.4	20.7±0.3	22.2±0.6	21.4±0.2
0	GA_3 100 p.p.m.	20.8±0.2	19.2±0.4	18.8±0.3	19.2±0.6	18.4±0.7	20.4±0.3	19.2±0.3
	CCC 1500 p.p.m.	21.8±0.4	21.5±0.2	20.01±0.3	21.3±0.3	19.6±0.3	21.1±0.2	20.9±0.5
	White wash 6%	19.7±0.03	19.0±0.3	18.0±0.4	18.7±0.3	17.2±0.3	19.1±0.4	18.4±0.4
	Salinised control	18.3±0.4	17.8±0.3	16.5±0.6	17.2±0.3	16.1±0.5	17.9±0.4	16.9±0.3
60	GA_3 100 p.p.m.	17.4±0.2	16.9±0.2	15.8±0.3	16.6±0.4	15.3±0.3	17.1±0.3	16.1±0.2
	CCC 1500 p.p.m	17.6±0.3	17.2±0.4	15.9±0.2	16.8±0.3	15.4±0.3	17.2±0.4	16.3±0.3
	White wash 6%	16.7±0.4	15.3±0.2	15.2±0.3	15.9±0.2	14.8±0.2	16.5±0.2	16.6±0.3
		Phytic acid (mg/100 g flour)						
	Control	320±4.8	280±6.6	275±5.2	244±3.9	239±7.4	262±6.0	255±5.8
0	GA_3 100 p.p.m.	316−7.7	275±5.0	272±4.6	241±4.9	235±5.1	265±4.7	253±6.5
	CCC 1500 p.p.m.	317±8.2	373±6.5	271±7.3	229±8.8	232±5.9	261±7.3	250±5.4
	White wash 6%	618±6.7	269±5.9	261±8.0	242±6.4	237±5.8	259±3.8	248±7.5
	Salinised control	321±7.9	277±7.4	271±6.7	239±7.3	126±8.4	260±5.7	253±5.9
60	GA_3 100 p.p.m.	317±6.2	273±6.6	266±5.8	240±5.8	231±7.5	259±9.1	253±6.0
	CCC 1500 p.p.m.	318±5.8	268±8.1	263±6.4	225±6.2	229±5.7	257±7.4	251±5.7
	White wash 6%	319±4.9	263±7.3	256±5.9	238±7.7	232±5.8	255±5.9	247±5.8
		Tannins (mg/g flour)						
	Control	6.9±0.7	6.9±0.5	6.7±0.8	6.6±0.5	6.4±0.4	6.7±0.3	6.5±0.5
0	GA_3 1500 p.p.m.	6.7±0.6	6.6±0.7	6.4±0.7	6.3±0.3	6.1±0.2	6.6±0.5	6.4±0.7
	CCC 1500 p.p.m.	6.4±0.5	6.4±0.3	6.2±0.4	6.0±6.6	5.9±0.6	6.3±0.4	6.2±0.4
	White wash 6%	6.7±0.8	6.5±0.6	6.2±0.5	6.1±0.4	5.8±0.4	6.5±0.3	6.3±0.5
	Salinised control	5.7±0.3	5.6±0.4	5.2±0.3	5.0±0.3	4.8±0.2	5.5±0.4	5.3±0.4
60	GA_3 100 p.p.m.	5.6±0.4	5.4±0.5	5.1±0.3	5.0±0.5	4.9±0.5	5.4±0.3	5.2±0.2
	CCC 1500 p.p.m.	5.4±0.6	5.3±0.3	5.0±0.5	5.1±0.3	4.9±0.3	5.3±0.4	5.1±0.3
	White wash 6%	5.3±0.4	5.3±0.2	5.0±0.4	5.2±0.4	4.7±0.4	5.2±0.3	5.0±0.4
		Total free amino acids (mg/g flour)						
	Control	16.0±0.6	15.7±0.5	15.4±0.8	15.3±0.4	15.0±0.3	14.9±0.7	14.7±0.3
0	GA_3 100 p.p.m.	17.8±0.5	17.6±0.7	17.3±0.6	17.2±0.3	17.0±0.2	16.8±0.5	16.7±0.6
	CCC 1500 p.p.m.	15.8±0.4	15.7±0.3	15.4±0.2	15.3±0.9	15.1±0.9	14.6±0.6	14.7±0.4
	White wash 6%	17.6±0.2	17.3±0.4	17.0±0.5	16.8±0.6	16.6±0.5	16.1±0.4	16.0±0.4
	Salinised Control	14.6±0.3	13.9±0.5	13.7±0.4	13.7±0.4	13.6±0.3	13.3±0.5	13.1±0.3
60	GA_3 100 p.p.m.	15.7±0.4	15.1±0.3	14.7±0.3	14.5±0.2	14.5±0.5	14.3±0.4	14.0±0.4
	CCC 1500 p.p.m	14.1±0.5	13.7±0.6	13.5±0.5	13.4±0.5	13.2±0.6	13.0±0.3	12.7±0.4
	White wash 6%	15.5±0.3	15.0±0.3	14.8±0.4	14.6±0.3	14.1±0.4	13.9±0.5	13.7±0.6
		***In Vitro* Protein digestibility (% digested protein)**						
	Control	61.5±2.4	94.9±4.1	95.9±3.9	97.2±5.6	98.4±6.3	92.3±3.3	94.3±4.2
0	GA_3 100 p.p.m.	66.7±4.4	95.4±3.4	96.3±4.8	98.7±4.5	99.0±2.7	94.6±4.7	96.2±7.1
	CCC 150 p.p.m.	63.3±5.6	93.9±6.6	94.3±5.9	96.0±0.3	91.1±3.1	92.8±5.0	93 1±4.2
	White wash 6%	67.4±5.8	94.8±5.3	96.2±3.6	97.6±5.5	98.7±4.4	93.7±3.9	94.2±5.6
	Salinised control	63.2±3.8	95.9±4.1	96.2±4.4	97.9±6.3	98.6±5.3	93.1±2.7	95.2±3.7
60	GA_3 100 p.p.m.	66.9±5.6	96.3±5.5	37.5±7.2	98.3±2.2	99.1±5.8	94.2±1.9	96.1±4.0
	CCC 1500 p.p.m.	63.4±3.3	95.4±4.60	96.4±5.3	97.8±3.5	98.5±4.8	93.3±3.5	95.7±5.2
	White wash 6%	65.9±2.6	96.1±3.2	97.2±2.4	98.0±4.2	98.8±3.6	94.0±2.7	94.8±3.7

*A_1 = Cooking without 2% NaCl under atmospheric pressure after soaking in distilled water for 12 hr.
A_2 = Cooking with 2% NaCl under atmospheric pressure after soaking in distilled water for 12 hr.
B_1 = Cooking without 2% NaCl under atmospheric pressure after soaking in hot distilled water for 12 hr.
B_2 = Cooking with 2% NaCl under atmospheric pressure after soaking in hot distilled water for 12 hr.
C_1 = Unsoaked, cooking without 2% NaCl under atmospheric pressure.
C_2 = Unsoaked, cooking with 2% NaCl under atmospheric pressure.
Means of three determinations ±SD.

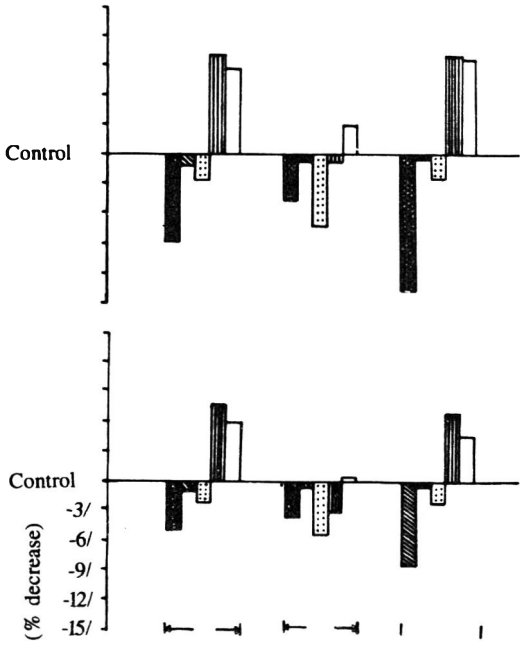

Fig.1. Effect of interaction between salinity and foliar application substances on the nutritional quality of raw cowpea seeds.

- Trypsin inhibitor activity (TUI/mg protein).
- Phytic acid (mg/100 g flour).
- Tannin(mg/g flour).
- Total free amino acids (mg/g dry wt),
- *In-vitro* protein digestibility (% digested protein).

protein digestibility index by pepsin increased due to application of all the three foliar substances, especially under non-saline conditions.

Effect of soaking and cooking on the nutritional quality of raw and treated cowpea seeds: Data in Table 3 show that the trypsin inhibitor activity (TIA) decreased due to cooking in all treatments, which can be attributed to the thermal effect during cooking. Similar observation on the destruction of TIA by cooking of cowpea seeds was reported by Ochetim and Bogere[16]. Cooked seeds after soaking in d.w. at room temperature for 12 hr showed lower TIA than that cooked without soaking. While the seeds cooked after soaking in hot water were slightly lower in TIA compared with those cooked after soaking in d.w. at room temperature, perhaps because of the denaturation and the release of much soluble proteins in the soaking water by the effect of heat. In addition, boiling in salted water tends to denature and extract more of the soluble proteins, and therefore these seeds contained the lowest TIA. Phytic acid followed the same trend as TIA and is in agreement with those results obtained by Long[17]. Furthermore, our results indicate that no pronounced differences were found in phytic acid content in all tested samples under saline and non-saline conditions. Seeds cooked after soaking in hot d.w. were slightly lower in tannin content compared to that cooked after soaking in d.w. at room temperature. In addition, cooking in 2 per cent NaCl solution tends to decrease the tannin content of the cowpea seeds, which obtained from plants grown under saline and non-saline conditions. This reduction may be due to leaching out of soluble protein-tannin complexes during cooking. Total free amino acids followed similar trend to both TIA and phytic acid[11]. Both soaking and cooking improved the *in vitro* protein digestibility, whereas the highest level of digested protein was found in cowpea seeds, which soaked in saline solution after soaking in hot d.w. for 12 hr. The improvement in digestibility by soaking could be due to removal of antinutritional factors and denaturation of protein by heat during cooking. This observation was reported by Sath and Salunkhe[18].

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J. Fd. Sci. Technol., 1991, Vol. 28, No. 5, 317—318

THE MICROBIOLOGICAL QUALITY OF ICE CREAMS SOLD IN BANGALORE CITY

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The bacteriological quality of ice creams and water ices which are referred as lollies sold in Bangalore city was examined. One hundred and twenty samples of ice creams in cups, cones, bars and lollies from hotels, parlours and local vendors were assessed for standard plate count and coliforms. Microbiologically, no significant differences were found between samples from hotels, parlours and local vendors. The counts were comparatively less in lollies than in ice-creams. Out of the total samples collected for the study, only 47 samples for standard plate count and 74 for coliforms were meeting the standards prescribed by Bureau of Indian Standards.

There are studies which support the fact that ice creams sold in Indian market are of poor quality[1-2]. Hence, great importance is given to ensure its safety for human consumption by regulating its manufacture, distribution and sales under strict hygienic conditions and by laying down bacterial standards of quality for the product. The present study was undertaken to assess the microbiological quality of ice creams sold in Bangalore city (India).

One hundred and twenty samples were collected for the study from hotels, parlours and local vendors. The samples from each variety i.e. cups, cones, bars and lollies were included in the study. Samples were brought in their original packing to the laboratory in sterile containers and analysed immediately. The standard plate and coliform counts were estimated using standard procedures[3]. Two way analysis of variance was done to know the significant difference between the source of ice creams and also varieties. To stabilise the variance in the values, transformation was done and results were analysed after transformation[4-5].

Statistically no significant differences were found in standard plate count between sources and interaction effect. However, the effect of coliform counts between source and variety was significant at both 1 and 5 per cent levels whereas varieties were found significant at only 5 per cent level (Table 1). The average standard plate counts of samples obtained from hotels, parlours and local vendors were 68.42×10^5, 46.18×10^5 and 45.54×10^5 respectively. This showed that local vendors have obtained ice creams from manufacturers who have prepared hygienically which is comparable to that of good hotels.

TABLE 1. ANALYSIS OF VARIANCE FOR STANDARD PLATE AND COLIFORM COUNTS

Source of variation	df	Standard plate count	Coliform count
Between sources (S)	2	8.74	605.37
Between varieties (V)	3	116.47**	18499.63*
Interaction (SxV)	6	45.36	18724.78**

*Significant at 5 per cent level.
**Significant at both 1 and 5 per cent levels.

Cup and cone ice creams differed significantly for standard plate counts compared with lollies. Highest coliforms were found in cone ice creams followed by cup ice creams. However, no significant differences in coliforms were found between lollies and bar ice creams. The coliform count for cone ice cream from local vendors was 30,1722 per g followed by cup ice creams from the same source i.e., 10,537 per g (Table 2). The total number of samples analysed were compared with Bureau of Indian Standards specification for plate as well as coliform counts. Only 47 samples for standard plate count and 74 for coliform count were meeting the prescribed standard specifications.

The poor quality of the cups, cones and wrappers used in packing is probably one of the factors contributing to the heavy load of organisms. Repeated handling and unhygienic surroundings is are other factors for the poor quality of ice creams.

TABLE 2. MICROBIOLOGICAL QUALITY OF ICE CREAMS AND LOLLIES

	Cups (V_1)	Cones (V_2)	Bars (V_3)	Lollies (V_4)	Mean
	Standard plate count ($\times 10^5$)				
Hotels (S_1)	70.82	75.85	65.03	61.99	68.42
Parlours (S_2)	45.33	107.74	28.93	1.73	46.18
Local vendors (S_3)	99.97	33.54	48.37	0.38	45.54
Mean	72.04	72.38	47.44	21.37	
CD(S) = 2.24 SEm = 2.29	CD (V) 2.59		CD(I) = 4.49		
	Coliform count				
Hotels (S_1)	674	1617	56	21	597
Parlours (S_2)	2098	4224	104	49	1619
Local vendors (S_3)	10537	301722	26	0	78071
Mean	4436	102521	62	23	
CD(S) = 30.98; SEm = 31.61	CD(V) = 35.79; CD(I) = 61.96				

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SCREENING FOR POPPING QUALITY IN POPCORN

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One hundred and nine half-sib families in quadruplicate were tested for popping quality to test the efficacy of using 'Popping value' instead of popping index. The popping value denoted only 15 families to be statistically at par with the best as compared to 21, 40 and 84 with respect to popping index, popped valume, and popping, respectively. Those 15 families were also best as regards the other characters studied. The popping value is having a very high phenotypic and genotypic correlation with the popping popping index and a highly significant correlation with the popping and popped volume. Popping value is recommended for use in the screening of popcorn varieties as it selects minimum allround best entries and possess a high degree of correlation with the established characters and direct commercial implication.

A popcorn population "Ludhiana Popcorn" developed through random mating is being improved through intra-population selection for popping quality, grain yield and other agronomic traits. Variability in the population was reported earlier and popping index was suggested to be the best parameter in screening for popping quality. During the course of studies, it was felt that another parameter, popping value be used, as this is most relevant to the trading of pops. The feasibility of the use of this parameter in relation to the ones already being used has been studied and reported here.

Random samples of 109 half-sib families grown during 1985 kharif, in quadruplicate were obtained from the Punjab Agricultural University, Ludhiana farms and evaluated for various popping characters according to the method described earlier[1]. The 'Popping value' was calculated as the popped volume/g weight of grains popped. The results were statistically examined using analysis of variance.

The mean popping percentage varied from 61.9 to 99.4 with a mean value of 89.2 (Table 1). Considering the critical difference (C.D.) value, 84 families with a popping value of 82.7 per cent and above were found to be statistically at par with 'HS 5' 'HS 98' and 'HS 186' registering the highest popping of 99.4 per cent. The popped volume ranged from 48.0 to 153.8 ml with a mean of 102.1 ml and on the basis of CD value, 40 families were adjudged to be at par with 'HS 7' producing the highest popped volume of 153.8 ml.

The popping index ranged from 6.93 to 21.05 and the C.D. value for the same was 5.77, whereby 21 families with a popping index of 15.28 and above were statistically at par with each other. Similarly, the popping value varied between 8.50 and 28.30 and taking into account the relevant C.D. value, 15 families with popping value of 20.80 ml/g. and more were rated at par with one another. Interestingly, all those 15 families were also having the same ranking with respect to all the other popping characters except 'HS 186' rated to be poorer in popped volume. However, the families at par with the best as regards popping, popped volume or popping index individually were not observed to be the best for all the characters studied. Amongst those 15 allround best families, the minimum values for popping, popped volume, popping index and popping value were : 90.6 per cent, 105 ml, 15.65 and 21.05 ml/g respectively and the corresponding number of entries securing values above those were: 57,40, 18 and 15, respectively. Again, the minimum number of entries so selected are in case of popping value. The families so selected are also securing popping index values in the desired range of 15-25[2,3].

The popping value had a highly significant correlation of 0.96, 0.79 and 0.50 with popping index, popped volume and popping respectively. However, a statistically significant negative correlation value of 0.35 and 0.36 existed between the popping value and the grain weight and grain volume, respectively. On the basis of all these observations, it is

TABLE 1. POPPING CHARACTERISTICS OF FAMILIES SELECTED ALLROUND BEST

Family	Popping (%)	Popped vol (ml)	Popping index	Popping value (ml/g)	Grain wt (g)	Grain vol (ml)
HS 1	96.3	151.3	18.98	24.95	5.92	7.88
HS 5	99.4	151.3	17.03	23.38	6.57	9.00
HS 7	94.1	153.8	21.05	28.30	5.48	7.38
HS 23	97.5	116.5	17.23	21.60	5.46	6.88
HS 54	97.5	145.0	19.58	25.65	5.78	7.75
HS 77	90.6	112.5	15.70	21.50	5.55	7.50
HS 78	98.8	152.5	20.00	26.25	6.18	8.13
HS 79	91.3	151.8	15.65	21.70	7.12	9.88
HS 95	97.5	120.8	15.93	21.30	6.86	9.25
HS 98	99.4	131.0	16.28	21.08	6.44	8.63
HS 186	99.4	105.0	17.45	21.93	4.69	5.88
HS 194	96.9	128.0	16.45	22.05	5.79	7.75
HS 228	90.6	127.5	17.50	22.15	6.04	7.63
HS 232	95.0	140.0	16.30	21.48	6.61	8.75
HS 268	95.0	130.0	16.43	21.05	6.19	8.00
Mean	95.9	134.5	17.44	22.96	6.05	8.02
Range	90.6— 99.4	105.0— 153.8	15.65— 21.05	21.05— 28.30	4.69— 7.12	5.88— 9.88
			Population			
Mean	89.2	102.1	12.64	15.96	6.30	8.38
Range	61.9— 99.4	48.0— 153.8	6.93— 21.05	8.50— 28.30	4.30— 8.41	5.75— 11.38
C.D.	16.7	42.3	5.77	7.50	—	—

recommended that 'popping value' be included as a screening paramater as it depicts fewer entries, best in all respects and has got direct commercial implication also.

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STUDIES ON THE QUALITY OF CASEIN-SOYA PROTEIN INCORPORATED RENNET CURD (COAGULUM)

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The effect of casein and soya protein mixture on various physico-chemical characteristics of rennet curd was studied. The amount of casein added to the milk in preparation of rennet curd is standardised at 4% level. The results indicated that replacement of 4% casein by soya proteins at 50% level improved the quality and nutritive value of rennet curd suitable for preparation of harder variety of cheeses and replacement at 75% level produced rennet curd of soft nature.

Generally, vegetable proteins are added to formulate the food products to improve upon one or more functional characteristics in addition to nutritional aspects. Soybean is the richest source of best quality vegetable protein and its combination with milk protein results in a mixture of having greatly enhanced protein quality. Soybean also acts as moisture retainer, emulsifier and stabiliser in addition to enhancing the shelf life of products[1]. The nature of rennet curd (coagulum) has an important bearing in the manufacture of cheese products and also useful in assessing its digestibility.

In the rennet curd prepared by addition of soya proteins alone in the milk has lowered the curd quality resulting in excessive loss of milk fat by soya proteins[2]. Hence, some studies were carried out to improve the quality of rennet curd by addition of casein and soya protein mixture to milk at different proportions and also to overcome the peanut flavour by addition of starter culture to rennet curd.

Acid casein was separated from milk according to the method of Mckenzie[3] and soybean protein isolates as per the method of Bhatia *et al.*[4]. The protein isolate was then de-ariated in a vaccum pump to remove the moisture and peanut flavour and dried in an incubator at 45-50°C and used for the preparation of rennet curd.

The mother culture was prepared as per the method of Sukumar de[5], using lyophilised powder of *Streptococcus lactis* culture. Fresh culture was used at 1 per cent level (0.6-0.8 per cent acidity) to inoculate the processed milk.

The fresh whole milk was collected from healthy cross bred cows of the farm, College of Veterinary Science, Tirupati, at random from time to time. In the first category, the milk was filled in 16 beakers of 50 ml capacity at the rate of 30 ml and the beakers were divided into four batches for preparation of rennet curd, without addition of starter culture. The amount of acid casein added to the milk in preparation of rennet curd is standardised at 4 per cent level.

The rennet curd prepared with the addition of 4 per cent casein alone is of soft curd nature when compared to 2 and 6 per cent levels. Hence, the soya protein isolates were added by substituting the acid casein (4 per cent level) to the extent of 50, 75 and 100 per cent levels to the milk. In the 2nd category, similar procedure was followed in other 16 beakers divided into four batches for inoculation of starter culture at 1 per cent level. All the beakers were labelled and pasteurised in water bath at 63°C for 30 min and cooled to 5°C.

In each category, two batches were utilised for sensory evaluation. Curd tension was measured from one batch and remaining the batch was utilised for estimation of rennet coagulation time and titratable acidity.

The method of preparation of rennet solution and measurement of curd tension is according to the method adopted by Jairam *et al.*[6]. Rennet coagulation time and titratable acidity of rennet curd was determined as per ISI method[7].

For sensory evaluation, the untrained staff of the department of Dairy Science, College of Veterinary Science, Tirupati acted as panel of judges. The acceptability of the product was measured based on the score above 80 treated as very good, between 60 and 80 score as acceptable and below 60 score as not acceptable. The data were statistically analysed[8].

The results of the quality of rennet curd prepared with and without addition of starter culture are presented in Table 1.

The results show that the increase of soya protein and decrease in casein content reduced the curd tension, titratable acidity and sensory quality to a significant level ($P< 0.01$). Not much change in rennet coagulation time was observed with increased content of soya protein upto 75 per cent level. The rennet coagulation time was increased significantly with 100 per cent substitution of soya proteins to casein. Similarly, the titratable acidity, curd tension, sensory quality were significantly ($P<0.01$) reduced at 100 per cent level indicating the poor quality curd. Further, the substitution of soya protein leads to softer curd, decrease in RCT, acidity and sensory quality with increased substitution of casein with soya proteins. As the curd tension was lowered with increased soya proteins[2,9,10], the substitution of soya proteins is recommended for the products having soft curd quality such as infant foods. The addition of casein-soya protein mixture in the product improved the nutritive value[11,12].

The incorporation of soya proteins in the product exhibited typical peanut flavour. In order to offset the flavour, addition of starter culture for development of acidity was made.

TABLE 1. PHYSICO-CHEMICAL CHARACTERISTICS OF SOYA PROTEIN SUBSTITUTED RENNET CURD.

Nature of incubation	Levels of substitution of soya protein to casein			
	0	50	75	100
Titratable acidity (% lactic acid)				
Without starter culture	$0.25^{a} \pm 0.00$	$0.23^{b} \pm 0.00$	$0.22^{b} \pm 0.00$	$0.21^{c} \pm 0.00$
With starter culture	$0.53^{a} \pm 0$	$0.53^{a} \pm 0$	$0.54^{a} \pm 0$	$0.57^{b} \pm 0$
Rennet coagulation time (min)				
Without starter culture	$22.50^{a} \pm 0.42$	$23.50^{a} \pm 0.42$	$24.50^{ab} \pm 0.42$	$26.83^{b} \pm 0.47$
With starter culture	$18.16^{a} \pm 0.47$	$20.00^{ab} \pm 0.47$	$21.16^{bc} \pm 0.47$	$21.50^{c} \pm 0.42$
Curd tension (g)				
Without starter culture	$84.50^{a} \pm 1.76$	$73.83^{b} \pm 1.04$	$71.33^{b} \pm 1.14$	$65.33^{c} \pm 1.58$
With starter culture	$89.83^{a} \pm 1.30$	$78.83^{b} \pm 1.13$	$75.16^{b} \pm 1.35$	$68.66^{c} \pm 1.47$
Sensory score				
Without starter culture	$88.16^{a} \pm 1.07$	$81.50^{b} \pm 1.17$	$79.33^{b} \pm 1.52$	$74.33^{c} \pm 0.66$
With starter culture	$90.16^{a} \pm 1.01$	$84.33^{b} \pm 1.45$	$81.66^{b} \pm 1.66$	77.00 ± 0.06

abc: Mean values bearing different superscripts differ significantly (P 0.01) in each row except in titratable acidity.

Addition of culture significantly ($P<0.01$) increased acidity, curd tension and sensory score except RCT. Significant differences ($P<0.01$) were also observed in acidity, curd tension, sensory score and RCT due to cultures and levels (Table 2).

From the data, it can be concluded that the substitution of soya proteins at 50 per cent with casein improved the quality and nutritive value of rennet curd and substitution at 75 per cent level is suitable for preparation of soft variety of cheeses.

TABLE 2. DIFFERENT CHARACTERISTICS OF RENNET CURD AS INFLUENCED BY DIFFERENT FACTORS*

Source of variation	df	Titratable acidity	Rennet coagulation time	Curd tension	Sensory score
Between cultures	1	1.2080**	204.187**	229.685**	72.82**
Between levels	3	0.0005**	31.743**	853.408**	378.19**
Cultures × levels	3	0.0034**	2.521	2.688	0.41
Error	40	0.0001	1.212	11.270	9.11

*Mean sum of squares
**Significant at 1 per cent level

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STUDIES ON PREPARATION OF MUTTON SAUSAGES

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Twelve batches of mutton sausages were prepared from recipes containing various formulations of the ingredients. Sheep meat allowed incorporation of hydrogenated vegetable oil in sausage mix giving better stability to the emulsion. The sensory evaluation indicated that the batch with higher contents of spices was superior than other batches in overall quality. The total viable count studies revealed that the sausages can be preserved at refrigeration temperature (7±1°C) for three days.

Beef and pork sausages are handicapped due to religious taboos of communities. Thus, preparation of sausage from meat of sheep and goat would be acceptable to a large majority of consumers in India. However, limited work has been done on the mutton sausages in India. This communication describes the development of suitable recipe for mutton sausage, its nutritive value, sensory attributes and shelf life when stored at refrigeration temperature.

Tweleve batches of mutton sausages were prepared with slight modification in each case (Table 1).

Preparation of sausage: Sheep were slaughtered by halal method on 12 different ccasions at Deonar Abattoir, Bombay. The carcasseswere broughtto M/s. Hindustan Meat Products, Vashi, New Bombay, for further processing. The carcasses were deboned and 5 kg mutton was minced for each batch.

The sheep casings of 12 to 16 mm diameter were obtained from M/s. Oriental Suppliers, Dharavi, Bombay and preserved in common salt at 4°C. They were treated with 1 per cent sodium hypochlorite solution just prior to stuffing.

A dry curing salt mixture was prepared by mixing 7 kg common salt with 200 g of sodium nitrate, 100 g sodium nitrite and 400 g trisodium phosphate. One hundred fifty g of this curing mixture was then mixed with 5 kg minced mutton and kept overnight at 4°C. Next day cured sausage mix was transferred to bowl chopper wherein, binders, fat

TABLE 1. RECIPES FOR MUTTON SAUSAGES FOR DIFFERENT BATCHES

Ingredients	Batches											
	A	B	C	D	E	F	G	H	I	J	K	L
Mutton (kg)	5	5	5	5	5	5	5	5	5	5	5	5
Curing mixture (g)	150	150	150	150	150	150	150	150	150	150	150	150
Tapioca powder (g)	400	400	—	—	—	—	—	—	250	250	—	—
Rava soji (g)	—	—	500	500	—	—	—	—	—	—	—	—
Wheat flour (g)	—	—	—	—	500	500	—	—	—	—	—	—
Gram flour (g)	—	—	—	—	—	—	500	500	—	—	—	—
Soya powder (g)	—	—	—	—	—	—	—	—	—	—	500	500
Ice (kg)	1.5	1.5	1.75	2	1.75	2	2	2	1.5	1.5	1.5	1.5
Black pepper essence (ml)	0.5	—	1	—	4	—	6	8	—	—	—	—
Black pepper (g)	—	5	—	8	—	6	—	—	10	15	20	25
Ginger essence (ml)	3	3	3	2.5	2.5	1.5	2	—	—	—	—	—
Ginger (g)	—	—	—	—	—	—	—	—	50	60	60	70
Onion essence (ml)	1.5	1	1	1.5	1.5	1.5	1.5	2	—	—	—	8
Onion (g)	—	—	—	—	—	—	—	—	350	300	250	—
Garlic essence (ml)	1.5	1.5	—	2	2	1	1	2	—	—	—	—
Garlic (g)	—	—	—	—	—	—	—	—	100	75	50	75
Clove essence (ml)	1	1	1	1	1	1	1	1	—	—	—	—
Clove (g)	—	—	—	—	—	—	—	—	10	5	5	3
Cinnamon essence (ml)	1	1	1	1	1	—	1	—	—	—	—	—
Cinnamon (g)	—	—	—	—	—	—	—	—	10	5	3	5
Aniseed essence (ml)	—	—	—	—	—	—	1	1	—	—	—	—
Dry milk powder (g)	50	50	75	50	50	60	60	70	50	60	50	50
Glucose powder (g)	50	50	50	75	60	50	60	70	50	60	50	50
Green chillies	—	—	—	—	—	—	—	—	30	50	60	60
Coriander leaves (g)	—	—	—	—	—	—	—	—	50	50	30	30
Dalda (g)	500	500	500	500	500	500	500	500	500	500	500	500
Table salt (g)	15	20	15	20	20	25	25	20	30	30	25	25

All the spices were raw and crushed.

and condiments were added. Fine emulsion was achieved by chopping the contents for 3-5 min and the temperature was maintained between 10 and 20°C by adding ice to sausage mix. The fine emulsion was transferred to stuffer immediately and stuffed into sheep casings. The sausages were linked manually into cocktail type. They were heated at 70°C (15-20 min) in hot water bath, washed with cold water (5 min), drained (5-10 min) at room temperature, chilled at 2-4°C (2-3 hr), packed in 1 kg polythene bags and stored at refrigeration temperature (7±1°C) for 7 days.

Sensory evaluation: Sensory characters like colour, flavour, taste, texture, odour and overall quality of sausages were studied as per ISI standards and done in two parts. The part I Hedonic rating test (clause 4.2 IS : 6273 part II 1971) was followed to measure food preference and to evaluate acceptability of sausages from different batches. Part II numerical scoring test (clause 4.2 . 7.3) was done to evaluate the panelists, response to different quality attributes like colour, appearance, taste, texture, odour and overall quality. Taste panel consisted of 12 members who were briefed about the procedure to be followed and recording of their response on "Evaluation Card".

The coded sausages fried in vegetable ghee were served hot to each member. Salt was supplied separately to use as per the requirements. Only one sample per session was evaluated to avoid carryover effect of flavour. Sensory evaluation study was done on 12 different occasions.

Proximate analysis: The proximate analyses viz. moisture, protein, fat, ash and carbohydrates in sausages were carried out as per AOAC[1] immediately after preparation of sausages.

Microbial analysis of batter, casings and sausages: The Total Viable Count (TVC) of batter, casings and sausages were estimated by standard plate count technique as per Cowan and Steel[2].

The TVC of batter of differnt batches was estimated immediately after their preparation and the casings just before they were filled in with emulsion whereas, sausages at 24 hr, 72 hr and 168 hr post storage.

Statistical analysis: The data obtained from sensory evaluations were subjected to statistical analysis employing Complete Randomized Design (CRD) as per Snedecor and Cochran[3].

The sausages thus prepared had pale pink colour, firm consistency, smooth texture, pleasant flavour, and spicy odour.

TABLE 3. THE PROXIMATE COMPOSITION OF MUTTON SAUSAGES

Batches	Protein (%)	Fat (%)	Moisture (%)	Ash (%)	Carbo-hydrate (%)
A	7.98	13.82	69.64	4.2	4.36
B	8.17	14.11	67.33	4.4	5.99
C	8.45	12.9	69.96	3.6	5.09
D	7.11	12.6	64.65	4.05	11.59
E	8.30	12.67	64.04	4.39	10.6
F	9.08	12.21	63.07	4.40	11.24
G	9.73	11.61	66.29	3.98	8.39
H	9.66	12.16	64.51	4.77	8.9
I	8.03	10.6	66.96	4.40	10.01
J	7.88	10.9	65.28	4.34	11.60
K	10.39	12.27	65.98	4.33	7.03
L	9.35	11.93	64.88	4.47	9.37

The results of the sensory studies of various batches (Table 2) showed that batch 'K' scored highest amongst all recipes for colour whereas the recipes of batches 'F' and 'L' scored highest but equal in respect of appearance. The batches 'E' and 'C' showed superior texture and recipe of batch 'C' was found to be best in taste and odour.

These differences were highly significant ($P<0.01$) and could be attributed to variations in raw materials including mutton which originated from sheep of varying nutritional status, variety and sex[4]. The recipe of batch 'L' was superior in overall quality and proved best amongst all 12 recipes and liked by most of the panel members. This may be due to higher levels of spices which are in general liked by Indians. Hence, the effectiveness of spices in masking unliked mutton flavour is in accordance with the observations of Baliga and Madaiah[4] and Bartholomew and Osuala[5].

The results of proximate analysis are presented in Table 3. From the Table, it is evident that various batches showed different proximate composition and this could possibly be due to different formulations, variations in the origin of material and heat losses. 'G', 'H', 'K' and 'L' batches showed relatively higher protein contents which may be attributed to high protein contents of soy flour and gram flour[6]. However, high ash contents in all the recipes may be due to the addition of salt, spices and other additives. Baliga and Madaiah[4] also observed ash contents of 5.20 per cent in the sausages.

TABLE 2. AVERAGE VALUES OF TREATMENT FOR SENSORY EVALUATION OF MUTTON SAUSAGES

Attributes	A	B	C	D	E	F	G	H	I	J	K	L
Colour	5.6	6.66	7.16	8.3	8.83	8.83	8.0	9.0	8.6	7.33	9.1	8.5
Appearance	6.83	6.83	8.16	7.5	8.5	8.83	8.0	8.33	7.83	7.0	8.0	8.83
Texture	6.5	6.66	6.83	7.83	8.33	7.66	7.33	8.0	8.16	7.0	8.5	8.33
Taste	7.66	8.16	7.33	8.33	8.83	8.5	8.0	8.83	9.16	8.33	9.0	9.66
Odour	6.33	6.66	7.33	8.33	9.33	9.16	7.6	8.66	8.5	7.83	9.3	9.5
Overall quality	7.1	7.66	7.66	8.66	8.66	8.5	8.83	9.0	9.0	8.33	9.33	10.0

Alphabets (A to L) represent various batches.

The total microbial load of casings, batter and sausages was studied and results are shown in Table 4. The results indicated that sausages had microbial load of 11.0 to 41.3 X 10^5 CFU/g at 24 hr of storage and the counts increased to 20.6 to 59.9 × 10^5 CFU/g at the end of 72 hr. However, no spoilage changes were seen. Sumnher *et al.*[7] observed 10^6 to 10^7 CFU/g in sausages and did not find any visible spoilage changes. The counts in the present study further increased with the increase in storage period and at the end of 7 days it varied from 17.4 to 67.8 × 10^7 CFU/g inducing notable spoilage changes in the sausages which lead to off-odour and slime formation. Similar results have been reported by Frazier and Westhoff[8]. It is, therefore, evident that the sausages can be preserved upto 3 days at refrigeration temperature (7±1°C).

TABLE 4. TOTAL VIABLE COUNT (TVC) (COUNT PER GRAM) OF BATTER, CASINGS AND SAUSAGES

Batches	Batter at 0 hr. (× 10^5)	Casings at 0 hr. (× 10^2)	Sausages at 24 hr	Sausages at 72 hr	Sausages at 168 hr
A	39.8	29.8	12.9	23.4	67.8
B	48.9	39.7	41.3	59.9	50.9
C	63.2	26.4	29.8	40.8	39.8
D	51.8	11.9	32.8	49.6	41.3
E	39.5	21.8	18.5	30.1	19.9
F	47.6	32.9	12.9	26.4	39.4
G	56.8	33.3	30.8	47.6	53.8
H	41.9	41.2	26.4	41.0	61.9
I	37.8	29.4	11.9	21.9	29.1
J	43.4	22.7	23.2	37.8	39.0
K	52.1	23.1	28.6	39.8	17.4
L	44.7	34.3	11.0	20.6	21.9

Counts of casings were taken just before stuffing

Thus it is concluded that recipe employed for preparation of batch 'L' is recommended for sausage manufacture. Hydrogenated vegetable oil (Dalda) can be incorporated satisfactorily in place of animal fat and the sausages can be preserved safely up to 72 hr at refrigeration temperature (7±1°C)

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NUTRITIONAL EVALUATION OF *EURYALE FEROX* SALISB. (MAKHANA)

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Amino acid composition of *Euryale ferox* Salisn. (Makhana) was worked out and feeding trials of this crop was carried out on albino rats. The values relating to essential amino acid index (EAAI) and chemical score (CS) of Makhana were close to those of fish. While EAAI and CS of Makhana were superior to those of most plant based diets, its biological value (BV) was found to be lower. The low BV of Makhana was attributed to the higher value of leucine to isoleucine ratio. The often quoted statement that a greater degree of utilization of protein by the experimental animal is predicted from a higher value of arginine plus lysine to proline ratio is found to be not applicable to Makhana.

Euryale ferox Salisbury, locally known as Makhana, is a monotypic genus of family Nymphaeacea. It is the main aquatic crop of Mithila (North Bihar) and is grown in the vast number of stagnant freshwater pools with not more than 1-1.5 metre deep. Darbhanga, Kosi and Purnea divisions are the main centres of its cultivation. In India, its present natural forms can be observed in the pools of north eastern and central India. Outside, its wild populations are available in China, Japan, U.S.S.R. and North America. Discoveries of a number of fossil *Euryale* species from different countries of Eurasia suggest its broader distribution in the past geological period.

Makhana serves a dessert delicacy and is effective against deficiency disease like beri beri[1]. It acts as a cardiac stimulant and has binding action in dysentry. It is known in the East and the South East Asia for its tonic, astringent, de-obstruent, anti-rheumatic, anti-diuretic and roborant properties. It has been found effective against spermatorrhoea and gonorrhoea also. It helps women to overcome postnatal weaknesses. Infusion of leaves is effective against difficult parturition. However, its aphrodisiac and spermatogenic potential has been much emphasized[2].

Makhana is one of the costly items and is beyond the reach of an average Indian. Information available so far hardly justifies it as being more nutritionally valuable[3]. Present study was aimed at finding out the amino acid composition and its implication on the nutritive and overall biological value.

Both raw and fried Makhana available in Darbhanga market (north Bihar) were collected, cleaned, powdered, sieved through 60 mesh and the fried material was used as experimental feed meterial for white albino rats of 30 days old, weighing 40-50 g. The rats were placed in individual wire cages with a raised platform. Water was available to them at all times. Food intake was measured every day and the animals were weighed thrice a week.

The protein content of the samples was calculated by multiplying the Kjeldahl N by 6.25. The amino acid composition was determined using a Technicon automatic amino acid analyser. Defatted samples containing 5g of protein were hydrolysed by refluxing with 5 ml of 6 N HCL for 22 hr. After removal of acid by evaporation under reduced pressure, the residue was dissolved in 2 ml of citrate buffer (pH 2.87). An aliquot (0.4 ml) was used for determination of amino acids according to the method of Moore and Stein[4].

The diets for the biological experiments were prepared at a 10 per cent protein level. The composition of 100 g of diets was as follows: Test sample, calculated weight to give 10 per cent protein; groundnut oil, 10 g (containing 1 mg of vit E); 4 per cent mineral mixture (U.S.P. XVII 4) composition as per Sikka *et al.*[5]; 5g of glucose and 5g of a complete vitamin mixture[6]; and 2 drops of adoxline containing vit. A (12000 IU/g) and vit. D^2 (IP 2000 IU/g) were fed orally twice a week. Biological value (BV) was determined as per the method described by Duggal and Eggum[7]. EAAI is based on the ratio of the amounts of essential amino acids in a protein to their amounts in whole egg protein. Chemical score (C.S.) is the percentage of the most deficient essential amino acid in the protein as compared to the requirement pattern[8]. True digestibility, net protein utilization and apparent digestibility figures were derived out of the data obtained from nitrogen balance study, as suggested by Eggum[9].

Both raw and fried Makhana were fairly rich in essential amino acids (Table 1). Data further reveal (Table 2) that Makhana possessed nutritionally comparable values to those of fish[10] with respect to essential amino acid index and chemical score. EAAI as well as CS of Makhana were also superior to those of most plant based diets[11-14]. BV of Makhana was, however, found to be lower than those of cow's milk and mutton[15].

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TABLE 1. PROTEIN AND AMINO ACID COMPOSITION (g/16gN). OF MAKHANA AS COMPARED WITH EGG AND FAO/WHO PATTERN

Amino acids	Raw Makhana	Fried Makhana	Egg	FAO/WHO (1973)
Lysine	3.79	4.69	6.7	5.4
Histidine	3.15	3.12	3.5	2.5
Arginine	15.19	16.07	6.7	5.2
Aspartic acid	5.76	5.05	10.40	7.7
Threonine	3.34	3.51	5.1	4.0
Serine	5.05	5.64	6.0	7.7
Glutamic Acid	16.64	17.06	25.2	14.7
Proline	4.00	3.24	—	10.7
Glycine	3.01	3.28	3.6	2.2
Alanine	5.50	5.84	3.5	6.1
Valine	5.18	5.49	7.5	5.0
Cystine	0.75	1.21	3.0	—
Methionine	3.06	2.95	2.3	3.5
Isoleucine	4.18	4.80	5.8	4.0
Leucine	8.34	8.85	8.9	7.0
Tyrosine	6.38	2.91	3.6	3.05
Phenylalanine	5.78	6.12	6.7	3.05
Tryptophan	—	—	1.5	1.00
Ammonia	0.90	1.16	—	—
Protein (%)	11.1	11.5		

TABLE 2. COMPARATIVE VALUES OF ESSENTIAL AMINO ACID INDEX (EAAI), CHEMICAL SCORE (CS) AND BIOLOGICAL VALUE (BV) OF FOODS.

Feeds	EAAI (%)	Chemical score (% FAO/WHO)	Chemical score (% egg)	BV
Rice[11]	82.88	68.15	54.93	68.0
Wheat[12]	65.18	49.26	39.70	62.6
Bengal Gram[11]	81.55	73.14	53.33	68.0
Soybean[13]	85.59	80.10	52.60	50.7
Amaranth[11]	57.72	50.29	40.93	—
Human milk[11]	81.55	76.92	59.70	—
Cow's milk[11]	88.80	67.69	52.54	84.5[14]
Fish[10]	89.20	100.00	65.7	59.7
Mutton[11]	87.24	102.40	71.46	74.0
Makhana				
Fried	89.95	70.18	56.57	55.0
Raw	93.63	86.85	70.00	—

The low BV of Makhana could be due to some dietry deficiency yet to be explored. The albino rats consumed proportionately less test feed as compared to those of control rats on skimmed milk diet. However, the rats remained very active and their skin was very soft and possessed a smooth, pleasing appearance when compared to those of control rats. The low consumption rate of Makhana is supposed to be due to the presence of high ratio of leucine to isoleucine in it (Table 3). However, this statement is difficult to apply in the case of cow's milk where leucine/isoleucine ratio is also quite high.

TABLE 3. COMPARATIVE VALUES OF LEUCINE TO ISOLEUCINE AND ARGININE + LYSINE TO PROLINE RATIOS IN FOODS.

Feeds	Leucine/Isoleucine	Arginine + Lysine / Proline
FAO/WHO[15]	1.75	0.99
Rice	1.66[11]	4.00[17]
Wheat[12]	1.66	0.71
Soybean[13]	1.45	2.86
Amaranth	1.27[11]	3.41[17]
Cow's milk[11]	1.76	—
Human milk[11]	1.58	—
Fish[10]	1.71	5.18
Mutton[11]	1.56	—
Makhana		
Raw[18]	1.90	7.60
Raw	1.84	
Fried	1.99	

Rogers *et al.*[16] observed that if given a choice between diets containing 5 per cent of the leucine and a protein-free diet, rats will prefer the protein free diet. In the present investigation, less consumption of the diet by the rats was observed.

It is stated that the utilization of a higher level of protein by rat, growth can be explained on the basis of a higher ratio of arginine plus lysine to proline in foods[17]. In the present investigation (Table 3), this ratio was found to be 6.3 and 4.74 in raw and fried Makhana respectively. However, a still higher value (7.6) was calculated out of the results obtained by Nath and Chakraborty[18] in the wild population of Makhana grown in Tripura.

Hence, larger utilization of Makhana protein by the rats was expected, but the present investigation (Table 2) indicated otherwise. However, the animals were found to be very active in their mobility which is supposed to be of greater importance than increase in their body weight. The increased activity of the animals in terms of mobility may be due to the other properties of Makhana starch[19,20] which constitutes approximately 80 per cent of the edible perisperm. Complete nutritional significance of Makhana could be revealed by further investigations on the hitherto untouched dietary components of this under-exploited crop[21].

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PROPORTIONATE INCIDENCE OF MYCOTOXIC FUNGI - *FUSARIUM* AND ITS EFFECT ON INGESTION BY POULTRY

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Penicillia, Aspergilli, Mucor and Fusaria are major fungi prevalent in different farms and fish products (dried and semi-dried). *Fusarium* infested rice mixed with standard feed (20:80, w/w) when fed to one week old chicks for 15 weeks, negative weight change and low feed intake rate were observed. Due to impairment of various enzyme activities of vital organs like liver, heart, spleen and pancreas, the metabolism and respiratory enzymes were affected.

It has been observed that mycotoxic fungi inhabit a variety of farm products and cause various organic disorders for laboratory and farm animals[1-5] and so have become a source of potential environmental pollution for the consumers. The present study was undertaken to investigate the proportionate incidence of mycotoxic fungus, *Fusarium*, in contrast to the presence of other potentially mycotoxic fungi, and to feed *Fusarium* infested long grain rice to one week old chickens of white Leghorn variety for 15 weeks and to study the effect on their enzymatic physiology.

Farm products like wheat *(Triticum vulgare)*, rice *(Oryza sativa)*, maize *(Zea mays)*, groundnut *(Arachis hypogea)*, mash *(Phaseolus aureus)*and rajmash *(Phaseolus vulgaris)* were procured from the local grain markets and the fish products like dried salted fish, dried crabs and dried smoked fish were obtained from fish markets of Veraval (Gujarat, India). White Leghorn chickens were supplied by the Central Poultry Breeding Farm, Chandigarh, India.

Fifty g of grains/fish were ground in pestle/mortar under sterile conditions in 150 ml phosphate buffer saline (pH 7.2, 0.02 per cent Tween-80, v/v) and allowed to settle for 5 min. One ml of the supernatant was spread on potato dextrose agar (PDA), Sabourauds' agar and malt agar plates. Different fungal media were used to study the facultative varieties. Fungal colonies were counted after 24 hr incubation (28 ± 2°C and 85 per cent R.H.). Well-defined colonies were picked and identified.

Long grain parboiled rice samples were washed with sterile distilled water to remove dust and grit particles. Fifty g rice were autoclaved with 25 ml water in Erlenmeyer flasks for 15 min at 15lb/sq in atmospheric pressure. The rice clumps were broken with sterile glass rods and individual grains set free for more and sufficient aeration and for providing more surface area for fungal growth. Autoclaved rice was inoculated with 1 ml (1 x 10^5 spore/ml) of spore suspension and incubated for 14 days (28±2°C, R.H. 85 per cent). The rice in flasks was shaken manually at frequent intervals for breaking clumps during fungal growth and to get more aeration. At the end of incubation, the flask contents were autoclaved. The fungus infested rice was mixed with standard poultry feed (Hind lever Limited, Bombay) in 20:80 proportions[6]. This mixed feed was given to 17 birds *ad lib* (group B). Group A of 15 birds receiving standard feed mixed with autoclaved rice (80:20) w/w served as control. All the birds were kept in separate cages. The feed intake and weight changes of the birds were monitored for 15 weeks. The birds were sacrificed after 15 weeks, different organs removed, kept under chilled conditions till enzymatic analysis. The blood was drawn from the marginal veins of wings and transferred to sterile vials for the preparation of serum for enzymatic analysis. Amylase activity[7], lactic and succinic acid dehydrogenases[8], serum glutamic oxaloacetate transaminase (SGOT)[9], serum glutamic pyruvate transaminase (SGPT)[9] and acid and alkaline phosphatases[10] were estimated in serum and/or 10 per cent tissue homogenates in the phosphate buffered saline (pH 7.4).

The growth of various fungi was studied on fungal media from different sources. Colonies representing distinct characteristics were picked from the petri dishes and identified. Mostly, potentially mycotoxic fungi were picked and studied. Approximately 20 per cent samples of rice, wheat and groundnut showed presence of Penicillia and 11-15 per cent samples of dried crabs and dried salted fishes showed *Penicillium* colonies (Table 1). Twelve to fourteen per cent samples of wheat and groundnut in contrast to (less than 10 per cent) samples of dried salted fish and dried crabs showed the presence of Aspergilli. Mucors were present in very few samples. Fusaria belonging to imperfect fungi group were present on 10 per cent samples of wheat.

Earlier workers have also shown that out of 96 species of fungi belonging to 27 genera could be possible source of toxicoses to the ingesting animals, out of those major genera belong to *Penicillium*, *Aspergillus* and *Fusarium*[11,12].

The results of feeding experiments shown in Table 2 indicate that there was a reduced weight gain of test birds (130g) in contrast to weight of control group (580 g). The rate of feed intake was reduced by 60g as compared to approximately 8.75 g by control group. It indicates the birds were accepting the feed to the minimal.

Enzyme activity in the sera showed (Table 3) that acid phosphatase and amylase activity decreased by 25 per cent, whereas alkaline phosphatase, glutamic oxaloacetate trans-

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TABLE 1. PROPORTIONATE INCIDENCE OF MYCOTOXIC FUNGI ON DIFFERENT FARM AND FISH COMMODITIES

Commodity	Fungal genera			
	Penicillia	Aspergilli	Mucor	Fusarium
Triticum vulgare	22 ± 2.0	14 ± 2.0	2 ± 0.5	8 ± 1.0
Oryzae sativa	18 ± 1.0	8 ± 1.0	1*	11 ± 1.0
Zea mays	2 ± 1.0	6 ± 1.0	6 ± 1.0	4 ± 1.0
Arachis hypogea	18 ± 2.0	12 ± 2.0	4 ± 1.0	8 ± 1.5
Phaseolus mungo	5 ± 0.5	3 ± 0.5	1*	1*
Phaseolus aureus	4 ± 1.0	2 ± 0.5	2 ± 0.5	1*
Phaseolus vulgaris	3 ± 1.0	2 ± 0.5	2	1*
Dried salted fish	11 ± 1.0	9 ± 1.0	3 ± 0.5	1*
Crabs (dried)	14 ± 1.0	9 ± 1.0	3 ± 0.5	11 ± 1.0
Smoked fish	4 ± 1.0	4 ± 1.0	6 ± 1.0	7 ± 1.0

*asterisk indicates less than one.

TABLE 2. EFFECT OF FEEDING F. *ROSEUM* INFESTED RICE ON WEIGHT CHANGE AND FEED CONSUMPTION

Parameters	Birds fed on	
	Normal feed (g)	Mouldy feed (g)
Initial mean wt of birds	520 ± 50	540 ± 40
Final mean wt of birds (after 105 days)	1040 ± 110	635 ± 78
Initial feed intake/day	117.4 ± 10	130 ± 12
Feed intake/day (after 105 days)	126 ± 12.8	70 ± 8
Change in rate of feed intake/day	± 8.75	−60

TABLE 3. EFFECT OF FEEDING *F. ROSEUM* INFESTED RICE ON THE INDICATOR ENZYMES OF SERUM OF BIRDS AFTER 15 WEEKS.

Enzymes	Activity (units)		Percent change
	Control	Test	
Acid phosphatase	0.667 ± 0.03	0.50 ± 0.03	− 24.92
Alkaline phosphatase	6.00 ±0.07	11.95 ±0.42	+ 99.17
Amylase	64.00 ± 4.00	48.00 ±4.00	− 25.00
Glutamic oxalo-acetate transaminase	45.00 ±5.00	96.25 ±14.00	+116.11
Glutamic pyruvate transaminase	20.00 ± 0.50	45.00 ± 4.00	+125.00

minase and glutamic pyruvate transminase activity increased by 100, 116 and 125 per cent respectively.

Experiments to find the effect on physiology of different vital organs of birds indicate that alkaline phosphatase activity in spleen is impaired as compared to pancreas, heart and liver (Table 4). Acid phosphatase activity is also impaired in pancreas and spleen but is activated to a significant extent in heart and liver. Succinic and acetic dehydrogenase activity is shown to be suppressed in all organs showing lowered respiration and tricarboxylic metabolism. It is observed that decreases of LDH, SDH and phosphatase indicate decreased rate of respiration and change in metabolic activities[13], and as a result, the tissue necrosis, along with degeneration and shrivelling of organs with reduced weight gain takes place. Changes in SGOT and SGPT activities are due to toxicity of ingested metabolites as corroborated by Wroblewski[14,15] and it caused due to acute hepatitis, showing that *Fusarium* also affects liver cells. It is observed that other hepatotoxins like aflatoxins affect, lactic dehydrogenase, fusarotoxins also affecting the LDH. These altered activities could be attributed to the liver damage to great extent and other organs to some extent. So, it is concluded that *Fusarium* ingested feeds, affect poultry in various manifestations.

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TABLE 4. EFFECT OF FEEDING *F. ROSEUM* INFESTED RICE ON TISSUE ENZYMES OF HENS AFTER 15 WEEKS

Tissue	Alkaline phosphatase (units)		Acid phosphatase (units)		Lactic dehydro genase (units)		Succinic dehydro genase (units)	
	Control	Test	Control	Test	Contro	Test	Control	Test
Pancreas	2.10 ± 0.05	1.55 ± 0.02	190 ± 6.00	158 ± 5.00	533 ± 2	514 ± 5.5	41.70 ± 2.9	37.70 ± 8.7
Heart	0.34 ± 0.01	0.58 ± 0.01	95 ±10.00	128 ± 4.02	515 ± 50	590 ±15.0	50.70 ± 1.2	41.0 ± 3.6
Spleen	4.05 ± 0.05	1.46 ± 0.03	128 ± 4.02	120 ± 6.02	550 ± 5	514 ±12.0	24.64 ± 3.1	35.10 ± 2.6
Liver	7.57 ± 1.20	17.47 ± 1.40	144 ± 18.00	220 ±16.00	524 ± 2	426 ±12.0	33.5 ± 2.5	27.5 ± 1.4

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BOOK REVIEWS

Microstructural Principles of Food Processing and Engineering: by Jose Miguel Aguilera and David W Stanley, Elsevier Applied Food Science Series, Elsevier Science Publishers Ltd. London and New York, 1990; pp:343; Price:£ 53.

This book has come to the field at the right time because the Food Scientists, Applied Scientists as they are, are trying to go deeper and deeper into the specialized areas. No one would deny that Food Science has made strides in the last decade and good scientific literature has been produced. Microstructural study of food is unique in the sense that scientists hereafter would like to understand not only by the explanations and arguments but they would like to see and believe the physical and chemical changes taking place by processing of food. They would like to bring, in the processed food, the desirable characteristics which can now be seen by the advent of the electron microscopy in the scientific field.

The present book gives a number of pictures showing the microstructures of foods derived from plants as well as animals, especially after processing. Harvesting, Processing and Storage bring out changes in food materials. Whether they are maintaining their quality characteristics or they are deteriorating or being attacked by micro-organisms can be easily seen by the microstructural studies. Mechanical damage, chilling or freezing damage, high temperature damage of agriculture products otherwise pose great problems of detection. Presence of aflatoxin and other toxins could also be detected.

The treatment of the materials in the book is good - a microphotograph and explanation in brief. The different chapters (groups of studies) contain 22 tables and 129 illustrations. However, it is still not exhaustive. A lot of microphotographs of food materials/processed materials are still available in the literature which, of course, could be included subsequently. The list of references shows that a good section of literature has been reviewed and it wiill be very useful to the researchers for further study. It will also be useful to the teachers teaching the subject on physical changes in food by Processing.

It is the opinion of this reviewer that the 'Micro-structural Principles of Food Processing and Engineering' would be a valuable addition to the already existing food literature. It will be useful to the Scientists who would like to specialize in study of microstructure of food materials.

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Engineering and Food, Volume 2, Preservation Processes and Related Techniques: Ed. by W.E.L. Spiess & H. Schubert, Elsevier Science Publishers, Crown House, Linton Road, Barking, Essex IG 11 8JU, England; 1990; pp:978; Price:£ 283.

The present book is the second part of the three volume proceedings of the Fifth International Congress on Engineering and Food held at Cologne, Germany in May-June 1989. The second volume is devoted to developments in the various fields of food preservation and to engineering highlights from around the world, as mentioned by the editors.

The book is devided into two parts. The first part covers Food preservation and related processes, while the second part provides an overview of the Engineering highlights from around the world. The first part is again divided into five sections covering respectively, Heating and related processes, Aseptic processing and packaging, Freezing of foods, Drying of Foods and Food Irradiation.

The section on Heating and Sterilization processes covers papers on engineering aspects of food contamination, Hygienic design of plants, Bulk heat exchangers, Heat transfer studies on liquid and particulate foods, Scraped surface heat exchangers, Thermal destruction kinetics, Heat stability of peroxidases, Thermal effects on texture of vegetables, fruits, Microwave cooking and related topics. The paper on the design and monitoring of bulk flow heat exchangers for aseptic treatment of viscous fluid gives a good insight into different aspects of continuous processing of viscous fluids in double pipe heat exchangers and presents simple rules to design heat exchangers for such applications. Another interesting article in this section is on preparation of high quality Tomato products using enzyme inactivation by microwave heating. The work examines the possibility of obtaining high quality product by microwave heating of whole tomatoes before crushing to inactivate enzymes they contain.

The section on Aseptic processes covers several papers of general nature reviewing recent developments in aseptic processing in flexible packages and light weight glass containers, besides papers on edible films from casein-lipid emulsions for fruits & vegetables and inert gas and modified atmosphere packaging.

The chapter on Freezing contains some general introductory articles besides several papers on research studies on freezing rates, modelling and simulation of freezing and chilling processes for selected commodities, prediction of freezing and thawing times for foods having brick or cylindrical shapes.

The section on Drying covers besides several papers of general nature covering drying rates and curves, dedicated papers on drying kinetics of apricots, food patties, antartic krill by-products, fluidized bed drying of microorganisms on carrier materials, scraped surface drying of tomatoes and osmatic dehydration of apples, grapes and carrots. There are interesting comparative studies on atmospheric freeze-drying using fluidized bed colum filled with a fine grained food compatible adsorbant (pregelatinised starch) and conventional freeze-drying under vacuum. Both energy and product quality aspects are discussed.

The section on Food irradiation contains three papers. In the first paper, the status of food irradiation is reviewed with special emphasis on the situation within the European community. The section also includes a paper covering preservation of CHILEAN ANALONE by gamma radiation and refrigeration.

The second part includes papers on different aspects of food processing and engineering and reports work carried out in selected countries like Korea, China and Turkey, novel approaches to accelarated storage studies, progress in engineering of oil and fat technology, developments inhigh pressure food processing and preservation and reports on some interesting studies on clarification and bacteria removal from milk products etc. This part also includes a useful paper reviewing the biotechnology of fermented food industry in Korea, where a number of diverse fermented foods with enhanced taste/flavour and long shelf life have been developed.

On the whole, this compilation can be a good source of useful reference materials to both Food technologists and Engineers. As mentioned in the preface, the papers covered show the many facets of the field of food engineering and reflect the different tasks which food engineers are confronted with.

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Studies of the Magnitude and Nature of Pesticide Residues in Stored Products Using Radiotracer Techniques: International Atomic Energy Agency (IAEA), Vienna: 1990; pp:146: Price: Not mentioned.

Proceedings of the final research coordination meeting on isotopic tracer aided studies of pesticide residues in stored products form the contents of this monograph. The meeting was organised by the joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture in Ankara from 30 May to 3 June 1988. The research programme was designed to assist scientists from developing countries to make safe and effective use of radiotracer techniques for studying pesticide residues in stored products. The papers presented by participating scientists contain model protocols for studying chemical residues in stored products as well as an appraisal of the overall programme accomplishments.

Five papers deal with the residues of ^{14}C-Pirimiphos-methyl in stored maize, wheat, barley, bread, barghul, parboiled wheat, both raw and processed products of sultana raisins and common beans. Another seven papers give an account of malathion residues in stored rice, faba beans, maize, bean seeds, corn and wheat. One paper deals with the degradation of malathion and chlopyrifos-methyl in stored wheat, while an another deals with the residues of fenvalerate in stored rice. There are two papers on the fumigants, one on ethylene dibromide residues (EDB) in stored maize grains and the other on methylation of food commodities during fumigation with methyl bromide. FAO/IAEA Model Protocols for the Determination of Pesticide Residues in stored products is also included together with two Annexures. Annexure I contains FAO/IAEA Model Protocol : Treatment of test samples with protectant insecticides and Analysis of Residues, while Annexure II deals with model protocol of treatment of test samples with the fumigant methylbromide and analysis of residue remaining after treatment. A report on the appraisal of overall programme accomplishments forms the last chapter.

Residue analysis of ^{14}C-Pirimiphos-methyl on various commodities shown above has revealed the following pattern. A total of 78% of the applied dose was recovered at 0-24 hr and this amount decreased to 16% after 180 days in storage. Although cooking has no effect on the levels of the residue recovered, some reduction in the extractable residues was observed as a result of cooking in some types of diet. The residues declined to 88% in wheat and 82% in barley after 12 months. The loss in milling during preparation of whole meal flour from pre-washed grain was 7% for wheat and 6% for barley. Processed products from wheat showed residue losses ranging from 24 to 25%. The total residues decreased from 86 to 68% for raisins in 8 months and from 89 to 44% for beans in 4 months. The bound residues in beans reached a maximum of 1.3%. The reduction of radioactivity during processing was 11 and 9% on pre-washed raisins and beans respectively. A concentration of 0.87 ppm was found on the hulled rice immediately after application and this concentration declined to 0.60 ppm after 6 months in storage. For unhulled rice, most of the residue was retained in the hull with no decrease in the overall level during the storage period.

Studies with ^{14}C-malathion on various commodities showed the following pattern of free and bound residues. Application of malathion on to the bagged milled rice resulted in the accumulation of malathion and its metabolites. At the end of 9 months storage, about 4% of the applied dose was still present 32 weeks after application of ^{14}C-malathion. Eighty per cent of the applied activity was recovered on beans, washed and cooked beans showed 1.39 ppm residue after 9 months storage. After 12 months in storage 28% of the applied dose was present on maize. Maximum malathion

terminal residue after 9 months in storage was 5.52 and 2.04 ppm respectively before and after cooking. Total terminal residues declined to 9.3 and 21.0 ppm from initial applied doses of 12.2 and 24.4 ppm respectively. A small percent of malaoxon was detected only during the early weeks after treatment. When wheat was stored in ^{14}C-malathion pre-treated wooden container, the residue of malathion in wheat increased slowly upto 3 months with no change upto 9 months. Terminal residue, in grain was 2.6 ppm after 9 months which is below the FAO/WHO limit.

There is an interesting article on ^{14}C-ethylene bromide (EDB) residue in stored maize. Total residue declined from 82 to 20 ppm after 4 weeks and to 12 ppm after 40 weeks. Data with ^{14}C-EDB indicated the presence of high unacceptable levels of EDB or its derivatives on maize at the stage of human consumption. This is a very important point to note for those countries, which are still using EDB as fumigant. Total residue declined from 82 ppm at zero time to about 20 ppm after 4 weeks and 12 ppm after 40 weeks. Surface and Methanol extractable residues accounted for 5 ppm of the terminal residue after 40 weeks, the remaining being bound. Another equally interesting article is on methylation of food commodities during fumigation with methyl bromide using ^{14}C-methyl bromide. The study indicated the differences in the levels of the major volatiles such as methanol, dimethyl sulphide and methyl mercapton, the products of O - and S-methylation resulting from treatment of the fumigated materials with IN NaOH. Histidine is the major amino acid that underwent the highest level of N-methylation.

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

Seafoods - Effects of Technology on Nutrition: by George M.Pigott and Barbee W Tucker, Marcel Dekker Inc., 270, Madison Avenue New York, 1990; pp:369: Price: £89. 75 (US & Canada), $119.5 (All other Countries).

Seafoods were till recently considered by Nutritionists as a source of good quality proteins which can even provide low cost supplements like fish flour to cure protein malnutrition. However, some remarkable advances have taken place in recent years on the nutritional value of fish oils which must have prompted the authors to offer this new book on Sea foods and their nutritive value. In fact, recent work on the biochemical significance of fish oils is of great interest to all food scientists and nutritionists and not merely to those concerned with fish processing. In the wake of earlier findings on the Cholesterol lowering effect of fish oils familiar to Indian workers, it was found that unsaturated fatty acids like C 20 : 5n-3, eicosapentaenoic acid (EPA) and C 22 : 6n 3, docosahexaenoic acid (DHA) from fish oils have a more specific effect on heart disease. A distinction is made in recent years between PUFA and HUFA (highly unsaturated fatty acids) which occur in fish oils. Although the physiological effect of fish oil consumption was attributed to n-3 fatty acids, it was only after understanding the biochemical role of Prostaglandins and other Eiosaenoids that the part played by n-3 HUFA began to be elucidated e.g. decreased aggregation of blood platelets preventing thrombosis and ischaemic heart disease and also modification of immune functions. Linolenic acid, the C 18: 3n-3 acid from other sources is no doubt elongated and desaturated to EPA and DHA in the body but the process is said to be inefficient in human cells resulting in an imbalance in the production of Thromboxane and Prostacyclin with opposite roles in platelet aggregation. Anti-inflammatory effect of fish oils is explained by the slowing down of immune system components providing relief in rheumatoid arthritis. Fish and fish oils have also been shown to reduce the induction and growth of tumours in rats whereas n-6 PUFA are in recent years suspected to be tumour producing.

Although this latest book on "Seafoods" is intended to highlight the effect of technology on the nutritional value of sea foods, methods of fishing and fish processing have been dealt with in considerable detail especially with regard to the recent developments in Irradiation and *Surimi* (gelled fish flesh) production. With the safety clearance given by WHO in 1981 for foods irradiated upto an average dose of 1 Mrad, intensive work is in progress in U.S.A. since 1987 which should be of particular interest to Indian workers. *Surimi*, obtained from washed fish mince serves as the base for a host of formulated food products which have become popular in recent years in U.S. and other countries. There are also chapters on commercial fish and shell fish farming and farming and seaweeds, said to be effective in lowering of cholesterol. Apart from marine oils, nutritive value of fish in general, has been adequately dealt with, including value of, trace elements and toxic factors due to pollution. Literature survey could have been more comprehensive. Shark meat is described to be low in protein (12.6%) on the basis of a single report (p.42).

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Chlorophenols Other Than Pentachlorophenol - Environmental Health Criteria — 93, WHO, Geneva, 1989; pp:208; Prices: Sw.fr.22.

This monograph belonging to Environmental Health Criteria Series has been published under the joint sponsorship of the United Nation's Environment Programme, the International Labour Organisation and the World Health Organisation. The review report contains the collective views of an international group of experts on the subject.

The global production of all chlorophenols is over 200 million kg/yr. Over 50% of this quantity consists of non-PCP chlorophenols. European countries and USA are the major producers and consumers of chlorophenols. Their principal application is in wood preservation.

The monograph begins with Summary of the whole review in *Section-1. Section-2* is on Identity, Physical and Chemical Properties and Analytical Methods. Information on the identity of 18 possible congeners are presented in Table-1. Occurrence of PCDD and PCDF, the usual microcontaminants in commercial chlorophenol samples is listed in Table-2. Physical and Chemical properties of chlorophenols are summarised in Table-3, while Analytical Methods for chlorophenol extraction and determination are enlisted in Table-4.

Section-3 is on Sources of Human and Environmental Exposure both natural as well as manmade sources. The global production and consumption figures for chlorophenols other that pentachlorophenol is given in Table-5. Principal uses of selected chlorophenols are listed in Table-6. The release of these compounds into the environment by various sources is discussed in detail and listed in Table-8.

Environmental Transport, Distribution and Transformation is dealt in *Section-4.* Bioaccumulation of chlorophenols appeaars to be moderate. Degradation is generally slowest for the higher chlorophenols. The various modes of degradation both non-biological and biological are reviewed in this Section. Factors (Physical, Chemical, and Biological) affecting bioaccumulation and degradation are also discussed.

Section-5 reviews Environmental levels and Human Exposure. Chlorophenol levels in air, water, soil, industrial effluents, food, treated wood, etc contributing to human population exposure are discussed. Kinetics and metabolism of chlorophenols is the content of *Section-6.* Effects of chlorophenols on environmental organisms is the subject matter of *Section 7.* Most toxicity data are confined to aquatic organisms and the toxicity generally increases with degree of chlorination of the phenolic ring.

Section-8 comprises effects on experimental animals and *in vitro* systems. Acute studies, studies on short term and long term exposure, effect on reproduction, embryotoxicity, teratogenecity, mutagenecity, carcinogenecity are reviewed. The toxicity of chlorophenols is generally in the order: $T_4CPs > MCP > DCPs > T_3CPs$. Both short term and long term exposures are known to produce haematological and immunological effects. Implication of liver and kidney and absence of carcinogenic effect in long term exposures, the fetotoxic effects of lower chlorophenols, and weak mutagenic response of a few chlorophenols are other salient features here. Mechanism of chlorophenol toxicity is also discussed in this section.

Section-9 deals with effect of chlorophenols on Man. Both acute and long term exposures are discussed. This is followed by Evaluation of Human Health Risks and Effect of Exposure in *Section-10.* Recommendation regarding production, disposal, occupational and general population exposure are contained in *Section-II,* followed by a brief section *(Section-12)* on Previous Recommendations.

The monograph has a vast bibliography containing 371 references. This extensive monograph on Chlorophenols other than Pentachlorophenol is useful for those working on chlorophenols and to those involved in pesticide regulation.

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

AFST(I) News

The Central Executive Committee of AFST(I) at its recent meeting, decided to arrange Technical Lectures on various topics in Food Science and Technology. It was also decided to organise a half-a day colloquium on current topics once in three months. Accordingly, a technical discussion was inaugurated by Dr. P.J. Dubash, President, AFST(I) on 19th August 1991 in the Assembly Hall of CFTRI, Mysore. Dr. A.M. Nanjundaswamy, Scientist, CFTRI, Mysore spoke on "Present Status and Future Scenario of Fruit and Vegetable Processing in India", which was followed by a video film on "Australian Mango Industry".

Founder's day celebrations: Headquarters

Founder's day was celebrated on 16th September 1991 at CFTRI. Dr. P. J. Dubash, President of the Association welcomed the gathering and Dr. S.R. Bhowmik, Director, CFTRI inaugurated the function. Dr. S.C. Basappa, Vice-President of the Association recalled the services rendered by Dr. V. Subrahmanyan, Founder-President of the Association, as a scientist and eulogised his qualities as a scientific person. This was followed by lectures on 'Interaction of Phyridoxal Phosphate at the Active Site of Serine Hydroxymethyl Transferase' by Prof. N. Appaji Rao, Head, Department of Biochemistry, Indian Institute of Science, Bangalore and 'Impact of New Industrial Policy on Food Processing Industry in India' by Dr. V.H. Potty, Chairman, Technology Application Division, CFTRI, Mysore. Dr. M.S. Prasad, Hon. Executive Secretary of the Association proposed a vote of thanks.

Bhopal Chapter

The following members were elected as office bearers for the year 1991-92:

President	:	Dr. N. Ali
Hon. Secretary	:	Shri S.D. Kulkarni
Hon. Treasurer	:	Shri S.P. Singh
Members	:	Dr. V. Kawalkar
		Shri K.K. Singh
		Smt. S.S. Despande

The Founder's day was celebrated under the Chairmanship of Dr. R.S. Devnani, Director-in-charge, C.I.A.E., Bhopal on 16th September 1991. Shri S.D. Kulkarni, Hon. Secretary of the Chapter welcomed the gathering. Shri S.C. Nandi, Public Analyst, Food & Drug Administration, Government of M.P., Bhopal spoke on the topic 'Food Standards and Consumer Protection'. The meeting was ended with a vote of thanks by the Hon. Secretary.

Pune Chapter

The Founder's cay was celebrated on 16th September 1991 at the I.H.M.C.T., Campus, Pune with welcome address by M . V.A. Gangolli, President, of the Association, Dr. S. Pingale spoke on the achievements and qualities of Founder-President Dr. V. Subrahmanyan, Mr. M.G. Sathe delivered a special lecture on 'Food Security' and Ms. K.S. Reddy, Jt. Secretary proposed a vote of thanks.

Jabalpur Chapter

The above chapter celebrated the Founder's day on 16th September 1991 at the Department of Food Science and Technology, Jabalpur. Dr. Y.K. Sharma welcomed the gathering. Dr. D.K. Sharma, Vice-Chancellor, JNKVV, Jabalpur, lighted the lamp and inaugurated the function. Special lectures were arranged on 'Processing of Milk and its Products' by Shri S. Kapoor, Managing Director, M.P. Dugdh Sangh, and on Prospects of Food Industry in Jabalpur by Shri A. Mangrulkar, Branch Manager, M.P. CON Consultancy. Shri S.S. Shukla, Hon. Secretary proposed a vote of thanks.

Nagpur Chapter

A 3-day National Seminar and Exhibition on 'Panchayat Udyog' was organised by the Small Industries, Artists, Rural Artisans, Talents and Handicraft Institution (SARATHI) in collaboration with the Chapter from 24th to 26th September 1991, which was inaugurated by Shri Banwarilal Purohit, Ex. M.P., and Managing Director, The Hitavada, Nagpur. Mr. Amar Wazalwar, Secretary, SARATHI, welcomed the gathering. The following persons participated in the technical deliberations: Shri S.A. Gaikawad, Managing Director, Maharashtra State Co-operative Tribal Development Corporation, Nasik, Shri Akhil Banarjee, General Manager (Planning), State Bank of India, Bombay, Shri Wagh, Jt. Director of Industries, Nagpur, Dr(Mrs) Sunanda Sonarikar, Head, Department of Economics, Nagpur University, Dr. S.D. Bhalerao, Head, CFTRI, Nagpur and Dr. Jaiswal, Director, Central Agmark Laboratory. Dr. G.D. Nageswar, President of the Chapter also spoke on the occasion.

ANNOUNCING FELLOWSHIPS
ASSOCIATION OF FOOD SCIENTISTS AND TECHNOLOGISTS (INDIA)

Central Technological Research Institute Campus, Mysore-570 013.

Subject:- FELLOWSHIPS OF AFST(I)

The Association has pleasure in announcing conferring of Fellowships of AFST(I) entitled "Fellow of Association of Food Scientists and Technologists (India)" (FAFST) to honour persons who have contributed significantly to the progress of Food Science and Technology.

The following are the highlights of the Fellowship:

General

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

Fellowships have been awarded to 22 AFST(I) members and 4 non-members who have contributed to the progress of Food Science and Technology.

Eligibility

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

Nominations

1. The nominee for Felowship should be proposed by five AFST(I) members of good standing for a minimum of 5 years or by 2 Fellows of the Association. This is applicable to AFST(I) members as well as non-members.
2. Any regular or life member of AFST(I) who has been continuously a member of the Association can sponsor the nomination for only one Fellowship in a particular year.
3. The nomination shall be accompanied by acceptance of the person proposed.
4. The nomination shall be in the format given. A brief biodata of the nominee with highlights of Scientific or Technological achievements in the area of Food Science and Technology supported by list of publication not exceeding 10 important research papers or other supporting documents not exceeding 20 pages must accompany the nominations.
5. The nomination duly proposed and accepted by the nominee's consent shall be sent to the Hony. Executive Secretary AFST(I) by January of each year.

Selection of Fellows

The nominations received will be placed before an expert committee appointed by CEC for suitable recommendations to CEC each year. CEC by majority decision will finalise Fellowships for each year. The decision of the CEC in this matter will be final.

Privileges of a Fellow

The Fellow shall be entitled to the following rights:-

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

Cessation of Fellowship

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

Conferring of Fellows

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

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

Please write to Hony. Executive Secretary, Association of Food Scientists & Technologists (India). CFTRI Campus, Mysore - 570013, India for application forms for nominations.

Last date for receiving the nominations is 15th January 1992.

Dr. M.S. Prasad
Hony. Exec. Secretary

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

Nomination Form

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

Full name and academic distinction

FULL NAME

ACADEMIC QUALIFICATIONS:

Date of Birth

Areas of specialization

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

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

.....

Seconder's name & Signature
Date:
Station:

Proposer's name & Signature
Date:
Station:

(Signature of supporters from personal/general knowledge)

(1) (2) (3)

I agree for the above nomination

(Name & Signature)

.....

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

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

(3) Last date for receipt nomination at the office is 15th January 1992.

ASSOCIATION OF FOOD SCIENTISTS & TECHNOLOGISTS (INDIA)

CFTRI Campus, Mysore — 570 013, India

NOMINATIONS FOR AFST (I) AWARDS FOR 1991

Nominations for the following awards of the AFST (I) for the year 1991 are invited. All nominations should be sent by Registered post, so as to reach Honorary Executive Secretary, Association of Food Scientists and Technologists (India), CFTRI Campus, Mysore — 570 013, before 15th January 1992.

PROF. V. SUBRAHMANYAN INDUSTRIAL ACHIEVEMENT AWARD

The guidelines for the award are:

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

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

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

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

The envelope containing the nominations along with biodata and contributions (five copies) should be superscribed "Nomination for Prof. V. Subrahmanyan Industrial Achievement Award — 1991.

LALJEE GODHOO SMARAK NIDHI AWARD

The guidelines for the award are:

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

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

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

The envelope containing the nominations (five copies) should be superscribed "Nomination for Laljee Godhoo Smarak Nidhi Award 1991.

BEST STUDENT AWARD

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

The guidelines for the Award are:

(i) The applicant must be an Indian national

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

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

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

(iii) He/she should not have completed 25 years of age on 31st December 1991.

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

The envelope containing the nomination should be superscribed "Nomination for Best Student Award — 1991.

YOUNG SCIENTIST AWARD

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

The guidelines for the Award are:

1 The candidate should be an Indian national below the age of 35 years on 31st December 1991 working in the area of Food Science and Technology.

(i) The candidate should furnish evidence of either:

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

OR

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

The application along with details of contributions of biodata (five copies) may be sent by registered post with the envelope superscribed: "Nomination for Young Scientists Award 1991.

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.

REG. NO. 24918/64

JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

Vol.28, No.6 Contents of forthcoming issue Nov./Dec. 1991

Research Papers

GAMMA IRRADIATION OF RICE GRAINS *by M.K. Roy, S.K. Ghosh and S.R. Chatterjee.*

KINETICS OF LIQUID WATER ABSORPTION BY EVACUATED PADDY GRAINS *by S.D. Kulkarni and S. Bal.*

EFFECT OF VARIETIES AND PROCESSING METHODS ON PHYTIC ACID AND PROTEIN DIGESTIBILITY OF GROUNDNUT (*ARACHIS HYPOGAEA* L.) *by U. Singh, B. Singh and O.D. Smith.*

DEHYDRATION CHARACTERISTICS OF TEN ONION CULTIVARS *by P.K. Sharma and Nirankar Nath.*

STUDIES ON THE PREPARATION, PACKAGING AND STORAGE OF INDERSE-AN INDIAN TRADITIONAL SWEET *by A.K. Saxena, S.G. Kulkarni, J.K. Manan, S.K. Berry and O.P. Beerh.*

ENERGY MANAGEMENT IN BAKING INDUSTRY *by M.B. Bera, R.K. Mukker, R. Mishra, Binu Apoorv and S. Mukherjee.*

PRODUCTION OF *NARAMPAK SANDESH* FROM BUFFALO MILK *by D.C. Sen and G.S. Rajorhia.*

STUDY ON INFLUENCE OF POST PRODUCTION HEAT TREATMENT ON QUALITY OF FRESH SHRIKHAND *by J.P. Prajapati, K.G. Upadhyay and H.K. Desai.*

EFFECT OF POLYPHOSPHATE CHILLING ON THE QUALITY OF QUAIL MEAT *by K. Prabhakar Reddy, D. Narahari and K. Kumara Raj.*

MICROBIAL PROFILE OF TROPICAL PRAWN *METAPENAEUS DOBSONI* DURING FROZEN STORAGE *by Nirmala Thampuram and K. Gopakumar.*

POTENTIAL OF SOME RHIZOMES OF ZINGIBERACEAE FAMILY AS GRAIN PROTECTANTS AGAINST STORAGE INSECT PESTS *by P.Y. Aneez Ahamad, and S.M. Ahmed.*

Research Notes

EVALUATION STUDIES ON HIMACHAL GALGAL (*CITRUS PSEUDOLIMON* TAN.) FOR PROCESSING INDUSTRY *by R. Mahajan and B.B. Lal.*

A COMPARATIVE EVALUATION OF MEDIA FOR ENUMERATION OF ENTEROTOXIGENIC STAPHYLOCOCCI BY SELECTIVE ENRICHMENT TECHNIQUE *by M.Y. Kamat, G. Sulebele and Nirupama Sabnis.*

PARBOILING OF RICE: EFFECT OF PHYSICO-CHEMICAL, MILLING AND COOKING PROPERTIES *by Amarjeet Kaur, K.S. Sekhon and H.P.S. Nagi.*

EXTENSION OF SHELF-LIFE OF PANEER BY SORBIC ACID AND IRRADIATION *by L. Singh, H.S. Murali and R. Sankaran.*

STANDARDISATION OF MANUFACTURE OF HIGH FAT YOGHURT WITH NATURAL FRUIT PULP *by B.V. Balasubramanyam and Satish Kulkarni.*

HEAT RESISTANCE OF ENTEROTOXIGENIC *S. AUREUS* IN MILK, RECONSTITUTED INFANT FOOD AND CREAM *by V.K. Batish, B. Nataraj and Sunita Grover.*

EFFECT OF SUPPLEMENTING POULTRY MEAT WITH TEXTURED SOY ON THE QUALITY OF LOAVES *by S.S. Thind, A.S. Bawa, Kashmira Singh and Pardeep Sharma.*

EVALUATION OF SENSORY ATTRIBUTES AND SOME QUALITY INDICES OF IRRADIATED SPICES *by G. Subbulakshmi, Shobha Udipi, Reshma Raheja, Arun Sharma, S.R. Padwal Desai and P.M. Nair.*

A REPORT OF MYCOTOXIN CONTAMINATION IN BHUTANESE CHEESE *by A.K. Sinha and K.S. Ranjan.*

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