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Processing, packaging and storage of pasta from proso millet

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ABSTRACT : Proso millet (*Panicum miliaceum*) a specific type of staple food popular in India and other parts of the world. There was no significant work on the commercial exploitation in the value addition of proso millet products. Hence, a study was conducted to produce pasta from clean and polished proso millet blended with wheat flour and water under different combinations. Also with a view to improve the shelf life of pasta by packaging interventions, the effect of LDPE and PP usage on the sensory, physico-chemical and biochemical quality of pasta during three months of storage at ambient atmosphere condition was studied. Pasta prepared under equal proportions of millet and wheat flour got maximum overall acceptance in the sensory panel and the rate of loss of most quality attributes was low in pasta stored under LDPE samples as compared to samples packaged under PP. Based on the results obtained in the study it was concluded that pasta could be best preserved up to 3 months at ambient atmospheric condition under LDPE without appreciable quality loss.

KEY WORDS : Proso millet, Storage, Packaging materials, Cold extrusion

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In India, different kinds of traditional foods made from small millet grains from staple diet for many rural and urban households. Number of technologies has been developed to enhance utility and commercial value of these grains. Pasta is a type of noodle and is a staple food of traditional Italian cuisine. Typically pasta is made from an unleavened dough of a durum wheat flour mixed with water and formed into sheets or various shapes, then cooked and served in any number of dishes. It can be made with flour from other cereals or grains, and eggs may be used instead of water as it was broadly categorized into, dried (pasta secca) and fresh (pasta fresca). Though pasta is a staple food in many countries, they are still considered as snack food here in India. Several studies have been reported in the value addition for different millets (Viraktamath *et al.*, 1971; Purseglove, 1972; Vaidhi *et al.*, 1985; Begum *et al.*, 2003; Veena *et al.*, 2004) but, little attempts have been made to prepare small millets based pasta products perhaps due to many reasons including non-availability of technology.

Good storage quality of processed food is an essential attribute to extend their utilization and the storage quality of processed foods was evaluated by several investigators in terms of sensory characters and chemical components. Sowbhagya and Ali (2001) prepared maize vermicelli with and without antioxidant and packed in cast polypropylene (CCP) and a laminate of metalized polyester with low density polyethylene (M-PET/PE). The packs were stored at 38°C, 92 per cent RH (accelerated storage) for 100-140 days. Firmness and elasticity of product remained good up to 100 days. Devraju *et al*. (2003) developed pasta with finger millet flour (50%), refined wheat flour (40%), defatted soy/whey protein concentrate (10%) and extruded using both cold (30°C) and hot water (75°C). Pasta with hot water extrusion was better in terms of cooking quality and also cooking loss found to be minimum (12%) and showed non-significant differences in the cooked pasta under sensory attributes after three months of storage. Since there was no significant research has been found under the development of the snack products from the proso millets and also lack of studies on the packaging and storage of ready to cook pasta like product blended with proso millet. Hence, a study was conducted with the objective to develop proso millets based extruded ready to cook pasta product under different formulations packed in different packaging materials for storage studies of three months with biochemical (fat, protein, carbohydrate, crude fibre, ash and moisture content) quality analysis under monthly intervals with the aim to provide a good processing packaging and storage technique for pasta like ready to cook product.

METHODOLOGY

Raw material and product formulation :

The raw materials used for the development of ready to cook pasta product were dehusked proso millet rice grain and wheat flour procured from the local super market. A domestic Grain Pulverizer (make: Anand Associates, Shimoga) was used to mill proso millet rice grains into desired particle size flour suitable for developing cold extruded pasta product. Through the preliminary trails it was observed that maximum 70 per cent of millet could be used to produce commercial quality pasta product. Hence, the maximum percentage use of proso millet was restricted to 70 per cent and the rest was make up by the wheat flour (atta) which provides necessary strength for the final product. Similarly, other two combinations were prepared as detailed in Table A.

Preparation of pasta :

When the dough characteristic was optimum, it was extruded using appropriate 'dies' (shanku, ribbed tube, twisted ribbons). The cutter speed was set to optimum level (3 to 12 rpm) depending upon the shape of the final product. The extruded pasta were collected in trays, steam cooked at 0.5 kg/cm^2 for 5 minutes and then dried in a convective hot air oven at 50^{0}C for about 3 hours to obtain translucent pasta. The products were then packed in two different packaging materials selected in the present study namely, low density poly ethylene (LDPE-200 gauge) and polypropylene bags (PP-200 gauge) for storage studies.

Sensory evaluation of cooked proso millet based pasta :

The pasta masala was prepared using locally available method and as per the preliminary sensory studies carried out for the commercially available pasta. The products were evaluated for sensory characteristics by a panel of 10 trained judges. Whole wheat pasta (control) was also prepared in similar way and presented for sensory evaluation along with the 3 combination samples (Based on proso millet) Table B The judges scored the sensory quality of cooked pasta based on its colour, texture, taste, flavor and overall acceptability on a nine point hedonic scale (Ranganna, 1997).

Storage of pasta :

Storage stability of developed proso millet pasta products were studied at ambient conditions by storing them in flexible packages LDPE and PP. The packaged samples were stored at ambient conditions of Bangalore (during April-June, 2012) for three months. The stored pastas' were periodically analyzed at monthly intervals for biochemical parameters and moisture in order to study their storage stability.

Bio-chemical analysis :

Moisture content :

Moisture content analysis of pasta samples during storage was examined for percentage difference in the weight of the samples before and after packaging during storage period as per the standard methods described by Hall (1957). The data on moisture content were presented in terms of percentage, which was calculated as:

$$\text{Moisture content (\%)} = \frac{W_1 - W_2}{W_1} \quad \text{.....(1)}$$

where,

W_1 = Initial weight of the sample, g

Table A : Formulation of proso millets based pasta products

Formulation	Proso millet flour (%)	Wheat flour (%)	Water (ml/kg)
Proso millet			
P-f_1	50	50	360
P-f_2	60	40	360
P-f_3	70	30	360

Table B : Mean sensory scores of different proso millet based pasta *p*roducts

Millet formulation	Colour	Texture	Flavour	Taste	Overall acceptability
P-f_1	6.9	7.0	7.3	7.2	7.1
P-f_2	7.5	7.42	7.42	7.56	7.4
P-f_3	7.72	7.26	7.6	7.42	7.36
Control	7.95	7.69	7.52	7.42	7.60
F-test	NS	NS	NS	NS	NS
C.D.@5%	-	-	-	-	-
S.E.±	0.35	0.30	0.26	0.30	0.34

P-f_1 - Proso millet rice flour (50%): Wheat flour (50%), P-f_2 - Proso millet rice flour (60%): Wheat flour (40%), P-f_3 - Proso millet rice flour (70%): Wheat flour (30%), NS - Non - significant

W_2= Final weight of the sample, g

Protein :

The protein content was determined from the organic nitrogen content by Micro-Kjeldahl method. The KEL PLUS Automatic Nitrogen/Protein Estimation System by Pelican Equipments, Chennai, India, was used for this estimation. The various nitrogenous compounds were converted into ammonium sulphate by boiling with concentrated sulphuric acid. The ammonium sulphate formed was decomposed with an alkali (NaOH) and the ammonia liberated was absorbed in excess of standard solution of acid and then back titrated with standard alkali. The nitrogen value was multiplied by 6.25 to obtain the protein content. The protein content was calculated as:

$$\text{Protein}(\%) = \frac{\text{14 x titre value x normality of HCl}}{\text{Sample weight}} \text{ x 6.25} \quad \text{.....(2)}$$

Fat content :

Fat was estimated as crude ether extract of the dry material. The dry sample (3-5 g) was weighed accurately in a thimble and plugged with cotton. The thimble was then placed in the Automatic Soxhlet Apparatus (make: Pelican Equipments, Chennai) and extracted with anhydrous ether for about 3 h. The ether is then evaporated and the flask with the residue dried in an oven at 80-100°C, cooled in a desiccator and weighed. The fat content was then calculated as:

$$\text{Fat content}(\%) = \frac{\text{Weight of ether extract}}{\text{Weight of sample}} \text{x100} \quad \text{.....(3)}$$

Crude fibre :

Crude fibre content of pasta samples during storage was examined for amount of water, fat and ash content present in the samples during quality analysis of storage period as per the standard method described by AOAC (1980). The data on moisture content were presented in terms of Percentage, which was calculated as:

$$\text{Crude fibre}(\%) = \frac{[100 - \{\text{moisture} + \text{fat}\}]x W_e - W_a}{\text{Wt. of sample taken}} \quad \text{.....(4)}$$

where,

W_e = Pre-weighed ash, g

W_a = Weight of the dish after washing, g

Ash content :

The total ash content was determined by weighing accurately in a previously heated and cooled silica / porcelain dish with about 3-5 g of the samples (AOAC, 1980). The samples were charred carefully on a heater or flame, then heated in a muffle furnace maintained at 525^0- 550^0C for 3 hours or until white ash is obtained. Then the ash content was calculated as mentioned:

$$\text{Ash}(\%) = \frac{W_1}{W2} \text{x100} \quad \text{.....(5)}$$

where,

W_1 = Weight of the sample, g

W_2 = Weight of the residue after ashing, g

Carbohydrate :

The available carbohydrate content in food sample was determined by the method of difference *i.e.*, by subtracting from 100, the sum of values (per 100 g) of moisture, protein, fat, ash and crude fibre.

Statistical analysis :

The data obtained in the present study were analyzed (ANOVA) by using the AGRESS software for the significance level of the dependent and independent variables.

■ RESULTS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads:

Biochemical changes in proso millets based pasta during storage :

Moisture content :

In Table 1, the change in the moisture content samples is tabulated for all the treatments. For samples blended under different ratios of millet and wheat flour (P-f_1, P-f_2, P-f_3 and control), moisture content remained with lower rate of increase for three months of storage without remarkable changes in P-f_1. However, samples packaged in different packaging materials has shown increased trend throughout the storage period but the percentage increase was less in LDPE (5.43 to 7.14 %) as compared to samples with PP (5.43 to 13.25%). Hence, for a

Table 1: Effect of packaging films on moisture content of different proso millet based pasta products during storage

Proso millet formulation	Moisture content (%)							F-test	C.D. @5%	SEd±
	LDPE (200 gauge)				PP (200 gauge)					
	Storage period (months)				Storage period (months)					
	0	1	2	3	1	2	3			
P-f_1	5.83	6.00	6.28	6.70	5.93	6.89	7.66	4.8396	0.52707	0.24191
P-f_2	5.80	6.43	6.47	6.90	6.43	7.57	7.83	5.4685	0.55724	0.25575
P-f_3	5.90	6.00	6.66	7.00	5.98	7.23	7.59	2.0046	0.54249	0.24898
Control	5.43	5.51	6.77	7.14	5.51	10.00	13.25	105.5148	0.65030	0.29846

given storage period, the moisture migration was higher to the pasta stored in the polypropylene package when compared to LDPE. The change in moisture content noticed in the present study are in similarity with the findings observed by many researchers as given by Srirajrajeshwari and Mamatha (1999).

Protein :

The changes in protein content of pasta samples prepared under different treatments during storage packaged in different packaging materials are given in Table 2. Among different treatments followed in the present study, irrespective of the different combination used all the combinations showed marginal change in the protein content during storage as compared to control expressed appreciable change in protein after three months of storage. Ramananthan *et al.* (1975) showed the similar observation in their research study. The samples packaged in both the packaging materials showed interesting protein change behavior during storage, *i.e.* the reduction in protein content of samples stored in LDPE (11.37 to 14.90 %)was almost in similarity with the control samples but the samples stored under PP (11.37 to 10.58%) showed minimum change throughout the storage period.

Fat :

In the present study, a gradual decrease in fat content of all pasta samples irrespective of the combinations followed in the production of pasta observed (Table 3). Even though the rate of decrease was highly not significant in all the samples (Table 3), there was a observable change noticed in the treatment P-f_2, control samples as compared to P-f_1 and P-f_3. The change in the fat content observed in the present study is in correlation with the findings by Ramananthan et al. (1975). The samples packaged in different packaging materials showed maximum reduction in fat content under LDPE P-f_2 and PP P-f_1 treatments with the fat content values of 0.39 and 0.46 per cent, respectively. The overall percentage reduction in LDPE was 0.10 to 0.78 per cent and in PP was 0.10 to 0.77 per cent, thus, showed that the change in fat content does not

Table 2 : Effect of packaging films on protein content of different proso millet based pasta products during storage

Millet formulation	Protein content (%)							F-test	C.D. @5%	SEd±
	LDPE (200 gauge)				PP (200 gauge)					
	Storage period (months)				Storage period (months)					
	0	1	2	3	1	2	3			
P-f_1	11.74	11.68	11.45	11.37	11.73	11.67	10.58	NS	-	0.42609
P-f_2	12.26	12.10	11.82	11.51	12.24	12.19	11.28	NS	-	0.44190
P-f_3	12.44	12.40	12.36	12.21	12.43	12.29	12.21	NS	-	0.45752
Control	14.90	14.70	13.61	12.81	13.98	13.5	12.04	NS	-	0.50344

NS=Non-significant

Table 3 : Effect of packaging films on fat content of different proso millet based pasta products during storage

Millet formulation	Fat content (%)							F-test	C.D. @5%	SEd±
	LDPE (200 gauge)				PP (200 gauge)					
	Storage period (months)				Storage period (months)					
	0	1	2	3	1	2	3			
P-f_1	0.54	0.53	0.52	0.50	0.53	0.48	0.46	NS	-	0.01883
P-f_2	0.60	0.52	0.49	0.39	0.53	0.50	0.50	NS	-	0.01820
P-f_3	0.78	0.77	0.75	0.74	0.77	0.76	0.75	NS	-	0.02811
Control	0.25	0.12	0.10	0.07	0.12	0.10	0.08	NS	-	0.00377

NS=Non-significant

Table 4 : Effect of packaging films on carbohydrates of different proso millet based pasta products during storage

Millet formulation	Carbohydrate content (%)							F-test	C.D. @5%	SEd±
	LDPE (200 gauge)				PP (200 gauge)					
	Storage period (months)				Storage period (months)					
	0	1	2	3	1	2	3			
P-f_1	78.38	78.28	77.23	77.93	78.30	77.45	77.82	NS	-	2.88862
P-f_2	77.67	79.98	75.66	77.45	79.37	78.01	76.42	NS	-	3.03110
P-f_3	77.67	77.28	77.67	77.77	77.13	76.09	76.77	NS	-	2.86357
Control	75.40	75.45	76.03	76.30	77.40	73.13	70.85	NS	-	2.79076

NS=Non-significate

affect the overall quality of pasta over period of three months.

Carbohydrates :

Immediately after production, samples under treatment (P-f_1, P-f_2 and P-f_3) did not show any important changes in carbohydrate, but remarkable change was observed between the control and treatment samples (Table 4). This trend was continued throughout the storage period with very negligible change in carbohydrate value upto three months of storage as compared to control samples. Gopalan *et al.* (2002) and Kulkarni *et al.* (1992) observed similar trend in their research study. Even the samples stored in LDPE and PP showed reduced rate of change in carbohydrate values during storage. Among the three combinations P-f_3, P-f_2 showed best results as compared to P-f_1.

Ash content and crude fibre :

The decimal change in the ash content and crude fibre content of the samples under different treatments are detailed and tabulated in Table 5 and 6, respectively. Since ash content in any product is purely depends on the mineral composition in that product, there was no much variation in ash content of pasta samples prepared under different combinations and packaged in different packaging materials were observed because of lack of change in the mineral proportions during storage period. Also, similar trend was observed in percentage change of crude fibre content in pasta samples throughout the storage. The observations are in correlation with the research findings of several earlier workers (Gopalan *et al.*, 2002; Malleshi and Desikachar, 1985; Kulkarni *et al.*, 1992).

Changes in sensory quality of proso millet based pasta during storage :

Organoleptic evaluation for colour, texture, flavor, taste and overall acceptability of small millets based pasta products was carried out after 3 months of storage. The sensory scores obtained for overall acceptability of different small millet based pasta stored in two packages are given in Table 7. The overall acceptability in case of P-f_1 declined from 7.10 to 6.60. Similarly the reduction in overall acceptability under P-f_2, P-f_3 was 7.40 to 6.98 and

Table 5: Effect of packaging films on ash content of different proso millet based pasta products during storage

Millet formulation	Ash content (%)						
	LDPE (200 gauge)				PP (200 gauge)		
	Storage period (months)				Storage period (months)		
	0	1	2	3	1	2	3
P-f_1	1.30	1.30	1.30	1.30	1.30	1.30	1.30
P-f_2	1.32	1.32	1.32	1.32	1.32	1.32	1.32
P-f_3	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Control	1.46	1.46	1.46	1.46	1.46	1.46	1.46

Table 6 : Effect of packaging films on fibre content of different proso millet based pasta products during storage

Millet formulation	Fibre content (%)						
	LDPE (200 gauge)				PP (200 gauge)		
	Storage period (months)				Storage period (months)		
	0	1	2	3	1	2	3
P-f_1	2.21	2.21	2.20	2.20	2.21	2.21	2.18
P-f_2	2.35	2.35	2.23	2.11	2.35	2.33	2.30
P-f_3	2.45	2.45	2.45	2.40	2.45	2.44	2.44
Control	2.56	2.56	1.44	1.52	2.16	1.97	1.72

Table 7: Sensory scores of proso millet based pasta products before and after storage under different packages

Type of pasta products	Colour			Texture			Flavour			Taste			Overall acceptability		
	Before storage	After storage		Before storage	After storage		Before storage	After storage		Before storage	After storage		Before storage	After storage	
		LDPE	PP		LDPE	PP		LDPE	PP		LDPE	PP		LDPE	PP
P-f_1	6.90	6.80	6.60	7.00	6.57	6.47	7.30	7.10	6.88	7.20	7.15	6.18	7.10	6.98	6.60
P-f_2	7.50	7.30	7.20	7.42	7.06	6.95	7.42	7.32	6.97	7.56	7.40	6.20	7.40	7.00	6.98
P-f_3	7.72	7.54	7.00	7.26	6.00	6.00	7.60	7.00	6.67	7.42	7.34	6.37	7.36	6.80	6.65
Control	7.95	7.80	7.38	7.69	7.20	7.10	7.52	7.49	7.00	7.42	7.00	6.98	7.60	7.37	7.00

7.36 to 6.65, respectively. However, the reduction in sensory scores was slightly more pronounced in the products stored in poly propylene packages as compared to LDPE after three months of storage.

Conclusion :

The present study attempted to improve the shelf-life of proso millet based pasta, prepared with different combinations by packaging interventions. From the results obtained, it was clear that there was a remarkable decrease in moisture, protein, fat and carbohydrates at different rates in all the samples packaged in different packaging materials. Accordingly, there was no much variation in ash and crude fibre during storage with different packaging materials. The product packaged in PP was found to keep good only for 30 days and the main cause of quality loss was more permeability to environment agents. Packaging in LDPE provided a shelf-life up to 3 months with an acceptable maintenance of quality at the end of storage period which was proved through sensory evaluation. Hence, it was concluded that LDPE packed proso millet based pasta (Proso millet + wheat flour @50% each) could be stored at room temperature for 3 months without appreciable quality deterioration.

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