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Studies on Development and Storage of Little Millet Based *Pasta*

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Little millet rich in essential nutrition is the most popular type of millet in India and other parts of the world. The present study was conducted to develop little millet based ready to cook pasta blended with wheat flour at different ratios and estimation of storage stability of the developed pasta product through sensory, physico-chemical and biochemical changes when stored under selected packaging materials. The results showed that, pasta prepared with equal proportions of mhillet and wheat flour got the maximum overall acceptance in the sensory panel. The samples stored in LDPE showed minimum changes in the quality during storage. It is concluded that, pasta could be best preserved up to three months at ambient condition under LDPE without any appreciable quality loss.

Key words: Little millet, extrusion, *pasta*, sensory, quality, packaging, storage

In India, different kinds of traditional foods made from small millet grains form staple diet for many rural and urban households. Number of technologies had 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 unleavened dough of a durum wheat flour mixed with water and formed into sheets or various shapes, then cooked and served with number of dishes. It can be made with flour from other cereals or grains. Eggs may be used instead of water and it is broadly categorized into, dried (pasta secca) and fresh (pasta fresca). Though pasta is a staple food in many countries, they are still considered as snacks in India. Several studies on value addition of different millets have been reported (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.t

Good storage quality of processed food is an essential attribute to extend utilization and the storage quality is evaluated in terms of sensory characters and chemical components. Sowbhagya and Ali (2000) prepared maize vermicelli with and without antioxidant packed in cast polypropylene (CCP) and in a laminated metalized polyester with low density polyethylene (M-PET/PE). The packs were stored at 38ºC and 92% RH (accelerated storage) for 100-140 days. Firmness and elasticity of the 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 the cooking loss was found to be minimum (12%) after three months of storage. Since there are minimum research on the development of pasta like snacks with little millets, their packaging and storage, a study was conducted with the objective to develop extruded ready to cook pasta with different formulations. The study also included different packaging materials for storage. The biochemical quality analyses for fat, protein, carbohydrate, crude fibre, ash and moisture content were carried out at monthly intervals.

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Materials and Methods

Raw material and product formulation

The raw materials used for ready to eat pasta product were dehusked little millet grain and wheat flour procured from local market. A domestic grain pulverizer (make: Anand Associates, Shimoga) was used to mill little millet rice grains into desired particle size suitable for developing cold extruded pasta product. Through preliminary trails, it was confirmed that 70% of millet can be used along with 30% whole wheat flour to produce commercial quality pasta product Similarly, other two combinations were prepared as detailed in Table I.

Preparation of pasta

The millet based pasta products were prepared by following the procedure advocated by the pasta machine manufacturer (especially for hard semolina of durum wheat). The sieved (BS 60 mesh size) flours of millet and wheat were first blended (in the machine itself) for 5 min and then kneaded for about 45 min after adding optimum quantity of water. When the dough characteristic was optimum, it was extruded using appropriate 'dyes' (shanku, ribbed tube, twisted ribbons) under a cold extruder. The cutter speed was

Fig. 1. Ready to cook pasta

set to an 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 min and then dried in a convective hot air oven at 50 °C for about 3 h to obtain translucent pasta. The products were then packed and sealed in two different packaging materials namely, Low Density Poly Ethylene (LDPE-200 gauge) and Polypropylene bags (PP-200 gauge) for storage studies.

Sensory evaluation of cooked little millet based pasta

Masala pasta for sensory evaluation was prepared using the ready to cook pasta (100g) with other ingredients such as vegetables (carrot, beans, tomato, capsicum and chili: 1 cup), onion (1 number), vegetable oil (3 tsp), salt, soy/chili sauce for taste. During preparation, ready to cook pasta was boiled in water for 5 min and excess water was drained out of the bowl. The chopped onion was fried in oil in a frying pan, along with other cut vegetables and cooked in slow fire after the addition of salt and soy / chili sauce. Finally, boiled pasta was mixed well with the materials in frying pan for 2 min and served hot. The same method was followed for all the trials conducted in the present study. The products were evaluated for sensory characteristics by a panel of 10 trained judges. Whole wheat pasta (control) was also prepared in a similar way and presented for sensory evaluation along with 3 combination samples (little millet based) Table 2. The judges scored the sensory quality of cooked pasta based on its colour, texture, taste, flavour and overall acceptability on a nine point hedonic scale (Ranganna, 1997).

Storage of pasta

Storage stability of developed little millet pasta products were studied at ambient conditions by

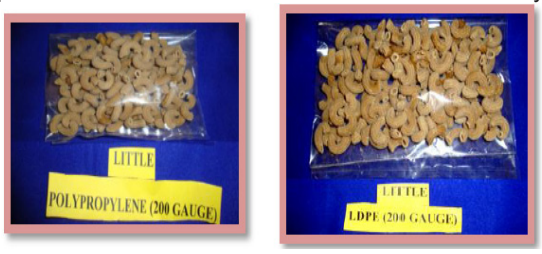

Fig. 2. Storage of millet based *pasta* in different packaging materials

storing them in flexible packages (LDPE and PP) at Bangalore condition (during April-June, 2012) for three months. The stored products were analyzed at monthly intervals for biochemical parameters and moisture content.

Colour

The colour measurement of the pasta was made using a spectrophotometer (Make: Konica Minolta Instrument, Osaka, Japan; Model-CM 5). The samples from each treatment and replication were measured for L* (i.e. [-] to [+] lightness coordinate), a* (i.e. green [-] to red [+] colour space coordinate) and b* (i.e. blue [-] to yellow [+] colour space coordinate). The L*, a* and b* readings were statistically evaluated.

Bio-chemical Analysis

Moisture content

The moisture content was determined by using an electric hot air oven. The samples weighing 5-10 g each were taken in non corrosive metal dishes and weighed (W_1). The samples were then placed in a hot air oven maintained at 105°C for 24 h as suggested by (Hall,1957). After taking out from the oven, the samples were cooled in a desiccator and weighed. The samples were once again kept in the oven, heated for 2 h, cooled and the weight was recorded. This procedure was repeated till a constant weight (W_2) of the sample was attained. The average moisture content of the samples was calculated by using the following equation:

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

Where,
W_1= Initial weight of the sample, g,
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 /p rotein 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

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

Fat content

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. Excess ether was

then evaporated and the flask with the residue was dried in an oven at 80-100°C, cooled in a desiccator and weighed (AOAC, 1990). The fat content was then calculated as:

$$\text{Fat content (\%)} = \frac{\textit{Weight of ether extract}}{\text{Weight of sample}} \text{ X } 100$$

.....(***3***)

Crude fibre

Crude fibre content of pasta samples was analyzed as per the standard method described by AOAC (1980). The data on fibre content was presented in terms of Percentage, which was calculated as,

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

.....(***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 porcelain dish with about 3-5 g of the samples (AOAC, 1980). The samples were charred carefully on a heater or over flame, then heated in a muffle furnace maintained at 525°- 550°C for 3 h or until white ash is obtained. Then the ash content was calculated as given below.

$$\text{Ash (\%)} = \frac{W_1}{W_2} \text{ X } 100$$

.....(***5***)

Where,

W_1 = Weight of the sample in g.

W_2 = Weight of the residue after ashing, g

Carbohydrate

The available carbohydrate content in food sample was determined by the method (FAO, 2003) of difference *i.e.*, by subtracting from 100, the sum of values (per 100 g) of moisture, protein, fat, ash and crude fiber.

Statistical analysis

The data obtained was analyzed (ANOVA) by using the AGRESS software (CRBD) for the significance level of the dependent and independent variables.

Results and Discussion

Colour

The influence of different packages on tri-stimulus colour values (L*, a*, b*) of little millet *pasta* during ambient storage is presented in Table 3. It was observed that the lightness (whiteness) factor L* of little millet *pasta* significantly decreased from initial value of 40.86 to 41.25 and 19.00 respectively in PP and LDPE packages three months. The reduction in L* value of *pasta* was more pronounced in LDPE package than in PP package. The products stored in LDPE became dull with storage duration. The type of package, storage duration and the interaction effect on L* value of *pasta* products were highly significant. Similarly, both a* and b* values of little millet *pasta* products decreased with storage in all the packages indicating the change in colour of the products.

Table 1. Formulation of little millets based *pasta* products

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

Table 2. Mean sensory scores of different little millet based pasta products

Millet formulation	Colour	Texture	Flavor	Taste	Overall acceptability
L-f_1	8.20	7.48	7.02	7.30	7.52
L-f_2	7.50	7.20	7.30	7.30	7.40
L-f_3	7.73	7.58	7.18	6.86	6.78
Control	7.95	7.69	7.52	7.42	7.60
F-test	NS	NS	NS	NS	NS
CD@5%	-	-	-	-	-
SEm±	0.35	0.30	0.33	0.37	0.34

L-f_1 - Little millet flour (50%): Wheat flour (50%)
L-f_2 - Little millet flour (60%): Wheat flour (40%)
L-f_3 - Little millet flour (70%): Wheat flour (30%)
NS - Non significant

Table 3. Effect of storage on Tristimulus Colour Values of little millet based *pasta* stored in various packaging films

Packaging material	Storage duration (month)	Mean tri-stimulus colour values		
		L*	a*	b*
PP	0	40.86	5.18	17.20
	1	26.09	4.72	11.29
	2	40.72	5.94	13.74
	3	41.25	5.85	12.59
LDPE	0	40.86	5.36	17.20
	1	29.92	3.71	13.67
	2	21.90	2.00	3.47
	3	19.00	1.29	3.38
Packaging (P)	F-Test	**	**	**
	SeM±	0.415	0.25	0.168
	CD @5%	1.25	0.76	0.50
	CD @1%	1.73	1.05	0.69
Storage duration (D)	F-Test	**	NS	**
	SeM±	0.593	0.13	0.238
	CD @5%	1.78125	-	0.71
	CD @1%	2.45426	-	0.98
P X D	F-Test	**	*	**
	SeM±	0.833	0.511	0.33
	CD @5%	2.51907	1.53	1.00
	CD @1%	3.47084	-	1.39

LDPE - Low density poly ethylene
PP - Poly propylene

Biochemical changes in little millets based pasta during storage

Moisture content

In Table 4, the change in the moisture content of samples is presented. For samples blended under different ratios of millet and wheat flour (L-f L-f L-f and control), moisture content increased during the three month storage in all the treatments, but slightly in L-f. The samples packaged in different packaging materials also showed increased moisture throughout the period of storage, but the rate of increase was less in LDPE (4.49 to 5.69 %) as compared to samples with PP, which showed the rate of increase of 19.7% during the storage period. Hence, for a given period of storage, the moisture migration was higher to the pasta stored in polypropylene package when compared to LDPE. The change in moisture content noticed in the present study was in similarity with the findings of Srirajrajeshwari and Mamatha (1999).

Table 4. Effect of packaging films on moisture content of different little millet based pasta products during storage

Millet formulation	Moisture content (%)							F-test	CD @5%	SEd±
	LDPE (200 gauge)				PP (200 gauge)					
	Storage period (months)				Storage period (months)					
	0	1	2	3	1	2	3			
L-f_1	4.45	4.65	5.85	5.05	3.85	6.76	9.63	NS	-	0.22059
L-f_2	4.78	4.90	6.42	6.71	3.93	6.90	11.76	NS	-	0.25075
L-f_3	5.03	5.65	6.70	6.98	3.12	7.92	12.55	NS	-	0.26774
Control	5.43	5.51	6.77	7.14	5.51	10.0	13.24	NS	-	0.29840

Table 5. Effect of packaging films on protein content of different little millet based *pasta* products during storage

Millet formulation	Protein content (%)							F-test	CD @5%	SEd±
	LDPE (200 gauge)				PP (200 gauge)					
	Storage period (months)				Storage period (months)					
	0	1	2	3	1	2	3			
L-f_1	12.54	12.38	12.01	11.64	12.18	12.02	11.86	NS	-	0.44649
L-f_2	12.13	12.08	11.91	11.46	12.03	11.91	11.46	NS	-	0.43946
L-f_3	12.28	12.19	12.08	11.68	12.11	11.96	11.74	NS	-	0.44470
Control	14.90	14.70	13.61	12.81	13.98	13.5	12.04	NS	-	0.50344

Protein

The changes in protein content of pasta samples prepared under different treatments during storage packaged in different packaging materials are given in Table 6. Among different treatments, all the combinations showed marginal change in the protein content during storage as compared to control. Ramananthan *et al*. (1975) has shown the similar observation in their study. But, the rate of change in the protein was less in treatment Lf as compared to other two treatments. The samples packaged in both the packaging materials showed protein change during storage, i.e. the reduction in protein content of samples stored in LDPE-200 guage (12.54 to 11.64 %) was less than that of control samples while, the samples stored under PP-200 guage (12.18 to 11.86%) showed minimum change throughout the storage period. Though the thickness of both the packaging materials used for the study was identical (200 gauge), the difference in the protein content of samples might be due to higher permeability factor of the LDPE (O_2: 250-350cc*mil/100in^2*day*atm, WVTR:0.175 cc/100in^2*day*atm @38°C, 90%RH) as

Table 6. Effect of packaging films on fat content of different little millet based pasta products during storage

Millet formulation	Fat content (%)							F-test	CD @5%	SEd±
	LDPE (200 gauge)				PP (200 gauge)					
	Storage period (months)				Storage period (months)					
	0	1	2	3	1	2	3			
L-f_1	0.36	0.29	0.24	0.21	0.29	0.29	0.28	NS	-	0.00993
L-f_2	0.33	0.28	0.25	0.20	0.27	0.26	0.25	NS	-	0.00665
L-f_3	0.32	0.28	0.24	0.18	0.28	0.27	0.27	NS	-	0.00946
Control	0.25	0.12	0.10	0.07	0.12	0.10	0.08	NS	-	0.00377

compared to PP (O_2 : 150 250cc*mil/100in^2*day*atm, WVTR:0.080 cc/100in^2*day*atm @38°C, 90%RH) (Kay Cooksey, 2004).

Fat

A gradual decrease in fat content of all pasta samples was observed irrespective of the combinations followed in the production of pasta (Table 6). Even though the rate of decrease was not highly significant in all the samples, there was an observable change noticed in the treatment L-f packaged under PP during the storage period as compared to control samples L-f and L-f . The change in the fat content observed in the present study was

Table 7. Effect of packaging films on carbohydrates of different little millet based pasta products during storage

Millet formulation	Carbohydrate content (%)							F-test	CD @5%	SEd±
	LDPE (200 gauge)				PP (200 gauge)					
	Storage period (months)				Storage period (months)					
	0	1	2	3	1	2	3			
L-f_1	79.93	79.87	78.88	78.34	81.06	76.63	74.75	NS	-	2.91505
L-f_2	76.43	76.18	77.96	77.45	76.38	76.21	75.92	NS	-	2.84930
L-f_3	76.12	76.01	75.73	75.55	76.03	75.96	76.13	NS	-	2.81672
Control	75.40	75.45	76.03	76.30	77.40	73.13	70.85	NS	-	2.79076

in correlation with the findings of Ramananthan *et al*. (1975). Among the samples packaged in different packaging materials, the maximum reduction in fat content was noticed in LDPE L-f treatment (0.18 after 3 months). The overall percentage reduction in fat content of samples were much lower than that

Table 8. Effect of packaging films on ash content of different little 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
L-f_1	1.27	1.27	1.27	1.25	1.27	1.25	1.25
L-f_2	1.31	1.31	1.30	1.30	1.20	1.19	1.17
L-f_3	1.28	1.27	1.27	1.26	1.28	1.28	1.27
Control	1.46	1.45	1.44	1.44	1.46	1.46	1.45

of control, This variation could be due to addition of little millet which would have reduced the reaction rate during the storage period

Carbohydrates

Immediately after production, samples under treatment (L-f_1, L-f_2 and L-f_3) did not show any

Table 9. Effect of packaging films on fibre content of different little 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
L-f_1	1.45	1.44	1.42	1.39	1.45	1.45	1.44
L-f_2	1.43	1.43	1.42	1.41	1.43	1.43	1.42
L-f_3	1.45	1.44	1.44	1.43	1.45	1.44	1.42
Control	2.56	2.56	1.44	1.52	2.16	1.97	1.72

noticeable changes in carbohydrate content, but remarkable change was observed between the control and treatment samples (Table7). This trend was continued throughout the storage period with negligible change in carbohydrate content upto three months of storage as compared to control. Gopalan

Table 10. Sensory scores of little millet based *pasta* products before and after storage under different packages

Type of pasta product	Colour			Texture			Flavor			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
L-f_1	8.20	7.00	7.00	7.48	6.80	7.00	7.02	6.10	7.00	7.30	7.10	6.80	7.52	7.20	7.00
L-f_2	7.50	7.00	7.30	7.20	6.60	6.70	7.30	6.10	7.10	7.30	7.00	6.90	7.40	7.10	6.90
L-f_3	7.30	7.10	7.20	7.58	6.80	6.80	7.18	6.00	6.90	6.86	6.90	6.50	6.78	6.50	6.40
Control	7.95	7.00	7.00	7.69	7.20	7.20	7.52	7.10	7.10	7.42	7.05	7.05	7.62	7.40	7.40

et al. (2002) and Kulkarni *et al*. (1992) observed similar trend in their study. The sample stored in LDPE and PP has showed reduced rate of change in carbohydrate values during storage. Among the three combinations L-f_1, L-f_2 has showed the best results as compared to L-f_3.

Ash content and crude fibre

The change in the ash content and crude fibre of the samples under different treatments are tabulated in Table 8 and 9, respectively. Since ash content in any product 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 containers. Also, similar trend was observed in percentage change of crude fibre content in pasta samples throughout the storage. The observations were in correlation with the research findings of several workers (Gopalan et al., 2002; Malleshi and Desikachar, 1985 and Kulkarni et al., 1992).

Changes in sensory quality of little millet based pasta during storage

Organoleptic evaluation for colour, texture, flavour, 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 10.Overall acceptability in case of L-f declined from 7.52 to 7.00. Similarly, the reduction in overall acceptability under L-f , L-f was 7.40 to 6.90 and 6.70 to 6.40 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 study was conducted to develop little millet based ready to eat snack product. Attempts were also made to improve the shelf life of little millet based pasta, prepared with different combinations with packaging interventions Among the three different treatments, Lf was found to be the best followed by Lf and Lf in terms of quality and sensory parameters. As per the observed results, it was clear that a remarkable decrease occurred in moisture, protein, fat and carbohydrate contents at different rates in all the samples packaged in different packaging materials. There was no much variation in ash and crude fibre during storage with different packaging materials. Samples packaged in PP could be able to retain their sensory properties only for 30 days and the main cause of quality loss was more permeability to gas, light and water vapour. However, samples packaged in LDPE provided a shelf life up to 3 months with an acceptable Quality. Hence, it is concluded that LDPE packed little millet based pasta (little millet + wheat flour @ 50% each) could be stored at room temperature for 3 months without appreciable quality deterioration.

References

AOAC International, 1980. Official Methods of Analysis. 13th edition,Association of Official Analytical Chemists, Washington, DC

Begum, M.J., Vijayakumari, J., Shamshad Begum, S. and Anupama, P. 2003. Sensory quality and storage quality of finger millet papad-A conventional dietary adjunct. Paper presented in the 5th *International Food Convention,* Mysore, 5-December, pp.76.

Devaraju, B., Mushtari Begum, J., Shamshad Begum, S. and Vidya, K. 2003. Nutritional quality, sensory attributes and storage study of finger millet *(Eleusine coracana)* composite flour *pasta*. Paper presented at the *5th International Food Convention,* Mysore, 5-8 December, pp.116.

FAO, 2003. Food energy – methods of analysis and conversion factors. 58.

Gopalan, C., Ramasastri, B.V. and Balasubramanian, S.C. 2002. Nutritive Value of Indian Foods. National Institute of Nutrition (ICMR), Hyderabad, pp. 47.

Hall, C.W. 1957. Drying farm crops. Agricultural consulting Associates, Inc., Engineering Specialists, Reynolds burg, Ohio.

Kay Cooksey, 2004. Flexible Packaging Conference. Clemson University, Clemson, SC. pp. 11.

Kulkarni, L.R., Naik, R.K. and Katarki, P.A. 1992. Chemical composition of minor millets. *Karnataka J. Agric. Sci.,* **5** : 255- 258.

Malleshi, N.G. and Desikachar, H.S.R. 1985. Milling, popping and malting characteristics of some minor millets. *J. Food Sci. Technol*., **22**: 400-403.

Purseglove, J.W. 1972. Tropical Crops: Monocotyledons. Longman Group Limited edition, Londres, London, pp. 334-336.

Ramanathan, K., Monterio, V.P. and Gopal, H.D. 1975. Chemical composition and in-vitro protein digestibility of Italian millet (*Setaria italica*). *Food Chemistry.*, **29**:19-26.

Ranganna, S. 1997. Manual of analysis and quality control for fruit and vegetable products. Tata McGraw-Hill Publishing Company Limited, New Delhi.

Sowbhagya, C.M. and Ali, S.Z. 2001. Vermicelli noodles and their quality assessment. *J. Food Sci. and Technol*., **38** :423-432.

Srirajrajeshwari, H. and Mamatha, K. 1999. Jack fruit seeds: Composition, functionality and use in product formulation. *Indian J. Nutr. Diet.*, **36** :312-319.

Vaidhi, M.P., Bharati, P. and Reddy, L. 1985, High protein biscuits made with *ragi* and oilseed flour blends. *Food and Nutrition Bulletin,* **7** : 61-64.

Veena, B., Chimmad, B.V., Naik, R.K. and Shantakumar, G. 2004, Development of barnyard millet based traditional foods. *Karnataka J. Agril. Sci*., **17** : 522-527.

Viraktamath, C.S., Raghavendra, G. and Desikachar, H.S.R. 1971, Use of milling machinery for commercial pearling of grain sorghum (Jowar) and culinary uses for pearled sorghum products. *J. Food Sci. and Technol.,* **8** : 11-13.

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