Development of Little Millet (*Panicum sumatrense*) Substituted Biscuits and Characterization of Packaging Requirements

G. Hemalatha, S. Amutha[1], D. Malathi[2], P. Vivekanadan[3] and G. Rajannan[4]

Department of Food Science and Nutrition
Home Science College and Research Institute
Tamil Nadu Agricultural University
Madurai - 625 104, Tamil Nadu, India.

ABSTRACT. *Biscuits from little millet (Panicum sumatrense) or samai were manufactured by substituting little millet at various levels of substitution (10-50%). Highly acceptable biscuits (comparing with the control) could be obtained by incorporating 30% millet flour in the biscuit formulations. Physical characteristics revealed a lower spread ratio and spread factor in the millet substituted biscuits compared to the control. The millet substituted biscuits recorded significantly higher levels of ash, calcium, phosphorus, iron, thiamine, riboflavin and fiber. Equilibrium relative humidity studies were carried out to standardize packaging requirements for the millet substituted biscuits. Moisture sorption studies of the biscuits substituted at 10, 20 and 30% levels indicated that a moisture content of 6.14, 6.57 and 7.04%, respectively equilibrated to 65% RH at 27^{0}C was critical with respect to the storage stability of the product compared to 6.10% in the control biscuits. From the data on the moisture sorption characteristics, metallised polyester polyethylene laminated pouches were selected for packing the biscuits and conduct of storage studies. Storage studies revealed an increase in acidity and moisture during storage for 120 days under ambient conditions. At the end of the storage period, the moisture content of the millet substituted biscuits (30%) were higher (4.04%) than control biscuits (3.82%) but was well within the critical moisture content indicating that the millet based biscuits had good storage stability.*

INTRODUCTION

Supplementation of non-wheat cereals in bakery products is becoming increasingly popular due to various nutritional and economic advantages. Millets are an important non-traditional ingredient which could provide required nutritional values and health benefits as well as improve consumer appeal. Most of the composite flour research on value addition was carried out in sorghum and very little on minor millets (Dendy, 1992). Among the minor millets, little millet (*Panicum sumatrense*) known as samai (in Tamil) and Kutki (in Hindi) is nutritionally superior to rice and to wheat and is grouped under nutritious cereals (Seetharama and Rao, 2004). Little millet is a cheap source of energy, protein, vitamin B, fiber and minerals, and particularly rich in iron, reported to be 9.30 mg/100g compared to 0.7 mg/100g in raw rice (Gopalan *et al.*, 2002). Srivastava *et al.* (2002) developed biscuits

---

1 Professor, Department of Food Science and Nutrition, HSC and RI, TNAU, Madurai, TN, India.

2 Professor, Post Harvest Technology Centre, TNAU, Coimbatore, Tamil Nadu, India.

3 Dean, Agricultural College and Research Institute, TNAU, Killikulam, Tamil Nadu, India.

4 Professor, Department of Environmental Science, TNAU, Coimbatore, Tamil Nadu, India.

by incorporating 40% finger millet/barnyard millet which were as acceptable as wheat biscuits.

In the present study, little millet was used in the preparation of biscuits at various levels of substitution and compared with wheat flour based biscuits as standard in terms of physical properties, sensory characteristics and chemical composition. In the study of the storage quality of biscuits, Equilibrium Relative Humidity (ERH) is an important control variable wherein moisture sorption has a direct effect upon chemical reactions and proliferation of microorganisms. Hence ERH studies were conducted on control biscuits and little millet flour supplemented biscuits as it would provide valuable information to standardize storage and packaging requirements.

MATERIALS AND METHODS

Little millet, variety CO 2 was obtained from Millet Breeding Station, Tamil Nadu Agricultural University, Coimbatore. The millet was milled using a Satake grain testing mill (Type THU 35 A) and polished for 120 seconds. The milled samples were pulverized in a commercial mill and the flour was sieved to pass through a BS 60 mesh sieve with flour particle size ranging between 125 and 250 microns. It was then heated at 60^0C for 2 h, allowed to cool and blended with refined wheat flour at substitution levels of 10, 20, 30, 40 and 50%. The little millet substituted composite flour mixes were used for the preparation of biscuits as per standard procedures.

The biscuit formulations at various substitution levels (0, 10, 20, 30, 40 and 50%) with little millet were sieved with 0.5% baking powder. Fat (50%) and powdered sugar (50%) were creamed, blended with the flour and made to dough, sheeted, punched manually into circular shapes, baked in preheated oven at 140^0C for 30 min. allowed to cool and evaluated.

The biscuits were subjected to sensory evaluation using a panel of 20 semi trained judges using a score card with 9 point hedonic scale (Amerine *et al*., 1965). The 9 point hedonic rating scale had sensory scores ranging from 9.0 to 1.0 with maximum scores assigned to each sensory attribute ranking from like extremely (9.0) to dislike extremely (1.0). The little millet substituted biscuits at 30% level of substitution were highly acceptable. The biscuits were assessed for physical characteristics viz., bulk density (weight /volume), spread ratio and spread factor. The spread ratio and spread factor were calculated using the formula given by Awasthi *et al.* (1999).

$$\text{Spread ratio (SR)} = \frac{\text{Width (cm)}}{\text{Thickness (cm)}}$$

$$\text{Spread factor} = \frac{\text{SR of products prepared from millet blends}}{\text{SR of products prepared from control}} \times 100$$

Protein, fat, crude fiber, ash, calcium, phosphorus, iron, thiamine, riboflavin, phytate and tannin content were evaluated by following the standardized procedures (AACC, 2000). ERH studies of biscuits were conducted by Wink's weight equilibrium method (Wink, 1946), while the method specified by Hall (1950) was adopted for selection of packaging materials. Known weight of samples were exposed to different relative humidity (10-90% RH) using sulphuric acid solutions of varying normalities as specified by Landrock and Proctor (1951) to obtain the required RH. Change in weight and moisture content were recorded every 24 h till a constant weight was obtained. The study was concluded after deduction of mould growth. The number of days to attain equilibrium was noted and Equilibrium Moisture Content (EMC) was calculated under different RH.

Moisture crispness relationship of the products was determined by keeping the products at 65% RH at 27^0C as per the prescribed Indian Standards condition (ISI, 1966) and crispness quality of the products were judged at different moisture levels. Equilibrium moisture curves were drawn using the data. The initial moisture content of the product (I), critical point (C), the stage at which the products became soft and danger point (D), the point that was 5% lower RH than the critical point was noted on the graph for each product. Permissible uptake of moisture by the product was calculated as the difference between D and I. Water vapour permeability value of the packaging material was calculated as per the formula given by Hall (1950).

Based on the moisture sorption characteristics of the biscuits, suitable packaging material was chosen to pack the biscuits and the change in acid value and moisture content was evaluated periodically at 30 days interval during a storage period of 120 days.

The data was subjected to statistical analysis using the factorial completely randomized design as per the method described by Gomez and Gomez (1984) with triplicate number of samples.

RESULTS AND DISCUSSION

Physical characteristics of biscuits

Data on bulk density and spread ratio of the control biscuits and the little millet flour substituted biscuits is presented in Table 1. The bulk density, diameter, thickness, spread ratio and spread factor of the millet substituted biscuits differed significantly as was revealed by the statistical analysis of the data. Bulk density which is an important index of good baking quality increased with increase in proportion of millet flour. The bulk density (weight/volume) of the control biscuits was 0.62 g/ml while the bulk density was observed to increase to 0.63 g/ml for millet substituted biscuits at 10 and 20% level and to 0.64 g/ml at 30% level. On examination of the biscuit dimensions, the diameter, spread ratio and spread factor decreased significantly ($P<0.01$) with increase in the level of substitution of little millet flour and an increasing trend was observed in terms of biscuit thickness, the value being 6.5 mm for the control and 6.8, 7.2 and 7.5 mm for the millet substituted biscuits at 10, 20 and 30% levels respectively. Spread ratio was maximum in control biscuits (6.69) followed by biscuits substituted at 10 (6.29), 20 (5.85) and 30% (5.55) levels of little millet flour. While the control biscuits had a spread factor of 100%, the millet substituted biscuits (10-30%) had a spread factor ranging from 94.0 to 82.9%. Chavan and Kadam (1993) reported that excessive starch damage during milling of millets caused deleterious effect on the spread ratio of biscuits and cookies. Awasthi *et al.* (1999) observed similar decrease in spread ratio in soy flour supplemented biscuits.

Table 1. Bulk density and spread ratio biscuits.

Substitution of little millet flour (%)	Bulk density (g/ml) (± SE)	Biscuit dimension			
		Diameter (mm) (± SE)	Thickness (mm) (± SE)	Spread ratio (± SE)	Spread factor (%) (± SE)
0	0.62 (0.0036)	43.50 (0.2510)	6.50 (0.0370)	6.69 (0.0380)	100.00 (0.5770)
10	0.63 (0.0036)	42.80 (0.2470)	6.80 (0.0390)	6.29 (0.0360)	94.00 (0.5420)
20	0.63 (0.0036)	42.10 (0.2430)	7.20 (0.0410)	5.85 (0.0330)	87.40 (0.5040)
30	0.64 (0.0036)	41.60 (0.2400)	7.50 (0.0430)	5.55 (0.0320)	82.90 (0.4780)
SD	0.0051	0.3471	0.0572	0.0499	0.7455
CD at 1%	0.0173**	1.1646**	0.1921**	0.1674**	2.5015**

Note: SD - Standard Deviation; SE - Standard Error; CD - Critical Difference; ** Significant at 1 % level.

Chemical constituents of biscuits

The data on to the chemical constituents of the control and millet substituted biscuits are presented in Table 2.

Table 2. Chemical constituents of little millet substituted biscuits.

Constituents (100g)	Control	Little millet substitution (%)			SD	CD at 1%
		10	20	30		
Protein (g)	7.39	7.30	7.28	7.23	0.00215	0.00559**
Ash (g)	1.01	1.16	1.35	1.52	0.00167	0.00447**
Fibre (g)	0.36	0.71	1.04	1.40	0.00167	0.00447**
Calcium (mg)	18.60	20.1	23.30	25.80	0.01361	0.03651**
Phosphorus (mg)	105.00	124	131.00	150.00	0.11785	0.31615**
Iron (mg)	1.61	2.50	3.30	4.21	0.07801	0.20926**
Thiamine (mg)	0.18	0.32	0.36	0.39	0.00167	0.00447**
Riboflavin (mg)	0.18	0.20	0.22	0.23	0.00136	0.00365**
Phytate (mg)	15.00	16.0	18.00	19.00	0.01416	0.03800**
Tannin (mg)	14.00	15.0	16.00	18.00	0.01361	0.03651**

Note: SD - Standard Deviation; CD - Critical Difference; ** Significant at 1 % level.

The protein content of the little millet substituted biscuits corresponding to 10, 20 and 30% level of incorporation were 7.30, 7.28 and 7.23% compared to the control samples which recorded a maximum value of 7.39%. Srivastava *et al. (*2002) also reported higher protein content in control biscuits (7.84%) compared to 6.82 and 5.97% in barnyard and finger millet biscuit, respectively. A gradual increase in ash and fiber content was noticed with increasing levels of millet flour incorporation. The ash and fiber content of the biscuits containing 30% of millet flour was 1.52 and 1.40% compared to 1.01 and 0.36, respectively in the control.

A similar trend was noticed in terms of calcium, phosphorus and iron levels. The corresponding figures in the control biscuits were 18.6, 105.0 and 1.61 mg/100g and maximum levels (25.8, 150.0 and 4.21 mg/100g) respectively were observed in the biscuits containing 30% of millet flour. A significant increase in iron levels were noticed indicating that utilization of little millet flour would enhance the mineral content of the product and could serve as a source of essential micronutrients. Swamy *et al*. (2003) reported an iron content of 4 mg/100g in finger millet substituted biscuits.

Thiamine levels of the biscuits increased significantly (P=0.0045) with increase in level of substitution of little millet flour. The thiamine levels of control biscuits were 0.18 mg and 0.32, 0.36 and 0.39 mg/100g, respectively in the little millet flour added biscuits with 10, 20 and 30% substitution. The corresponding values for riboflavin were 0.20, 0.22 and 0.23 mg/100g, respectively and minimum values of 0.18 mg/100g were observed in the control biscuits. The differences in riboflavin levels at the different levels of millet substitution were highly significant (P=0.0037).

The millet flour substituted biscuits recorded significantly higher (P<0.01) phytate and tannin levels compared to the control. The phytate and tannin content of the control biscuits was 15 and 14 mg/100, respectively while the biscuits substituted with little millet flour (10-30%) recorded a phytate content ranging from 16 to 19 mg/100g. The corresponding values for tannin content ranged between 15 to 18 mg/100g.

Sensory evaluation

The result of the sensory evaluation of the biscuits is presented in Table 3.

Table 3. Sensory characteristics of little millet enriched biscuits.

Sensory attributes	Little millet substitution (%)				P	F value
	0	10	20	30		
Color and appearance	8.48	8.48	8.50	8.52		
Taste	8.51	8.51	8.53	8.55		
Texture	8.61	8.60	8.58	8.57	0.9378	3.2388**
Flavor	8.63	8.64	8.66	8.67		
Overall acceptability	8.35	8.42	8.43	8.45		

Note: ** Significant at 1 % level.

From Table 3, it can be inferred that the little millet flour substituted biscuits (30%) recorded significantly high sensory scores in terms of color and appearance (8.52), taste (8.55), flavor (8.67) and overall acceptability (8.45) compared to the control, which recorded 8.48, 8.51, 8.63 and 8.35 for the respective sensory attributes on a 9 point hedonic rating scale. However, the scores for texture was lower in the millet substituted biscuits at 10, 20 and 30% levels of incorporation the scores being 8.60, 8.58 and 8.57, respectively compared to the control which recorded maximum score of 8.61. Above 30% level of substitution with millet flour, the sensory scores decreased gradually. This could be attributed to the slight tongue coating experienced on increasing millet flour substitution above 30% level. Swamy *et al.* (2003) reported a sensory score of 7.8 to 8.3 for a maximum score of 9 for cookies substituted with 20% finger millet flour and stated that highly attractive and flavored product could be obtained by using minor millets in cookies.

Equilibrium moisture content

The data pertaining to equilibrium moisture content of the biscuits at different RH are given Table 4.

Table 4. Equilibrium moisture content of biscuits substituted with little millet.

Relative humidity (%)	Control (± SE)	Equilibrium moisture content of little millet substituted biscuits (%) (± SE)		
		10	20	30
10	2.92 (0.016)	3.15 (0.018)	3.15 (0.018)	3.20 (0.018)
20	3.19 (0.018)	3.41 (0.019)	3.37 (0.019)	3.49 (0.020)
30	3.89 (0.022)	3.30 (0.019)	4.49 (0.025)	4.58 (0.026)
40	3.97 (0.022)	4.36 (0.025)	4.55 (0.026)	4.74 (0.027)
50	4.95 (0.028)	5.31 (0.030)	5.42 (0.031)	5.62 (0.032)
60	6.66 (0.038)	7.11 (0.040)	7.30 (0.042)	7.63 (0.044)
70	9.74 (0.056)	10.05 (0.058)	10.25 (0.059)	10.29 (0.059)
80	10.85 (0.062)	11.77 (0.067)	11.99 (0.069)	12.20 (0.070)
90	14.25 (0.082)	14.92 (0.086)	14.95 (0.086)	15.10 (0.087)

Note: SE - Standard Error.

It was observed that in the control, the biscuits equilibrated to 10, 20, 30 and 40% RH were crisp and had lower EMC values ranging from 2.92 to 3.97%, compared to the little millet biscuits. The EMC indicated an increasing trend with increase in level of millet incorporation, the comparative figures for the biscuits made from little millet flour blends at 30% level of incorporation ranging 3.20 and 4.74%. However, the crispness quality remained unchanged. When equilibrated to 50% RH, the products became slightly crisp. The biscuits became soft and unacceptable when the EMC for the control increased beyond 6.66% at 60% RH. The millet blended biscuits at a RH of 60% had higher levels of EMC, the values ranging from 7.11 to 7.63% for biscuits blended with little millet flour at different levels (10-30%). At higher levels of RH, the EMC of biscuits further increased and the biscuits became soggy, and mould growth was noted in the control. The EMC, being higher in the millet substituted biscuits could also be attributed to the higher starch content in the millet added composite flour compared to the control. Gunjal *et al.* (1987) made similar observations wherein at a given temperature and relative humidity, corn flour having a higher starch content had higher sorptive capacity compared to rice flour.

There was no difference in terms of the number of days to attain EMC in both the control and the millet substituted biscuits. At 10 and 20% RH, the biscuits attained its equilibrium on the 18th and 19th day, respectively whereas at 30, 40, 50, 60 and 70% RH it took 22, 23, 24, 25 and 25 days, respectively to attain the equilibrium. At 80% RH, the mould growth developed on the 17th day for the control, while the mould growth was observed on the 18th day for millet substituted biscuits. At 90% RH, equilibrium was attained on the 10th day and mould growth was observed in both the control and millet substituted biscuits. Selvaraj *et al.* (1995) reported similar results on sorption studies carried out on cake premix wherein at 75% RH and above, the product became lumpy and developed mould growth within 15 days.

Packaging requirements of biscuits

The data prerequisite for the selection of the packaging material best suited to pack the biscuits are presented in Table 5.

Table 5. Packaging requirements for little millet flour substituted biscuits.

Substitution of millet (%)	Initial moisture (%) (± SE)	Critical moisture (%) (± SE)	Moisture danger point (%) (± SE)	Permissible moisture uptake (%) (± SE)	Water vapor permeability value (cc/cm^2/sec/cm of Hg) (± SE)
0	3.48 (0.020)	6.10 (0.035)	5.20 (0.032)	1.72 (0.009)	23 x 10^{-8} (0.132)
10	3.85 (0.022)	6.14 (0.034)	5.60 (0.032)	1.75 (0.010)	23 x 10^{-8} (0.138)
20	3.90 (0.022)	6.57 (0.037)	5.70 (0.032)	1.80 (0.010)	24 x 10^{-8} (0.138)
30	4.03 (0.023)	7.04 (0.040)	6.00 (0.034)	1.97 (0.011)	26 x 10^{-8} (0.150)

Note: SE - Standard Error.

From the sorption studies, it was inferred that a moisture content of 6.10% equilibrating to 65% RH at 27^{0}C is critical for the control biscuits at which stage the products becomes soft. The comparative values for the little millet flour substituted biscuits increased with increase in level of millet incorporation. The critical moisture at which stage the products became soft (Wink, 1946) ranged from 6.14 to 7.04% for the biscuits substituted with little millet flour at 10 to 30% levels of substitution. Similar results were obtained by Balasubramanyam *et al.* (1981), reported that a moisture content of more than 7.0% was critical with respect to loss of crispness in salt biscuits. Moisture at danger point was 5.2% for the control and was slightly higher, ranging from 5.6 to 6.0% for the biscuits substituted with little millet flour.

Further, the results suggested that the permissible moisture uptake to maintain crispness for the control biscuits was 1.72% while the comparative figures for the biscuits substituted with little millet flour at 10, 20 and 30% levels were 1.75, 1.80 and 1.97%, respectively. This indicates that the higher fiber content provides a better safety range in terms of moisture uptake in maintaining crispness and quality.

The water vapor permissibility was 23 x 10^{-8} cc/cm^2/sec/cm of Hg for control biscuits, and ranged from 23 to 26 x 10^{-8} for the biscuits substituted with little millet flour at 10 to 30% levels of incorporation. Landrock and Proctor (1951) recommended high density polyethylene (HDP), Saran film or laminate of HDP with aluminum or regenerated cellulose as packaging material for this range of water vapor permissibility.

Selvaraj *et al*. (2002) made similar observations on sorption studies carried out on finger millet substituted biscuits at 20% level and a moisture content of 5.0% and above was critical with respect to loss of crispness in both the control and finger millet substituted biscuits. Similar values (<5.1%) were observed in the present study for loss of crispness in the little millet substituted biscuits compared to 4.9% recorded for the control. Further, biscuits containing little millet flour and the control were observed to have similar sorption characteristics and equal to moisture content of 5.0% ISI (1992) specification for biscuits. Based on the above findings and related studies, metallised polyester polyethylene laminated pouches were chosen for packing the biscuits and for conducting the storage study.

Storage study

Table 6. Changes in acidity and moisture (%) of biscuits during storage.

Storage	Control	Substitution of little millet flour (%)		
		10	20	30
0	0.75 (3.45)	0.75 (3.48)	0.77 (3.53)	0.78 (3.71)
30	0.83 (3.49)	0.85 (3.50)	0.87 (3.56)	0.89 (3.75)
60	0.89 (3.63)	0.91 (3.62)	0.93 (3.68)	0.94 (3.80)
90	0.94 (3.70)	0.94 (3.71)	0.99 (3.79)	1.01 (3.94)
120	0.97 (3.82)	0.98 (3.84)	1.03 (3.88)	1.08 (4.04)
	S	**T**	**S x T**	
SD	0.0037	0.0033	0.0074	
CD	0.0100**	0.0089**	0.0200**	

Note: Values in parenthesis indicate moisture; SD - Standard Deviation; CD - Critical Difference; ** Significant at 1% level; S x T - Interaction between storage (S) and treatment (T).

From Table 6, it can be inferred that the acid value and moisture content increased during storage of the biscuits. In the control biscuit there was a significant increase (P=0.01) in acidity by 0.22% from 0.75 to 0.97% after 120 days of storage. The increase in acidity in the millet substituted biscuits were slightly higher recording an increase of 0.23, 0.26, and 0.30% from an initial level of 0.75, 0.77 and 0.78% corresponding to 10, 20 and 30% levels of substitution with little millet flour.

A similar trend was noticed in terms of moisture pick up during storage. The moisture content of the control biscuit was 3.45% while moisture content of the little millet flour substituted biscuits corresponding to 10, 20 and 30% levels of incorporation were 3.48, 3.53 and 3.71%, respectively and after 120 days of storage, there was an increase to 3.84, 3.88 and 4.04%, respectively. Slightly lower values (3.82%) were recorded in the control. Selvaraj *et al*. (2002) reported a critical moisture of 5.0% in finger millet substituted biscuits after 140 days storage.

CONCLUSIONS

Physical characteristics revealed a lower spread ratio and spread factor in the millet substituted biscuits compared to the control. The spread factor of the millet substituted biscuits was 82.9% compared to a spread factor of 100% in the control biscuits. Significantly high ash, calcium, phosphorus, iron, thiamine, riboflavin and fiber content were observed in the millet added biscuits compared to the control. The iron content in the millet substituted biscuits (30%) was 4.21% compared to 1.61% in the control. Sensory evaluation using a nine point hedonic rating scale revealed that the millet substituted biscuits (30%) were highly acceptable in terms of color and appearance (8.52), taste (8.55), flavor (8.67) and overall acceptability (8.45). The moisture sorption studies revealed that the biscuits equilibrated to 10 to 40% RH were crisp and the control biscuits recorded lower EMC values compared to the millet substituted biscuits. Moisture sorption studies of the biscuits substituted at 10, 20 and 30% levels indicated that a moisture content of 6.14, 6.57 and 7.04 equilibrated to 65% RH at 27^0C was critical with respect to the storage stability of the product compared to 6.10% in the control biscuits. From the data on the moisture sorption characteristics, metallised polyester polyethylene laminated pouches were assessed to be most suitable for packing the biscuits and conduct of storage studies. The increase in acidity and moisture content of the biscuits during storage revealed that the moisture absorption of the millet substituted biscuits was well within the critical moisture content expressing that the biscuits had good storage stability.

REFERENCES

AACC (2000). Approved Methods of the American Association of Cereal Chemists 9^{th} Ed. AACC, St Paul. Minessota. USA.

Amerine, M.A., Pangborn, R.M. and Roseller, E.B. (1965). Principles of Sensory Evaluation of Food, Academic Press, New York. Pp. 131.

Awasthi, P., Yadav, M.C. and Misra, A. (1999). Effect of incorporation of defatted soy flour on physical and sensory quality of biscuits. Beverage and Food World. 26(6): 14-16.

Balasubramanyam, N., Indriamma, A.R., Baldev Raj, B. and Anandaswamy, B. (1981). Evaluation of shelf life of packaged salty biscuits. Indian Food Packer 35(6): 14-19.

Chavan, J.K. and Kadam, S.S. (1993). Nutritional enrichment of bakery products by supplementation with non-wheat flour. Critical Reviews in Food Science and Nutrition 33(3): 189-226.

Dendy, D.A.V. (1992). Composite flour - past, present and future. A review with special emphasis on the place of composite flour in the semi arid zones. pp. 67-73. *In*: Gomez, M.I., House, L.R., Rooney, L.W. and Dendy, D.A.V. (Eds). Utilization of Sorghum and Millets. ICRISAT, Pantancheru. India.

Gomez, K.H. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. 2^{nd} edition, John Wiley and Sons, New York. Pp 381.

Gopalan, C., Ramasastri, B.V. and Balasubramaniyan, S.C. (2002). Nutritive value of Indian foods. National Institute of Nutrition. Hyderabad, India. pp. 20-50.

Gunjal, B.B., Wankhede, D.B., Katake, R.S. and Taur, A.T. (1987). Water vapor adsorption by corn and rice flours. J. Food Sci. Technol. 24(1): 38-40.

Hall, E.E. (1995). Procedure for selection of packaging material. pp. 488-491. *In*: Ranganna, S. (Ed). Analysis and quality control of fruits and vegetable products. 2^{nd} edition, Tata McGraw Hill Pub, New Delhi.

ISI (1966). Indian Standards Institution. Methods of sampling and test for paper and its products. Part I Bureau of Indian Standards. Manak Bhavan, New Delhi IS. pp. 1060-1966.

ISI (1992). Indian Standards Institution. Biscuits specification, Bureau of Indian Standards Manak Bhavan, New Delhi, IS. pp. 1011-1992.

Landrock, A.H. and Proctor, B.E. (1951). Modern Packaging. 24(6): Pp. 123.

Seetharama, N. and Rao, D.B. (2004). Sustaining nutritional security. The Hindu Survey of Indian Agriculture. Pp. 37.

Selvaraj, A. Balasubramanyam, N. and Rao, P.H. (1995). Studies on cake doughnut premix. Packaging and keeping quality in flexible packs. J. Food Sci. Technol. 32(3): 227-230.

Selvaraj, A., Balasubramanyan, N. and Rao, H. (2002). Packaging and storage studies on biscuits containing finger millet (ragi) flour. J. Food Sci. Technol. 39(1): 66-68.

Srivastava, S., Singh, P., Dhyani, M. and Singh, G. (2002). Development of low glycemic index biscuits containing millets for diabetics. Pp. 76. *In*: 15^{th} International Convention of Food Scientist and Technologists (ICFOST) Souvenier, 12-13 December 2002. Central Food Technological Research Institute, Mysore, India.

Swamy, Y.S.S., Premavalli, K.S. and Bawa, A.S. (2003). Development of functional cookie mixes. Pp. 105. *In*: Poster abstracts of 5^{th} International Food Conference. 5-8 December, Central Food Technological Research Institute, Mysore, India.

Wink, W.A. (1995). Wink's weight equilibration method. Pp. 482. *In*: Ranganna, S. (Ed). Analysis and quality control of fruits and vegetable products. 2^{nd} Edition, Tata McGraw Hill Pub., New Delhi.