IJFANS

International Journal of Food And Nutritional Sciences

Volume 2, Issue 2, Apr-Jun-2013, www.ijfans.com e-ISSN: 2320-7876

Official Journal of IIFANS

INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

e-ISSN 2320 –7876 *www.ijfans.com*
Vol.2, Iss.2, Apr-Jun 2013

Research Paper *Open Access*

EVALUATION OF QUALITY CHARACTERISTICS OF BREAD FROM KODO, LITTLE AND FOXTAIL MILLETS

Karuppasamy.P[1*], Malathi.D[2], Banumathi.P[3], Varadharaju.N[4] and K. Seetharaman[5]

[1, 2] Department of Food Science and Nutrition, Post Harvest Technology Centre, Agricultural Engineering College and Research Institute, Coimbatore, [3]Home Science College and Research Institute, Madurai,
[4]Department of Food and Agricultural Process Engineering, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu,
[5]Department of Food Science, University of Guelph, ON N1G 2W1, Canada.

[*]Corresponding Author: samysks@gmail.com

ABSTRACT

Small millets incorporated breads were standardized by incorporating millet flour *viz.*, kodo millet, little millet and foxtail millet at 10, 20, 30, 40, 50, 60 and 70% levels. The developed bread was evaluated for their sensory attributes and it was highly acceptable at 20% level of small millets incorporation. The developed products were analyzed for their physico-chemical properties. The incorporation of millet flour increased the bread characteristics such as height, weight, specific volume, bulk density, water absorption and decreased the dough extensibility. As the level of substitution increases, the whiteness index increased and the yellowness index decreased for the developed millet bread. The staleness of bread crumb was increased on storage. The texture profiles like springiness, cohesiveness and resilience were decreased. The fibre content of the millet bread was 1.31g, 1.46g and 1.53g for kodo, little and foxtail millet bread respectively and was higher than the control (0.36g) bread. The calcium and iron content of the developed bread was 21.54 and 1.96mg, 19.88 and 3.36mg and 22.21mg and 2.28mg per 100g of the kodo, little and foxtail millet bread respectively. The shelf life of the bread was 7 days under ambient condition in different packaging materials and the microbial population was within the safer limit during the storage period.

Key words: Small millets, Bread, Sensory evaluation, Texture profile analysis, Physico-chemical properties.

INTRODUCTION

Millets are small seeded annual coarse cereals grown throughout the world. Millets include five genera: *Panicum, Setaria, Echinochloa, Pennisetum and Paspalum*. The cultivated species include kodo millet (*Paspalum scrobiculatum*), little millet (*Panicum miliare*) and Italian Millet (*Setaria italica*). Kodo millet, considered a crop for poor people, is grown mainly in India. Little millet is grown in South East Asia and foxtail millet is grown in china, Bangladesh and India. It requires warm weather and matures quickly in the hot summer months. Practically devoid of grain storage pest, foxtail millet has a long storage life. In developing countries, millets are consumed by people from the low economic strata and as forage crop (Baker, 2003). They are nutritionally comparable or even superior to staple cereals such as rice and wheat (Gopalan et al., 2004). Millets are rich in vitamins, minerals, sulphur containing amino acids and phytochemicals, and hence are termed as 'nutri-cereals'. They have higher proportions of non starchy polysaccharides and dietary fibre. Millets release sugars slowly and thus have a low Glycemic index.

Millets have great potential for being utilized in different food systems by virtue of their nutritional quality and economic importance. There is a wide scope of their exploitation in different food products including baked goods like breads, biscuits, cakes, cookies, breakfast cereals, muffins, pies, pancakes, snacks and extruded food stuffs. The present study was undertaken to blend kodo millet, little millet and foxtail millet flours with refined wheat flour to prepare the bread and to evaluate its physico-chemical properties, texture profiles and sensory qualities.

MATERIALS AND METHODS

Kodo millet, little millet and foxtail millet grains were procured from Peraiyur, Madurai District and Javwadhu hills, Thiruvannamalai District of Tamil Nadu. The grains were cleaned to remove dust, other foreign materials and grinded in a commercial roller mill. The flour was sieved using a BS 40-mesh sieve to obtain fine flour and was stored in stainless steel containers. The other ingredients were purchased from the local market.

PREPARATION OF SMALL MILLET INCORPORATED BREAD

Bread were prepared from refined wheat flour (T_1 - control), kodo millet (T_2), little millet (T_3) and foxtail millet flour (T_4). Millet incorporated bread were standardized by incorporating millet flour *viz.*, kodo millet, little millet and foxtail millet at 10, 20, 30, 40, 50, 60 and

70% levels and control bread were prepared from 100% refined wheat flour. The ingredients used for the preparation of the bread dough were refined wheat flour (80g), millet flour (20g), yeast (3g), salt (1.5g), sugar (18g), calcium propionate (0.3g) and vanaspathy (2.5g). The dough was prepared and baking caution for making bread were 5 min, fermentation time 75min, remixing time 50seconds, proofing (32^{o}C/85%RH) time 60min and baking at 215^{o}C for 15min. The bread were cooled and packed in thermally sealed polypropylene bags (70gauge-P_1), polypropylene bags (100gauge-P_2) for a month at room temperature ranging 32-37^{o}C and relative humidity of 65-85%. The bread was analyzed for their physico-chemical properties, texture profiles, sensory qualities and microbial populations at alternate days.

TEXTURE ANALYSIS OF SMALL MILLET INCORPORATED BREAD DOUGH

The texture (extensibility) of the dough was determined using the texture analyzer (TA-XT2i, Stable Micro Systems, Model: Texture Export Version 1.22, Surrey, UK), (AACC, 1983 and Bourne, 1978).

PHYSICAL PROPERTIES OF SMALL MILLET INCORPORATED BREAD

Height (cm), weight (g), length (cm), specific volume and bulk density (w/v) of the bread were measured.

SENSORY QUALITY

Bread were evaluated for their sensory attributes by a panel of 30 untrained members using 100 point scale (AACC method, 1983).The mean scores of sensory attributes viz. External properties (volume crust, colour, symmetry and appearance), internal properties (texture, crumb colour and grain colour) and taste properties (Aroma and taste) were recorded.

COLOUR

Colour of bread was measured by using Hunter Lab Colorimeter. Hunter lab calorimeter value L^*(0=black, 100=white), a^*(+value = red, -value = green) and b^*(+value = yellow, -value = blue) values were recorded (Wyszecki and Stiles, 1982).

TEXTURE PROFILE ANALYSIS (TPA)

Texture analysis of the millet incorporated bread was done by Texture Analyzer (Make Stable Micro System, UK, Model TA-XT2). TPA (firmness, hardness, springiness, cohesiveness, gumminess, chewiness and resilience) test was done [AACC, 1983 and Bourne, 1978].

NUTRIENT ANALYSIS

The small millet breads were analyzed for moisture (Ranganna, 1995). Carbohydrates (Dubois *et al.*, 1956), crude protein (Micro kjeldahal, Nx6.25), crude fat (solvent extraction), ash (muffle furnace - dry ash), calcium (titration), iron (colorimetric) were determined by the AOAC (1980). Crude fibre (acid and alkali), tannin (colorimetric) were determined by the method of Sadasivam and Manickam (1996).

MICROBIAL POPULATION

The microbial load of the kodo millet, little millet and foxtail millet incorporated breads were enumerated by the method described by Istavankiss (1984).

STATISTICAL ANALYSIS

All the data are presented as mean±SED of two replicates. The nutritive values of bread were subjected to Analysis of variance (ANOVA) to distinguish the responses of different levels of substitution and performed using Completely Randomized Design (CRD). The levels of significant differences are reported as $p \leq 0.05$.

RESULTS AND DISCUSSION

PHYSICAL PROPERTIES OF DOUGH AND BREAD

The dough weight was 281g for control and 281 for kodo millet, 277g for little millet and 286.5 g for foxtail millet. For control the water absorption was 70.7 per cent, which increased to 73.3 per cent at 20 per cent incorporation level of kodo millet, little millet and foxtail millet flour with refined wheat flour. Higher water absorption by the millet flour compared to control (refined wheat flour) can be related to the high water absorption capacity. The high water absorption is the characteristics of fibre supplemented flours as reported by Rasco *et al.*, (1991). The water absorption was differ in the various millet flours are attributed to differences in particle size of flour, presence of large proportion of husk in whole flours, percentage of damaged starch in milled flours and protein content of different millet flours (Singh *et al.*, 2005). Levels of bread length and breadth exhibited slight difference in behaviour with increasing incorporation level at 10 to 70 per cent of small millet flour. This adverse effect intensified along with increase in millets. The length and breadth of bread showed a marked difference, which shows the inability of the millets added dough to prove well, because of the dilution of refined wheat flour. Height of the small millet incorporated bread (6.4 cm for kodo millet, 7.0 cm for little millet and 7.40 cm for foxtail millet) had reduced than the control (7.80 cm). The effect can be related to the gluten dilution effect of bran (Sharma, 2005). The effects of the ratio of millets flour: refined wheat flour on the loaf height were similar to those effects on loaf volume. As less wheat gluten in the formulation may retain less fermentation gas, this may be the primary reason for the decline in both loaf volume and height in bread containing millet flour than the control (Chin-Lin *et al.*, 2004)

The dough made from the millet flour had lower extensibility (16.37g for kodo millet, 15.06g for little millet and 14.50g for foxtail millet) and higher hardness (0.18N for kodo millet, 0.17N for little millet and 0.18N for foxtail millet) than refined wheat flour (20.33g and 0.26N).

The data in the present study indicated that the volume, height and specific loaf volume reduced whereas

the loaf weight and bulk density of bread increased as the level of incorporation of millet increased (Table 1). The results suggest that the presence of millets in refined wheat flour decrease the rate of evaporation of water during baking. Haridas *et al.,* (1991) also observed an increase in loaf weight and bulk density as a function of bran.

Table 1 - Mean value of the dough extensibility, hardness and bread Loaf weight, bulk density

Treatments	Dough		Bread		Staleness of bread	
	Extensibility (g)	Hardness (N)	Loaf Weight (g)	Bulk Density (g/cc)	Initial (1^{st} day) (g)	Final (7^{th} day) (g)
T_1	20.33 ± 0.03	0.26 ± 0.08	219.50	0.27 ± 0.00	492.67	1255.11
T_2	16.37 ± 0.23	0.18 ± 0.02	217.00	0.29 ± 0.02	531.24	1116.12
T_3	15.06 ± 0.89	0.17 ± 0.01	223.00	0.28 ± 0.00	578.64	1206.69
T_4	14.50 ± 0.11	0.18 ± 0.00	222.00	0.29 ± 0.01	497.77	1005.15

T_1 - Refined wheat flour, T_2 - Kodo millet flour, T_3 -Little millet flour, T_4 - Foxtail millet flour

Kodo, little and foxtail millet incorporated bread exhibited faster rate of staling than control. A significant effect of storage and incorporation levels indicated that millet incorporated flour had a pronounced effect on the firmness properties of bread. The crumb firmness was increased in kodo millet (531.24 to 1116.12 g f), little millet (578.64 to 1206.69 g f) and foxtail millet (497.77 to 1005.15 g f) incorporated bread and control (492.67 to 1255.11 g f). The undesirable staling of millet incorporated bread was due to the starch base (Chen *et al.,* 2003). The starch retrogradation is believed to be the major cause of bread staling and amylopectin has an important role in the starch retrogradation. Recent studies reported that lower incorporation of millet flour resulted in retention of more moisture in bread crumbs and retardation of staling and extension of shelf life of bread (Lee *et al.,* 2001 and Morita *et al.,* 2002).

EFFECT OF INCORPORATION OF MILLET FLOUR ON THE SENSORY CHARACTERISTICS OF BREAD (20%)

The control bread was rated as highest among all the treatments in terms of external, internal and taste properties 28.0, 31.0 and 31.0 per cent respectively. The external properties scores decreased slightly with increasing levels of kodo millet, little millet and foxtail millet flour in bread formula ranging from 26.5 to 25.9, 26.5 to 25.8 per cent and 26.0 to 25.3 per cent respectively. Similarly, internal and taste properties were slightly affected with kodo millet (29.0 to 28.2 and 30.5 to 29.9 per cent, little millet (29.5 to 28.7 and 31.0 to 30.5 per cent) and foxtail millet (29.0 to 28.2 and 30.5 to 30.0 per cent) incorporated of bread. Panellists agreed that eatability of high millet incorporated bread did not reach appealing values because of their chewy crusts and gummy crumbs. Similar observation was findout by Iwuoha *et al.,* (1997).

MEAN VALUE FOR EFFECT OF STORAGE ON CRUST AND CRUMB COLOUR OF THE SMALL MILLET INCORPORATED BREAD

The data on crust and crumb colour of the bread is given in table 2. The lightness of control bread had lighter crust (45.78) and crumb (69.30) colour compared to millet incorporated bread (for kodo 48.70 and 57.85, for little 39.60 and 59.91 and for foxtail 42.32 and 65.00). The crust and crumb lightness was increased significantly on par with level of kodo millet (48.70 to 49.41 for P_1, 49.64 P_2 and 57.85 to 59.94 for P_1, 60.01 P_2), little millet (39.60 to 47.16 for P_1, 47.31 P_2 and 59.91 to 59.96 for P_1, 60.02 P_2) and foxtail millet (42.32 to 46.06 for P_1, 46.14 P_2 and 65.00 to 66.65 for P_1, 66.72 P_2) flours increased respectively. This result was due to the high amount of phenolic compounds in bran of all millets. The different colour found both in the crust and in the crumb may have been related to the use of different millet grains, its varieties, and/or to gassing power of dough made from various blends during fermentation processes that may have lead to the production of compounds differently active in the non-enzymatic browning process during baking (McCarthy *et al.,* 2005).

Table 2 - Mean value for effect of storage on crust and crumb colour of the small millet incorporated bread

Bread	Days	*L* Value*			
		Crust		Crumb	
		P_1	P_2	P_1	P_2
Refined wheat flour	1	45.78	45.78	69.30	69.30
	7	51.79	52.06	70.67	70.72
Kodo millet flour	1	48.70	48.70	57.85	57.85
	7	49.41	49.64	59.94	60.01
Little millet flour	1	39.60	39.60	59.91	59.91
	7	47.16	47.31	59.96	60.02
Foxtail millet flour	1	42.32	42.32	65.00	65.00
	7	46.06	46.14	66.65	66.72

P_1- Poly Propylene 70 gauge, P_2- Poly Propylene 100 gauge

MEAN VALUE FOR TEXTURE PROFILE ANALYSIS OF BREAD

The data on texture profile of the bread is given in table 3. The initial crumb firmness were 169.30 for T_1, 239.95 for T_2, 174.06 for T_3 and 210.23 for T_4, It was increased to 929.21 in P_1, 928.12 in P_2 for T_1, 783.94 in P_1, 781.50 in P_2 for T_2, 773.22 in P_1, 771.18 in P_2 for T_3 and 837.04 in P_1, 835.02 in P_2 for T_4, The higher addition of fibre usually leads to firm crumb and crust. Keetals *et al.,* 1996 stated that crumb firmness and an increase in crumbliness have a negative impact on the eating quality

of bread. Crust firmness for control, kodo, little and foxtail (327, 346, 360.45 and 389.45 g f) were increased to 1134.16 for P_1 and 1130.08 for P_2 in control, 1160.48 for P_1 and 1158.26 for P_2 in kodo millet, 1165.98 in P_1 and 1162.35 in P_2 for little millet and 1154.25 in P_1 and 1152.19 gf in $P_{2)}$ observed on 7th day of storage. Springiness, Cohesiveness and Resilience were decreased over seven days.

Table 3 - Mean value for Texture Profile Analysis of Bread

Treatments	Days	Texture Profiles							
		T_1		T_2		T_3		T_4	
		P_1	P_2	P_1	P_2	P_1	P_2	P_1	P_2
Crumb firmness (g f)	1	169.30	169.30	239.95	239.95	174.06	174.06	210.23	210.23
	7	929.21	928.12	783.94	781.50	773.22	771.18	837.04	835.02
Crust firmness (g f)	1	327.00	327.00	346.00	346.00	360.45	360.45	389.45	389.45
	7	1134.16	1130.08	1160.48	1158.26	1165.98	1162.35	1154.25	1152.19
Hardness (g f)	1	177.56	177.56	266.79	266.79	188.17	188.17	223.16	223.16
	7	1160.39	1158.23	1288.80	1285.42	1185.74	1183.46	1492.90	1490.00
Springiness	1	3.14	3.14	2.14	2.14	3.36	3.36	1.20	1.20
	7	0.92	0.98	0.90	0.93	0.92	0.96	0.88	0.93
Cohesiveness	1	0.87	0.87	0.77	0.77	0.80	0.80	0.83	0.83
	7	0.50	0.47	0.29	0.25	0.34	0.30	0.27	0.23
Gumminess	1	156.07	156.07	206.86	206.86	152.30	152.30	185.60	185.60
	7	583.67	581.60	383.67	382.16	408.58	407.35	403.99	401.42
Chewiness	1	491.80	491.80	443.21	443.21	511.44	511.44	227.24	227.24
	7	537.12	538.42	345.46	347.00	374.78	376.27	358.73	359.78
Resilience	1	0.51	0.51	0.44	0.44	0.43	0.43	0.45	0.45
	7	0.25	0.29	0.15	0.18	0.17	0.21	0.13	0.15

Table 4- Nutrient Changes in the Optimized Millet Incorporated Bread during Storage (Per 100g)

Nutrients		T_1		T_2		T_3		T_4		CD (0.05)
		P_1	P_2	P_1	P_2	P_1	P_2	P_1	P_2	
Moisture (g)	I	10.33	10.33	11.01	11.01	10.84	10.84	10.75	10.75	0.037**
	F	10.25	10.29	10.94	10.97	10.65	10.78	10.62	10.70	
CHO (g)	I	73.78	73.78	74.79	74.79	74.58	74.58	73.96	73.96	0.035**
	F	73.12	73.34	74.13	74.54	74.19	74.32	73.21	73.76	
Protein (g)	I	11.26	11.26	8.69	8.69	8.59	8.59	9.35	9.35	0.040**
	F	11.14	11.20	8.42	8.51	8.46	8.50	9.11	9.23	
Fat (g)	I	2.86	2.86	2.90	2.90	3.76	3.76	3.24	3.24	0.041**
	F	2.81	2.83	2.84	2.86	3.73	3.75	3.20	3.22	
Crude fibre (g)	I	0.36	0.36	1.31	1.31	1.46	1.46	1.53	1.53	0.037**
	F	0.33	0.35	1.29	1.30	1.42	1.44	1.51	1.52	
Ash (g)	I	1.29	1.29	1.35	1.35	1.30	1.30	1.26	1.26	0.042**
	F	1.26	1.28	1.31	1.34	1.26	1.28	1.22	1.25	
Calcium (mg)	I	20.61	20.61	21.54	21.54	19.88	19.88	22.21	22.21	0.030**
	F	20.58	20.60	21.51	21.53	19.86	19.87	22.18	22.19	
Iron (mg)	I	2.24	2.24	1.96	1.96	3.36	3.36	2.28	2.28	0.035**
	F	2.21	2.23	1.93	1.95	3.33	3.35	2.26	2.27	
Tannin (mg)	I	54.71	54.71	55.86	55.86	58.86	58.86	73.22	73.22	0.046**
	F	54.69	54.70	55.84	55.85	58.83	58.85	73.20	73.21	

**Significant at 5% level, I-Initial, F-Final, T_1- Refined wheat flour, T_2- Kodo millet flour, T_3 -Little millet flour, T_4 - Foxtail millet flour, P_1- 70 gauge polypropylene pack, P_2- 100 gauge polypropylene pack

NUTRIENT ANALYSIS OF THE FOXTAIL MILLET BASED COOKIES

The nutrient content of the small millet incorporated bread is presented in Table 4. The small millet incorporated bread had high crude fibre, calcium, iron and tannin content than control. The fibre content of the kodo millet, little millet and foxtail millet (1.35, 1.30 and 1.26g) bread was found to be higher than the control (0.36g). Highly significant difference was noted for moisture, carbohydrate**,** crude fibre and tannin content at 5% level ($p \leq 0.05$) in treatment, packaging and storage.

MICROBIAL POPULATION

The microbial load of the bread was found to increase during the storage period in different packaging materials. Initially the total plate count range was 0.66 to 1.00 for control and small millet incorporated bread. Among the packaging materials 100gauge polypropylene pack (P_2) samples showed low microbial population and was found to be within the safer limits.

CONCLUSION

Based on the physical characteristics of the dough, sensory and nutritional characteristics of the small millet incorporated bread, 20% incorporation level was found to be highly acceptable. The fibre, calcium and iron content of the small millet incorporated bread were higher than the refined wheat bread. The shelf life of the millet bread was upto 7 days in different packaging materials. The microbial load was found to be within in the safer limit.

ACKNOWLEDGEMENT

International Development Research Centre (IDRC) and Canadian International Development Agency (CIDA) and University of Guelph, Canada.

REFERENCES

- AACC. Approved methods of the American Association of Cereal Chemists, 7th edn. St Paul, Minnesota, USA. 1969.
- AACC. Approved methods of the American Association of Cereal Chemists, Method: 10-10B, 74-09, 10-70, 8th edn. American Association of Cereal Chemists, Minnesota, USA. 1983.
- AOAC. Official Method of Analysis, 11th edn. Association of Official Analytical Chemists, Washington, D.C. 1980.
- Baker, RD. Millet Production. Available on htpp://Lubbock.tamu.edu/other crops /doc/nmsumilletprod.htm. 2003 [Accessed 20 February, 2010].
- Bourne, M.C. Texture profile analysis. *Food Technol*. 1978. 32 (7): 62-80.
- Bourne, M.C., Moyer, J.C., and Hand, D.B.. Measurement of food texture by a universal testing machine. *Food Technol*. 1966. 20: 522-526.
- Clark and Collip. Estimation of calcium J. Biol. Chem. 1925. 63: 641.
- Cohen, E. H. J. Assoc. Anal. Chem. 1917. 54: 212.
- Dubois, M., Gilles, K.A., Hamilton, J.K., Rebers, P.A. and Smith, F. Colorimetric method for determination of sugars and related substances. Anal. Chem., 1956. 28: 350-356.
- Gopalan, C., Ramashastri, BV and Balasubramanium, SC (eds). Nutritive Value of Indian Foods. ICMR, New Delhi. 2004.
- Istavankiss. Testing methods in food microbiology. Eleservia Pub. Ltd. 1984; p395-397.
- Ma, T. and Zuazaga, G. Estimation of protein. In: Ranganna, S. Analysis and quality control for fruits and vegetables products. 2nd edn. Tata McGraw Hill Pub. Co. New Delhi. 1942; 1995. p. 3-10.
- Ranganna, S. Manual analysis of fruit and vegetable products. Tata McGraw Hill Publishing, Co. Ltd., New Delhi: 1995; p891.
- Sadasivam, S and Manickam, A. Biochemical methods. IInd edition, New Age International (P) Ltd. New Delhi: 1996; p63.
- Watts, B.M., Jlimaki, G.L., Jeffery, L.E and Elias, L.G. Basic sensory methods for food evaluation. International Development Research Centre (IDRC), Ottawa, Canada. 1989; p1-16.
- Wong. Estimation of iron. In: B.L. Oser (ed.). Hawks physiological chemistry, 1928.14th edi: 1094.
- Wyszecki, G and Stile, W.S. "Color Science". Concept and Methods, Quantitative Data and Formulae. 2nd ed. John Wiley and Sons, New York. 1982.
- Singh, P. Gurmukh, Srivastsava, S and Agarwal, P. Functional characteristics of blends containing wheat flour and millet flour, Beverage and Food World. 2005; pp 28-31.
- Haridas Rao, P. and Shurpalekar, S.R. Utilization of Milo in bakery products. Journal of Food Science and Technology. 1976; 13: p293-299.
- Iwuoha, C.I., Anyadike, A.C. & Eke, O.S. The effect of flour blending on the physiochemical and sensory qualities of bread. Journal of food science and technology India; 1997. 34, p311-315.
- McCarthy, D.F, Gallagher, E, Gormley, T.R, Schober, T.J, and Arendt, E.K. Application of response surface methodology in the development of gluten-free bread, Cereal chem**.** 2005. 82(5)**:** 609-615.