Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 9[5] April 2020 : 74-79

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Physicochemical, Thermal and Sensory characteristics of mixed finger and Pearl millet fortified bread

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ABSTRACT

Mixed millet flour (finger millet + Pearl millet, 1:1 w/w) was added at 10, 20 and 30% levels in wheat flour for making millet fortified bread and effect of addition of mixed millet flour on physicochemical, thermal, and sensory characteristics of bread was studied. Addition of mixed millet flour significantly increased the mineral content in the bread. The loaf volume was found to decrease significantly ($p<0.05$) with increase in the ratio of millet flour. The instrumental L value decreased significantly ($p<0.05$), whereas, a* and b* values increased significantly ($p<0.05$) with increase in the content of millet flour. Hardness of bread was found to decrease significantly ($p<0.05$)with increase in the content of millet flour; whereas, onset temperature (T_0) significantly ($p<0.05$) decreased while end set temperature (T_c) and enthalpy of gelatinization (ΔH) significantly ($p<0.05$) increased with increase in level of millet flour. The sensory acceptability also decreased with increase in the level of millet flour. Addition of 10 percent of mixed millet flour was found optimum for preparation of fortified mixed millet bread.*

Keywords: Millet, Bread, Texture, Thermal, Color, Sensory.

Received 10.01.2020 Revised 12.02.2020 Accepted 09.04.2020

INTRODUCTION

Millets are a group of small-seeded species of cereal crops or grains, widely grown around the world for food and fodder [1] [2] [3] They do not form a taxonomic group, but rather a functional or agronomic one. Their essential similarities are that they are small-seeded grasses grown in difficult production environments such as those at risk of drought. They have been in cultivation in East Asia for the last 10,000 years. Millets were consumed in India, china, Egypt and other countries in prehistoric times, but little is known of their origin .[4] [2] [3]They probably were developed in eastern or central Asia .Some students belief that millet was the first cultivated crop because it was grown in the so-called Hoe Age which preceded the Plow Age. In ancient and medieval times millet was grown in most of the known world .During the Middle Ages it was one of the principle foods of the poor people of Europe. During the nineteenth century, millet was gradually superseded in Western Europe by wheat, rye, rice, maize and potatoes, which usually produce higher yields. Development of yeast raised bread contributed to this loss in popularity because millet is not satisfactory for making good raised bread. The protein content in millet is very close to that of wheat; both provide about 11% protein by weight. Millets are rich in B vitamins, especially niacin, B6 and folic acid, calcium, iron, potassium, magnesium, and zinc.[5] [6] [7] [8] [9] Millet is used as a meal, for making bread and cakes or as paste from pounded soaked seed, or as boiled gruel.In Asia, glutenous types of proso or foxtail millets are used in cakes, puddings, or other holiday delicacies.[10] In the U.S.S.R., proso millet is eaten mostly in the form of thick porridge called kasha or in the bread .Millets sometimes are used in making alcoholic drinks. In the United States, proso is grown for feed grain and the other millets are used for forage. Finger millet *(Eleusine coracana*) also is known as ragi, nagli, birds-foot millet, coracana millet, and African millet. It is cultivated for human food in Africa and in southern Asia. Finger millet ranks second in importance among the millets in India .It is grown in the southern part of the country. Pearl millet (*Pennisetum glaucum*) is the most widely grown type of millet. Grown in Africa and the Indian subcontinent since prehistoric times, it is generally accepted that pearl millet originated in Africa and was subsequently introduced into India. Millets contain no gluten, so they are not suitable for raised bread. When combined with wheat, (or xanthan gum for those who have celiac disease), they can be used for raised bread[11]. Alone, they are suited for flatbread. Therefore, the

present investigation was undertaken to standardize the formulation of fortified millet (pearl millet and finger millet) bread and evaluation of its chemical, physical, thermal and sensory characteristics.

MATERIAL AND METHODS

Finger and pearl millet flours were procured from the local market and sieved separately through (400 μ) sieve and keep in air tight container. The millet flour (finger millet: Pearl millet: 1:1 w/w) was added along with refined wheat flour in the percentages (10%, 20%, 30%) for making the bread. The formulation used flour (300g), water (210ml), yeast (6g), sugar (7.5g), salt (3g), and vegetable oil (0.2g). Dry ingredients were first mixed in a HOBART mixer (low speed), shortening (if required) was added, and then water was slowly poured into the blend. All the ingredients were based on flour weight. The mixing times were 2 min of slow speed (100rpm). The fast mixing speed (200rpm) were for 3mins. The temperature of the dough was kept at 27°C, 75% RH for 30mins in a proofing chamber (National Manufacturing Co. Lincoln nebr, Mexico) after mixing. After the intermediate proof, the dough was scaled into two 180g pieces, rounded, and molded with bread molder. (National Manufacturing Co. Lincoln nebr, Mexico). The breads were placed on baking pans and proofed for 45mins. The loaves were baked at 220°C for 25 to 30 min Fig: 1.

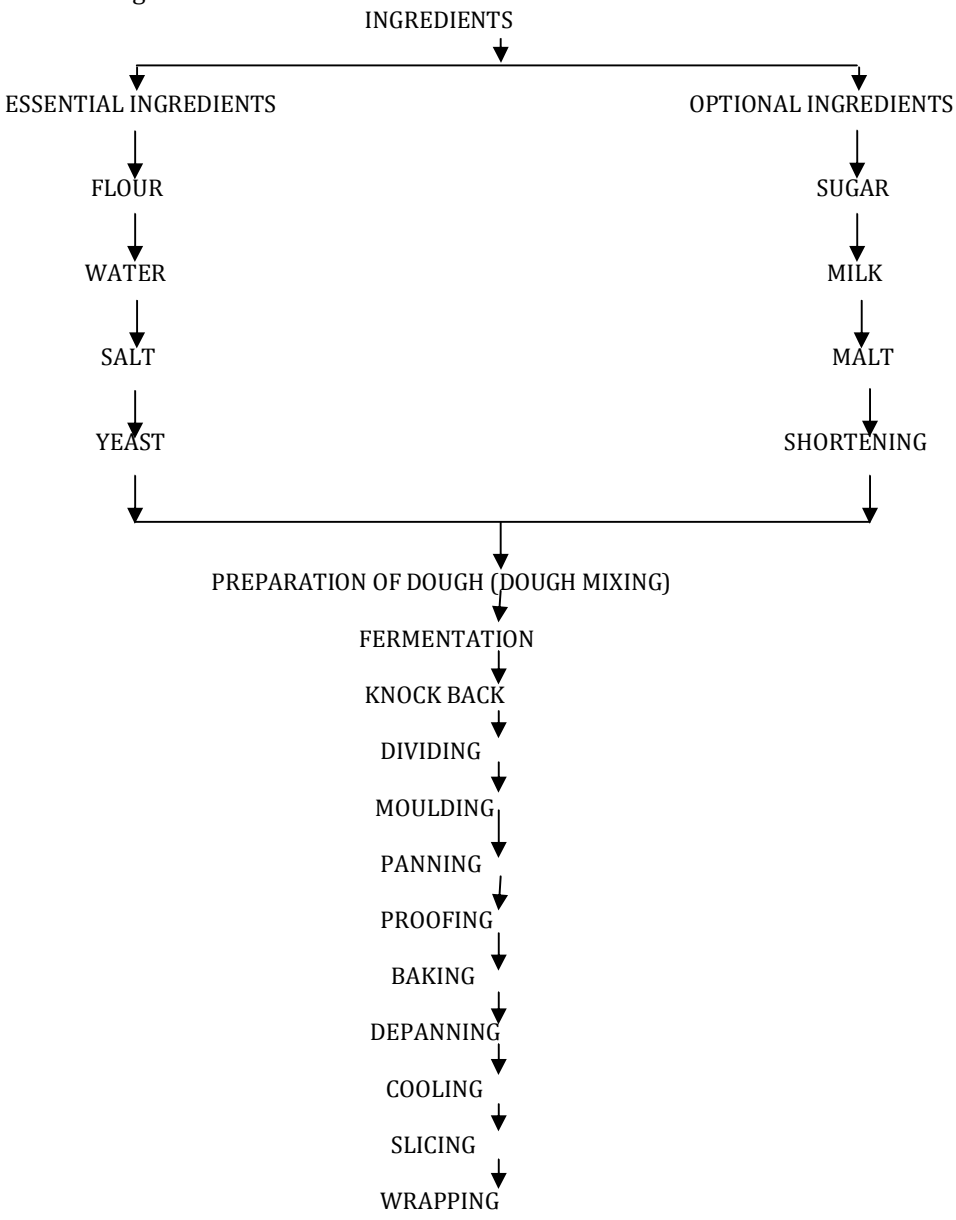

Fig: 1 Bread making Formulation

The loaves were cooled before removal from the pan. Loaf volume was determined by rapeseed displacement method. Color index readings were made using a tristimulus colorimeter (Mini Scan XE Plus, Model 45/0-S, Hunter Associates Laboratory, Inc., Reston, VA, USA). Texture was analyzed using a texture analyser (TA-HDi, Stable Microsystems, UK). Samples were immediately wrapped in LDPE films and sealed until analysis to prevent moisture loss.

The sensory quality in terms of colour, appearance, flavour, texture and overall acceptability of the product was measured by a sensory panel of 30 members including both male and female healthy scientific staff of the institution using 9 point hedonic scale.

All the physico-chemical analyses were done in triplicate and the data obtained were analyzed statistically by one-way ANOVA with least significant difference (LSD) at $p<0.05$, using Statistica 7 software (Stat Soft, Tulsa, OK, USA).

RESULTS AND DISCUSSION

Proximate composition of breads (control and millet bread) is given in Table 1. Moisture content is slightly higher in millet bread as compared to control one. This may be due to higher amount of fibre in millet bread. Fat content in both the breads ranged between 1.42 to 2.76%. The protein content in breads ranged from 9.08 to 9.14%. The total ash content in bread reflects the quality of wheat flour and level of salt used in the bread manufacturing. In breads the total ash content varied from 0.53 to 0.79%. The mineral content of control and fortified millet bread are also shown in Table 1. It was observed that the fortified millet bread contains higher amount of Fe, Zn, Ca and K as compared to control. The values are slighter on a higher side is due to the presence of combination millet to that of reported by [12] [13] [14].

Table 1: Chemical composition of bread prepared from unfortified and fortified refined wheat flour (n = 3)

Parameters	Control	FMB (10%)	FMB (20%)	FMB (30%)
Moisture (%)	35.41^{a}	35.07^{a}	34.79^{b}	33.09^{c}
Total ash (%)	0.53^{a}	0.64^{b}	0.71^{c}	0.79^{d}
Sugar (%)	1.92^{a}	1.86^{a}	1.77^{b}	1.60^{c}
Protein (%)	9.08^{a}	9.10^{a}	9.13^{a}	9.14^{a}
Fat (%)	1.42^{a}	1.84^{b}	2.23^{c}	2.76^{d}
Fiber (%)	0.32^{a}	0.98^{b}	2.18^{c}	3.47^{d}
Fe (mg/100g)	1.24^{a}	1.68^{b}	2.01^{c}	3.08^{d}
Zn (mg/100g)	0.71^{a}	0.90^{b}	1.09^{c}	1.27^{d}
Ca (mg/100g)	16.11^{a}	16.84^{a}	17.45^{b}	18.24^{c}
K (mg/100g)	120.24^{a}	141.86^{b}	152.71^{c}	181.04^{d}
Na (mg/100g)	358.80^{a}	360.01^{b}	360.28^{b}	360.61^{b}

*Values with different superscripts in same row differ significantly ($p<0.05$), FMB: Fortified millet bread

Physical characteristics

The loaf volume, loaf weight and specific volume decreased significantly ($p<0.05$) with increase in the amount of millet flour. The control bread shoed a loaf volume of 1300.00 cc which decreased to 1197.10, 1007.66 and 889.85 cc after addition of 10, 20, and 30% millet flour because the incorporation of millets has a negative impact on the structure building mechanical properties of dough [15]. Specific volume and loaf weight of the breads also showed similar trend. Decrease in specific volume and loaf volume might be attributed to decrease in the gluten content in the dough due to addition of millet flour [16] [7] [17].

Table 2: Physical characteristics of bread prepared from unfortified and fortified refined wheat flour(n = 3)

Parameter	Control	FMB (10%)	FMB (20%)	FMB (30%)
Total volume (cc)	1300^{a}	1197^{b}	1007^{c}	889^{d}
Loaf Weight	500.00^{a}	482.66^{b}	464.36^{c}	438.35$_{d}$
Specific (g) volume (cc/g)	2.60^{a}	2.48^{b}	2.17^{c}	2.03^{d}

*Values with different superscripts in same row differ significantly ($p<0.05$), FMB: Fortified millet bread

Instrumental color values

Browning is a common phenomenon for breads during baking [18] In the present study the L* value of breads decreased, while a* and b* value increased with increased proportion of millets (Table 3).The increase in a* and b* values may be due to increase in redness and yellowness during baking. The decrease in L* values and increase in a* and b* values resulted in darkening of the breads, which ultimately affected the sensory score for color. Similar studies have also been reported by [19]. These declines in the values have been reported earlier too, due to the polyphenolic pigments present in pericarp, aleuronic layer, and endosperm region of the respective millets.[20] stated that brown pigments produced during baking is due to the maillard reaction and thus ultimately decreases L* values, and these compounds effect for aroma, taste, and baked characteristics of the finished product.

Table 3: Color values of control & fortified millet bread (n=3)

Sample	L*	a*	b*
Control	61.15^{a}	1.58^{a}	10.92^{a}
FMB (10%)	54.74^{b}	2.11^{b}	13.72^{b}
FMB (20%)	47.63^{c}	3.33^{c}	13.11^{b}
FMB (30%)	42.76^{d}	4.48^{d}	14.01^{c}

*Values with different superscripts in same column differ significantly (p<0.05), FMB: Fortified millet bread

Textural properties

Effect of millet incorporation in bread and their effect on textural properties are shown in Table 4. Results indicated that fortification of millet from (10% - 30%) increased the hardness, springiness and cohesiveness of bread, whereas, adhesiveness decreased significantly (p<0.05). The increase in hardness might be attributed to less gluten content which also declines the extensibility, in fortified bread the result in less puffiness due to gas holding capacity and reduced water absorption capacity [19].

Table 4: Texture properties of control, fortified millet bread(n = 3)

Sample	Hardness (g)	Adhesiveness	Springiness	Cohesiveness	Gumminess	Chewiness
Control	3701.16^{a}	93.12^{a}	0.73^{a}	0.57^{a}	2135.35^{a}	1558.80^{a}
FMB (10%)	3843.47^{b}	90.61^{b}	0.78^{a}	0.52^{a}	2000.69^{b}	1575.54^{b}
FMB (20%)	5699.21^{c}	4.39^{c}	0.91^{b}	0.70^{b}	4027.36^{c}	3674.97^{c}
FMB (30%)	7549.19^{d}	3.76^{d}	0.96^{b}	0.73^{b}	5265.24^{d}	4916.84^{d}

*Values with different superscripts in same column differ significantly (p<0.05), FMB: Fortified millet bread

Thermal properties

The thermal properties of the bread were examined using differential scanning calorimetry
and results are shown in Table 5. The onset temperature (T 0) significantly (p<0.05)decreased while end set temperature (T c) and enthalpy of gelatinization (⍰H) significantly (p<0.05)increased from 59.78 to 57.98ºC, 84.64 to 90.05ºC and 13.77 to 51.53 J/g, respectively due to addition of 10 to 30% incorporation of millets. In the present study T c and H were higher than control because of the presence of other ingredients, especially combination millets. As fortified millet bread contained high amount of fiber than the control ones and it may be competing with starch for water absorption and hence limiting starch swelling and gelatinization results is high T c value. Similar finding has been reported in pasta containing pea fiber [22]. As the results obtained in this study suggested that the enthalpy of a complex increased with addition of millet concentration. It may be due to increase in moisture contain as early researchers have also reported that the gelatinization enthalpy increased with increasing moisture content [23] [24].

Table 5: Effect of millet fortification on thermal properties of bread (n=3)

Sample	T_0(%)	T_c(%)	ΔH (J/g)
Control	59.78^{a}	84.64^{a}	13.77^{a}
FMB (10%)	58.64^{b}	86.58^{b}	30.92^{b}
FMB (20%)	58.22^{b}	88.14^{c}	44.65^{c}
FMB (30%)	57.98^{c}	90.05^{d}	51.33^{d}

*Values with different superscripts in same column differ significantly (p<0.05), FMB: Fortified millet bread

Influence of millets on sensory characteristics of bread

The sensory characteristics of control and fortified bread are given in Table 6. Addition of millet flours from (10% - 30%) in bread significantly (p<0.05)decreased the sensory scores for colour, taste, aroma, texture and overall acceptability. Addition of millet flour though reduced the sensory acceptability of the

bread, however, the products are found to be in acceptable limits. It was observed that upto 10% of millet flour was found to be acceptable by the sensory panellists. Similar results were also observed by[19] [21] It was observed from different quality parameters that the addition of combination millet flour i.e, finger millet and pearl millet flour affected color, flavor, texture of bread but all the values were in acceptable range. However, bread with 20% and 30% finger millet and pearl millet flour has lower values for overall acceptability and thus may not have wider acceptability. So it can be concluded that the 10% finger millet pearl millet flour addition can be considered acceptable to avail nutritional, phyto chemical, and health benefits of this fortified bread

Table 6: Sensory characteristics of control & fortified millet breads(n = 30)

Sample	Color	Taste	Aroma	Texture	OAA
Control	8.10^{a}	8.22^{a}	8.11^{a}	8.10^{a}	8.20^{a}
FMB (10%)	7.52^{b}	7.60^{b}	7.55^{b}	7.48^{b}	7.51^{b}
FMB (20%)	7.20^{c}	7.42^{c}	7.35^{c}	7.15^{c}	7.22^{c}
FMB (30%)	6.00^{d}	7.10^{d}	7.21^{d}	6.15^{d}	6.12^{d}

*Values with different superscripts in same column differ significantly ($p<0.05$), FMB: Fortified millet bread

CONCLUSION

The present study revealed that addition of mixed millet flour (finger millet and Pearl millet) in wheat flour during preparation of bread is possible without much affecting the physical properties of bread in terms of loaf volume, instrumental color, texture, thermal and sensory attributes. Addition of mixed millet flour decreased the sensory acceptability as well as loaf volume, but, the products were found to be in acceptable range. As such, addition of 10% mixed millet flour is recommended for bread making. Addition of mixed millet flour in bread also increased the mineral content significantly in the bread. The incorporation of combination finger millet pearl millet flour to wheat flour significantly affected the rheological and pasting characteristics due to difference in the gluten content, fibre, and starch presence. The reduced setback values supported the combination millet incorporation and have delayed the bread staling by maintaining freshness for longer time period. It was observed that addition of combination millet flour has changed the dough characteristics in terms of rheological parameters. These results may be helpful to enhance the utilization of millet flour and to improve the nutritional value of breads.

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CITATION OF THIS ARTICLE

B Jyothi, A Khan, OP Chauhan, AD Semwal and GK Sharma. Physicochemical, Thermal and Sensory characteristics of mixed finger and Pearl millet fortified bread. Bull. Env. Pharmacol. Life Sci., Vol 9[5] April 2020 : 23-32