

Development of Bread from Fermented Pearl Millet Flour

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Abstract

The probiotic bacteria are found to get developed in the spontaneously fermented pearl millet. Bakery products are used as a vehicle for incorporation of different nutritionally rich ingredients. Fortification of wheat flour with non-wheat proteins increases protein quality by improving its amino acid profiles. The anti-nutrients phytic acid was reduced from 858.4 mg/ 100 g in the raw pearl millet to 380.3 mg/100 g in the cooked fermented pearl millet. Tannin did not show any reduction in its amount after cooking and fermenting the pearl millet from the raw pearl millet. The cooked fermented pearl millet was utilized for the production of bread substituting refined wheat flour. The bread substituted with 10, 15 and 20 per cent of the cooked fermented pearl millet flour showed good textural and physical properties and the quality was comparable to the market bread.

Keywords: Probiotics; Composite bread and cooked fermented pearl millet flour

aggregation, Low Density Lipid cholesterol accumulation and the immune system.

Introduction

Pearl millet (*Pennisetum glaucum*) is one of the important crops in semi-arid areas of Africa and India. Pearl millet crop has a wide adaptability to local environments for its properties to be tolerant to drought and heat. For this reason, it is widely grown in tropical regions of the world including Africa and Asia. Pearl millet is currently the world's sixth most important cereal grain and is grown extensively in Africa, Asia, India and the Near East as a food grain and is the staple source of nutrition for millions of people. India is the largest producer of pearl millet, both in terms of area 9.8 Mha and production 8.3 Mt (ICRISAT) [1]. The amino acid profile of pearl millet is better than that of sorghum and maize and is comparable to wheat, barley and rice. Millet grains can substitute rice or wheat component of such fermented foods.

Review of Literature

Pearl millet is nutritionally better than most other cereals; it has higher levels of calcium, iron, zinc, lipids and high quality proteins [2]. But, as in other cereal grains, nutritional quality is considerably lowered by the presence of anti-nutritional factors leading to poor digestibility of proteins, carbohydrates and minerals.

In his review Rai et al. [3] stated that the amino acid composition has significant effect on the nutritional quality of protein. The amino acid profile of pearl millet is better than that of sorghum and maize and is comparable to wheat, barley, and rice. In a recent review, Dykes and Rooney (2007) [4] examined that pearl millet is rich in oil and linoleic acid accounts for 4 per cent of the total fatty acids in this oil, giving it a higher percentage of n-3 fatty acids as compared to maize in which linoleic acid accounts for only 0.9 per cent of the total fatty acids and hence, is highly deficient in n-3 fatty acids. The n-3 fatty acids play an important role in many physiological functions, including platelet

Composite Bread

Baked goods from wheat and rye are problematic for an increasing amount of people suffering from celiac disease. Thus, there is a market for new novel bakery products produced by using alternative cereals like rice, maize, sorghum and millet [5]. These plants do not contain gluten, the causative agent for celiac disease. Moreover, millets are rich in proteins, especially in essential amino acids such as lysine [6], which is limited in wheat and rye flour. The use of such alternative flours is restricted due to their low baking quality, as well as the sensory quality of the baked products [7]. Fermentation of such alternative flours may improve both the sensory and baking qualities.

Characteristics of fermented pearl millet

The fermentation is carried out at room temperature and spontaneous fermentation has been done by keeping the cooked pearl millet at 24 hours at room temperature. The ant nutrients like phytic acid tannin are removed from the pearl millet during fermentation. The digestibility of the complex protein has been improved during fermentation.

Materials and Methods

Fermentation of cooked pearl millet

The completely cooked pearl millet was allowed for spontaneous fermentation by adding various ratios of 1:2, 1:3 and 1:4 of water with the cooked pearl millet. The growth and survival of probiotic bacteria is continuously enumerated by plate count method in selective medium Man, Rogosa and Sharpe (MRS) for every 6 hours interval until fermentation for 48 hours. The cooked fermented probiotic millet water was incubated at 37°C [8] by keeping in a BOD incubator (Genuine Equipment MFRS, Coimbatore) for 48 h for encouraging faster multiplication of probiotic bacteria. The fermented cooked pearl

millet is stored under both refrigerated and ambient temperature and the survival of probiotic bacteria is noted for consecutive days of storage.

Preparation of bread

The bread is prepared with the cooked fermented flour in different ratio along with the refined wheat flour. The pearl millet flour which is rich in fibre makes the composite bread rich in fibre. Due to the negligible amount of gluten in the pearl millet flour, the higher ratio of the cooked fermented pearl millet flour lowers the raising volume of the bread. So the percentage of the cooked fermented pearl millet flour with the refined wheat flour in the development of value added composite bread was limited to 10, 15, 20 and 25 per cent (Table 1).

Independent variables	Dependent variables
Ratio of refined wheat flour and fermented flour (10,15,20 and 25% for bread; 50 and 100% for cookies)	Colour Loaf volume for bread Spread ratio for cookies Textural properties Sensory evaluation

Table 1: Process parameter for bread

Specific volume of bread

The specific volume of bread was calculated according to the AACC method 10- 05.01 (AACC) [9,10] by dividing volume (cc) by weight (g). Loaf volume was measured by rapeseed displacement immediately after removal from the oven and weighing. Loaves were placed in a container of known volume into which rapeseeds were run until the container was full. The volume of seeds displaced by the loaf was considered as the loaf volume.

Loaf Specific Volume (LSV), was calculated according to the following formula:

$$L.S.V = \text{Loaf volume (cc)} / \text{Loaf weight (g)}$$

Texture analysis

The texture of the product is of great importance in determining the quality and acceptability of fermented pearl millet and value added products from pearl millet. The textural property of value added bread was determined using Texture Analyzer.

Determination of firmness of composite bread

Firmness tests were conducted on a single bread slice at a time and then the required values were got from the graph. The probe moved to compress the sample to a specified distance of 10 mm. Once the probe touched the sample, the maximum force required to penetrate the spent layer chicken piece was observed and compared between the samples. The bread firmness is determined by using the AACC [9] Standard method.

TA-XT2 Settings

Mode	: Measure Force in Compression
Option	: Return to Start
Pre-Test Speed	: 1.0 mm/s

Test Speed	: 1.7 mm/s
Post-Test Speed	: 10.0 mm/s
Strain	: 40 per cent
Trigger Type: Auto	: 5 g
Data Acquisition Rate	: 250 pps
Probe	: AACC 36 mm cylinder probe with radius (P/36R) using 5 kg load cell

Edges of the cylinder are 'rounded' to remove sharpness of the perimeter of the probe, hence reducing tendency of the probe to cut the sample upon penetration. The bread loaf is sliced mechanically into equal slice thickness of 12.5 mm. The probe calibration was done by carrying out the test using '% strain' measurement. To do this the probe was lowered, so that it is close to the test surface. The T.A. in the menu bar was clicked and then Calibrate Probe and specify the distance of about 30 mm that the probe to return to, after sample compression which is suggested. Within the 'Run a Test' window, the auto height box was checked before commencing the tests. The sample was placed centrally under the cylinder probe, avoiding any irregular or non-representative areas of crumb and the test is commenced. Once the trigger force is attained, the probe proceeds to compress the sample until it has compressed it by 40 per cent of the product height. It then withdraws from the sample and returns to its starting position. The result is obtained in a texture expert exceed plots. Then the observation is made from the graph and result window.

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Color measurement

The color of the bread is measured using Hunter color lab. The sample is kept in the transparent tile and the reading has taken for the L, a and b values. The color values L (light-dark), a (red-green), and b (yellow-blue) of the bread and crumb samples.

Sensory evaluation

The composite bread with the incorporation of 10, 15, 20 and 25 per cent of cooked fermented pearl millet flour with refined wheat flour was given to the sensory panelists keeping the bread prepared from complete refined wheat flour as control. The attributes evaluated for bread was color, flavor, taste, chewiness and overall acceptability. Twenty five Semi trained panelists out of which 10 were male and 15 are female genders, of age varied from 16 - 35 were given a hedonic scale questionnaire to evaluate the composite bread using a 9 points scale (1- extremely dislike, 2- dislike very much, 3- dislike moderately, 4- dislike slightly, 5- neither like nor dislike, 6- like slightly, 7- like moderately, 8- like very much, and 9 - extremely like). Composite bread was evaluated for general appearance, crumb grain, odor, softness, taste, mouth feel and overall acceptability measures.

Results and Discussion

Studies on composite bread

Specific volume of composite bread: The effect of Cooked Fermented Pearl Millet (CFPM) flour on specific volume of composite bread is presented in Table 2. Bread specific volume decreased significantly with increasing CFPM flour substitution level. The volume of bread made from composite flours, were lower than those

made from pure refined wheat flour. The highest bread specific volume was 5.93 cc/g obtained from control bread, while flour containing 25 per cent CFPM flour resulted in the lowest bread specific volume of 5.04 and 5.27 cc/g, respectively. This finding was in agreement with that reported by Aluko and Olugbemi's [11], who found lower volumes associated with composite as opposed to 100 per cent wheat, while the specific volume of commercially available bread loaf in the market is 6 cc/g [12,13].

Parameters	Control	10 % of CFPM flour	15 % of CFPM flour	20 % of CFPM flour	25 % of CFPM flour
Loaf weight(g)	154	154	152	152	153
Loaf volume (cc)	913	866	836	832	772
Loaf specific volume (cc/gm)	5.93	5.61	5.55	5.47	5.04
Hardness(N)	11.48	12.22	16.7	19.65	21.15
Cohesiveness	0.71	0.69	0.7	0.63	0.61
Springiness	0.9	0.85	0.82	0.87	0.81
Gumminess (N)	8.19	8.48	11.65	12.42	12.9
Chewiness (N)	7.41	6.35	9.61	10.8	10.45

Table 2: Effect of cooked fermented pearl millet flour addition on specific volume and textural attributes of composite bread (CFPM- Cooked fermented pearl millet)

Textural properties of composite bread: The bread firmness, cohesiveness, springiness, gumminess and chewiness values was found for the composite bread with the ratio of 10, 15, 20 and 25 per cent of Cooked Fermented Pearl Millet (CFPM) flour with the refined wheat flour. The Table 3 illustrates the textural properties of composite bread. From the table it was understood that the hardness of the composite bread increases with increase in percentage concentration of the CFPM flour. The higher value of 21.15 N was observed for the bread with 25 per cent incorporation of the CFPM flour to the refined wheat flour. While the hardness of the remaining per cent of incorporation shows lower value [14-16].

The hardness value of bread with 10 per cent incorporation of CFPM flour show less deviation from the control sample whose hardness was 11.48 N and the hardness of 10 per cent bread was 12.22 N. There was no remarkable difference in the values of cohesiveness and springiness in spite of any per cent of incorporation.

Effect of adding cooked fermented pearl millet flours on refined wheat flour bread and bread crumb color:

The color values L (light-dark), a (red-green), and b (yellow-blue) of the bread and crumb samples of blended flour are provided in Table 2. The results indicate that, as the per cent of CFPM flour replacement increased, L-values shifted significantly from white to gray, a values shifted from green to red, and b values shifted from blue to yellow. Overall, the L values of the bread and bread crumb samples substituted with CFPM flour decreased from 72.54 to 62.47 and from 64.54 to 55.47, indicating a significant increase in grayish color. The highest a-value was that of bread made with 25 per cent CFPM flour (-0.13); whereas, the lowest value was observed in bread made from 100 per cent refined wheat flour as indicated by a higher intensities of green color [17,18]. On the other hand, the lowest b value was associated with bread made from the 100 per cent refined wheat flour 9.51, whereas the highest value 12.67 was associated with bread made with 25 per cent CFPM flour. The effects of CFPM flour substitution on the color of the bread crumb were more obvious than that of bread color. The results from this study indicate that CFPM flour darkened crumb color.

Bread crumb					
Colour value	Control	10% of CFPM flour	15% of CFPM flour	20% of CFPM flour	25% of CFPM flour
L-value	64.54	60.58	58.18	57.29	55.47
a-value	-0.75	-0.67	-0.47	-0.23	-0.13
b-value	29.51	20.4	19.45	15.53	12.67
Bread					
L-value	72.54	71.58	69.18	65.29	62.47
a-value	-0.62	-0.58	-0.35	-0.21	-0.09
b-value	9.51	10.45	11.83	12.37	11.92

Table 3: Effect of adding cooked fermented pearl millet flours on refined wheat flour bread and bread crumb colour (CFPM- Cooked fermented pearl millet)

Sensory evaluation of composite breads

Semi trained panelists were given a hedonic scale questionnaire to evaluate the composite bread using a 9 points scale (1- extremely dislike, 2- dislike very much, 3- dislike moderately, 4- dislike slightly,

5- neither like nor dislike, 6- like slightly, 7- like moderately, 8- like very much, and 9 - extremely like). Composite bread was evaluated for general appearance, crumb grain, odour, softness, taste, mouth feel and overall acceptability measures.

From the Table 4 given below, it can be predicted that there was significant difference in the overall acceptability with increasing level of CFPM flour with the refined wheat flour. The color of the composite breads made with 5 and 10 per cent substituted CFPM flour was similar to the control (100 per cent refined wheat flour); whereas at higher levels of substitution, samples were significantly darker. The mouth feels score decrease significantly as the level of CFPM flour increased. The mouth feels score of 10 and 15 per cent composite

bread was found to be similar with each other with the mean score of 7.59 and 7.5. The sensory evaluation score for the composite bread prepared from the 25 per cent substitution of CFPM flour in the refined wheat flour ranges from 5.22 to 6 for the sensory attributes. These results are in agreement with those reported by Summer and Nielsen, who concluded that incorporation of 25 per cent millet flour in bread formulation darkened the internal and external loaf color. In this study, overall bread quality at the different levels of cooked fermented pearl millet flour to the substitution levels from 10 to 20 per cent was found to be acceptable. However, acceptability increased as the level of substitution of CFPM flour decreased. These results are in agreement with the work of Kyomugisha [19].

Sensory attributes	Control	10 % of CFPM flour	15% of CFPM flour	20% of CFPM flour	25% of CFPM flour
Appearance	8.44	8.12	8.4	7.5	6
Colour	8.5	8	7.99	6.86	4.89
Taste	8.8	8.2	7.11	6.92	5.59
Softness	8.6	7.76	6.94	6.51	5.22
Mouth feel	8.7	7.59	7.5	6.23	5.44
Over all acceptability	8.6	7.48	6.98	6.8	5.41

Table 4: Sensory evaluation of composite bread (CFPM- Cooked fermented pearl millet)

Conclusion

The Cooked Fermented Pearl Millet (CFPM) was also utilized for preparing bakery products. The bakery products are usually made of refined or whole wheat flour, due to the less availability of fibre, frequent consumption of them leads to constipation problem and colon cancer for consumers. The substitution of cooked fermented pearl millet flour for the refined whole wheat flour finds utilization of pearl millet in bakery. The non-glutinous nature of cooked fermented pearl millet flour shows reduction in raising level during the preparation of bread. Hence the substitution level of cooked fermented pearl millet (CFPM) flour for refined wheat flour was limited to 25 per cent. The bread with 10 per cent incorporation of CFPM flour finds no remarkable change in the physicochemical and textural properties with the commercially available in the market whose hardness is 11.48 N and for 10 per cent CFPM is 12.22 N. The bread prepared from 25 per cent substitution show increased hardness value of 21.15 N. The color declined from white to yellow with increase in replacement of refined wheat flour. The sensory evaluation of composite bread has shown increase in the likeness with decrease in degree of substitution of CFPM flour for refined wheat flour. The advantage of the fermentation of pearl millet is that, the anti-nutrients phytic acid present in the sample is was reduced from 858.4 mg/ 100 g in the raw pearl millet to 380.3 mg/100 g in the cooked fermented pearl millet. The probiotic bacteria are not thermo stable, so during the baking temperature these probiotic nature has been disintegrated .The 25 per cent incorporation was unacceptable in terms of both textural and physical attributes. The composite breads with 10, 15 and 20 per cent of substitution of CFPM flour shown good consumer acceptability.

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