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SHORT COMMUNICATION

Quality characteristics of bread produced from wheat, rice and maize flours

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Abstract Rice (*Oryza sativa*) flour and maize (*Zea mays*) meal substitution in wheat (*Triticum aestivum*) flour, from 0 to 100% each, for the production of bread was investigated. The proximate analysis, pasting properties, bread making qualities of raw materials and sensory evaluation of the bread samples were determined. The pasting temperature increased with increased percentage of rice flour and maize meal. But the other pasting characters decreased with the higher proportion of rice flour. The baking absorption was observed to increase with higher level of maize meal but it decreased when level of rice flour was increased. Loaf weight (g) decreased with progressive increase in the proportion of maize meal but increased when rice flour incorporation was increased. Loaf volume, loaf height and specific volume decreased for progressively higher level of maize meal and rice flour. The sensory evaluation revealed that 25% replacement of wheat flour was found to be more acceptable than control sample.

Keywords Maize meal · Pasting properties · Rice flour · Sensory quality · Wheat flour

Introduction

Bread is traditionally produced from wheat (*Triticum aestivum*) flour. Non-wheat growing regions import the wheat or bread to fulfill their demands. The inability of some countries to sustain their wheat import for making wheat based foods makes it imperative that some substitutes for wheat must be incorporated in the bread preparation. The concept of alternate flour in bread making was introduced many years ago and graded levels of wheat achieve degrees of success in bread making (Harden and Yang 1975; D'Appolonia 1977). Indigenous non wheat flours were utilized in replacing portions of wheat flour in bread making (Okaka and Potter 1977).

Maize (*Zea mays*) is the cheapest cereal among food grains which provide both energy as well as good quality protein. Although its pericarp fraction, which contains 77.7–84.6% dietary fibre (Gupta and Singh 1981) and adheres so tightly to the outer surface of aleuronic layer, which cannot be removed easily, is responsible for decreasing digestibility and smoothness of its dough.

Rice (*Oryza sativa*) is one of the most important crops in the world in addition to wheat and maize and more than 650 million metric tons of paddy rice is produced worldwide per year (InterRice 2009). Among the chemical components of rice grains, amylase and protein contents are very important factors influencing the eating quality of rice. Also the moisture content, low molecular weight sugar and mineral content affect the palatability of rice.

This study was aimed for determining proximate composition and pasting properties of raw materials, bread making quality and sensory qualities of breads produced from varying substitutions of rice flour and maize meal with wheat flour.

Materials and methods

The rice (*Oryza sativa*) flour and maize (*Zea mays*) meal was milled to suitable size flour from the commercial stone

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grinding mill. Wheat flour was procured from M/s Gilco Flour Mills, Ludhiana for making bread. Compressed yeast, i.e. prestige yeast (*Saccharomyces cerevisae*) (SAF yeast Co., Bombay) was obtained fresh from a local store and kept in refrigerator for baking tests. Bakery shortening (Amrit Vanaspati Ltd., Chandigarh Road, Rajpura-140401, Punjab) having melting point of 37 °C, sugar, salt and potassium bromate were obtained from the local market.

Physico-chemical composition of raw material Standard procedures for moisture, protein, ash, fat, fiber contents (AACC 1990), calorific values (Swaminathan 1989) and pasting properties (Batey et al. 1997) were determined as reported earlier (Rai et al. 2011).

The formula for control bread was 100 g flour, 3 g compressed yeast, 2.5 g sugar, 4 g bakery shortening, 1.5 g common salt, 10 ppm potassium bromated and optimum quantity of water. The dough was prepared and baking caution for making bread were mixing time 3 min, fermentation time 75 min, remixing time 25 s, recovery time 20 min, proofing (30 °C/75% RH) time 55 min and baking at 232 °C for 25 min.

For experimental bread preparation was done by replacing wheat flour with 25, 50, 75 and 100% with rice or maize flour.

The bread loaves were packed in polyethylene bags and analyzed for volume, specific volume and height. Sensory evaluation for appearance, crust color, aroma, taste and overall acceptability was carried out the next day as per score card by a panel of minimum six semi trained judges on 9-point).hedonic scale.

The experimental data (three replicates) were analyzed with using ANOVA technique of Snedecor and Cochran (1968) using completely randomized design.

Results and discussion

Results are presented in Table 1. Proximate chemical composition and functional properties of raw materials were similar to earlier report (Rai et al. 2011). Pasting temperature increased with increasing levels of rice flour incorporation (67.7–74.8 °C). The peak viscosity, hold viscosity and final viscosity increased with progressively higher level of rice flour in the formulation. The final viscosity was maximum (6,870 cP) for rice flour as compared to control flour (2,913 cP). The break down and set back viscosity increased with increasing levels of

Table 1 Quality characteristics of different flour mixtures and bread

	Flour mixture								
	Control	Wheat: Rice				Wheat: maize				CD ($P \geq 0.05$)
		25:75	50:50	75:25	0:100	25:75	50:50	75:25	0:100	
Pasting properties ($n=3$)										
Pasting temp, °C	67.7	68.5	71.8	72.7	74.8	73.9	77.1	79.1	83.6	0.28
Peak viscosity, cP	2,243	2,493	2,694	2,930	3,877	1,539	1,045	895	764	3.23
Hold viscosity, cP	1,651	1,899	2,177	2,450	3,192	984	843	707	590	2.80
Final viscosity, cP	2,913	3,439	4,340	5,170	6,870	3,357	2,188	1,761	1,583	0.01
Break down viscosity , cP	592	594	517	480	685	555	338	174	52	3.43
Setback viscosity, cP	1,262	1,537	2,163	2,720	3,684	2,514	1,204	1,054	993	3.02
Bread making quality ($n=3$)										
Baking absorption, ml	67.3	65.0	64.0	62.0	60.0	66.5	67.0	68.0	69.0	0.30
Loaf weight, g	152.0	143.3	145.9	142.1	140.9	156.5	157.1	157.0	159.2	0.20
Loaf volume, cc	575	535	475	445	435	480	430	420	410	3.36
Loaf height, cm	9.3	9.2	8.5	7.5	5.5	9.2	9.2	8.7	5.4	0.34
Specific volume, cc/g	3.78	3.73	3.25	3.13	3.08	3.07	2.74	2.74	2.68	0.03
Sensory quality ($n=6$ panelists)										
Appearance	8.1	8.2	7.7	7.5	6.4	8.2	8.1	7.2	6.2	0.23
Crust color	8.2	8.4	8.2	7.2	6.1	8.0	7.9	6.9	6.3	0.28
Crumb color	8.0	8.1	7.7	7.0	6.2	7.8	7.7	7.9	6.0	0.28
Aroma	7.8	8.0	7.8	7.0	6.8	7.7	7.6	7.7	6.2	0.35
Taste	8.0	8.2	8.0	6.5	6.2	7.8	7.6	7.6	6.5	0.34
Overall acceptability	8.0	8.2	7.9	7.0	6.3	7.9	7.8	7.3	6.2	0.12

rice flour as compared to control. Singh et al. (1996) reported that blending of mung (*Vigna radiata*) flour and addition of sodium bicarbonate significantly increased the gelatinization temperature but reduced the viscosity. Incorporation of increasing levels of maize flour increased pasting temperature (67.7–83.6 °C). The peak viscosity, hold viscosity and breakdown viscosity decreased but final viscosity (2,913–3,357 cP) and set back viscosity (1,262–2,514 cP) increased with higher level of maize flour.

Pasting temperature of maize flour was maximum (83.6 °C) and was minimum for wheat flour (67.7 °C). The peak viscosity was minimum (764 cP) in maize flour and maximum in rice flour (3,877 cP). The hold viscosity was maximum in rice flour (3,192 cP) and minimum in maize flour (590 cP). Rice flour was found to have maximum paste viscosity (6,870 cP) and minimum paste viscosity was observed in maize meal (1,583 cP). Break down viscosity was observed to be maximum in rice flour (685 cP) and minimum for 100% maize meal (52 cP) whereas, set back viscosity was observed to be minimum in maize flour (993 cP) and maximum for rice flour (3,684 cP). Gujral et al. (2003) reported the effect of cyclodextrinase (CGTase) addition to rice flour on pasting properties. Addition of CGTase lowered the peak viscosity and slightly affected the final viscosity, indicating that the enzyme breaks the starch and thus lowers the viscosity.

Bread making quality As the level of rice flour incorporation increased, a decrease in baking absorption, loaf weight, loaf volume, loaf height and specific volume was observed although handling of dough was smooth for all levels of incorporation of rice flour. However, with 25% level of rice flour the bread making quality was comparable with control flour but further increase (more than 25%) of alternate flour (maize or rice) significantly deteriorated the bread making quality of flour mixture. With increased levels of maize flour the baking absorption and loaf weight increased but in loaf volume, loaf height and specific volume (cc/g) decreased. Rhee et al. (1982) reported that loaf volume of bread prepared from barely-wheat blend was similar to the control. Bhatty (1986) studied that 50% replacement of wheat flour with barely flour had no serious effects on loaf volume and it was maximum at 25% level of incorporation of rice flour and maize meal. Rao and Rao (1997) reported that the water absorption of flour blends and bread volume decreased with increasing level of sorghum substitution.

Sensory quality of bread During bread making, the optimum level of rice or maize flours should be 25% only and more than this level of incorporation decreased the sensory quality of breads. Sanchez et al. (2002) reported maximum of response surfaces for crumb-grain score and bread score which revealed that optimal gluten-free bread can be prepared from 74.2% cornstarch, 17.2% rice flour, and 8.6% cassava starch. Similar to our findings Patel et al. (1996) reported that the quality of bread prepared using composite flours had decreased. Shalini and Lakshmi (2005) reported that the bread incorporated with 30% wheat bran, 20% finger millet flour, 10% ginger, 10% garlic and 3% mixed spices was well accepted and incorporation of functional ingredients didn't alter the softness but interfered with the gluten formation by decreasing the tensile strength of the bread.

Conclusion

The most acceptable preparations of alternate flour based breads were selected on the basis of bread making and sensory quality of breads after incorporation of rice flour and maize meal at different levels. Pasting properties of wheat flour altered significantly after incorporation of various levels of rice or maize flour. Rice or maize flour can substitute wheat flour by 25% for bread making without affecting bread making quality adversely.

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