J. Bangladesh Agril. Univ. 9(2): 297–304, 2011 **ISSN 1810-3030**

Studies on the effect of brown rice and maize flour on the quality of bread

M. Z. Islam[1] and M. Shams-Ud-Din[2] and M. A. Haque[3]
[1]Department of Food Engineering and Tea Technology, Shahjalal University of Science and Technology, Sylhet-3114, [2]Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh and [3]Department of Food Technology and Nutritional Science, Mawlana Bhashani Science and Technology University Santosh, Tangail-1902, Email: zohurulislam.engg@gmail.com

Abstract

Breads were prepared with various combinations of maize, brown rice and wheat flours in the basic formulation of bread. The baking properties and chemical composition of bread were evaluated and analysed, respectively. The bread volume decreased, where as bread weight and moisture content increased with the increasing level of maize and brown rice flour. The crumb and crust colour of breads were improved with addition of 8% maize and 8% brown rice flour in bread formulation. The protein content and other nutrients of breads were increased by addition of maize and brown rice flours. The effects of various levels of yeast, sugar, fat, improver and salt on the quality of breads prepared with maize and brown rice flour were evaluated. Bread quality in respects of bread volume and crumb texture were improved by using 2.5% yeast, 5% sugar, 5% fat and 0.6% improver. The analysis of bread containing added 8% maize and 8% brown rice flours showed protein 9.76%, fat 4.10%, ash 2.10%, crude fibre 5.16%, sugar 2.26% and total carbohydrates 46.91%. Bread having 8% maize and 8% brown rice flour had most acceptable flavour, texture, colour and overall acceptability when compared with other bread with maize and brown rice flour.

Keywords: Bread, Brown rice flour, Maize flour, Wheat flour

Introduction

Brown rice is the entire grain with only the inedible outer husk removed. The nutritious, high-fiber bran coating gives it a light tan color, nutlike flavor and chewy texture. Whole-grain brown rice flours add a different flavor and chewy texture to baked products. Such flours from raw, untreated rice grains have limited shelf-life stability, due chiefly to lipase activity (initiated in bran layers during flour milling), which causes enzymatic hydrolysis of lipid components to free fatty acids. Several methods exist for stabilizing rice bran separated during the raw milled rice (Sayre *et al*. 1982). The rice bran contains 12-16% protein which has high nutritional value. The addition of rice bran improves the lysine content of baked product and also contributes a bland pleasant flavor (Lynn, 1969).

Maize is a high energy food having highly digestible carbohydrate, high protein content composed of amino acids essential for human nutrition, cholesterol free oil and good quantity of trace minerals (Martin and Leonard, 1967). Maize is a fairly rich in vitamins-B and the yellow kernel is also good source of the pro-vitamin-A, beta-carotene, which can prevent human blindness. It contains 11.2% protein, 66.2% carbohydrates, 3.6% fat, 1.5% minerals and 2.7% fiber (Gopalan *et al*. 1981). In our country maize is confined in roasted cob, a poultry feed, fodder, starch and snacks. Other forms of food using maize flour alone or mixed with flours from other cereals and pulses include bread, chapati, parota, pulse puri, soup, mixed food, bhutta polao etc. thus the development of the technology for effective utilization of non-wheat flour like brown rice flour, maize flour may be a part of the subject of research in the field of cereal processing technology in the country.

Bread is the most widely used breakfast items in urban and sub-urban areas in Bangladesh. Around the world bread is the principal food and provides more nutrients than any other single food source. In most European countries it is the source of half of the total carbohydrates requirements, one third of the protein requirements, and over 50% of the B-vitamins and 75% of vitamin-E requirements (Pomeranz and Shellenberger, 1971). As a result of changing food habits, increasing population and urbanization the consumption of leavened wheat bread has risen dramatically in many developed countries including Bangladesh. On the other hand for climatic reason many developing countries can not grow wheat suitable for bread making. Thus partial substitutions of wheat flour with flour from indigenous crops or the production of alternative wheat less bread may be the subject of research.

Taking the above points in considerations the present study was undertaken with the following objectives:

i. to develop dietary fiber-enriched baked product such as bread by incorporation of brown rice, maize and wheat flour in the formulations;
ii. to study the effect of various levels of brown rice and maize flour on loaf quality, composition and sensory properties of prepared bread.

Materials and Methods

The investigation was conducted in the laboratory of the Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh, Bangladesh. The maize, raw paddy (pajam) and commercial wheat flours were collected from local market. Brown rice flour was processed from pajam variety by removing the husk. Maize flour was processed from the straw yellow varieties of maize, free from immature, field damage and black maize. The samples were grounded to powder in a flour mill. The initial samples of brown rice and maize flour were analyzed for moisture content, ash, protein and fat as per the methods of AOAC (2004). All the determinations were done in triplicate and results were expressed as the average value in Table 1. The breads were prepared with various levels of brown rice and maize flour in the formulation. The replacements of wheat flour in the formulation were made with 0, 5, 8, 11 and 14% of brown rice and maize flour respectively.

Table 1. Formulation of Bread

Ingredients	Bread Formulation				
	A	B	C	D	E
Wheat flour (g)	100	90	84	78	72
Maize flour (g)	0.0	5	8	11	14
Brown rice flour (g)	0.0	5	8	11	14
[1]Dry yeast (g)	2.5	2.5	2.5	2.5	2.5
[2]Salt (g)	2.5	2.5	2.5	2.5	2.5
[3]Sugar (g)	2	2	2	2	2
[4]Fat (g)	2	2	2	2	2
Water (ml)	65	65	65	65	65
*Bread improver (g)	1.2	1.2	1.2	1.2	1.2

*Bread improver consists of a mixture of potassium bromate 0.30g, ascorbic acid 0.50g, calcium sulphate 7.5g, ammonium chloride 5.0g and malt flour 36.07g.
[1]Dry yeast were added at the level of 0.25 to 3% on the flour weight basis.
[2]Salt were added at the level of 0.5 to 3% on the flour weight basis.
[3]Sugar were added at the level of 1to 6% on the flour weight basis.
[4]Fat were added at the level of 1 to 6% on the flour weight basis.
*Bread improver were added at the level of 0.2 to 0.70% on the flour weight basis.

Breads were prepared as per the procedures described by kent (1984). Bread volume was initially used as an important parameter of bread quality. The bread volume was determined by seed displacement method (ott, 1987). The results were expressed in cc (ml) and the values were average of three replications. Loaf weight, moisture content, colour, crust and crumb quality were also determined with the following standard methods described by Kent (1984) and ott (1987).

Results and Discussion

Composition of brown rice and maize flour: The results of the proximate composition analysis of brown rice and maize flour are presented in Table 2. The Table showed that brown rice flour contained moisture 10.75%, protein 8.24%, fat 2.65%, ash 1.5%, crude fibre 2.25% and total carbohydrate 76.86%. The findings of this analysis are in agreement with that of Grist (1965) who reported 9.67-9.54% protein, 2.0-2.54% fat, 1.19-1.9% ash, 0.16-0.4% crude fibre and 79-91.4% total carbohydrate. Julialo (1972) reported that 7.1-15.4% proetin, 0.6-4.0% fat, 0.2-2.6% fibre, 0.5-2.1% ash. McCall et al. (1951) observed the range of moisture of brown rice was 9.1-12.6%.

The prepared maize flour was analyzed for its composition. The results are presented in Table 2. The analysis showed that the maize flour contained moisture 8.98%, protein 9.0%, fat 3.50%, ash 1.48% and total carbohydrate 78.04%. The moisture, protein, fat and ash content were more or less similar and carbohydrate contents higher than those reported by Kent (1990). He reported that the maize flour contains 12.6% moisture 9.4 % protein 4.1% fat, 1.4% ash, and crude fibre 2.0% and 72.1% carbohydrates. All results are also shown in dry basis (db).The differences observed in these compositions may be due to the following reasons are varietal differences, agro-ecological condition, extent of drying, fertilizer use and methods of analysis etc.

Table 2. Composition of brown rice and maize flour

Components	Brown rice flour	Maize flour
Moisture (%)	10.75 (12.04db)	8.98 (9.86 db)
Protein (%)	8.24 (8.98 db)	9.00 (9.88 db)
Fat (%)	2.65 (2.97db)	2.50 (2.75 db)
Ash (%)	1.50 (1.68db)	1.48 (1.63 db)
Crude fibre (%)	2.10 (2.35db)	2.25 (2.47 db)
Total carbohydrates (%by difference) (%)	76.86 (86.12db)	78.04 (85.74db)

The parenthesis values (db) indicate dry basis

The effect of maize and brown rice flour on bread properties

Physical properties of breads incorporating brown rice and maize flour: The effects of maize and brown rice flour on the breads are presented in Table 3. It can be seen from Table 3. that the control bread gave higher volume (512cc) than those other breads prepared with 5, 8, 11 and 14 levels of brown rice and maize flour. It was also observed that the bread volume progressively decreases with the increasing of brown rice and maize flour in the formulation. Since brown rice and maize flour does not contain gluten, its substitution in wheat flour reduced the gluten content in the dough. This might be due to decrease in volume of bread containing brown rice and maize flour. The breads with different levels of maize and brown rice flour had higher moisture contents (36.25-40.10 %) than that of the control bread. The moisture content of the bread samples gradually decreases with reducing the level of maize and brown rice flour in dough. This might be due to the fact that higher moisture content in composite flour bread contained higher amount of fibre (cellulose, hemicelluloses, or pentosans, lignin and other dietary fiber components) which are contributed by maize and brown rice flour in the dough. These might hold the water which may contribute to the higher moisture content of the maize and brown rice flour containing bread. Similarly the weights of the bread prepared with different level of maize and brown rice flours in the formulation observed that all the bread samples (230-246gm) had higher weights than that of control bread (220 g).

Table 3. Effect of maize and brown rice flour on volume, weight, specific volume and moisture content of bread

Bread with	Volume (cc)	Weight (g)	Specific volume (cc/g)	Colour	Moisture content (%)
Maize flour=0 Brown rice flour =0	512	220	2.327	Light brown	35.16
Maize flour=5 Brown rice flour =5	498	230	2.165	Light brown	36.25
Maize flour=8 Brown rice flour =8	490	237	2.067	Light brown	37.17
Maize flour=11 Brown rice flour =11	475	240	1.979	Red brown	39.15
Maize flour=14 Brown rice flour =14	470	246	1.91	Red brown	39.71

Physical Properties of bread: General appearance, crust and crumb characteristics of bread containing brown rice and maize flour are presented in Table 4. It is observed that control bread had better appearance compared with 5, 8, 11 and 14% brown rice and maize flour containing bread. The crust colour of the bread containing 5% brown rice and 5% maize flour and the bread containing 8% brown rice and 8% maize flour were deeper than those of the control bread and other bread samples. The bread containing 11% maize and 11% brown rice flour and bread containing 14% maize and 14% brown rice flour had harder crust compared to both the control and the bread containing 8% brown rice and 8% maize flour. The overall crust characteristics of the bread containing 8% brown rice and 8% maize flour seemed to be better than other samples. In general, the differences in crust colour between different bread samples become larger as the substitution levels of maize and brown rice flour increased in dough. Crumb colour of the breads containing different level of maize and brown rice flour is presented in Table 4. Colour evaluation was made with interior slices. As shown in Table 4. the crumb colour of bread containing 14% maize and 14% brown rice flour was generally yellowish than the control sample. As a whole, the bread containing 5% maize and 5% brown rice flour and bread containing 8% maize and 8% brown rice flour had better crumb colour than those obtained from different levels of maize and brown rice flour. This might be due to the yellow colour of the maize flour. The decrease in the levels of maize and brown rice flour substitution changed the crumb colour of the samples from yellowish to white yellow. A good colour regardless of kinds of bread is always desirable.

A significant differences in texture was observed between bread without maize and brown rice flour and bread having 14% maize and 14% brown rice flour and this differences increased with increasing the levels of maize and brown rice flour.

Uniformity of size with thin walled cell is most desirable for crumb grain. Coarseness, thick walled cells, uneven cell size and large holes are indicative of poor grain. As shown in the Table 4. The bread containing 11% maize and 11% brown rice flour and the bread containing 14% maize and 14% brown rice flour were contained these properties. The characteristics of air cell observed for the experimental breads containing brown rice and maize flour and that of control are presented in Table 4. The air cell size in the bread containing 11% maize and 11% brown rice flour and bread containing 14% maize and 14% brown rice flour were slightly larger than other breads.

Table 4. Effects of maize and brown rice flour on general appearances, crust and crumb characteristics of bread

Bread with	General appearance			Crust characteristics		Crumb characteristics					
										Grain	
	Evenness	Edges	Centre	Colour	Consistency	Colour	structure	Texture	Odour	Presence of large air cell	Shape and size
Maize flour=0 Brown rice flour =0	Even	Medium	Medium	Light brown	Tender	White-yellow	Fine even	soft silky	Appetizing	None or very few	Uniform, thin walled cells
Maize flour=5 Brown rice flour =5	Even	Medium	Medium	brown	Tender	White-yellow	even	Light Silky	Sweet	Very few	Uniform
Maize flour=8 Brown rice flour =8	Even	Medium	Medium	Light brown	Tender	Slightly yellow	even	light, silky	Appetizing	Very few	Uniform
Maize flour=11 Brown rice flour =11	Medium Even	Low	Low	Brownish	Medium tender	Yellowish	Coarse even	Light silky	Medium fresh	Very few	Less uniform
Maize flour=14 Brown rice flour =14	Uneven	Too low	Low	deep brown	Medium Tough	Yellowish	Coarse even	Light silky	Slightly fresh	few	Non - uniform

The effect of maize and brown rice flour on the composition of bread: In the present study five different samples of bread were processed and chemical properties were measured to assess the quality. The bread samples were analyzed for moisture, protein, fat, ash, crude fiber and total carbohydrates content. The moisture contents of five different bread samples processed with different levels of maize and brown rice flour were shown in Table 5 and showed that the moisture content of the bread without maize and brown rice flour (35.16%) was lower than those of the other bread. The highest moisture content 40.1% was found in the bread containing 14% maize and 14% brown rice flour. It can be seen

that the moisture content of the bread gradually increases with increasing levels of maize and brown rice flour. This might be due to the high concentration of fibers significantly increasing in water holding capacity of the higher portion of maize and brown rice flour bread. In present study it was observed that the protein contents of all samples were 7.89-6.79% much lower than that of the bread without maize and brown rice flour 8.50%. It was observed that protein content in bread decreases with increasing levels of brown rice and maize flour. The might be due to the higher percentage of protein content in wheat flour (12% protein reported by Kent, 1990). Fat content was highest (4.29%) in sample S_5 where wheat flour was substituted by 14% maize and 11% brown rice flour and lowest (1.60%) in controlled sample. The fat contents of the bread samples increased with increasing the percentage of maize flour in dough. Since maize flour contains approximately 3.50 % fat where as brown rice and wheat flour contain 2.65%, 0.91% fat respectively. Where as McCall *et. al*. (1951) found that brown rice contained 1.4-2.6% fat and Gopalan et al., 1981 found that maize flour and wheat flour contained 3.6 and 1.6% of fat respectively.

The maximum ash was found in bread containing 14% maize and 14% brown rice flour 2.42% and lowest in the bread without maize and brown rice flour 0.85%. Increasing the amount of brown rice and maize flour in breads gave increased ash content of samples. This might be due to the dry matter content of the maize and brown rice flour. In Table 5. it was shown that the highest fibre content 5.86% was obtained in the bread containing 14% maize and 14% brown rice flour and the lowest fibre content was obtained in the bread without maize and brown rice flour 0.65%. This is due to the addition of increasing amount of brown rice and maize flour. The total sugar content of bread was also evaluated. The higher value 2.46% of sugar was observed in brown rice and maize flour containing bread and lower value 1.85% in bread without maize and brown rice flour.

Table 5. Composition of bread containing different levels of maize and brown rice flour[a]

Components	Bread with				
	0% maize and brown rice flour	5% maize and brown rice flour	8% maize and brown rice flour	11% maize and brown rice flour	14% maize and brown rice flour
Moisture (%)	35.16 (54.22 db)	36.25 (56.86 db)	37.13 (59.08 db)	39.75 (65.97 db)	40.10 (66.94 db)
Protein[b]	8.50 (13.11 db)	7.89 (12.37 db)	7.55 (12.00 db)	6.92 (11.48 db)	6.79 (11.33 db)
Fat (%)	1.60 (2.46 db)	3.96 (6.12 db)	4.10 (6.52 db)	4.21 (6.987 db)	4.29 (7.16 db)
Ash (%)	0.85 (1.312 db)	1.96 (3.074db)	2.10 (3.34 db)	2.26 (3.75 db)	2.42 (4.04 db)
Crude fibre	0.65 (1.002 db)	4.96 (7.78 db)	5.16 (8.21 db)	5.42 (8.99db)	5.86 (9.78 db)
Total sugar	1.85 (2.85 db)	2.13 (3.34 db)	2.26 (3.59 db)	2.39 (3.966 db)	2.46 (4.10 db)
Total carbohydrate (% by difference)	53.89 (83.122 db)	48.21 (75.62 db)	46.91 (73.16 db)	43.91 (72.87db)	43.07 (71.90 db)

The parenthesis values (db) indicate dry basis.
[a]Values are an averages of three determination.
[b]6.25 was used as a conversion factor from nitrogen to protein.

Effect of various levels of sugar, on the quality of bread containing different level of maize and brown rice flour: The optimum level of sucrose enhanced the flavor of bread but more sugar contents decreased the acceptability of bread. Different levels of maize and brown rice flour were incorporated into standard wheat flour in the bread formulation and sugar was added at the rate of 1% to 6% on the flour weight basis. Volume, specific volume, weight and moisture content were evaluated for different type of breads from Table 6. It was observed that increasing level of sugar addition increases the bread volume, weight, moisture content.

Table 6. Effects of various levels of sugar addition on the quality of bread containing maize and brown rice flour

Level of sugar addition	Type of breads															
	Bread with 5% maize and 5% brown rice flour				Bread with 8% maize and 8% brown rice flour				Bread with 11% maize and 11% brown rice flour				Bread with 14% maize and 14% brown rice flour			
	Volume (CC)	Weight (gm)	Specific volume CC/gm	Moisture content	Volume (CC)	Weight (gm)	Specific volume CC/gm	Moisture content	Volume (CC)	Weight (gm)	Specific Volume CC/gm	Moisture content	Volume (CC)	Wt. (gm)	specific volume CC/gm	Moisture Content
1	492	227.5	2.163	35.50	489	233	2.098	36.19	488	234	2.085	36.0	485.5	237	2.049	35.15
2	493	228	2.162	36.16	490	233.5	2.098	36.90	489	234	2.080	37.5	486	238	2.042	36.5
3	493	228.5	2.156	36.93	491	234	2.098	36.99	489	235.5	2.076	37.76	487	238.5	2.042	37.79
4	494	229	2.157	36.97	491	235	2.089	37.14	490	236.5	2.071	37.92	487.5	239	2.040	38.87
5	495	230.5	2.148	37.99	492	235	2.094	38.04	491.5	237	2.073	38.2	488	240	2.033	39.1
6	496	231	2.147	38.00	493	236	2.089	38.12	491	237.5	2.067	38.4 4	489	241	2.029	39.2

Effects of various levels of yeast on the quality of bread containing maize and brown rice flour: Yeast was added in the bread formulation at the rate of 0.25% to 3% on the flour weight basis. Volume, weight and moisture content were evaluated for different type of breads and the results are given in Table 7. It was observed that the bread volume increases gradually with increasing level of yeast addition from 0.25 to 3.00%. It is found that the highest volume of the bread was found at highest level of yeast addition (i.e. 3.0%). The most acceptable level of yeast were found to be 2.5%, in 8% maize and 8% brown rice flour containing bread and 2.0% in other breads. These levels of yeast addition give smooth, uniform and soft texture with the most acceptable volume of bread.

Table 7. The effects of various levels of yeast addition on the quality of bread containing maize and brown rice flour

Level of yeast addition	Type of breads															
	Bread with 5% maize and 5% brown rice flour				Bread with 8% maize and 8% brown rice flour				Bread with 11% maize and 11% brown rice flour				Bread with 14% maize and 14% brown rice flour			
	Volume (CC)	Weight (gm)	Specific volume CC/gm	Moisture content	Volume (CC)	Weight (gm)	Specific volume CC/gm	Moisture content	Volume (CC)	Weight (gm)	Specific Volume CC/gm	Moisture content	Volume (CC)	Wt. (gm)	specific volume CC/gm	Moisture Content
0.25	485	227	2.136	33.5	480	231	2.078	34	484	230	2.104	34.5	476	232	2.051	35.8
0.50	487	227.5	2.140	34.27	481	232	2.073	35.5	485	231	2.099	35.0	479	234.5	2.043	36.0
1.00	490	228	2.149	35.61	485	233.5	2.078	37.14	488	233	2.094	36.75	483	236	2.047	37.27
1.5	493	229	2.153	36.7	489	235	2.080	37.9	491	234.5	2.094	37.98	485	238.5	2.034	38.42
2.0	495	230	2.152	36.97	492	237	2.080	38.14	492	235	2.094	37.14	487	239	2.034	38.90
2.5	496	231	2.147	37.08	493	238	2.071	38.25	492	235.5	2.089	37.9	488	240	2.033	39.05

The effects of various levels of improver on the quality of maize and brown rice flour containing bread: Improver was added in the bread formulation at the rate of 0.2% to 0.7% on the flour weight basis. Volume weight, specific volume and moisture content were evaluated for different type of maize and brown rice flour containing bread and the results are given in Table 8. It was observed that the bread volume increases gradually with increasing level of improver addition from 0.2 to 0.7%. In case of 8% maize and 8% brown rice flour containing bread the optimum level of improver was found to be 0.6% in order to achieve acceptable volume, texture and structure of bread.

Table 8. The effects of various levels of improver addition on the quality of bread containing maize and brown rice flour

Level of improver addition	Type of breads															
	Bread with 5% maize and 5% brown rice flour				Bread with 8% maize and 8% brown rice flour				Bread with 11% maize and 11% brown rice flour				Bread with 14% maize and 14% brown rice flour			
	Volume (CC)	Weight (gm)	Specific Volume CC/gm	Moisture content	Volume (CC)	Weight (gm)	Specific volume CC/gm	Moisture content	Volume (CC)	Weight (gm)	Specific Volume CC/gm	Moisture content	Volume (CC)	Wt. (gm)	specific volume CC/gm	Moisture content
0.2	494	228.5	2.162	36.53	485	238.9	2.030	38.5	491	233	2.107	37.06	484	238	2.033	37.07
0.3	495	229	2.162	36.91	485	239	2.029	38.70	492	233.5	2.107	37.21	485	239	2.029	37.52
0.4	496	229	2.166	37.09	486	239.5	2.029	38.87	494	234	2.111	37.59	486.5	239.5	2.031	37.7
0.5	498	230	2.165	37.14	487	239.5	2.033	39.0	495	235	2.106	37.88	487	240	2.029	38.4
0.6	499	231	2.160	37.90	488	240	2.033	39.1	495	236	2.106	38.12	488.5	240.5	2.031	38.56
0.7	500	232	2.155	38.01	489	241	2.023	39.2	496	236.5	2.097	38.20	489	241	2.029	38.70

Effects of various level of fat on the quality of bread: The breads were prepared by adding 1 to 6% fats on the flour weight basis. The volume, weight, specific volume and moisture content of the prepared bread were evaluated and results are given in Table 9. It was observed that the bread volume increases gradually with increasing level of improver addition from 1 to 6%. With the addition of 1 to 2% level of fat on the flour weight basis, the volume of bread increases slowly and the addition of 3 to5% level of fat on the flour weight basis, the volume of bread increases sharply. The highest weight of the bread containing maize and brown rice flour was found at 6% level of fat addition and the lowest weight was obtained at the lowest level of fat addition (i.e. 1%). This might be due to the highest water content of the bread. At various level of fat the specific volume of bread were approximately same for each sample. The moisture content of bread ranges from 34 to 39.50% with the addition of different level of fat on the flour weight basis.

Table 9. The effects of various levels of fat addition on the quality of bread containing maize and brown rice flour

Level of fat addition	Type of breads															
	Bread with 5% maize and 5% brown rice flour				Bread with 8% maize and 8% brown rice flour				Bread with 11% maize and 11% brown rice flour				Bread with 14% maize and 14% brown rice flour			
	Volume (CC)	Weight (gm)	Specific Volume CC/gm	Moisture content	Volume (CC)	Weight (gm)	Specific volume CC/gm	Moisture Content	Volume (CC)	Weight (gm)	Specific Volume CC/gm	Moisture content	Volume (CC)	Wt. (gm)	specific volume CC/gm	Moisture content
1	492	228	2.158	34.00	489	234.5	2.072	35.00	486	232	2.108	35.19	485	238.5	2.036	36.9
2	493	229	2.153	34.14	489	235	2.070	36.77	486.5	233	2.098	35.52	485	239	2.030	37.47
3	493	229.5	2.148	35.32	490	236	2.063	37.01	487	233.5	2.098	36.34	486	239	2.033	38.11
4	495	230	2.152	36.90	491	237	2.063	37.57	489	234	2.098	37.20	487	239.5	2.033	38.83
5	495	231	2.143	37.87	492	237.5	2.063	38.13	489.5	234.5	2.098	38.38 8	488	240	2.033	39.10
6	496	231	2.147	37.99	493	238	2.058	38.20	490	235	2.098	38.50	488.5	241	2.027	39.50

Sensory Evaluation of bread containing maize and brown rice flour: From the results of mean sensory score, it was apparent that there was significant (P<0.05) difference in overall acceptability among the breads. The results (Table 10) indicate that the overall acceptability of control bread and the bread containing 8% maize and 8% brown rice flour were equally acceptable. The DMRT test for overall acceptability preference was performed and the results are given in Table 10. The bread without maize and brown rice flour scored the highest score for overall acceptability among the other bread containing maize and brown rice flour. The overall acceptability of bread containing 11% maize and 11% brown rice flour and the bread containing 14% maize and 14% brown rice flour were equally acceptable. These bread were significantly different from the bread without maize and brown rice flour, bread containing 8% maize and 8% brown rice flour and the bread containing 5% maize and 5% brown rice flour. It was also observed that the bread containing 8% maize and 8% brown rice flour secured the highest scored overall acceptability among the samples with maize and brown rice flour while bread containing 14% maize and 14% brown rice flour obtained the lowest among breads.

Table 10. Mean sensory scores of breads for control and the breads containing maize and brown rice flour

Bread with	**Sensory attributes**			
	Colour	Flavour	Texture	Overall acceptability
0% maize and brown rice flour	8.813^{a}	8.688^{a}	8.250^{a}	8.813^{a}
5% maize and brown rice flour	7.938^{b}	7.563^{b}	7.188^{b}	7.875^{b}
8% maize and brown rice flour	8.563^{a}	7.940^{b}	7.687^{b}	8.500^{a}
11% maize and brown rice flour	7.188^{c}	6.438^{c}	6.375^{c}	6.750^{c}
14% maize and brown rice flour	7.063^{c}	5.875^{d}	6.188^{c}	6.438^{c}
LSD (P<0.05)	0.2873	0.3171	0.5386	0.3317

Mean with same superscript within a column are not significantly different at p<0.05

References

AOAC. 2004. Official method of Analysis of the Association of official Analytical chemists. 15th Ed. Washington. DC.

Gopalan, C., Rama Sastri, B.V. and Balasubramanian, S.C. 1981. Nutritive value of Indian foods. National institute of nutrition. ICMR, Hyderabad, India

Grist, D.H. 1965. Rice 4th Ed. Longamans, London. 66.

Juliano, B.O. 1972. The rice caryopsis and Lts composition; In; Houston, D.F. (Ed), Rice Chemistry and Technology. Am. Assoc. Cereal chemistry, Inc. St. Paul. Minn. 16.

Kent, N.L. 1984. Technology of cereal: An introduction for students of food science and agriculture, 3rd edition, Pergamon Press, Oxford.

Kent, N.L. 1990. Technology of cereals: An Introduction of Students of Food Science and Agriculture. Third edition. Pergamon Press, Oxford.

Lynn, J. 1969. Edible rice bran Foods. In protein enriched cereal Foods for world needs. M. Milner (Editor). Amer. Assoc, Cereal Chem., St. Paul, Minn.

Martin, J.H. and Leonard, W.H.. 1967. Principle of Field Crop Production. The McMillan and Co., New York.

Mccall, Elizabeth, R., Hoff., Pauir, Carrol, L. and Skau; Dororthy, B. 1951. The chemical composition of rice. A literature review. U.S. Dept. Bur. Agr. Ind. Chem. Mimco Cire. AIC-312,49.

Ott, D.B. 1987. Applied Food Science Manual. Michigan State University. Pergramon press, USA.

Pomeranz, Y. and Shellenerger. 1971. Bread science and Technology, 2nd Ed. Westport, Connecticut.

Sayre, R.N., Saunders, R.M., Enochian, R.V., Schultz, W.G. and Beagle, E.C. 1982. Review of rice bran stabilization systems with emphasis on extrusion cooking. Cereal foods world 27:317-322.