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Quality Characteristics and Consumer Acceptance of Bread from Wheat and Rice Composite Flour

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Abstract

The quality characteristics and consumer acceptance of wheat-rice composite flour bread were evaluated. Substitution of rice flour was done in wheat flour from 0 to 100% and the composite flour was used to produce bread. The bread samples were subjected to proximate, physical, and sensory analyses. The results showed significant differences ($p \leq 0.05$) between the proximate compositions of bread samples studied. Bread from control (100% wheat flour) had moisture content of 28.61±0.28%. Bread from 10-50% wheat-rice composite flour had moisture contents ranged from 28.04±0.41 - 24.81±0.40%. The oven spring of the samples from control (100% wheat flour) had the highest value of 1.12±0.28 cm. The oven spring of wheat-rice composite bread ranged between 1.00±0.22 and 0.82±0.38 cm. There was inverse relationship between loaf weight (g), loaf volume and specific volume and the quantities of rice flour added to the wheat flour. The results of consumer acceptance showed that bread with 70:30 wheat: rice flour ratio was acceptable to the consumers. In conclusion, bread of good quality and good consumer acceptance could be made from wheat-rice composite flour.

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Introduction

Bread is a delicacy and a well acceptable conventional baked product all over the world. Traditionally, wheat (*Triticum aestivum*) flour is major ingredient used in bread preparation. Also, there has been increase in demand for bread in Nigeria and other African countries in the last three decades. However, most of these African countries are importers of wheat and this has affected their foreign reserves and fragile economies negatively. Most countries in the tropics could not afford the high cost of wheat importation as a result of fragile economy and the use of locally available crops becomes imperative. The use of composite flour in developing countries has been in use at different levels of substitutions which had achieved varying levels of success.[1,2] Locally available cereals and tubers were used to substitute wheat flour at varying levels.[3] In Nigeria, for instance incorporation of high quality cassava flour to the tune of 10% has been approved by Federal Government of Nigeria.[3] However, cassava has competing uses which make the use of other cereal and tuber crops imperative.[3]

Rice *Oryza sativa* is the most widely grown and consumed staple in many countries in Asia and Africa. Apart from sugarcane and maize, rice ranked as third most cultivated cereal.[4]

African rice (*Oryza glaberrima*) is grown in many African countries. Rice serves as cereal food for almost half of the human race.[5] According to National Research Council,[6] half of the World population depend on rice for their major food needs. Because of increase in rice consumption, Food and Agricultural Organization stipulated that annual rice production need to be increased by almost 50%. This will assist in meeting the ever increase in demand for rice in these countries.

According to National Research Council,[6] West Africa produced and consumed the largest amounts of rice in sub-Saharan Africa. West African countries account for about 64.2 and 61.9 % of total rice production and consumption in Africa. African rice (*Oryza glaberrima*) in Nigeria and other West African countries is consumed as cooked rice, jollof rice or fried rice. African rice (*Oryza glaberrima*) has little industrial applications as rice produced locally is meant for domestic consumption.

Several researchers had worked on rice, Ebuehi, *et al.,*[7] worked the moisture content of rice as it affects storage of rice. Ibukun,[8] has worked on the effect of prolonged parboiling duration on proximate composition of rice. Edeogu, *et al.,*[9] also worked on proximate compositions of rice in Ebonyi State, South Eastern Nigeria. Little works had been done on industrial applications of Nigerian rice varieties in bread making. The use of Nigerian rice for bread and other conventional baked products will improve industrial utilization of rice as well as improve socio-economic capacity of the local rice farmers. This will also boost the nation's economy.

This study evaluated the quality characteristics and consumer acceptance of wheat-rice composite bread.

Materials and Methods

Materials

Ofada rice (*Oryza glaberrima*) samples used for this study were obtained from Ofada market, Nigeria. Other materials such as wheat flour, sugar, margarine, yeast, and salt were bought in Bodija market, Ibadan, Nigeria.

Preparation of Rice Flour

Ofada rice (*Oryza glaberrima*) samples were used for this study. The rice flour was prepared according to the method of[10] Ofada rice (*Oryza glaberrima*) samples were sorted and grinded using a disc attrition mill locally fabricated. The rice flour samples were sieved and allowed to pass through a mesh of 250 µm opening and kept in polythene bags until needed.[16]

Formulation for Production of Bread

The formulation for production of bread was as reported by Oke *et al.,*[11] Bread (100% wheat flour bread (Control) was prepared with 100 g wheat flour (90%), 3 g yeast (3%), 2.5 g sugar (2%), 4 g margarine (4%), 1.5 g salt (1%), 10 ppm potassium bromated and 100ml of water. The ingredients were mixed for 3 minutes to form dough; fermentation was done for 75 minutes and then remixed for 25 seconds with recovery time of 20 minutes. The dough was proofed at 30°C/75% RH for 55 minutes and baking was done at 232°C for 25 min. Wheat flour was substituted with rice flour at the ratio of 10, 20, 30, 40, 50 and 100%. This was done experimentally and

since rice flour is non-glutenous, 100% rice flour was used to determine bread making quality of rice flour. Bread samples were prepared by using straight dough process described by Olu Malomo, *et al.,*[12] The ingredients were mixed for 3 minutes to form dough; fermentation was done for 75 minutes and then remixed for 25 seconds with recovery time of 20 minutes. The dough (350g) was scaled and proofed at 35°C/85% RH for 90 minutes and baking was done at 230°C for 20 min.

Proximate Composition of Bread

The proximate composition (moisture, crude protein, fat, ash, and crude fibre) of the bread samples were determined by using standard method, AOAC.[13] Carbohydrate content of bread samples was calculated by difference.

Physical Properties of Bread

Oven Spring Determination

The differences in the height of dough just before and after baking was used to determine the oven spring of the bread as described by Idowu, *et al.,*[14]

Loaf Volume Determination

Sorghum seed displacement method was used to determine loaf volume according to the method described by Feili *et al.,*[15] An empty container was used for the test, sorghum seeds were poured into an empty container until full and the sorghum seeds were measured in a graduated cylinder and marked as V_1. Each sample of bread was placed same empty container and sorghum seeds were poured till the bread sample was covered and the container was full. The sorghum seeds were collected and measured in a graduated cylinder as V_2. The volume of bread sample was determined by using the formula.[11]

Loaf volume (ml) = $V_1 - V_2$

Weight of Bread

The weights of the loaves were obtained by using Feili *et al.,*[15] method. Loaf samples were placed on the weighing balance that have previous zero and the weight values were recorded for each sample.[11]

Colour of Bread

The colour of the crust and crumb was determined by the method of Feili *et al.,* ([15] Konica colour reader (CR- 400, Konica Minolta Japan) (Fig. 1) was used to determine the level of lightness of material, (L), redness, (a), and yellowness, (b), of the bread samples. The colour of the crust was determined according to the method of Mohd. Jusoh *et al.,*[17] by pointing the colour reader directly to the top surface of the crust. The L, a, and b values were indicated after the scanning process.

Fig.1: CR- 400, Konica Minolta Japan

Sensory Evaluation

Bread prepared from wheat-rice composite flour was assessed for consumer acceptance. Bread samples from composite flour of wheat and rice were compared to bread from control (100% wheat flour sample) named reference sample (R). 100 untrained sensory panellists were used.[16,18] The panellists were instructed to evaluate the quality attributes of the bread samples: colour, texture, taste and overall acceptability on a nine-point Hedonic scale where 9 = Like extremely and 1 = Dislike extremely.

Data Analyses

Data were means of triplicate data ± standard deviation and subjected to one-way analysis of variance (ANOVA) with random model using IBM SPSS version 21.0 software.[35] Mean differences were separated and compared using Duncan's Multiple Range Test ($p \leq 0.05$) to study the difference among means. Differences between bread samples were evaluated using independent T- test.

Results and Discussion

Proximate Composition of Bread

The results of proximate composition can be seen in Table 1. There was an inverse relationship between the moisture content of the bread and the percentage of rice flour. Bread from control (100% wheat flour) was found to have highest moisture content, while bread from 100% rice flour had the least.

Table 1: Proximate composition of bread produced from wheat and rice composite flour

Wheat/rice flour ratio	Moisture content (%)	Protein content (%)	Fat content (%)	Crude fibre content(%)	Ash content (%)	Carbohydrate content(%)
100:00:00	28.61 ± 0.28^{d}	10.64± 0.08^{e}	1.38 ± 0.02^{a}	0.78 ± 0.01^{a}	0.83 ± 0.36^{a}	57.78 ± 0.24^{a}
90:10:00	28.04± 0.41^{cd}	9.93± 0.06^{d}	1.46 ± 0.04^{ab}	0.86 ± 0.01^{a}	0.95 ± 0.42^{a}	58.76 ± 0.41^{b}
80:20:00	27.36 ± 0.36^{c}	9.26 ± 0.04^{cd}	1.51 ± 0.03^{b}	0.93 ± 0.02^{b}	1.04 ± 0.39^{ab}	59.90 ± 0.36^{c}
70:30:00	26.48 ± 0.38^{b}	8.71 ± 0.06^{c}	1.59 ± 0.06^{bc}	1.02 ± 0.02^{bc}	1.11 ± 0.48^{b}	61.09 ± 0.48^{d}
60:40:00	25.63 ± 0.46^{ab}	8.35 ± 0.04^{b}	1.63 ± 0.04^{c}	1.08 ± 0.04^{c}	1.20 ± 0.42^{bc}	62.11 ± 0.42^{d}
50:50:00	24.81 ± 0.40^{ab}	8.04 ± 0.06^{ab}	1.68 ± 0.06^{cd}	1.16 ± 0.06^{d}	1.26 ± 0.48^{c}	63.05 ± 0.46^{e}
0:100	23.49 ± 0.48^{a}	7.69 ± 0.08^{a}	1.74 ± 0.08^{d}	1.31 ± 0.04^{e}	1.39 ± 0.54^{d}	64.38 ± 0.48^{f}

Values are mean ± standard deviation of triplicate determinations. Means on the same row with different sets of superscripts are statistically different ($p \leq 0.05$).

Moisture contents of wheat–rice composite bread agreed with the results of[19,20] who substituted wheat with tigernut flour, rice or maize flour and orange flesh sweet potato flour in production of bread. There was an increase and decrease in the fat and protein contents of the bread as the quantity of rice flour in the bread increases; this could be attributed to the low fat and protein contents of the rice flour. Increase in rice flour in the bread also increased the amount of fibre and ash. This increase in ash content of the wheat-rice composite bread shows increased levels of minerals bread. Wheat-rice composite bread also had high fibres which could be beneficial to the consumers.[21-23]

Quality of Wheat-Rice Composite Bread

Oven spring is one of quality parameters in baking. It signifies the ability of the dough to trap carbon dioxide and to be stretched. An inverse relationship was observed as the substitution increases, the oven spring decreases (Table 2) and this may be due to the reduction in the amount of gluten in the dough.[24] Gluten has visco-elastic properties which help to trap carbon dioxide from dough fermentation and give wheat flour bread the fluffy or foam structure as well as improve bread volume.

But, lower oven spring was obtained in this study[25] when compared with when orange peel sweet potato flour was substituted with wheat flour in production of bread. According to Shittu *et al.,*[26] loaf weight constitutes the amounts of dough baked and the quantity of moisture and carbon dioxide released out of the loaf during baking. This is due to the fact that rice flour is non-glutenous and will aid moisture and carbon dioxide loss in the loaf. This reduces

Table 2: Quality of bread produced from wheat and rice composite flour

Wheat/rice flour flour ratio	Oven spring (cm)	Loaf weight (g)	Loaf volume (cm^3)	Specific volume (cm^3/g)
100:0	1.12 ± 0.28^{e}	196.40 ± 1.59^{f}	178 ± 0.24^{f}	0.92 ± 0.30^{f}
90:10	1 .00±0.22^{d}	189.68±1.46^{e}	164 ± 0.32^{e}	0.84 ± 0.26^{e}
80:20	0.96±0.26^{cd}	173.90±1.68^{d}	158 ± 0.48^{d}	0.80 ± 0.33^{de}
70:30	0.91±0.37^{c}	170.08±1.49^{cd}	152 ± 0.38^{cd}	0.76 ± 0.30^{d}
60:40	0.87±0.46^{bc}	166.83±1.54^{c}	149±0.32^{c}	0.71 ±0.34^{c}
50:50	0.82 ± 0.38^{b}	160.30±1.46^{b}	142±0.44^{b}	0.66 ± 0.26^{b}
0:100	0.71 ± 0.42^{a}	151.30±1.64^{a}	136 ± 0.48^{a}	0.60 ± 0.34^{a}

Values are mean ± standard deviation of triplicate determinations. Means on the same row with different sets of superscripts are statistically different ($p \leq 0.05$)

loaf weight and volume. It was observed in this study that loaf weight decreased from 189.68±1.46 to 160.03±1.46 gram as rice flour substitution increased; this may be due to the reduction in the amount of gluten in the dough.[26] According to[27] loaf volume determines baking performance and it is influenced by the quantity and quality of gluten in the flour.[28,29] The addition of rice flour to wheat negatively affected loaf volume of final product which reduce from 178±0.24 cm^3 (wheat flour) to 136±0.48 cm^3 (100% rice flour). Decrease in loaf volume of bread was due to inclusion of rice flour, which reduced the wheat gluten and consequently weakened the gluten network in the dough. This agreed with previous works of[30-33] who also obtained a decrease in the volume of bread in pigeon pea, lupin seed, and mango flour supplemented bread.

Crust and Crumb Colour of Wheat–Rice Composite Bread

Colour of the crust and crumb is expressed as lightness (L*), redness (a*) and yellowness (b*) as reported in (Table 3). Between lightness (L*), redness (+a*), and yellowness (+b*) of the crust colour of the bread there existed significant difference ($p \leq 0.05$) but not found in yellowness (+b*) of the crumb colour in wheat–rice composite bread. There was an inverse relationship between lightness and rice flour substitution in the wheat–rice composite bread and direct relationship between redness and yellowness with increase in rice flour substitution. Wheat flour substitution with rice flour affected the crust colour of wheat-rice composite bread. It was revealed that the crust colour of the bread became darker as more rice flour was added. The crust of the control samples from 100% wheat flour was lighter and less yellow than any of the other samples. The dark brown colour of bread could be due to reactions between proteins and the carbohydrate in the dough at high temperature.[34] It was observed that bread baked at lower temperature and time has higher L value when compared with those bread baked at high temperature. Mohd.Jusoh *et al.,*[17] also observed that "lower baking temperature and time produced breads of lower a and b values indicating lower redness and yellowness intensity".

Table 3: Crumb and crust colour of bread produced from wheat and rice composite flour

Wheat /rice flour ratio	Crumb L*	Crumb a*	Crumb b*	Crust L*	Crust a*	Crust b*
100:0	85.32 ± 1.28^{g}	1.43 ± 0.24^{a}	29.46 ± 0.68^{a}	64.11 ± 1.41^{g}	18.14 ± 0.16^{g}	28.41 ± 0.15^{a}
90:10	83.03 ± 1.26^{f}	1.59 ± 0.24^{ab}	30.01 ± 0.46^{ab}	61.38 ± 1.68^{f}	17.81 ± 0.28^{f}	29.72 ± 0.21^{b}
80:20	81.56± 1.37^{e}	1.62 ± 0.28^{b}	30.62 ± 0.62^{b}	60 .21 ± 1.48^{e}	16.59± 0.18^{e}	30.48 ± 0.26^{c}
70:30	80.49± 1.32^{d}	1.67 ± 0.22^{c}	30.98 ± 0.83^{bc}	58 .92 ± 1.82^{d}	15.42 ± 0.26^{d}	31.22 ± 0.15^{d}
60:40	78.86± 1.26^{c}	1.70 ± 0.24^{cd}	31.33 ± 0.66^{c}	56 .73 ± 1.64^{c}	14.85 ± 0.31^{c}	32.80 ± 0.21^{e}
50:50	76.94± 1.30^{b}	1.74± 0.26^{d}	31.85± 0.48^{cd}	55.95± 1.91^{b}	13.98± 0.26^{b}	33.49± 0.18^{f}
0:100	73.70± 1.43^{a}	1.83± 0.28^{e}	32.27± 0.62^{d}	54.16± 1.88^{a}	12.63± 0.28^{a}	34.85± 0.26^{g}

Values are mean ± standard deviation of triplicate determinations. Means on the same row with different sets of superscripts are statistically different ($p \leq 0.05$).

Sensory Evaluation of Wheat–Rice Composite Bread

Bread from 100% wheat flour (control) was found to have highest sensory scores for texture, flavour, colour and overall acceptability (Table 4). The implications of this are that bread from 100% wheat flour was preferred by consumers in all the sensory parameters studied except in taste. This result agreed with findings of Araki et al.,[35] Bread from 100% rice flour had the lowest sensory scores for texture, colour and overall acceptability and highest score value for taste. The sensory score for taste exhibited by bread from 100% rice flour may be due to high aroma of ofada rice as flavour of food is the combination of aroma and taste. Sensory scores are decreased for all the attributes excluding taste as the rice flour level is increased in bread from 10% to 50%. Also, the composite bread had lower

sensory scores than the control bread (100% wheat flour bread). Bread from wheat-rice composite flour also showed significant difference (P≤0.05) for taste. It was discovered that the taste of bread samples is influenced by rice flour substitution. Consumer's overall acceptance showed that the bread samples have good panellists' acceptance. From the sensory evaluation results, the most preferred bread sample was from 100% wheat flour, while the least preferred was from 100% rice flour bread sample. On the final analysis, it was revealed that bread of good quality and good acceptability could be prepared with up to 30% wheat substitution with ofada rice flour. Therefore, baked bread with up to 30% ofada rice flour could be commercialized.

Table 4: Sensory evaluation of bread produced from wheat and rice composite flour

Wheat/rice flour ratio	Texture	Flavour	Taste	Colour	Overall Acceptability
100:0	7.8±0.03^{g}	7.2±0.02^{g}	6.8±0.02^{f}	8.4±0.05^{g}	8.1±0.06^{g}
90:10	7.2±0.02^{f}	6.9±0.02^{f}	6.6±0.02^{e}	7.8±0.04^{f}	7.9±0.06^{f}
80:20	6.8±0.02^{e}	6.7±0.02^{d}	6.5±0.02^{d}	7.5±0.05^{e}	7.6±0.05^{e}
70:30	6.4±0.02^{d}	6.5±0.02^{c}	6.4±0.02^{c}	7.2±0.04^{d}	7.5±0.04^{d}
60:40	6.2±0.02^{c}	6.3±0.02^{b}	6.2±0.02^{b}	7.0±0.04^{c}	7.2±0.05^{c}
50:50	6.0± 0.02^{b}	6.1± 0.02^{a}	6.0± 0.02^{a}	6.7± 0.05^{b}	7.0± 0.04^{b}
0:100	5.8± 0.01^{a}	6.8± 0.02^{e}	7.5± 0.02^{g}	6.3± 0.04^{a}	6.7± 0.04^{a}

Values are mean ± standard deviation of triplicate determinations. Means on the same row with different sets of superscripts are statistically different ($p \leq 0.05$)

Conclusions

In conclusion, the study showed that rice flour could be incorporated as baking ingredient with wheat flour for making bread. Loaf weight (g), loaf volume and specific volume had inverse relationship with the quantities of rice flour incorporated into the wheat flour. The results of consumer acceptance showed that bread with 30% substitution of wheat flour with rice flour was acceptable to the consumers. Finally, bread of good quality could be produced from wheat and rice flour blends.

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Conflict of interest

The author(s) do not have any conflict of interest.

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