Quality evaluation of composite bread produced from wheat, water yam and brown hamburger bean flours

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ABSTRACT

Bread was produced from wheat, water yam and brown hamburger bean. Five samples (A-E) were produced in the following ratios A=(100:0:0), B=(70:20:10), C=(65:20:15), D=(60:20:20), E=(55:20:25). Wheat flour (100%) served as the control. Proximate composition, physical properties, vitamin composition, mineral composition and sensory attributes of the bread were evaluated. The proximate composition of the bread showed significant increase at ($P<0.05$) in protein, crude fibre, fat, ash, and caloric value which ranged between 8.93-14.47%, 1.88-3.66%, 2.37-3.24%, 1.09-1.99%, and 286.39-305.16% and a significant decrease ($P<0.05$) in moisture content (22.11-28.44%) and carbohydrate (54.53-57.29%) respectively. The result of the physical properties showed that the constant amount of 20% water yam flour and incremental addition of brown hamburger bean flour led to increase in the loaf weight, decrease in loaf volume, specific volume and loaf height which ranged from 213.80-232.60 g, 555.00-605.00 cm^3, 2.38-2.83 cm^3/g and 3.65-7.45 cm, respectively. The vitamin and mineral contents showed increase in vitamin A, vitamin C, iron, magnesium, calcium and phosphorus which ranged from 1.75-1.97 mg/100 g, 0.09-0.23 mg/100 g, 1.76-4.01 mg/100 g, 62.46-65.28 mg/100 g, 16.34-21.02 mg/100 g, 83.35-95.98 mg/100 g, respectively. The sensory attributes of the bread showed significant differences in aroma, taste, crust appearance, crumb texture, crumb colour and general acceptability. All the samples (A-E) were generally accepted according on the 9 point hedonic scale except sample E (55% wheat, 20% water yam, 25% brown hamburger bean) which scored below 5point the minimum acceptable value on the scale. Therefore sample A, B, C and D can be used in the production of bread depending on nutritional needs.

Keywords: Quality evaluation, Wheat, Water yam, Brown hamburger bean, Composite bread

INTRODUCTION

Bread can be defined as a fermented confectionary product produced mainly from wheat flour, water, yeast and salt by series of processes involving mixing, kneading, proofing, shaping and baking (Dewettinck et al., 2008). It is also an important staple food consumed by many people in both developing and developed countries (Aider et al., 2012). The nutritional value of bread varies with the type of ingredients used in preparation. The composition of ingredients used for a of loaf bread is approximately 100% flour, 35% water, 8% sugar, 3% fat, and 1.5% salt (Balami et al., 2004). Wheat has been the major ingredient in the production of bread but is relatively low in total protein especially in lysine and other important amino acids, which could be supplemented by the use of water yam and brown hamburger beans. Water yam is rich in dietary fibre which aids digestion (Nwakaudi et al., 2017). Legumes usually improve the quality of the cereal protein by supplementing them with limiting amino acids such as lysine and sometimes methionine (Chinma and Akpapunam 2007).

Composite flour can be defined as a mixture of two or more flours obtained from roots, tubers, cereals and legumes with or without the addition of wheat flour (Shittu et al., 2007). Researchers have also shown that bread and other baked products can be produced from different types of composite flours (McWatters et al., 2003, Mignouna et al., 2011). Composite flours have also been reported to be more nutritious than wheat and flours from single crops (Ndife et al., 2011, Alozie et al., 2009). Local raw materials substitution for wheat flour is increasing due to the growing market for confectioneries and consumers growing consciousness for nutritious foods (Noor et al., 2012) In Nigeria, the use of composite flour would reduce the importation of wheat flour resulting in savings from importation. The use of local crops in flour preparation would diversify its use, encourage production and increase farmer's income. Moreover, jobs opportunities would also result from the use of local crops in production of flours for baked foods and confectioneries (Hugo et al., 2000).

Wheat (*Triticum* spp.) is a cereal grain that belongs to the family *Poaceae gramineae* (Sramkova et al., 2009). Globally, it is one of the most important human food grain used to make different baked product such as cookies, cakes, pasta, and noodles, and for fermentation to make beer (Ranhotra et al., 1998). Generally, it contains carbohydrate 78.10%, protein 14.70%, fat 2.10%, minerals 2.10% and considerable proportions of vitamins (thiamine and vitamin-B) and minerals (Zinc, iron, selenium and magnesium) (Kumar et al., 2011).

Water yam (*Dioscorea alata*) belongs to the genus Dioscorea, family Dioscoreaceae. It is the most widely distributed species globally (Mignouna et al., 2011) and the world's most popular yam after the *D. rotundata* (white yam) in terms of consumption. It is also known as ten month yam because it takes nine to ten months to mature (Okoye et al., 2010). Due to the perishability of the crop, the tubers cannot be kept for more than a few weeks after harvesting. Water yam is highly susceptible to deterioration because of its high moisture content 65-75%. It contains about 20-31% carbohydrate, soluble polysaccharides, bioactive compounds such as diosgenin and dioscorine and has several essential nutrients (Liu et al., 2007).

Brown hamburger bean (*Mucuna soloanei*) belongs to the family leguminosae and is naturally found in tropical and sub-tropical regions of the world. It is an underutilized legume in Africa. It is compose of adequate amount of protein, fat, ash and carbohydrate that are comparable to other common legumes (Igbabul et al., 2012). It is also called velvet bean, devil bean and horse eye. Brown hamburger bean contribute immensely to the human nutrition as it contains high content of protein (Igbabul et al., 2012). It is a good source of phosphorus which can help improve the nutritional content of bread, but only fair in its supply of iron and calcium (Oko et al., 2015). Brown hamburger bean flour is used in some states (Benue, Anambra, Ondo, Akwa Ibom, and Imo) in Nigeria as soup thickeners, emulsifiers as well as flavouring agents in traditional soups. It is usually limited in the sulphur containing amino acids particularly methionine which are found in cereals such as wheat. The use of wheat, water yam and brown hamburger bean flours would enhance production of nutrients dense products. The aim of this work therefore, is to produce composite flours from wheat, water yam and brown hamburger bean for utilization in bread production and quality evaluation.

MATERIALS AND METHODS

Sources of Raw Materials

Wheat flour (golden penny), and other baking ingredients such as margarine, salt, sugar, dry yeast were purchased from North bank market. Water yam and brown hamburger bean were purchased from railway market all in Makurdi, Benue state. All chemicals to be used were of analytical grade.

Preparation of Raw materials

Preparation of water yam flour: The method by (Balami et al., 2004) was used for the preparation of water yam flour. The water yam was peeled, washed, sliced into 2.0 thicknesses and heated in water bath at 50°C for 2hrs. After heating, the water yam slices were steeped in the same water for 24hrs. The water yam slices were drained and dried in a cabinet dryer for 60ºC for 2 days to obtain constant moisture content of 8%. The dried water yam slices were then milled into flour using a dry mill machine. This is illustrated in **Figure 1**.

Preparation of brown hamburger bean: The method outlined by (Igbabul et al., 2012) was used. The seeds of the brown hamburger were sorted out to remove unwanted materials, they were then cracked using a hammer mill, they were washed, dried in an oven (60ºC), grinded in the laboratory thereby reducing the size using attrition mill and hammer mill was used to further grind the bean into fine powder. This is illustrated in **Figure 2**.

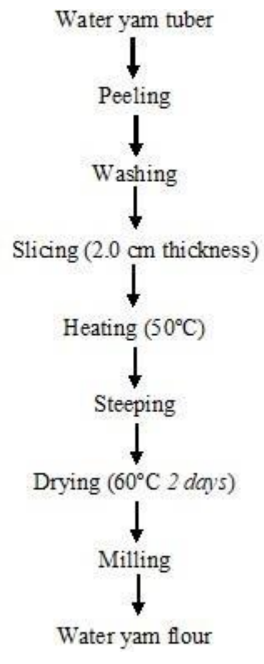

Figure 1: Flow chart for the production of water yam flour (Balami et al., 2004).

Figure 2: Flowchart for the production of brown hamburger bean flour (Igbabul et al., 2012).

Formulation of flour blends: Wheat flour, water yam and brown hamburger bean were mixed at different proportions; A=(100:0:0), B=(70:20:10), C=(65:20:15), D=(60:20:20), E=(55:20:25) to give samples A-E. The sample (A) with 100% wheat flour was the control as shown in **Table 1**.

Table 1: Formulation of blends from water yam, wheat and brown hamburger bean for bread preparation.

Samples	Wheat flour (%)	Water yam flour (%)	Brown hamburger bean (%)
A (control)	100	0	0
B	70	20	10
C	65	20	15
D	60	20	20
E	55	20	25

Bread preparation: The straight-dough method by (Chauhan et al., 1992) was used to prepare five different samples of bread, of which four were having varying amounts of wheat and brown hamburger bean flours with constant amount of water yam flour. The sample with 100% wheat flour served as the control. All the ingredients (flour, salt, sugar, yeast and water etc.) were mixed thoroughly to form the dough. The dough was adequately kneaded to smooth consistently, divided into equal sized pieces, moulded and transferred into clean baking pans that have its inside walls smeared with vegetable oil. The dough was allowed to proof at ambient temperature and then baked at 220ºC for 45 min. This is illustrated in **Figure 3**.

Proximate Composition of the Bread Samples

The moisture content, ash, crude fibre, crude protein and fat content of the bread produced from wheat, water yam and brown hamburger bean were determined using the method of AOAC (2012). Total carbohydrate was calculated by difference. The caloric value was determined using the Atwater factors of protein (4), fat (9), and carbohydrate (4).

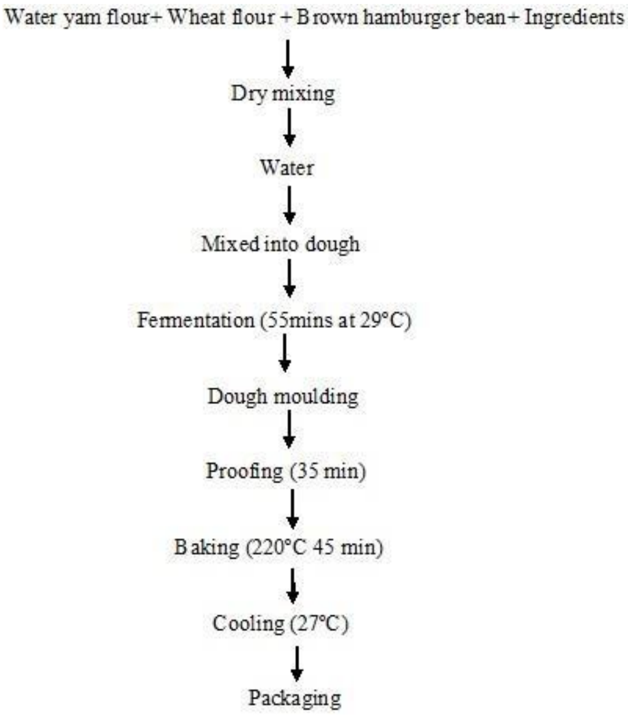

Figure 3: Flowchart for the production of bread (Chauhan et al.,1992).

These factors were used to multiply the values determined for the stated nutrients and the sum total of the multiplied values recorded.

Physical Properties of Dough and Bread Loaves

Bread loaves were weighed after baking using the electronic weighing balance and the loaf weights were recorded in grams. The bread loaf height was measured by using a measuring ruler. The loaf volume was determined using the Rape seed displacement method AACC (2000). Sorghum grains were loaded into an empty box with calibrated mark until it reached a marked level and unloaded back. The bread samples were put in the box and the remaining sorghum grains left outside the box was measured using a measuring cylinder (250 mL) and recorded as loaf volume in cm^3. The specific volume was calculated as loaf volume divided by loaf weight (cm^3/g).

Vitamins and Minerals Composition

The vitamins (pro- vitamin A, beta carotene and vitamin C) were determined by the method of AOAC (2005) using the Atomic Absorption Spectrophotometer (AA 800 Perkin-Elmer Germany).

The minerals (phosphorus and magnesium) content of bread were determined by the method of Onwuka (2005) while the iron and calcium were determined by AOAC method (2005).

Sensory Evaluation

The bread samples were presented to a 20-member panel of Judges that comprised of the students and staff of the Department of Food Science and Technology, University of Agriculture Makurdi. The samples were assessed for crust appearance, crumb colour, crumb texture, aroma, and overall acceptability using a nine-point hedonic scale, where 9 indicated “liked extremely” and 1 indicated “dislike extremely” according to Ihekoronye and Ngody (1985).

Statistical analysis

Analyses were conducted in duplicates. Means and standard deviations were calculated. Data obtained was subjected to analysis of variance (ANOVA), Steel and Torrie (1980). Turkey’s test was used in the separation of means where significant differences existed. SPSS 19 version 2011 was used.

RESULTS AND DISCUSSION

Proximate Composition

The result for the proximate composition of bread produced from the flour blends is shown in **Table 2**. The moisture content of the bread samples differed significantly at ($p<0.05$) and it ranged from 22.11-28.44%. The control (sample A) had the highest moisture content of (28.44%) while sample E had the least moisture content of (22.11%). The moisture content of the bread samples decreased with addition of brown hamburger bean flour. It was reported by Palmer (2001) that moisture content of bread decreases with increase in composite flours in wheat, acha and mung beans composite bread. The decrease in moisture could be explained on the lower content of gluten in non-wheat flours which result in formation of gluten network with weak cell structure that embed lower moisture. The decreased moisture content would also enhance longer shelf life. There was a significant increase ($p<0.05$) in the protein content of the bread ranging from 8.93-14.47%, with increase in the addition of brown hamburger bean flour. This agrees with the work of Alozie et al., 2009 where protein increased as a result of increased in Bambara nut in wheat- Bambara nut composite bread. Similar results were reported by Olaoye et al., 2006 in the production of composite bread from wheat, plantain and soybeans. The increase in protein content with increasing brown hamburger bean flour is expected since the bean is reported to be rich in proteins (Okaka et al., 2016) Protein functions in the building and repairs of the body parts.

The crude fibre content ranged from 1.88-3.66%. The control sample (100% wheat) had the lowest number which increased with increased quantity of brown hamburger bean flour. The increase might be due to the high fibre content present in brown hamburger bean and water yam. Crude fibre is reported to be important in glycemic control and it helps improve the morbidity of diabetic patients. Crude fibre according to Schneeman, (2002) supports the health of gastrointestinal and metabolic systems in man.

The fat content ranged from 2.37-3.24% and increased significantly ($P<0.05$) with increase in the brown hamburger bean flour. The crop is reported to contain a high quantity of fat. This implies that foods prepared using this composite flour would be energy dense foods suitable (Igbabul et al., 2014) for people with high energy needs.

There was significant increase in ash content at ($p<0.05$) of the bread samples with a range of 1.09-1.99%, with increase in brown hamburger bean flour. This in agreement with Idris (2011) who observed that ash content is generally taken to be a measure of the mineral content of the original food.

The Carbohydrate content of the bread ranged from 54.53-57.29% and decrease significantly with increase in the brown hamburger bean flour. The caloric/ energy value of the bread ranged from 286.39-305.16%. There was a significant increase in energy values with increase in brown hamburger bean and constant water yam flour of 20%. The high energy values could be attributed by water yam (carbohydrate) as well as brown hamburger bean flour which has high fat content. Sample E has the highest caloric value.

Physical Properties

The physical properties of the bread prepared from the flour blends are shown in **Table 3**. There was significant ($P<0.05$) increase in the loaf weight from 213.80-232.60 g, sample A had the highest weight. According to Yusufu et al., 2013,

Table 2: Proximate composition of composite bread produced from wheat, water yam and brown hamburger bean flours (%).

Samples	Moisture	Protein	Fibre	Fat	Ash	CHO	Caloric value
A	$28.44^{a} \pm 0.01$	$8.93^{e} \pm 0.02$	$1.88^{e} \pm 0.01$	$2.37^{e} \pm 0.01$	$1.09^{e} \pm 0.01$	$57.29^{a} \pm 0.07$	$286.39^{e} \pm 0.07$
B	$26.56^{b} \pm 0.01$	$10.10^{d} \pm 0.01$	$2.14^{d} \pm 0.03$	$2.65^{d} \pm 0.01$	$1.24^{d} \pm 0.02$	$57.04^{a} \pm 0.35$	$292.41^{d} \pm 0.03$
C	$25.37^{c} \pm 0.03$	$11.28^{c} \pm 0.01$	$2.88^{c} \pm 0.02$	$2.92^{c} \pm 0.04$	$1.48^{c} \pm 0.01$	$56.07^{b} \pm 0.02$	$295.68^{c} \pm 0.08$
D	$23.34^{d} \pm 0.01$	$13.35^{b} \pm 0.06$	$3.35^{b} \pm 0.04$	$3.05^{b} \pm 0.01$	$1.69^{b} \pm 0.01$	$55.22^{c} \pm 0.01$	$301.73^{b} \pm 0.16$
E	$22.11^{e} \pm 0.02$	$14.47^{a} \pm 0.04$	$3.66^{a} \pm 0.03$	$3.24^{a} \pm 0.00$	$1.99^{a} \pm 0.00$	$54.53^{d} \pm 0.04$	$305.16^{a} \pm 0.03$
LSD	0.01	0.08	0.07	0.06	0.03	0.42	0.22

Values are means ± standard deviations of duplicate determinations. Means in the same column with different superscripts are significantly different ($p<0.05$). A: 100% Wheat Flour; B: 70% Wheat Flour, 20% Water Yam Flour, 10% Brown Hamburger Bean Flour; C: 65% Wheat Flour, 20% Water Yam Flour, 15% Brown Hamburger Bean Flour; D: 60% Wheat Flour, 20% Water Yam Flour, 20% Brown Hamburger Bean Flour; E: 55% Wheat Flour, 20% Water Yam Flour, 25% Brown Hamburger Bean Flour; LSD: Least Significance Difference; CHO: Carbohydrate bread loaf weight was determined by amount of baked dough, moisture and carbon dioxide diffused out of the loaf during baking.

Table 3: Physical properties of bread produced from wheat, water yam and brown hamburger bean flours.

Sample	Loaf weight (g)	Loaf volume (cm^3)	Specific volume (cm^3/g)	Loaf height (cm)
A	$213.80^{e} \pm 0.07$	$605.00^{a} \pm 7.02$	$2.83^{a} \pm 0.26$	$7.45^{a} \pm 0.04$
B	$225.40^{d} \pm 0.07$	$600.00^{b} \pm 7.07$	$2.66^{a} \pm 0.05$	$4.55^{b} \pm 0.07$
C	$227.40^{c} \pm 0.05$	$585.00^{c} \pm 7.04$	$2.57^{a} \pm 0.03$	$4.35^{c} \pm 0.02$
D	$229.60^{b} \pm 0.07$	$575.00^{d} \pm 7.00$	$2.50^{ab} \pm 0.08$	$3.95^{d} \pm 0.05$
E	$232.60^{a} \pm 0.04$	$555.00^{e} \pm 7.02$	$2.38^{ac} \pm 0.05$	$3.65^{e} \pm 0.02$
LSD	0.18	4.18	0.27	0.18

Values are means ± standard deviations of duplicate determinations. Means in the same column with different superscript are significantly different ($p<0.05$) A: 100% Wheat Flour; B: 70% Wheat Flour, 20% Water Yam Flour, 10% Brown Hamburger Bean Flour; C: 65% Wheat Flour, 20% Water Yam Flour, 15% Brown Hamburger Bean Flour; D: 60% Wheat Flour, 20% Water Yam Flour, 20% Brown Hamburger Bean Flour; E: 55% Wheat Flour, 20% Water Yam Flour, 25% Brown Hamburger Bean Flour; LSD: Least Significance Difference

The loaf height of the bread ranged from 3.65-7.45 cm with decrease in the loaf volume from sample A to E. The loaf volume varied from 555.00-605.00 cm^3. Sample A has the highest volume (605.00 cm^3) and Sample E has the least value (555.00 cm^3), while the other samples decreased significantly. The decrease may be as a result of the increase in the amount of brown hamburger bean which does not contain gluten and thus dilutes the gluten content of wheat. The specific volume also decreased with increase in brown hamburger bean flour and constant water yam flour content. This varied from 2.38-2.83 cm^3/g. This is in line with the findings of Ndife et al., 2011, which stated that progressive inclusion of soy bean (legumes) flour to wheat flour decreased the bread volume.

Vitamin and Mineral Composition

The result for the vitamin composition of bread produced from the flour blends is shown in **Table 4**. The vitamin A (β-carotene) content of the bread increased significantly with increase in brown hamburger bean and constant amount of water yam. The range was from 1.75-1.97 mg/100g. Sample A had the least amount of vitamin A while sample E has the highest amount of vitamin A. Vitamin A has an integral role in regulating metabolic activities in the body as well as enhances the body immune system (Abiaka et al., 2002). The Vitamin C content (0-0.23 mg/100g) of the bread also increased significantly with increase in brown hamburger bean flour but it was not detected in sample A. Vitamin C is effective in prevention of oxidative damage in tissues, and also suppresses formation of carcinogens.

The mineral content of the composite bread indicated that iron (1.76-4.01 mg/100 g) Magnesium (62.46-65.28 mg/100 g), Calcium (16.34-21.02 mg/100 g), and Phosphorus (83.35-95.98 mg/100 g), all increased significantly ($p<0.05$) with increment in brown hamburger bean flour. Magnesium and Phosphorus have been reported by (Shittu et al., 2007) to reduce high blood pressure. Iron which is a minor element is also present in brown hamburger and water yam flours as increase in the flour (brown hamburger bean) increased their composition in the bread. Iron supports the formation of hemoglobin in red blood cells (Franz et al., 2002). Calcium enhances the well -being and health of bones and teeth (Amoakoah et al., 2015).

Sensory properties

The sensory scores of the composite bread is shown in **Table 5**.The result showed that sample A (100% wheat flour) was most preferred to other bread samples in all the sensory attributes evaluated followed by sample B (70% Wheat Flour, 20% Water Yam Flour and 10% Brown Hamburger Bean Flour). Samples A to D were generally accepted on the 9-point Hedonic scale as all the sensory scores were above five which is the minimum value acceptable. Sample E was generally rejected since it scored below 5 point on a 9- point Hedonic scale.

CONCLUSION

The study has shown that bread produced from wheat, water yam and brown hamburger bean composite flours had increased macro -nutrients of protein, fat, fibre and micro-nutrients of vitamins A and C, and minerals (iron, calcium, magnesium and phosphorus). Bread of acceptable quality was produced from wheat flour substituted up to 40% with 20% water yam flour and 20% brown hamburger bean flour.

Table 4: Vitamin and mineral composition of bread produced from wheat, water yam and brown hamburger bean flours (mg/100g).

Samples	Vitamin A	Vitamin C	Iron	Magnesium	Calcium	Phosphorus
A	$1.75^{d} \pm 0.03$	ND	$1.76^{c} \pm 0.01$	$62.46^{e} \pm 0.04$	$16.34^{e} \pm 0.01$	$83.35^{e} \pm 0.01$
B	$1.82^{c} \pm 0.01$	$0.09^{d} \pm 0.00$	$2.40^{b} \pm 0.01$	$63.97^{d} \pm 0.01$	$18.70^{d} \pm 0.02$	$93.88^{d} \pm 0.02$
C	$1.90^{b} \pm 0.01$	$0.12^{c} \pm 0.01$	$2.65^{b} \pm 0.50$	$64.13^{c} \pm 0.01$	$19.37^{c} \pm 0.06$	$94.94^{c} \pm 0.07$
D	$1.93^{ab} \pm 0.01$	$0.20^{b} \pm 0.01$	$3.62^{a} \pm 0.03$	$64.95^{b} \pm 0.04$	$20.12^{b} \pm 0.02$	$95.36^{b} \pm 0.04$
E	$1.97^{a} \pm 0.01$	$0.23^{a} \pm 0.00$	$4.01^{a} \pm 0.01$	$65.28^{a} \pm 0.06$	$21.02^{a} \pm 0.02$	$95.98^{a} \pm 0.00$
LSD	0.04	0.02	0.58	0.1	0.08	0.1

Values are means ± standard deviations of duplicate determinations. Means in the same column with different superscript are significantly different ($p<0.05$). A: 100% Wheat Flour; B: 70% Wheat Flour, 20% Water Yam Flour, 10% Brown Hamburger Bean Flour; C: 65% Wheat Flour, 20% Water Yam Flour, 15% Brown Hamburger Bean Flour; D: 60% Wheat Flour, 20% Water Yam Flour, 20% Brown Hamburger Bean Flour; E: 55% Wheat Flour, 20% Water Yam Flour, 25% Brown Hamburger Bean Flour; LSD: Least Significance Difference

Table 5: Sensory properties of bread from the flour blends of wheat, water yam and brown hamburger bean.

Sample	Taste	Aroma	Crust appearance	Crumb texture	Crumb colour	Overall acceptability
A	$7.67^a \pm 1.18$	$7.60^a \pm 0.99$	$7.47^a \pm 0.99$	$7.67^a \pm 1.25$	$7.87^a \pm 0.83$	$8.07^a \pm 0.80$
B	$6.60^b \pm 1.06$	$6.07^b \pm 1.39$	$6.33^b \pm 1.11$	$6.47^b \pm 0.99$	$5.93^b \pm 1.67$	$6.47^b \pm 1.25$
C	$6.20^b \pm 1.16$	$5.60^b \pm 1.55$	$6.00^b \pm 1.46$	$5.93^b \pm 1.34$	$5.47^b \pm 1.46$	$5.80^b \pm 1.27$
D	$5.80^b \pm 1.42$	$5.33^b \pm 1.54$	$5.40^b \pm 1.50$	$5.20^b \pm 1.37$	$5.93^b \pm 1.49$	$5.07^b \pm 1.39$
E	$4.20^c \pm 1.61$	$4.13^c \pm 1.69$	$4.33^c \pm 1.54$	$4.67^c \pm 1.72$	$4.67^c \pm 1.76$	$4.33^c \pm 1.50$
LSD	0.95	1.06	0.98	0.99	1.08	0.92

Values are means ± standard deviations of duplicate determinations. Means in the same column with different superscript are significantly different (P<0.05). A: 100% Wheat Flour; B: 70% Wheat Flour, 20% Water Yam Flour, 10% Brown Hamburger Bean Flour; C: 65% Wheat Flour, 20% Water Yam Flour, 15% Brown Hamburger Bean Flour; D: 60% Wheat Flour, 20% Water Yam Flour, 20% Brown Hamburger Bean Flour; E: 55% Wheat Flour, 20% Water Yam Flour, 25% Brown Hamburger Bean Flour; LSD: Least Significance Difference

This would encourage production of the crops by farmers. Utilization of these crops in bakeries will also increase farmers and bakers' income as well as provision of nutrients rich bread for consumers of all ages to combat malnutrition, enhance food security and save foreign exchange used in importation of wheat.

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