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PHYSICOCHEMICAL PROPERTIES AND SENSORY CHARACTERISTICS OF BREAD PREPARED FROM WHEAT-AFRICAN FINGER MILLET (Eluesine coracana) COMPOSITE FLOUR BLENDS

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The study evaluated the physical, chemical and sensory qualities of wheat-finger millet composite breads. The whole wheat and finger millet flours were composites at replacement levels of 10, 20, 30, 40 and 50% while whole wheat flour bread (sample A) served as control. Standard methods were used in flour and bread production, nutrients, physical and sensory characteristics determination. Composite bread formulated using 50% finger millet flour substitution had higher moisture, crude fat, fibre, ash, calcium, magnesium, phosphorus, zinc, iron and loaf weight increase relative to control. The calcium, magnesium, phosphorus, zinc, iron and potassium contents of composite breads increased significantly ($p<0.05$) with every 10% increase in finger millet flour while sodium contents decreased relative to control. Substitution of wheat flour with finger millet flour significantly ($p<0.05$) increased loaf volume and specific loaf volume but decreased the loaf weight of composite breads relative to control. Whole wheat bread was most preferred for all sensory attributes except taste while composite bread 90:10 was most preferred for taste. Among composite breads however, composite bread 80:20 was the most preferred for all sensory parameters. Finger millet flour has ability to improve physical, nutritional and sensory characteristics of bread. It's inclusion in bread production may impact positively on macro- and micro-mineral nutriture of consumers.

Keywords: Physicochemical and sensory characteristics, African finger millet, Composite bread, Composite flour, Mineral elements nutriture

INTRODUCTION

Finger millet (*Eleusine coracana L.*) is an important staple food crop grown extensively in various regions of Africa and India, where it is consumed in form of thin and thick porridges, unleavened breads, pancakes, dumpling and roti (Tsehaye *et al.*, 2006; Desai *et al.*, 2010; and Devi *et al.*, 2011). Its nutritional strengths include low carbohydrate (65-75%) and fat (1-2%) contents, high dietary fibre (15-20%) and mineral (2.5-3.5%) contents (Mathanghi and Sudha, 2012). It is a very rich source of dietary fibre, micronutrients (zinc, iron), polyphenols and gluten free (Mallashi and Hadimani, 1994). The health benefits of regular intake of finger millet include anti-diabetic, hypocholesterolemic, anti-tumerogenic, antiulcerative, atherosclerogenic effects, antioxidant and antimicrobial properties which are attributed to its polyphenol and dietary fiber contents (Archna, 2014). Finger millet is a boon for diabetic patients and obese people, as its slow rate of digestion, prevents spikes in blood sugar levels while its tryptophan content reduces appetite and thus help control

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food intake (Shobana and Malleshi, 2007). The incidence of diabetes is rapidly rising throughout the world (Huizinga and Rothman, 2006). Therefore, there is a need to healthy food products which would cater to the needs of millions suffering from degenerative diseases like diabetes mellitus. Millet based ready-to- eat food products can be utilized as dietary supplements for diabetics. At present ready-to-eat food products of millets are not available in the market. The use of millet for a varied range of food products is constrained by grittiness of flour and lack of gluten. This setback can be remedied by blending millet flour with other cereal flours. One possibility is blending millet flour with wheat flour for the preparation of baked products. Finger millet flour can be blended with wheat flour up to 30% for preparation of bread (Beswa *et al.*, 2010). Bakery products can be developed and targeted to fulfill specific therapeutic needs of consumers. The objectives of composite flour formulation have been identified to include: 1) reduction of over dependence on wheat flour as major ingredient in bread production; 2) promote utilization and increase exploitation of locally available underutilized food crops for bakery and confectionary industries; 3) improve nutritional quality and create variety of baked products in the market; and 4) ultimately reduce the cost of the final baked product (Iombor *et al.*, 2016). The demand for baked foods has been on the increase in Nigeria; however the country depends on imported wheat majorly to produce its baked products. This has negative impact on its Gross Domestic Product (GDP), food security and nutritional status of its citizens. The country however produces staples such as finger millet (*Eleusine coracana*) which presently has limited application in bakery industry. It would be beneficial to integrate the utilization of finger millet on an industrial scale, create varieties in bread production and improve nutrient densities of bread. The study was therefore designed to evaluate effect of substitution levels of finger millet flour to wheat flour on physical, chemical and sensory properties of wheat-finger millet composite breads.

MATERIALS AND METHODS

Materials

African Finger millet seeds were purchased from Heipang Market in Barkin-Ladi Local Government Area, Plateau State, Nigeria. Wheat flour, Yeast, fat, sugar and other ingredients were purchased from North-Bank market in Makurdi, Benue State, Nigeria.

Production of African Finger Millet Flour

Sorting, winnowing, washing, oven drying (50 °C; 6 hr), dry milling (hammer mill), sieving (0.7 mm) and packaging were processing techniques used to transform African Finger millet *seeds* into flour. The flour was packed in air tight container and stored at ambient temperature (32 ± 2 °C) for further studies.

Composite Flour Blend Formulation

Wheat and African finger millet flours were blended on percentage basis in ratios of 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50% and labeled A, B, C, D, E and F samples, respectively. Sample A with 0% finger millet flour served as control. The blend formulations in this study were produced based on standard method previously adopted (Shittu *et al.*, 2014). Kenwood mixer was used for mixing flour samples at speed 5 for 8 minutes to ensure uniformity.

Proportion of Ingredients for Bread Production

The proportion of ingredients used in preparation of wheat-African finger millet composite bread samples were composed of 100 g, 90 g, 80 g, 70 g, 60 g and 50 g wheat flour and 0 g, 10 g, 20 g, 30 g, 40 g and 50 g African finger millet flour for sample A, B, C, D, E and F, respectively. The quantity of salt (2.5 g), yeast (2 g), fat (2 g), sugar (2 g) and water (65 ml) used was kept constant in each bread sample.

Bread Production

The bread loaves were produced using the straight dough method (Udofia *et al.*, 2013). Prior to the actual baking of the breads, baking trials were carried out under laboratory conditions to optimize baking conditions. Composite flours and doughs were weighed using laboratory-scale (CE-410I, Camry Emperors, China). Doughs and ingredients were thoroughly mixed to optimum consistency in a Kenwood mixer (Model A 907 D, Kenwood Ltd., England) with low speed of 85 rpm for 5 min. Final dough temperature was 33 ± 2 °C. Composite mixed doughs were then kneaded and left to proof for 45 min. Proofed doughs were scaled into105 g portions, manually shaped and put into oiled aluminium baking pans. Baking was achieved at 230 ± 2 °C in an electric oven (Electric oven SL-9 Infra red Food Oven, Hubert, China) for 45 min or until a golden brown colour was formed. The resulting bread samples were allowed to cool at room temperature (30 ± 2 °C) for 2 h after which it was weighed and packaged into transparent polyethylene bags until further analysis were carried out on them.

Determination of Proximate Composition

The moisture, crude protein, crude fats, crude fibre and ash content of the composite bread samples were determined according to the method of (AOAC, 2000) while available carbohydrate was determined by difference.

Mineral Elements Determination

The mineral elements calcium, iron, copper, manganese, magnesium and zinc contents of bread samples were determined using (Onwuka, 2005) while sodium and potassium evaluated using (William and Latimer, 2000).

Determination of Physical Properties of Bread Samples

The loaf volume was determined using the seed displacement method described previously (Gregory and Okpara, 2005). Loaf weight was measured using an electronic balance while the Specific volume was estimated by finding the ratio of the loaf volume to its corresponding loaf weight: Specific volume = v/wt (cm^3/g).

Sensory Evaluation

The organoleptic properties of bread samples were evaluated by a 15 member panelists drawn from Federal University of Agriculture, Makurdi community, composed of both staff and students who were regular bread consumers. The breads were evaluated for taste, aroma, texture, crumb color and general acceptability using a 5-point hedonic scale (5 = extremely liked to 1 = extremely disliked) (See *et al.*, 2007).

Data Analysis

The triplicate data obtained from the physical, chemical and sensory analysis were subjected to one way analysis of variance (ANOVA) and Duncan Multiple range test was used to separate means in which significant differences existed at $p<0.05$. The data entry and analyses were achieved using SPSS software version 21.0.

RESULTS AND DISCUSSION

Proximate Composition of Wheat–African Finger Millet Composite Bread

The proximate composition of wheat-African finger millet composite breads is presented in Table 1. The substitution of wheat flour (10-50%) with African finger millet (*Eluesine coracana*) flour in bread production significantly ($p<0.05$) increased moisture (7.42-10.12%), crude fats (4.47-7.11%), fibre (1.12-1.49%) and ash (1.14-1.77%) contents of composite bread samples (Samples B to F) relative to 7.07%, 4.18%, 0.87% and 0.76% of sample A (control), respectively. Substitution however, significantly ($p<0.05$) decreased protein (11.21-8.58%), carbohydrate (74.33-72.03%) and energy (133.46-123.73 Kcal) contents of composite bread samples relative to 11.76%, 74.46% and 127.46 Kcal of whole wheat bread, respectively. The decrease in protein, carbohydrate and energy contents of composite bread samples may be attributed to lower protein, carbohydrate and fats content of finger millet grains than wheat grains. It may also be due to higher moisture contents of composite bread samples. The high moisture contents of composite bread samples, relative to 100% wheat bread may be attributed to high fibre content of finger millet flour (Thorat and Ramachandran, 2016) which tends to absorb and tightly bind larger volume of water (Živancev *et al.*, 2016). Studies have shown that incorporating millet flour with wheat flour in bread production increases the moisture content of composite breads above whole wheat bread (Food and Agricultural Organization, 2000; Chhavi and Sarita, 2012; and Singh *et al.*, 2012). Higher moisture contents of wheat-finger millet bread (38.70%), wheat-foxtail bread (38.38%), barnyard millet-wheat composite bread (34.10%) and barnyard, finger, proso millet-wheat composite bread (29.80%) have earlier been reported. The moisture contents of this study were in line with 9.57 g/100 g moisture content of decorticated pearl millet-wheat composite bread and within recommended levels for maintenance of shelf stability and wholesomeness of loafs while in storage (Standard Organization of Nigeria, 1976; and Ihekoronye and Ngoddy, 1985). The fibre and ash contents of the composite bread samples were higher than whole wheat bread. Significant higher crude fibre and ash contents of 1.5% (barnyard-wheat composite bread) and 1.4% (barnyard, finger, proso millet-wheat composite bread) than 1.4% and 1.2% in whole wheat bread, respectively had earlier been observed (Singh and Mishra, 2014). The fibre contents of this study were lower than 1.60% and 1.91%, respectively of two varieties of finger millet-wheat composite bread. The fibre contents of these breads may be utilized in the management/treatment or prevention of constipation, hypercholesterolemia, hyperglycemia, protect against cardiovascular diseases, stimulate and sustain satiety, regulate frequency and quantity of food consumed (Truswell, 2002; and Gupta *et al.*, 2012). Beneficial effect of dietary fiber is usually attributed either to slower gastric emptying or formation of un-absorbable complexes with available carbohydrates in the gut lumen and these two properties might result in

Table 1: Effect of 10% Substitution of Wheat Flour with African Finger Flour on Proximate Parameters of Wheat-African Finger Millet Composite Breads (%)

Samples	Moisture	Protein	Fat	Fibre	Ash	Carbohydrate	Energy (Kcal)
A(100:0)	7.07±0.01[f]	11.74±0.01[a]	4.18±0.05[f]	0.87±0.00[f]	0.76±0.00[f]	74.46±0.03[a]	127.46±0.09[d]
B(90:10)	7.42±0.00[e]	11.21±0.00[b]	7.11±0.01[a]	1.12±0.00[e]	1.14±0.00[e]	74.33±0.02[a]	133.46±0.11[a]
C(80:20)	7.95±0.00[d]	11.22±0.00[b]	6.83±0.01[b]	1.13±0.00[d]	1.22±0.00[d]	74.01±0.00[b]	132.90±0.11[b]
D(70:30)	8.24±0.00[c]	10.07±0.00[c]	5.49±0.01[c]	1.14±0.01[c]	1.35±0.01[c]	73.79±0.02[b]	132.23±0.11[c]
E(60:40)	8.74±0.00[b]	8.76±0.00[d]	4.68±0.01[d]	1.35±0.00[b]	1.64±0.00[b]	72.26±0.01[c]	126.74±0.08[e]
F(50:50)	10.12±0.01[a]	8.58±0.00[e]	4.47±0.00[e]	1.49±0.00[a]	1.77±0.01[a]	72.03±0.39[c]	123.73±0.15[f]

Note: Mean ± SD of triplicate determinations. Means with the same superscripts in a column are significantly not different ($p \leq 0.05$).

delayed absorption of carbohydrates and in reduction of absolute quantity absorbed. The fat and carbohydrate contents of the composite bread samples decreased with increase in finger millet flour relative to whole wheat bread. Decreases in carbohydrate contents of wheat-finger millet composite bread had earlier been observed. The decrease in fat and carbohydrate content of composite bread samples were in conformity with decreased fats and carbohydrate contents of wheat-African yam bean composite bread (Ade *et al.*, 2012). The decrease in crude fats and carbohydrate content of wheat-finger millet composite breads with increased incorporation of finger millet flour affirms the fats and carbohydrate content of the grains. The significant ($p<0.05$) decrease in carbohydrate and energy content of bread samples with increase in African finger millet flour incorporation may be suggestive of their low glycemic index, making them good diabetic foods, that may prevent unhealthy weight gain yet maintaining a healthy weight pattern thereby conferring protection against cardiovascular diseases among consumers. Research has shown that the carbohydrates present in finger millet are slowly digested and assimilated than those present in other cereals. Therefore regular consumption of these bread samples may reduce risk of diabetes mellitus and gastrointestinal tract disorders. The composite breads had lower protein contents relative to 100% wheat bread which may be attributed to differences in levels of extraction of wheat flour and finger millet flour used in bread production. The increase in ash contents of composite bread samples could be attributed to none decortications of finger millet grains in flour production. The use of finger millet flour in bread production would increase its utilization, diversify its food uses and boost income base of farm families involved in its production, at same time improve Gross Domestic Product (GDP) of the country.

Mineral Content of Content of Wheat–African Finger Millet Composite Bread

The mineral element contents of wheat-finger millet composite breads compared to 100% wheat bread (control) are presented in Table 2. The calcium contents of wheat-finger millet composite breads increased from 3.00 mg/100 g (sample B) to 62.00 mg/100 g (sample F). The magnesium, phosphorus and potassium contents increased from 11.33 - 138.34 mg/100 g, 570.79-906.33 mg/100 g and 7.41-7.66 mg/100 g in samples B-F, respectively compared to whole wheat bread. The sodium contents however significantly ($p<0.05$) decreased from 83.00-65.00 mg/100 g in samples B-F, respectively relative to control. The micro-mineral contents of composite breads were also significantly ($p<0.05$) elevated from 3.25-11.82 mg/100 g (Zn) and 2.39-5.24 mg/100 g (Fe), relative to whole wheat bread. Calcium, magnesium, phosphorus, zinc and iron values of composite bread samples peaked at 50% African finger millet flour incorporation while potassium peaked at 30% African finger millet flour incorporation. Quantitatively, phosphorus ranked highest in abundance in composite bread samples and was followed by magnesium, calcium, sodium, potassium, zinc and iron, respectively. Significant differences were observed in calcium contents of finger millet flour incorporated breads. The calcium contents of wheat-finger millet breads were significantly higher than whole wheat bread. Similar significant increases in calcium contents of finger millet-wheat composite bread had earlier been reported. This is not surprising because finger millet grains had been reported to contain higher calcium than wheat

Table 2: Mineral Elements Content of Wheat-African Finger Millet Composite Bread (mg/100 g)

Samples	Calcium	Magnesium	Phosphorus	Zinc	Iron (μg/g)	Potassium	Sodium
A(100:0)	124.67 ± 2.52^{b}	134.33 ± 1.53^{e}	520.25 ± 0.01^{d}	3.25 ± 0.01^{e}	2.39 ± 0.01^{f}	17.67 ± 0.58^{b}	83.00 ± 3.00^{a}
B(90:10)	127.67 ± 3.21^{b}	146.00 ± 2.65^{d}	1091.04 ± 0.01^{c}	5.64 ± 0.01^{d}	3.12 ± 0.01^{e}	17.33 ± 1.53^{b}	68.67 ± 4.15^{b}
C(80:20)	146.00 ± 4.70^{b}	244.67 ± 4.16^{c}	1298.28 ± 3.51^{b}	7.42 ± 0.01^{c}	3.62 ± 0.01^{d}	17.67 ± 2.08^{b}	65.67 ± 3.51^{c}
D(70:30)	147.67 ± 3.21^{b}	266.00 ± 2.00^{b}	1387.34 ± 0.01^{a}	10.62 ± 0.01^{b}	4.42 ± 0.01^{c}	25.33 ± 2.31^{a}	65.67 ± 2.89^{c}
E(60:40)	150.00 ± 6.56^{b}	268.33 ± 3.06^{ab}	1411.40 ± 0.01^{a}	10.63 ± 0.01^{b}	5.00 ± 0.01^{b}	25.08 ± 1.00^{a}	65.00 ± 4.58^{c}
F(50:50)	186.67 ± 2.08^{a}	272.67 ± 3.21^{a}	1426.58 ± 0.01^{a}	11.82 ± 0.01^{a}	5.24 ± 0.01^{a}	25.00 ± 2.65^{a}	65.00 ± 1.00^{c}

Note: Mean ± SD of triplicate determinations. Means with the same superscripts in a column are significantly not different ($p \leq 0.05$).

grains (Gopalan *et al.*, 1997; and Railey, 2000). The magnesium, phosphorus, zinc, iron and potassium contents of composite bread significantly increased with increase supplementation of finger millet flour, relative to whole wheat bread (control). The sodium contents of wheat-finger millet composite bread samples however decreased with increase substitution of wheat flour. Similar significant increases in potassium, phosphorus, zinc, iron, copper, manganese and calcium contents of barnyard, finger, proso millet-wheat flours bread have been reported. Consumption of 100 g of wheat-finger millet composite bread may provide 10.64% and 15.56%, 47.00 and 98.50%, 26.00 and 43.67% of the Recommended Daily Intake of Calcium, Zinc and iron of 15 to 18 years old male consumers, respectively while 10.64% and 15.56%, 58.44% and 131.33%, 26% and 43.67% of the Recommended Daily Intake of Calcium, Zinc and iron of 15 to 18 years old female consumers, respectively.

Physical Properties of Composite Bread

The effect of African finger millet flour incorporation on physical properties of wheat-African finger millet composite breads is presented in Table 3. The loaf volume of composite breads varied from 545-595 cm (samples B-F), compared to control. The significant ($p<0.05$) increase in loaf volume with increase substitution of wheat flour peaked at 40% African finger millet flour incorporation. One of the most important parameter for estimation of bread quality is loaf volume as a quantitative measure of baking process (Tronsmo *et al.*, 2003). It is usually considered that high volume of bread correlates with softer texture and high porosity, which is a consequence of high quality of the flour. The increase in loaf volume of bread samples with decreasing protein content contrasts earlier findings (Faergestad *et al.*, 2000; Kamaraddi and Shantha Kumar, 2003; Ragaee and Abdel-Aal, 2006; and Patil *et al.*, 2016). The increase in bread volume with increased substitution of wheat flour with finger millet flour contrasts decrease in loaf volume with increase in millet flour substitution up to 30% earlier reported (Chinma *et al.*, 2014). These contrasts could be attributed to extraction level and protein contents of wheat flour used in these studies. Partial replacement of wheat with non-glutinous flour in bread production has been reported to lower bread volume and specific volume (Shittu *et al.*, 2007; and Akubor, 2008a). Peak increase in specific loaf volume of composite bread samples was observed in wheat-finger millet composite blend with 30% African finger millet flour. The specific loaf volume of bread ranged from 2.64-3.08 cm^3/g. The specific volume has been generally adopted in literature as a more reliable measure of loaf size. Higher specific loaf volume is desirable for good quality bread (Akubor, 2008b). The specific loaf volumes of

Table 3: Physical Properties of Wheat-African Finger Millet Composite Bread

Samples	Loaf Volume (Cm)	Specific Loaf Volume (Cm^3/g)	Loaf Weight (g)
A(100:0)	415.00 ± 7.07^{c}	2.07 ± 0.01^{d}	206.00 ± 2.12^{a}
B(90:10)	545.00 ± 7.07^{b}	2.64 ± 0.06^{c}	198.50 ± 2.12^{b}
C(80:20)	547.50 ± 3.54^{b}	2.84 ± 0.06^{b}	188.00 ± 2.83^{c}
D(70:30)	594.50 ± 7.78^{a}	3.08 ± 0.00^{a}	192.50 ± 3.54^{bc}
E(60:40)	595.00 ± 7.07^{a}	2.95 ± 0.08^{b}	199.00 ± 1.41^{b}
F(50:50)	548.50 ± 2.12^{b}	2.61 ± 0.01^{c}	207.50 ± 3.54^{a}

Note: Mean ± SD of triplicate determinations. Means with same superscripts in a column are significantly not different ($p \leq 0.05$).

wheat-finger millet composite bread samples were significantly higher than control (100:0). The specific loaf volumes of this study were lower than 3.82 cm^3/g and 3.23 cm^3/g reported earlier. This implies that incorporation of finger millet flour in bread production may impact negatively on consumer acceptability of the loaves. The decrease in specific loaf volume of wheat-finger millet composite breads with increase incorporation of finger millet flour may be attributed to decrease in gluten content of composite flour blends arising from poor gluten content of finger millet grains. The loaf weight ranged from 206.0-207.50 g. The loaf weight of wheat-finger millet composite breads showed maximum (207.50 g) value at 50% African finger millet flour substitution of wheat flour. Before then, loaf weights of wheat-finger millet composite breads with lower blends of African finger millet flour were lower than 100% wheat bread. Low loaf weights of wheat-finger millet composite bread may have negative economic effect at the retail end. The low loaf weights of wheat-finger millet composite bread samples may be attributed to low gluten content of finger millet flours, with poor rising and water retention abilities hence providing less dense bread loaves. The low loaf weight of this study collaborate the low loaf weight earlier reported for wheat-cowpea composite breads (Hathorn *et al.*, 2007).

Sensory Properties of Bread Produced from Wheat-Finger Millet Flour Blends

Wheat-African finger millet composite breads were evaluated for colour, taste, texture, aroma and overall acceptability (Table 4). The mean sensory scores of judges showed greater preference for whole wheat bread for colour (4.40), texture (3.80), aroma (3.67) and overall acceptability (3.87) while composite bread samples B (90:10) and C (60:40) were most preferred for taste (3.87) by panelists. Among composite bread samples however, samples B (90:10) and C (80:20); D (70:30), B (90:10) and C (80:20) were most preferred for colour (3.20), texture (3.53), aroma (3.47) and overall acceptability (3.53), respectively. Crumb colour varied between 2.33 and 4.40 and decreased significantly ($p<0.05$) with increase level of African finger millet flour addition. The mean taste rating of composite breads increased up to 20% finger millet flour incorporation but declined at 30-50% finger millet addition, relative to 100% wheat bread. The texture ratings significantly ($p<0.05$) decreased with increased substitution of wheat flour. The aroma and overall acceptability of composite breads were not significantly ($p>0.05$) different from 100% wheat bread, but decreased with increase wheat flour substitution. Sensory analysis indicated that among composite breads, bread produced with 10% and 20% finger millet flour had significantly higher ($p<0.05$) preference for colour (3.20) and taste (3.87) by panelists. Generally, as quantity of African finger millet increased, composite bread samples became darker (dark gray) in colour, impacting negatively on its preference by consumers. The decrease in crust and crumb colour of composite bread samples with increasing level of finger millet flour substitution could be attributed to their high ash/mineral contents that impacted dark colour on the loafs. The change in crust colour of composite bread with increased substitution of wheat flour with finger millet flour had earlier been observed in wheat-barnyard millet bread; wheat-barnyard-finger-proso millet bread, wheat-sesame bread, wheat-barley bread and wheat-pearl millet bread, respectively. The crust colour of bread is a very important parameter for consumers (Hathorn *et al.*, 2007) because of acceptability of the product. The crust colour of control and composite breads showed significant variation because

Table 4: Sensory Evaluation of Finger Millet Flour Incorporated Bread Samples

Samples	Colour	Taste	Texture	Aroma	Acceptability
A(100:0)	4.40 ± 0.83^a	3.67 ± 0.72^a	3.80 ± 0.86^a	3.67 ± 0.98^a	3.87 ± 1.06^a
B(90:10)	3.20 ± 1.08^b	3.87 ± 0.99^a	3.53 ± 1.06^{ab}	3.47 ± 0.92^a	3.53 ± 0.92^a
C(80:20)	3.20 ± 1.52^b	3.87 ± 0.99^a	3.47 ± 0.99^{ab}	3.40 ± 0.91^a	3.47 ± 0.92^a
D(70:30)	2.93 ± 1.39^{bc}	3.67 ± 0.90^a	3.41 ± 0.95^b	3.40 ± 1.12^a	3.40 ± 0.82^a
E(60:40)	2.73 ± 0.88^{bc}	3.40 ± 1.18^{ab}	3.40 ± 0.74^{ab}	3.27 ± 0.79^a	3.33 ± 0.90^a
F(50:50)	2.33 ± 1.23^c	2.73 ± 0.80^b	3.20 ± 0.94^{ab}	3.27 ± 0.96^a	3.20 ± 1.08^a

Note: Mean ± SD of triplicate determinations. Means with same superscripts in a column are significantly not different ($p\leq0.05$).

composite bread colour reflected colour of finger millet flour used in composite flour production. The light brown crust colour of control bread decreased with increased substitution of finger millet flour. These results indicate that crust colour of wheat-finger millet composite breads were dark brown than crust colour of control bread. An increase in sensory preference of taste was observed up to 20% finger millet flour substitution of wheat flour. This is an indication that tasty bread can be produced with up to 80:20 of wheat-finger millet composite flour blends, thereby reducing use of wheat flour by 20% in bread production. This however contrasts earlier 30% finger millet flour substitution of wheat flour in bread production being the most tasteful wheat-finger millet composite bread. The findings of this study were in agreement with Sittu *et al.* (2007) findings who reported higher preference for composite bread samples with lower content of vitamin A enriched cassava flour and groundnut skin flour, respectively. Preference of wheat-finger composite bread on the basis of texture decreased with increase in African finger millet flour. The increase addition of African finger millet flour decreased the grainer feel of bread samples and hence poor texture score of products by panelists. The mean texture scores of wheat-finger millet composite bread samples obtained in this study was in line with those of wheat-African yam bean flour bread. Substitution of wheat flour with African finger millet flour impacted negatively on aroma of the composite breads which may had been responsible for their poor rating by panelist. The acceptability of composite bread samples decreased as level of African finger millet flour increased. The results were in agreement with Ade *et al.* (2012) who reported decrease in overall acceptability of bread prepared from wheat-African yam bean water extractable proteins flour blends.

CONCLUSION

The study showed that high quality bread with acceptable organoleptic attributes can be produced from 80:20% wheat-African finger millet composite flour blends, with concomitant improvement in loaf volume and specific loaf volume, fats, fibre and mineral elements. Although composite bread sample D (70:30) had the highest loaf volume and specific loaf volume, composite bread sample C (80:20) was generally the most preferred by consumers, its commercial production is therefore recommended.

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