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Production and Evaluation of Breakfast Cereal Produced from Finger Millet, Wheat, Soybean, and Peanut Flour Blend

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Abstract
In this study, finger millet based breakfast food was prepared, supplemented with wheat, soybean, and peanut in the ratios of (100:0), (90:10), (80:20), (70:30), and (60:40) and labeled as samples A, B, C, D and E respectively. These products were analyzed for proximate composition, mineral contents, functional properties and sensory quality attributes. Results showed that, the protein content of finger millet increased significantly ($p<0.05$) with increase in supplementation from 9.70% in sample A to 13.15% in sample E, with a corresponding increase in fat and ash content. Mineral content also increased significantly ($p<0.05$) with increased level of supplementation in terms of zinc, sodium and potassium, while calcium decreased significantly. The functional properties of the flour blends showed significant improvement ($p<0.05$) with increase in the level of supplementation, as the oil absorption capacity, water absorption capacity, foaming capacity, and pH increased significantly, however, there was significant decreased in bulk density and longer reconstitution time. Sensory quality attributes showed that sample E had the highest preference in terms of appearance, taste, mouth feel, aroma and general acceptability. The study therefore suggests that supplementation of finger millet based breakfast with wheat, soybean, and peanut improves the protein, fat, ash, mineral contents, functional properties and improves the organoleptic properties of the product as 60:40 supplemented finger millet based breakfast cereal sample was the most preferred. Hence, the supplementation of finger millet based breakfast cereal should be encouraged as it offers better physicochemical, functional and sensory quality attributes.

Keywords: *breakfast cereal; evaluation; finger millet; flour blend; production*

Introduction

Breakfast is the nutritional foundation or the first meal of the day. In developing countries, particularly sub-Saharan Africa, breakfast meals for both adults and infants are based on local staple diet made from cereals, legumes, and few tubers. However, the most widely eaten breakfast foods are cereals (Kowtaluk, 2001). Breakfast cereals are legally defined as foods obtained by swelling, grinding, rolling or flaking of any cereal (Sharma and Caralli, 2004). The common cereal products in Nigeria include NASCO Cornflakes, Good morning corn flakes, Kellogg's cornflakes, NABISCO flakes, Weetabix, Quaker oats, rice crisps among others.

Cereal such as finger millet (*Eleusine coracna*) is a known variety of millet with extensive shelf life characteristic and it is cultivated in several semi-arid and tropical regions predominantly in some part of Africa, eastern and southern Asia. Staple foods prepared from the grains are major sources of minerals and nutrients and are especially important for pregnant woman, lactating mothers and children. Finger millet is 3-5 times nutritionally superior to the widely promoted rice and wheat in terms of protein, mineral and vitamins

(Bhohale, 2013). Wheat, another cereal is an important agricultural commodity and a primary food ingredient worldwide and contains considerable beneficial nutritional components. Wheat and wheat-based food ingredients rich in natural antioxidants can ideally serve as the basis for development of functional foods designed to improve the health of millions of consumers (Tomas *et al.*, 2014).
Legumes or pulses are edible fruits or seeds of pod bearing plants. Their seeds are put to a myriad of uses, both nutritional and industrial, and in some parts of the developing world they are the principal source of protein for humans (Trevor *et al.*, 2005). The common legumes in Nigeria include, cowpea (*Vigna unguiculata)*, soybeans (*Glycine max*), pigeon pea (*Cajanus cajan*), and peanut (*Arachis hypogea)*. Peanut (*Arachis hypogaea*), is an oilseed crop cultivated in semi-arid and subtropical regions of the world. Nigeria is the largest peanut producing country in West Africa, accounting for 51% of production. Peanut is a major source of edible oil as well as livelihoods for small-scale farmers in the northern Nigeria (Ajeigbe, 2015). Soybean (*Glycine max*) another legume is one of the world's largest sources of plant protein and oil. Soybean protein has high crude protein and a balanced amino acid profile. Soybeans had been used to enrich other food stuffs such as cassava products, cereal products (Ayo *et al*., 2007).

Research has continued to focus on the need and how to augment the low level of protein in the diets of the vulnerable group of people in developing nations. In these, developing nations where protein deficiencies are endemic and where animal-proteins are not available in adequate quantities, a well-planned vegetarian diet, based on the concept of supplementation could be a logical solution to the protein problem. Cereals are limiting in some essential amino acids especially threonine and tryptophan (Onweluzo and Nnamuchi, 2009). Finger millet, like other cereals is limiting in these amino acids too, however, a combination of this cereal with other cereals and/or with legumes will complement each other in the amount of amino acids to improve nutritional quality, develop a new product that will benefit hungry and malnourish individuals, and improve the utilization of finger millet, provide income for farmers and processors of finger millet-based breakfast cereals.

Materials and methods

Materials

The finger millet *(Eleusine coracana)*, wheat *(Triticum spp.)*, soybeans *(Glycine max)*, and peanuts (*Arachis hypogea*) were purchased from Wednesday market in Dutsinma, Katsina state. The chemicals and equipment/facilities used were obtained from food processing laboratory of Federal University, Dutsinma.

Sample preparation

Processing of toasted soybean seeds

Soybean seeds were cleaned, sorted and cracked using mortar and pestle for easy decortication, toasted in the oven at 70^{o}C for one (1) hour. The seeds were then dried in the sun and dehulled using mortar and pestle to remove the testa. The testa from the dehulled seeds, were separated by winnowing in order to obtain toasted soybean seeds.

Processing of toasted peanut seeds

Peanut seeds were cleaned, sorted and toasted in oven at 70^{o}C for one (1) hour. They were then dried in the sun and dehulled using hands to remove the testa. The testa from the dehulled seeds, were separated by winnowing in order to obtain toasted peanut seeds.

Composite formulation

The finger millet and (wheat, soybean and peanut) grain samples were mixed using material balance at the ratios of 100:0, 90:10, 80:20, 70:30 and 60:40, labeled as A, B, C, D and E as shown in Table 1. Sample A with the 100% finger millet served as the control.

Table 1: Blend formulation for breakfast cereals

COMPOSITION	A	B	C	D	E
FM (g)	97.00	87.31	77.50	67.90	58.20
W (g)	0.00	3.23	6.47	9.70	12.93
S (g)	0.00	3.23	6.47	9.70	12.93
P (g)	0.00	3.23	6.47	9.70	12.93
G&C (g)	3.00	3.00	3.00	3.00	3.00

Key; FM = finger millet; W = wheat; S = soybeans; P = peanuts; G&C = ginger/cloves

Processing of finger millet, wheat, soybean, and peanut flour blends

Cleaned finger millet, wheat, toasted soybeans and peanut, were weight with electronic chemical balance based on the formulation in Table 1 and milled using harmer mill. Each of the milled four sample obtained were then subjected to sieving process with 2 mm pore sieve size.

Proximate compositions of formulated samples

The proximate compositions of the samples were determined using standard methods (AOAC, 2012) for moisture content, crude fat content, crude protein content, crude ash, crude fibre, and carbohydrate content. Energy calculation was done based on Artwater factor (% Protein x 4, % Carbohydrate x 4, % Fat x 9) kcal/100 g

Mineral content analysis

The mineral content of the products were determined using methods as described by AOAC (2012), for zinc (Zn), calcium (Ca), sodium (Na) and potassium (K).

Functional properties

These were determined by the methods described by Onwuka (2005), for foaming capacity, bulk density, water absorption capacity, oil absorption capacity, pH and reconstitution time.

Preparation of complementary food

Method described by Olapade *et al*., 2012 was used for the preparation of the meal for sensory evalaution.

Sensory analysis

The sensory evaluation of gruels produced from the breakfast cereal formulations was conducted at the food laboratory of Federal University Dutsinma and performed by affective testing (Iwe, 2002). Thirty students were randomly selected to evaluate the breakfast cereal using a nine (9) point hedonic scale ranked from 1 – 9. The judges evaluated the breakfast cereals for taste, aroma, mouth feel, appearance, and general acceptability.

Statistical analysis

The analysis of variance (ANOVA) was used to analyze all data using the statistical package for statistical package for social sciences (SPSS) version 16 for windows. Mean separation was performed by the LSD test ($p \leq 0.05$).

Results

Proximate Composition

Table 2, Shows the results of the proximate composition of finger millet *(Eleusine coracana),* wheat *(Triticum spp.),* soybeans *(Glycine max),* and peanuts (*Arachis hypogea*) flour blends. This result was as expected as there was significant increase in the protein, ash, fat, and energy contents with a corresponding decrease in carbohydrate, moisture, and fibre contents. The carbohydrate content ranged from 61.70 to 71.25 %. Sample A had the highest while sample E had the least carbohydrate content. The mean moisture contents of samples A, B, C, D and E ranged from 6.95 to 7.85 % with sample A (control) having the least while sample E had the highest value. There was however, no significant difference among all the samples at $P<0.05$. The fat content of samples A, B, C, D and E were 1.5%, 3.15%, 4.05%, 7.20%, 8.50% respectively, indicating that fat content increased with increase in supplementation. The fibre content of these samples ranged from 4.25 % in sample E to 8.20 % fibre content in sample A. however, sample A was significantly different from all the other samples ($P<0.05$) in the fibre content with decrease in fibre content as the level of supplementation increases. The protein content increased significantly ($P<0.05$) with increase in the supplementation of finger millet from 9.70 % in sample A to 13.5 % in sample E. The energy or caloric value shows that the calorific values ranged between 337.30 - 375.90 kcal/ 100 g in samples A, B, C, D, and E.

Table 2: Proximate Composition of breakfast cereal

Samples	Carbohydrate (%)	Moisture (%)	Ash (%)	Fat (%)	Fibre (%)	Protein (%)	Energy (kcal/100g)
A	71.25^{a}	6.95^{a}	2.40^{a}	1.50^{c}	8.20^{a}	9.70^{b}	337.30^{e}
B	70.55^{a}	7.20^{a}	3.10^{a}	3.15^{bc}	6.30^{ab}	11.20^{ab}	357.55^{c}
C	67.95^{ab}	7.55^{a}	3.00^{a}	4.05^{b}	6.25^{ab}	11.60^{ab}	353.05^{d}
D	64.00^{bc}	7.70^{a}	3.20^{a}	7.20^{a}	6.10^{c}	11.75^{ab}	367.20^{b}
E	61.70^{c}	7.85^{a}	3.10^{a}	8.50^{a}	4.25^{c}	13.15^{a}	375.90^{a}
LSD	5.98	1.04	0.85	1.83	1.99	3.40	0.00

Values are means of duplicate determinations. Values with the same superscript within the column are not significantly different ($p > 0.05$).

Key; A = 100 % finger millet, B = 90 % finger millet & 10 % (wheat, soybean, peanut), C = 80 % finger millet & 20 % (wheat, soybean, peanut), D = 70 % finger millet & 30 % (wheat, soybean, peanut) E = 60 % finger millet & 40 % (wheat, soybean, peanut).

Mineral Content

Table 3 shows the mineral composition of flour samples A, B, C, D and E in mg/100 g produced from finger millet and (wheat, soybeans, and peanut) blends in the ratios 100:0, 90:10, 80:20, 70:30, 60:40 respectively. The value of calcium continued to decrease while that of potassium, zinc and sodium increased with increase in the level of substitution. Sample A had the least zinc content of 6.94 mg/100 g zinc content and the incorporation of wheat, soybeans, and peanut blends significantly increased the zinc content up to

16.67mg/100g in sample E with 40 % supplementation. The control (sample A) had the least potassium value 566.67mg/100g while amples B, C, D and E showed higher potassium content of between (1000 – 1400 mg/l00 g).

Table 3; Mineral composition of breakfast cereal

Samples	Zn (mg/100g)	Ca (mg/100g)	Na (mg/100g)	K (mg/100g)
A	6.94^{c}	183.33^{a}	5.83^{c}	566.67c
B	8.33^{b}	158.33^{ab}	8.33^{b}	1000.00^{b}
C	8.33^{b}	116.67^{bc}	10.83^{a}	1066.67^{b}
D	13.89^{ab}	83.33^{c}	11.67^{a}	1166.67^{b}
E	16.67^{a}	66.67^{c}	12.50^{a}	1400.00^{a}
LSD	7.31	54.75	1.79	198.50

Values are means of duplicate determinations. Values with the same superscript within the column are not significantly different ($p > 0.05$).
Key; A = 100 % finger millet, B = 90 % finger millet & 10 % (wheat, soybean, peanut), C = 80 % finger millet & 20 % (wheat, soybean, peanut), D = 70 % finger millet & 30 % (wheat, soybean, peanut) E = 60 % finger millet & 40 % (wheat, soybean, peanut).

Functional properties

Results of the functional properties of breakfast cereals produced from finger millet, wheat, soybean and peanut flour blends are as presented in Table 4. Oil absorption, water absorption, reconstitution time, pH and foaming capacity increased with increase in supplementation, while bulk density decreases.

Table 4: Functional Properties of breakfast cereal

Samples	Bulk Density	Oil Absorption	Water Absorption	Reconstitution Time	Foaming Capacity	pH
A	0.860^{a}	0.895^{a}	1.000^{b}	40.5000^{b}	8.145^{b}	6.200^{b}
B	0.830^{ab}	0.995^{a}	1.010^{b}	41.5000^{b}	8.100^{b}	6.300^{a}
	0.780^{bc}	1.055^{a}	1.105^{b}	49.000^{ab}	8.900^{c}	6.300^{a}
D	0.760^{cd}	1.165^{a}	1.100^{b}	53.500^{a}	9.700^{ab}	6.300^{a}
E	0.715^{d}	1.255^{a}	1.480^{a}	60.000^{a}	11.280^{a}	6.300^{a}
LSD	0.056	0.529	0.343	11.158	2.728	0.000

Values are means of duplicate determinations. Values with the same superscript within the column are not significantly different ($p > 0.05$).
Key; A = 100 % finger millet, B = 90 % finger millet & 10 % (wheat, soybean, peanut), C = 80 % finger millet & 20 % (wheat, soybean, peanut), D = 70 % finger millet & 30 % (wheat, soybean, peanut) E = 60 % finger millet & 40 % (wheat, soybean, peanut).

Sensory attributes

Results of the sensory quality attributes of breakfast cereals produced from finger millet, wheat, soybean and peanut flour blends are as presented in Table 5 for taste, aroma, mouth feel, appearance and general acceptability.

Table 5: Sensory Attribute of breakfast cereal

Samples	Taste	Aroma	Mouth feel	Appearance	Gen. Acceptability
A	7.20^{b}	6.60^{b}	6.23^{d}	5.97^{d}	6.67^{d}
B	7.00^{c}	6.27^{d}	6.30^{c}	6.13^{c}	6.77^{b}
C	6.87^{d}	6.40^{c}	6.03^{e}	6.57^{b}	6.63^{e}
D	6.27^{e}	6.17^{e}	6.47^{b}	6.57^{b}	6.70^{c}
E	7.50^{a}	6.90^{a}	7.10^{a}	7.03^{a}	7.47^{a}
LSD	0.00	0.00	0.00	0.00	0.00

Values are means of duplicate determinations. Values with the same superscript within the column are not significantly different ($p > 0.05$).
Key; A = 100 % finger millet, B = 90 % finger millet & 10 % (wheat, soybean, peanut), C = 80 % finger millet & 20 % (wheat, soybean, peanut), D = 70 % finger millet & 30 % (wheat, soybean, peanut) E = 60 % finger millet & 40 % (wheat, soybean, peanut).

Discussion

Carbohydrate: Results from 100 % finger millet flour shows that carbohydrate content was 71.25 and this was similar to the report of (Bhatt *et al*., 2003) who stated that finger millet have 72 to 79.5% carbohydrate. The amount of the carbohydrate in the blends decreased with increase in the supplementation of finger millet. This decrease could be as a result of the inclusion of wheat, soybean and peanut which have a higher protein content hence the reduction in the resultant carbohydrate. Carbohydrate content contributes energy value of food formulations. The high carbohydrate in these blends make them ideal for all age groups most especially infants since they require energy for their rapid growth.
Moisture: The decrease in moisture content could be as a result of increase in protein content caused by the supplementation with legumes as protein is known to bind moisture and make them unavailable. The moisture content of any food is an index of its water activity and is used as a measure of stability and susceptibility to microbial contamination. Although the products have relatively low moisture content, this is an indication that the products would have good storage stability if properly packaged.
Ash: The ash content gives an indication of the mineral composition preserved in the food materials (Nnamani *et al*., 2009). The ash content increased with supplementation from 2.40 % in sample A to 3.20 % in sample D. Higher ash content indicates a higher mineral content which implies that individual feeding on the flour blends will not be mineral deficient.
Fat: The increase in fat content could be as a result of the increase in the quantity of oil bearing seeds in the formulation. However, the fat contents obtained are lower than the recommended 10 % FAO (1996) for weaning food formulation. This low fat content is an advantage for people suffering from obesity and also implies that the storage life of the flour blends may increase due to their low fat. Dietary fats function in the increase of palatability of food by absorbing and retaining flavours (Antia *et al*., 2006). A diet providing 1-2 % of its caloric of energy as fat is said to be sufficient to human beings. Excess consumption of fatty foods has been implicated in certain cardiovascular disorders such as atherosclerosis, cancer, and aging (Antia *et al*., 2006). Therefore, these flour blends for diets will not pose any risk of the above diseases in man.
Fibre: Decrease in fibre content is as expected as wheat, soybean, and peanut have low fibre content when compared to figer millet. The fibre content of the blends exceeds the required quantity for infants, as it has been documented that the fibre content of infant cereals should

be between the ranges of 0.3 % to 2.5 % (Odom *et al.,* 2013). Fibre helps in the maintenance of human health and has been known to reduce cholesterol level in the body Bello *et al. (*2008). Fibre is an indigestible component of plant material that helps in improving roughage and bulk as well as contributes to a healthy condition of the intestine (Potter and Hotchkiss, 2004). Fibre increases stool bulk and decreases the time that waste materials spend on in the gastro intestinal track.

Protein: The increase in the protein content could be as a result of the protein contributed by wheat, soybean, and peanut as Hou and Chang. (2003) reported soybeans to contain 44 - 48 % crude protein. Effiong *et al. (*2009) stated that any plant foods that provide about 12 % of the caloric value from protein are considered good sources of protein. Ayo *et al.* (2007) reported the use of soy in cassava and cereal products, Sanni *et al*., 2005 also demonstrated that well prepared soy can produce results equivalent or sometimes superior to those obtained with animal sources. Similar increase was observed by Kudake *et al.* (2018). The results of the protein content are comparable to the 12 % stipulated by Effiong *et al. (*2009) and hence the supplemented flour blends met this requirement. The percentage protein is enough to prevent protein energy malnutrition in an adult who depends on this meal for protein source.

Energy/ Caloric value: The high energy values could be attributed to the breakdown of carbohydrate (starch) to simpler sugars thereby increasing the calories. Also, the blending of the finger millet and wheat, soybean, and peanut to form composites increased the energy values probably due to the inherent nutrients in all the supplemented samples. Sample A (the control), showed least energy values ($p<0.05$) while samples E had relatively highest energy. Similar results were reported by other researchers such as Ejikeme (2005), who obtained energy content of between 316.46 - 411.04 Kcal/100 g for pigeon pea and sorghum flour blends. The high energy content is advantageous for product formulation like breakfast cereals.

Zinc: Zinc plays a vital role in many biological functions such as reproduction, diabetes control, stress level, immune resistance, smell, taste, physical growth, appetite and digestion (Michael and Frank, 2004). Zinc is needed for many processes in the body and is necessary for a strong immune system and healing and protecting skin.

Calcium: The need of calcium for the development of bone and teeth cannot be over emphasized. It is also greatly required in binding many cellular proteins resulting in their activation. The calcium content of sample A was determined to be 183.33 mg/100 g. The result obtained was in line with the findings reported by Bachar *et al.* (2013) where the calcium content of finger millet was reported to be between 84.71 - 567.45 mg/100g among different varieties. The calcium content in this research decreased significantly ($p<0.05$) to 66.67 mg/100g with inclusion of wheat, soybeans, and peanut. This is in agreement with the works of Bhatt *et al.* (2003) who reported that the calcium content of finger millet was 344 mg/100 g. Singh and Raghuvanshi (2012) also reported that the finger millet has the highest calcium content among all cereals (344 mg/100g). Calcium deficiency leading to bone and teeth disorder can hence be overcome by introducing finger millet in our daily diet.

Sodium: Sodium is an important mineral that helps to control body water and regulate thirst. The sodium content of sample A was 5.83 mg/100 g, this increased significantly to 12.50 mg/100 g of sodium with up to 40 % supplementation of finger millet in sample E. The result therefore shows that the incorporation of wheat, soybeans, and peanut in the blend increases sodium content in the product.

Potassium: Results for potassium from this research shows that the supplemented grains significantly increased the potassium content of the samples. This increased potassium level could be an added advantage to the product as potassium is important mineral in maintaining osmotic pressure and acid-base balance.

Bulk density: The bulk density is influenced by particle size and density of the flour. And this gives information on the porosity of a product and can influence the choice of package and its design (Odedeji and Oyeleke, 2010). The results for bulk density ranged from 0.715 – 0.860 g/cm^3 with 100% finger millet flour having the highest bulk density. The results for bulk density of the flour blends showed that sample A was significantly different ($p<0.05$) from all the other samples. Low bulk density is influenced by the loose structure of the starch polymer (Olu *et al*., 2012). This implies a lesser packed weight for same volume with increase in supplementation.

Oil absorption capacity: The low oil absorption capacity seen in sample A could be due to presence of hydrophilic group from the finger millet flour. Oil absorption capacity is another vital functional property of flour hence it's excellent in enhancing the mouth feel while preserve the flavor of food products. The removal of fat from the samples exposes the water binding sites on the side chain groups of protein units previously blocked in a lipophilic environment thereby leading to an increase in water absorption capacity value. Oil absorption increase in proportion to the protein contents of the flour as the oil absorption of the wheat, soybeans, and peanut blends flour was higher than that of finger millet flour only. This implied that the supplemented samples may have more hydrophobic proteins flour. The more hydrophobic proteins demonstrate superior binding of lipids. Hence the major chemical component affecting oil absorption capacity is protein, which is composed of both hydrophilic and hydrophobic parts.

Water absorption capacity: The low water absorption seen in 100% finger millet could be due to high proportion of hydrophilic group and polar amino acid on the surface of the protein molecules and the increase may be due to the water binding properties of the flour blends. Water absorption capacity is a critical function of fat and protein in various food products like soups, gravies, dough and baked products Sosulski *et al*. (1977). Osundahunsi *et al*. (2003) reported that higher water absorption capacity is desirable in food system to improve yield and consistency of such food product.

Reconstitution time: Results for reconstitution time showed continued increase from sample A with a mean value of 40.50 seconds up to 60.0 seconds at 40 % level of substitution. However, sample E is not significantly different from sample D at P<0. Sample E took the highest period to disperse in the solvent and this was as expected simply due to presence of constituents in soybean and peanut such as fats that are not readily soluble in water. Similar result was reported by Ejikeme. (2005).

Foaming capacity: This is as expected as protein has the ability to form foam, and the inclusion of wheat, soybean and peanut has improved the protein content of the breakfast cereal. Similar observation was reported by Ejikeme, 2005. Foam is produced in a liquid when air is introduced resulting in formation of bubbles. The differences in the foaming capacity of the flours may be attributed to the different composition and nature of the protein fractions. It may also be explained on the basis of presence of globular proteins which makes denaturing of the surface difficult.

pH: Results for pH showed that sample A had a pH of 6.2 while the others had 6.3. The result was as such because all the component cereals used are low acid foods and the presence of more amino acids from the legumes might have resulted to such increase. Similar result was reported by Ejikeme, (2005).

Taste: Taste is a code given to different food by the sensorial palate when the food is ingested into the mouth. Sample with 40 % level of incorporation emerged as the one with highest taste quality with mean value of 7.50, while the control was 7.20 and sample D ranked the least with 6.17 as its mean value. There was significant difference ($p< 0.05$) among the samples and results showed that the increase in the level of supplementation improved the taste of the breakfast cereal.

Aroma: Aroma is a fundamental sensory attribute which refers to the sensations in the nostrils as a result of rising of food or drink volatile compounds. Sample with 40% supplementation had the highest mean value of 6.90. Sample A had 6.23 while sample D had the least mean score of 6.17. There was however significant difference ($p<0.05$) among samples as sample E was more acceptable in terms of aroma, indicating that supplementation with wheat, toasted soybean and peanut has improved the aroma. This improvement could probably be due to the mild acrid flavour impacted by the toasted soybean and groundnut.

Mouth feel: This shows the response of sense organs in the mouth to the roughness, smoothness, chew ability, stickiness of food in the mouth. The control (100% finger millet) had a mean value of 6.23, where samples with 10%, 20%, 30%, and 40% wheat, soybean, and peanut blend level of incorporation had 6.30, 6.03, 6.47, and 7.10 respectively. There was significant difference at $p<0.05$ among samples. The result was as expected because the sample with supplementation contained oil bearing seed most especially sample with 40% level of inclusion, as oil containing foods are described to have better mouth feel as the oil in the foods contributes to palate-fullness and smooth texture of the foods.

Appearance: From this research, it was observed that the inclusion of wheat, soybean, and peanuts improved the appearance of the control (sample A). Sample with 40% (wheat, soybean, peanut) blend had the most acceptable appearance with mean value 7.03, while the control (100% finger millet flour) had the least mean value of 5.97. The result was as expected because; the inclusion of soybean and peanut modified the appearance of finger millet as it has been reported by Desai *et al.* (2010) that finger millet flour has a poor physical appearance. There was however, significant difference ($p<0.05$) among samples with improvement in the level of appearance as the level of supplementation increased.

General acceptability: Sample with 40% (wheat, soybean, and peanut) blend had the highest score for general acceptability with a mean value of 7.47, while the control had the least score of 6.67. There was however, significant difference ($p<0.05$) among the samples. The result showed an increasing trend in the level of general acceptability and this could be attributed to the increase in the level of wheat, soybean and peanut in the supplementation.

Conclusion

This work has shown that there is improvement in the proximate composition of finger millet based breakfast cereals through supplementation with wheat, soybeans and peanut as it offers higher percentages of protein, fats, ash and energy with a corresponding increase in the mineral content especially in zinc, sodium and potassium. Functional properties also improved in terms of oil and water absorption capacities, foaming capacity and pH while the bulk density decreased as the reconstitution time increased. Supplementation also improved the sensory quality attributes of breakfast cereal in terms of taste, aroma, mouth feel, appearance and general acceptability. Hence the production of finger millet based breakfast cereal flours, blended in the ratio 60:40 of finger millet to (wheat, soybean, and peanut) should be adopted for use as it performed the best among others in terms of nutritional, functional and sensory quality attributes.

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