IPS Journal of Nutrition and Food Science
IPS J Nutr Food Sci, 1(1): 21-26 (2022)
DOI: https://doi.org/10.54117/ijnfs.v1i1.6

Physiochemical and Sensory Attribute of Breakfast Cereals from Blends of Finger Millet, Soy Cake, and Beetroot

Opeyimi Rhoda Fasua[1], Adedamola Iyioluwa Akinyede[1], Johnson Adeola Adegboyega[2,*]

[1]Department of Food Science and Technology, Federal University of Technology, P.M.B 704 Akure, Ondo State, Nigeria.
[2]Department of Agricultural Engineering, Federal University of Technology, P.M.B 704 Akure, Ondo State, Nigeria.

*Corresponding author: johnsonadegboyega63@gmail.com

Abstract

This study was carried out to evaluate the proximate, functional properties, anti-nutritional factors, amino acid, and sensory attributes of extruded products from Finger millet, Soy cake, and Beetroot. The samples were prepared at different mixing ratios: Sample F (100% Finger millet), FS (70% Finger millet flour and 30% Soycake), FB (85% Finger millet flour and 15% Beetroot flour), and FSB (60% Finger millet, 30% Soycake and 10% Beetroot). The formulated flours were extruded using a Federal University of Agriculture Abeokuta fabricated laboratory single-screw extruder at barrel temperature (100ºC), feed moisture content of 10%, and screw speed (90 rpm). The proximate composition, mineral composition, amino acid, and anti-nutritional of extruded products from Finger millet, Soy cake, and Beetroot were determined using standardized methods. The following range of values were obtained for carbohydrate (30.51-70.17%), protein (10.23-17.16%), fat (7.55-10.66%), moisture (1.01-8.10%), fibre (3.21-3.81%) and ash (8.00-12.05%) content. The extruded products' carbohydrate, protein, fat, and ash contents increased while moisture and fat contents reduced. The extruded products' functional properties increased compared to the flours except for oil absorption capacity. The saponin and tannin levels were reduced, possibly due to extrusion. The highest amino acid value was glutamic acid. It was observed from the sensory evaluation that sample FSB was more acceptable to the panellists.

Keywords: *Breakfast, Extrusion, Physio-chemical properties, sensory evaluation*

Article History
Received: 11 April 2022
Accepted: 20 April 2022
Published: 02 May 2022

Scan QR code to view♦

How to cite this paper: Fasua, O. R., Akinyede, A. I., & Adegboyega, J. A. (2022). Physiochemical and Sensory Attribute of Breakfast Cereals from Blends of Finger Millet, Soy Cake, and Beetroot. *IPS Journal of Nutrition and Food Science*, *1*(1): 21-26. https://doi.org/10.54117/ijnfs.v1i1.6.

Introduction

Breakfast cereals are any food obtained by swelling, roasting, grinding, rolling, or flaking any cereal (Williams, 2014). Though consumed dry in the early hours of the day, breakfast cereals serve as a good source of strength, a vital requirement of the human body. They are not usually consumed alone but supplemented by other food classes (Oke, 2011; Ene-Obong and Obizoba, 2013; Obizoba *et al*., 2014).

In many developing countries, such as Nigeria, malnutrition is a common dietary problem, it is characterized by micro-nutrient deficiency and protein-energy malnutrition (Mbaeyi and Onweluzo, 2010). Over the last few years, efforts have been made to reduce or eliminate the problem worldwide (Blum and Niva (2011); Nnanyelugo, 2012). Cereal-Legume blends are employed in producing weaning food for 'infant formula (complementary foods) for both infants and small children under five years. These works tried to arrest the situation of malnutrition.

According to Blum and Niva (2011), many workers have suggested dietary diversification as the ultimate solution to malnutrition. The diversification involves the use of commonly known grains and or legumes in more than one form while still meeting the dietary nutritional need of the target consumers. However, many other locally available bowls of cereal and legumes can serve as good alternatives to these highly sought-after conventional raw materials in use. Among such locally available alternatives are millet and Soybean, which Soybean some decades ago were only used in the Far East for sauces but now have become a choice raw material for many products due to research efforts. Plant protein products are gaining increased interest as ingredients in food systems throughout many parts of the world; utilizing plant proteins as additives depends significantly upon the favorable characteristics they impart to food (Molina Ortiz *et al*., 2004). The soya bean seed is the richest in food value of all plant foods consumed globally, and it is viewed as equivalent to creating nourishments in several food products (Anupam and Suprodip, 2019). It is used in the production of bread as composite flour (Dhingra and Jood, 2004). Soya bean is used by leading infant food manufacturers because of its high nutritional value.

Materials and Method

Finger millet seeds were obtained from a local market in Jos Plateau, Nigeria, Beetroot was purchased from Oba market, Akure, Nigeria, and defatted soy cake from Rom Farm, Ibadan, Nigeria.

Sample Preparation

Brown variety of millet seeds was subjected to cleaning, washing, and drying to identify the delicate texture that will impart some desirable quality characteristics.

Processing of Millet flour

Finger Millet has been processed into flour according to the Guldiken *et al*. (2016) method. Finger millet grains were cleaned from soil particles and debris and milled using an attrition mill. The flour obtained was sieved to pass through a 1mm pore-sized/60 mesh sieve to obtain fine flour.

Processing of Beetroot flour

Freshly harvested beet was processed into flour using the method described by Guldiken *et al.* (2016). The beetroots were washed in running tap water several times to remove dirt. Peels were removed with the stainless steel knife, and trimming was also done. It was sliced and spread uniformly on a tray and dried in a cabinet dryer at 60^{0}C for 12hours. The dried root was ground using an electric blender.

Formulation of the extruded Breakfast Cereal

The breakfast cereal produced from the raw materials is produced by mixing the samples in appropriate ratios as shown in Table 1. Four samples were used for the formulation of breakfast cereals from Finger millet, beetroot, and soy cake, the breakfast cereal is produced by mixing it with clean cold water to form a smooth paste. The extruder is allowed to heat up and then the smooth paste is added gradually into the extruding machine for proper extrusion. This is then allowed to cool for 5 minutes, dried in a cabinet dryer for 24hours, cooled, and served either sweetened or unsweetened. The ratios of the samples used are shown in Table 1.

Table 1: Formulation of Extruded Product Composite Blends

Sample code	Ratio	Percentage (%)
F	100:0	100% F,
FS	70:30	70% F, 30%S
FB	85:15	85% F,15% B
FSB	55:30:15	55% F,30% S,15%B

Key: FS= Finger millet and soy cake, FB= Finger millet and beetroot, FSB= Finger millet, soy cake and beetroot and F= Finger millet.
Source: Rehab et al. (2017).

Production of Breakfast Cereals

The method described by (Mbaeyi - Nwaoha, 2016) was modified to produce breakfast cereals. The composite flour was mixed, a small quantity of water was added to the flour to serve as a binding effect, salt and sugar were added in different proportions to taste, the mixture was then fed through the feeder of a fabricated extruder into the barrel at a speed of 90sp for 5minutes to gelatinize the starch and the screw inside the barrel enhanced the cooking of the sample fed in at 100^{0}C. The dough came out of the barrel through the die with uniform shapes. It was oven-dried at a temperature of 60^{0}C for 24hours, after which the extruded breakfast cereals were allowed to cool under room temperature and packed in an air-tight container for analysis.

Proximate Composition

The proximate composition (moisture content, crude fiber, crude fat, total ash, and crude protein contents of the flour was carried out in triplicates, and flour blends and products were determined as described by AOAC(2012). The total carbohydrate content was obtained by difference. The methods of determination of the parameters were discussed below:

Gross Chemical composition

The proximate composition (moisture content, crude fiber, crude fat, total ash, and crude protein contents (N×6.25) of the flour and that of the extruded breakfast cereals was carried out in triplicates, flour blends and products were determined according to the AOAC(2012). The total carbohydrate content was obtained by difference. Calories values were calculated from the sum of the percentage of crude protein and total carbohydrates multiplied by a factor of 4(Kcal.g-1) plus the crude fat content multiplied by 9(Kcal.g-1) described by Zambrano *et al*. (2004).

Minerals

Minerals (sodium, potassium, calcium, zinc, copper, iron, phosphorus) the ash of each sample was digested with 5ml of 2M HNO_3 and heated to dryness on a heating mantle. 5ml of 2M of HNO_3 has been added again, heated to boil, and filtered through a No.1 filter paper into a 100ml volumetric flask. The filtrate was made up of distilled water. Calcium was determined using the Jenway Digital Flame Photometer (PFP7 Model), while other minerals apart from phosphorus were determined using Buck Scientific Atomic Absorption Spectrophotometer (BUCK 210VGP model). The phosphorus in the sample filtrate was determined using Vanadomolybdate reagent at 400nm using the colorimetric method (AOAC, 2012).

Determination of anti-nutritional factors

Trypsin inhibitor was extracted and determined using the method of Kalade *et al*. (1969), which was modified by Smith (1999). Saponin was determined by Obadoni and Ochuko (2001). Tannin was determined by Price and Butler (1997). Phytic acid was determined by Thompson and Erdman (1982). Oxalate was analyzed according to the AOAC (2012).

Determination of Amino Acid profile

Amino acid content was determined using a Technicon amino acid analyzer (TSM-1 Technicon Instrument, Basingstoke, Hampshire, UK) after hydrolyzing the samples with 6 M HCl at 1100C,24hrs (Lohlum, et. Al, 2010).

Functional Properties of the Flour Blends

Bulk density was determined according to Asoegwu *et al*. (2006). Water absorption capacity (WAO), Oil absorption capacity (OAC), and Least Gelation Concentration (LGC) was determined by the modified method described by Adebowale *et al*. (2005). The swelling power of each sample was calculated as a multiple of the original volume as done by Ukpabi and Ndimele (1990).

Sensory Evaluation

The sensory evaluations carried out on the samples were appearances, taste, aroma, texture, and general acceptability. They were prepared and coded as follows; sample (F) from 100% millet, (FSB) from 65% millet, 25% soybean and 10% beetroot, (FS) from 70% finger millet, 30% soybean, (FB) from 80% finger millet and 20% beetroot, and (CONTROL) a commercial product. Breakfast cereal samples were served in cups with hot water, milk, and sugar for panellists. Twenty-panel members familiar with breakfast cereals' quality attributes were randomly selected from students of the Federal University of Technology, Akure, to perform the evaluation. Samples were given to panelists in tasting booths so that there would not be any interference in their evaluation. Water was also provided for them to rinse their mouths. Analysis was on a nine-point hedonic scale basis 9 = Like extremely, 8 = like much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike much, 1 = dislike extremely (Meilgaard *et al*., 1991).

Statistical Analysis

Data generated were analyzed using SPSS version 21.0. The triplicate data's mean and standard error of means (SEM) were analyzed using a statistical package. Means were subjected to ANOVA and separated using Duncan New Multiple Range (DNMR) test at $p<0.05$.

Results and discussion

Proximate Composition of the Flour Blends

The proximate composition of the flour blends is presented in table 2. The moisture content of the flour blends ranged from 6.65 to 9.09 from FSB to FB. Protein content ranged from 2.31 to 23.93 from f to FSB. Ash content ranged from 3.44 to 5.60 from F to FSB. An increase in moisture, protein, and ash content was observed in flour blends compared with the control sample (100% millet). The higher level of moisture content may lead to the short shelf life of the flour blends and may cause microbial growth leading to spoilage, and the more significant increase in the protein content could be due to the inclusion of soy cake fractions into the flour blends; soy cake is an excellent source of protein, it helps to improve the quality and quantity of food protein content. This higher protein level is a good supplement for low protein flour in cereals for infant feeding and adults as well. An increase in the ash could be due to the addition of the beetroot fraction into the blended flour. Also, an increase in fat content could be due to the addition of soybean in oil. There was a slight increase in the fiber content; this could be due to the addition of beetroot and finger millet, except in the sample FS, which has a reduced value of 2.53% compared with control, which could be a result of the non-inclusion of the beetroot. There is a decrease in the carbohydrate content of the flour blends a similar result was to develop a functional biscuit that shows the effect of soy flour and rice bran. There were significant differences in protein, carbohydrate, fat, and ash content between each sample when compared with control, except in fiber content, which has no significant difference.

Proximate Composition of extruded breakfast cereals

The proximate composition of the product (breakfast cereal) is shown in table 3. The results obtained indicate a reduction in the protein content of the breakfast cereals compared with the protein content of the flour blend; this decrease might be attributed to the higher temperature of toasting, a result leading to protein denaturation. There was an increase in the carbohydrate content of the product, and this may be probably due to the heat involved, which reduced other components as a result of denaturation, thereby leading to higher carbohydrate content, a similar result was obtained by Agugo and Onimawo (2008) for toasting mung bean flour which showed that toasting significantly increase the carbohydrate content.

Table 2. Proximate Composition of the Flour Blends of finger millet, soy cake and beetroot

Sample	Moisture	Ash	Fiber	Fat	Protein	CHO
F	8.01±0.01[b]	9.01±0.01[a]	3.35± 0.01[d]	7.33±2.23[a]	11.25± 0.01[d]	73.27± 6.94[a]
FS	9.01±0.01[a]	9.50±0.5[a]	3.51± 0.00[c]	10.33±0.33[a]	20.40± 0.01[a]	58.42± 7.13[b]
FB	6.68±0.01[c]	10.01±0.50[ab]	3.81±0.01[b]	5.44±4.39[a]	11.50±0.01[c]	37.38± 5.52[c]
FSB	9.01±0.01[a]	12.50±0.01[a]	4.03±0.00[a]	10.66±1.20[a]	18.39±0.01[b]	35.59± 6.08[c]

Means (±SEM) with different alphabetical superscripts in the same row are significantly different at P<0.05
Key: F: 100% Millet, FB: Finger millet: Soy cake (65:25:10) %, FSB: Finger millet: Soy cake: Beetroot (60:30:10) %, FS: Finger millet: Soy cake (70:30) %

Table 3. Proximate Composition of the extruded Breakfast Cereals from Finger millet, soycake and beetroot

Sample	Moisture	Ash	Fibre	Fat	Protein	CHO
F	8.10±0.01[a]	12.00±0.00[a]	3.21±0.01[d]	7.55±2.36[a]	10.23± 0.01[d]	73.27± 6.94[a]
FS	1.01±0.01[d]	8.00±4.00[a]	3.34± 0.01[c]	10.66±1.45[a]	17.16± 0.01[a]	58.42± 7.13[b]
FB	3.31±0.01[b]	12.50±2.50[a]	3.51± 0.00[b]	8.66±2.08[a]	11.11±0.01[c]	37.38± 5.52[c]
FSB	2.31±0.01[c]	10.00±0.00[a]	3.81± 6.01[a]	8.66±2.08[a]	13.23±0.01[b]	35.59± 6.08[c]

Means (±SEM) with different alphabetical superscripts in the same row are significantly different at P<0.05
KEY: F: 100% Millet, FS: Finger millet: soy cake (65:25) %, FB: Finger millet: Beetroot (60:30:10) %, FSB: Finger millet: Soy cake: Beetroot(60:30)

Mineral Composition of the Breakfast Cereals
The mineral compositions of breakfast are presented in Table 4. The mineral compositions of Phosphorous had the highest concentration while copper had the most negligible mineral concentration. Statistically, the concentration of phosphorus, calcium, and iron was significantly higher than in 100% millet, but the concentration of zinc was lower when compared to the 100% millet product of the breakfast cereals.

Table 4: Mineral Composition (mg/100 g) of the extruded breakfast cereals from finger millet, soy cake, and beetroot.

Samples	Na	K	Ca	Zn	Cu	Fe	P
F	1.32±0.01[a]	1.32±0.01[a]	0.80±0.02[d]	3.00±0.09[a]	0.03±0.00[a]	0.77±0.03[e]	23.72±0.13[d]
FS	1.06±0.01[d]	3.77±0.2[d]	1.86±0.09[c]	2.75±0.09[b]	0.03±0.01[a]	4.56±0.01[b]	31.66±0.04[c]
FB	1.14±0.01[c]	1.86±0.09[c]	2.71±0.11[a]	2.50±0.09[c]	0.04±0.01[a]	5.59±0.08[a]	34.23±0.90[a]
FSB	1.07±0.01[d]	2.50±0.09[c]	2.25±0.05[b]	2.75±0.09[b]	0.03±0.00[a]	4.13±0.03[c]	34.05±0.31[b]

Means (±SEM) with different alphabetical superscripts in the same row are significantly different at P<0.05
Key: F: 100%finger millet, FS: finger millet: soy cake (65:25) %, FB: Finger millet: Beetroot (60:30) %, FSB: Finger millet: soy cake: Beetroot (60:30:10) %

Determination of anti-nutritional properties of the extruded Breakfast Cereals forms finger millet, soy cake and beetroot.
Table 5 shows the results of tannin, phytate, oxalate, saponin, and trypsin contents of the extruded product. It was revealed from the table that the level of anti-nutritional factor that, low tannin value may be a result of the application of heat during extrusion. Saponin increases the permeability of small intestinal mucosa cells, thereby inhibiting the transportation of nutrients (Jimoh *et al*., 2011). The sample FS with the highest soy cake had the lowest level of tannin (0.05mg/100g) and the highest value of phytate. The reduction in tannin level follows the report of Anuonye *et al*. (2012), which observed a low tannin level after extrusion of cereal and soybean. Tannins have been reported to form insoluble complexes with proteins and reduce their digestibility, palatability, and utilization of food proteins (Delumen and Salament, 1980; Uzeochina, 2007).

Table 5: Anti-nutritional properties of the extruded product from blends of Finger millet, Soy cake, and Beetroot

Samples	Tanin (mg/100g)	Oxalate (mg/100g)	Saponin (mg/100g)	Phytate (mg/100g)	Trypsin (mg/100g)
F	0.05±0.00[b]	0.89±0.00[c]	1.16±0.01[c]	0.94±0.01[d]	0.78±0.00[a]
FS	0.05±0.01[b]	1.17±0.00[b]	1.27±0.01[b]	5.36±0.00[b]	0.80±0.00[b]
FB	0.43±0.00[c]	1.17±0.00[b]	1.33±0.01[a]	3.06±0.00[d]	0.58±0.00[c]
FSB	1.32±0.00[a]	1.26±0.00[a]	0.94±0.01[d]	3.82±0.00[c]	0.63±0.00[d]

Means (±SEM) with different alphabetical superscripts in the same row are significantly different at P<0.0
Key: F: 100% Millet, FS: Finger millet: Soy cake (65:25) %, FB: Finger millet: Beetroot (70:30) %, FSB: Finger millet: Soycake Beetroot (60:30:10) %

Amino acids profile
Table 6 shows the amino acid profile of the extruded products. The sample with a higher percentage of soybean and Beetroot was higher in glycine, glutamic acid, alanine, cysteine, lysine, and histidine compared with other samples. All samples had high values for leucine. Findings by some authors showed that high leucine might be a factor contributing to the development of pellagra, as observed in maize (Aremu *et al*., 2011; FA0, 2011; Belavady and Gopalan, 1969). Therefore, the Leucine Isoleucine ratios would be considered essential; conversely, samples in this study had low values (1.57-1.82) for Leucine/Ile. The result showed that samples contained all essential amino acids, which were significantly higher than acceptable standards of recommended daily allowance. From the result obtained for predicted nutritional qualities, the percentage of the total essential amino acid (TEAA) to total non-essential amino acid (TNEAA) ranged from 0.75 to 0.65. The percentage ratios of TEAA to total amino acid (TAA) in the samples ranged from 75.84 to 45.34. Oshodi *et al*. (1993) reported a 43.6 % ratio of TEAA to TAA in pigeon pea flour, while the result obtained by Aremu *et al*. (2011) for different ratios of maize ogi fortified with Kerstingiella geocarpa seed flour was slightly comparable to results obtained for extruded products from millet flour and Beetroot.

Furthermore, the percentage ratios of TNEAA to TAA in the samples ranged from 45.32 to 65 3. It was observed that sample FS and FSB had values significantly above 40 %, considered acceptable for model protein diet for infants, 30 % for children, and 12 % for adults, according to reports by FAO/WHO(1991). It is expected that FS FB and FSB can sufficiently make available the daily essential amino acids needed by the consumers for development.

Table 6: Amino Acid Profile (mg/100g protein) of extruded breakfast cereals from finger millet, soy cake and Beetroot.

Samples	F	FS	FB	FSB	FAO/WHO (2007)
Non-essential amino acids					
Glycine	2.17±0.05[c]	2.66±0.05[b]	2.55±0.02[b]	2.40±0.03[c]	-
Alanine	6.12±0.03[a]	6.05±0.02[a]	6.14±0.01[b]	5.49±0.06[b]	-
Serine	3.62±0.02[c]	3.64±0.02[c]	3.28±0.01[d]	2.77±0.02[e]	-
Proline	5.52±0.02[c]	5.53±0.03[c]	6.55±0.02[a]	6.48±0.01[b]	-
Aspartic	5.58±0.01[a]	4.75±0.03[d]	5.83±0.02[c]	6.03±0.02[b]	-
Cystine	0.27±0.01[a]	0.23±0.01[b]	0.15±0.02[c]	0.14±0.01[c]	-
Glutamic	15.33±0.01[a]	14.97±0.01[c]	16.90±0.02[c]	17.43±0.02[b]	-
Tyrosine	3.62±0.03[a]	3.46±0.02[b]	3.50±0.03[b]	2.87±0.02[d]	-
Arginine	3.72±0.02[a]	3.48±0.08[b]	3.46±0.02[b]	2.90±0.02[d]	-
ΣNEAAs	45.95±0.44	44.77±0.55	48.36±0.35	46.51± 0.43	-
Essential Amino Acids					
Phenylalanine	5.16±0.01[a]	4.66±0.02[d]	3.67±0.01[f]	3.93±0.022[e]	2.80
Histidine	2.21±0.02[a]	1.67±0.02[d]	1.94±0.02[c]	2.05±0.04[b]	1.9
Methionine	2.04±0.02[a]	1.09±0.02[d]	1.18±0.02[c]	1.32±0.03[d]	1.5
Valine	4.12±0.01[b]	3.58±0.02[d]	4.29±0.01[a]	4.24±0.02[b]	3.5
Tryptophan	1.10±0.01[a]	1.05±0.01[b]	1.22±0.02[a]	1.01±0.02[d]	1.1
Threonine	3.42±0.02[b]	4.76±0.02[a]	2.86±0.02[c]	2.67±0.03[c]	3.4
Isoleucine	2.94±0.05[b]	3.23±0.03[a]	3.02±0.03[c]	3.72±0.04[a]	2.8
Leucine	6.67±0.06[b]	6.36±0.02[c]	8.94±0.03[a]	8.52±0.02[a]	6.6
Lysine	2.22±0.02[a]	1.58±0.02[d]	1.75±0.02[c]	1.89±0.02[b]	5.8
ΣEAAs+His	29.88±0.22	27.98±0.20	28.87±0.19	29.35±0.42	
Predicted nutritional quality					
TAA	75.84[a]	72.75[d]	77.23[a]	75.84[b]	-
TEAA/TNEAA	0.65[b]	0.62[b]	0.60[b]	0.63[a]	-
ΣSAA(Meth+Cys)	2.31[c]	1.32	1.33[b]	1.46[b]	-
ΣArAA(Phe+Tyr)	8.78[a]	8.12[d]	7.10[e]	6.80[f]	-
Arginine/Lysine	1.68[e]	2.20[a]	1.98[c]	1.53[f]	-
BCAAs	13.73[d]	13.17[f]	16.25[b]	16.48[a]	-

*RDA of essential amino acids (mg/100g). *FAO/WHO,2007); Total essential amino acids (ΣEAA), Total non-essential amino acids (ΣNEAA), Total sulfur amino acid (ΣSAA), Total Aromatic amino acids (ΣAr*AA), *Limiting amino acid (LAA), Abundant amino acid (AAA), Branched – chain amino acids (ΣBCAAs=Leu., Isoleu., Valine).*

Sensory Evaluation of the Product

It could be deduced from Table 7 and Table 8 that there was no significant difference (p<0.05) among the samples for the aroma and overall acceptability, while significant differences existed among the samples for taste, appearance, and texture. Sample FSB had the highest score for aroma, taste, and overall acceptability of 6.50, 6.50, and 5.65 scores respectively, while sample F had the least score in texture and overall acceptability of 5.25 and 5.80 score. Sample M had the highest score in texture and appearance of 6.4 and 6.55, respectively, while sample F had the lowest in taste and appearance with 5.00 and 5.65 scores. Concerning the non-significant differences in the aroma and overall acceptability of the breakfast cereal mentioned earlier, all the breakfast cereals samples were generally acceptable by the panelists, but samples FB and FSB were the most preferred sample.

Table 7: Sensory Evaluation of the Breakfast Cereals of Finger millet Soycake and Beetroot.

Sample	Aroma	Appearance	Texture	Taste	Flavour	Overall
F	5.90±1. 74[b]	6.00±2.53[b]	6.15±1.59[ab]	5.90±2.44[b]	5.60±1.60[b]	5.75±1.94[b]
FS	6.00±1.62[b]	5.80±1.66[b]	5.75±1.83[b]	5.85±1.66[b]	5.90±1.55[b]	5.95±1.87[b]
FB	5.65±1.69[b]	5.40±1.76[b]	5.75±2.02[b]	5.65±1.69[b]	5.45±1.63[b]	4.70±1.86[b]
FSB	6.10±1.37[b]	6.40±1.27[b]	5.60±1.78[b]	6.10±1.37[b]	5.30±2.05[b]	4.70±1.75[b]
COIt NTROL	7.95±0.94[a]	8.20±1.11[a]	7.70±1.83[a]	7.90±1.77[a]	8.45±0.68[b]	8.20±0.50[a]

Same letters in superscripts indicate no significant difference (p≤ 0.05)

Key; *F: 100% Millet, FS: Finger millet: Soy cake (65:25) %, FB: Finger millet: Beetroot (60:30) %, FSB: Finger Millet: Beetroot: Soy cake (60:30:5)%*

Table 8. Sensory Evaluation for Breakfast Cereals of finger millet soycake and Beetroot Served with cold milk.

Sample	Aroma	Appearance	Texture	Taste	Overall
F	6.10±0. 36[a]	6.55±0.28[ab]	6.4±0.32[ab]	5.7±0.38[ab]	5.45±0.59[a]
FS	6.05±0. 42[a]	5.8±0.44[b]	5.4±0.46[b]	5.6±0.45[ab]	5.2±0.60[a]
FB	6.35±0.39[a]	5.65±0.41[b]	5.55±O.35[ab]	5.00±0.37[b]	4.85±O.55[a]
FSB	5.80±0.43[a]	5.70±0.39[b]	5.25±0.45[b]	5.50±0.44[ab]	4.70±0.59[a]
CONTROL	6.20±0.16[a]	6.19±0.20[a]	5.87±0.16[a]	5.74±0.16[ab]	5.28±0.24[a]

Same letters in superscripts indicate no significant difference (p≤ 0.05)
Key*: F: 100% Millet, FS: Finger millet: Soy cake (65:25 %), FB: Finger millet: Beetroot (60:30) %, FSB: Finger Millet : Beetroot : Soy cake (60:30:10) %*

Functional Properties of the Flour

Table 9 shows that the bulk density of the flour ranged from 6.70±0.03 to 7.00±0.01g/ml. Sample F and FSB had the exact value of 6.70g/ml, and sample FS had the highest value of 7.00±0.03g/ml, followed by FB with 6.90±0.10. Bulk density is an important criterion that suggests the packaging material and transportation. The lower the bulk density, the higher the number of flour particles that bind together, leading to a higher energy value. There was no significant difference between sample F, FS, and sample FB and FSB.

Oil absorption capacity ranged from 7.90± 0.30g/ml to 8.90± 0.10g/ml. sample FB had the highest value of oil absorption capacity of 8.90± 0.10g/ml, and FS had the lowest value of 7.90± 0.30g/ml, with a significant difference.

Water absorption ranged from 7.00±0.00g/ml to 6.70± 0.03g/ml, with a significant difference. Sample FS has the highest value of 7.00± 0.00g/ml. Water absorption capacity can also be said to be the ability of flour to absorb water and swell for improved consistency in food. It is desirable in food systems to improve yield and consistency and give body to the food (Osundahunsi *et al*., 2003).

Least gelation is the ability of proteins to form gels, is traditionally measured by the most negligible gelation concentration (LGC), defined as the minimal protein concentration required for inverting a tube without producing sliding of the gel in the walls. The values ranged from 2% to 6%. Sample FS and FSB had the highest value of 2%, with no significant difference. These variations in the gelling properties of different cereals and legume flours may be due to variations in the ratios of different constituents such as carbohydrates, lipids, and proteins that make up the flours. Much higher values of gelation capacity have been reported for other legumes like raw (16%) and heat-processed (18%) cowpea flour (Abbey and Ibeh, 1988).

Swelling capacity: the values ranged from 59.44± 0.42 to 199.40± 0.04%. Sample MSC had the highest value of 199.40± 0.04%, while sample M, the 100% millet, had 59.44± 0.42%with no significant difference.

Table 9. Functional Properties of the Flour Blends

Samples	Bulk Density (g/ml)	Oil Absorption (g/ml)	Water Absorption (g/ml)	Least gelation (%)	Swelling Capacity (%)
F	6.70±0.30[a]	8.40±0.20[ab]	6.70±0.30[a]	12.00±0.00[b]	59.44±0.41[b]
FS	7.00±0.00[a]	7.90±0.30[b]	7.00±0.00[a]	16.00±0.00[b]	129.50±0.23[b]
FB	6.90±0.10[a]	8.90±0.10[a]	6.90±0.10[a]	12.00±0.00[b]	199.40±0.04[b]
FSB	6.70±0.30[a]	8.20±0.20[b]	6.70±0.30[a]	16.00±0.00[b]	169.63±0.21[b]

Means (±SEM) with different alphabetical superscripts in the same row are significantly different at P<0.0
Key: *F: 100% Millet, FS: Finger millet: Soy cake (75:25) % FB: Finger millet: Beetroot (70:30) % FSB: Finger millet: Soy cake: Beetroot (60:30:10) %*

Conclusion

From the study results, breakfast cereals (convenient foods) could be formulated from the graded proportion of Finger millet, Soy cake, and Beetroot. It is apparent from the study that Soy cake and Beetroot incorporated into the flour blend increased the quality of the formulated breakfast cereal. The extrusion process contributes to the reduction of saponin and tannin. Sample FSB had the highest value of glycine, glutamic acid, cysteine, lysine, and histidine, and it was the most acceptable sample in sensory evaluation; this indicates that the utilization of by-products will be enhanced when processed into breakfast cereals and may serve as a complementary food for both young and old.

Declarations

Competing Interest

The authors declare no competing interest.

Authors' Contributions

All authors collaborated in the achievement of this work. Author ORF designed the study, and statistical analysis, analyzed and interpreted the data. Author AIA drafted the protocol, contributed materials, and supervised the project. Author AJA proofread and reviewed thoroughly the manuscript. All authors read and approved the final manuscript.

Funding

This article received no funding.

References

Abbey, B.W. and G.O. Ibeh, (1988). Functional properties of raw and heat-processed cowpea (Vigna unguiculata, Walp) flour. Journal of Food Science, 53: 1775-1777

Adebowale, A.A, Sanni, L.O, Awonarin, S.O (2005). Effect of texture modifiers on the physicochemical and sensory properties of dried fufu. Food Science and Technology international. 11:373-382.45

Agugo UA, IA Onimawo (2008). Effect of heat treatment on the nutritional value of mungbean.. MSc Project. Department of Nutrition and Dietetic, MOUAU, Abia State, Nigeria. Pp. 5 –7, 28, 32-35.

Anupam S, Suprodip, M.B. (2019). Nutritional Benefit of Soybean and Its Advancement in Research. Sustainable Food Production. ISSN: 2624-876X, Vol. 5, pp 6-16.

Anuonye, J. C., Inyang, C. U., Chinma, C. E. and James, S. Y. (2012). Sensory Properties of Extruded Blends of 'Acha'and Soybean Flour–A Response Surface Analysis.

AOAC (2012). Official methods of Analysis of the A.O.A.C. International 18th Edition. Gaithersburg, Maryland USA.

Aremu, M.O., Ozonya, G.N., Pius Patrick Ikokoh Ikokoh, P.P. (2011). Physicochemical properties of well, borehole, and stream waters in Kubwa, Bwari Area Council, FCT, Nigeria. Electronic Journal of Environmental, Agricultural and Food Chemistry. Volume 10(Issue 6): Page 2296-2304.

Asoegwu, S., Ohanyere, S., Kanu, O., and Iwueke, O. (2006). "Physical Properties of African Oil Bean Seed (Pentaclethra macrophylla)" Agricultural Engineering International: the CIGR Ejournal. Manuscript FP 05 006. Vol. VIII. August, 2006.

Belavady, B. and Gopalan, C. (1969). The role of leucine in the pathogenesis of canine black tongue and pellagra. Lancet, 2: 956-957.

Blum and Niva (2011). All foods affect health, understanding of functional food and healthy eating health-oriented and inns. Appetite, 48: 384-393.

Delumen, B., & Salament, L. A. (1980). Trypsin inhibitor activity in winged bean (Psophocarpus tetragonolobu) and the possible role of tannin. Journal of Agric & Food Chemistry, 28, 533-536. Http://dx.doi.org/10.1021/jf60229a042.

Dhingra, S., & Jood, S. (2004). Effect of flour blending on functional, baking and organoleptic characteristics of bread. International Journal of Food Science and Technology, 39, 213–222.10.1046/j.0950-5423.2003.00766.x [Crossref], [Web of Science ®], [Google Scholar]

Ene-Obong, H. N. and Obizoba, I. C. (2013). The protein quality of some Nigerian traditional diets is based on the African yam bean (SphenostyIiss temcarpa) and pigeon pea (Cajmsc ujan). Plant Foods for Human Nutrition 48: 297-309.

FAO/WHO (1991). Protein Quality Evaluation. Food and Agricultural Organization of the United Nations, Rome, Italy

FAO (2011). Dietary protein quality evaluation in human nutrition. Food and Agricultural Organization, Rome Italy. FAO Food and Nutrition Paper. Volume 92.

Guldiken, B., Toydemir, G., Nur Memis, K., Okur, S., Boyacioglu, D., and Capanoglu, E. (2016). Hairy root cultures of the red beetroot Beta vulgaris cv. Detroit dark red. Plant Foods.

Jimoh, A.K., Desalu, O.O., Salawu, F.K., *et al*. (2011) Diabetic Foot Care: Self Reported Knowledge and Practice among Patients Attending Three Tertiary Hospital in Nigeria. Ghana Medical Journal, 45, 60-65.https://doi.org/10.4314/gmj.v45i2.68930.

Kakade, M. L., Simons N, Liener, I.E. (1969). The evaluation of natural vs synthetic Substrates for measuring the antitrypsin activities of soybean samples. Journal of Cereal Chemistry. 46:518-526.

Lohlum, S. A, Maikidi, G. H, and Solomon, M. (2010). Proximate composition, amino acid profile and phytochemical screening of Lophira lanceolate seeds. African Journal of Food Agriculture Nutrition and Development, Vol. 10, No. 1, pp. 2001-2011.

Mbaeyi IE, and Onweluzo JC (2010). Effect of Sprouting and Pregelatinization on the Physicochemical Properties of Sorghum-Pigeon Pea Composite Blend Used for the Production of Breakfast cereal. Journal of Tropical Agric. 2: 234-239.

Mbaeyi-Nwaoha, I. E., and Uchendu, N.O. (2016). Production and evaluation of breakfast cereals from blends of acha and fermented soybean paste (okara). Journal of Food Science Technology. 53(1):50–70. DOI 10.1007/s13197-015-2032-8

Meilgaard, M., Cille, C. V, and Cam. B. T. (1991). Sensory Evaluation Techniques, 2nd edition CRC Press, Boca Raton, Florida, pp 22-45.

Molina-Ortiz S.E., Puppo M.C., Wagner J.R. (2004) Relationship between structural changes and functional properties of soy protein isolates—carrageenan systems. Food Hydrocoll. 2004;18:1045–1053.

Moronye, A. I. and Oladunjoye, M. G. (2005). Formulation and Physio-Chemical Properties of High-Protein Food Beverage Powder Based on Protein Concentrate from the Nigerian "Red Skin" Groundnut (Arachis Hogue) protein concentrates. Journal Science of and Food Agriculture54:89 - 98.

Nnanyelugo, D. 0. (2012). Strategies Nigeria Presented at Vitamin (Nigeria) Limited at Sheraton Hotel and Towers, Lagos, October 3 1: 1-8.

Nnanyelugo, D. 0. (1999). Opportunities for food fortification technology in Nigeria. Vitamin Information Centre, South Mca, pp 1-17.

Obadoni, B.O. and Ochuko, P.O. (2001) Phytochemical Studies and Comparative Efficacy of the Crude Extracts of Some Homeostatic Plants in Edo and Delta States of Nigeria. Global Journal of Pure and Applied Science, 8, 203-208.

Obizoba, I. C., Chikwendu, J. N., Igbatim, A.C. (2014). Chemical Composition of Processed Cowpea Tender Leaves and Husks. International Journal of Scientific and Research Publications, Volume 4, Issue 5

Oke, O. L. (2011). The role of hydrocyanic acid content in nutrition. WM. Review. Nutrition and. Diet.11: 118 - 147.

Oshodi, A. A.; Olaofe, O.; Hall, G. M. (1993). Amino acid, fatty acid, and mineral composition of pigeon pea (Cajanus cajan). International Journal Food Science Nutrition, 43 (4): 187-191.

Osundahunsi, O. F., Fagbemi, T. N., Kesselman, E, and Shimoni, E. Comparison of the Physicochemical Properties and Pasting Characteristics of Flour and Starch from Red and White Sweet Potato Cultivars. (2003). Journal of Agricultural and Food Chemistry 51(8):2232-6

Price, M. L., and Butler, L.G. (1977). Rapid visual examination and spectrophotometric determination of tannin content of sorghum grain. Journal of Agricultural Food Chemistry. 25(6): 1268 - 1273.

Rehab, A. Mostafa, Azza, E.M. Abd-EL Haleen, Salawa, S. Gabal(2017). Formulation and evaluationn of some novel breakfast blends made from cereal and legumes.

Smith, (1999)'. Extrusion - Process and Product Development Syrup. American Cereal food, St. Louis Publisher. Ltd., Missouri, 7 1 - 78.

Thompson, D. B., and Erdman, J. W. Jnr. (1982). Pythic acid determination in soybean. Journal of Food Science. 47: 5 13 - 5 17.

Ukpabi, U.J, and Ndimela, C. (1990). Evaluation of the quality of garri production in Imo State Nig. Food Journal. 8:105-110.

Uzoechina, O.B. (2007). Evaluation of the effect of processing techniques on the nutrient and antinutrient contents of Pigeon Pea (Cajanuscajan) seed flours. J. Food Sci. 28: 76-77.

William, P. (2014). Breakfast cereals. In: Food Industries Manual, Publication, London, 11

Zambrano, F., Despinoy, P., Ormenese, R. C.S.C and Faria.E. V (2004). The use of guar and xanthan gums in the production of light low-fat cakes. International Journal of Food Science and Technology, 39: 959-956

Rickman, J.C, Bruhn, C.M. & Barrett, (2007). Nutritional comparison of fresh, frozen and canned fruits and vegetables II. Vitamin II. Vitamin A and carotenoids, vitamin E., minerals and fiber. Journal of the sciences of food and Agriculture 87(7): 1185 – 1196.

Rizzo, N. (2019). Seven Nutrition and Health Benefits of Okra. Retrieved on 1-7-2020 from healthline.com/nutrition/okra-health-benefits.

Sass, C. (2019). Eight Benefits of Carrots Retrieved on 1-7-2020 from health.com/nutrition/health-benefit-of-carrots

Timmos, T. (2019). Five healthy Benefits of Adding Celery your Diet. Retrieved on 1-7-2020 from Health.com/health/food nutrition/health-benefits of celery.

Ware, M. (2018). Why are onions good for you. Retrieved on 1-7-2020 from Medical/newstoda.com/article/276714.63).

•*Thank you for publishing with us.*