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Proximate Composition And Sensory Properties Of Cereals Prepared From Sorghum (*Sorghum bicolor L*) Fortified With Soy Bean (*Glycine max*) And Coconut (*Cocos nucifera L.)*

Ibrahim[1] K.O., Akinola[1] M.O., Jegede[1] O.A., Akande[2] M.A., Ogunsina[1] A.A., and Adedeji[1] A.O.

[1]Departmentof Home &Rural Economics Federal College of Agriculture, Moor Plantation, Ibadan, Oyo State Nigeria.

[2]Department of Agricultural & Bioenvironmental Engineering Federal College of Agriculture, Moor Plantation, Ibadan Oyo State Nigeria.

Abstract

***Background**: Cereals are an integral part to family meals. They are mainly produced from cereal grains and are often consumed as early in the morning as part of the breakfast. Hence, the name breakfast cereal.*

***Materials and Methods:** Three flour blends, each containing sorghum, soybean and coconut were prepared by mixing the flours in the proportions of 80:10:10, 70:20:10, 60:30:10 using hand mixing. Sugar and salt were added to taste. 3cups of hot water was added to the mixture, stirred and spread thinly on a parchment paper placed on a baking tray. It was then baked at 120^0C for 30 minutes after which it was broken into small sizes/shapes and allowed to cool. The products were subjected to analysis and the result varied in nutrient composition.*

***Result**: The result showed that sample C had the highest ash content. The protein contents of the samples shows no significant difference (p<0.05) between samples A and B. The moisture content were significantly different (P<0.05) in sample A and C. Crude fat show no significant difference (p<0.05) among samples A and B, Fibre content ranged from 2.84^{ab}-2.13^{c}.Carbohydrate content of the breakfast cereals was lower to the control. The sensory evaluation result showed that the sample A was the most preferred of the formulated samples in term of color, taste and aroma, the result also shows that sample B was mostly preferred in terms of mouth feel and appearance while sample C has the highest overall acceptability.*

***Conclusion**: It was concluded that acceptable ready-to-eat breakfast cereals could be produced from sorghum, soybean and coconut flour blends and its suitable for growing children. Feeding infants with the breakfast cereal formulated will help in the prevention of malnutrition.*

***Keywords:** breakfast cereals, meal, staple, nutritious, coconut*

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I. Introduction

Cereals are staple foods produced by swelling, grinding, rolling or flaking of food materials from cereals, legumes, and few tubers[1,2]. It is the most important meal of the day and its consumption is emphasized to help adhere to nutritional recommendation and healthy lifestyle. Cereals are basically produced from cereal grains which are the dry seeds member of the grass family grown for their grains and are by far the most important plants eaten by man. Cereals are low-fat, nutrient-dense food with many essential vitamins and minerals such as zinc, phosphorus, calcium among others[3]. They are important sources of energy, carbohydrate, protein, fibre and bioactive substances. The final nutrient content of a cereal is dependent on of outer bran and aleourone layers removed during processing; the remaining endosperm is mostly carbohydrate. The commonly consumed cereals in Nigeria include*: NASCO Cornflakes, Golden Morn, Kellogg's cornflakes, NABISCO flakes, Quaker oats, Rice crisps* among others. Though traditionally consumed during the early hours of the day, they can also be taken at anytime of the day. Cereals serve as a good source of strength which is vital requirement for the human body [4]. Cereals have been used over the years as industrial raw material because of the high carbohydrate, low fat and protein contents. Cereals such as maize and sorghum are rich in sulphur-containing essential amino acids such as methionine, cysteine and tryptophan[5]. Among cereals, sorghum (*Sorghum bicolor*) is considered to have better protein quality or amino acid scores[6] and the fifth most important cereal after wheat, rice, corn and barley[7]. Nigeria is the third largest world producer, after the United States and India[8] .The utilization of sorghum in breakfast cereals as main meal and for fortification have been reported by several researchers,[9] formulated a sorghum based weaning food with different blends of soybean and unripe plantain flour,[10] incorporated avocado pear into a sorghum based complementary food. Sorghum grains like most other cereal grains have a low nutrient density because they are relatively high in unmodified starch and low in fat[11]. Sorghum has a macromolecular composition similar to that of maize and wheat. Sorghum contains 60 - 80 % starch and thus needs to be enriched with affordable source of other essential nutrients.

Legumes are significant cheap sources of protein, dietary fibre, carbohydrates and dietary minerals[12]. Soybean is a legume, with a high-protein quality, close to 40–45% of the total solids [13]. They are among the best sources of plant-based proteins, their protein content ranges from 36-56% dry weight [14]. Soybeans contain significant amounts of phytic acid, dietary fibre, minerals and B vitamins. It is economically the most important bean in the world providing vegetable protein for millions of people and ingredients for hundreds of chemical products [15].

Coconut (*Cocos nucifera L.*), a common fruit which is normally eaten raw or used as ingredient in cooking as well as in the preparation of fruit juices, toffees and drinks. Coconut has high nutritional value, especially minerals. Coconut contains flavournoids and other phenolic compounds as reported by [16]. As a result, coconut imparts sweet flavor to food, and present processing facilitation attributes due to its oil content. Some of the processing facilitation attribute of coconut is the ability of the coconut oil to soothe the surfaces of the processing machine to allow easy passage of materials through it and for a maximum product yield to be obtained. These attributes and functionality makes coconut a suitable component in the processing and production of ready to eat breakfast cereal.

To diversify the use of sorghum as a cereal and improve its protein and fiber, sorghum could be supplemented with legumes such as soybean among other legumes. Thus, this study was aimed at evaluating the proximate composition and sensory properties of breakfast cereal prepared from sorghum fortified with soybean and coconuts.

II. Materials And Methods

Materials

Sorghum (*Sorghum bicolor L*), Soy bean (*Glycine max*) and Coconut (*Cocos nucifera L.*) were obtained from Apata market in Ibadan, Oyo State, Nigeria. The chemicals and equipment/facilities used were obtained from food processing laboratory of IAR&T Moor Plantation, Ibadan.

Sample preparation

Preparation of sorghum flour

Method for the preparation of sorghum flour was adopted based on the expectations (simplicity and low cost) of the beneficiaries of the technology. Sorghum flour was produced according to Figure 3.1. The sorghum grains were soaked in water for 8hours, dried at 100^0C in a cabinet dryer to moisture content of less than 10 % and milled to pass through a sieve of 250 micron.

Production of Soybean Flour

Soybean flour was produced using an earlier method of [17]. Soybean seeds were carefully cleaned and sorted out to remove defective and small sized seeds, foreign particles such as stones, sticks and leaves. Grains of soybean weighing 2 kg were soaked for 8 hours in clean water until the seed coat became soaked and wet to facilitate dehulling. The soaked soy bean was dehulled manually. The dehulled soybean was washed to remove the seed coat, drained and then partially sun dried. The soybean was then traditionally roasted using an open thick aluminum pot. The dried soybean was milled into fine flour using an electric blender and let to pass through a sieve of about 1 mm mesh screen. The soybean flour was packaged in a plastic container until when required.

Production of coconut flour

The procedure used was a modification of a method described by[18]. 3kg freshly dehusked coconut was properly cleaned and cracked to expel the liquid content. The coconut flesh was removed from the shell with the aid of a sharp pointed knife. The brown colour of the skin was scraped off with a knife. The coconut flesh was diced into smaller pieces with a knife and was blended with an electric blender adding 50mls of water. The blended coconut was poured into a muslin cloth and squeezed to obtain the coconut paste that was further rinsed with hot water (>70^oC) till the filtrate became colourless. The coconut residue was then dried at (60^oC) to a flour and packaged in a polythene bag and sealed for further analysis. The flow chart for the production of coconut flour is shown below.

Preparation of breakfast cereal

The procedure used was a modification of a method described by[19]. Three flour blends, each containing sorghum, soybean and coconut were prepared by mixing the flours in the proportions of 80:10:10, 70:20:10, 60:30:10 using hand mixing. 2table spoon of sugar and 2 teaspoon of salt were added. 2 cups of cold water and 3 cups of hot water was added to the mixture and was heat treated in hot oven at 120^{0}C for 30 min. The mixture was removed from the oven and cut into very small shapes in baking pans and flaked or toasted in an oven at a temperature of 120°C for 15min after which the flaked/ toasted breakfast cereals were allowed to cool under room temperature and packaged in a plastic container for analysis.

Sorghum seeds
↓
Sorting
↓
Soaking (ambient temperature 8hours)
↓
Decant
↓
Drying (100^{0}C)
↓
Milling
↓
Sieving (250μm)
↓
Sorghum flour

Figure.1: Production of sorghum flour

Soy bean seed
↓
Sorting
↓
Soaking (for 8hours)
↓
Decant
↓
Dehulling
↓
Drying (80^{0}C, 18hours)
↓
Milling
↓
Sieving
↓
Soybean flour

Figure 2: Production of Soybean flour

Dehusked Coconut
↓
Cracking (manual)
↓
De-shelling
↓
Grating (using hand grater)
↓
Blending (electric blender)
↓
Sieving/pressing
↓
Rinsing
↓

Drying (60^oC for 10hours)
↓
Coconut flour

Figure 3: Production of Coconut flour

Proximate compositions of formulated samples
Determination of Crude Protein

The Keldjhal method as described by[20] was used. The total nitrogen was determined and 6.25 were used to multiply to obtain the protein. Two (2) grams of each of the samples was boiled in 10ml of concentrated H2SO4 in the presence of selenium catalyst. Boiling was done under a fume cupboard until a clear solution was formed. The digest was transferred into a volumetric flask containing a 100 ml of distilled water and 10ml of it was mixed with equal volumes of 45% NaOH solution and was poured into a Keldjhal distillate apparatus. On distillation of the mixture; the distillate was collected in a 100ml of 4% Boric acid solution containing 3 drops of a mixed indicator (methyl red and bromocresol green). A total of 50ml distillate was collected and titrated against 0.02N H_2SO_4solution. Titration was done from green to a deep red end point. A reagent blank was determined as discussed above but without the sample. The protein content was calculated.

Moisture Content

The gravimetric method by[21] was used for this analysis. Exactly 2ml of the sample was measured each into two previously weighed moisture crucible. The crucibles and samples were allowed to dry in a hot air electric oven at 105^0C for 2 hours at the end of the time; the crucibles were carefully removed and kept to cool in a desiccator. The crucibles and the samples were re-weighed and put back into the oven for further drying; cooling and weighing were done respectively until a constant weight was obtained.

Fat Determination:

The method of solvent extraction in a Soxhlet reflux apparatus described by[22] was adopted. Exactly 2g of the sample was wrapped in a porous material (Whatman filter paper) and placed in the reflux flask. Exactly 2g samples was measured again into another paper and placed in another soxhlet flask to form replicate. The flasks were mounted on weighed oil extraction flask containing 200ml of petroleum ether. All the parts of the soxhlet apparatus were coupled and heat applied through the electro-thermal heating mantle, the heated solvent vaporized and condensed into the reflux flask containing the sample. Oil was extracted from the sample until the flask was removed from each set up after 4 hours and dried for 3minutes in the oven at 60^0C.

Crude Fiber Determination:

The method described by[22] was adopted for this analysis. 5g of the sample was measured each into two fold muslin cloth and heated in 24 200ml of 1.25% H_2SO_4 for 30 minutes under reflux. Each cloth was washed thoroughly with boiling water. The cloths each was transferred back to boiling flasks containing 1.25% NaOH solution. Boiling was done for 3minutes under reflux. The clothes were washed and transferred to an already weighed porcelain crucible 1(w) dried in the oven constant weight 2(w). Then the sample were taken to the furnace and reduced to ashed at 550^0C then cooled in a desiccators and the weight (w) noted.

Ash Determination

The method described by[22] was adopted, in determining the ash content. Exactly 2g was measured into two previously weighed porcelain crucibles the muffle furnace was heated to 550^0C before the samples in the crucible were introduced into it. The samples burned at that holding temperature for 2 hours, ashing continued until all the samples became ash.

Carbohydrate Determination

This was determined by differences suggested by[22]. It was done by summing up the percentage protein, crude fiber, fats, total ash and moisture and subtracting the result from 100.

Sensory evaluation

The three formulated samples were served to 20 panelists familiar with the consumption of breakfast cereal consisting of staffs and students of the Federal College of Agriculture, Moor Plantation, Ibadan, about 10.00 am along with NASCO Cornflakes (commercial control) using a 9 point Hedonic scale (1=dislike extremely, 9=like extremely). The samples were served raw/dry, with cold water, milk and assessed for colour, taste, aroma, mouth feel, appearance and overall acceptability.

Statistical analysis

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

III. Results And Discussion

Proximate composition of cereals prepared from sorghum fortified with soybean and coconut.

Table 1. shows the results of the proximate composition of cereal prepared from sorghum (*Sorghum bicolor l.*) fortified with soy bean (*Glycine max*) and coconut (*Cocos nucifera l.*) flour blends. There was significant increase in the protein, ash and fat with a corresponding decrease in carbohydrate, moisture, and fibre contents.

From the table, the mean ash content ranged from 1.53^{a} 0.73^{ab}, sample C had the highest while sample A had the least mean with no significant difference ($p<0.05$) among the three samples. The ash content of the formulated samples was higher than the control (0.21^{b}). Ash content of the breakfast cereals decreased with increased in sorghum flour substitution. Ash content is the residue remaining after destroying combustible organic matter. The value of the ash obtained is comparable to the value of 1.98 - 2.40 as reported by[23] for breakfast cereals formulated with local rice, soya beans and defatted coconut flours. The ash content gives an overall estimate of the total mineral elements present in the food.

The result further shows that the mean value of the protein contents of the samples range from 43.56^{a}-32.62^{b}, the result showed that there were no significant difference ($p<0.05$) in the protein content of samples A and B while samples C had significantly highest mean values of 43.56^{a} which was higher than the control (6.07^{c}) and making the formulated cereals a good source of protein. However, no statistical difference exists among the samples. The protein content of the blends was higher than that of pap known as *ogi* in Yoruba and *akamu* in Igbo tribes, a popular Nigerian cereals which has been reported to contain 10.92% protein[24]. This implies that the formulated breakfast cereals in this study will serve as a good source of protein which could help in preventing protein carbohydrate malnutrition which is wide spread in Africa. The table also shows the moisture content revealed that there were significant differences ($P<0.05$) in sample A and C. The highest value ($8.33^{a}\pm0.58$) of moisture content was observed in Sample B (70:20:10) formulation. The least value (mean=5.33^{b}) was observed in sample A (80:10:10) formulation. The increase in moisture content could be due to an increase in the percentage composition of soybean flour[25] also observed low moisture content of breakfast cereals from blends of *acha* and fermented soybean to be within the range of 4.71 to 9.88 %.

Values for crude fat ranged from 14.33^{a}- 12.00^{b} which was higher than the control (2.93^{c}) and making the formulated cereal a good source of crude fat, there were no significant difference ($p<0.05$) among sample A and B, while sample C was significantly different from other samples. However, all the samples were statistically the same. Dietary fat that provides essential fatty acid has been shown to enhance the taste and acceptability of food products, slows gastric emptying and intestinal motility. Thus, prolonging satiety and facilitating the absorption of water soluble vitamins [26,27]. Fibre content ranged from 2.84^{b}-2.13^{c} which was lower than the control (5.83^{a}) with no significant difference between all the samples. Fibre is important for the removal of waste products from the body thereby preventing constipation, colon cancer, heart failure and many other health disorders. Consumption of plant fibre has been shown to reduce cholesterol level, risk of coronary heart diseases and insulin sensitivity[24]. The fibre content of the cereals was lower as compared to that formulated from blends of local rice, soybeans and defatted coconut flour with values of 2.11-3.30%[23]. This could be attributed to the natural fibre contents of the food materials used in the blends.

Carbohydrate content of breakfast cereals ranged from $31.39^{c}\pm0.79$ to $47.19^{ab}\pm1.77$.All samples were not significantly ($P<0.05$) different. Cereals with 80:10:10 (sample A) formulation had the highest carbohydrate value (mean=47.19^{a}) which was lower than the control (80.00^{a}). The carbohydrate content of the samples increased with increase in percentage composition of sorghum flour in the blend formulation. Sorghum are a rich source of carbohydrate, sorghum contain up to 70-80% starch on a dry weight basis[27]. High values (62.44 ± 0.22 – 66.48 ± 0.04%) of carbohydrate content for cereals formulated from blends of *acha* and fermented soybean paste (okara) were also recorded by[2].

Table 1: Proximate composition of cereals prepared from sorghum fortified with soybean and coconut.

Sample	Ash	Protein	Moisture	Fat	Crude Fibre	CHO
Sample A	$0.73^{ab}\pm0.21$	$32.62^{b}\pm0.04$	$5.33^{b}\pm1.04$	$12.00^{b}\pm1.00$	$2.13^{c}\pm0.00$	$47.19^{ab}\pm1.77$
Sample B	$0.90^{ab}\pm0.36$	$37.08^{b}\pm0.04$	$8.33^{a}\pm0.58$	$12.33^{b}\pm0.58$	$2.42^{b}\pm0.00$	$38.93^{b}\pm1.48$
Sample C	$1.53^{a}\pm0.06$	$43.56^{a}\pm0.04$	$6.33^{b}\pm0.29$	$14.33^{a}\pm0.58$	$2.84^{ab}\pm0.00$	$31.39^{c}\pm0.79$
Control	0.21^{c}	6.07^{c}	7.14^{ab}	2.93^{c}	5.83^{a}	80.00^{a}

Values are means +SD of triplicate determinations. Means differently superscripted along the vertical columns are significantly different ($p<0.05$).

Key:
Sample A - 80%Sorghum +20%Soybean+0% Coconut,
Sample B-70%SG+20%SB+10%CN,
Sample C-60%SG+30%SB+10%CN
Control - NASCO Cornflakes
Keys: Sorghum (SG): Soybean (SB): Coconut (CN)

Sensory properties of cereals prepared from sorghum, soybean and coconut flour.

Table 2 shows the sensory properties of cereals prepared from sorghum, soybean and coconut flour and NASCO Cornflakes (commercial control). The result showed that sample A (80:10:10) with the mean value of 6.2^{b} was the most preferred of the formulated samples in term of color by the respondents, there was a significant difference between sample A and the commercial control. Colour is a very important parameter in assessing the suitability of raw material to be used for the preparation of food product which also provides information about the formulation and quality of the product[28]. The result further indicated that sample A (80:10:10) with the mean value of 6.1^{b} was the most preferred of the formulated samples in term of taste and was ranked next to the control. However, significant differences (p<0.05) were observed between the samples and the control which had the highest score, while samples C was least. This may be due to the high level of defatted coconut fiber present in it. Furthermore, the result revealed that that sample A (80:10:10) with the mean value of 6.9^{b} was the most preferred of the formulated samples in term of aroma, while the least mean was recorded in the sample C with the mean value of 4.1^{c}. However, there is significant difference between the samples. In terms of mouth-feel sample B with the mean value of 7.4^{ab} was mostly preferred. However, there is significant different between the samples when compared with the control. The result also indicated that sample B was mostly preferred in term of appearance with the mean value of 7.4^{ab}, while sample C had the least mean value of 4.7^{c}. However, there is significant difference between the formulated samples when compared with the control. The result also showed that the overall acceptability ranges from 8.5^{a} to 6.1^{b}, which implies that all the samples compared favourably with the control.

Table 2: Sensory properties of cereals prepared from sorghum, soybean and coconut flour.

Samples	Colour	Taste	Aroma	Mouthfeel	Appearance	Overall acceptability
Sample A	6.2^{b}	6.1^{b}	6.9^{b}	7.3^{ab}	6.1^{b}	7.5^{ab}
Sample B	5.9^{bc}	6.0^{b}	5.8^{bc}	7.4^{ab}	6.4^{b}	7.1^{ab}
Sample C	4.3^{c}	5.2^{bc}	4.1^{c}	3.7^{c}	4.7^{c}	6.1^{b}
Sample D	8.5^{a}	8.2^{a}	8.5^{a}	8.4^{a}	8.8^{a}	8.5^{a}

Means differently superscripted along the vertical columns are significantly different (p<0.05).
Key:
Sample A-80%Sorghum +10%Soybean+10% Coconut,
Sample B-70%Sorghum +20%Soybean +10%Coconut,
Sample C-60%Sorghum +30%Soybean +10%Coconut
Sample D- NASCO Cornflakes (commercial control)

IV. Conclusion

It was concluded that acceptable ready-to-eat cereals could be produced from sorghum, soybean and coconut flour blends. It was also observed that the cereals were rich in protein, fat, carbohydrates and ash contents compared to cereals (NASCO cornflake). Hence, this product can solve the problems of protein energy malnutrition in developing counties and the flour blends can serve as ingredient in food formulation. The cereals made from the composite flour compared favorably with the control (NASCO Cornflakes) implying the product's acceptability when commercialized. Feeding young children with the formulated cereal will further promote the use of food crops as well as prevent incidence of malnutrition. Further research should be carried out to ascertain the shelf stability and the best packaging materials for the formulated cereal. These along with other factors will influence the commercialization of the food product as well as its sustainability.

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