Afropolitan Journals

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ISSN: 3027-2637 www.afropolitanjournals.com

Physicochemical and Sensory Properties of Breakfast Flakes from Blends of Sorghum, African Yam Bean, and Moringa Leaf Powder

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DOI: *https://doi.org/10.62154/ajasfr.2025.020.01013*

Abstract

This study aimed to determine the physiochemical properties of flakes produced from sorghum, African yam bean and moringa leaf blends. Flours were processed from sorghum and African yam bean using traditional methods while moringa leaves were processed into powder after drying at room temperature. Sorghum flour, African yam bean flour and Moringa leaf powder were blended in different proportions; 100:0:0, 90:5:5, 80:15:5, 70:25:5, 60:35:5 and 50:45:5 respectively. These composite flours were formulated and used to produce flakes. Sensory evaluation was conducted on the samples to select the best three samples which were subjected to proximate analysis using standard methods. Samples containing sorghum: African yam bean: moringa leaf in the ratio100:0:0, 90:5:5 and 70:25:5 respectively, were the most accepted samples with the overall acceptability score of 6.84, 5.82 and 5.50 respectively. The results of the proximate composition of these three samples showed values ranging from 9.98 – 10.29% for moisture, 8.62 – 10.70% for crude protein, 15.73 – 16.12% for crude fat; 1.27 – 1.41% for crude fibre, 1.51 – 1.99% for ash and 60.06 – 61.95% for carbohydrate content. The study concluded that flakes of improved nutrition and sensory acceptability were produced from blends of sorghum, African yam bean and moringa leaf blends.

Keywords: Proximate Analysis, Sensory Analysis, Sorghum, African Yam Bean, Moringa Leaf.

Introduction

Flakes are ready-to-eat and convenient breakfast cereals that are obtained by swelling, roasting, grinding, rolling or flaking of any cereal especially maize or in combination with other food materials such as legumes, nuts, fruits and vegetables (Olurin *et al.*, 2021). They are consumed by the young population groups in many countries (Omaima *et al.*, 2020). This ready-to-eat grain food is typically consumed with milk or cream for breakfast in different parts of the world and they are often consumed with sugar, syrup, or fruit (Usman *et al.*, 2015).

Sorghum botanically known as *Sorghum bicolor* is a food crop that is grown in the tropical and semi-arid regions of the world (Alebiosu *et al.*, 2020). Globally, sorghum is the fifth most important cereal crop by acreage after wheat, rice, maize, and barley. As reported in the study of Arukwe *et al.* (2021), sorghum contains significant proportions of protein (11.30-13.00%), dietary fibre (3.00 -6.00%) and carbohydrate (70-74.63%) but its fat content

(1-3.30%) is very low. The average starch content of the grain ranged from 56 to 73%. It is relatively rich in iron and phosphorus but do not contain pro-vitamin A (Alebiosu *et al.*, 2020). Sorghum grain is utilized in preparation of many traditional foods and in bakery preparations like bread, cakes and biscuits (Adebayo and Okoli, 2017).

African yam bean (*Sphenostylis stenocarpa*) is a leguminous crop that is predominantly cultivated in West Africa. It produces nutritious pods, highly proteinous seeds and is capable of growing in marginal areas where other pulses fail to thrive (Egbujie and Okoye, 2019). The Igbo people of the South Eastern Nigeria calls it "*Okpodudu, Ijiriji, Azama*", the *Ibibios* call it "*Nsama*". The seeds contain about 19-23% crude protein and are rich in lysine and threonine, an essential amino acid that is lacking in cereal grains and also has the potential to meet the everincreasing protein demands of the people in areas where it is produced in commercial quantity (Momoh *et al.,* 2020).

Moringa contains over ninety antioxidants. It gives more than 100% of the daily value of B_{12}, Riboflavin B_2 and Thiamin B_1, vital nutrients especially for celiac. *Moringa oleifera* is the most nutrient dense plant known to science. The leaves, flowers, bark, wood and roots of the moringa trees are used all over the world for a wide variety of health, pharmacological and nutritional purposes (Otokpa *et al.,* 2019). The leaves are rich in minerals like calcium, potassium, zinc, magnesium, iron and copper (Kumsa and Haile, 2020).

Breakfast cereals such as flakes have the potential to be significant contributor of essential nutrients in the human diet when produced with nutrient-dense ingredients. This is primarily because they are very popular and well accepted by consumers including children, youths, women etc. (Mbaeyi-Nwaoha and Odo, 2018). Hence, flakes could be a good source of nutrients for all. A successful way to improve the nutritional aspect of flakes is by preparing it with enriched flours (composite flour) which contain a significant amount of nutrient such as protein, vitamins and minerals (Mbaeyi-Nwaoha *et al.,* 2020; Olurin *et al.,* 2021). Flours with better nutritional quality would be highly desirable, especially in developing countries where malnutrition is prevalent. Therefore, production of flaked breakfast cereal from blends of sorghum, African yam bean and moringa leaf composite flours is hoped to improve its nutritional composition being that the selected raw materials especially moringa leaves are rich in wide array of nutrients. The fortification of breakfast cereals with African yam bean and moringa leaves can also help to supply some of the nutrients that might have been lost during the preparation of cereal products.

Materials and Methods

Two kilograms (2kg) of sorghum grains, sugar, margarine, packaging materials and salt were obtained from Eke Oko Market in Anambra State while two kilograms (2kg) of African yam bean seeds were purchased from Ogbaete Main Market in Enugu State. Also, enough quantity of fresh moringa leaves was plucked from a local farm in Ekwulobia in Anambra State.

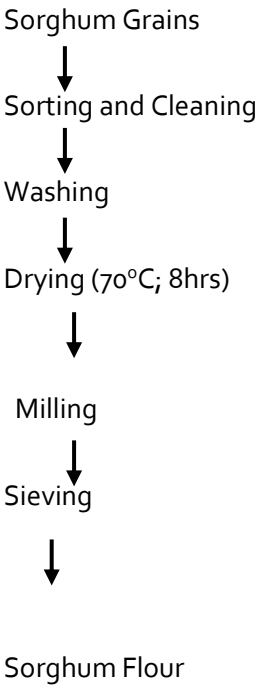


Fig. 1: Flow chart for the processing of sorghum flour

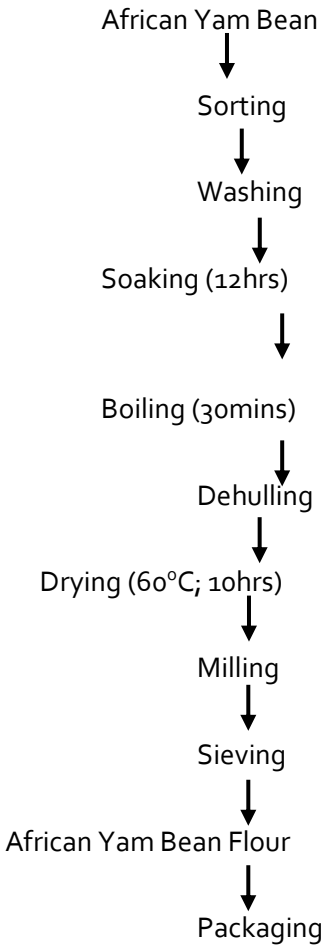


Fig. 2: Flow chart for the processing of African yam bean flour.

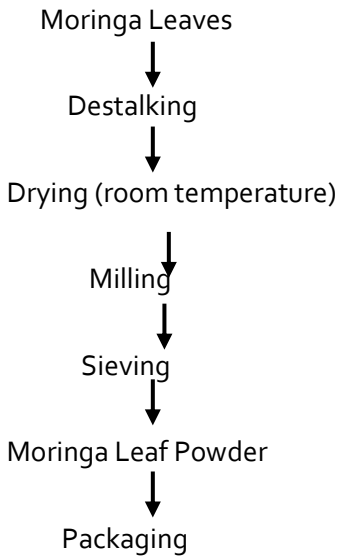


Fig. 3: Flow chart for the processing of moringa leaf powder.

Formulation of Blends

Sorghum flour, African yam bean flour and moringa leaf powder were blended in the proportions namely 100:0:0; 90:5:5; 80:15:5; 70:25:5; 60:35:5; and 50:45:5.

Table 1: Formulation of Composite Flours

Sample	Sorghum flour	AYB Flour	Moringa leaf powder
1	100	0	0
2	90	5	5
3	80	15	5
4	70	25	5
5	60	35	5
6	50	45	5

Production of Flakes

The flakes were produced by adopting the method described in the study of Odimegwu *et al.* (2019) with slight modification as shown in figure 4.

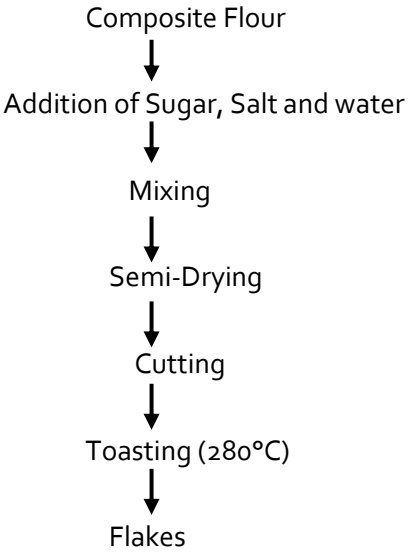


Fig. 4: Flow chart for the production of flakes.

Determination of Proximate Composition

The proximate composition of the flakes samples were determined using the standard methods described by the AOAC (2012).

Sensory Evaluation

A semi-trained panel of 20 judges from the Department of Food Technology, Federal Polytechnic Oko was used and they evaluated the samples with a 9-point Hedonic scale.

Statistical Analysis

Data generated from the respective analyses were compiled appropriately and subjected to Analysis of Variance (ANOVA) using Statistical Packages for Social Science (SPSS) software (version 25.0). All other data had the means separated using the Duncan Multiple Range test at 95% confidence test.

Results and Discussion

Table 2: Sensory evaluation of flakes produced from sorghum, African yam bean and moringa leaf blends.

Sample	Colour	Taste	Texture	Mouth-Feel	Flavour	Overall Acceptability
SP1	$7.20^{a}\pm0.6$	$6.80^{a}\pm1.0$	$6.80^{a}\pm1.2$	$6.50^{a}\pm1.6$	$6.90^{a}\pm1.1$	$6.84^{a}\pm0.91$
SP2	$5.80^{b}\pm1.1$	$6.00^{ab}\pm1.2$	$5.90^{ab}\pm1.4$	$5.80^{a}\pm0.9$	$5.60^{ab}\pm1.1$	$5.82^{ab}\pm0.82$
SP3	$5.40^{b}\pm1.4$	$5.20^{bc}\pm1.1$	$5.00^{b}\pm1.6$	$5.40^{a}\pm1.7$	$5.70^{ab}\pm1.8$	$5.34^{b}\pm1.15$
SP4	$5.50^{b}\pm1.0$	$5.40^{bc}\pm1.7$	$5.30^{b}\pm1.3$	$6.00^{a}\pm1.8$	$5.60^{ab}\pm1.2$	$5.50^{b}\pm1.06$
SP5	$4.90^{b}\pm1.9$	$4.70^{b}\pm1.3$	$4.60^{b}\pm1.7$	$4.90^{a}\pm1.7$	$4.50^{b}\pm1.8$	$4.72^{b}\pm1.57$
SP6	$4.50^{b}\pm1.8$	$4.50^{b}\pm1.7$	$5.00^{b}\pm1.3$	$5.00^{a}\pm1.6$	$5.10^{b}\pm1.3$	$4.82^{b}\pm1.34$

*Values are means ± standard deviations of sensory evaluation. Means with the different superscripts in the same column are significantly different ($p < 0.05$).

Keys:

SP1: 100:0:0 Sorghum-African Yam Bean-Moringa Leaf Flakes.

SP2: 90:5:5 Sorghum-African Yam Bean-Moringa Leaf Flakes.

SP3: 80:15:5 Sorghum-African Yam Bean-Moringa Leaf Flakes.

SP4: 70:25:5 Sorghum-African Yam Bean-Moringa Leaf Flakes.

SP5: 60:35:5 Sorghum-African Yam Bean-Moringa Leaf Flakes.

SP6: 50:45:5 Sorghum-African Yam Bean-Moringa Leaf Flakes.

Table 3: Proximate composition of flakes produced from sorghum, African yam bean and moringa blends.

Sample	Moisture (%)	Crude Protein	Crude Fat (%)	Crude Fibre	Ash (%)	Carbohydrates (%)
SP1	$10.29^{a}\pm0.2$	$8.62^{b}\pm0.2$	$16.5^{a}\pm0.5$	$1.3^{a}\pm0.0$	$1.5^{c}\pm0.0$	$61.62^{a}\pm0.22$
SP2	$9.98^{a}\pm0.58$	$9.08^{b}\pm0.4$	$15.7^{a}\pm0.9$	$1.3^{a}\pm0.0$	$2.0^{a}\pm0.0$	$61.95^{a}\pm0.01$
SP4	$10.08^{a}\pm0.6$	$10.7^{a}\pm0.0$	$15.8^{a}\pm0.3$	$1.4^{a}\pm0.1$	$1.9^{b}\pm0.0$	$60.1^{b}\pm0.42$

*Values are means ± standard deviations of triplicate determination. Means with the different superscripts in the same column are significantly different ($P < 0.05$).

Keys:

SP1: 100:0:0 Sorghum-African Yam Bean-Moringa Leaf Flakes.

SP2: 90:5:5 Sorghum-African Yam Bean-Moringa Leaf Flakes.

SP4: 70:25:5 Sorghum-African Yam Bean-Moringa Leaf Flakes.

Discussion

The means scores for the sensory evaluation of flakes produced from blends of sorghum, African yam bean and moringa leaf composite blends are presented in Table 2. There were significant differences (P<0.05) between the control sample and the other formulated flakes samples in their sensory attributes.

The overall acceptability score of the breakfast cereals samples ranged from 4.72 – 6.84 with sample SP5 (60:35:5 Sorghum-African Yam Bean-Moringa Leaf Flakes) having the least acceptance score while sample SP1 (control) had the highest score. However, samples SP1 (100:0:0 Sorghum-African Yam Bean-Moringa Leaf Flakes), SP2 (90:5:5 Sorghum-African Yam Bean-Moringa Leaf Flakes) and SP4 (70:25:5 Sorghum-African Yam Bean-Moringa Leaf Flakes) were further subjected to proximate analysis because they were the most preferred samples among the six samples that were formulated.

The results of the proximate composition of flakes produced from sorghum, African yam bean and moringa leaf composite blends are presented in Table 3. The moisture content of the flakes samples ranged from 9.98 % to 10.29 % with sample SP2 (90:5:5 Sorghum-African Yam Bean-Moringa Leaf Flakes) having the lowest value and sample SP1 (control) having the highest value. These values are higher than the values of 3.62 - 4.14% recorded by Odimegwu *et al.* (2019) for a breakfast cereal made from Maize and jackfruit seed flour but fell within the range of 6.60 – 11.20% and 5.41 – 10.52% reported for breakfast cereals produced from acha-mung bean-orange fleshed sweet potato (Mbaeyi-Nwaoha and Odo, 2018) and maize-African yam bean (Akinwande *et al.,* 2014) composite flours respectively. The variation in these results could be due to differences in the raw materials used. According to Edima-Nyah *et al.* (2019), the moisture content of a food affects its stability and overall quality; high moisture content leads to spoilage. Thus, the moderate moisture contents observed in the formulated flakes samples maybe beneficial in extending the shelf life of the products with proper packaging and storage.

The protein content of the flakes ranged from 8.62 % to 10.70 %. Sample SP1 (control) had the least value while sample SP4 (70:25:5 Sorghum-African Yam Bean-Moringa Leaf Flakes) had the highest protein content and significant difference existed amongst the samples. It was observed that supplementation with African yam bean and moringa leaf increased the protein content. The values obtained for protein in this study fell within the range of 9.70 % to 13.15 % reported by Okache *et al.* (2020) for breakfast cereal produced from wheat, millet, soybean and peanut flour blends.

The fat contents of the formulated samples ranged from 15.73 % to 16.52 %. Sample SP2 (90:5:5 Sorghum-African Yam Bean-Moringa Leaf Flakes) recorded the least value while sample SP1 (control) recorded the highest value. This implied that inclusion of African yam bean and moringa leaf powder slightly decreased the fat content. The variation in the fat content is because of differences in raw material used in the formulation of the samples.

The ash content of the formulated flakes ranged from 1.50 % to 1.99 % and significant differences (P < 0.05) existed amongst the samples. Sample SP1 (control) recorded the least ash content while the highest ash content was observed in sample SP2 (90:5:5 Sorghum-

African Yam Bean-Moringa Leaf Flakes). The range of values obtained were lower than that recorded for a breakfast cereal made from composite of grains, nuts and fruit which had an ash content ranging from 5.25 to 6.13% (Adeoye *et al.*, 2019). The variation in the ash content is because of differences in raw material used in the formulation of the breakfast cereals. On the other hand, the ash content obtained in the present study are similar to the values (1.89 – 3.85 %) reported by Odimegwu *et al.* (2019) for maize-jackfruit seed breakfast cereals. Ash content is the residue remaining after destroying combustible organic matter and it gives an overall estimate of the total mineral elements present in the food (Edima-Nyah *et al.*, 2019).

Conclusion

The results of this study have shown that incorporation of various proportions of African yam bean and moringa leaf into sorghum flour in flakes formulation significantly influenced the sensory acceptability of the products. Production of these composite flakes at commercial level has the potential to reduce protein-energy malnutrition and also increase food security in most developing countries. This will strengthen the innovation capabilities of African agricultural systems as a means of addressing poverty, improving food security and achieving broader economic growth and development.

This study recommends the production of flakes from composite flours of 90 % sorghum, 5 % African yam bean and 5 % moringa leaf powder since it did not adversely affect the sensory qualities.

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