Physicochemical and Sensory Attributes of Breakfast Food from Blends of *Ipomoea batatas* and *Sphenostylis stenocarpa* Flours

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KEYWORDS

African yam bean,
Flake,
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ABSTRACT

The research was carried out to produce flakes from blends of Orange fleshed sweet potato (OFSP) and African yam bean (AYB) and determine its proximate, functional, vitamin, anti-nutrient and sensory properties. The different flours were mixed at different ratios of 75:25, 50:50, 0:100, 100:0, 50:50, 25:75, 100:0, and 0:100, for OFSP and AYB respectively and used to produce flakes. Analysis was carried out using standard procedures. There was significant difference in the properties of all the eight blended samples of flour. The proximate composition (%) of flake showed that crude fibre content ranged from (1.64 - 2.31), moisture content (6.41- 7.18), ash content (2.16 - 3.41), protein content (9.69 - 21.23), carbohydrate content (64.73 - 78.71) and fat content (1.15 - 1.84). The functional properties bulk density, water absorption capacity, oil absorption capacity and breaking strength of the flakes differed significantly ($p< 0.05$) The vitamin A and hydrogen cyanide of the sample also differed significantly ($p < 0.05$) The result showed that sample 6 (25 OFSP and 75 AYB), 3 (0 OFSP and100AYB) and 8 (0 OFSP and100 AYB) produced the most acceptable flake and could be recommended.

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INTRODUCTION

Flake, can be known to be small, flat, very thin pieces of food products which can be used as breakfast (Kadan and Caldwell, 2003). Sharma and Caralli., (2004) stated that breakfast cereal are foods obtained by swelling, grinding, rolling or flaking of any cereal. Ready-to-eat breakfast cereals are increasingly gaining acceptance in most developing countries, and gradually displacing most traditional diets that serve as breakfast due to convenience, nutritional values, improved income, and status symbol and job demands (Edima-Nyah *et al*., 2019). The common cereal products in Nigeria include Nasco Cornflakes, Good morning corn flakes, Kellogg's cornflakes, Nabisco flakes, Weetabix, Quaker Oats, Rice crisps.

African yam bean belongs to the family: *Fabaceae* (alt. Leguminosae) subfamily: *Faboideae* tribe: *Phaseoleae* subtribe: *Phaseolinae.*, also placed in: *Papilionaceae*, genus *Sphenostylis.* African yam bean (AYB) seeds can be brown, white, speckled or marbled with a hilum having a dark-brown border (Ikhajiagbe and Mensah, 2012). The Igbo people of the south eastern Nigeria call it "Okpodudu, Ijiriji, Azama" and the seeds may be boiled and eaten with local seasoning, starchy roots, tubers. The seeds can also be toasted and eaten with palm kernels (Enwere, 1998).African yam bean (AYB), is known to have a nutritive and culinary value, which has brought it into focus to previous workers as (Agunbiade and Ojezele, (2010) Abbey *et al.* (1991) evaluated the functional properties of African yam bean flour. Orange fleshed sweet potato (OFSP) is a bio-fortified sweet potato, it is a new crop that has been introduced due to its high beta-carotene, which is an organic, red-orange pigment abundant in plants and fruits (Ukoma, *et al*., 2019). Beta-carotene is what gives OFSP an orange colour and is converted to vitamin A in the after consumption to provide additional nutritional benefits (Edima-Nyah , 2019).

Thus, the aim of this work was to produce breakfast cereal in form of flake from blended flours of African yam bean and orange fleshed potatoes. The specific objectives were to evaluate its proximate, physical and sensory properties and drive the optimum blend ratio for the product.

MATERIALS AND METHODS

Source of raw materials

Mature *Ipomoea batatas* (orange fleshed sweet potatoes) was purchased from Zodok farms limited, Yenagoa, Bayelsa state, Nigeria and *Sphenostylis stenocarpa* (African yam bean) was purchased from new market, Enugu State, Nigeria.

Preparations of raw materials

Production of OFSP flour (Carrot C)

The OFSP flour was produced according to Kulkarni *et al.* (1988) with little modification. The freshly harvested potatoes (Carrot C) was sorted washed, brushed and peeled. The eyes and all bruises were pitted out. Immediately after the peeling, the potatoes were sliced and put into a container. Portable water that boiled at 100°C was poured into the container containing the sliced potatoes and left for 3 minutes, drained and uniformly layered in a tray and dried at a temperature of 75 °C in a hot air cabinet drier for 15 h. The dried potatoes were milled and sieved through the 1mm mesh sieve. The potato flour was packed in air-tight containers

Production of African yam bean flour (AYB)

The procedure described by (Enwere, 1998) was used with little modification. The African yam bean was cleaned, sorted, weighed and washed thoroughly with clean running tap water after which it was soaked in water for 12 hours at room temperature and boiled for 30 minutes. The boiled African yam beans was dried in a hot air oven at 60°C for 10 hours, dehulled and milled using an attrition mill. The flour obtained was sieved and packaged in polyethylene bags for further analysis. The flow diagram for the production of African yam bean flour

Production from the blends of orange fleshed sweet potato flour and African yam bean flour

The blend of OFSP and AYB flour was used to produce the flakes according to Banjoko *et al*. (2019) with little modification. Potable water (100 ml) was added and mixed thoroughly to produce slurry. Foils were placed on baking pan and the slurry poured on it evenly. It was oven baked at 150 ℃ for 30 min and cooled.

Experimental design

The experiment is a Completely Randomized Design

Table 1 shows the blend ratios of the OFSP and AYB flours used in the production of the flakes

Table 1: Experimental design

	OFSP (%)	AYB (%)
1	75	25
2	50	50
3	0	100
4	100	0
5	50	50
6	25	75
7	100	0
8	0	100

Analyses

Proximate composition

Proximate composition was determined according to the standard methods of Association of Official Analytical Chemists (AOAC, 2010).

Physical properties

The bulk density and water absorption capacity were determined according to the methods described by Onwuka (2018). The breaking strength was determined according to the method described by Okaka and Isiehs (1997).

Sensory Attributes

Sensory properties were determined using 9 point Hedonic scale were 9 = like extremely and 1 = dislike extremely (Ishiwu and Onyeji, 2004)

Statistical analysis

The scores obtained were subjected to a one-way Analysis of Variance (ANOVA) version 23. The Least Significant Difference (LSD) test and Duncan Multiple Range Tests were used to determine significant differences between means and separate means respectively at $p < 0.05$ levels using SPSS package version 17.0.

RESULTS AND DISCUSSION

Proximate composition of the sample

The proximate composition of the flake is represented in Table 2. The moisture content of the samples ranged from 7.18 - 6.52 %. From the results, there was no significant difference ($p > 0.05$) in the moisture content of the samples. A low level of moisture content in products helps to prohibit the growth of bacterial in the food product thereby increasing its shelf life (Ishiwu and Onyeji, 2004; Adebowale *et al*., 2014)

The protein content of the samples ranged from 9.69 - 21.23%. There were significant differences ($p < 0.05$) among the samples. The protein content obtained were higher than protein content reported on breakfast cereal from rice. Protein helps to boost metabolism and increase muscle mass and strength (Okoronkwo *et al*., 2019)

The ash content of the samples which is a measure of mineral element ranged from 2.16 - 3.41% in the flakes. There was no significant difference ($p > 0.05$) between. The high ash content implies high amount of mineral in the samples provided there wasn't any contamination of the samples by foreign matters (Ishiwu and Onyeji, 2004). Adebanjo *et al*. (2020) worked on extruded flakes from pearl millet and carrot blended flour production and reported higher ash content of 1.19-2.97%. among the samples. The fat content of the samples ranged from 1.15 - 1.84%. There was no significant difference among the samples ($p > 0.05$) in the fat content of the samples. The crude fibre content of the samples ranged from 1.64 - 2.31%. There was significant difference ($p < 0.05$) in the crude fibre among the samples. Fibre would help to boost the health, normalize bowel movement when ingested (Adebanjo *et al*., 2020).

The carbohydrate content of the flake samples ranged from 64.73 - 78.71%. There was significant difference ($p < 0.05$) in carbohydrate between the samples.

Physical properties of the flake samples

The analyzed data for functional properties for all the samples are presented in Table 3. The bulk density appreciably increased from 0.63 to 0.83 g/cm^3. This result indicated that BD increased with increased substitution of OFSP flour.

Table 2: Proximate Composition (%) of the Flake Sample

Sample	Moisture	Protein	Ash	Fat	C. fibre	CHO
1	6.63^{a}±0.35	12.56^{d}±0.06	2.46^{d}±0.01	1.35^{d}±0.01	1.80^{d}±0.01	75.21^{b}±0.06
2	7.18^{a}±0.74	14.69^{c}±0.04	2.76^{c}±0.01	1.49^{c}±0.07	1.96^{c}±0.07	71.91^{c}±0.62
3	6.52^{a}±0.42	21.25^{a}±0.02	3.41^{a}±0.21	1.86^{a}±0.14	2.31^{a}±0.07	64.73^{e}±0.04
4	6.65^{a}±0.42	$9.69\pm^{e}0.21$	2.16^{e}±0.01	1.15^{e}±0.01	1.64^{e}±0.00	78.71^{a}±0.00
5	7.18^{a}±0.74	14.69^{c}±0.04	2.76^{c}±0.01	1.49^{c}±0.07	1.96^{c}±0.07	71.91^{c}±0.62
6	6.58^{a}±0.28	18.26^{b}±0.01	3.07^{b}±0.03	1.61^{b}±0.01	2.15^{b}±0.01	68.34^{d}±0.01
7	6.65^{a}±0.42	9.69^{e}±0.21	2.16^{e}±0.01	1.15^{e}±0.01	1.64^{e}±0.00	78.71^{a}±0.00
8	6.52^{a}±0.42	21.25^{a}±0.02	3.41^{a}±0.21	1.86^{a}±0.14	2.31^{a}±0.07	64.73^{e}±0.04

Values represented as mean ± standard deviation. Means with different superscripts in the same column are significantly different ($p < 0.05$).

Low bulk density can be beneficial in formulation of infant foods since small quantity will be required to obtain desired bulkiness of food products (Suresh, 2013).

Water absorption capacity indicates the ability of flour to reconstitute under limited water conditions (Suresh, 2013). Values of the Water absorption capacity (WAC) ranged from 2.97 to 3.55 ml/g. Water absorption capacity would be affected by the granule structure of the blended flours caused by the starch fractions of amylose and amylopectin molecules. Heat treatment of the product could have dissociated the protein into smaller subunits making it have more binding capacity for water.

The tensile strength or breaking strength ranged from 50.00 to 98.53g.. Significant difference ($p < 0.05$) existed between samples. Breaking strength mostly called tensile strength is maximum load that a material can support without fracture when being stretched, divided by the original cross-sectional area of the material (Britannica, 2021). The result showed that the samples with a lower breaking strength are more crunchy and easier to chew than the samples with higher breaking strength.

Sensory properties of the flakes

The mean score of the sensory attribute of flaked samples is presented in Table 3.

Table 4: Sensory Properties (%) of Flaked Samples

S/N	App	Aroma	Taste	Cr	Mouth F	Gen Accep
1	$3.40^{e}\pm1.23$	$3.72^{f}\pm0.98$	$3.76^{d}\pm1.27$	$4.16^{c}\pm1.14$	$3.80^{e}\pm1.26$	$3.96^{e}\pm1.21$
2	$4.48^{d}\pm1.36$	$4.04^{ef}\pm1.04$	$4.16^{cd}\pm0.175$	$4.40^{c}\pm1.85$	$4.08^{de}\pm1.51$	$4.68^{de}\pm1.60$
3	$7.04^{b}\pm0.58$	$7.28^{ab}\pm0.61$	$7.52^{a}\pm0.59$	$7.36^{a}\pm0.76$	$7.04^{b}\pm1.37$	$7.52^{b}\pm0.96$
4	$4.92^{d}\pm1.66$	$4.60^{de}\pm1.76$	$4.24^{cd}\pm1.79$	$4.84^{c}\pm1.99$	$4.20^{e}\pm1.56$	$4.68^{de}\pm1.89$
5	$4.52^{d}\pm1.23$	$4.04^{ef}\pm1.27$	$3.96^{d}\pm1.134$	$4.56^{d}\pm1.76$	$7.16^{b}\pm0.85$	$4.60^{de}\pm1.41$
6	$7.52^{bc}\pm0.94$	$6.96^{b}\pm0.61$	$7.16^{a}\pm0.75$	$7.44^{a}\pm1.12$	$7.04^{b}\pm0.84$	$7.44^{b}\pm0.87$
7	$5.04^{d}\pm1.57$	$4.88^{d}\pm1.72$	$4.88^{c}\pm1.61$	$5.04^{c}\pm1.65$	$4.00^{de}\pm1.32$	$5.12^{d}\pm1.79$
8	$6.76^{c}\pm1.59$	$5.96^{c}\pm2.03$	$6.16^{b}\pm2.08$	$6.24^{b}\pm1.91$	$6.00^{c}\pm2.04$	$5.96^{c}\pm2.28$
9	$8.56^{a}\pm0.71$	$7.96^{a}\pm1.02$	$7.52^{a}\pm1.45$	$7.68^{a}\pm0.95$	$7.92^{a}\pm0.76$	$8.56^{a}\pm0.77$

Values represented as mean ± standard deviation. Means with different superscripts in the column are significantly different ($p < 0.05$) suggesting a high interpretation that the model is a

Table 3: Physical properties of the flake

Sample	Bulk density (g/cm^3)	Water absorption (ml/g)	Breaking strength (g)
1	$0.81^{b}\pm0.01$	$3.05^{b}\pm0.01$	$97.93^{a}\pm0.18$
2	$0.77^{c}\pm0.00$	$3.03^{bc}\pm0.01$	$98.53^{a}\pm0.04$
3	$0.68^{e}\pm0.00$	$2.97^{d}\pm0.01$	$51.06^{a}\pm72.20$
4	$0.83^{a}\pm0.00$	$3.55^{a}\pm0.01$	$96.61^{a}\pm0.15$
5	$0.77^{c}\pm0.00$	$3.03^{bc}\pm0.01$	$98.53^{a}\pm0.04$
6	$0.73^{d}\pm0.00$	$2.98^{cd}\pm0.43$	$50.00^{a}\pm70.72$
7	$0.83^{a}\pm0.00$	$3.55^{a}\pm0.01$	$96.61^{a}\pm0.15$
8	$0.68^{e}\pm0.00$	$2.97^{d}\pm0.01$	$51.06^{a}\pm72.20$

Values represented as mean ± standard deviation. Means with different superscripts in the same column are significantly different ($p < 0.05$)

Appearance is an important sensory attribute of any food because it influences the acceptability of the product. There were significant differences ($p < 0.05$) among the samples in appearance which is an important attribute to consumer's true representation of the relationship between the orange fleshed sweet potato and African yam bean

CONCLUSION

The flakes had high carbohydrate and protein content, the tensile strength of sample (50 OFSP: 50 AYB) and (was higher, and sample 3 was high in overall acceptability and aroma. Samples 6 (25 OFSP : 75AYB), 3 (0 OFSP:100AYB) were most acceptable and could be recommended.

RECOMMENDATION

It is recommended that further experimental investigation geared towards ascertaining the mineral quality, microbial load, shelf stability of the flakes be investigated

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