Proximate Composition and Sensory Evaluation of Blends of Cassava Fufu, Cooking Banana (*Musa saba*) and African Yam Bean (*Sphenostylis stenocarpa*) Composite Flours and Paste.

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Abstract

The proximate composition of blends of cassava fufu, cooking banana, and African Yam Bean composite flours was carried out, with the sensory analysis of the reconstituted paste using simplex lattice mixture experimental design. The results revealed an overall improved nutrition and some sensory attributes in the blended composite flours and paste. The moisture contents of all the samples were below 14 % which made them desirable. The overall protein content and fat content of the blended flour samples increased with increase in the AYB component of the blended samples. The ash contents of the mixtures generally increased with increase in the cooking banana flour component of the mixture. The fibre contents of blended samples significantly increased with increase in both cooking banana and AYB. The sensory evaluation, based on a nine-point hedonic scale, indicated that sample number 10 which contains 33.3% CF, 33.3% CB, and 33.4 % AYB scored highest in texture (7.08) and aroma (7.00) followed by the Control 1 (100 % cassava fufu) that scored (6.79 and 6.96) in texture and aroma respectively, though not significantly different (p>0.05). The taste (7.21) and general acceptability (7.43) of Control 1 sample (100 % fufu) was not significantly different (p>0.05) from that of pastes from sample number 10 that scored 7.17 and 7.42 for taste and general acceptability respectively. Paste sample number 10 reconstituted from flours (33.3% CF, 33.3% CB, and 33.4 % AYB) was recommended as the most acceptable of the blended samples.

Keywords: *blends, cassava fufu, cooking banana, African Yam Bean (AYB), sensory evaluation.*

Introduction

In Nigeria, our staple foods are mostly roots and tubers which are predominantly starchy and deficient in protein. Cassava (*manihot esculenta*) is vital to economy of Nigeria as the country is the largest producer of the commodity. Cassava is also major source of dietary energy for low income consumers in many parts of tropical Africa including major urban areas. However, the consumption of cassava products has been implicated in malnutrition due to its very low protein content (Akoja and Mohammed, 2011). Cassava fufu is a traditional paste made from fermented cassava which is a staple food in Nigeria particularly in South-Eastern parts. It is ranked next to gari as an indigenous food of most Nigerians in the south (IITA, 2005).

Cooking banana (*Musa saba:* ABB group) is primarily consumed fried, porridge and boiled, although it can also be eaten raw when ripe. In Nigeria, *Musa saba* is available year round in Southern part of the country but highly underutilized and thereby predisposing it to rapid post-harvest spoilage contributed by its physiological metabolic activities and high moisture content (Ogbonna *et al*., 2016). The carbohydrate type in banana is resistant starch and non-starch polysaccharides, which have low glycemic index or low digestibility (Lehmann and Robin, 2007). Bananas are good sources of minerals especially potassium, a mineral involved in proper muscle contraction (Adeniji *et al*., 2010). They are known as a powerful secondary antioxidant source; the antioxidant compounds identified in bananas include ascorbic acid, tocopherol, beta carotene, phenolic groups, dopamine and gallocatechin (Qusti *et al*., 2010). It is relatively cheaper as compared to dessert bananas and plantains and has been reported to be rich in minerals, ash and ascorbic acid (Ogbonna *et al*., 2016).

African Yam Bean (AYB), *Sphenostylis stenocarpa*, is a grain legume cultivated in Central African Republic, Zaire, East Africa, and Ethiopia for its tubers and in the south-eastern Nigeria for its edible seeds (Ndidi *et al*., 2014). AYB is a good source of protein; its amino acid profile is comparable to those for most edible pulses (Ndu *et al*., 2014). Besides protein, AYB is a good source of fibre, carbohydrate and also rich in minerals such as phosphorus, iron and potassium (Aniedu and Aniedu, 2014).

Food enrichment can be achieved through the combination of two or more food stuff to improve the nutrient quality of the resultant food for the people who consume it. This strategy can be applied in communities where there is risk of a deficiency of the nutrient or nutrients concerned (Olapade *et al*., 2014). In some instances, enrichment is the easiest, cheapest and best way to reduce a dietary deficiency problem. The mixture of cassava fufu, cooking banana and AYB will improve the overall nutrition, increase the crops utilization as well as encourage farmers to produce more.

The aim of this study was to evaluate the proximate composition of the composite flours and determine the sensory quality of reconstituted fufu produced from blends of cassava fufu, cooking banana and AYB composite flours.

Materials and Methods

Source of Materials

Freshly harvested roots of Cassava Mosaic Disease (CMD) resistant variety (TME 419), a bitter variety, was obtained from the National Roots Crops Research Institute (NRCRI), Umudike, Abia State, Nigeria, at about 11- 12 months old after planting.

Preparation of cassava fufu flour

The cassava *fufu* flour was produced by a method of (Etudaiye *et al*., 2009) with little modifications. The cassava *fufu* flour was produced as described by Figure 1 below. The roots were washed, peeled, and rewashed. Then the peeled roots were cut into cylindrical sizes of 6-8 cm, and soaked in water to ferment for 3 days. Then the fermented cassava was washed and grated into a mash using locally fabricated motorized grating machine. The mash produced was put in a big plastic container, covered to protect from flies for 2 days. Thereafter, the mash was dewatered after putting it in a clean bag using a locally fabricated dewatering machine. The dewatered caked mash was broken into granules and spread out on a raised platform to sun-dry. The dry cassava granules were milled into powder using Hammer mill to produce cassava *fufu* flour. The *fufu* flours obtained were properly packaged and sealed in grip-seal polyethylene bags (GI-model, 2.25" x 2.25", jiffy bags macro packaging co., United Kingdom). Packaged samples were stored at room temperature (28±2^{0}C) until ready for analysis.

Fresh cassava Roots
↓
Wash
↓
Peel
↓
Wash
↓
Ferment for 3 days
↓
Grate
↓
Ferment Mash for a day
↓
Dewater
↓
Dry (on a raised platform to avoid contamination)
↓
Mill into powder
↓
Cassava *fufu* flour

Fig 1: flow Chart for the processing of Cassava fufu flour

Preparation of Cooking Banana four

Cooking banana flour was produced by the method adoted by (Udofia *et al*., 2010). The method of Six kilograms of matured green cooking banana was obtained from Ahia Nkwo Market in Aba North, Abia State. Cooking banana flour was prepared according to the method described by Heads of cooking banana were cut into separate bunches which were subsequently defingered. The fingers were washed, peeled, cut into thin slices of about 2cm thick and blanched at 80^{0}C for 5 min. Blanched plantain slices were drained and dried in an oven at 60^{0}C for 24 h. The dried slices were milled into flour in a local grinder hammer mill to pass through a 250 micro metre aperture sieve and packed in a two-poly medium density (0.926-0.949) polyethylene.

Preparation of AYB flour

AYB flour was prepared by the method employed by (Aniedu and Aniedu, 2014). AYB flour was processed as shown in Figure 2. The seeds of AYB were thoroughly cleaned and sorted. Then 4kg of the clean seeds were fermented for 24 hours and sun-dried. The AYB were then dehulled separately using plate mill with clearance of 6mm between the plates. Then the cotyledons of the differently treated Africa-Yam-Bean were milled into powder using hammer mill. Thereafter, the powders were sieved using muslin cloth (0.8mmscreen size).

Proximate Analysis
The proximate composition of the processed roots was determined according to AOAC (1990) for fat, ash, crude protein, moisture, crude fibre and carbohydrate.

AFRICAN YAM BEAN

↓

Sort

↓

Ferment for 24 hours

↓

Sun-dry

↓

Dehull

↓

Mill

↓

Sieve

(Using muslin cloth 0.8mm screen size)

↓

SOAKED AFRICAN YAM BEAN FLOUR

Fig. 2: Flow diagram for processing of soaked AYB flour.

Experimental Design
A three component **simplex lattice Mixture** experimental design was adopted for this work as shown in Table 1.
A + B + C = 1 or (100%).

Table 1: A three component simplex lattice Mixture Design

S/No	A	B	C
1	1	0	0
2	0	1	0
3	0	0	1
4	0.667	0.333	0
5	0.667	0	0.333
6	0.333	0.667	0
7	0.333	0	0.667
8	0	0.667	0.333

9	0	0.333	0.667
10	0.333	0.333	0.334

A = cassava fufu flour, B = cooking banana flour and C = AYB flour.
S/No 1, 2, and 3 represent: 100 % cassava fufu (CF) (Control 1), 100 % cooking banana (CB) (Control 2), and =100% African Yam Bean (AYB) (Control 3) respectively.

Sensory Evaluation

The blended composite flours samples were reconstituted into paste by cooking 100 g of each of the samples with 3 parts of water while stirring vigorously for 5 minutes until it gelatinized and formed into suitable paste. A completely randomized block design was used to administer the samples in similar plates each with coded 3-digit non-misleading numbers to the panels. The dough samples were then presented to a panel of 20 untrained panelists who are cassava *fufu* consumers. The attributes assessed included appearance, taste, texture, and overall acceptability. These were scored using a 9 point- Hedonic scale which ranged from 1=like extremely to 9=dislike extremely, with 5=Neither like nor dislike and the results analyzed amongst means compared using the ANOVA method and differences amongst means compared using the multiple F-test at 5% level of significance as described by (Iwe, 2002). The difference between the mean values was determined by Tukey's test.

Results and Discussion

The moisture content of the composite flour blends ranged between 7.50% and 11.20% as shown in Table 2. The moisture content (11.20%) of Control 3 that contains 100% AYB was the highest, followed by the moisture content of sample No9 (0, 33.3, and 66.7 %) of CF, CB, and AYB flours respectively. The least moisture content (7.5 %) was observed in Control 1 which contains 100 % CF flour. Moisture content above 14% indicates a danger of bacteria action and mould growth which results in short shelf life and development of hydrolytic rancidity in such flours (Ihekoronye and Ngoddy, 1985). Thus, all the moisture contents of the flour samples were okay.

Table 2: Proximate Composition of flour samples

S/No	A	B	C	M/C (%)	Protein (%)	Fats (%)	Ash (%)	Fibre (%)	CHO (%)
1	1	0	0	7.50[e]	1.96[i]	0.50[e]	0.46[f]	0.59[e]	88.90[a]
2	0	1	0	8.30[d]	2.89[g]	0.70[e]	2.58[a]	2.30[d]	81.73[b]
3	0	0	1	11.20[a]	19.53[a]	4.91[a]	1.92[c]	2.78[a]	59.66[g]
4	0.667	0.333	0	7.70[e]	2.90[h]	0.60[e]	1.70[d]	0.95[e]	86.15[a]
5	0.667	0	0.333	9.40[c]	9.10[e]	3.40[h]	1.25[e]	2.00[c]	74.80[cd]
6	0.333	0.667	0	8.10[d]	3.10[h]	0.59[e]	2.10[bc]	1.20[d]	84.51[ab]
7	0.333	0	0.667	10.10[b]	10.20[d]	3.50[b]	1.55[d]	2.41[b]	71.94[d]
8	0	0.667	0.333	9.80[c]	11.30[c]	2.50[c]	2.30[b]	2.45[bc]	71.70[d]
9	0	0.333	0.667	10.20[b]	15.40[b]	3.60[b]	1.95[c]	2.55[c]	65.95[e]
10	0.333	0.333	0.334	10.10[b]	8.32[f]	2.10[d]	1.75[d]	2.15[d]	75.48[c]

The crude protein values (1.96 – 17.53 %,) of the blended flour samples increased significantly ($p<0.05$) with increase in AYB flour component of the mixture (Table 3). The 100 % flour sample of AYB had the highest protein content of 17.53 % , while the mixture sample with 66.6 % AYB and 33.3% cooking banana flour had the second highest protein content. The least protein content was observed in Control 1(100 % cassava fufu flour) sample. Legumes are generally considered good sources of plant-based protein and are also recommended as healthy alternative to animal-derived foods because of their high protein content

The crude fat content ranged from 0.40 to 5.01% (Table 2). The increase in AYB component of the mixture resulted to increase in crude fat. AYB flour (Control 3) had the highest fat content (4.91 %), while the crude fat content of both CF and CB had the least 0.50 and 0.70 % respectively.

The ash contents the samples ranged from 0.46 to 2.58%. 100 % cooking banana flour had the highest ash content (2.58 %) while 100% cassava fufu flour had the least ash content (0.46). The ash content of the mixture samples generally increased with increase in the cooking banana flour component of the mixture. Bananas are good sources of minerals especially potassium, a mineral involved in proper muscle contraction (Lehmann and Robin, 2007).

The fibre contents varied from 0.59 to 2.78 % in the flour samples (Table 2). The AYB flour was the major contributor of fibre in the mixture, having the highest fibre content of 2.78 %, followed by flour mixture of sample 7 (33 % CB and 66.6 % AYB), while the least fibre content (0.59 %) came from control 1 (100 % CF flour). Fibres are important part of our diet; they in our meal speed up the passage of food in the gut, helping prevent constipation (FAO, 1998)

The carbohydrate contents of the samples ranged from the least (55.66 %) in Control 3 to the highest (88.90 %).in Control 1. The second highest in carbohydrate content (86.15 %) was found in the mixed flours of sample 4 (66.6 % CF and 33.3 % CB). Thus, increasing AYB flour content in the mixture generally decreased the carbohydrate content of the blended flour samples. This could be attributed to relative low carbohydrate content of AYB flour when compared with cassava fufu flour and cooking banana.

Table 3 shows the mean scores of the sensory assessment of the reconstituted paste samples. The scores, in terms of appearance, ranged from 6.54 to 7.25 in the paste (Tables 3). The paste from 100% cassava (Control) flour scored the highest (7.25) while the second highest score (6.96) for appearance was observed in samples 4, 5, and 10. However, the score of appearance on the control sample was not significantly different ($p>0.05$) with samples number 4, 5, and 10. The paste made from 100% AYB flour had the least score (6.54) for appearance. Other scores for the samples mixtures on appearance were not significantly different ($p>0.05$).

The scores for sensory texture ranged from 6.24 to 7.21 for the composite paste (Table 3). The paste with the best sensory texture score (7.21) was produced from mixture sample number 9, followed by paste made from 100% AYB flour (Control 3). However, the difference is statistically significant ($p>0.05$). The paste sample (66.6% CB and 33.3% AYB) scored the least (6.24), followed by the paste sample (66.7% cassava fufu and 33.3% cooking banana and 0% AYB) for the texture.

Table 3: Mean scores for sensory evaluation of pastes from flour samples

S/no	Appearance	Texture	Taste	Aroma	Gen Acceptability
1	7.25^{a} ±0.65	6.79^{ab}±0.75	7.21±0.85	6.96±0.86	7.43^{a} ±0.62
2	6.94^{a} ±0.63	6.83^{ab}±0.76	6.83±0.94	6.63±0.86	6.94^{ab} ±0.67
3	6.54^{b} ±0.60	7.13^{a}±0.65	6.67±0.85	6.79±0.84	7.42^{a} ±0.85
4	6.96^{ab} ±0.64	7.08^{a}±0.86	6.58±0.85	6.54±0.94	7.42^{a} ±0.86
5	6.96^{ab} ±0.65	6.42^{b}±0.67	6.54±0.94	6.83±0.86	6.92^{ab} ±0.66
6	6.79^{ab} ±0.74	6.75^{ab}±0.68	6.71±0.94	6.21±0.87	6.50^{b} ±0.88
7	6.73^{ab} ±0.72	6.83^{ab}±0.82	6.38±0.85	6.71±0.85	6.67^{b} ±0.87
8	6.86^{ab} ±0.68	6.24^{b}±0.68	6.17±1.00	6.29±0.83	6.72^{b} ±0.78
9	6.67^{ab} ±0.58	7.21^{a}±0.67	6.46±0.94	6.04±1.01	7.25^{ab} ±0.85
10	6.96^{a} ±0.68	7.08^{a}±0.56	7.17±0.84	7.00±0.73	7.42^{a} ±0.65

Any two means followed by the same superscript letter for the same attribute in the same column are not significantly different at 5% significant level.

Therefore, the textures of some of the mixtures were found to be more preferable than the texture of paste made from 100 % cassava fufu flour. The texture of foods has a substantial impact on consumers' perception of 'quality' (Fellows, 2000).

The sensory score for taste ranged from 6.84 to 7.00 (Tables 3). The taste was rated 'good' on the average by the judges. However, the differences in sensory data for taste was not significantly different (p>0.05). This implies that the taste of the different paste samples were fairly the same irrespective of the variations in the component compositions of sample blends.

The aroma scores for the varying component samples ranged from 6.21 in (33% CF, 66.7 CB and 0% AYB) to 7.00 in (33.3% CF, 33.3% CB, and 33.34 AYB) as shown in Table 3. The scores represented by the panelists indicate that, on the average, the aroma was good. The differences in sensory data for aroma of the reconstituted paste samples in were not statistically significant (p>0.05). Panelists were used to consuming traditionally processed cassava *fufu* which is odorous. This might be the reason they for the general scoring of 'good' in all the mixture paste samples.

The scores for general acceptability ranged from 6.50 to 7.43 (Tables 3). There was no significant difference (p>0.05) between the general acceptability (7.43) of the control (100 % cassava fufu), and the general acceptability (7.42) of other three different component mixtures of the samples (100 % AYB; 66.6 % CF and 33.3 % CB; 33.3%, CF, 33.3 % CB, and 33.4 % AYB).

Conclusion and Recommendation

This study revealed that paste or fufu with improved nutrition, texture and aroma can be produced from blends of cassava fufu, cooking banana, and African Yam Bean composite flours. The moisture contents of all the samples were below 14 % which made them desirable.

The overall protein content and fat content of the blended flour samples increased with increase in the AYB component of the mixture. The ash content of the blended flour samples generally increased with increase in the cooking banana flour component of the mixture. Increase in both cooking banana and AYB flours resulted to increase in overall fibre contents of the blended samples.

The sensory evaluation indicated that sample number 10 scored higher than Control 1 (100 % cassava fufu) in terms of texture, taste and aroma, though not significantly different (p>0.05). The general acceptability of the Control 1 sample (100 % cassava fufu) was highest but not significantly different (p>0.05) from that of pastes from sample number 3, 4, 9 & 10. Sample number 10 which contains 33.3% CF, 33.3% CB, and 33.4 % AYB is hereby recommended as the most preferred sample. A further study on the glycemic index and texture profile analysis (TPA) of this work is highly recommended.

References

Akoja, S. S. and Mohammed, A. O. (2011). Evaluation of the proximate, pasting and sensory characteristics of cassava flour (fufu) fortified with pigeon pea flour. Pakistan Journal of Nutrition 10 (2): 124-128.

Adeniji, T. A., Tenkouano, A., Ezurike, J. N.1, Ariyo, C. O.1 and Vroh-Bi, I. (2010). Value Adding post harvest processing of cooking bananas (*Musa* spp. AAB and ABB genome groups). African Journal of Biotechnology Vol. 9 (54), pp. 9135-9141,

Aniedu, C. and Aniedu, O. C. (2014). Fortification of Cassava *fufu* flour with African yam Bean flour: Implications for improved nutrition in Nigeria. Asian Journal of Plant Science and Research, 4(3):63-66.

AOAC (1990).Official Methods of Analysis (15th Edition).Association of Official Chemists. Washington D.C USA.

Etudaiye, H.A, Nwabueze,T.U and Sanni L.O. (2009). Quality of *fufu* processed from cassava mosaic disease (CMD) resistant varieties. African Journal of Food Sci. 3: 61-67.

FAO (1998). Effects of food processing on dietary carbohydrates: Carbohydrates in human nutrition. Report of a Joint FAO/WHO Expert Consultation, Rome.(FAO Food & Nutrition paper-60).

Fellows, P.J. (2000).*Food processing Technology*.*Principle and practice*.Second edition. Woodhead Publishing Ltd. Great Abington Cambridge, England.p 16.

Iwe, M.O. (2002). Handbook of sensory methods and analysis.Rojoint comm. Serv. Ltd Uwani, Enugu. p 24-28, 50, 83.

Ihekoronye, A.I. and Ngoddy.P.O. (1985). Integrated food science and technology for the tropics. Macmillan Publishers London, p 283-285.

IITA (2005): Fufu flour. Integrated Cassava Project (ICP) of the International Institute of Tropical Agriculture (IITA) Ibadan, to encourage, promote and expand agribusiness development in the cassava subsector in Nigeria. (iita-icp@cgiar.org).

Lehmann, U., & Robin, F. (2007). Slowly digestible starch -its structure and health implications:a review. Trends Food Sci. Technol. 18 (7), 346 –355.

Ndidi, U. S., Ndidi, C. U., Aliyu, A. O., Billy, F. G. and Okpe, O. (2014).Proximate, Antinutrients and Mineral Composition of Raw and Processed (Boiled and Roasted) Sphenostylisstenocarpa Seeds from Southern Kaduna, Northwest Nigeria. ISRN Nutrition.

Ngwu, E. K., Aburime, L. C. and Ani, P. N. (2014).Effect of processing methods on the proximate composition of African yam bean (*Sphenostylisstenocarpa*) flours and sensory characteristics of their gruels. International Journal of Basic and Applied Sciences, 3 (3) 285-290

Ogbonna, O. A., Izundu, A. I., Okoye, N. H. andMgbakor, M. N. (2016). Vitamin Compositions of three Musa species at three stages of development. *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR -JESTFT) 2319-2399.Volume 10, Issue 6 Ver. I II.*

Olapade, A. A., Babalola, Y. O. and Aworh, O. C. (2014). Quality attributes of fufu (fermentedcassava) flour supplemented with bambara flour. International Food Research Journal 21(5): 2025-2032.

Qusti, S.Y., et al (2010). Free radical scavenger enzymes of fruit plant species cited in Holy Quran.World Appl. Sci. J. 9(3), 338—344.

Udofia, P. G., Umokaso, M. M., Udoekong, N., Ekanem, M. C, Udoudoh, P. J. and Eyen, N. O. (2010). Optimization of functional, organoleptic and marketing attributes of wheat-plantain-cocoyam (WPC) composite flour bread. NIFST-Garden City 2010 Conference.Pg 146-148.