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Effect of blending on the Proximate, Pasting and Sensory Attributes of Cassava – African yam Bean Fufu Flour

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ABSTRACT

Abstract - Nutritional attributes of Fufu-fermented cassava flour was improved through blending with 10, 20, 30 and 40% African Yam Bean (*Sphenostylis stenocarpa*) flour and the products were subjected to proximate analysis, pasting properties and sensory evaluation, with 100% cassava fufu flour as control. The results showed that the African Yam bean - Fufu flour contained 6.50% protein, 1.08% ash, 0.65% fibre, 0.26% fat at 10% level of inclusion and this increased to 16.45, 1.22, 0.90 and 1.24% respectively at 40% level of inclusion. However, the carbohydrate contents decreased from 91.51 - 80.87% at 10% and 40% inclusion of African yam bean flour respectively. All pasting characteristics with the exception of pasting temperature and peak time decreased with increased African Yam Bean inclusion. Peak viscosity (340.22 - 203.34) RVU, final viscosity (300.06 - 180.33) RVU, setback (79.72 - 39.13) RVU, break down (133.22 – 88.00) RVU, trough at 95^0 C (220.00 – 141.20) RVU at 10% and 40% level of inclusion of African Yam Bean respectively. There was a slight significant difference ($p \leq 0.05$) in overall acceptability between 10% level of inclusion and the control (100% cassava flour). The values ranged from 6.2 – 7.9 respectively. Generally, the rating of all the sensory attributes assessed reduced with increased in the inclusion of AYB flour.

***Index Terms* –** Blending; Cassava - African Yam Bean (AYB) fufu flour; Pasting Characteristics; Proximate Analysis; and Sensory Evaluation

I. Introduction

Cassava (*Manihot esculetus Crantz*) is a root crop cultivated and consumed as a staple in many regions of the developing countries). In Nigeria, cassava is processed into various products that are consumed in various ways. Among the fermented cassava roots products are ‘garri’, ‘fufu’, ‘tapioca’, and ‘lafun’ (Oyewole, 1991).

Cassava plays a food security role in areas prone to drought, famine and in periods of strives and civil disturbance. The crop’s ability to provide a staple food base is a function of its flexibility in terms of planting and harvesting strategies and because of its relative tolerance of poor solids and pest/disease problems (Adebowale *et al*., 2005). Cassava is a major source of dietary energy for low income consumers in many parts of tropical Africa, including major urban areas.

However, the utilization of cassava is limited by its extremely low protein content and so the consumption of its products has been implicated in malnutrition. The low protein intake in Africa has been attributed to the increasing high cost of traditional sources of animal protein. Legumes are some of the low-priced sources of protein rich foods that have been important in alleviating protein malnutrition (Aykroyd *et al*., 1992). Accordingly the compositional evaluations of leguminous seeds such as soybean, cowpea, groundnut, pigeon pea, chicken pea and red gram have been carried out in different locations by many investigators (Oloyo, 2002).

African Yam bean (*Sphenostylis stenocarpa*) is one of the edible, underutilised grain legumes widely cultivated in Africa that is used for man and animal nutrition (Eke, 2002). Like most grain legumes cultivated in Africa, African Yam bean is rich in protein (19.5%), carbohydrates (62.6%), fat (2.5%), vitamins and minerals (Iwuoha and Eke, 1996). The protein is made up of over 32 % essential amino acids, with lysine and leucine being predominant (Onyenekwe *et al.*, 2000). In spite of its composition, it has a low consumption rate. This is mainly due to its long cooking time about 145 min. (Nwokolo, 1996). Cultivation of African yam bean which has started as far back as 3000 years ago, are now widely cultivated in all tropical and semi-tropical regions of both the old and the new world. Therefore, African Yam bean as one of the ideal source for protein supplementation of starchy foods has been proposed because it will also help to extend the use of this lesser- known and utilised legumes in a number of food preparations especially in the developing countries for human consumption.

Fortification of inexpensive staples such as cassava and maize has resulted in products of high nutritional value (Oyarekua, 2009). An acceptable, nutritionally-enriched food that can be stored in the home should be produced for consumption in areas where protein intake is low. This work is aimed at determining the effect of in-cooperation of African Yam bean on the pasting, proximate and sensory attributes of “fufu” a fermented cassava-based- food.

II. MATERIALS AND METHODS

Collection of samples and equipments: Freshly harvested matured cassava *(Manihot esculetus Crantz*) roots (NR 8083) were obtained from the research farm of Imo State Polytechnic, Umuagwo-Ohaji. Imo State, Nigeria. African Yam Bean (*Sphenostylis stenocarpa*) seeds were bought from Ekeonunwa market in Owerri, Imo state, Nigeria. Facilities and equipments described for cassava and African Yam Bean (AYB) flour processing used were source from cassava processing plant of Imo State Polytechnic Umuagwo-Ohaji. Imo state Nigeria.

Preparation of samples: The cassava roots were sorted and cleaned to remove dirts and soils. The following steps were adopted in the production of fufu: manual peeling of cassava roots, washing, soaking, sieving, sedimentation, decantation, drying and milling. The African yam bean flour was prepared according to the method described by Enwere (1998). During preparation, two kilograms of African yam bean seeds which were free from foreign particles such as stones, leaves and sticks, as well as damaged and contaminated seeds were weighed, cleaned and soaked in tap water containing 0.1% sodium metabisulphite ($NaHS0_3$) for 12h. Thereafter the soaked seeds were manually dehulled, drained and boiled (100^0C, 20min). The dehulled and boiled seeds were spread on the trays and dried in the tray dryer (60^0C, 10h). After that, the dried seeds were immediately milled (attrition mill) and sieved through a 500µm mesh sieve. The cooked African yam bean flour produced was finally packaged in sealed polyethylene bags for blending with fufu flour as shown in table 1.

Analytical Methods

Proximate Composition Analysis: This was carried out according to the method of AOAC (1995).

Moisture Content Determination

Two grams of each of the sample was weighed into dried weighed crucible. The samples was put into a moisture extraction oven at 105^0C and heated for 3h. The dried samples were put into desiccators, allowed to cool and reweighed. The process was reported until constant weight was obtained. The difference in weight was calculated as a percentage of the original sample.

$$\text{Percentage moisture} = \frac{W2 - W_1}{W_2 - W_3} \times \frac{100}{1}$$

Where:

W_1 = Initial weight of empty dish
W_2 = Weight of dish + un - dried sample
W_3 = Weight of dish + dried sample

Ash Content Determination

Two grams of each of the samples was weight into crucible, heated in a moisture extraction oven for 3h at $100\ ^0$C before being transferred into a muffle furnace at $550\ ^0$C until it turned white and free of carbon. The sample was then removed from the furnace, cooled in a desiccator to a room temperature and reweighed immediately. The weight of the residual ash was then calculated as Ash Content.

$$\text{Percentage Ash} = \frac{\text{Weight of Ash}}{\text{Weight of original of sample}} \times \frac{100}{1}$$

Crude Protein Determination

The micro Kjeldahl method described by A.O.A.C (1995) was used. Two grams of each of the samples was mixed with 10ml of concentrated H_2SO_4 in a heating tube. One table of Selenium catalyst was added to the tube and mixture heated inside a fume cupboard. The digest was transferred into distilled water. Ten millimeter portion of the digest mixed with equal volume of 45% NaOH solution was poured into a Kjeldahl distillation apparatus. The mixture was distilled and the distillate collected into 4% Boric acid solution containing 3 drops of Methyl red indicator. A total of 50ml distillate was collected and titrated as well. The sample was duplicated and the average value taken. The Nitrogen content was calculated and multiplied with 6.25 to obtain the crude protein content.

$$\text{This is given as percentage Nitrogen} = \frac{(100 \times N \times 14 \times VF)T}{100 \times Va}$$

Where:

N= Normality of the titrate (0.1N)
VF= Total volume of the digest= 100ml
T= Titre Value
Va= Aliquot Volume distilled

Fat Content Determination

Two grams of the sample was loosely wrapped with a filter paper and put into the thimble which was fitted to a clean round bottom flask, which has been cleaned, dried and weighed. The flask contained 120ml of Petroleum ether. The sample was heated with a heating mantle and allowed to reflux for 5h. The heating was then stopped and the thimbles with the spent samples kept and later weighed. The difference in weight was received as mass of fat and is expressed in percentage of the sample.

The percentage oil content is percentage fat = $\frac{W_2 - W_1}{W_3} \times \frac{100}{1}$

Where;

W_1 = weight of the empty extraction flask

W_2 = weight of the flask and oil extracted

W_3 = weight of the sample

Crude Fibre Determination

Two grams (2g) sample and 1g asbestos were put into 200ml of 1.25% of H_2S0_4 and boiled for 30 minutes. The solution and content then poured into Buchner funnel equipped with muslin cloth and secured with elastic band. This was allowed to filter and residue was then put into 200ml boiled NaOH and boiling continued for 30 minutes, then transferred to the Buchner funnel and filtered. It was then washed twice with alcohol, the material obtained washed thrice with petroleum ether. The residue obtained was put in a clean dry crucible and dried in the moisture extraction oven to a constant weight. The dried crucible was removed, cooled and weighed. Then, difference of weight (i.e. loss in ignition) is recorded as crucible fibre and expressed in percentage crude fibre

$= \frac{W_1 - W_2}{W3} \times \frac{100}{1}$

Where:

W_1 = weight of sample before incineration

W_2 = weight of sample after incineration

W_3 = weight of original sample

Carbohydrate Content Determination

The nitrogen free method described by A.O.A.C (1995) was used. The carbohydrate is calculated as weight by difference between 100 and the summation of other proximate parameters as Nitrogen free Extract (NFE) percentage carbohydrate.

(NFE). = 100- $(m + p + F_1 + A + F_2)$

Where:

m = moisture

p = protein

F_1 = Fat

A = ash

F_2 = Crude fibre

Pasting characteristics Determination: Pasting characteristics of the flour blends were evaluated using a Rapid Visco Analyzer (RVA). First, 2.5 g of samples were weighed into a dried empty canister; then 25 ml of distilled water was dispensed into the canister containing the sample. The solution was thoroughly mixed and the canister was well fitted into the RVA as recommended. The slurry was heated from (50-95)^{0}C with a holding time of 2 min followed by cooling to 50^{0}C with 2 min holding time. The rate of heating and cooling were at a constant rate of 11.25^{0}C per min. Peak viscosity; trough, breakdown, final viscosity; set back, peak time and pasting temperature were read from the pasting profile with the aid of thermocline for windows software connected to a computer (Newport Scientific, 1998).

Sensory evaluation: The sensory evaluation was carried out on the following parameters: appearance, taste, aroma, mouth feel (texture) and overall acceptability on the heat – treated reconstituted samples by a panel of twenty semi – trained members who were familiar with the product 'fufu' using a 9-point Hedonic scale. The rating of the samples ranged from 1 (Dislike extremely) to 9 (Like extremely).

Statistical analysis: The statistical significance of the observed differences among the means of triplicate readings of experimental results was evaluated by Analysis of Variance (ANOVA) while means were separated using Duncan's Range Test. These analyses were carried out using SPSS (2001) Package (Version 11.0).

III. RESULTS AND DISCUSSION

Proximate Composition of the Cassava-African Yam Bean Fufu Blends: Proximate composition of the fufu blend samples showed a significant variation among the parameter examined with exception of carbohydrate (Table 2). Fufu blend of 60:40 (FAY_4) had the highest protein content (16.45 %) when compared with value of (6.50%) sample blend containing the least African Yam bean incorporation (FAY_1). The high protein content of the FAY_4 could be due to the level of African yam Beans flour inclusion, which has high protein content. According to Padmaja and Jisha (2005), protein content of the Cassava based composite flours could be elevated through the incorporation of legume flours. Similar trend was observed on other proximate properties such fat content which increased from 0.26 – 0.56 %, ash 1.08 – 1.22 %, crude fibre 0.65 – 0.90% for FAY_1 and FAY_4 respectively. The blend FAY_1 (Fufu flour/ African yam Beans flour 90:10) had the highest carbohydrate content (91.51) %, while the blend FAY_4 (Fufu flour/African yam Beans flour 60:40) had the lowest (80.87) %. The observation on carbohydrate could be attributed to differences in proportion of blend of the two major materials. From the results, it appears that the improvement of nutritional value of fufu could be dependent on the level of African yam Beans inclusions. This work confirms earlier report by Fashakin *et al.* (1986) on the beneficial effect of vegetable protein supplementation in carbohydrate-based foods.

Pasting characteristics of Cassava-African Yam Bean Blends: Amylographic studies (Table 3) showed that the pasting characteristics of Cassava-African Yam Bean blends are generally lower in values when compared with the control sample (FF). Peak viscosity is the maximum viscosity developed during or soon after the heating aspect of the test. High peak viscosity has been attributed to be significant in the preparation of stiff dough products like fufu (Thomas and Atwell, 1999).The peak viscosity of FF was 370.22 RVU at a temperature of 74.40 ^{0}C in 4.00 min. The Fufu- African yam bean flours had lower values in the range of (203.34-340.22) RVU. However, higher peak viscosity may be attributed to difference in protein content (Sandhu and Singh, 2007). This suggests that the presence and interaction of components like fats and protein (from African yam bean) with cassava starch lowers the peak viscosity of the blends (Egouletey and Aworh, 1991). The holding period is usually accompanied by breakdown viscosity which could also be referred to as shear thinning, hot paste viscosity, paste stability or trough. It is regarded as the measure of the degree of disintegration of the granules or "paste stability" (Dengate, 1984). It gives an indication of hot paste stability and the smaller the value, the higher the stability (Hugo *et al*., 2000). Trough and breakdown are pasting properties which indicate the ability of a food material to remain undisrupted when subjected to long periods of constant high temperature and ability to withstand breakdown during cooking (Normita and Cruz, 2002). The breakdown viscosity of FF was 200.33 RVU. The blend samples had lower values in the range of 133.21-88.00RVU as inclusion of AYB flour increased. Adebowale *et al*. (2005), reported that the higher the breakdown in viscosity, the lower the ability of the sample to withstand heating and shear stress during cooking. Therefore, sample FAY_4 might be able to withstand heating and shear stress compared to other samples because of its low breakdown value. The final viscosity ranged from 180.33-332.24RVU and the control sample FF had the highest 332.24 RVU final viscosity. Shimels *et al*. (2006) reported that final viscosity is used to indicate the ability of starch to form various paste or gel after cooling and that less stability of starch paste is commonly accompanied with high value of breakdown. The final viscosity is the most commonly used parameters to determine a particular starch based sample quality. It gives an idea of the ability of a material to gel after cooking. This implies that sample FF will be less stable after cooling compared to Fufu- African yam bean flours blend. The variation in the final viscosity might be due to the simple kinetic effect of cooling on viscosity and the re - association of starch molecules in the samples. The difference between final viscosity and trough give rise to a pasting property known as setback viscosity. Setback values have been reported to correlate with ability of starches to gel into semi solid pastes. It is the phase of the pasting curve after cooling the starches to 50 ^{0} C. This stage involves re – association, retrogradation or re – ordering of starch molecules. It has been correlated with the texture of the food products (Michiyo *et al.*, 2004). High setback viscosity is associated with weeping or syneresis. Among the fufu blends studied, FAY_1 had the highest retrogradation tendency of 79.72 RVU setback viscosity, followed by FAY_2 (66.00RVU) and FAY_3 (41.99RVU) while FAY_4 had the lowest value 39.13RVU. The apparent gelatinization (pasting) temperature is the temperature were viscosities first increases by at least 2 RVU over a 20 Sec period. This was 74.40 ^{0}C for the control sample while those of Cassava - African yam bean fufu flours varied from (76.33-78.11) ^{0}C. This may be due to the buffering effect of fat (from African yam bean) on starch which interferes with the gelatinization process (Egouletey and Aworh, 1991). The pasting temperature is one of the characteristic which provide an indication of the minimum temperature required for sample cooking, energy cost involved and other components stability. It is clear from the results that the control sample FF will cook faster with less energy, thereby saving cost and time compared to other samples because of its lower pasting temperature. The ability of starch to imbibe water and swell is primarily dependent on the pasting temperature. Hence in the presence of water and heat, starch granules swell and form paste by imbibing water (Rincon *et al.*, 2004).

Sensory Evaluation of Reconstituted Cassava-African Yam Bean Blends: Table 4 showed a significant difference ($p \leq 0.05$) on the sensory characteristics of fufu blends. It was observed that the control sample and blends varied in terms of overall acceptability, and the value ranged from 7.9 – 5.0. The control food sample was rated higher than Cassava - African Yam Beans-Fufu flours. This could be attributed to the fact that panellist have been used to control sample (FF) and difference in the nature and chemical composition of the major raw materials used. African Yam beans flour supplementation (FAY_1) was rated next to the control food sample but there was no significant difference between FAY_3 and FAY_4 in overall acceptability because of closeness in the blending proportions. The rating for aroma significantly differs from each other and reduced as the inclusion of AYB flour increases (7.3 – 3.2). This could be attributed to the increase in bean- off flavour associated with legumes (Eke, 2002).

IV. CONCLUSION

This study has shown that the nutritional status of Fufu a cassava – based staple food can be enhanced through African yam Beans Flour supplementation .The developed Cassava - African Yam Bean Fufu flour were found to be nutritious and can easily be prepared by using simple domestic processing techniques. The developed composite flour can be incorporated into the diet to prevent protein-energy malnutrition in Nigeria and other African countries where cassava products are staples, which is known to exacerbate many diseases prevalent in Nigeria and other African countries where cassava products are staples. These value-added products can also be produced to diversify the monotonous Nigerian diet and be a fortress against diseases.

The study also, revealed the pasting property variations that exist in samples of composite Cassava- African yam bean-fufu flours. The knowledge of pasting characteristics will assist consumers to know the ease of reconstitution and consistency of starchy pastes prepared from these varying blends of flours.

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Table 1: Cassava - African Yam Bean fufu flour blends

Samples	Fufu (%)	African Yan Bean (%)
FF	100	0
AYF	0	100
FAY_1	90	10
FAY_2	80	20
FAY_3	70	30
FAY_4	60	40

FF = Fufu flour; AYF = African Yam Beans flour; FAY = Fufu-African Yam Beans blend

Table 2: Mean proximate composition (%) of developed supplements
Proximate composition (%)

Samples	Protein	Ash	Crude fat	Crude fibre	Carbohydrate
FF	3.09^{a}	0.96^{a}	0.18^{a}	0.36^{a}	95.41^{a}
FAY_1	6.50^{b}	1.08^{a}	0.26^{b}	0.65^{b}	91.51^{b}
FAY_2	10.05^{c}	1.10^{a}	0.37^{c}	0.76^{c}	87.72^{c}
FAY_3	13.44^{d}	1.14^{b}	0.44^{d}	0.84^{d}	84.14^{d}
FAY_4	16.45^{e}	1.22^{c}	0.56^{e}	0.90^{e}	80.87^{e}

Means with the same superscripts on the same column are not significantly different from each other at ($p \leq 0.05$).
(FF = 100% Fufu, FAY_1 = 90:10% of Fufu: African yam bean, FAY_2 = 80:20% of Fufu: African yam bean, FAY_3 = 70:30% of Fufu: African yam bean, FAY_4 = 60:40% of Fufu African yam bean)

Table 3: Mean pasting properties of Cassava – African yam beans fufu flour blends

	Viscosity (RVU)						
Samples	**Peak Viscosity**	**Final Viscosity**	**Peak time (min)**	**Pasting Temp (^0C)**	**Trough @ (95^0C)**	**Break down**	**Set back**
FF	370.22^e	332.24^e	4.00^a	74.40^a	230.00^e	200.33^e	102.24^e
FAY_1	340.22^d	300.06^d	4.23^b	76.33^b	220.34^d	133.21^d	79.72^d
FAY_2	292.09^c	266.00^c	5.32^c	76.00^b	200.00^c	99.35^c	66.00^c
FAY_3	263.11^b	230.34^b	3.60^a	78.35^c	188.35^b	92.00^b	41.99^b
FAY_4	203.34^a	180.33^a	4.25^b	78.11^c	141.20^a	88.00^a	39.13^a

Means with the same superscripts on the same column are not significantly different from each other at ($p \leq 0.05$)
(FF = 100% Fufu, FAY_1 = 90:10% of Fufu: African yam bean, FAY_2 = 80:20% of Fufu: African yam bean, FAY_3 = 70:30% of Fufu: African yam bean, FAY_4 = 60:40% of Fufu African yam bean)

Table 4: Mean Sensory evaluation scores for reconstituted Cassava - African Yam Bean Fufu flour blends

Samples	Appearance	Taste	Aroma	Texture	Overall acceptability
FF	8.0^c	7.6^c	7.3^c	7.4^c	7.9^c
FAY_1	7.4^{bc}	6.4^{bc}	5.5^{bc}	6.5^{bc}	6.2^b
FAY_2	6.0^{ab}	5.2^b	5.3^b	5.0^a	5.0^a
FAY_3	5.8^a	5.2^b	5.2^b	5.4^{ab}	5.3^a
FAY_4	6.0^{ab}	3.4^a	3.2^a	5.0^a	5.3^a

Means with the same superscripts on the same column are not significantly different from each other at ($p \leq 0.05$).
(FF = 100% Fufu, FAY_1 = 90:10% of Fufu: African yam bean, FAY_2 = 80:20% of Fufu: African yam bean, FAY_3 = 70:30% of Fufu: African yam bean, FAY_4 = 60:40% of Fufu African yam bean)