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Organoleptic and Nutritional Evaluation of African Yam Bean (*Sphenostylis stenocarpa*) Flour Enriched Complementary Foods

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Abstract: African yam bean (AYB) seeds were processed into flour using some of the identified methods and the flour was incorporated in traditionally prepared maize gruel. Maize was soaked, fermented for two days, processed into gruel starch and used in the preparation of pap and porridge (*agidi jollof*). The resultant flour from AYB was used to enrich the prepared pap and porridge (*agidi jollof)*. The enriched and unenriched pap and porridge (*agidi jollof*) samples were analyzed for proximate and anti-nutrient constituents as well as evaluated organoleptically by a panel of consumers. Enrichment with AYB flour significantly increased ($p<0.05$) protein, moisture and ash content of the pap (PY) and porridge (*agidi jollof)* (AB) samples. Organoleptic properties of the enriched pap (PY) and porridge (*agidi jollof*) (AB) samples were similar to control ($p>0.05$). The level of tannin was higher ($p>0.05$) in both AYB enriched pap (PY) and porridge (AB), though within the acceptable level. Sensory evaluation of the samples showed that the enriched samples were well accepted by the panelists. The result revealed the proximate potential of AYB flour in the development and enrichment of complementary foods with acceptable organoleptic attributes when incorporated in complementary foods.
Keywords: Complementary foods, infants, enrichment, African yam bean, pap, *agidi jollof*.

INTRODUCTION

The prevailing problem of protein energy malnutrition (PEM) which is at its peak during the period of complementary feeding (i.e. between 6 months and about 2 years of age) may be attributed to inadequate consumption of animal based proteins [1]. It could also be due to consumption of too much cereal based *paps* and porridges whose nutrient density is reduced as a result of further dilution to the consistency the child can tolerate [1].

In Nigerian households, foods such as cereal pap (*ogi*) and *agidi* (cereal starch pudding) prepared from maize, millet or guninea corn) are commonly used as infant foods. After successful introduction of these at about 6 months of age, other starchy family foods such as yam, rice or *garri* which may be eaten with sauce are given to the child. Foods of animal origin such as meat, fish, and egg are seldom fed to the child due to socioeconomic factors, taboos and ignorance. Special efforts are seldom made to prepare complementary foods for the infants separately [2].

Ogi is a traditional fermented cereal porridge processed from wet milling of maize, sorghum or millet grains in many parts of West Africa. It is used extensively as a weaning food or breakfast cereal and can even be made into a very stiff paste called *eko* or *agidi* [3]. Traditionally, the grains are soaked in water for up to three days, before wet milling and sieving to remove husks. The filtered cereal is then allowed to ferment for up to three days until sour. It is then boiled into a pap, or cooked to make a stiff porridge (*agidi*) [4]. The waterg porridge has very little nutritive value and the nutritional losses have been reported in the wet milling method of preparing *ogi* [3]. As a result of this, many attempts have been made to improve the nutrient content particularly protein in order to reduce the high prevalence of protein energy malnutrition among infants. Thus, supplementation with other food sources which have high protein content is recommended.

In developing countries, the low income groups who constitute the bulk of the population are particularly at risk of malnutrition. They have no alternative than to depend on cereals and legumes which are cheaper and affordable [5]. The use of legumes in increasing the protein content of cereal based foods and their acceptability has been widely investigated [6]. However, certain factors limit the use of legumes as alternative sources of protein in complementary foods. These include the long cooking time, inconveniences in preparing them into local dishes and presence of anti nutritional factors [7]. These have however been partly overcome by different processing methods [8].

African yam bean is one of such legumes with a protein, fat and carbohydrate content of 22%, 62.5% and 2.5%, respectively [9]. Despite its nutritive value and increased production in the study area and other south eastern states of Nigeria, consumption has not increased as with cereal products. African yam bean has been reported to have the potential for supplementing the protein requirement of many families throughout the year [9]. Several processing methods have been used to enhance its acceptability and nutritional value [10,11,12]. This study was designed to process AYB seeds into flour using some of the identified methods, incorporate the flour in traditionally prepared maize gruel (pap and *agidi jollof*) as well as assess the products for nutritional and organoleptic properties.

MATERIALS AND METHODS

Source of raw materials

The major raw materials were yellow maize (Zea mays), African yam bean (*Sphenosstlis stenocarpa*). These were procured from a local market in Ndoro, Umuahia Abia state, Nigeria. The ingredients and chemicals used for analysis were of high quality grade.

Processing of African yam bean

The method of Eke [13] was used for the production of African yam bean flour with slight modifications. The AYB seeds were hand picked, carefully sorted and winnowed to remove unwholesome seeds and other foreign particles. The clean seeds were steeped in warm water overnight. In the morning, the seeds were manually dehulled and washed to remove the seed coat after which they were sundried for three days. After sun drying, they were winnowed before milling into flour using a hammer mill to a particle size that could pass through a 6 mm sieve. The milled samples were stored in air tight polyethene bags at -20^0C prior to use.

Processing of maize into starch

The maize grains were also sorted to remove unwanted particles. Steeping in cold water was carried out for two days for fermentation to take place. The seeds were washed, drained and wet milled afterwards. The wet milled maize slurry was sieved with muslin cloth and sieved with muslin cloth. The sieved maize was allowed to stand for about one hour so that the starch would sediment. The supernatant was drained off leaving wet maize.

The formulation of blends for the preparation of pap and *agidi jollof* samples is as illustrated in Tables 1 and 2.

Preparation of pap

The maize starch obtained was used in the preparation of pap and this was divided into two portions approximately 125g each. Clean water was boiled and the two portions of maize starch were separately mixed with 100ml of water. The boiling hot water was poured into the maize starch and stirred until a thick gel formed (*pap*). About two teaspoons of sugar was added to the gelled maize starch (*pap*). This was labeled as sample PA. To the other portion, 25g of AYB flour was added to the mixture and boiled for about 3 minutes with continuous stirring. This was labeled as sample PY (Table 1).

Preparation of *agidi jollof*

The *agidi jollof* was prepared with wet maize starch and this was divided into two portions. About 275g of maize starch each was mixed with 900 ml of water in a pot and put on the fire. It was continuously stirred as it boiled to avoid lumps. After about 10 minutes, the following ingredients were added to the cooked starch on the fire for sample AJ: 25g of ground crayfish, 50ml of palm oil, I cube of crushed bullion cube, 1 teaspoon of pepper and half teaspoon of salt. This was allowed to cook further for another 10 minutes until a thick corn starch was obtained. It was removed from the fire, poured into clean molds and partially covered to cool and set into a firm gel known as *agidi jollof*. A similar procedure was followed in the preparation of the other portion of maize starch but with the addition of 25g AYB along with the other ingredients. This sample was labeled as AB (Table 2).

Sensory evaluation of AYB enriched pap and *agidi jollof*.

Thirty (30) untrained panelists who were conversant with the product were randomly selected from staff and students of College of Applied Food Sciences and Tourism. The products were presented immediately after preparation. Water at room temperature was provided for the judges to rinse their mouth after each taste to avoid carrying over the taste from one sample to the other. The attributes evaluated were aroma, taste, flavor and overall acceptability using a 9 point hedonic scale as described by Iwe [14]. The highest point represents “like extremely’ while the lowest point represents dislike extremely.

Chemical analysis

The protein, fat, crude fibre and ash contents of the samples were determined using standard methods [15] (AOAC, 2006). Carbohydrate was determined by difference while energy value was by Atwater factor. The anti nutrients trypsin inhibitors was determined by methods of Arntfield *et al.* [16], oxalate was as described by Ukpabi and Ejidah [17], phytate by Obeitase *et al.* [18], while total sugar was determined using the anthrone method described by Ojiako and Akubugwo [19]. Oligosaccharides (raffinose and starchyose) content was according to methods of Akpapunam and Markakis [20]. Analysis of samples was carried out in triplicates.

Statistical analysis

Duncan multiple range test was used to separate means as described by Iwe [21]. A level of $P<0.05$ was accepted as statistically significant.

RESULTS AND DISCUSSION

The proximate composition of the AYB enriched (PA) and plain pap (PY) samples are shown in Table 3. The Moisture, protein and ash content were significantly higher ($p<0.05$) in PY, while PA had higher ($p<0.05$) dry matter and carbohydrate content. The addition of AYB to pap and *agidi jollof* samples improved the protein content of the samples and this is in agreement with earlier observations [22,23] on the addition of soybean and bambara groundnut flour, respectively to complementary foods. The use of AYB in complementing infant foods based on cereals and legumes is therefore encouraged, since it will improve the protein quality of the food. Moreover, it is considerably less expensive than animal protein. The proportion of dry matter and carbohydrate were significantly higher for plain *agidi jollof* (AJ), while AYB enriched *agidi jollof* (AB) had significantly higher ($p<0.05$) values for protein, fat, fibre and ash as shown in Table 4. The high fat observed in the enriched and unenriched *agidi jollof* could be due to addition of palm oil during the preparation of the porridge. The high moisture content of both enriched and unenriched pap samples (86.42±0.02 Vs 85.81±0.05%) (Table 3) compared to the agidi samples (32.3±0.01 Vs 18.53%) (Table 4) indicates that the porridge (*agidi jollof*) samples might have better storage stability than the pap samples.

The result in Table 5 revealed that there was a significant increase ($p<0.05$) in the tannin content from 0.03±0.00% in the plain pap (PA) to 0.05±0.01% in the fortified pap (PY) ($p<0.05$). Similarly, starchyose increased from 0.01±0.00% in PA to 0.03±0.00% in PY. The proportion of other anti nutrients did not differ significantly between the two samples ($P>0.05$). As shown in Table 6, no significant difference was observed in all the parameters for the enriched and unenriched *agidi jollof* samples except for raffinose which was significantly higher ($p<0.05$) in AYB enriched samples (AB).

The higher but non significant tannin content of AYB enriched pap (PY) (0.05±0.01%) and *agidi jollof* (AB)(0.06±0.01%) showed that all the tannin in the African yam bean (AYB) were not totally removed during processing. AYB is known to contain high levels of this anti nutrient and this is one of the major constraints to its use. However, the level detected was little and may not be harmful to the child because it is within the safe limits [24]. Other anti nutrients occurred in very low amounts in the samples and may have probably been removed during the various processing times. Other studies [25,26] reported low anti nutrients in cereal and legume based complementary foods studied.

The sensory scores of the pap samples as shown in Table 7 revealed that the two samples were similar in terms of color, taste, aroma and flavor. The overall acceptability however did not differ significantly between the two samples ($p>0.05$). Table 8 revealed that the addition of AYB flour to the *agidi jollof* did not differ significantly from the plain *jollof agidi* in terms of organoleptic properties ($p>0.05$). As regards the colour, the panelists preferred the colour of plain *agidi jollof* probably because it was brighter in colour. That notwithstanding, the AYB enriched *agidi jollof* compared favorably with the traditional *agidi jollof* and could therefore be recommended for infant feeding.

Table 1: Recipe for preparation of pap

Sample code	Maize starch	Sugar	Water	AYB
PA	125g	2 tsp	250ml	-
PY	125g	2 tsp	250ml	25g

PA= plain pap, PY=African yam bean fortified pap, AYB=African yam bean

Table 2: Recipe for preparation of *agidi jollof*

Sample code	Maize starch	Crayfish	Palm oil	Salt	Pepper	Bullion cube	Water	AYB
AJ	125g	-	500ml	½ tsp	1tsp	20g	900ml	-
AB	125g	25	500ml	½ tsp	1tsp	20g	900ml	25g

AJ= Plain *agidi jollof*, AB= African yam bean fortified *agidi jollof*, AYB=African yam bean

Table 3: Proximate composition of enriched and unenriched pap samples (%)

Parameters	PA	PY
Moisture (%)	85.81±0.05^{b}	86.42±0.02^{a}
Dry matter (%)	14.20±0.05^{a}	13.59±0.02^{b}
Ash (%)	0.59±0.01^{a}	0.73±0.01^{b}
Crude fibre (%)	0.09±0.01^{a}	0.07±0.00^{a}
Fat (%)	0.06±0.01^{a}	0.05±0.00^{a}
Protein (%)	0.02±0.00^{a}	1.07±0.02^{b}
Carbohydrate (%)	10.65±0.06^{a}	9.80±0.03^{b}

^{a,b} Means along the same row with different superscripts are significantly different, PA =plain pap, PY= African yam bean enriched pap

Table 4: Proximate composition of enriched and unenriched *agidi jollof* samples

Parameters	AJ	AB
Moisture (%)	18.53±0.08 [a]	32.3±0.01 [a]
Dry matter (%)	18.48±0.08 [a]	17.7±0.02 [b]
Ash (%)	1.54±0.01 [a]	1.65±0.03 [b]
Crude fibre (%)	0.45±0.00 [a]	0.64±0.02 [b]
Fat (%)	4.28±0.00 [a]	4.92±0.02 [b]
Protein (%)	2.20±0.01 [b]	2.74±0.01 [a]
Carbohydrate (%)	11.32±0.08 [a]	10.34±2.04 [a]

AJ =plain *agidi*, AB = African yam bean enriched *agidi jollof*, [a,b] Means along the same row with different superscripts are significantly different, AJ =plain pap, AB= African yam bean enriched pap

Table 5: Anti-nutrient content of enriched and unenriched pap samples

Parameters	PA	PY
Tannin (%)	0.03±0.00 [b]	0.05±0.01 [a]
Phytate (%)	0.07±0.00 [a]	0.09±0.00 [a]
Trypsin inhibitor (TUI/g)	0.06±0.00 [a]	0.09±0.01 [a]
Raffinose (%)	0.02±0.00 [a]	0.05±0.00 [a]
Starchyose (%)	0.01±0.00 [b]	0.03±0.00 [a]
Oxalate (%)	ND	0.03±0.00 [a]

ND = Not detected, PA =plain pap, PY = African yam bean enriched pap, [a,b] Means along the same row with different superscripts are significantly different

Table 6: Anti nutrient content of enriched and unenriched *agidi jollof* samples

Parameters	AJ	AB
Tannin (%)	0.04±0.00 [a]	0.06±0.01 [a]
Phytate (%)	ND	ND
Trypsin inhibitor (TUI/g)	0.07±0.00 [a]	0.05±0.01 [a]
Raffinose (%)	0.05±0.00 [a]	0.06±0.00 [b]
Starchyose (%)	0.02±0.00 [a]	0.04±0.01 [a]
Oxalate (%)	ND	ND

ND = Not detected, AJ =plain agidi jollof, AB = African yam bean enriched *agidi jollof*, [a,b] Means along the same row with different superscripts are significantly different

Table 7: Sensory scores of the enriched and unenriched pap samples

Parameters	PA	PY
Color	6.97±0.35 [a]	6.90±0.32 [a]
Taste	6.70±0.29 [a]	6.47±0.38 [a]
Texture	7.00±0.32 [a]	6.40±0.37 [a]
Aroma	6.63±0.27 [a]	6.63±0.31 [a]
Flavor	6.73±0.31 [a]	6.83±0.28 [a]
Overall acceptability	7.03±0.33 [a]	7.03±0.28 [a]

PA =plain pap, PY = African yam bean enriched pap, [a,b] Means along the same row with the same superscripts are not significantly different

Table 8: Sensory scores of the enriched and unenriched *agidi jollof* samples

Parameters	AJ	AB
Colour	6.50±0.36 [a]	5.37±0.43 [a]
Taste	5.56±0.35 [a]	5.67±0.43 [a]
Texture	5.67±0.36 [a]	4.83±±0.46 [a]
Aroma	5.73±0.39 [a]	5.20±0.43 [a]
Flavour	5.33±0.42 [a]	3.33±0.39 [a]
Overall acceptability	5.93±0.37[a]	5.63±0.42 [a]

AJ =plain *agidi jollof*, AB = African yam bean enriched *agidi jollof*, [a,b] Means along the same row with the same superscripts are not significantly different

CONCLUSION

The result reveals the proximate potentials and acceptable organoleptic properties of AYB when incorporated in infant formulations.

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