NUTRITIONAL AND SENSORY QUALITIES OF FERMENTED SEASONINGS FROM SOYBEAN AND FLUTED PUMPKIN SEEDS

ABSTRACT

Specialty condiment (*ogiri*) was produced from seeds of soybean (*Glycine Max*) and fluted pumpkin (*Telfairia occidentalis*) by spontaneous moist solid substrate fermentation of their pre-processed mash. The two samples which were coded FSBM and FFPM respectively were evaluated for nutritional changes after fermentation, and the relative values in the two fermented products. The two samples were further subjected to sensory analysis using a conventional variety derived from castor bean (*Ricunus cummunis*) seeds coded FCBM as a control. Results show that FFPM was significantly ($p<0.05$) higher in ash, crude fiber and protein, but significantly lower in moisture and fat than the FSBM. There was no significant ($p>0.05$) difference in carbohydrate content of the two samples. The FFPM recorded significant ($p<0.05$) increase in crude fiber, fat and protein, and significant ($p<0.05$) decrease in moisture, ash and carbohydrate from values in the fluted pumpkin seeds. The FSBM recorded significant ($p<0.05$) rise in fat and protein, but significant drop in moisture, ash, crude fiber and carbohydrate from the values in soybean seeds. Sensory results show that FFPM was significantly ($p<0.05$) higher than FSBM in flavor and marginally ($p>0.05$) different in color, texture, taste and general acceptability. Baring the marginal ($p<0.05$) superiority in taste, the FCBM was significantly ($p<0.05$) lower in every other attributes considered. It follows that good quality fermented condiments can be derived from cheaper and underutilized sources.

Keywords: fermentation, nutritional, oil seeds, quality, seasoning, sensory.

1.0 INTRODUCTION

Fermentation is a biochemical conversion of food materials to desirable products by the action of specific microorganisms or enzymes, either by natural (spontaneous) or controlled process. Positive attributes of food fermentation include longer keeping quality, variety in flavor, enhanced nutritional value due to removal of anti-nutrients and decreased toxicity leading to safe consumption of inedible foods.

Fermented foods constitute a significant component of African diets, some as staple foods, while others include weaning foods and condiments; as such they play an important role in the diets in tropical developing countries (Asagbra et al., 2019). As an ageless practice, fermented foods contribute significantly to food culture across the globe, providing varietal supply of massive food or condiments. Preserving by fermentation not only made food available for future use, but more digestible and flavorful (Egwim et al., 2013). Several animal and plant materials are

fermented for various aforementioned purposes. Plant seeds rich in protein and oil are fermented to make seasonings that enhance the flavor of foods including soups, sauces, and often such seeds are inedible in their unfermented state, containing toxic or anti-nutritional factors (Okpara and Ugwuanyi, 2017). Such seasonings include iru, ogiri, ugba and okpenye, which are fermented products of African locust bean, melon or castor oil seeds, oil bean seeds and seeds of *Prosposis africana* respectively (Kuye and Sanni, I999; Onawole et al., 2011).

Fermentation of oil seeds to produce condiments for soups and other delicacies is a common practice in the sub-Saharan Africa. Among the Igbo people of Nigeria, African oil bean (*Pentaclethra macrophylla*, Benth) is fermented to *ugba* or *ukpaka*, castor bean (*Ricunus cummunis*) is fermented to *ogiri ugba*, while melon seeds (*Citrullus vulgaria*) are fermented to *ogiri egwusi*. *Ogiri Igbo*, which is the common name for the two varieties, is used as an irreplaceable spice for a highly relished soup utilizing cocoyam mash as a major thickening agent. It also finds application in other local dishes. Production of *ogiri* from fermented castor bean seeds and melon seeds have been reported by Onawole et al. (2011) and Egwim et al. (2013).

Traditionally *ogiri* production is a moist solid substrate fermentation of preprocessed leguminous seeds by natural action of mixed cultures under largely anaerobic conditions. Flavor is considered a quality index of fermented oil seeds and plays a role in consumer acceptability, and differences in flavor range and intensities may vary due to various compounds produced by fermenting population (Kabuo et al., 2007; Ogueke et al., 2010). It will be added that the nature and chemical composition of the oil seed can be contributory factors. Methyl esters of fatty acids are predominant aroma compounds produced enzymatically during fermentation by the methanolysis of acetyl-COA that is forming during fatty acid synthesis, and has been reported to be responsible for quality sensory properties of various fermented foods (Perestrelo et al., 2005).

Although *ogiri*, like other fermented oil seeds, is used to impart peculiar aroma and taste in some local delicacies, it confers improved nutritional quality. Oboh (2006) evaluated the nutritional and sensory qualities of condiments produced from some underutilized legumes in Nigeria such as soybean (*Glycine Max*), Locust bean (*Parckia filicoidea* L.) and pigeon pea (*Cajanus cajan*) which were subjected to solid substrate fermentation with recorded positive impact. Ifediba et al. (2018) reported appreciable increase in nutritional properties of African breadfruit-corn fermented beverages. Okpara and Ugwuanyi (2017) reported enhanced nutritional value of fermented plant seeds, among other positive attributes.
Soybean seeds are used extensively in the production of vegetable oil, soymilk, sprung protein, animal feed, among other applications. Fluted pumpkin seeds are generally reserved for planting purposes, since only the green leafy portion is consumed as vegetable. Yet like other legumes the seeds abound in plant proteins and oil that can be fermented into highly flavored seasoning of the nature obtainable from castor oil bean and melon seeds. In the face of a dwindling supply of

castor oil seeds and an upsurge in price of melon seeds, production of *ogiri* from cheaper source, has become an imperative. Against this backdrop, the use of soybean and fluted pumpkin seeds for *ogiri* production deserves empirical studies.

2.0 MATERIALS AND METHOD

2.1 Source of materials

Two matured big pod heads of fluted pumpkin (*Telfairia occidentalis*) and 1kg of soybean (*Glycine Max*) were purchased from Eke Awka Market in the capital city of Anambra State, Nigeria.

2.2 Preparation of raw materials

2.2.1 Fluted pumpkin seeds: The pod heads were cut in half using machete and the seeds were manually recovered from fresh fleshy pulp. The adhering pulp was removed by brushing with fine sea sand and washing in excess volume of water. The clean seeds were hulled and the outer cover removed before they were diced for further processing.

2.2.2 Soybean seeds: The 1kg soybean seeds were sorted to remove extraneous matters before washing in excess volume of water to further remove unwholesome beans. The beans were soaked for 12h, hulled and washed to obtain clean seeds which were reserved for further processing.

2.3 Production of fermented mash (*ogiri*)

2.3.1 Production of fermented fluted pumpkin mash (*ogiri ugu*)

The reserved diced fluted pumpkin seeds were boiled at 100±2^{o}C for 1h over electric stove, drained in a basket and allowed to cool before wrapping in banana (*Musa saplentum*) leaves that were previously cleaned and blanched over flaming fire. The wrapped seeds were left to ferment at ambient temperature (30±2^{o}C), under predominantly sunny weather for initial five (5) days. This was unwrapped and mashed in a disc attrition mill. The moist mash was divided into ten equal portions and separately wrapped in banana leaves blanched as before, and allowed to ferment for another two (2) days under similar conditions. The warmth from the sun probably aided solid state fermentation by chance inoculation. The fermented condiment was stored at room temperature (28±2^{o}C) for immediate use. The sample was coded FFPM.

2.3.2 Production of fermented soybean mash

The reserved hulled soybean seeds were boiled over electric stove for 1h at 100±2^{o}C, drained and left to cool in a basket. The seeds were wrapped in clean blanched banana leaves and allowed to ferment for five (5) days at ambient temperature (30±2^{o}C), under predominantly

sunny weather. At the end of the initial fermentation the seeds were unwrapped and reduced in a disc attrition mill. The resultant moist mash was divided into ten equal portions as in the production of fluted pumpkin sample. They were wrapped in clean blanched banana leaves and subjected to two (2) days fermentation at ambient conditions as before. The fermented condiment was stored at room temperature (28±2^{o}C) for immediate use. The sample was coded FSBM.

2.4 Procurement of fermented castor bean mash (*ogiri ugba*)

A freshly prepared commercial variety from castor bean seeds was procured from a local producer reputed for high quality products. The sample was coded FCBM to serve as a control.

2.5 PROXIMATE ANALYSIS

The proximate composition of moisture, ash, crude fiber, fat, protein and carbohydrate were determined according to the method of analysis described by the Association of Official and Analytical Chemists, (AOAC 2000).

2.5.1 Moisture Content

Petri dish were washed and dried in the oven.

Exactly 2 g of the sample was weighed into each Petri-dish and the weight of the Petri dish and sample were noted before drying.

The Petri dish and sample were put in the oven and heated at 100^{0}C for 1 h. The result was noted and was heated another 1 h until a steady result is obtained and the weight was noted.

$$\% \text{ Moisture content} = \frac{W_1 - W_2}{\text{Weightofsample}} \text{x}100$$

Where W_1 = weight of Petri dish and sample before drying

W_2 = weight of Petri dish and sample after drying.

2.5.2 Ash content

Empty platinum crucibles were washed, dried and the weights were noted. Exactly 2 g of wet sample was weighed into each platinum crucible and placed in a muffle furnace at 500^{0}C for 3 h. The samples were cooled in desiccators after burning and weighed.

Calculations:

$$\% \text{ Ash content} = \frac{W_3 - W_1}{W_2 - W_1} \text{x } 100$$

Where

W1 = Weight of empty platinum crucible

W2 = Weight of platinum crucible and sample before burning

W3 = Weight of platinum and ash.

2.5.3 Crude fiber

Exactly 2 g was weighed in a beaker and boiled for 30 min with 200 ml of a solution containing 1.25 g of carbonate free NaOH per 100 ml. The final residue was filtered through a thin but close pad of washed and ignited asbestos in a Gooch crucible. This was subsequently dried in an electric oven and weighed. It was afterwards incinerated, cooled and reweighed. The loss in weight after incineration is the weight of the fiber.

$$\% \text{ Crude fiber} = \frac{\text{weight of fiber}}{\text{weight of sample}} \times 100$$

2.5.4 Crude fat

Sox let Fat Extraction Method was used.

Approximately 250 ml clean boiling flask was dried in oven at 105 to 110^{0}C for about 30 min. This was transferred into desiccators and allowed to cool. Correspondingly labeled boiling flasks were weighed.

The boiling flasks were filled with about 200 ml of petroleum ether (boiling point 40 to 60^{0}C). Approximately 2 g of sample was placed in an extraction thimble and was plugged lightly with cotton wool. The sox let apparatus was assembled and allowed to reflux for about 6 h. The thimble was removed with care and petroleum ether in the top container of the set-up was collected and drained into a container for re-use.

When the flask was almost free of petroleum ether it was removed and dried at 105 to 110^{0}C for 1 h. This was transferred from the oven into desiccators and allowed to cool; then weighed.

The weight so obtained was expressed as a percentage of the 2 g sample used.

2.5.5 Crude protein

Principle: the method is the digestion of sample with hot concentrated sulphuric acid in the presence of a metallic catalyst. Organic nitrogen in the sample is reduced to ammonia. This is retained in the solution as ammonium sulphate. The solution is made alkaline, and then distilled to release the ammonia. The ammonia is trapped in dilute acid and then titrated.

Exactly 2 g of sample was weighed into a 300 ml kjehdal flask (gently to prevent the sample from touching the surface and 20 ml concentrated sulphuric acid was added. The flask was held

in a stopper and shaken. Then 0.5 g of the Kjedahl catalyst mixture was added. The mixture was heated cautiously in a digestion rack under fire until a clear solution appeared.

The clear solution was then allowed to stand for 30 min to cool. After cooling about 100 ml of distilled water was added to avoid caking and then 50 ml was transferred to the Kjedahl distillation apparatus.

A 100 ml receiver flask containing 5 ml of 2% boric acid and indicator mixture containing 5 drops of Bromocresol blue and 1 drop of Methylene blue was placed under a condenser of the distillation apparatus so that the tap was about 20 cm inside the solution. About 5 ml of 40% sodium hydroxide was added to the digested sample in the apparatus and distillation commenced immediately until 50 drops gets into the receiver flask, after which it was titrated to pink colour using 0.01N hydrochloric acid.

Calculations:

% Nitrogen = Titre value x 0.01 x14 x 4

% Protein = % Nitrogen x 6.25

2.5.6 Carbohydrate determination

The percentage carbohydrate was determined by differential method

100 – (%Protein + % Moisture + % Ash + % Fat + % Fiber)

2.6 SENSORY EVALUATION

The method described by Iwe (2010) was employed. The analysis was carried out in the Food Laboratory facility of the Nutrition and Dietetics Department, Anambra State Polytechnic, Mgbkwu; consisting of a kitchen, store and a Test panel room.

The three samples of fermented mash, namely FFPM, FSBM and FCBM were assembled for preparation of three distinct pots of bitter leaf soup, which is the most popular application of such condiment. As is required even quantities of the three varieties were added to each pot of soup using common recipe and method of cooking. The three soup samples were maintained at warm conditions in similar thermo flasks prior to use.

Sensory evaluation was conducted using fourteen (14) member of panel consisting of seven (7) males and seven (7) females from the polytechnic community on the basis of their familiarity with bitter leaf soup. The three soup samples were coded A, B and C in order to conceal their identities. They were presented in a similar form to the fourteen (14) panel member who were required to rate them for appearance, color, taste, texture, flavor and general acceptability on a 9-point Hedonic scale where 1= dislikes extremely and 9= like extremely. Each panelist was

provided with warm potable water to rinse the mouth between sample testing. Adequate privacy was maintained and order of presentation varied to avoid bias judgment. The scores obtained were collated for further analysis.

2.7 STATISTICAL ANALYSIS

Means of triplicate results of proximate analysis were subjected to T-Test and difference between means evaluated at $p<0.05$ for two tailed test. Means of scores for sensory attributes were subjected to one way analysis of variance (ANOVA) and difference between means evaluated at $p<0.05$ using Turkey's Test.

3.0 RESULTS AND DISCUSSION

Table 1: Proximate values of fruited pumpkin seeds and fermented mash

Samples	Moisture	Ash	Crude fiber	Fat	Protein	Carbohydrate
FFPM	2.60 ± 0.01^{b}	5.90 ± 0.02^{b}	4.91 ± 0.01^{a}	7.20 ± 0.02^{a}	70.20 ± 0.02^{a}	9.19 ± 0.03^{b}
UFPS	6.11 ± 0.01^{a}	8.52 ± 0.02^{a}	3.63 ± 0.02^{b}	1.41 ± 0.01^{b}	60.15 ± 0.01^{b}	20.18 ± 0.02^{a}

Means within a column followed by different superscripts are significantly ($p<0.05$) different, FFPM= Fermented fluted pumpkin mash, UFPS= Unfermented fluted pumpkin seeds

Table 2: Proximate values of soybean seeds and fermented mash

Samples	Moisture	Ash	Crude fiber	Fat	Protein	Carbohydrate
FSBM	9.20 ± 0.10^{b}	0.88 ± 0.11^{b}	1.31 ± 0.01^{b}	18.87 ± 0.26^{a}	61.09 ± 0.07^{a}	8.65 ± 0.54^{b}
USBS	10.77 ± 0.09^{a}	3.16 ± 0.05^{a}	2.66 ± 0.04^{a}	15.20 ± 0.14^{b}	49.28 ± 0.14^{b}	18.93 ± 0.05^{a}

Means within a column followed by different superscripts are significantly ($p<0.05$) different, FSBM= Fermented soybean mash, USBS= Unfermented soybean seeds

Table 3: Proximate values of fermented soybean mash and fermented fluted pumpkin mash

Samples	Moisture	Ash	Crude fiber	Fat	Protein	Carbohydrate
FSBM	9.20 ± 0.10^{b}	0.88 ± 0.11^{b}	1.31 ± 0.01^{b}	18.87 ± 0.26^{a}	61.09 ± 0.07^{a}	8.65 ± 0.54^{b}

FFPM	2.60±0.01[b]	5.90±0.02[b]	4.91±0.01[a]	7.20±0.02[a]	70.20±0.02[a]	9.19±0.03[b]

Means within a column followed by different superscripts are significantly ($p<0.05$) different, FSBM= Fermented soybean mash, FFPM= Fermented fluted pumpkin mash

Table 4: Sensory scores of fermented castor bean, soybean and fluted pumpkin mashes

Samples	Color	Texture	Flavor	Taste	Gen. acceptability
FFPM	7.93±1.10[a]	8.10±0.94[a]	7.93±1.28[a]	7.71±1.38[a]	8.00±1.25[a]
FSBM	7.86±0.99[a]	8.14±0.74[a]	7.00±1.31[b]	7.43±1.35[a]	7.71±1.03[a]
FCBM	7.14±1.30[b]	6.79±1.52[b]	7.00±1.36[b]	7.36±1.23[a]	6.79±1.37[b]
LSD	0.39	0.46	0.53	-	0.84

Means within a column followed by different superscripts are significantly ($p<0.05$) different, FFPM= Fermented fluted pumpkin mash, FSBM= Fermented soybean mash, FCBM= Fermented castor oil mash

3.1 PROXIMATE VALUES

From Table 1 the moisture content of the unfermented fluted pumpkin seeds (UFPS) significantly ($p<0.05$) decreased from 6.11 to 2.60% in the fermented mash (FFPM). A similar result was obtained in Table 2, where the moisture content of unfermented soybean seeds (USBS) recorded significant ($p<0.05$) decrease from 10.77 to 9.20% in the fermented mash (FSBM). Unlike reported increase in moisture in fermented starchy substrates (Oslen, 1995; Irtwange and Achimba, 2009) arising liquefaction, saccharification and isomerization, a marginal decrease in moisture in protein rich substrates was reported by Ifediba et al. (2018) which was attributed to proteolysis by lactic acid bacteria. The significant drop in moisture in this case may be due to losses to sunrays and possible adsorption in the banana leaf wrapper.

Tables 1 and 2 also indicate significant ($p<0.05$) drop in ash from 8.52% in FFPS to 5.905 in FFPM, and from 3.16% in USBS to 0.88% in FSBM. The decrease contradicted the reported increase in ash in fermented garri by Irtwange and Achimba (2009) but in accord with the reported decrease in ash by Adebayo (2014) and Ifediba et al. (2018) for soaked lima beans and fermented African breadfruit-corn milk respectively. The significant decrease in the fermented mashes may be attributed to high mineral demand of the mixed culture typical of natural fermentation.

There was significant increase in crude fiber from 3.63% in UFPS to 4.91% in FFPM, as opposed to the significant ($p<0.05$) drop from 2.66% in USBS to 1.31% in FSBM. There has been conflicting reports on variations in crude fiber in fermented foods. Whereas decrease in fiber has been reported (Laurena et al., 1986; Emire and Buta, 2015; Ifediba et al., 2018), increase in fiber has been variously reported by Irtwnge and Achimba (2009) and Adebayo

(2014). Thus the trend remains uncertain, but may relate to nature of fiber, micro flora and fermenting conditions.

The fat content of UFPS significantly ($p<0.05$) increased from 1.41 to 7.20% in FFPM, which is similar to the significant increase from 15.20 in USBS to 18.87% in FSBM. Diverse trend in change of fat content during fermentation have been reported by several researchers. Ene-Obong and Obizoba (1996) observed an increase in fat content after 12h soaking of sorghum, while Emire and Buta (2015) reported an increase in crude fat content in Quality protein maize and soy blend for 24h and 48h using natural and controlled fermentation. On the contrary, Adebayo (2014) reported a decrease in crude fat in lima beans after 12h soaking, and Ifediba et al. (2018) recorded a marginal decrease in fermented African breadfruit-corn milk. However, the significant increase in fat in the fermented mashes in the present case may be attributed to lipase activities resulting in accelerated release of free fatty acids.

There was significant ($p<0.05$) increase in protein from 60.15% in UFPS to 70.20% in FFPM. There was similar increase in protein from 49.28% in USBS to 61.09% in FSBM. Protein increase in fermented products have been previously reported by researchers as in the fermentation of African oil beans (Njoku and Okemadu, 1989; Enujiugha, 2003), in fermented African breadfruit seeds (Onweluzo and Nnamuchi, 2009), in Quality protein maize and soy blends (Emire and Buta, 2015) and in fermented Africa breadfruit-corn milk (Ifediba et al., 2018). Obasi and Wogu (2008) however observed that fermentation process do not significantly change the total protein content and amino acid composition of substrate. The recorded increase may be due to proteolyses induced by enzymatic and biochemical actions of the fermenting culture. Egwim et al. (2013) reported a general increase in concentration of amino acids during the production of condiments (*dawadawa, ogiri, ugba*) as fermentation day increases, which was attributed to effect of protease enzyme which results in hydrolysis of protein molecules to smaller units such as amino acids.

There was significant ($p<0.05$) decrease in carbohydrate from 20.18% in UFPS to 9.19% in FFPM, and from 18.93% in USBS to 8.65% in FSBM. The reduction in carbohydrate may be due to enzymatic hydrolysis of starch during fermentation. Carmego et al. (1988) reported that the organic acids and amylase released by the microorganisms degrade starch granules, leading to carbohydrate decrease. Egwim et al. (2013) reported increase in reducing sugars up to day five of fermentation due to hydrolysis of carbohydrate in the presence of certain enzymes, such as amylases and galactases.

From Table 3 the FSBM was significantly ($P<0.05$) higher in moisture with a value of 9.20% compared to the 2.60% of FFPM. The lower moisture in FFPM may be due to the lower occurrence in the fluted pumpkin seeds compared to the soybean seeds. The extent of liquefaction of the carbohydrate fractions in the two seeds, in addition to nature of glycosides may also be a contributory factor. The lower moisture in FFPM entails better keeping quality.

The FFPM was significantly ($p<0.05$) higher in ash with a value of 5.90% compared to the 0.88% in FSBM. The much higher ash in FFPM may derive from the preponderance in the raw seeds compared to the soybean seeds. High ash deposit correlates high mineral spread in food materials (Olaoye et al., 2007), which may imply that the fluted pumpkin seed is richer in mineral than the soybean seed.

The 4.91% crude fiber in FFPM was significantly higher than the 1.13% in FSBM. This followed the level of crude fiber presence in the respective seeds. The higher fibrous nature of the pumpkin seeds in relation to the soybean seed justifies the higher value in the fermented mash.

The FSBM was significantly ($p<0.05$) higher in fat with a record value of 18.87% compared to the 7.20% in FFPM. The higher fat in FSBM is expected since the soybean seeds far exceeded the pumpkin seeds in vegetable fat reserve.

The 70.20% protein in FFPM was significantly ($p<0.05$) higher than the 61.09% in FSBM. Again this followed the trend in their respective seeds; given the commensurate increase in their fermented mash.

There was no significant ($p>0.05$) difference in the 8.65% carbohydrate in FSBM in relation to the 9.19% in FFPM. This reflects the relative values in the two seeds which proportionately decreased after fermentation.

3.2 SENSORY

The values in Table 4 show that the 7.93 color score for FFPM was marginally ($p>0.05$) higher than the 7.86 of the FSBM; which were significantly ($p<0.05$) higher than the 7.14 of FCBM. The brighter colors of fluted pumpkin and soybean seeds may be responsible for the superior color of their fermented mash, which impacted positively on the appearance of the soup.

The 8.14 texture score of FSBM was marginally ($p>0.05$) higher than the 8.10 of FFPM; which were significantly ($p<0.05$) higher than the 6.79 of FCBM. The difference may occur as a product of higher fat and less fiber in the condiments, resulting in better mouth feel, which bears great influence on texture of liquid and semi-liquid foods.

The 7.93 flavor score of FFPM was significantly higher than the 7.00 of FSBM and FCOM. The difference in flavor may be due to varietal spread of volatile compounds in fermenting mash. Volatile compounds have been shown to be mostly responsible for the aroma of several fermented foods (Zhao et al., 2010; Jeleen et al., 2013). Nwokelema and Ugwuanyi (2015)

reported that GC-MS of fermenting seeds revealed a mixture of several volatile aroma compounds, mostly methyl esters of various long chain fatty acids, which changed with time and starter organism. They added that qualitative and quantitative contribution of individual compounds may only be determined following flavor threshold analysis. This validates the dense fatty acid composition of fermented oil bean seeds as reviewed by Ogueke et al. (2010). Although fermented condiments are traditionally odoriferous, offensive rancid flavors may vary partly due to oxidative rancidity of the unsaturated fatty acids in oil seeds, and partly due to hydrolytic rancidity of their moist mashes by lipolytic enzymes from culture organisms. Baring recorded fatty acid profiling of the different seeds; the lower moisture in FFPM (Table 3) may have contributed to the better flavor, since hydrolytic rancidity will be less rapid.

There was no significant ($p>0.05$) difference in the 7.71, 7.43 and 7.36 taste scores for FFPM, FSBM and FCOM respectively. The high protein content of the three seeds may be responsible for the marginal difference in the taste of their fermented mashes. Obi (2003) posited that most condiments used as flavoring agent contain vegetable proteins which are usually rich in glutamine and asparagines, and these can be either enzymatically or chemically hydrolyzed to glutamic acid and aspartic acid by microorganisms. Other products of the hydrolysis are alanine, arginine and proline. This is evident in Ogueke et al. (2010) who reviewed a versed range of amino acids in fermented oil bean seeds, which may positively impact on flavor development. The general acceptability (8.00) of FFPM was marginally ($p>0.05$) higher than the 7.71 of FSBM, and both were significantly ($p<0.05$) higher than the 6.79 of FCOM. The general acceptability scores as obtained drew from the cumulative effect of the other attributes considered.

CONCLUSION

In view of the findings, there are prospects that fermented condiment for preparation of certain local delicacies can be derived from cheaper and underutilized oil seeds that are substantially rich in vegetable proteins. Process optimization is however required to arrive at products with improved nutritional and sensory qualities. Also, there is need to do a comprehensive flavor profiling to bridge the knowledge gap in the flavor components of African fermented seasonings.

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