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Research Article

Evaluation of Proximate Composition and Sensory Characteristics of *Agidi* Enriched with Legumes Soybeans (G*lycine max*), Groundnut (A*rachis hypogaea*) and Bambara nuts (V*igna subterranean*)

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Abstract

Agidi is a gel-like traditional fermented starch pudding produced from maize (*Zea mays*) flour. This research work aimed at evaluating the proximate composition and sensory evaluation of *Agidi* enriched with varying percentage addition of legumes such as soybeans, groundnut and bambara nut at a ratio of 70:30 and coded Sample B (70% maize 30% soybeans), Sample C (70% maize 30% groundnut) Sample D (70% maize 30% bambara nut) respectively and was compared to the control Sample A (100% maize). The product was analysed for protein, fat, moisture, Ash and fibre and carbohydrate determined by simple difference method. The result of the proximate composition showed that for crude protein content, Sample C had the highest value (13.95±0.06) while Sample A (8.93±0.9) had the least. Fat content showed that Sample C had the highest value (4.66±0.43) while Sample A (3.49±0.07) had the least value. Crude fiber showed that Sample D had the highest value (2.14±0.08) while Sample B (0.69±0.03) had the least value. Ash content showed that Sample B had the highest value (2.26±0.06) while Sample A (1.03±0.09) had the least value. The moisture content result showed that Sample C (87.2%) had the highest value while Sample B (83.19%) had the least value. Carbohydrates content was highest in Sample A (84.16± 0.45) and least in Sample C (78.24 ± 0.23). The Sample B (411.79 kcal) had the highest energy value while Sample D (402.67) had the least value. The results of the sensory evaluation showed that the control, Sample A had the highest value in all sensory attributes evaluated namely: colour (8.3), texture (8.2), flavour (7.65), taste (8.1) and overall acceptability (8.3) and was significantly different (p≤0.05) from all the other

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samples except in Taste where there was no significant difference ($p \leq 0.05$) between the control, Sample A and the other samples. The use of enriched agidi could be used in alleviating the scourge of protein energy malnutrition especially in third world countries.

Keywords: *Agidi*, enriched, Protein energy malnutrition

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Introduction

Agidi is a gel-like traditional fermented starch pudding produced from maize (*Zea mays)* flour although millet and sorghum are now being used in its production. When maize is used a cream to glassy white product is obtained whereas a light brown colour is obtained for sorghum and grey to greenish colour for millet (Otunola *et al.*,2007). It is a popular food product in Nigeria and some west African countries and known as "Eko" among the Yorubas, "Akasan" in Benin, "Komu" in Hausa, "Ekwa" in Nupe and "Agidi" in Igbo (Osungbaro, 2009). It is very popular and greatly accepted along with the ease of consumption with local condiments like soup, stew, bean cake (Akara), moi-moi as light meal especially amongst post-operative patient, children and weaning infants makes it very popular (Onyeka and Dibia, 2002). *Agidi* has the economic potential above a closely relate maize product *pap*, a popular food utilized especially as a complimentary food, since it can be eaten alone as whole meal or as solid or semi-solid both by adult and children alike and it is not restricted as infant weaning food nor as breakfast cereal (Ogiehor, *et al*., 2005). It can be eaten warm hence must be prepared fresh each time, spice and seasoning may be added to improve taste and for the rich ones, minced meat may be added. (Akinrele, 2014).

However, *Agidi* produced from fermented maize flour is inherently deficient in nutrients like lysine and moreover significant amount of it nutrient are lost as a result of leaching due to the processing techniques used in tradition production (Adeyemi and Beckly, 1986). Such deficiencies can result in protein energy malnutrition particularly among young children and infants who are fed with the product as weaning food especially in communities where consumption of *agidi* is a staple (Adeyemi *et al.*, 1987) observed that during infancy and early childhood (birth to 2 years), adequate amount of appropriate nutrition has paramount importance for full development of children's human potential. This period is also regarded as "critical window" for child's health, growth, and development. It is also peak period for faltering in child's growth, micronutrient deficiencies, and emergence of common childhood ailments such as stunting growth (World Bank, 2005). During these formative years, poor nutrition has immediate consequences of increased morbidity and mortality and delayed development of the brain and other nervous systems (Krebs *et al*., 2011). Legumes

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occupy an important place in human nutrition especially in the dietary pattern of low-income groups of people in developing countries. Along with macronutrients, leguminous seeds also contain appreciable amounts of some vitamins and minerals, dietary fiber, good sources of slow release carbohydrates and are rich in protein. It is critical that infants eat high quality and easily digestible proteins which can be provided by animal foods or by properly mixing cereals with legumes such as soybeans, Bambara nuts and ground nuts (Tharanathan *et al*., 2003). A study conducted by Addisalem *et al*. (2015) in southern Ethiopia, found that the protein concentration of a pulse-supplemented maize *(Zea mays)* and kocho *(Enset ventricosum)* complementary food improved by 60% compared with the traditional maize and *kocho*. The overall aim of this study was to evaluate the proximate composition and sensory characteristics of *agidi* enriched with legumes (soybeans, groundnut and bambara nuts)

Materials and methods

The maize *(Zea mays*), soya beans (G*lycine max*), ground nut (A*rachis hypogaea*) and Bambara nut (V*igna subterranean*) used for the study were obtained from the Muda Lawal modern market Bauchi state, Nigeria.

Preparation of fermented maize slurry

The maize flour was prepared by the wet milling process with slight modification (Nkama *et al*., 2000). The maize grains were cleaned and sorted to remove stone, dirt and other extraneous materials. The cleaned seeds were steeped in water (1:10) for 8 hours at room temperature after which the water was drained off and the grains was rinsed with cleaned water and wet-milled with an attrition mill. The milled paste was then sieved using a clean muslin cloth in excess water and over tail was discarded. The slurry obtained was left to sediment. It was decanted and fine slurry obtained (Figure 1).

Preparation of soy beans slurry

The soy slurry was prepared according to the method reported (Amadou *et al*., 2009. The soy beans were sorted and cleaned to remove, stone, dirt, shaft and other foreign bodies that may affect the quality of the final product, the cleaned seeds were steeped few hours at room temperature, after which the beans were drained and cleaned and thereafter were milled in commercial milling machine, the milled soy beans were sieved using a clean muslin cloth. The soy beans slurry was use later (Iwe, 2003).

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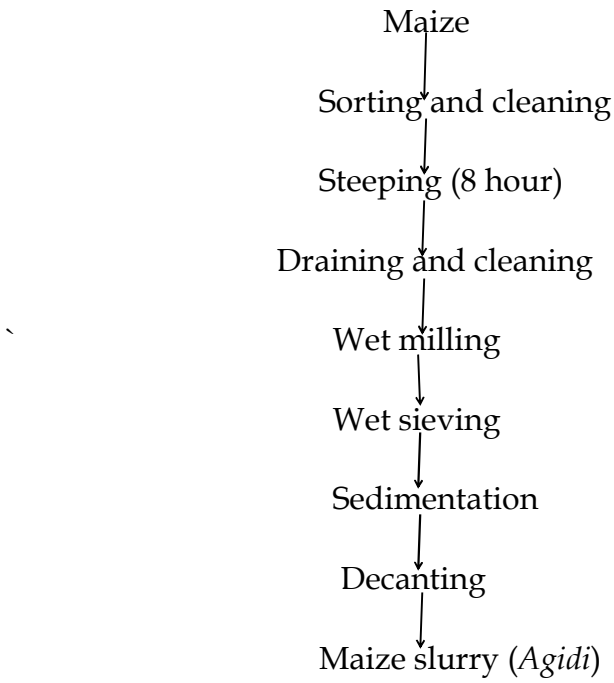

Figure 1: Flow chart for the production of *Agidi*

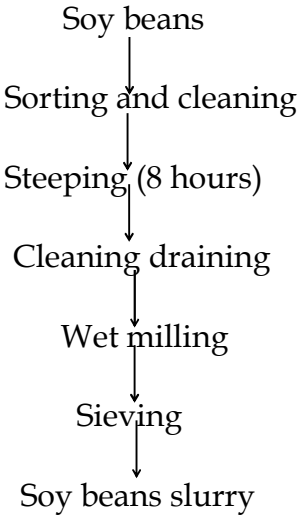

Figure 2: flow chart for the production of soy slurry.
(Source: Amadou *et al*., 2009).

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Preparation of groundnut slurry

The groundnut slurry was prepared by sorting and cleaning to remove stones, dirts and other extraneous materials. The nuts were then roasted under low temperature and then dehulled. It was thereafter wet milled using an attrition mill. The milled groundnut slurry was sieved using a clean muslin cloth and kept for later use (Figure 3).

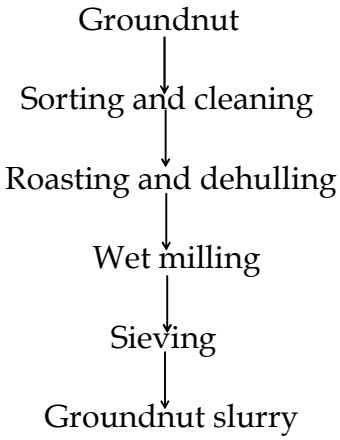

Figure 3. Flowchart of the production groundnut slurry

Preparation of bambara nut slurry

The bambara nut slurry was prepared by firstly removing the outer shell covering the seed, it was sorted and cleaned properly. The bambara nut was soaked for 8 hours to equilibrate the seed and it was then wet milled using an attrition miller and then sieved using a clean muslin cloth (Figure 4)

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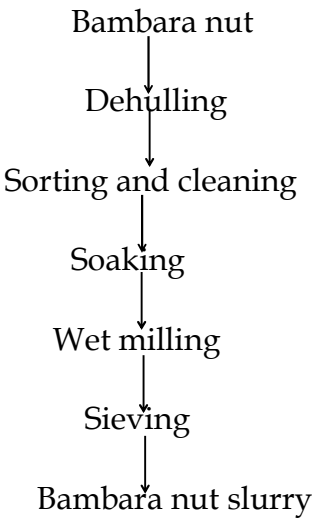

Figure 4. Flow chart of the production of bambara nut slurry

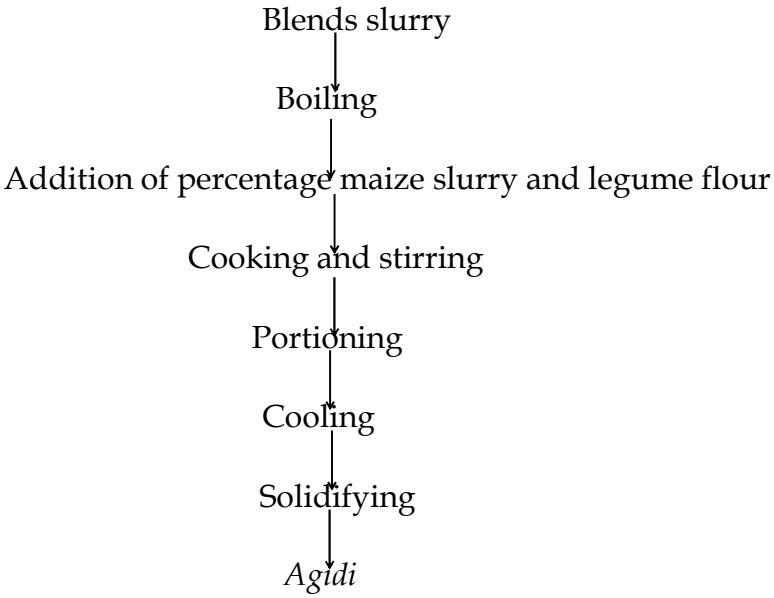

Figure 5. Flowchart for production of enriched *Agidi* with legumes
Source: Ukegbu *et al.* (2015)

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Preparation of *agidi*

The *agidi* was prepared adopting the method described by Ukegbu *et al*. (2015) with slight modifications. About 275g of maize starch and legumes were each mixed with 900 ml of water in a pot and put on the fire. It was continuously stirred as it boiled to avoid lumps. 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 moulds and partially covered to cool and set into a firm gel known as *agidi* (Figure 5).

Blend formulation

Four different blends were formulated based on *Agidi* enriched with varying percentage addition of different legume like soybeans, groundnut and bambara nut and coded Sample A (100% maize) as the control; Sample B (70% maize 30% soybeans), Sample C (70% maize 30% groundnut) Sample D (70% maize 30% bambara nut) respectively (Akpapunam *et al*., 1997).

Proximate composition

Proximate composition was carried out on the bread products moisture, ash, protein, fat and fiber determination was determined according to AOAC (2006) standard. While carbohydrate content was determined by the sample difference of AOAC (2000).

Sensory evaluation

The sample was subjected to sensory evaluation using 9- point Hedonic scale as described by Iwe (2013). The evaluation panels were semi-trained panelist. The sample was evaluated for colour, texture, flavour, taste and overall acceptability. The significant difference between the mean and standard deviation was analysed using microsoft Excel starter (version 10).

Results and Discussion

Table 1 showed the result of the chemical composition of Agidi enriched legumes. that the crude protein content of the enriched "agidi" ranged from 8.93g to 13.95g, with Sample C having the highest value (13.95±0.06) while sample A (8.93±0.9) had the least. This is consistence with reports of Ikya *et al*. (2013) who observed that the content of protein, fat, fibre and ash increased with addition of the legumes flour but conversely, the carbohydrate content decreased considerably. This is a reflection of the superior nutritional properties of soybean flour over ground nut, bambara nut flour and maize flour respectively and is demonstrated in their mutual supplementation effect.

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The crude fat ranged between 3.49g to 4.66g and showed that sample D (4.66±0.43) had the highest value whereas sample A (3.49±0.07) had the least value. The crude fiber value ranged from 0.69g to 2.14g. Sample D (2.14g) had the highest value and sample B (0.69g) had the least value. The ash content ranged from 1.03g to 2.26g. Sample B had the highest mean score of 2.26±0.06 while sample A bad the least of 1.03±0.09. Also the moisture content ranged from 83.19% to 87.2%. The moisture content of the blends was highest in sample C (87.2%) and least in sample A (83.19%). The value for carbohydrates ranged between 78.24g to 84.16g. Sample A had the highest value (84.16g) while sample C had the least value. The result for energy varied from 402 Kcal to 411.79 Kcal. The highest energy value of the blends is seen in sample B (411.79 kcal) while the least value is seen in sample D (402.67). It's imperative to note that the protein values compared favourably with the high caloric value of the blends. It is an indication that agidi produced from the blends would be a good source of energy and a solution to protein energy malnutrition in most third world countries.

Table 1 Proximate composition of "Agidi" enriched with soybeans, groundnut, and bambara nut (wet basis) g/100g.

Parameters	A	B	C	D
Crude protein	$8.93^{b} \pm 0.9$	$11.34^{a} \pm 0.1$	$13.95^{a} \pm 0.06$	$9.29^{b} \pm 0.29$
Crude fat	$3.49^{a} \pm 0.07$	$3.87^{a} \pm 008$	$4.66^{a} \pm 0.43$	$3.59^{a} \pm 0.07$
Crude fibre	$1.64^{b} \pm 0.09$	$0.69^{c} \pm 0.03$	$1.36^{b} \pm 0.04$	$2.14^{a} \pm 0.08$
Ash content	$1.03^{b} \pm 0.09$	$2.26^{a} \pm 0.06$	$1.69^{b} \pm 0.07$	$1.51^{b} \pm 0.02$
Moisture content(%)	$85.08^{a} \pm 0.03$	$83.19^{a} \pm 0.18$	$87.2^{a} \pm 0.3$	$84.72^{a} \pm 0.31$
carbohydrate	$84.16^{a} \pm 0.45$	$82.9^{a} \pm 0.16$	$78.24^{b} \pm 0.23$	$83.3^{a} \pm 0.13$
Energy value (k cal)	403.77	411.79	410.70	402.67

KEY: Values are mean ± standard deviation of duplicate determined. Values with same superscript are not significantly different at p (<0.05)
A = 100% maize
B = 70% maize 30% groundnut
C = 70% maize 30% soybeans
D = 70% maize 30% bambara nut

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Table 2 shows the result of sensory evaluation of enriched *agidi* produced from soybeans, groundnut and bambara nut. The value for colour ranged from 7.3 to 8.3. There was however a significant difference in terms of colour between sample A and the other samples at p≤0.05. this could be attributed to consumer preference and the slight coloration of the other flours. The result for texture ranged from 6.9 to 8.2. There was however a significant difference in terms of texture between sample A and the other samples at p≤0.05. The result of flavour ranged from 7.1 to 7.65. There was however a significant difference in terms of flavour between sample A and the other samples at p≤0.05. Ampofo (2009) however had a contrary observation where there were no statistical differences in flavour in his research on agidi with percentage addition of soy flour supplementation. He observed that Panel members did not detect any beany flavour in the products, which probably was an indication that the processing of the soybean seeds was able to remove the typical beany flavours associated with soy products. The result of taste ranged from 7.25 to 8.1. There was however no significant difference in terms of taste between sample A and the other samples at p≤0.05. This important as taste is a key factor in consumer acceptance of a product. More so, these products are nutrient dense food that can serve a means of alleviation malnutrition problems in most third world countries. While overall acceptability values ranged from 7.15 to 8.3. There was however a significant difference in terms of general acceptability between sample A and the other samples at p≤0.05.

Table 2 Sensory evaluation of *agidi* enriched with soybeans, groundnut, and bambara nut.

Parameters	A	B	C	D
Colour	8.3 ± 0.9^a	7.5 ± 0.80^b	7.45 ± 1.12^b	7.3 ± 0.78^b
Texture	8.2 ± 0.81^a	7.5 ± 0.67^b	7.45 ± 1.20^b	6.9 ± 1.7^b
Flavor	7.65 ± 1.35^a	7.1 ± 0.94^b	7.3 ± 1.31^b	7.25 ± 1.04^b
Taste	8.1 ± 0.99^a	7.7 ± 0.78^a	7.25 ± 0.89^a	7.5 ± 0.97^a
Overall acceptability	8.3 ± 0.71^a	7.35 ± 1.06^b	7.45 ± 0.92^b	7.15 ± 0.79^b

Key: Values are mean ± standard deviation of duplicate determined. Values with same superscript are not significantly different at p (<0.05)
A = 100% maize, B = 70% maize 30% groundnut, C = 70% maize 30% soybeans
D= 70% maize 30% bambara nut.

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Conclusion

The enrichment of agidi with soy, groundnut and Bambara nut flour respectively was found to significantly improve the nutrient composition of the food. Most importantly, the high caloric value and protein content of the blends are an indication that enriched agidi could be used in alleviating the scourge of protein energy malnutrition especially in third world countries. Furthermore, enrichment with these legumes were comparatively acceptable in terms of the sensory parameters assessed with respect to the control.

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