*Full Length Research Paper*

# Physico-chemical and sensory properties of "Agidi" from pearl-millet (*Pennisetum glaucum)* and bambara groundnut *(Vigna subterranean*) flour blends

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**Agidi was produced from different formulations of pearl millet ogi and Bambara groundnut flours. Six agidi products were produced at the laboratory scale with one as the control. The recipe formulations for the products were 100:0, 95:5, 90:10, 85:15, 80:20 and 75:25 pearl millet to bambara groundnut flours, respectively. The six formulated products were subjected to proximate, physico chemical and sensory analysis. The results showed that the protein contents increased with increased addition of bambara groundnut flour. The protein contents ranged from 2.44 to 7.0% on dry weight basis. The fat contents ranged from 1.25 to 3.1%. Carbohydrate content ranged from 71.2 to 77.7%. The physico-chemical parameters also varied. The pH ranged from 4.13 to 4.40 while titratable acidity ranged from 0.02 to 0.03. The bulk density increased from 0.32 to 0.44 g/ml as the proportion of bambara flour increased. The sensory panelists rated the products highly for all the parameters investigated. Product B with the proportion of 90:5 pearl millet to bambara flour was most acceptable to the panelists. It is concluded that an acceptable agidi can be produced from pearl millet and bambara groundnut at 5% substitution level.**

**Key words:** Bambara groundnut, pearl millet, "agidi", bulk density.

## INTRODUCTION

Pearl millet (*Pennisetum glaucum*) is the sixth most important drought tolerant crops of the tropical and sub-tropical regions of the world. It grows in harsh environ-ment where other crops do not grow well (Abdullahi et al., 1998). According to FAOSTAT (2005) the global millet production in 2004 was about 28 million tons. Pearl millet is annually grown on more than 29 million hectares in the semi-arid tropical regions of Asia, Africa and Latin America. India is the largest producer of this crop, both in terms of area (9.1 million hectares) and production (7.3 million tons), with an average productivity of 780 kg ha$^{-1}$ during the last five years. Nigeria produces about 6.7 million tons on a total of 5.8 million hectares (USDA, 2005). One of the commonest products of millet in

Nigeria is "Ogi", which is a white starchy mash, traditionally obtained by soaking and wet extraction of millet. "Ogi" or "akamu", a fermented cereal based porridge is a popular food in Nigeria, Ghana, Mali and Niger (Nkama et al., 2000). It may be mixed with boiling water to form a thin gruel called "Akamu" or "ogi porridge". "Akamu" is consumed mostly as weaning food, as meal for sick and old, and sometimes as breakfast cereal (Akingbala et al., 1981a), in which case it is eaten with other more solid food such as "Akara" (bean cake). "Ogi" may also be cooked to ogi paste, a stiff gel called "Agidi" (Akingbala et al., 1981b; Umoh and Fields, 1981). This can be eaten alone or with vegetable soup or stew. It can also be eaten with "moi-moi" or "akara".

Agidi has added advantages over "Akamu" in that it can be eaten alone, as solid or semi-solid, it is consumed both by adults and by children alike and it is not restricted as infant weaning food nor as breakfast cereal. It can be

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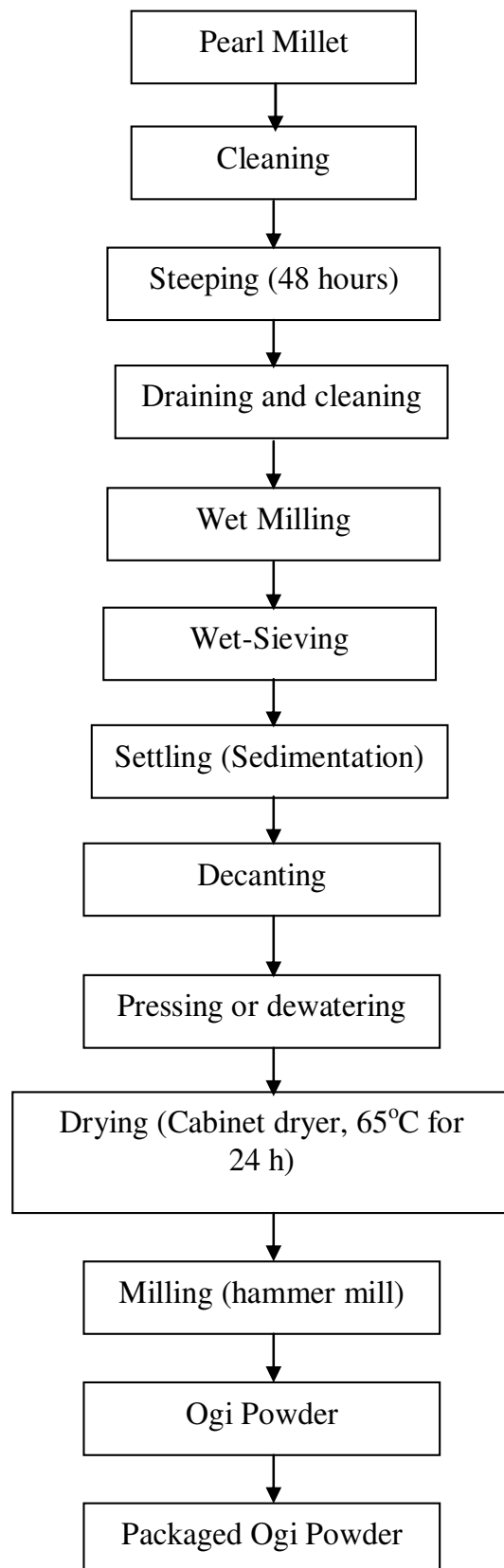*Corresponding author. E-mail: esabbo@yahoo.com.

eaten cold, thus, it could be prepared long before use, unlike "akamu" that must be eaten warm and hence must be prepared fresh each time (Ogiehor et al., 2005). Spices and seasonings may be added to improve taste, and for the rich ones, minced meat may be added (Akinrele, 1970). Considering the important role of millet in the diets of Nigerian, improving its protein quality becomes necessary. Thus, fortification with other cheap but protein rich vegetables will be beneficial to the poor and rural populace. Legumes readily serve as these sources. They are essentially economical sources of protein, minerals and B-vitamins (Akpapunam and Banigo, 1981). Phyiscal, chemical, rheological and sensory properties of "Akamu" from different pearl millet cultivars have been studied by Nkama et al. (2000). However, there is no reported literature data on the physico-chemical and sensory properties of "Agidi" fortified with bambara groundnut. The objective of this study was to determine the acceptability of pearl millet – bambara groundnut agidi and to evaluate the effect of fortification on the physico-chemical properties of the developed products.

## MATERIALS AND METHODS

### Samples collection

Pearl millet grains (*P. glaucum*) and Bambara ground nut seeds (*Vigna subterranean)* (harvested in 2009 season) used for this study was obtained from a commercial store in Kaduna Central Market, Kaduna. All chemical reagents used were of analytical grade, and obtained from the Department of Food Technology, Kaduna Polytechnic, Kaduna. The data generated from chemical analysis and sensory evaluation were analyzed using analysis of variance (ANOVA).

### Preparation of raw materials

Pearl millet ogi was prepared following the method of Nkama et al., (2000). Pearl millet grains were cleaned to remove stones, dirts, shafts and other foreign bodies that may affect the quality of the final product. The cleaned seeds were steeped for 48 h at room temperature, after which the grains were drained. The fermented grains were rinsed with clean water and wet-milled in commercial attrition milling machine. The milled grain was sieved using a clean muslin cloth and over tail was discarded. The sieved through was allowed to sediment during which fermentation set in (Nkama et al., 2000). It was decanted and a fine slurry obtained (wet ogi slurry). The slurry was pressed manually in a muslin cloth to remove the water. It was then dried in a cabinet dryer at 65°C for 24 h. The dried product was milled with a laboratory hammer mill (Cristy-Hunt, England) into fine powder. The powder was packaged in an airtight polythene pack, until required for use. The flow chart for the preparation is shown in Figure 1.

The bambara groundnut flour was prepared using the method of Ayinde and Olusegun (2003) as shown in Figure 2. Bambara groundnut peas were cleaned and sorted to remove foreign materials. The cleaned peas were blanched for 30 min using hot water. The blanched peas were dehulled manually by rubbing between palms. The dehulled peas were washed and dried in a
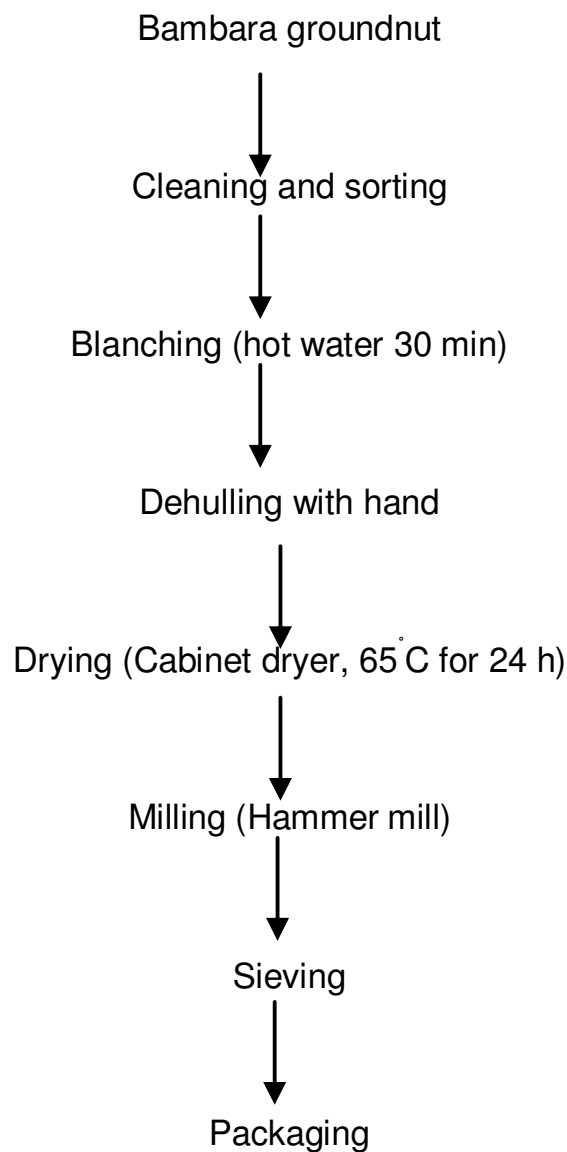


**Figure 1.** Flow chart for the production of Ogi powder.

Bambara groundnut

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Cleaning and sorting

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Blanching (hot water 30 min)

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Dehulling with hand

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Drying (Cabinet dryer, 65°C for 24 h)

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Milling (Hammer mill)

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Sieving

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Packaging

**Figure 2.** Flow chart for the production of bambara groundnut flour blends.

cabinet dryer at 65°C for 24 h. The peas were then milled with a laboratory hammer mill into fine powder.

**Preparation of Agidi from pearl millet ogi flour and bambara groundnut flour blends**

Six formulations designated composites, A, B, C, D, E. and F were prepared by mixing various proportions of flour recipes. Sample A is the control with 100% millet ogi flour, B is 95% ogi flour and 5% Bambara, C is 90% ogi flour and 10% Bambara, D is 85% ogi flour and 15% bambara, E is 80% ogi flour and 20% bambara flour on dry weight basis. The blends were mixed and reconstituted separately in water. The reconstituted blends were cooked in 500 ml of water with continuous stirring until a stiff gel is obtained. The

gel is packed into polyethylene bag and allowed to cool and set. The production flow chart is shown in Figure 3.

**Analytical determinations**

The hot air oven method, AOAC, (2000) was used for moisture determination. The samples were dried in a hot air oven (Gallenkamp BS, 250, England) at 130°C for 1 h to constant weights. Crude protein, fat, fibre, Ash and carbohydrate contents were determined by AOAC (2000) method. The pH was measured with a Pye Unicam pH meter (model 290 MK2, England) standardized with water (pH 7.0). The AOAC (2000) method was used for the determination of total titratable acidity. Viscosity of the products was measured by the modified method of Mosha and
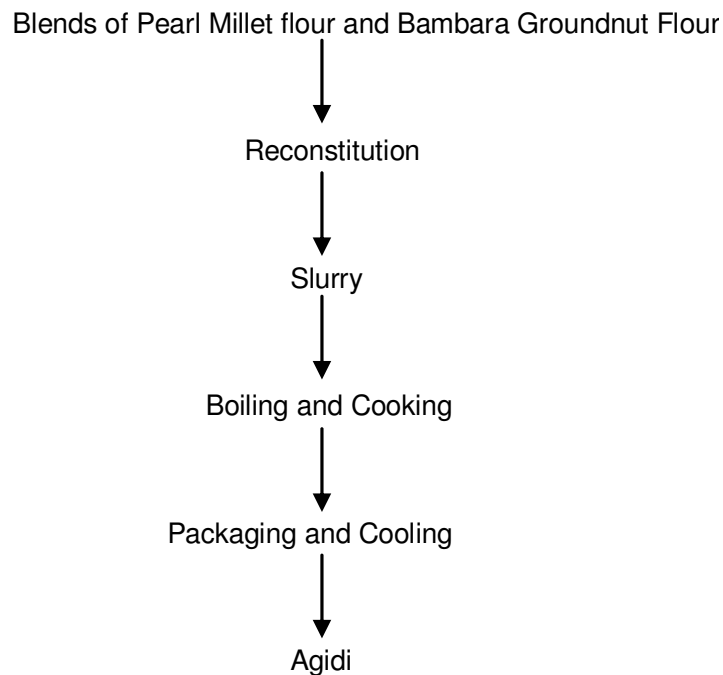
Blends of Pearl Millet flour and Bambara Groundnut Flour

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Reconstitution

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Slurry

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Boiling and Cooking

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Packaging and Cooling

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Agidi

**Figure 3.** Flow chart for the production of enriched Agidi.

**Table 1.** Proximate composition of formulated Agidi.

| Parameters on % Dry wt basis | Samples | | | | | |
|---|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** | **F** |
| Moisture | $12.5^b$ | $12.8^a$ | $12.6^b$ | $12.1^c$ | $12.0^c$ | $12.9^c$ |
| Ash | $0.21^c$ | $0.21^c$ | $0.41^a$ | $0.23^c$ | $0.42^a$ | $0.34^b$ |
| Lipid | $1.25^f$ | $1.50^e$ | $1.90^d$ | $2.20^c$ | $2.50^b$ | $3.10^a$ |
| Crude fibre | $2.90^{be}$ | $4.10^b$ | $4.40^c$ | $3.80^c$ | $3.80^c$ | $3.40^d$ |
| Crude Protein | $2.44^e$ | $3.25^d$ | $4.50^c$ | $5.30^b$ | $5.60^a$ | $7.0^a$ |
| Carbohydrate | $77.70^a$ | $75.14^b$ | $72.19^c$ | $73.37^d$ | $72.68^d$ | $71.16^e$ |

Values are means of triplicate determinations.  Means in the row with different superscripts are significantly (P < 0.05) different. A = 100% millet Agidi. B = 95:05 pearl millet and bambara groundnut blend. C = 90:10 pearl millet and bambara ground nut blend. D = 85:15 pearl millet and bambara groundnut blend. E = 80:20 pearl millet and bambara groundnut blend. F = 75:25 pearl millet and bambara groundnut blend.

Svanberg (1983). A thin gruel was prepared by heating each sample of the flour (10% w/v) in water to a cooking temperature of 83°C within 6 min with constant stirring. It was then transferred to water bath at 40°C and the viscosity was measured using Brookfield viscometer (model LV8, U.K. Ltd). Bulk densities were determined by the method of Okaka and Potter, (1979). Twenty grams of each of the samples were weighed into 100 cm³ graduated cylinders and tapped ten times against the palm of hand. The volume of powder after tapping was recorded and the bulk density expressed as g/cm³. Coded samples of Agidi were served at room temperature to fifteen untrained taste panelists, consisting of both students and staff of Food Technology Department, Kaduna Polytechnic, Kaduna.  A descriptive 7-poing hedonic rating scale was used to score the samples for taste, colour, texture, firmness, flavour and overall acceptability with 7 as like extremely and 1 as dislike extremely. Mean scores were analysed statistically using analysis of variance and least significant difference test (Ihekoronye and Ngoddy, 1985).

## RESULT AND DISCUSSION

The results of proximate composition of formulated agidi and the control are shown in Table 1. The result shows that moisture, ash lipid, crude fibre, protein and carbohydrate varied. The lipid content increased as the percentage of bambara groundnut increased. The protein content also increased significantly (p < 0.05) with

**Table 2.** Physico chemical properties of Agidi.

| Parameters on % Dry wet basis | Samples | | | | | |
|---|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **E** | **F** |
| pH | 4.13[d] | 4.16[c] | 3.36[a] | 4.29[b] | 4.40[a] | 4.37[b] |
| Titratable acidity | 0.03[a] | 0.03[a] | 0.02[a] | 0.02[a] | 0.02[a] | 0.02[a] |
| Bulk density (g/ml) | 0.44[a] | 0.42[b] | 0.40[c] | 0.38[c] | 0.35[d] | 0.32[e] |
| Viscosity (cp) | 84.55[a] | 84.56[a] | 84.56[a] | 84.57[a] | 84.57[a] | 84.57[a] |

**Table 3.** Sensory parameters of Agidi sample.

| Sample | Taste | Colour | Texture | Firmness | Flavour | Overall acceptability |
|---|---|---|---|---|---|---|
| A | 5.9[a] | 4.0[a] | 5.2[b] | 5.1[a] | 5.4[a] | 5.9[a] |
| B | 5.7[b] | 5.1[a] | 5.3[a] | 5.3[a] | 4.6[a] | 5.8[a] |
| C | 5.7[a] | 4.9[a] | 4.7[b] | 4.7[a] | 5.1[a] | 5.3[a] |
| D | 4.6[b] | 5.3[a] | 5.2[b] | 4.3[a] | 4.4[b] | 4.2[c] |
| E | 2.9[c] | 5.4[a] | 3.4[a] | 2.7[b] | 3.0[c] | 3.0[c] |
| F | 2.4[c] | 4.8[a] | 2.8[c] | 2.7[b] | 2.9[c] | 2.6[c] |

Means followed by the same superscripts on vertical column are not significantly ($P < 0.05$) different. A = 100% millet flour (100:0). B = 95% millet flour (95:05). C = 90% millet flour (90:10). D = 85% millet flour (85:15). E = 80% millet flour (80:20). F = 75% millet flour (75:25).

increasing addition of bambara groundnut. The fat or lipid content ranged from 1.25 to 3.1%, while protein content ranged from 2.44 to 7.0%. The increase in fat and protein contents with increasing addition of bambara groundnut was due to high levels of fat and protein in bambara flour. The increase in fat and protein was also observed by Ayinde and Olusegun, (2003). The variation of ash and crude fibre was also observed by Ayinde and Olusegun (2003). Minka and Buretean (2000) also observed similar changes in proximate composition. Table 2 shows the physico-chemical properties of agidi. The pH varied from 4.13 to 4.37. Total titratable acidity varied from 0.02 to 0.03. The total titratable acidity (TTA) did not vary significantly ($p < 0.05$). Bulk densities varied from 0.32 to 0.44 g/ml. The bulk density decreased as the percentage addition of bambara groundnut flour increased. The reduction in bulk densities has nutritional implication as more can be eaten resulting in high energy and nutrient densities. This reduction is consistent with the report of Nnam (2000). The decrease in bulk density will help in reduction of transportation and packaging cost.

The viscosity of the gruel prepared from the various proportions of the blend did not vary significantly ($p < 0.05$). Table 2 shows that the viscosities ranged from 84.55 to 84.57. The viscosities obtained from the experimental data allowed for uniform and palatable consistency. Most people prefer thin gruels with low viscosities. This will result in higher intake of the gruel and consequently higher energy intake. Table 3 shows

the result of sensory evaluation. The mean scores for colour ranged from 4.0 to 5.4. The result showed that there was no significant difference ($p < 0.05$) in colour. Table 3 also shows that the mean scores for taste ranged from 2.4 to 5.9, texture 2.8 to 5.3, firmness 2.7 to 5.3, flavor 2.9 to 5.4 and overall acceptability 2.6 to 5.9. These indicate that there were significant differences observed for taste, texture, firmness, flavour and overall acceptability. The addition of bambara groundnut has not contributed negatively to the acceptability of the product. Sample B (95% millet flour, and 5% bambara flour) was rated high and close to control (sample A, 100 millet flour) in all the parameters investigated (as shown in Table 3). It then means that an acceptable "agidi" can be produced from millet ogi or millet flour with the addition of 5% bambara flour. The addition of bambara groundnut will improve the protein quality and enhance the taste of the product.

## Conclusion

Millet grains are nutritionally better than other grains like maize in terms of protein content. Bambara groundnut is a legume that contains high level of protein, but yet under-utilized. The combination of pearl millet and bambara groundnut in the production of agidi resulted in product of high nutritional status with an enhanced flavour. From the study one can conclude that fortification

of pearl millet flour with bambara groundnut in the processing of agidi at the substitution level of 95:05 was acceptable to the consumers.

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