

*Full Length Research Paper*

# **Chemical composition, functional and organoleptic properties of complementary foods formulated from millet, soybean and African locust bean fruit pulp flour blends**

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This study was aimed at producing and evaluating the quality of complementary foods from millet, soybean and African locust bean fruit pulp. The millet, soybean and African locust bean fruits were obtained locally in Kaduna, Nigeria. These materials were separately cleaned, dried, milled and sieved into flours. The flours were mixed as follows: Sample A (60% millet, 10% soybean, 30% African locust bean fruit pulp), sample B (60% millet, 20% soybean, 20% African locust bean fruit pulp), Sample C (50% millet, 40% soybean, 10% African locust bean fruit pulp), sample D (50% millet, 30% soybean, 20% African locust bean fruit pulp), sample E (50% millet, 20% soybean, 30% African locust bean fruit pulp). The chemical composition, functional properties and sensory attributes were determined using standard methods. The moisture content of the food samples varied from 7.5 to 11%, protein ranged from 28.9 to 37.0%, fat from 3.1 to 5.1%, Ash ranged from 1.4 to 2.51%, crude fibre ranged from 2.0 to 3.2%, carbohydrate varied ranged from 47.0 to 52.1%. The energy values ranged from 351 to 381.9 kcal/g and appreciable amount of minerals were recorded. Calcium ranged from 128.0 to 165.0 mg/100 g, iron ranged from 3.2 to 5.8 mg/100 g and zinc ranged from 2.6 to 3.2 mg/100 g. The results of functional properties showed that bulk density ranged from 0.61 to 0.66 g/ml, water absorption capacity ranged from 1.89 to 2.31 g/g, swelling capacity ranged from 0.67 to 2.45% and least gelation ranged from 9.00 to 11.62%. Sensory evaluation indicated that the samples were highly rated ( $P < 0.05$ ) for all the parameters investigated. Sample E (50% millet, 20% soybean and 30% African locust bean pulp flour) was most acceptable to the panelists and should be encouraged in weaning food preparation.

**Key words:** African locust bean fruit pulp, complementary foods, functional properties, chemical composition.

## **INTRODUCTION**

Protein-energy malnutrition among children is the major health challenges in developing countries, particularly Nigeria (FAO, 2001; Ijarotimi and Keshinro 2012). Malnutrition during early life leads to permanent stunting in growth (Nzeagwu and Nwaejike, 2008) and there may

also be irreversible sequence from micronutrient deficiencies that affect brain development and other functional outcomes (Martorell et al., 1995). This nutrition problem is associated with inappropriate complementary feeding practices, low nutritional quality of traditional

complementary foods and high cost of quality protein based commercial complementary foods (Nemer et al., 2001; Muller et al., 2003; Black et al., 2003; FAO, 2004, Alozie et al., 2009; Eka et al., 2010). The tragic consequences of malnutrition include death, disability, stunting, mental and physical growth and as a result, retarded national socio-economic development (Ijarotimi and Keshinro, 2012). It is evidence that high prevalence of deaths each year among children aged under five years in the developing world are associated with malnutrition (WHO, 2002). The interaction of poverty, poor health and poor complementary feeding practices has a multiplier effect on the general welfare of the children population and contributes significantly towards growth retardation, poor cognitive development, illness and death among children in developing countries, particularly Nigeria (Pollit, 1994; Duncan et al., 1994; Kretchmer et al., 1996; Bhattacharya et al., 2004; Anigo et al., 2007).

The complementary feeding which usually begins at 4 to 6 months continues up to the age of 24 months when the transition from exclusive breastfeeding to semi solid food begins. It is at this stage that the nutritional requirements of many infants are not met, thus leading to onset of malnutrition that is prevalent in children under 5 years of age (Anigo et al., 2009). The traditional complementary foods in Nigeria are cereal based (e.g. ogi) and other family diets (tuwo, cassava, yam, etc.) and these plant based complementary foods are not beneficial to the growth and development of children (Ijarotimi and Keshinro, 2012). Investigations have shown that ogi (corn gruel, a traditional complementary food) and other family diets often fail to meet the nutritional needs of the infants due to poor nutritive values (Fernandex et al., 2002; Solomon, 2005), hence they have been implicated in the etiology of protein energy malnutrition in the community where they are solely used as complementary foods (Okoye, 1992, Devlin, 1997).

In view of the nutritional problem associated with the traditional complementary foods, coupled with high cost of commercial baby foods, this study is therefore aimed at formulating complementary foods from millet, soybean and African locust bean fruit pulp (*Parkia biglobosa*) and to evaluate the quality of the formulated foods.

## MATERIALS AND METHODS

Soybeans and millet grains were purchased from Monday Market in Kaduna South Local Government, Kaduna. Locust bean fruits were bought from Kasuwan Magani, a village in Kajuru Local

Government of Kaduna State. All the equipment used for this study were from the Department of Food Technology Kaduna Polytechnic, Kaduna. The chemicals used for analyses were of analytical grade and obtained from the laboratory of the Department of Food Technology, Kaduna Polytechnic, Kaduna. The chemicals were products of synth, Sao Paulo, Brazil.

### Preparation of materials

Soybean seeds were cleaned, sorted and roasted at 100°C for 2 h. The roasted seeds were cooled and milled into flour using a laboratory hammer mill (Christy Hunt, UK). The flour was sieved using a 60 mm mesh sieve (British Standard). The flour was packed in a plastic container, sealed and stored at room temperature (25°C). The millet grains were cleaned and sorted. The sorted grains were then milled into powder using the laboratory hammer mill and sieved to fine powder using a 60 mm mesh sieve.

The locust bean fruit pulp flour was prepared using the method described by Zakari et al. (2013) and Zakari et al. (2015). The outer brown cover of the pods was manually striped open and the yellow pulp was separated from the seeds embedded within the pulp. The yellow pulp was dried in a hot air oven (model T121, Gen lab Widnes, UK) at 60°C for 9 h to moisture content of 10.5%. The dried powder was milled with a laboratory hammer mill and sieved using a 60 mm mesh sieve. The flour was also packed in a plastic container and stored at room temperature (25°C) prior to analyses.

### Food formulation

Composites were formulated as indicated on table 1, from the processed flours in ratio of 60:10:30, 60:20:20, 60:30:10, 50:30:20, 50:20:30 of millet, soybean and locust bean in pulp, to obtain products A, B, C, D and E, respectively.

### Analytical determinations

The nutrient composition of the flour samples was determined according to the standard assay methods of AOAC (2005). Moisture content was determined by oven method, crude protein by microkjedahl method using 6.25 as a conversion factor. Fat was determined by ether extraction using soxhlet extractor and ash was determined by drying ashing method. The carbohydrate content was determined by difference. Addition of all the percentages of moisture, fat, crude protein ash and crude fibre was subtracted from 100%. This gives the amount of nitrogen free extract otherwise known as carbohydrate. All the analyses were determined following the method of AOAC (2005):

$$\% \text{ Carbohydrate} = 100 - (\% \text{ moisture} + \% \text{ fat} + \% \text{ Ash} + \% \text{ Crude fibre} + \% \text{ crude protein}).$$

The sample calorific value was estimated (in kcal/g) by multiplying the percentages of crude protein, fat and carbohydrate using Atwater conversion factor (4, 9, and 4, respectively) as proposed by Mahan and Escott-Stump (2008). Calcium, Iron and Zinc were determined by atomic absorption spectrophotometer.

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**Table 1.** Recipe formulation.

Component	Samples				
	A	B	C	D	E
Millet flour	60	60	50	50	50
Soybean flour	10	20	40	30	20
African locust bean fruit pulp	30	20	10	20	30

Functional properties of the flour samples were also determined. Bulk density, water absorption capacity were determined by Okaka and Porter (1979). The gelation properties were determined by the method of Coffman and Garcia (1977). The swelling capacity was determined by Coffman and Garcia, (1977) with slight modifications. One gram of the flour sample was mixed with 10ml distilled water in a centrifuge tube and heated at 80°C for 30 min. This was continually shaken during the heating period. After heating, the suspension was centrifuged at 1000 × g for 15 min. The supernatant was decanted and the weight of the paste taken. Swelling capacity was calculated as weight of the paste/weight of dry flour.

#### Sensory evaluation

Porridges were prepared from each of the composite flours. Briefly, 20 g of each of the samples were homogenized in 60 ml of water and the slurry was heated slowly with constant stirring for 15 min, one teaspoon of sugar was added to each sample. The porridges were kept separately in thermos flask for sensory evaluation. Sensory evaluation was conducted on the reconstituted samples which were coded and presented to 15 untrained panelists. The sensory evaluation was conducted in a well standard sensory evaluation room, where each of the panelists was positioned in a separate cubicle to avoid interference. The samples were rated on the following sensory characteristics, that is, colour, taste, mouthfeel and overall acceptability using 9-point hedonic scale, with 9 as like extremely and 1 as dislike extremely (Ihenkoronye and Ngodi, 1985).

#### Statistical analysis

The data obtained from the study were analyzed using means and standard deviation. Analysis of Variance (ANOVA) and Duncan's New Multiple Range Test (DNMT) (Ihenkoronye, 1985) were used to test the significance between the means ( $p < 0.05$ ) of sensory scores.

## RESULTS AND DISCUSSION

Table 2 presents the nutrient composition of millet, soybean and African locust bean fruit pulp flour blends. The moisture content of blends ranged from 7.5 to 11.0%. The moisture content of the blends (7.5 to 11.0%) was within the range for flour (11 to 12%) as reported by Ihenkoronye and Ngoddy, (1985). This moisture level is also in agreement with the work of Nzeagwu and Nwaejike (2008). The low moisture content is desirable as it enhances the keeping quality of the samples since

water for microbial activity is low. This report agreed with similar work of Ijarotimi and Keshinro (2012).

The protein content ranged from 28.9 to 37%. The high levels of protein could be a result of supplementation with soybean. The protein levels increased with increasing addition of soybean flour. Nnam (2001) made a similar observation when the sorghum traditional complementary food was supplemented with bambara groundnut and sweet potato. Similarly, Nzeagwu and Nwaejike (2008) reported increases in protein when sorghum traditional complementary food was supplemented with groundnut and crayfish. The content also follows the same trend of increases with increasing addition of soybean. The fat varied from 3.00 to 5.1%. The high fat content of soybean resulted in the high fat level of sample C (50:40:10). The ash content varied from 1.4 to 2.51%. The carbohydrate content ranged between 47.0 to 52.1%. The energy value ranged from 351 to 381.9 kcal with sample C having the highest energy value. The energy values of the formulated samples met the FAO/WHO (1991) specification guidelines for young children complementary food formulations. The mineral composition of the formulated food samples shown on Table 2, indicated that calcium ranged from 128 to 165 mg/100g, with sample A having the highest calcium level. The high calcium levels in sample A may be due to high proportion of millet and African locust bean fruit pulp flour. The iron and zinc content were also higher in sample A (60:10:30), with the lowest percentage of soybean.

The functional properties of the formulated food materials are shown in Table 3. The results showed that bulk density ranged from 0.61 to 0.66 g/ml, water absorption capacity ranged from 1.89 to 2.31% swelling capacity ranged from 0.67 to 2.45%, least gelation ranged from 9.0 to 11.62%. The result showed that the samples possess low bulk density, which is an advantage in the preparation of complementary food, because high bulk limits the caloric and nutrient intake per feed of a child (Onimawo and Egbekun, 1998; Omueti et al., 2009). The low bulk density is economical in food packaging. The water absorption capacity is also at lower level for all the samples. The water absorption capacity is an index of the maximum amount of water that a food product would absorb and retain (Ijarotimi and Keshinro, 2012). With respect to water absorption capacity, Giami and Bekehand (1992) reported that microbial activities of food

**Table 2.** Proximate and mineral composition of millet, soybean and locust bean fruit pulp blends.

Parameter	Sample A (60:10:30)	Sample B (60:20:20)	Sample C (50:40:10)	Sample D (50:30:20)	Sample E (50:20:30)
Moisture (%)	10.5 ± 0.14 <sup>a</sup>	10.5 ± 0.14 <sup>a</sup>	7.5 ± 0.21 <sup>c</sup>	8.0 ± 0.14 <sup>b</sup>	11.0 ± 0.49 <sup>a</sup>
Protein (%)	28.9 ± 0.14 <sup>d</sup>	32.7 ± 0.14 <sup>c</sup>	37 ± 0.20 <sup>a</sup>	35 ± 0.02 <sup>b</sup>	31.6 ± 0.21 <sup>c</sup>
Fat (%)	3.00 ± 0.20 <sup>d</sup>	4.5 ± 0.02 <sup>b</sup>	5.1 ± 0.02 <sup>a</sup>	4.8 ± 0.20 <sup>c</sup>	4.46 ± 0.20 <sup>c</sup>
Ash %	2.5 ± 0.02 <sup>a</sup>	2.0 ± 0.02 <sup>b</sup>	1.4 ± 0.14 <sup>c</sup>	2.1 ± 0.14 <sup>b</sup>	2.51 ± 0.02 <sup>a</sup>
Crude Fibre (%)	3.00 ± 0.02 <sup>a</sup>	2.5 ± 0.02 <sup>b</sup>	2.0 ± 0.02 <sup>c</sup>	2.51 ± 0.02 <sup>b</sup>	3.2 ± 0.02 <sup>a</sup>
Carbohydrate (%)	52.10 ± 0.22 <sup>a</sup>	47.80 ± 2.00 <sup>b</sup>	47.0 ± 0.02 <sup>e</sup>	47.59 ± 0.02 <sup>c</sup>	47.2 ± 0.02 <sup>e</sup>
Energy (Kcal/g)	351 <sup>c</sup>	362.5 <sup>c</sup>	381.9 <sup>a</sup>	373.56 <sup>b</sup>	355.61 <sup>d</sup>
Calcium (mg/100g)	165 ± 0.2 <sup>a</sup>	160 ± 0.2 <sup>c</sup>	128 ± 0.4 <sup>e</sup>	159 ± 0.1	163 ± 0.2 <sup>b</sup>
Iron (mg/100g)	5.8 ± 0.2 <sup>a</sup>	4.8 ± 0.1 <sup>b</sup>	3.2 ± 0.2 <sup>d</sup>	4.7 ± 0.2 <sup>b</sup>	4.7 ± 0.2 <sup>c</sup>
Zinc (mg/100g)	3.2 ± 0.01 <sup>a</sup>	2.6 ± 0.02 <sup>d</sup>	2.7 ± 0.01 <sup>c</sup>	2.9 ± 0.2 <sup>b</sup>	2.93 ± 0.2 <sup>b</sup>

Means with different superscripts on horizontal line are significantly (P<0.05) different.

**Table 3.** Functional properties of millet, soybean and locust bean fruit pulp blends.

Parameter	Sample A (60:10:30)	Sample B (60:20:20)	Sample C (50:40:10)	Sample D (50:30:20)	Sample E (50:20:30)
Bulk Density (g/ml)	0.65 ± 0.05 <sup>a</sup>	0.60 ± 0.05 <sup>c</sup>	0.63 ± 0.02 <sup>b</sup>	0.6 ± 0.02 <sup>c</sup>	0.65 ± 0.05 <sup>a</sup>
Water absorption capacity (g/g)	2.19 ± 0.2 <sup>c</sup>	1.96 ± 0.02 <sup>d</sup>	2.04 ± 0.02 <sup>b</sup>	1.89 ± 0.2 <sup>e</sup>	2.31 ± 0.02 <sup>a</sup>
Swelling capacity (%)	0.67 ± 0.04 <sup>c</sup>	2.22 ± 0.03 <sup>d</sup>	2.45 ± 0.02 <sup>a</sup>	2.42 ± 0.03 <sup>b</sup>	2.41 ± 0.02 <sup>c</sup>
Least Gelation (%)	9.00 ± 0.02 <sup>d</sup>	11.50 ± 0.04 <sup>c</sup>	11.62 ± 0.01 <sup>b</sup>	11.61 ± 0.03 <sup>b</sup>	11.51 ± 0.02 <sup>c</sup>

Means with different superscripts on horizontal line are significantly (P<0.05) different.

**Table 4.** Sensory attributes of complementary foods from millet, soybean and African locust bean fruit pulp (P=0.05).

Parameter	Sample A (60:10:30)	Sample B (60:20:20)	Sample C (50:40:10)	Sample D (50:30:20)	Sample E (50:20:30)
Taste	6.87 <sup>c</sup>	7.23 <sup>c</sup>	6.73 <sup>c</sup>	7.03 <sup>c</sup>	7.93 <sup>a</sup>
Mouthfeel	7.00 <sup>c</sup>	7.46 <sup>b</sup>	6.86 <sup>c</sup>	7.46 <sup>b</sup>	7.93 <sup>a</sup>
Colour	6.40 <sup>a</sup>	6.0 <sup>a</sup>	7.00 <sup>c</sup>	7.60 <sup>a</sup>	7.80 <sup>a</sup>
Overall acc	6.93 <sup>a</sup>	7.33 <sup>c</sup>	6.80 <sup>d</sup>	7.60 <sup>b</sup>	7.93 <sup>a</sup>

Means with different superscripts on horizontal line are significantly (P<0.05) different.

products with low water absorption capacity would be reduced. Hence the shelf life of such product would be extended. The swelling capacity is used in the determination of the amount of water that food samples can absorb and the degree of swelling within a given time. The gelling properties indicated that the products can be used as complementary food formulation.

The results of sensory evaluation are shown in table 4. The results showed that there are significant (<0.05) differences in all the attributes tested for the samples. However sample E (50:20:30) with 50% millet, 20%

soybean and 30% African locust bean fruit pulp was more acceptable to the panelists on all the attributes tested.

## Conclusions

The study has shown that acceptable complementary food can be produced from composites of millet, soybean and African locust bean fruit pulp. This study has also shown that composites of millet, soybean and African locust bean fruit pulp are nutritionally adequate and

possess good functional and sensory properties, which are required for the preparation of complementary foods for infants and children.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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