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# Nutrient Composition of Cereal (Maize), Legume (Soybean) and Fruit (Banana) as a Complementary Food for Older Infants and Their Sensory Assessment

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**Abstract:** Four complementary foods were prepared from local foodstuffs which are maize (*Zea mays*), soyabean (*Glycine max*) and banana (*Musa acuminate colla*). Four complementary samples were produced from the proportion of maize/soyabean/banana composite flours as 60%: 30%: 10% (B), 60%: 25%: 15% (C), 60%: 20%: 20% (D), 50%: 30%: 20% (E) and Nestle Cerelac was the control sample (A). The formulated diets were subjected to nutritional analysis-along with a commonly used proprietary infant cereal (Nestle Cerelac) as control. Standard chemical methods were used to determine the proximate nutrient composition, some micronutrients and anti-nutritional factors. The samples produced have increased nutrients of fibre that enhances digestibility (2.07%-3.11%), protein and ash contents. The supplementation of up to 20% soybean flour and banana flour recorded the best results in terms of proximate and mineral compositions and compared favourably with the control sample, in terms of sensory evaluation using hedonic method, sample A was most accepted but did not differ significantly from sample D. Therefore, nutritious and acceptable complementary food can be produced from fermented maize, soybean and banana flours. Results of molar ratios of some minerals and anti-nutritional factors in the compounded diets suggest that the anti-nutrients will not pose any serious problem in the usage of the complementary diets. The cost of producing the formulated diets is about N50-N100 (50 cents) per gram cheaper than cerelac. The study has therefore, revealed that with proper selection of local foodstuff, it is possible to prepare nutritious complementary diets that would be acceptable, readily available, affordable and nutritionally adequate.

**Key words:** Complementary food, blends, maize and soybean.

## 1. Introduction

In the sub-Saharan region of the tropics, protein deficiency in diets is common and it is usually associated with deficiencies in calories leading to endemic protein malnutrition with its attendant health consequences particularly in children. Despite abundant global food supplied, widespread malnutrition persists in many developing countries. The World Health Organization (WHO) and UNICEF have been concerned about this trend, particularly of Protein Energy Malnutrition (PEM) and micronutrient deficiencies (Hidden Hunger) among infants, children and pregnant women. The United Nations' Standing Committee on Nutrition (SCN) pointed out that malnutrition is directly and indirectly associated with more than 50% of all children mortality, is the contributor to disease in developing world [1].

When blends are prepared in the proper way, the starch structures bind large amounts of water, which results in gruels with high viscosity [2]. Seed proteins especially from leguminous sources such as soybeans have been put forward as potentially excellent sources of protein for the nutritionally quality upgrading of starchy roots and tubers for use in baby foods in countries which import their entire milk requirement [3].

Complementary foods are foods other than breast milk introduced to an infant to provide nutrients. In developing countries like Nigeria, complementary foods are mainly based on starch tubers like cocoyam, sweet potato or on cereals like maize, millet and

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sorghum. Children are normally given these staples in the form of gruels that is either mixed with boiled water or boiled with water [4].

The period during which other foods or liquids are given to a young child along with breast milk is considered the period of complementary feeding and any nutrient containing foods or liquids other than breast milk, provided the child during this period are defined as complementary foods [5]. Thus, it is essential that infants receive appropriate, adequate and safe complementary food to ensure the right transition from breastfeeding to the full use of family foods [6]. Lack of appropriate feeding can set up risk factors for ill-health. The life-long impact may include poor school performance, reduced productivity, impaired intellectual and social development or chronic diseases [7].

*1.1 Statement of Problem*

In Nigeria and indeed most developing countries the underlying problems have been identified to include poverty, inadequate nutrient intake particularly during pregnancy, period of rapid growth and complementary feeding in older infants, ignorance about nutrient values of foodstuff and parasitic infections [8]. Results of the 2001-2003 food consumption and nutrition survey showed a step increase in the incidence of child wasting between 6 and 12 months, which is the period of complementary feeding for most children [9].

Major international and national efforts towards addressing these problems include nutritional supplementation, fortification of staple food and modification of traditional diets to meet specific requirements. The promotion and support of exclusive breast feeding, access to and the initiation of nutritious complementary food between ages 6 months remain essential components of activating optimal nutrition and malnutrition control programmes for infants and children [5]. Failure to achieve these components predisposes the older infants to malnutrition, growth retardation, infection and increased risk of mortality.

Complementary feeding is instituted according to country-specific infant guidelines, which also take into cognizance the availability, and affordability of infant instant cereal formulas. Proprietary formulas are usually considered nutritious, acceptable and safe to older infants but their high cost has put them beyond the reach of most families, especially those in the low income “bracket”. Most families depend on locally formulated diets for older infant and young children. The locally formulated foods (pap and porridges) are low in protein and high in anti nutritional factors that reduce the bioavailability of some micronutrients. Poor processing and cooking methods also contribute substantially to loss of micronutrients, leading to micronutrient deficiency disorders in older infants fed these foods.

Different approaches have been adopted to combat the problem particularly of “hidden hunger” in Nigeria and most developing countries. One of such immediate approach is oral supplementation of micronutrients especially the global focal micronutrients Fe, Zn, Al and vitamin A. Various organization and individuals [10, 11] have upheld that, the most sustainable solutions are those that are likely to be maintained in the long term. These would include food-based approaches like diet diversity, food fortification and bio-fortification which could be the most cost effective of all public health interventions and thus within the economic reach of even the world’s poorest. The 1992 International Conference of Nutrition (ICN) suggested other approaches to include improved food availability, food preservation, research nutrition education and hygiene.

Based on these recommendations, a joint FAO/WHO consultative forum in 1998, established the scientific basic for the development and evolution of Food-Based Dietary Guidelines (FBDG) for various region of the world. Sequel to this, the Federal

Ministry of Health (FMOH) in Nigeria published the Food-Based Dietary Guidelines [12]. The guidelines recommended some sustainable food-based approaches that encourage dietary diversification through the production and consumption by all population groups, of both macro and micro nutrient-rich foods, including traditional foods found in different parts of the country. The report recommended the use of staples starchy roots, tubers and cereals in combination with legumes, vegetables, fruits and if possible animal sourced foods in preparing weaning foods for infants and children. Based on these recommendations, different variables effecting micronutrient intake and ways to combat deficiency have been considered in several nutrition [13, 14] fora.

Besides, the reports by many researchers on the nutritive potentials of cereals, legumes, vegetables and fruits in the formulation of complementary food have been promising [15, 16]. It is imperative that blends of such foodstuffs found in various communities be formulated and biochemical studies be carried out on their composites for use as complementary food.

### *1.2 Significance of the Study*

This study was a part of exploratory effort on the improvement of the nutritional quality of traditional complementary foods. It was designed to use staple foodstuffs indigenous to Imo State to formulate composite blends that could be nutritious, readily available and affordable to both rural and poor urban mothers. Findings from the study offered answers to the questions: (a) whether such blends can meet the various dietary recommendations for older infants and children, (b) whether they can substitute the more expensive proprietary formulas sold in the market and (c) formulate composite blends using selected cereal (maize), legumes (soybeans) and fruit (banana) commonly cultivated and consumed in Imo state.

### *1.3 Objectives*

The research was undertaken principally to formulate composite blends using selected cereal (maize), legume (soyabean) and fruit (banana) commonly cultivated and consumed in Imo State.

Below are the specific objectives:

(1) Determined the macro and micro-nutrient composition of the composite blends, and compared their nutrient profile with a reference proprietary formula (Nestle Cerelac) and Recommend Dietary allowance (RDAS);

(2) Determined the sensory scores of the diet samples;

(3) Made informed recommendations on the use and nutritive adequacy of the local composites for older infants and young children.

## 2. Material and Methods

### *2.1 Sources of Materials*

The yellow maize variety (*Zea mays*), soybeans (*Glycine max*) and banana (Musa *acuminate colla*) were procured from Eke Ukwu market, Owerri Municipal Area of Imo State.

### *2.2 Preparation of "Ogi"Flour*

Ogi was produced (Fig. 1) from wholesome yellow maize, cereal grains by the traditional method, which involved sorting the grains to eliminate the bad grains, cleaning the grains to get them rid of debris and other foreign bodies that may constitute a problem to the quality of the end product, and steeping the clean grains in clean tap water for 48 hours at room temperature. The steeped grains were washed again with clean water, wet milled using commercial corn mill and wet sieved using a 300 um sieve. The husks were disposed while the filtrate (slurry) was allowed to settle for 48 hours. At the end of fermentation period the ogi was recovered using a cheese cloth to squeeze out the water. The wet ogi sample was then dried using an oven drier at a temperature of 60 $^{o}$C.

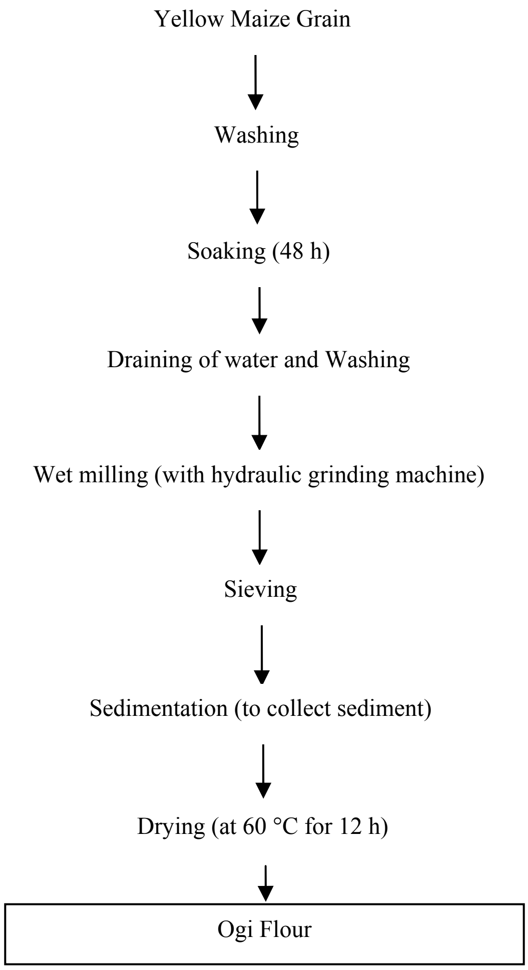


**Fig. 1 Flow Diagram for the production of Ogi Flour.**

*2.3 Preparation of Soyabeans Powder*

Soybean seeds were cleaned by removing unwanted particles and then soaked in clean water overnight. Testa was removed by rubbing in-between the palms and washed several times with more water. The washed beans were then air-dried. The dried beans samples were then slightly roasted in an oven at 70 °C for 30 minutes, to reduce the anti-nutritional content and then it was dehulled and milled (Fig. 2).

*2.4 Peparation of Banana Flour*

Ripe firm bananas were washed, peeled and cut into transverse slices of about 2 mm thickness. To reduce enzymic browning, slices were then dipped in 0.5% (w/v) sodium metabisulphite solution for 5 minutes, drained and dried in oven (AFOS Mini Klin at 600 °C

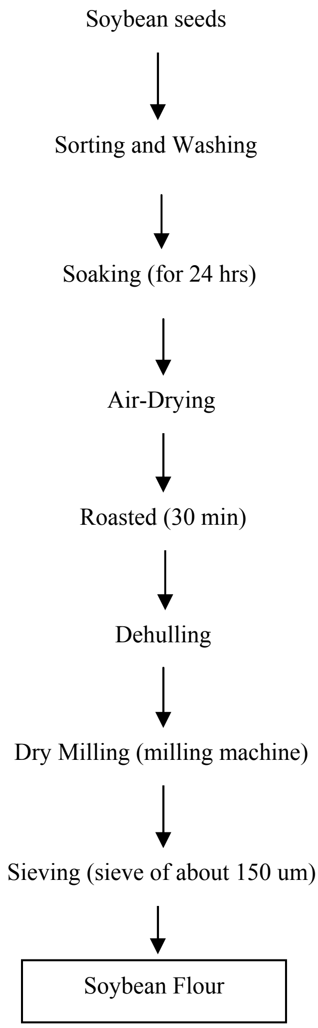


**Fig. 2 Flow Diagram for the production of Soybean Flour.**

overnight). The dried samples were ground in a Retsch Mill laboratory (Retsch AS200) to pass through 60 mesh screen to obtain banana flour (Fig. 3). The flour was stored in airtight plastic packs for further analyses.

*2.5 Formulation of the Experimental Diets (Composite Blends)*

The samples were formulated as follows:

Sample A—Nestle Ceralac (served as standard or control diet);

Sample B—Yellow Maize: Soybeans: Banana (60%: 30%: 10%);

Sample C—Yellow Maize: Soybeans: Banana (60%: 25%: 15%);

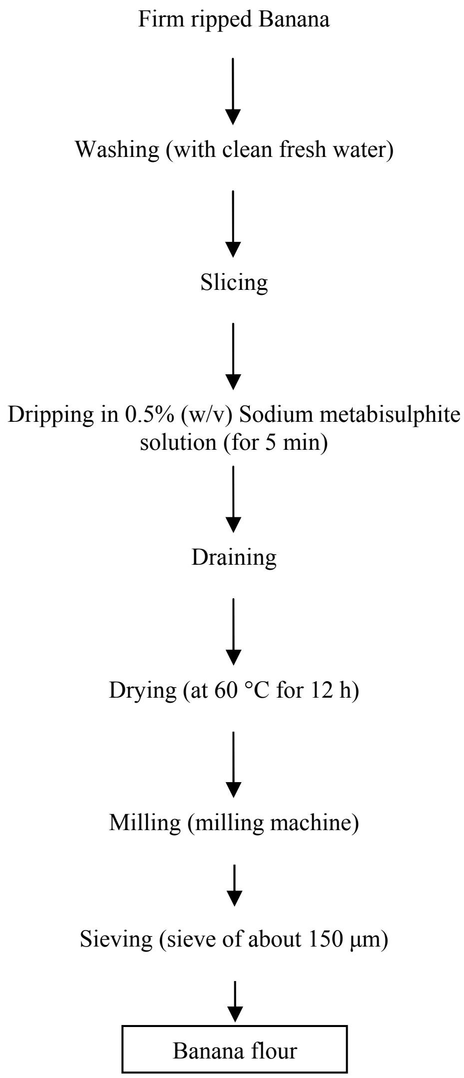


**Fig. 3 Flow Diagram for the production of Banana Flour.**

Sample D—Yellow Maize: Soybeans: Banana (60%: 20%: 20%);

Sample E—Yellow Maize: Soybeans: Banana (50%: 30%: 20%).

Formulated complementary foods for older infants and young children means food that is suitable for use during the complementary feeding period. These foods are specially formulated with appropriate nutrition quality to provide additional energy and nutrients to complement the family foods derived from the local diet by providing those nutrients to complement the family foods derived from local diets, which are either lacking or are present in insufficient quantities as recommended by codex standard for processed cereal—based foods for infants and young children [17].

The procedures used for these analyses (a-g) were described by AOAC [18]. They include

(a) Moisture Determination Using The Oven Method;

(b) Ash Content Determination;

(c) Crude Protein Determination;

(d) Fat Content Determination;

(e) Crude Fibre Determination;

(f) Carbohydrate Determination;

(g) Micronutrients determination: (i) Vitamin C (Ascorbic acid) Determination.

This was achieved by the method of Roe and Kuether [19].

Minerals Determination AOAC [20] methods were used to determine mineral composition of the samples. Antinuritional Factors Determination of Phytate: This was achieved using the method of AOAC [18].

Determination of Tannins: The method of AOAC [21] was also used in determination.

### *2.6 Sensory Evaluation*

The five different samples of complimentary diet were evaluated using hedonic method for sensory characteristics and the overall acceptability by panelists of 15 judges from mothers living around Owerri club environs using a 9 point hedonic scale preference test as described by Ihekoronye and Ngoddy [22] was used. The hedonic was used to compare commercially formulated food (Nestle Cerelac) and traditionally formulated food from fermented maize, soyabean and banana to know which complimentary diet was preferable in colour, texture, aroma, taste and general acceptability. The quantities evaluated were rated on a scale ranging from one to nine (1 to 9) where;

9—Like extremely;

8—Like very much;

7—like moderately;

6—Like slightly;

5—Neither like nor dislike;
4—Dislike slightly;
3—Dislike moderately;
2—Dislike very much;
1—Dislike extremely.

### 2.7 Statistical Analysis

The statistical analysis was done using analysis of variance (ANOVA) and mean separation as described by Ihekoronye and Ngoddy [22] to determine the difference among sample means were applicable.

## 3. Results and Discussion

### 3.1 Proximate Composition of the Raw Samples (Maize, Soyabean and Banana Flours)

Results of proximate nutrient composition of raw samples (maize, soybean and banana flour) are presented in Table 1. Moisture content of the samples ranged from 7.43% to 10.57%, ash ranged from 1.09% to 6.44%, crude fat ranged from 3.42% to 18.80%, crude protein ranged from 2.78% to 43.10%, crude fibre ranged from 0.11% to 0.88% and carbohydrate content ranged from 26.14% to 80.08% respectively. It was observed that banana flour sample recorded the highest value for moisture content and ash content compared to the order sample analyzed. Banana is an excellent source of nutrients comprising vitamin $B_6$, vitamin C, vitamin A and potassium [23]. Also soybean flour sample recorded the highest values of fat, crude fibre and protein content. Soybean (*Glycine max*) has been the primary source of protein and fat for use as a functional ingredient in food system. Its protein content is about 32.20% [24]. It was observed that maize flour recorded the highest value for carbohydrate.

### 3.2 Proximate Composition of the Blends (Maize, Soyabean and Banana Flours)

The proximate composition of the maize, soybeans and banana blends and the control sample is shown in Table 2. The ash and crude fibre content of the blends increased significantly ($p < 0.05$) with increased substitution with banana flour of each flour. The ash content varied from 2.87% while the fibre content varied from 2.07%-3.11%.

The fat and protein contents on the other hand decreased significantly ($p < 0.05$) with increased banana flour substitution but increased with increased proportion soybean flour substitution. The increased ash and fibre contents could be attributed to the banana flour which is rich in minerals and fibre [25]. Banana is reported to be a rich source of potassium which is an important component of the body cells and fluids that helps to control heart rate and blood pressure thus; it counteracts the negative effects of sodium.

The higher protein and fat contents in the composite flours could have come from the soybean flour which is known to contain high protein and fat contents [25]. The increased moisture contents could be due to increased hydrophilic molecules provided by the banana flour. The lower content of carbohydrate in composite flours could be due to the soybean flour that contributed high proteins and low carbohydrate.

**Table 1 Proximate Composition of the Raw Sample (Maize, Soybean and Banana Flours).**

| Parameters% | Maize flour | Soybean flour | Banana flour | LSD |
|---|---|---|---|---|
| Moisture Content | $8.31 \pm 0.01^a$ | $7.43 \pm 0.01^b$ | $10.57 \pm 0.03^c$ | 0.17 |
| Ash | $1.09 \pm 0.00^a$ | $3.65 \pm 0.04^b$ | $6.44 \pm 0.01^c$ | 0.15 |
| Crude fat | $5.17 \pm 0.04^a$ | $18.80 \pm 0.14^b$ | $3.42 \pm 0.01^c$ | 0.16 |
| Crude protein | $4.50 \pm 0.03^a$ | $43.10 \pm 0.05^b$ | $2.78 \pm 0.01^c$ | 0.22 |
| Crude fibre | $0.85 \pm 0.00^a$ | $0.88 \pm 0.04^a$ | $0.11 \pm 0.03^b$ | 0.17 |
| Carbohydrat | $80.08 \pm 0.03^a$ | $26.14 \pm 0.06^a$ | $76.68 \pm 0.50^c$ | 1.71 |

Mean in the row with the same superscript are not significantly different at $p < 0.05$. The means were separated using least significant difference (LSD).

**Table 2 Proximate Composition of the Blends (Maize, Soyabean And Banana Flours).**

| SAMPLES | | | | | | |
|---|---|---|---|---|---|---|
| Parameter (%) | A | B | C | D | E | LSD |
| Moisture content | $3.30 \pm 0.04^a$ | $3.75 \pm 0.02^b$ | $4.09 \pm 0.01^c$ | $4.19 \pm 0.02^c$ | $4.12 \pm 0.04^c$ | 0.18 |
| Ash | $3.16 \pm 0.03^a$ | $2.87 \pm 0.00^b$ | $2.91 \pm 0.01^b$ | $3.12 \pm 0.00^{ac}$ | $3.02 \pm 0.04^c$ | 0.13 |
| Crude Fat | $3.53 \pm 0.04^a$ | $7.04 \pm 0.00^b$ | $6.88 \pm 0.04^c$ | $6.62 \pm 0.02^d$ | $6.94 \pm 0.04^b$ | 0.21 |
| Crude Protein | $13.75 \pm 0.02^a$ | $14.11 \pm 0.01^b$ | $11.02 \pm 0.00^c$ | $9.98 \pm 0.0^d$ | $14.02 \pm 0.02^b$ | 0.12 |
| Crude Fibre | $3.11 \pm 0.01^a$ | $2.07 \pm 0.07^b$ | $2.28 \pm 0.04^c$ | $2.77 \pm 0.0^d$ | $2.27 \pm 0.01^c$ | 0.16 |
| Carbohydrate | $73.15 \pm 0.09^a$ | $70.16 \pm 0.02^b$ | $72.01 \pm 0.07^c$ | $73.32 \pm 0.07^a$ | $69.63 \pm 0.01$ | 0.38 |

**Key:** A—Cerelac (control); B—60: 30: 10 (Maize: Soyabean: Banana); C—60: 25: 15 (Maize: Soyabean: Banana); D—60: 20: 20 (Maize: Soyabean: Banana); E—50: 30: 20 (Maize: Soyabean: Banana).

**Table 3 Micronutrients of the Blends (Maize, Soyabean and Banana Flours).**

| Samples | | | | | | |
|---|---|---|---|---|---|---|
| Parameter (mg/100g) | A | B | C | D | E | LSD |
| Vitamin C | $2.34 \pm 0.00^a$ | $45.21 \pm 0.01^b$ | $49.07 \pm 0.04^c$ | $49.88 \pm 0.04^d$ | $50.41 \pm 0.04^e$ | 0.17 |
| Zinc | $4.55 \pm 0.04^a$ | $2.74 \pm 0.02^b$ | $3.31 \pm 0.00^b$ | $4.21 \pm 0.01^d$ | $3.30 \pm 0.05^c$ | 0.19 |
| Magnesuim | $0.00 \pm 0.00^a$ | $9.12 \pm 0.00^b$ | $9.68 \pm 0.02^c$ | $9.84 \pm 0.00^d$ | $6.44 \pm 0.02^e$ | 0.10 |
| Calcuim | $273 \pm 0.00^a$ | $172.10 \pm 0.04^b$ | $177.77 \pm 0.01^c$ | $198.00 \pm 0.00^d$ | $177.84 \pm 0.02^c$ | 2.13 |
| Iron | $15.36 \pm 0.04^a$ | $3.34 \pm 0.02^b$ | $3.76 \pm 0.00^c$ | $3.82 \pm 0.02^d$ | $3.92 \pm 0.01^d$ | 0.15 |

**Key:** A—Cerelac (control); B—60: 30: 10 (Maize: Soyabean: Banana); C—60:25: 15 (Maize: Soyabean: Banana); D—60: 20: 20 (Maize: Soyabean: Banana); E—50: 30: 20 (Maize: Soyabean: Banana).

The increased protein content is an indication that supplementation of maize flour with soybean and banana flours greatly improved the protein and nutritional quality of the complementary food. Thus the enriched complementary food can be used to solve malnutrition problems. Soybean flour and banana are reported to contain all the essential amino acids [22]. High fibre is reported by Schneeman and Tieiven [26], to enhance the gastrointestinal tract (GIT) health. It helps normal bowel movements thereby reducing constipation problems.

### *3.3 Micronutrients of the Blends (Maize, Soyabean and Banana Flours)*

Table 3 shows the micronutrient composition of the complementary food blend and that of the control (Cerelac). The control vitamin C content varied from 2.34 mg/100 g to 50.41 mg/100 g. The control sample had 2.34 mg/100 g. it was observed that Vitamin C content of the blend increased significantly ($p < 0.05$) with increased substitution with banana flour. Banana has an excellent source of nutrients comprising of Vitamin $B_6$, Vitamin A.

The zinc values of the samples ranged from 2.74 mg/100 g to 4.55 mg/100 g. The control sample had the highest zinc value which was significantly ($p < 0.05$) different from the other samples, followed by sample D (60: 20: 20 for Maize: Soybean: Banana respectively).

The magnesium content ranged from 0.00 mg/100 g to 9.84 mg/100 g with sample D (60: 20: 20 for Maize: Soybean: Banana respectively) recording the highest value ($p < 0.05$).

The calcium values varied from 172.10 mg/100 g to 273 mg/100 g ($p < 0.05$). The control sample had the highest value (273 mg/100 g) which was significantly ($p < 0.05$) different from the other samples followed by sample D (60: 20: 20 for Maize: Soybean: Banana respectively).

The iron composition varied from 3.34 mg/100 g to 15.36 mg/100 g. The control sample had the highest value (15.36 mg/100 g) which was significantly ($p < 0.05$) different from the other samples followed by sample E (50: 30: 20 for Maize: Soybean: Banana respectively) which didn't not differ significantly ($p < 0.05$) from sample D (60: 20: 20 for Maize: Soybean:

**Table 4 Antinutritional Properties of the Blends (Maize, Soybean and Banana Flours).**

| SAMPLES | | | | | | |
|---|---|---|---|---|---|---|
| Parameters (%) | A | B | C | D | E | LSD |
| Tannin | $0.00^{a}$ | $2.4^{b}$ | $2.38^{b}$ | $2.22^{c}$ | $2.40^{b}$ | 0.15 |
| Phytate | $0.00^{a}$ | $1.90^{b}$ | $1.82^{b}$ | $1.40^{c}$ | $1.84^{b}$ | 0.16 |

**Key:** A—Cerelac (Control); B—60: 30: 10 (Maize: Soybean: Banana); C—60: 25: 15: (Maize: Soybean: Banana); D—60: 20: 20 (Maize: Soybean: Banana); E-—50: 30: 20: (Maize: Soybean: Banana).

**Table 5 Sensory Scores of the Blends.**

| Samples | | | | | | |
|---|---|---|---|---|---|---|
| Parameters | A | B | C | D | E | LSD |
| Colour | $6.41 \pm 002^{a}$ | $6.02 \pm 0.11^{b}$ | $6.22 \pm 0.004^{b}$ | $6.31 \pm 0.08^{b}$ | $5.99 \pm 0.08^{b}$ | 0.12 |
| Texture | $6.22 \pm 0.04^{a}$ | $6.13 \pm 0.00^{b}$ | $6.08 \pm 0.02^{b}$ | $6.18 \pm 006^{ab}$ | $6.02 \pm 0.08^{b}$ | 0.08 |
| Aroma | $6.82 \pm 0.02^{a}$ | $6.20 \pm 0.04^{b}$ | $6.11 \pm 0.08^{b}$ | $6.42 \pm 0.12^{c}$ | $6.00 \pm 0.06^{b}$ | 0.20 |
| Taste | $6.66 \pm 0.02^{a}$ | $6.34 \pm 0.08^{b}$ | $6.43 \pm 0.01^{b}$ | $6.52 \pm 0.11^{ab}$ | $5.82 \pm 0.11^{c}$ | 0.18 |
| Overall acceptability | $6.12 \pm 0.08^{a}$ | $5.92 \pm 0.04^{b}$ | $5.98 \pm 0.11^{b}$ | $6.08 \pm 0.17^{a}$ | $5.62 \pm 0.11^{c}$ | 0.12 |

Mean in the same row with different superscripts are significantly different at P < 0.05. The means were separated using least significantly difference (LSD).

**Key:** A—Cerelac (control); B—60 : 30 : 10 (Maize: Soybean: Banana); C—60: 20: 15 (Maize : Soybean : Banana); D—60: 20: 20 (Maize: Soybean: Banana); E—50: 30: 20 (Maize: Soybean: Banana).

Banana respectively). The blends compared favorably with the control in minerals and vitamins investigated and portent no treat to cause micro nutrient deficiency in this respect.

### *3.4 Antinutritional Properties of the Blends (Maize, Soybean and Banana Flours)*

Table 4 shows the anti nutrients contents of the complementary food blends at varying ratios and that of the control (cerelac). The tannin composition varied from 0.00% to 2.41%. Sample B had the highest value (2.41%) which did not differ significantly ($p < 0.05$) from samples C and E. The phytate composition ranged from 0.00% to 1.90%. Sample B had the highest value (1.90%) which did not differ significantly ($p < 0.05$) from samples C and E too.

It was observed that tannin and phytate were absent in the control sample. The level of the tannin and phytate present in the blended samples are within the safe limit according to FAO/WHO, Codex Alimentarius Commission [17] and Food Standards and can be further eliminated by processing such as cooking and boiling.

### *3.5 Sensory Scores of the Blended Samples (Mize—Soybean—Banana Flour)*

Sensory scores obtained from sensory evaluation are shown in Table 5. In terms of all the sensory attributes tested, sample A was most acceptable by the panelists and was not significantly different ($p < 0.05$) from that of sample D. In all, the samples were accepted by the panelist with exception of sample E which recorded the lowest values.

## 4. Conclusion

This study has shown that complementary food of acceptable quality can be produced from composite flours of maize, soybeans and banana. The samples produced have increased nutrients of fibre, protein and ash contents which are all desirable for good health and wellbeing. The supplementation of up to 20% soybean flour and banana flour recorded the best results in terms of proximate and mineral compositions and compared favourably with the control sample and sensory evaluation provides acceptability therefore, nutritious and acceptable complementary food can be produced from fermented maize, soybean and banana flours. This would save a lot of foreign exchange used on foreign complementary importation and provide nutritious complementary food to combat malnutrition problems and enhance food security.

## Recommendation

It is therefore recommended that fortification of fermented maize flour with soybean and banana flours be encouraged since it will serve as a food based approach for combating micronutrient deficiency among infants that use the local "akamu/ogu" as complementary foods. Further work has to be done to determine the amino acid profile of the blend in order to determine protein quality.

## References


[1] Standing Committee on Nutritional (SCN). 2004. *Nutrition for Improved Development Outcomes*. 5th Report on the Would Nutrition Situation (SCN), Geneva.

[2] Hellstrom, A., Hermansson, A. M., Karlsson, A. L., Tungquist, B., Melander, D., and Svanberg, U. 1981. "Dietary Bulk Asalinsting Factor for Nutrient Intake in Pre-School Children in Consistency as Related to Dietary Bulk—A Model Study." *J. Trop. Pediatr.* 27: 127.

[3] Okaka, J. C., and Okaka, A. N. C. 1990. *Food Composition Spoilage and Shelf Life Extension*. OCJANCO Academic, Publishers. Enugu.

[4] Igyor, M. A., Yusuf, P. A., and Senger, I. A. 2011. "Evaluation and Physiolochemical, Functional and Sensory Properties of Fermented Fura Powder Supplemented with Soy." *Nigerian Food Journal* 28: 113-121.

[5] World Health Organization (WHO). 1998. "Complementary Feeding of Young Children in Developing Countries." A review of Current Scientific Knowledge. *WHO/NUT*/ 98.1 Geneva WHO.

[6] WHO. 2003. "Feeding and Nutrition of Infants and Young Children: Guidelines for the WHO European Region with Emphasis on the Former Soviet Union." *WHO Regional Publications.* European series, No. 87, 1-296.

[7] Nestle, P., Briend, A., de Benoist, E., and Decker, E. 2003. "Complementary Food Supplements to Achieve Micro-Nutrient Adequacy for Infants and Young Children." *J. Pediatr. Gastroenterol. Nutr.* 36: 316-28.

[8] National Plan of Action on Food and Nutrition (NPFN) in Nigeria. 2002. National Planning Commission, Abuja, Report.

[9] International Institute for Tropical Agriculture (IITA). 2004. "Summary Proceedings for the stakeholder Meeting for the Project on Micronutrient Enrichment of Maize and Plantain in Nigeria." *A Sustainable Approach to Mitigate Hidden Hunger*. IITA, 7-8th Sept., 2004.

[10] International Conference on Nutrition (ICN). 1992. Caring for Socio-Financially Deprived and Nutritionally Vulnerable. ICN, Theme paper No.3 fad/WHO, Rome.

[11] Food and Agriculture Organization (FAO)/WHO. 1998. *Preparation and Uses of Food Based Dietary Guidelines.* A Report of joint FAO/WHO consultation. WHO technical Report, series 880, Geneva.

[12] Federal Ministry of Health (FMOH). 1999. *Food Based Dietary Guidelines for Nigeria*. Nutrition Division, Abuja, report.

[13] Nigerian Nutrition Network (nnn). 2002. In *1st Annual Nigerian Nutrition Network Meeting*, 12-13th, Dec. 2002, Abeokuta.

[14] National Advisory Committee on Micronutrient Deficiency (NACMD). 2003. In *The Meeting of the NACMD*, 27-28th March, 2003, Abuja.

[15] Badmosi, E. J., Ibrahim, L. M., and Temple, V. J. 1995. "Nutritional Evaluation of a Locally Formulated Weaning Food, JUTH-PAP." *West Afri. J. Biol. Sci*. 3: 85-93.

[16] FAO/WHO M. 1997. "Preventing Micronutrients Mal Nutrients Malnutrition, a Guide to Food-Based Approaches." *A Manual for Policy Makers and Programmed Planners FAO of the United Nations and International Life Science Institute*, Washington DC, 2-6.

[17] CODEX Alimentarius. 2006. *CODEX STAN* 74-1981, *Rev*. 1. 2006.

[18] Association of Official Analytical Chemists (AOAC). 1990. *Official Methods of Analysis.* 15th ed. AOAC, Washington DC.

[19] Roe, J. H., and Kuether, C. A. 1943. "Photometric Assay of Vitamin." C. *J. Biol. Chem.* 147: 399.

[20] AOAC. 2005. *Official Methods of Analysis,* 17th ed. Arling, VA.

[21] AOAC. 1980. *Official Method of Analysis*, 13th ed. AOAC, Washington, DC.

[22] Ihekoronye, A. I., and Ngoddy, P. O. 1985. *Integrated Food Science and Technology for the Tropics.* New York: Macmillian Publishers, 296-301.

[23] Sampath, K., Kumar, K., Debjit, P., Bhowmik, S., Duraivel, M., and Umadov, M. 2012. "Traditional and Medicinal Uses of Banana." *Journal of Pharmacognosy and Phytochemistry* 1 (3): 51-63.

[24] Gernah, D. I., and Chima, C. E. 2006. "Bread Making Potential of Cassava-Maize-Soyabean Flour." *J. Sustain Agric. Environ.* 8 (2): 196-206.

[25] Olaoye, O. A., Onilude, A. A., and Idowu, O. A. 2006. "Quality Characteristics of Bread Produced from Composite Flours of Wheat, Plantain and Soyabeans." *Afr. J. Biotechn.* 5: 1102-6.

[26] Schneeman, B. C., and Tieven, I. 1994. "Dietary Fibre." *Modern Nutrition in Health and Disease.* Edited by Shils, M. E., Ohlson, I. A., and Shike, A. 8th ed. Philadelphia: Lea Febiger, 89-100.