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Full Length Research Paper

Evaluation of the chemical composition and functional properties of bambara groundnut and cooking banana

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The cooking banana and bambara ground nut were processed into flour, mixed in ratios of 90:10, 80:20, 70:30 and 60:40 respectively and chemical, functional and sensory properties were evaluated. The protein contents of formulated samples were significantly higher than ogi, but lower than nutrend ($p < 0.05$). Also, the energy values of CBR_4 (384.4 ± 0.3 kcal.) was significantly lower than the nutrend (397.1 ± 1.8 kcal.) ($p < 0.05$) and there was no significant difference with the ogi (383.1 ± 0.1 kcal.) ($p < 0.05$). The mineral composition of CBR_4 had the highest amount of calcium, magnesium, iron, potassium, sodium and phosphorous when compared with other formulated food samples. The CBR_4 had the highest water absorption capacity, least gelation capacity and swelling capacity, while CBR_1 had the least values of the formulated food samples. The overall acceptability of the formulated food samples were significantly lower than the ogi and nutrend ($p < 0.05$). The amount of CBR_3 and CBR_4 needed to meet the RDA for energy, protein and minerals of infant were comparable with that of nutrend, but lower than ogi. The study concluded that the nutrient composition of CBR_4 was better than ogi, but lower than nutrend. Hence, it may be used as a substitute for ogi and the expensive commercial weaning formula.

Key words: Chemical composition, functional properties, cooking banana, bambara groundnut, infant mix.

INTRODUCTION

Childhood malnutrition is very common in developing countries (Plahar and Hoyle, 1991; Kim, 2000; FAO, 2004). This is because infants at this stage of develop-ment require higher energy and proteins in their diet so as to meet increasing demand for metabolism. The nu-triational status of children less than 5 years of age is of particular concern, since the early years of life represent the period for optimal growth and development (Prechu-lek et al., 1999). Their nutritional well-being reflects household, community and national investments in family health thereby contributing both directly and indirectly to overall country development and in particular, develop-ment of human resource (Central Bureau of Statistic, 1999).

Malnutrition contributes directly or indirectly to more than 60% of ten million child deaths each year (WHO, 2002). It has been reported that over 226 million children below 5 years old are stunted, 67 million are wasted and 183 million weight less than they should for their age (UNICEF, 1998). The prevalence of malnutrition incre-ases dramatically from the age of 6 - 18 months as a re-sult of poor feeding practices and low purchasing power that characterized many homes. Diets in developing cou-ntries are frequently deficient in macronutrients (protein, carbohydrates and fat, leading to protein-energy mal-nutrition), micronutrients (electrolytes, minerals and vita-mins, leading to specific micronutrient deficiencies) or both (Brabin and Coulter, 2003; Pinstrup-Andersen et al., 1993; Levin et al., 1993; Millward and Jackson, 2004). In order to solve this nutrition problem many researchers have worked extensively on cereal-legume combinations in Nigeria. For example, Fashakin and Ogunsoola (1982) formulated nut-ogi (a mixture of corn gruel and peanut), Akinrele and Edwards (1989) formulated soya-ogi (corn gruel plus soya bean).The traditional weaning foods could be improved upon by combining locally available foods that complement each other in such a way that new pattern of amino acids created by this combination is similar to that recommended for infants (Fashakin et al.,

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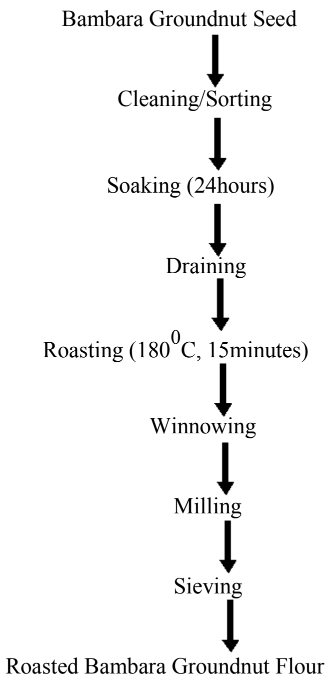

Figure 1. Flow chart showing roasted bambara groundnut flour.

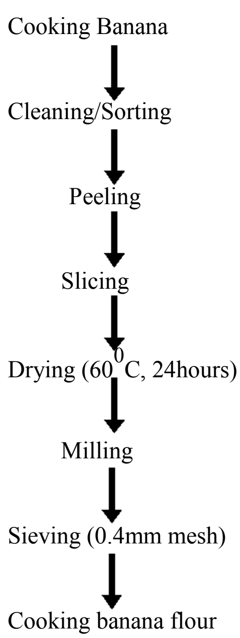

Figure 2. Flow chart showing cooking banana flour.

1986).

In view of this, the present study therefore was undertaken to develop low cost formulations, using cooking banana fruits (*Musa* spp., ABB Genome) and roasted bambara groundnut seeds (*Vigna subterranean* L. Verde) with locally available technology and an attempt was made to evaluate the chemical composition and functional properties of the food samples.

MATERIALS AND METHODS

Materials

The materials, that is, raw green cooking banana (*Musa spp, ABB genome*), bambara groundnut *(V. subterranean* L. Verdc*),* nutrend (a commercial weaning food) and Ogi (a traditional weaning food) were purchased from a local market in Akure town, Ondo state, Nigeria.

Methods

Preparation of samples

The bambara groundnut seeds were sorted, soaked for 24 h in hot water, drained and roasted in hot fine sand at 180°C for 15 min. The roasted seeds were winnowed, dry milled, sieved through 0.4 mm wire mesh screen (Figure 1). Cooking banana fruits were peeled, sliced into pieces, oven-dried at 60°C for 24 h, milled and sieved through 0.4 mm wire mesh screen. The flours were stored in sealed cellophane bag at room temperature (Figure 2). The cooking banana flour and roasted bambara groundnut flour were mixed in ratios of 90:10, 80: 20, 70: 30 and 60:40 respectively and the flour were then stored in cellophane bag at room temperature prior to analysis.

Chemical analyses

The nutrient composition of the food samples was determined using the standard procedures of association of official analytical chemists (1990) . Triplicate samples of each sample were determined for moisture content in a hot-air circulating oven (Galenkamp). Ash was determined by incineration (550°C) of known weights of the samples in a muffle furnace (Gallenkamp, size 3). Crude fat was determined by exhaustively extracting a known weight of sample in petroleum ether (boiling point, 40 to 60°C) in a soxhlet extractor. Protein (N × 6.25) was determined by the Kjeldahl method. Crude fiber was determined after digesting a known weight of fat-free sample in refluxing 1.25% sulfuric acid and 1.25% sodium hydroxide. The carbohydrate content was determined by subtracting the total crude protein, crude fiber, ash and fat from the total dry weight (100 g) of the food sample differences. The gross energy was determined with a Gallenkamp ballistic bomb calorimeter (Gallenkamp ccb-330-010L UK).

Minerals content (sodium, potassium, calcium, magnesium, iron, copper, zinc, manganese and selenium) of the flour samples was determined using association of official analytical chemists (1990) method. Flour was digested with a mixture of concentrated nitric acid, sulfuric acid and perchloric acid (10:0.5:2, v/v and analysed using an atomic absorption spectrophotometer (GBC 904AA; Germany). The total phosphorus was determined as orthophosphate by the ascorbic acid method after acid digestion and neutralization using phenolphthalein indicator and combined reagent (APHA, 1995). The absorbance was read at 880 nm (Spectronic 21 D, Miltonroy, New York, USA) and KH_2PO_4 (Merck, Mumbai, India) served as a standard.

Anti-nutrient determinations

Phytic acid was extracted from each 3 g flour sample with 3%

trichloro-acetic acid by shaking at room temperature followed by high speed centrifugation as described by Wheeler and Ferrel (1971). The phytic acid in the supernatant was precipitated as ferric phytate and iron in the sample was estimated. Phytate-phosphorus (phytate-P) was calculated from the iron results assuming a 4:6 iron: phosphorus molecular ratio. The phytic acid was estimated by multiplying the amount of phytate-phosphorus by the factor 3.55 based on the empirical formula $C_6P_6O_{24}H_{18}$. Tannin contents were determined by the modified vanillin-HCl methods (Burns 1971; Price et al., 1978) . A 2 g sample was extracted with 50 ml 99.9% methanol for 20 min at room temperature with constant agitation. After centrifugation for 10 min at 653 x g, 5 ml of vanillin- HCl (2% vanilli and 1% HCl) reagent was added to 1 ml aliquots and the colour developed after 20 min at room temperature was read at 500 nm. Correction for interference light natural pigments in the sample was achieved by subjecting the extract to the conditions of the reaction, but without vanillin reagent. A standard curve was prepared using catechin (Sigma Chemical, St. Louis, MO) after correcting for blank and tannin concentration was expressed in g/100 g. Oxalate was determined by AOAC (1990) method. 1 g of the sample was weighed into 100 ml conical flask. 75 ml of 3 M H_2SO_4 was added and the solution was carefully stirred intermittently with a magnetic stirrer for about 1h and then filtered using whatman No.1 filter paper. The sample filtrate (extract) (25 ml) was collected and titrated against hot (80 - 90°C) 0.1 N $KMnO_4$ solution to the point when a faint pink colour appeared that persisted for at least 30 s. The concentration of oxalate in each sample was obtained from the calculation: 1 ml 0.1 permanganate = 0.006303 g oxalate.

Trypsin inhibition activity (TIA)

The trypsin inhibition activity was assayed in terms of the extent to which an extract of the defatted flour inhibited the action of bovine trypsin (EC 3.4.21.4) on the substrate benzoyl-DL- arginine-p-nitrianilide (BAPNA) hydrochloric (Kakade et al., 1974). The samples (1 g each) were extracted continuously at ambient temperature for 3 h with 50 mL, 10 mM NaOH using a mechanical shaker (GallenKamp orbital shaker Surrey, UK). The pH of the resulting slurry was adjusted to 9.4 - 9.6 with 1 M NaOH. After extraction, the suspendsion was shaken and diluted with distilled water such that 1 cm^3 of the extract produced trypsin inhibition of 40 - 60% at 37°C. The respective dilutions were noted. Consequently, TIA was calculated in terms of mg pure trypsin (Sigma type lll, lot 20H0868)

$$TIA = \frac{2.632DA}{S} \text{ mg pure trypsin inhibited } g^{-1} \text{ sample}$$

Where D is the dilution factor, A is the change in absorbance at 410 mm due to trypsin inhibition per cm^3 diluted sample extract and S is the weight of the sample.

Functional property determination

Water absorption capacity was determined using the method of Salunkhe (1985) modified by Adebowale et al. (2002). 10 ml of distilled and deionized water was added to 1.0 g of the sample in a beaker. The suspension was stirred using magnetic stirrer for 5 min. The suspension obtained was centrifuge at 3500 rpm for 30 min and the supernatant was measured into a 10 ml graduated cylinder. Water absorbed was calculated as the difference between the initial volume of water added to the sample and the volume of the supernatant. Least gelation property was determined using the method described by Coffman and Garcia (1977). Sample suspendsions of 2 - 16% were prepared in distilled water. 10 ml of each of the prepared dispersions was transferred into a test tube and heated in a boiling water bath for 1 h, cooled rapidly in a cold water bath and allowed to cool further at 4°C for 2 h. The least gelation concentration was determined when the sample from the inverted test tube did not slip or fall. Swelling capacity was determined by weighing 20 g of the food sample into a cleaned, dried graduated cylinder. The cylinder was tapped 3 times on the table and then 80 ml of distilled water was poured into the cylinder. The cylinder was allowed to stand for 1 h after which the final volume of the food sample was noted. The ratio of the final volume to initial volume gave the swelling capacity on volume basis. The supernatant was decanted and the weight of food sample and the cylinder was obtained and the ratio of final weight to initial weight of the food sample gave the swelling capacity on weight basis.

Sensory evaluation

The 4 formulated samples obtained from the different fractions of cooking banana and bambara groundnut mixes were made into light gruels, using about 20 g and 60 ml of water. The reconstituted formulated and control food samples (that is, nutrend, a commercial weaning food and Ogi, a traditional weaning food) were coded and presented to 30 panelists that were familiar with the product. The samples were rated based on colour, aroma, taste, mouth feel and overall acceptability using 9 point hedonic scale scored from dislike extremely (1) to like extremely (9).

Statistical analysis

The data were analysed using SPSS version 13.0. The mean and standard error of means (SEM) of the triplicate analyses were calculated. The analysis of variance (ANOVA) was performed to determine significant differences between the means, while the means were separated using the new Duncan multiple range test.

RESULTS AND DISCUSSION

The proximate composition of the formulated food samples are shown in Tables 1. The formulated diet containing 60% cooking banana fruit flour and 40% bambara groundnut flour (CBR_4) had the highest energy value (384.4 ± 1.3 kcal.), while the sample containing 90% cooking banana and 10% bambara groundnut flour (CBR_1) had the least energy value (361.5 ± 1.0 kcal.). The energy value of CBR_4 was insignificantly high when compared with other formulated diets and ogi (traditional weaning diet, corn gruel) ($p > 0.05$), but significantly lower when compared with the nutrend (commercial weaning diet) ($p < 0.05$). The protein content of CBR_4 (13.8 ± 0.01 g) was significantly higher than ogi (5.60 ± 0.02 g) and other formulated foods, but also significantly lower than nutrend (16.00 ± 0.2 g). In this present study it was shown that the protein content of the formulated diet increases progressively as the % of bambara groundnut increases. Also, it was observed that the protein content of cooking banana diet supplemented with roasted bambara groundnut (13.8 ± 0.01 g) was lower when compared with the cooking banana and fermented bambara ground nut mixed (Ijarotimi, 2008). Quite a number of studies have reported that fermentation method improves the nutritive values of food products compared with other processing methods, such as roasting, cooking, etc (Paredes-López and Harry, 1988; Adams, 1990; Obizoba

Table 1. Mean (SEM) of proximate composition of cooking banana and bambara groundnut formulated diets.

Nutrients	RCB	RBG	CBR_1	CBR_2	CBR_3	CBR_4	Ogi	Nutrend
Energy (Kcal)	361.5 ± 1.0d	387.8 ± 1.9b	359.7± 1.5d	368.8 ± 1.0c	382.5 ± 3.0b	384.4 ± 0.3b	383.1 ± 0.1b	397.1 ± 1.8a
Moisture (g)	8.9 ± 0.2a	4.6 ± 0.3e	5.9 ± 0.01d	6.4 ± 0.03c	6.7b ± 0.03c	6.9 ± 0.02b	2.9 ± 0.06f	4.8 ± 0.02e
Protein (g)	3.3 ± 0.1h	18.9 ± 0.1a	6.7 ± 0.18f	8.6 ± 0.02e	11.5 ± 0.02d	13.8 ± 0.01c	5.6 ± 0.02g	16.2 ± 0.2b
Fat (g)	1.5 ± 0.1f	6.6 ± 0.2b	2.4 ±0.02e	3.3 ± 0.06d	3.6 ± 0.23d	5.9 ± 0.05c	0.80 ± 02g	8.5 ± 0.03a
Fibre (g)	1.2 ± 0.2e	3.8 ± 0.2b	3.9 ± 0.01b	2.8 ± 0.03c	2.7 ± 0.01c	2.3 ± 0.01d	0.5 ± 0.01f	4.5 ± 0.01a
Ash (g)	2.6 ± 0.2bc	3.5 ± 0.1a	3.4 ± 0.4a	3.1a ± 0.03b	2.9 ± 0.02ab	2.3 ± 0.06cd	1.7 ± 00.02d	2.7 ± 0.02bc
Carbohydrate(g)	83.7 ± 0.1b	63.3 ± 0.7f	77.8 ± 0.2c	76.1 ± 0.2d	75.9 ± 0.3d	68.9 ± 0.2e	88.4 ± 0.01a	64.0 ± 0.2f

CBR_1 - Cooking banana + roasted bambara groundnut (90:10)
CBR_2 - Cooking banana + roasted bambara groundnut (80:20)
CBR_3 - Cooking banana + roasted bambara groundnut (70:30)
CBR_4 - Cooking banana + roasted bambara groundnut (60:40)
Nutrend - commercial weaning (Nutrend)
Ogi - Traditional weaning food
RBG - Raw bambara groundnut
RCB - Raw cooking banana.

and Atii, 1991; Aletor, 1993). The fibre content of the formulated diets decreases as the % of bambara groundnut increases, but CBR_1 diet contained the highest fibre content (3.9 ± 0.2 g) when compared with the remaining formulated diets, while CBR_4 contained the least fibre content (2.3 ± 0.01 g).

The mineral composition of the diets is presented in Table 2. The mineral composition of the formulated diets showed that CBR_4 sample contained the highest mineral content, while CBR_1 contained the least in virtually all the minerals determined. In this study, it was also observed that the mineral content of the food samples increases as the % of bambara groundnut increases. The increased in vital nutrients as supplementation of bambara ground increases could be attributed to the fact that bambara groundnut is a good source of protein and minerals. Quite a number of studies have reported that legumes and nuts seeds are good sources of protein and minerals and that these seeds are usually consumed in many parts of the developing countries, particularly, where animal proteins are scarce or very expensive (Brough et al., 1993; Lalude and Fashakin, 2006).

The anti-nutritional factors of the formulated diets are presented in Table 3. The formulated diet containing 60% of cooking banana and 40% bambara groundnut flour (CBR_4) contained the highest amount of oxalate (1.16 ± 0.06 mg/100 g), tannic acid (0.24 mg/100 g), phytin acid (27.25 ± 0.46 mg/100 g), phytin-phosphorus (7.5 ± 0.3 mg/ 100 g) and trypsin inhibitor (7.40 ± 0.5± mg/100 g), while CBR_1 diet contained the least concentration of oxalate (0.3 mg/100 g), tannic acid (0.05 mg/100 g), phytic acid (7.2 mg/100 g), phytin-phosphorus (1.9 mg/100 g) and trypsin inhibitor (1.9 mg/100 g) of the formulated food samples. It is evident in the present study that the concentration of antinutrients increased as the % of bambara groundnut increased. Several studies have reported that legumes, such as soybean, bambara groundnut etc., contain antinutritional or toxic components (Grant et al., 1989; Hwei-Ming et al., 1997), such as protease inhibitors, lectins, goitrogens, antivitamins, saponins, tannins, phytoestrogens, flatulence factors (Rachis, 1975), lysinoalanine, allergens, phytate (Leiner, 1994), soytoxin (Vasconcelos et al., 1997). Legumes consumption has been related to various deleterious effects, such as growth retardation (Martinez et al., 1995a), lowered digestibility and absorption of dietary nutrients (Pusztai et al., 1995) and physiological, metabolic and immunological disturbances (Hajobs et al., 1995; Martinez et al., 1995b). However, it is evident that the antinutrient concentration in legumes can be eliminated or reduced to tolerable level through processing methods like roasting, fermentation, soaking etc. (Grant et al., 1989; Leiner, 1994; Vasconcelos et al., 1997; Agbede and Aletor, 2003; Khokhar and Chauham, 1986). The functional properties of the formulated food samples are shown in Table 4. The water absorption capacity of food materials is an index of the maximum amount of water that it can take up and retain, hence determine the

Table 2. Mean (SEM) mineral composition of cooking banana and bambara groundnut formulated diets.

Nutrients	RCB	RBG	CBR1	CBR2	CBR3	CBR4	Ogi	*Nutrend
Calcium (mg)	30.45 ± 0.06e	60.0 ± 0.30a	19.79 ± 0.11g	27.11 ± 0.26f	39.38 ± 0.56d	45.95 ± 0.24c	51.85 ± 0.65b	39 ± 0.00d
Magnesium (mg)	62.98 ± 0.23e	57.19 ± 0.21f	65.69 ± 0.08d	102.28 ± 0.37c	136.44 ± 0.51b	184.80 ± 0.90a	14.29 ± 0.39g	ND
Zinc (mg)	0.28 ± 0.03c	5.70 ± 0.20a	0.013 ± 0.002d	0.15 ± 0.02cd	0.016 ± 0.002d	0.016 ± 0.002d	-	0.7 ± 0.00b
Iron (mg)	2.60 ± 0.02b	5.50± 0.2a	0.15 ± 0.01d	0.24 ± 0.02d	0.22 ± 0.01d	0.24 ± 0.02d	0.34 ± 0.04d	1.0 ± 0.00c
Potassium (mg)	51.47 ± 0.09g	33.94± 0.16h	54.72 ± 0.06e	68.14 ± 0.15c	69.69 ± 0.10b	71.95 ± 0.07a	52.81 ± 0.39f	57.0 ± 0.00d
Sodium (mg)	26.72 ± 0.04d	7.6 ± 0.01f	26.52 ± 0.06d	27.56 ± 0.17c	27.73 ± 0.57c	30.89 ± 0.08b	40.27 ± 0.13a	22.0 ± 0.00e
Phosphorus (mg)	94.06 ± 0.12b	33.32± 0.21g	41.93 ± 0.16f	47.22 ± 0.30e	70.19 ± 0.84d	75.31 ± 0.89c	97.55 ± 0.15a	22.0 ± 0.00h
Manganese (mg)	-	0.93± 0.06	-	-	-	-	-	ND
Copper (mg)	-	0.12± 0.01	-	-	-	-	-	ND
Aluminum (mg)	-	-	-	-	-	-	-	ND
Lead (mg)	-	-	-	-	-	-	-	ND
Chromium (mg)	-	-	-	-	-	-	-	ND
Mercury (mg)	-	-	-	-	-	-	-	ND

*The values as specified by the manufacturer.

Table 3. Mean (SEM) antinutritional contents of cooking banana and roasted bambara groundnut mixed.

Sample	Oxalate (mg/100 g)	Tannic acid (mg/100 g)	Phytic acid(mg/100g)	Phytin phosphorous (mg/100 g)	Trypsin inhibitor (mg/100 g)
CBR_1	0.32 ± 0.02d	0.06 ± 0.01b	7.0 ± 0.02d	2.05 ± 0.15d	1.75 ± 0.15d
CBR_2	0.54 ± 0.04c	0.08 ± 0.01b	14.12 ± 0.25c	4.10 ± 0.20c	3.30± 0.20c
CBR_3	0.81 ± 0.02b	0.16 ± 0.02a	19.70 ± 0.80b	6.10 ± 0.20b	5.00 ± 0.20b
CBR_4	1.16 ± 0.06a	0.24 ± 0.03a	27.25 ± 0.46a	7.5 ± 0.30a	7.40 ± 0.50a

energy and nutrient dense of a food. Recently, se-veral studies have reported that the high pre-valence of protein- energy malnutrition in many parts of developing countries is as result of low-dense energy and other vital nutrient intakes (Levin et al., 1993; Pinstrup -Andersen et al., 1993; Brabin and Coulter, 2003; Milward and Jackson, 2004). The least gelation concentration of the for-mulated food samples increased with successive substitution levels and there were no significant difference between the formulated samples be-yond 20% substitution levels and the ogi and that of nutrend samples respectively ($p > 0.05$). The high gelation value implies that the diet would re-quire more energy consumption to cook and hence the gel strength of the diets would be weak and undesirable (Enujiugha, 2006). The swelling capacity increased with the % increase of bam-bara groundnut flour. However, the swelling capa-cities of the formulated diets were significantly higher than ogi but lower than the nutrend ($p < 0.05$).

Table 5 shows the results of sensory attributes of prepared formulated diets, ogi and nutrend. All the sensory attributes of the formulated diets samples were significantly low compared to the nutrend (a commercial weaning food) and ogi (a traditional weaning food) ($p < 0.05$). The disparity between the flavour and taste of the formulated diets samples and the control food samples could be attributed to the characteristics beany aroma and taste of bambara groundnut flour. The poor rating of the formulated diets samples in term of aroma, taste, texture and colour compared with the ogi and nutrend could also be attributed to the familiarity of the panel of judges to these food

Table 4. Functional properties of the formulated weaning formulation and the controls.

Sample	% Water Absorption Capacity (WAC)	% Least Gelation Concentration (LGC)	% Swelling Capacity (SW)
CBR_1	178.3 ± 0.98^{fg}	4.0 ± 1.15^{c}	11.9 ± 0.31^{f}
CBR_2	183.7 ± 0.82^{f}	5.3 ± 0.67^{bc}	13.7 ± 0.41^{e}
CBR_3	205.4 ± 0.62^{e}	6.0 ± 1.15^{abc}	18.9 ± 0.08^{c}
CBR_4	207.2 ± 1.13^{e}	6.0 ± 1.20^{abc}	23.2 ± 0.51^{b}
OGI	123.5 ± 0.29^{k}	6.0 ± 1.13^{abc}	13.7 ± 0.41^{e}
Nutrend	346.5 ± 3.25^{a}	8.0 ± 1.16^{ab}	31.6 ± 0.48^{a}

Table 5. Sensory qualities of the reconstituted formulated weaning foods and control samples.

Samples	Colour	Aroma	Taste	Mouth Feel	Overall Acceptability
CBR_1	5.00 ± 0.82^{c}	6.00 ± 0.69^{bc}	6.00 ± 0.62^{c}	5.57 ± 0.81^{b}	6.29 ± 0.47^{b}
CBR_2	5.14 ± 0.55^{c}	5.71 ± 0.29^{bc}	5.43 ± 0.43^{c}	5.86 ± 0.55^{b}	5.29 ± 0.52^{b}
CBR_3	6.29 ± 0.36^{bc}	5.71 ± 0.42^{bc}	5.71 ± 0.18^{c}	5.43 ± 0.75^{b}	5.71 ± 0.29^{b}
CBR_4	6.14 ± 0.59^{bc}	5.43 ± 0.78^{c}	4.86 ± 0.40^{c}	6.00 ± 0.54^{b}	5.57 ± 0.48^{b}
OGI	7.43 ± 0.29^{b}	7.14 ± 0.34^{b}	7.14 ± 0.34^{b}	7.86 ± 0.63^{a}	7.71 ± 0.52^{a}
Nutrend	9.00 ± 0.00^{a}	9.00 ± 0.00^{a}	8.86 ± 0.14^{a}	8.43 ± 0.20^{a}	8.86 ± 0.14^{a}

Table 6. The amount of formulated, ogi and nutrend food samples to meet recommended daily allowance (RDA) of infant.

Nutrients	RDA (< 1 years)	CBR_3(70:30)	CBR_4(60:40)	Ogi	Nutrend
Energy (Kcal)	3444	214	212	212	207
Protein (g)	14	116	101	249	88
Carbohydrate (g)	95	140	65	107	149
Fat (g)	30	439	502	3947	355
Calcium (mg)	270	789	591	527	692
Phosphorus (mg)	275	579	370	282	1058
Sodium (mg)	370	472	1200	922	1682
Potassium (mg)	700	818	972	1336	1228
Zinc (mg)	3	30000	30000	-	429
Magnesium (mg)	75	52	40	511	-
Copper (mg)	0.5	-	-	-	-
Iron (mg)	1.1	5000	5000	3667	1100
Manganese (mg)	0.6	231	-	-	-

samples.

The amount of formulated, ogi and nutrend food samples that needed to meet the recommended daily allowance (RDA) of infant (< 1 year) is shown in Table 6. The amounts of CBR $_3$ and CBR_4, which are needed to meet the daily energy and protein requirement of infants, were absolutely within the same range with that of nutrend, but lesser amount of CBR_3 and CBR_4 were needed RDA for the protein, phosphorous and potassium requirement of the infant compared with ogi and nutrend. However, the amount of the formulated diets that were needed for RDA for iron and zinc were high compared with the nutrend food sample.

Conclusion

The findings in this present study justify the use of bambara ground seeds and cooking banana flour mixes, particularly 60% of cooking banana and 40% bambara groundnut flour, as a substitute for ogi (a traditional weaning food) and expensive commercial weaning formula. However, the level of antinutrient composition of the formulated diet could be further reduced either by hydrothermal or fermentation treatments. Also, the pos-sibility of adding sweetening and flavouring agent to the formulated food samples should be employed as a way of improving the sensory quality of the formulated diets.

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