Ghana J. Sci. **51** (2011), 51-56

NUTRITIVE VALUE OF INFANT FOOD PROCESSED FROM AFRICAN YAM BEAN (*SPHENOSTYLICA STERNOCARPA*) AND BAMBARA GROUNDNUT (*VOANDZEIA SUBTERRANEA*)

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Abstracts

Nutritive value of three infant diets formulated from composite flour of germinated African yam bean and bambara groundnut were evaluated using Nutrend Nestle infant food as a standard. The proximate analysis showed the values of the test diets and Nutrend as protein (21.38%, 22.23%, 23.63%, 16.41%); carbohydrates (54%, 54.21%, 53.28%, 70.13%); lipids (7.51%, 6.73%, 6.30%, 3.01%, 0.80%); moisture (10.33%, 10.63%, 10.55%, 7.55%); fibre (2.94%, 3.01%, 3.01%, 0.80%); ash (2.98%, 3.20%, 3.10%,) and caloric value (372.5%, 366.3%, 364.7%, 364.3%) Kcal/100 g, respectively. The minerals and vitamins' value in test diets were potassium (981.0 – 1132) mg/100 g; sodium (210.51 – 315.0) mg/100 g; calcium (513.10 – 592.10) mg/100 g; magnesium (41.10 – 49.41); mg/100g; phosphorus (20.10 – 27.06) mg/100 g; vitamin A (0.52 – 0.76, 0.05) mg/100 g; and vitamin C (5.12 – 5.84, 0.65) mg/100 g. Results of the study indicated a high nutritive value for the test diets which could adequately meet the protein and energy requirements of infants if used as weaning foods. Diet 1 (Africa yam bean: bambara groundnut ratio 1:4) was recommended as the best formulation.

Introduction

Despite its high nutritive quality, human milk is only adequate for most infants up to the age of 5 months (Puffer & Serrano, 1973). Complementation with other food as from 6 months (WHO, 2004 ; UNICEF, 2003) ought to be provided to supplement breast milk nutrients to sustain the child as the child matures since the body requires more energy and nutrients to support normal growth (Bradlley, Baldwin & Armstrong,1987; UNICEF, 2003). At this stage weaning period occurs whereby the infant is gradually introduced to adult diet (Cameron & Hof Vander, 1983). Malnutrition frequently sets in during this weaning period attributable to weaning foods that lack sufficient and necessary nutrients.

Large populace in the developing countries are of low socio-economic status and cannot afford the ever increasing standard breast milk supplements available in the markets. Additionally, nursing mothers do not eat balanced diets, resulting in the production of under-nourished breast milk, further increasing infant nutritional problem (Kon, 1996). However, infant mortality and morbidity can be minimised if infants are properly fed at their early childhood. Thus, concerted efforts have been geared towards processing high quality infant food from indigenous food material. Commonly used materials are cereals and legumes like cowpea and soybean (Paulon-Avalon *et al.*, 1997). Others such as African yam bean (AYB) and bambara groundnut (BG) are yet to be adequately harnessed in the production of protein–rich infant formula. Inadequate utilisation of these locally available legumes in home–made infant food could be because of their extensive cooking time, and limited information on both their composition and alternative methods of processing.

The study was aimed at processing infant food from lesser familiar legumes - African yam bean

(AYB) and bambara groundnut (BG) instead of the extensively used soybeans; evaluate the nutrient composition of the processed blend (AYB and BG), and introduce the use of germination instead of the traditional cooking method of processing legumes.

Experimental

One hundred and fifty grams of each sample of African yam bean (AYB) and bambara groundnut (BG) from Owerri main market in Imo State of Nigeria were washed separately, after the seeds were sorted to remove damaged and insect infected seeds. They were soaked in tap water for 12 h at room temperature. The seeds were rewashed and placed in a cloth–lined basket for 3 days to germinate. Each day, the germinating seeds were washed with water, twice, to remove adhering husk and microbes, which consequently restricted fermentation within the heap. At the end of the third day, with the sprout about 1 cm long, the seeds were finally rinsed, oven-dried in a Gallenkamp oven (Model 1H -150) at 85 °C for 14 h and milled into flour and stored for use. Fresh carrots were washed with saline solution, grated and oven-dried at about 60 °C for 3 h.

Diet formation

The various flour samples were oven-dried at 40 °C for 3 h before being used for diet preparation. Diet 1 consisted of 20 g of AYB and 80 g of BG. Diet 2 was formulated using 50 g each of AYB and BG while Diet 3 had 80 g of AYB and 20 g of BG. All diets were each fortified with 5 g of carrot. One hundred grams of Nutrient Nestle infant food was used as diet 4 and also served as the control diet.

Proximate analysis

Moisture, crude fibre, ash, lipids and protein were determined by the AOAC (1984) method. Carbohydrate content was determined by subtracting the weight of protein, ash, lipid, fibre and moisture contents from 100 per cent. Total caloric energy was calculated by multiplying carbohydrate and protein by a factor of 4 and lipid by a factor of 9. The value was expressed in Kcal/100 g.

Analysis of mineral

Analyses for potassium, calcium, magnesium, sodium, iron and phosphorous were determined by wet ashing (AOAC, 1984). The contents of sodium, potassium and calcium were determined from standard readings obtained from flame photometer. While magnesium, iron and phosphorus were determined by taking absorbance at 530 nm, 510 nm and 660 nm spectrophotometer, respectively, and values obtained from standard curve.

Determination of vitamins

Vitamin A (Beta – carotene). Two gram of the sample was blended with hot ethanol for 30 min. The resulting yellow extract was decanted and diluted to 85 per cent ethanol with water. The extract was cooled and shaken with 30 ml of petroleum ether, filtered and separated. The ethanol extract was washed three times with petroleum ether and added to the original ether phase collected for carotenoid estimation. The ether extract was rewashed with ethanol to remove trace of xanthophylls. Volume of all petroleum ether extract were then made up to 100 ml. 2 ml of aliquot from the diluted ether phase was used to estimate the carotenoid in the sample. The absorbance reading was noted while the concentration was extrapolated from the standard curve prepared from standard beta – carotene (0.05 mg/100 ml).

Vitamin C (Ascorbic acid). Fifty grams of sample was blended with 20 g of 6 per cent meta–phosphoric acid. The resulting slurry was weighed into a 50-ml flask and diluted to mark with 3 per cent meta-phosphoric acid solution, then filtered. Fifty milligrams of sodium salt of 2,6-dichlorophenol indophenol dye was dissolved in

150 ml hot water containing 12 mg of $NaHCO_3$. The solution was cooled and diluted to 200 ml with distilled water and standard ascorbic acid (100 g) was dissolved in 3 per cent meta-phosphoric acid, from which 5 ml was diluted with 5 ml of the solvent and used as standard. Then, 10 ml of filtrate was titrated with the standardised dye solution to give a pink colored end point. The titrate was used to calculate the ascorbic acid content of the sample.

Result

Table 1 represent the nutrients composition of raw and processed samples of AYB and BG seeds. The values show noticeable trend in the level of treated samples. Crude protein, carbohydrate and lipid contents of processed samples show a significant decrease ($P < 0.05$) when compared with raw samples. It also showed a higher protein content in AYB than in BG, while the lipid content was the reverse. The results were in agreement with Marero (1988), who observed that germination reduced the crude protein, carbohydrate and lipids content of legumes and cereals. The lipid content of BG (6.57) was significantly higher ($P < 0.05$) than that of AYB (3.61 %) in agreement with FAO (1985).

The crude fibre, moisture and ash content of processed flour samples were significantly higher ($P < 0.05$) than that of raw sample for both AYB and BG. These trends of increase were in line with the reports of Ologhobos and Fetuga (1986) and Nwokolo's (1987) on the effect of germination on varieties of legumes.

Diets 1, 2 and 3 differ only in their proportion of AYB and BG blending. Diet 4 is the control diet Nutrend. Diets 1, 2 and 3 had protein values of 21.38, 22.23 and 23.68 per cent, respectively, and were remarkably higher than that of Nutrend (16.61%) at $P < 0.05$ (Table 2). The percentage protein content of the diets also increased with increasing amount of AYB proportion. Diet 3, with the highest proportion of AYB, had the highest protein content. Diet 4 had the highest carbohydrate content of 70.13 per cent compared to those of test diets. The values for diets 1, 2 and 3 were similar (54.86 %, 54.21 % and 53.28 %) with slight decrease as the BG proportion decreased. Lipid contents of the test diets 1, 2 and 3 were 7.51, 6.73 and 6.10 per cent, respectively, significantly higher than diet 4 (2.02%). BG proportion decreased as the lipid content decreased. Crude fibre values obtained for the test diets were 2.94, 3.0 and 3.01 per cent, all significantly higher ($P < 0.05$) than in Nutrend (0.80%). Test diets values fell within the recommended limit of crude fibre supplementary foods by Protein Advising Group (PAG) of the United Nation. Moisture content of the test diets

TABLE 1

Proximate nutrient values of raw and processed flour samples

Sample	*Protein (%)*	*Carbohydrate (%)*	*Lipids (%)*	*Fibre (%)*	*Moisture (%)*	*Ash (%)*
Raw AYB	22.91 + 0.01	59.34 + 0..02	3.61+ 0.01	2.20 + 0.01	9.24 + 0.03	2.70 + 0.03
Processed AYB	21.15 + 0.02	57.98 + 0.03	2. 90+ 0.01	3.26 + 0.03	11.60+ 0.02	3.01 + 0.01
Raw BG	18.12 + 0.02	61.57 + 0.03	6.57 + 0.03	2.01 + 0.00	8.80 + 0.02	2.93 + 0.02
Processed BG	17.69 + 0.03	59.85 ± 0.01	5.51 ± 0.01	3.10 ± 0.01	10.75 ± 0.05	3.20 ± 0.02

AYB – African yam beans, BG–Bambara groundnut.

TABLE 2

Proximate nutrient values of test diets and nutrient

Samples	Protein (%)	Carbohydrate (%)	Lipids (%)	Fibre (%)	Moisture (%)	Ash (%)
Diet 1	21.38+ 0.02	54.86+ 0.02	7.51+ 0.00	2.94+ 0.01	10.33+ 0.02	2.98+ 0.01
Diet 2	22.23+ 0.03	54.21+ 0.01	6.73+ 0.01	3.00+ 0.01	10.63+ 0.01	3.20+ 0.02
Diet 3	23.68+ 0.01	53.28+ 0.02	6.30+ 0.01	3.01+ 0.01	10.55+ 0.02	3.10+ 0.01
Diet 4	16.14± 0.01	70.13± 0.01	2.02±0.00	0.80± 0.01	7.55± 0.01	3.09± 0.02

Diet1: 20 g AYB and 80 g BG; diet 2: 50 g AYB and 50 g AYB and 50 g BG diet 3: 80 g AYB and 20 g BG; diet 4: Nutrend Nestle Infant food

TABLE 3

Calculated energy values of test diets and nutrend (Kcal/100 g)

Samples	Carbohydrate energy	Protein energy	Lipids energy	Gross energy
Diet 1	219.44	85.52	67.59	372.55
Diet 2	216.84	88.92	00.57	366.33
Diet 3	213.12	94.72	56.70	364.74
Diet 4	280.52	65.64	18.18	364.34

Diet1: 20 g AYB and 80 g BG; diet 2: 50 g AYB and 50 g AYB and 50 g BG diet 3: 80 g AYB and 20 g BG; diet 4: Nutrend Nestle Infant food

TABLE 4

Minerals and vitamins content

	K^+	Ca^{2+}	Na^+	Mg^{2+}	P	Vit.A	Vit. C
Diet 1	981.00± 3.13	513.10±3.20	210.51± 2.31	41.10± 1.32	20.10±1.10	0.52± 0.03	5.12±0.02
Diet 2	1011.2± 4.21	562.31± 3.30	243.10± 2.42	44.01±1.21	21. 13±1.12	0.67± 0.01	5.65±0.01
Diet 3	1132.0± 4.4	592.10± 3.33	315.23± 2.52	49.41±1.13	29.06±1.32	0.76± 0.03	5.84±0.02
Diet 4	802.1± 2.32	664.10± 4.51	240.10± 2.14	57.60 ±1.21	26.11±1.23	0.05± 0.01	0.65±0.02

Diet1: 20 g AYB and 80 g BG; diet 2: 50 g AYB and 50 g AYB and 50 g BG diet 3: 80 g AYB and 20 g BG; diet 4: Nutrend Nestle Infant food

were close -10.33, 10.63 and 10.79 per cent, respectively, and significantly higher ($P < 0.05$) than in Nutrend (7.35%). The ash contents of all the samples were similar ($P < 0.05$).

The calculated gross energy values show similar results, for test diet. The values were also close to that of the control (Nutrend) and were within the recommended energy allowance for infant food and also agreed with other values for home-made infant food similar to Pellet and Marmabachi (1978), who obtained energy value of 353.0 Kcal/100 g in home-made weaning mixture. The results show that the vitamin contents, of test diet 3 were remarkably higher than those of diets, 1, 2, and 4. Potassium, Na and P contents increased significantly as the AYB proportion of the diets increased (Table 4), and increased with increasing quantity of AYB in each diet.

Calcium and Mg contents in diet 4 (Table 4) were remarkably higher than the corresponding values in test diets. However, the mineral and vitamin contents of the test diets were significantly higher than that in diet 4 (contol).

Discussions

Crude protein values of processed African Yam Bean (AYB) and Bambara Groundnut (BG) were less than those of their raw samples. The results compared well with the records of FAO (1985) and Hentges *et al.* (1991) that protein decrease accompany germination. Decreased crude protein content was attributed to increased peptidase activity that hydrolysed the crude protein to amino acids during germination. FAO (1985) recorded increased essential amino acids while Abou-Samaha *et al.* (1985) observed that soaking decreased protein content by loss of soluble protein through leaching. However, the blending of both AYB and BG processed flour gave the test diets higher protein content when compared to that of diet 4, thereby, giving nutritional advantage over the commercial Nestle infant food (Nutrend).

Carbohydrate composition of the Nutrend was higher than those of test diets. The low carbohydrate values of the diets could be because of the reduction in the carbohydrate content of processed AYB and BG. The reduction could be linked to the hydrolysis of starch to dextrin and other reducing sugars (Marero, 1988; Bressari, 1985). As the starch content decreased, sugar content increased. Also, the partial hydrolysis of starch is said to improved digestibility. Bambara groundnut confers the relatively high lipid contents to the test diets off-setting the energy defect from the low carbohydrate value. The high lipid composition tends to proffer nutrient quality to the diet because of its various constituents like essential fatty acids.

Slight increase in fibre content of processed flour samples as against raw samples agreed with records of other legumes like jack beans, chick peas, cowpeas and soyabean (FAO, 1985; Bressani & Elias, 1985; Ologhobo & Fetuga, 1986; Nwokolo, 1987). The fibre content of test diets were higher than that of the Nutrend, and also fell within the allowable maximum fibre level of 5.0 per cent recommended by PAG for infants supplementary food. Considering the importance of fibre in human nutrition as reported by Bach & Munck (1985), it is suggested that the fibre contents of test diets is of better nutritive advantage when compared to that of Nutrend.

Calculated gross energy values of test diets compared favourably with that of Nutrend. All fell within the daily allowable energy of 105 Kcal/kg body weight or 350–450 kcal/100 g food samples for weaning mixture (FAO, 1980). The results indicate the high potential to adequately supply the energy requirement of the infant. A positive correlation exists between energy intake and protein utilization (Achinewhu & Isichei, 1988), thus, the high energy values will likely help in the effective utilization of protein by the body.

The mineral elements (K^+, Mg^{2+}, Na^+, Ca^{2+} and P) values of test diets were comparable with those of Nutrend. The diets showed good sources of K, Na and Ca while P and Mg were moderate. Vitamins A and C values were remarkably higher in test diets than in Nutrend. This could be attributed to the processing techniques applied – soaking and germination (FAO, 1985). High content of vitamin A in test diets could be attributed to carrot (vegetable) added to fortify the diet.

Conclusion

African yam bean and bambara groundnut contain appreciable amounts of nutrients that can be used in place of cowpeas or soybean in processing infant food. Diets formulated from germinated composite flour of these legumes compared favourably with the commercial infant food Nutrend, and had higher protein content quality. Diet 3 had the highest content of K and Na. As a result of hyper-osmolar activity of these cations, diet 3 is considered least favourable for infants. Overall, Diet 1 is suggested as the best option for weaning infants .

Weaning foods prepared from legumes and even the commercial Nutrend ought to be fortified with vegetables or food materials, such as palm oil, carrot, etc., which are high in vitamin A content.

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Received 15 Oct 09; revised 20 Apr 11.