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Effects of Fortification of Rice with Banjara Beans and Sesame on Chemical Composition, Mineral Elements and Vitamin Contents of a Complementary Meal

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Abstract

A weaning food blend was formulated from a local variety of Rice (Dikwa), Banjara Beans and Sesame in a 70:20:10 ratio. The cereal used was fermented rice; Banjara beans and sesame were dehulled and roasted respectively. Standard procedures of Association of official analytical chemist (AOAC) were used to determine the parameters assayed. The results indicated an increase in the Mg (69.3 ± 0.02) Zn (2.45 ± 0.02) and Fe (6.34 ± 0.01) levels of the weaning food blend. Low level of calcium (76.4 ± 0.02) and sodium was recorded. The Riboflavin (0.3254 ± 0.00001) and thiamine (0.6287 ± 0.00001) level were higher compared to the control. The protein content was (8.31 ± 5.41), the moisture content (2.86 ± 1.91), while the fibre content was (5.6 ± 4.40). Carbohydrate content of the blend was lower than the commercial weaning food cerelac® but was however higher than the Recommended Daily Allowance (RDA) for infants at weaning age. It can be concluded that; protein, moisture, fat and carbohydrate content, as well as mineral and Vitamin of the weaning food blend met the RDA value of infants (0 month to 1 year) and thus it can be used in the management of problems associated with protein - energy - malnutrition.

Keywords: *Fermentation; Rice; Banjara beans; Sesame; Vitamin content; Mineral*

Introduction

Adaptation of recommended breast feeding and complementary feeding practices and access to the appropriate quality and quantity of foods are essential components of optimal nutrition for infants and young children [1]. Weaning is a gradual process of introducing solids foods to an infant's diet, alongside breast milk from the age of three to four months, since the breast feeding along cannot meet the infant nutritional requirement [2]. Nutritional status in children is most vulnerable during the weaning stages when both macro and micronutrient may be insufficient to maintain growth and development. The major problems associated with infant during transitional phase of weaning are protein energy malnutrition (PEM). Protein energy malnutrition occurs when children are weaned from liquid to semi-solid or fully adult foods. During this period, children need nutritionally balanced calories - dense supplementary foods in addition to mother's milk because of the increasing nutritional demands of the growing baby [3]. Weaning food plays a vital role in the all round growth development and mental health of children. The effects of supplementation are highly beneficial as a result of infant's specific nutritional need for protein, fat, carbohydrate, minerals and vitamins [4].

The aim of the study is to formulate a weaning blend from rice, Banjara bean and sesame and to determine the chemical composition and Nutritional quality of the weaning food blend.

Materials and Methods

Sources of raw materials

Rice, Banjara beans and Sesame were all obtained from Maiduguri, Monday Market, Borno State Nigeria. The cereal and legumes were authenticated by a seed breeder and plant taxonomist form Lake Chad Research Institute and Department of Biological Science University of Maidugri respectively.

Sample preparation

Preparation of rice

The rice was prepared by method described by Voughan and Tamooka [5]. One hundred grams (100 g) of cleaned rice was steeped in 200 ml of distilled water (1:2 w/v) for 24 hours. At the end of the 24 hours the rice was washed and sun-dried. The dried rice was ground into a fine powder and sieved into a uniform particle using a 10 mm sieve size.

Preparation of Banjara beans

About 100 g of Banjara beans seed was cleaned washed and then soaked in distilled water for twenty minutes. The seeds were dehulled washed to remove the husk, after which it was sun-dried to a constant weight. The dried Banjara beans seed was roasted and then milled into fine powdered flour [6].

Preparation of sesame seed

About 100 g of sesame seed was washed by using calabash to remove sand and other impurities and sun-died. The dried sesame seed was milled into a fine powder as described by Ray Haysen [7].

Formulation of the weaning food blends

The weaning food was formulated in a 70:20:10 ratio *i.e.*, 70 parts of fermented rice, 20 parts of roasted Banjara beans and 10 parts of sesame. (70 g Rice: 20 g Banjara beans: 10 g Sesame)

Proximate composition

Proximate composition (moisture, ash, crude protein, crude fat, crude fibre and carbohydrate content) was determined according to the methods of AOAC [8].

Mineral elements analysis (AAS)

Twenty grams of each sample was weighed using electric weighing machine. The sample was then ashed in a furnace at ashing temperature of 550°C. After the ashing, 1 g of ashed sampled was digested. One gram of the sample was in a 200 ml beaker and 30 ml of nitric acid and distilled water was then added to sample in the beaker. The sample is then warmed over water bath for 35 minutes and then allowed to cool. The digested sample is then filtered using white man filter paper and diluted with water to volume of 100 ml. The sample was then run at a particular wave length using Atomic absorption spectrometer (Model AA analyst 400) of Perkin Elmer company product to determine the mineral elements. Vitamin determination was according to AOAC (2000) [8].

Statistical analysis

Data obtained from the research were analyzed using analysis of variance (ANOVA) Duncan multiple range test was used to compare the deficiencies between the means significance was accepted at $P < 0.05$

Results

Table 1 shows the mineral element composition of the unprocessed and processed rice, Banjara beans and sesame. A significant decrease ($P < 0.05$) was observed in the levels of calcium, Zinc and Potassium of the unprocessed and processed rice, Banjara beans and sesame. There was a significant increase in the level of Zn in the processed rice and Banjara beans after processing. There was no significant decrease ($P < 0.05$) in the levels of magnesium in both the unprocessed and processed cereal and legumes, there was also significant increase in the level of sodium Na in the processed sesame and Banjara beans as compared to the unprocessed sesame and Banjara beans. A significant increase was observed in the phosphorus level of the processed rice as compared to that of the unprocessed rice.

Minerals	Rice		Banjara Beans		Sesame	
(Mg/g)	Unprocessed	Processed	Unprocessed	Processed	unprocessed	processed
K	24.81 ± 0.02[a]	23.81 ± 0.02[a]	25.31 ± 0.01[b]	28.26 ± 0.02[c]	34.47 ± 0.01[d]	40.24 ± 0.01[e]
Ca	49.22 ± 0.02[a]	47.25 ± 0.02[b]	52.46 ± 0.0I[c]	51.52 ± 0.02[c]	86.33 ± 0.01[c]	82.81 ± 0.02[d]
Na	32.12 ± 0.01[a]	32.02 ± 0.02[a]	29.03 ± 0.01[b]	30.22 ± 0.02[b]	26.33 ± 0.01[b]	82.81 ± 0.02[c]
Mg	85.12 ± 0.02[a]	84.57 ± 0.02[a]	53.27 ± 0.02[a]	54.04 ± 0.01[a]	65.75 ± 0.02[a]	66.27 ± 0.01[a]
Fe	4.63 ± 0.02[a]	5.25 ± 0.02[a]	4.85 ± 0.02[b]	3.24 ± 0.02[c]	5.87 ± 0.02[a]	4.24 ± 0.02[b]
Zn	3.13 ± 0.02[a]	5.82 ± 0.02[b]	2.81 ± 0.02[c]	4.74 ± 0.02[d]	6.05 ± 0.02[e]	4.53 ± 0.02[f]
P	52.45 ± 0.02[b]	66.2 ± 0.02[a]	106.5 ± 0.02[a]	65.23 ± 0.02	61.05 ± 0.02	55.23 ± 0.02

Table 1: *Mineral element composition of unprocessed and processed rice, banjara beans and sesame.*
Values are recorded as mean ± SD of three determination values in the same row with different superscripts are significantly different (P < 0.05).

Table 2 below shows the mineral element composition of the weaning food blend compared with commercial weaning food. The level of magnesium, zinc and iron compare favourable with the commercial weaning food frisogold® while the levels of Ca, Na and P were lower than the values reported in the commercial weaning food Frisogold®

Mineral Element (Mg/g)	Formulated Weaning Meal Rice, Banjara Beans and Sesame(70:20:10) (100 g/g)	Commercial Weaning Food Frisogold® (100 g/g)
K	32.8 ± 0.01	495
Ca	76.32 ± 0.02	350
Na	33.3 ± 0.02	120
Mg	69.25 ± 0.02	39
Fe	5.34 ± 0.01	7.5
Zn	2.45 ± 0.02	1.7
P	94.5 ± 0.01	330

Table 2: *Mineral element of a weaning meal compared with commercial weaning diet cereal.*
Values are recorded as mean ± SD of three determination values in the same row with different superscripts are significantly different (P < 0.05).
**70 parts of rice, 20 parts of banjara beans, 10 parts of sesame.*
***The commercial weaning food Frisogold® is NAFDAC approved.*
****Frisogold®.*

Table 3 below presents the vitamin content of the unprocessed and processed rice, Banjara beans and sesame. There was a decrease in the ascorbic acid level in the rice, Banjara beans and sesame. An increase in the thiamine content of the Banjara beans was increased in the processed beans. Thiamine and Riboflavin content was not detected in the rice and riboflavin was not detected in the sesame.

Table 4 below presents the vitamin content of the weaning food blend. Thiamine level of the weaning blend compare with the commercial weaning food Friscogold®. The level of riboflavin of the weaning food blend is close to that of the commercial weaning food.

Vitamins	Rice		Banjara Beans		Sesame	
(Mg/ml)	Unprocessed	Processed	Unprocessed	Processed	unprocessed	processed
Ascorbic acid	0.00037 ± 0.00001	0.00015 ± 0.00001	0.13963 ± 0.00001	0.02788 ± 0.00001	0.01742 ± 0.00001	0.01147 ± 0.00001
Thiamine	-	-	0.2875 ± 0.00001	0.8026 ± 0.00001	0.5284 ± 0.00001	0.01136 ± 0.00001
Riboflavin	-	-	0.02263 ± 0.00001	0.00606 ± 0.00001	-	-

Table 3: *Vitamins contents of processed and unprocessed rice, Banjara beans and sesame.*
Values are recorded as mean ± SD of three determination values in the same row with different superscripts are significantly different (P < 0.05).

Vitamins (mg/ml)	Formulated Weaning Meal Rice, Banjara Beans and Sesame (70:20:10) (100 g/g)	Commercial Weaning Food Frisogold® (100 g/g)
Ascorbic acid	0.0254 ± 0.00001	ND
Thiamine	0.6287 ± 0.00001	0.6
Riboflavin	0.3252 ± 0.00001	0.45

Table 4: *Vitamin Composition of the weaning food blend compared with commercial weaning food Frisogold®.*
Values are recorded as mean ± SD of three determination values in the same row with different superscripts are significantly different (P < 0.05).
**70 parts of rice, 20 parts of banjara beans, 10 parts of sesame.*
***The commercial weaning food Frisogold® is NAFDAC approved.*
**** Frisogold®.*
***** Not detected.*

Table 5 below shows the proximate composition of the raw and processed rice, Banjara beans and sesame. There is a significant decrease I the level of rice after processing protein content was higher in the processed rice and Banjara beans after processing. A decrease was observed in the processed sesame. The Ash fat dry matter of all the cerelac and legume did to show and significant differences (P > 0.05). Fibre content of the raw and processed Banjara beans and sesame showed a significant difference (P < 0.05). A significant difference (P < 0.05) was not shown in the carbohydrate content of the raw and processed Banjara beans, however a significant difference (P < 0.05) was observed in the carbohydrate content of the raw and processed rice and sesame. A significant (P < 0.05) decrease was observed in the moisture content of the processed rice. The legumes did not show any significant difference in the moisture content.

The proximate composition of the weaning food blend compared to the commercial weaning food is present in table 5. The results indicated that moisture and fat content were higher than the commercial weaning food cerelac® and recommended daily allowance of infant (9 months - 1 year). The protein and fibre content of the weaning meal/blend compare favourably with the RDA value for infants (0 month - 1 year) though the protein content of the commercial weaning food cerelac® was higher than the weaning food blend levels of carbohydrate in the weaning food blend was higher than that of the RDA value and closely compared to that of the commercial weaning food.

Proximate Analysis	Unprocessed Rice	Processed Rice	Unprocessed Banjara Bean	Processed Banjara Bean	Unprocessed Sesame	Processed Sesame
% Dry matter content	71.07 ± 47.38[a]	71.81 ± 47.87[a]	72.34 ± 48.22[a]	72.71 ± 48.30[a]	73.71 ± 49.18[a]	73.40 ± 48[a]
% Moisture content	8.07 ± 47.38[a]	3.22 ± 2.15[b]	2.68 ± 1.79[a]	2.57 ± 1.75[a]	1.24 ± 0.82[a]	1.55 ± 1.03[a]
% Crude protein content	4.85 ± 3.23[a]	15.48 ± 10.32[a]	9.41 ± 6.28[a]	11.00 ± 7.34[b]	12.19 ± 18.13[b]	8.66 ± 5.78[a]
% Ether extract/fat content	0.80 ± 0.54[a]	0.80 ± 0.54[a]	0.80 ± 0.54[a]	0.80 ± 0.54[a]	20.2 ± 13.49[a]	16.45 ± 10.9[b]
% Crude fiber content	1.35 ± 0.93[a]	2.3 ± 1.5[a]	6.80 ± 4.53[a]	3.6 ± 2.41[b]	30.8 ± 20.53[a]	37.35 ± 24[b]
% Ash content	0.80 ± 0.54[a]	0.80 ± 0.54[a]	0.80 ± 0.54[a]	1.35 ± 0.93[a]	0.80 ± 0.54[a]	0.80 ± 0.54[a]
% Nitrogen free extract	47.15 ± 49.38[a]	55.76 ± 37.18[b]	12.41 ± 11.32[a]	58.39 ± 38.9[b]	11.10 ± 7.41[a]	11.89 ± 7.94[a]
% Carbohydrate content	64.16 ± 42.78[a]	53.30 ± 35.53[b]	55.43 ± 36.96[b]	56.50 ± 37.6[b]	30.06 ± 20.04[c]	26.70 ± 17.8[d]

Table 5: *Proximate Composition of Raw and Processed Rice, Banjara Beans and sesame.*
Values are recorded as mean ± SD of three determination values in the same row with different superscripts are significantly different (P < 0.05).

Discussion

The loss in the levels of the essential minerals such as calcium and zinc could be attributed to the loss in ash content during processing [9]. Also the increase in the level of phosphorus, sodium in the processed Banjara beans, sesame and rice could be due to the reduction of phytic acid during processing [10]. The level of Mg, (69.3 ± 0.04) Zn (2.45 ± 0.02) and Fe (6.34 ± 0.01) compare favourably with the commercial weaning food and the recommended daily allowance of infants form 0 months to 1 year similar results were reported by Idowu, *et al*. [11]. The decrease in ascorbic acid content in the cereal legume weaning food blend and increase in the thiamine level of Banjara beans goes in the with the findings of Marero, *et al*. [12] which also reported an increase in thiamine content in a cereal legume weaning food blend Riboflavin (0.3254 ± 0.00001) and Thiamine (0.6287 ± 0.00001) content of the weaning food blend compared favourably with the commercial weaning food frisogold® and has met the RDA value of infants at weaning age. The same findings were reported by Elemo, *et al*. [13]. The low moisture content (2.86 ± 1.91) indicates that the weaning food blend will have a good shelf life, because high moisture content of food encourage microbial growth [14]. Low moisture on content of formulations and required for convenient packaging and transport of products [15]. The increase in the protein content of the processed rice, Banjara beans and sesame could be as a result of improvement in protein content during processing increase in protein content (8.13 ± 5.41) of the weaning food blend was contributed by the complementation with legumes. According to FAO/WHO [16], a minimum protein content of 8.0% is required for maximum complementation of amino acids in foods and growth of infants. The fibre composition of 5.6 is corresponding to that of the commercial weaning food and RDA value fibre for weaning infant. The carbohydrate content (56.67 ± 3.78) of the weaning food blend compare closely to the commercial weaning food cerelac®. This implies that the product would supply the needed energy to meet infants growth demand [17]. Ash for the raw and processed rice, Banjara beans sesame and the weaning food blend was observed to be very low in the range of 0.8 ± 0.54, these values are similar to the values reported by Egountely [18]. Nitrogen extent was higher in the processed rice, Banjara beans and sesame than the raw samples. This is in line with earlier report of Mariam [2].

Conclusion

The study revealed that the weaning food blend formulated from fermented rice, Banjara beans and sesame can adequately meet both micro and macro nutrients needs of infants and children. The weaning food blend were comparable to commercial weaning food cerelac® and met the RDA for infants at weaning age. It can therefore be used as potential substitute for weaning food for infants at 1-3 years.

Recommendation

There is the need to improve on the ascorbic acid content of the weaning food blend as well as the Ca, K and Na levels since they are essential for the growing children

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