

Studies on the Proximate Composition, Antinutritional Properties, Vitamin and Mineral Element Content of Rice Fermented Meal Fortified with Steamed Cowpea Flour and Roasted Groundnut

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Abstract

Nutrient and antinutritional properties of a weaning food blend was produced using rice, cowpea and groundnut. The rice was fermented, the cowpea was steamed and the groundnut was roasted. The weaning food blend was formulated in a 70: 10: 20 ratio i.e. 70(g) of rice, 10(g) of cowpea and 20(g) of groundnut. The parameters assayed include proximate composition, antinutritional properties vitamins and mineral element using standard laboratory procedures: The statistical package for social science (SPSS) expressed as mean \pm SEM. One way analysis of variance (ANOVA) was used as a method of obtaining data and the means were compared using Duncan's multiple range test. Differences were considered significant at $p < 0.05$. The weaning food blend exhibited a low moisture content (4.1 ± 0.01). The result of the protein of the weaning food blend (12.31 ± 0.01) is below to the commercial weaning food cerelac[®] (15) but has met the RDA of infants (12.44). Processing and supplementation resulted in decreased level of phytic acid and tannin content. Processing (fermenting steaming, roasting), also reduced the levels of some vitamins and minerals vitamin B1 (1.30 ± 0.16) and B2 (0.38 ± 0.31) of the weaning food blend is equal when compared to weaning food cerelac[®] (0.3) (04) and met the RDA of infants 0 - 1 year (0.3) and (0.4) respectively. Value of sodium in the weaning food blend (121.04 ± 0.03) was slightly higher than the RDA of infants 0 - 1 year (120). In conclusion the results from this study shows that the fortification of rice with cowpea and groundnut as a weaning food blend has improved the nutrient quality and can be used for infants at weaning age.

Keywords: Rice; Cowpea; Groundnut; Commercial Weaning Food

Introduction

The term weaning is defined as "to introduce a child to feed on a meal other than the mothers breast milk". Weaning can also be defined as introducing food other than breast milk. At about 6months of age, low levels of iron and vitamin D have been observed with an increase need of nutrients. Good weaning practices play a major role in reducing nutritional problems [1].

Akamu or koko is the first weaning food prepared in most developing countries like Nigeria which is usually prepared from maize, Millet, Rice etc. After the successful introduction of cereal gruels, other staple foods in the family menu are given to the child. These foods include rice, maize, yam, gari etc. Like other cereal products e.g. sorghum, rice, maize products have poor nutritional value and it is due to the deficiency of some essential amino acid and presence of some anti-nutritional factors such as phytic acid and tannins [2].

Cereals have high carbohydrate but lack the essential amino acids such as lysine which makes them inferior in terms of protein quality [3]. There is need to supplement these cereals with suitable protein crops (Legumes) like cowpea (steamed), groundnut, soybean etc. to be suitable as a weaning meal. In Africa a lot of infant formula have been produced from local cereals and legumes [4,5]. This has been suggested by the Integrated Child Development Scheme (ICDS) and FMO to combat malnutrition among children of low socio-economic group.

Exclusive breast feeding is adequate up to 3 - 4 months of age in West African countries, after then it becomes insufficient to support the growth of the infant [6]. Note, that breastmilk is the best food needed by the growing infant because it contains all the necessary nutrients [7]. When the child is undergoing rapid growth, physiological maturation and development breast milk is no longer sufficient to meet nutritional needs of the infant, there is the need to introduce other foods to the infant alongside breast milk [8]. Traditional weaning foods in Nigeria and most part of the West Africa are produced from high carbohydrate low protein foods referred to as "Akamu" or "Ogi" [9]. Commercial infant formula are expensive in Nigeria and about 40% of the population cannot afford it mainly because of poverty [10].

The early discontinuance of breast feeding by mothers of low income groups in urban areas of most developing countries has been a serious concern for some years [11]. Malnutrition (often in combination with infection) is the factor responsible for the high infant mortality (WHO, 1980). Most of these infants' morbidity and mortality could be prevented by improved nutrition, hygiene, housing and healthcare [12]. There is need for weaning diets high in protein, digestible and affordable. Unfortunately, this is lacking especially in rural parts of developing countries [13]. Processing methods such as fermentation have improved the nutritional quality by reducing the levels of antinutritional factors as reported by various researchers [14].

Objectives of the Study

The objectives are to determine:

- The proximate composition (moisture, ash, fibre, fat, carbohydrate, protein and dry matter) of the weaning food blend.
- The anti-nutritional properties of the weaning food blend.
- Vitamin composition of the weaning food blend.
- The Mineral element content of the weaning food blend.

Materials and Methods

Materials

Rice (Dikwa rice), cowpea seeds and groundnut were purchased from Maiduguri Monday Market in Maiduguri and authenticated by a seed breeder at Lake Chad Research Institute, Borno State, Nigeria.

Methods

Preparation of Rice (processed or fermented)

The rice was first cleaned by picking the black particles. The "Akamu" was prepared as method adopted by Akingbala, *et al* [15].

Two thousand grams (2000g) of rice was soaked in 4000mls of water in a clean transparent plastic bucket. After 3 days fermentation, the rice was then washed and milled into slurry and then sieved using a sieving cloth just like it is done in the preparation of "Akamu". The residue was allowed to stand for 24 hours then dried under the sun i.e sun drying for days to obtain powdered flour (rice flour) at constant moisture.

Preparation of cowpea (processed or steamed)

Cowpea seeds were also thoroughly cleaned of dirt’s and stones by picking and sorting the good ones from the bad ones. 100 grams of the cleaned cowpea seeds was steamed for 20-30 minutes by moist heat method (steaming) using colander and pot. The steamed cowpea seeds were dehulled using mortar and pestle. The seeds were washed by hands to remove the seeds coats. The seeds were thoroughly washed and sun dried on a grease free clean mat for three (3) days. The dried cowpea seeds were milled into a fine powder to obtain the processed cowpea flour [16].

Preparation of groundnut (processed or roasted groundnut)

The groundnut was sorted of all dirt by picking the bad ones. About 100 grams of the cleaned groundnut was roasted at low temperature and dehulled. The cleaned and dehulled groundnuts were milled into powdered form but note: not as fine as the cowpea and the rice but also not oily. The groundnut was milled into “cous-cous” sized powder [17].

Formulation of the infant Weaning Food Blend

Weaning food was formulated in of 70:10:20 ratio. The processed or fermented rice flour was mixed with groundnut flour and cowpea flour in the ratio 70:10:20 respectively. 70g of fermented rice, 10g of cowpea flour (processed), 20g of processed groundnut flour to produce fermented rice flour fortified with steamed cowpea and roasted groundnut. i.e. 70g: Rice; 10g: Cowpea; 20g: G/nut.

Drying pattern

The processed rice (“Akamu”) was dried till constant moisture was obtained. The initial weight of the “akamu” was 3897.5g and it was sun dried for seven days before constant moisture was attained at the weight of 1794.2g which is the final weight. The days and weight of the Akamu in the drying pattern is shown below.

Days	Weight (g)
Initial	3897.5
Day 1	2393.8
Day 2	1834.7
Day 3	1819.2
Day 4	1805.0
Day 5	1794.7
Day 6	1794.2
Day 7	1794.2

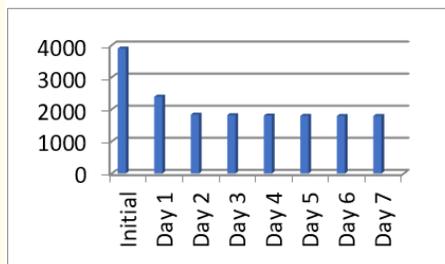


Figure 1: Drying pattern.

Proximate analysis

Proximate analysis (chemical analysis) the moisture contents, protein, fat, ash, crude fiber and carbohydrate of rice, cowpea and groundnut were determined using Association of Official Analytical Chemist [18].

Determination of crude protein

Keljedal method was used in determining the level of crude protein as described by Okalebo., *et al.* (2002) 1g or 2g of samples was weight into a digestion tube and 1 or 2 Keljedal tablets were added, 10 or 20mls of concentrated sulphuric acid (Conc. H₂SO₄) was added onto the tube and digested at 420°C for 3 - 5 hours. After cooling, 80 or 90 mls of distilled water was added into the digested solution. About 50 mls of 40% caustic soda (NaOH) was added onto 50 mls of digested and diluted solution and placed on heating section of the distillation chamber, 30 mls of 4% boric acid bromo cresol green and methyl red as an indicator was put onto conical flask and placed underneath the distillation chamber for collection of ammonia, the solution changed from orange to green colour. About 0.1 normal solution of hydrochloric acid (HCl) was weight into burette. The conical flask containing the solution was titrated until the color changes from green to pink, the burette reading was taken.

The crude protein was calculated using the formula:

$$\% \text{crude protein} = \frac{(A-B) \times N \times F \times 6.25}{\text{mg of sample}} \times 100$$

Where:

A= mls of acid used for titrating the sample

B= mls of acid used for titrating blank sample (0)

N= Normality of acid used for titration

F= Factor = 14.007

6.25= constant

100 = conversion to %.

Determination of dry matter content

The dry matter content of the samples were determined by weighing log of samples into petri dish while placed in hot oven at 105°C for 24 hours and then removed and placed in desiccator to cool, after cooling you reweigh it.

The dry matter content was calculated using the formula: $\frac{W_1 - W_2}{W} \times 100$

Where:

W1= Weight of petri dish with sample in grams before oven dried

W2= Weight of petri dish with sample in grams after oven dried

W= Weight of empty petri dish in grams.

Determination of crude fibre content

Crude fibre was determined by weighing 2g of samples placed in a round or flat bottom flask and 50 mls of Tri-chloroacetic Acid reagent (TCA) was added, the mixture was boiled and refluxed for 40 minutes. Fiber paper was removed and cooled to 100m temperature. The residue was filtered using a filter paper. The residue obtained was washed 4 times with hot water and once with petroleum ether than the filter paper plus were folded together and dried at 30°C – 60°C in an oven for 24 hours, reweighed and ash at 650°C and then cooled and reweighed.

The crude fiber content was calculated using the formula:

$$\% \text{crude fiber} = \frac{\text{Difference in weighing}}{\text{Weight of sample on DM basis}} \times 100$$

Determination of ether extract (fat) content

The ether extract was determined by using Soxhlet apparatus, 1 or 2 grams of the feed sample was weighed into a thimble and 200mls of petroleum ether was measured with measuring cylinder, the solution was put into round or flat bottom flask and was heated at 45°C for 1 hour interval for 2 hours. The collecting flask was removed and cooled into desiccators for 15 minutes and percentage fat sample is determined by using the formula:

$$\% \text{ Fat} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

Determination of ash content

To determine the ash content, 1 or 2 grams of sample was weight into crucible and dried at 105°C for 244 hours then cooled in a desiccators for 15 minutes and reweighed. It was then charred at 600°C or 650°C in muffle furnace for 2 - 3 hours. Then cooled in desiccators for 15 minutes and reweighed.

The ash content was calculated using the formula:

$$\% \text{ Ash} = \frac{\text{loss in weight}}{\text{initial weight}} \times 100$$

Determination of carbohydrate content

Percentage carbohydrate was determined by computing indirectly by difference using the formula:

$$\% \text{ carbohydrate} = 100 - (\% \text{Mct} + \% \text{Cp} + \text{Cf})$$

Determination of energy content

The energy of each sample was calculated using water factor method as described by Mahgoub (1999).

$$\text{Energy (kg)/100} = 4.186 \times (\% \text{ Cp} \times 4) + (\% \text{fat} \times 9) + (\% \text{ carbohydrate} \times 4).$$

Antinutritional factor

Phytic acid procedure

Phytic acid content of the raw and processed rice, cowpea and groundnut were determined according to the method described by Davies and Reid [19]. A gram (1g) of sample was extracted by taking 40 ml of 0.5 M nitric acid in a conical flask and shaken for 1h on a shaker at 30°C and 80 revolutions per minute. The samples were filtered and 5 ml of 0.08M ferric chloride was added and boiled for 20 min and filtered. The free iron (Fe) remaining in the solution was determined colorimetrically by adding 2 ml of 0.005M ammonium thiocyanate and the iron binding capacities of the extract was determined by difference. Results were recorded in Mg bound per gram of sample.

Tannin procedure

Method described by Price and Butler [20] was used in determination of the tannin content. About 0.2g of sample was weighed into Erlenmeyer flask, and 10 ml of 4% HCL in methanol was pipetted into the flask. The flask was closed with parafilm and shaken for 20 min on a shaker. 1 ml of extract was pipetted and 1 ml of 1% vanillin and 0.5 ml of conc. HCL was added.

Five test tubes were labelled 1, 2, 3, 4 and 5 to produce the standard solutions. Into the five test tubes, 0.1, 0.3, 0.5, 0.7 and 1.0 ml of phenol reagent was added respectively. The test tubes were made up to 1 ml with methanol (8% HCL in methanol). 1.0 ml of 1% vanillin and 0.5 ml conc. HCL was added to the tubes and made up to 5.5 ml with 4% HCL in methanol. 5 ml of 4% HCL in methanol was prepared as blank. Spectrophotometer was used to read the absorbance of standard solutions, sample extract and blank at 500nm 20 min after incubation.

Calculation

$$A_u = A_{std}$$

$$C_u = C_{std}$$

$$C_u = A_u \times C_{std} = \text{mg/g}$$

$$A_{std}$$

Where

A_u = Absorbance of unknown.

A_{std} = Absorbance of standard.

C_u = Concentration of unknown.

C_{std} = Concentration of standard.

Mineral element was determined by AAS

The technique makes use of absorption spectrometry to assess the concentration of analyte in the samples Rice, groundnut and cowpea. It requires standard with known analyte content to establish the relation between the measured absorbance and the analyte concentration and relies therefore on the Beer-Lambert Law.

Atomic Absorption Spectrophotometer (AAS) AA 6800 series Shimadzu Corp was used for the determination of Ca, P, K, Fe, and Mg.

Procedure

Two gram (2g) of the sample in a crucible was weighed and incinerated at 600c for 2 hours. The ashes were transferred into 199ml volumetric flask and 100ml of distilled water was added into it and a reading was taken on the AAS (Atomic Absorption Spectrophotometer). The appropriate lamps and wavelength for each element were specified in the instruction manual (Sun DH., *et al.* 2000).

Determination of vitamin B1, B2, B6, C

Material: Reagent and glass were all use in this work, work wares of analytical grade and distilled water was used throughout the experimentation. Then glass wares were washed with liquid soap rinsed with water before used.

Centrifuge, ultrasonic machine, uv/visible spectrophotometer, glass wares 0.1% TFA (Trifluoroacetic and Etharnol) (95%) and weighing balance (Thompson 1977).

Procedures

One (1g) of sample was accurately weighed using weighing balance and transferred to a centrifuge test tube. 10 mls of 0.1% TFA was added to the sample and mixed with aid of ultrasonic machine for 50 minutes. The sample was then removed and centrifuged using machine for 30 minutes at 2500 RPM.

The filtrate was then scanned using UV-VIS spectrophotometer at different wavelength for each of the vitamin (B1-233 nm, B2-266 nm, B6-290 nm and C-244 nm). The vitamin and the absorbance was then recorded for each of the Vitamin and the concentration of the sample was calculated using beer-lambert format.

A= abc

Where A = Absorbance

a= Molar absorptivity

b= Path length of the cuvette

c = Concentration.

Statistical tool

Analysis of variance (ANOVA) was used in determining the data obtained from the experiment. All the determination were made in three triplicates and the differences among the means were separated using the DUNCAN multiple range test with significant differences at 5% ($p < 0.05$).

Results

The proximate composition of the unprocessed and processed rice, cowpea and groundnut are presented in table 1. Significant decreases ($p \leq 0.05$) in ash, fat and dry matter contents were observed in the processed rice, cowpea and groundnut. Significant increase ($p \leq 0.05$) processed rice showed significant reduction in their moisture content and there is a significant decrease and the moisture of processed cowpea is (4.60 ± 0.15) and groundnut (3.10 ± 0.06). Significant decrease ($p \leq 0.05$) in fiber contents were observed in processed rice (9.00 ± 0.05) and cowpea (1.06 ± 0.02) and significant increase observed in processed groundnut (1.21 ± 0.01). Significant decrease in protein content of processed cowpea (9.36 ± 0.01) is observed and significant increase in protein content is observed in processed rice (9.51 ± 0.02) and groundnut (10.45 ± 0.02). Significant increase in carbohydrate contents were observed in processed groundnut and rice, and there is significant decrease in the carbohydrate content of cowpea. Processed cowpea and rice increased in their energy value and processed groundnut significantly decreased as observed.

Nutrients (%)	Sample					
	Rice		Cowpea		Groundnut	
	Raw	Fermented	Raw	Steamed	Raw	Roasted
Moisture %	3.30 ± 0.09 ^a	3.60 ± 0.10 ^b	8.11 ± 0.01 ^c	4.60 ± 0.15 ^d	4.56 ± 0.02 ^d	3.10 ± 0.06 ^b
Ash %	2.50 ± 0.03 ^a	1.60 ± 0.01 ^b	2.11 ± 0.02 ^a	1.31 ± 0.01 ^b	1.95 ± 0.01 ^a	1.03 ± 0.01 ^b
Fibre %	14.03 ± 0.02 ^a	9.00 ± 0.15 ^b	1.67 ± 0.01 ^c	1.06 ± 0.02 ^d	0.56 ± 0.01 ^e	1.21 ± 0.02 ^d
Fat %	1.97 ± 0.01 ^a	2.15 ± 0.10 ^b	3.46 ± 0.02 ^c	2.91 ± 0.02 ^b	7.31 ± 0.02 ^d	1.36 ± 0.02 ^b
Protein %	8.71 ± 0.01 ^a	9.51 ± 0.02 ^b	11.34 ± 0.01 ^c	9.36 ± 0.01 ^b	9.86 ± 0.01 ^a	10.45 ± 0.02 ^b
Carbohydrate %	70.0 ± 0.06 ^a	75.10 ± 0.06 ^b	60.11 ± 0.01 ^c	59.30 ± 0.12 ^d	55.71 ± 0.01 ^c	60.20 ± 0.12 ^f
Energy (Kcal/100g) %	89.51 ± 0.06 ^a	90.78 ± 0.01 ^b	55.67 ± 0.06 ^c	56.71 ± 0.02 ^c	79.41 ± 0.01 ^d	63.40 ± 0.03 ^e
Dry matter %	96.91 ± 0.03 ^a	90.60 ± 0.04 ^b	71.30 ± 0.06 ^c	9.34 ± 0.01 ^e	63.40 ± 0.02 ^f	3.41 ± 0.01 ^g

Table 1: The Proximate composition of raw and processed rice, cowpea, and groundnut.

Values were expressed as mean ± SEM of triplicate determination. Values with different superscript in the same row are significantly different ($P < 0.05$).

The proximate composition of the rice, cowpea and groundnut formulated weaning food blend and commercial infant food cerelac[®] is presented in table 2. The fat content (3.31 ± 0.04) and the energy content (96.75 ± 0.01) of the weaning food blend is below the commercial weaning food cerelac[®] and RDA of infant. The protein content (12.31 ± 0.01) of the weaning food blend is low to the commercial weaning food cerelac[®] (15), and comparable to RDA of infants 0 - 1 year (12.44). Level of fibre of the weaning food blend is higher than the weaning food cerelac[®].

Parameter (%)	Weaning Food Blend		
	70: 10: 20 (RCG)	Cerelac [®]	RDA
Moisture (%)	4.1 ± 0.01	ND	-
Ash %	2.11 ± 0.01	3.0	-
Fat %	3.31 ± 0.02	10	10
Protein %	12.31 ± 0.01	15	12.44
Fibre %	8.67 ± 0.01	2.0	-
Energy %	96.75 ± 0.01	410	400
Dry Matter %	97.31 ± 0.02	ND	-

Table 2: The proximate composition of weaning food blend and commercial weaning food (Cerelac[®]).

Values were expressed as Mean ± SEM of triplicate determination.

RCG - Rice, Cowpea, Groundnut (70:10:20), Cerelac[®] - Nestle Nigeria Plc, ND - Not Determinant; RDA - Recommended Dietary Allowance.

Antinutritional content

The phytic acid and Tannin content of unprocessed and processed rice, Cowpea and Groundnut is presented in table 3.

Parameter	Sample					
	Rice		Cowpea		Groundnut	
	Raw	Fermented	Raw	Steamed	Raw	Roasted
Phytic acid %	1.23 ± 0.12 ^a	0.23 ± 0.10 ^b	0.52 ± 0.31 ^c	0.16 ± 0.01 ^d	0.47 ± 0.05 ^e	0.12 ± 0.16 ^f
Tannin %	1.75 ± 0.20 ^a	0.51 ± 0.20 ^b	0.74 ± 0.07 ^a	0.21 ± 0.05 ^b	0.40 ± 0.03 ^a	1.63 ± 0.13 ^a

Table 3: Anti nutritional content of raw and processed rice, cowpea and groundnut.

Value were recorded as mean ± S.D of three determinant. Values in the same row with different superscript are significant different ($P \leq 0.05$).

Phytic acid

Significant decreases ($P \leq 0.05$) in phytic acid level were observed in the processed rice and steamed cowpea and roasted groundnut. A reduction of (0.23 ± 0.20%), (0.16 ± 0.01%) and (0.14 ± 0.01%) were observed in the phytic acid content of fermented rice, steamed cowpea and roasted groundnut respectively. Unprocessed rice had (1.23 ± 0.12%), raw cowpea (0.52 ± 0.31%) and the raw groundnut (0.47 ± 0.05%).

Tannins

Significant reduction ($P \leq 0.05$) in tannin in rice, steamed cowpea and roasted groundnut were observed. A reduction of (0.51 ± 0.33%) of fermented rice, (0.21 ± 0.05%) of steamed cowpea and (0.12 ± 0.16%) of roasted groundnut were observed.

Significant increase was recorded in rice (1.75 ± 0.20%), raw cowpea (0.074 ± 0.07%) and the raw groundnut (0.40 ± 0.03%). The blend has the highest values of (1.46 ± 0.11%), (1.63 ± 0.13%) phytic acid and tannin respectively.

The vitamin content of the raw and processed Rice, cowpea and groundnut is presented in table 4. Vitamin B1, B2 and B6 unprocessed and processed rice, cowpea and groundnut showed significant decreases and an significant increase was observed in the vitamin C content of fermented rice (0.67 ± 0.24) as compared to unprocessed rice (0.52 ± 0.18).

Parameter	Sample					
	Rice		Cowpea		Groundnut	
	Raw	Fermented	Raw	Steamed	Raw	Roasted
Vitamin B1	0.93 ± 0.04 ^a	0.83 ± 0.009 ^b	0.39 ± 0.30 ^c	0.05 ± 0.01 ^d	0.67 ± 0.27 ^e	0.09 ± 0.05 ^f
Vitamin B2	0.76 ± 0.02 ^a	0.43 ± 0.20 ^b	0.39 ± 0.30 ^c	0.3 ± 0.3 ^d	0.53 ± 0.26 ^e	0.33 ± 0.32 ^f
Vitamin B6	0.77 ± 0.020 ^a	0.74 ± 0.25 ^b	0.37 ± 0.31 ^c	0.3 ± 0.5 ^d	0.64 ± 0.26 ^e	0.31 ± 0.23 ^d
Vitamin C	0.52 ± 0.18 ^a	0.67 ± 0.24 ^b	0.14 ± 0.03 ^c	0.07 ± 0.01 ^d	0.61 ± 0.25 ^e	0.55 ± 0.36 ^f

Table 4: Shows the vitamin content of unprocessed and process rice, cowpea bean and groundnut (µg/g).

Value were recorded as mean ± S.D of three determinant. Values in the same row with different superscript are significant different ($P \leq 0.05$).

Vitamin content of the weaning food blend is shown in table 5. Weaning food blend had vitamin B1 (1.30 ± 0.16), B2 (0.38 ± 0.31) which were higher than that of the commercial weaning food cerelac® (0.3) and RDA of infant (0.4) respectively. Vitamin B6 content of the weaning food blend (0.06 ± 0.02) is below of that of commercial weaning food cerelac® (0.5) and the RDA of infant, the vitamin C content of the weaning food blend (0.33 ± 0.10) is below to the RDA of infant.

Parameter	Sample		
	Blend 70:10:20 RCG	Commercial weaning food Cerelac® (100 g/g)	RDA
Vitamin B1	1.30 ± 0.16	0.3	0.3
Vitamin B2	0.38 ± 0.31	0.4	0.4
Vitamin B6	0.06 ± 0.02	0.5	0.3
Vitamin C	0.33 ± 0.10	25	40

Table 5: The content of vitamin of the weaning food blend compared to commercial weaning food cerelac® ($\mu\text{g/g}$).

Value were recorded as mean \pm S.D of three determinants.

RCG - Rice, Cowpea, Groundnut (70:10:20), Cerelac® - Nestle Nigeria Plc, ND - Not determinant, RDA - Recommended Dietary Allowance.

Unprocessed and processed rice, cowpea, and groundnut have their mineral element presented in table 6. A significant ($p < 0.05$) decrease was observed in the sodium, calcium of level of raw and processed rice, cowpea and groundnut. A significant decrease were also observed in the magnesium and potassium content of the raw and processed rice and cowpea, however, a significant increase was observed in the groundnut content of processed as compared to raw groundnut in terms of Magnesium.

Parameter	Sample					
	Rice		Cowpea		Groundnut	
	Raw	Fermented	Raw	Steamed	Raw	Roasted
Sodium	93.3 ± 0.20^a	75.07 ± 0.14^b	20.48 ± 0.23^c	14.56 ± 0.25^d	101.3 ± 0.09^e	65.9 ± 0.05^f
Calcium	1.9 ± 0.17^a	1.8 ± 0.041^b	93.4 ± 0.16^c	74.3 ± 42.9^b	121.25 ± 0.12^e	97.2 ± 0.94^f
Phosphorus	0.36 ± 0.08^a	0.156 ± 0.008^b	4.47 ± 0.18^c	1.98 ± 0.49^d	8.10 ± 0.40^a	7.8 ± 0.12^f
Magnesium	1.83 ± 0.08^a	1.41 ± 0.052^b	163.23 ± 0.08^c	13.7 ± 0.1^b	76.1 ± 37.1^c	98.4 ± 0.20^f
Potassium	34.4 ± 0.28^a	13.2 ± 0.15^b	36.4 ± 0.17^a	30.2 ± 0.21^c	435.62 ± 0.10^d	393.4 ± 0.20^d

Table 6: Mineral content of raw and process rice, cowpea and groundnut ($\text{mg}/100\text{g}$).

Value were recorded as mean \pm S.D of three determinants. Values in the same row with different superscript are significant different ($P \leq 0.05$).

The mineral element content of the weaning food blend is presented in table 7. Sodium, calcium, phosphorus and potassium and magnesium of the weaning food blend were lower than the commercial weaning food blend cerelac®, however, the levels of sodium(121.04 ± 0.03) and magnesium(148.3 ± 0.02) were higher than the RDA of infant 0 – 1 year (120) and (40) respectively.

Parameter	Sample		
	70:10:20 (RCG)	Cerelac®	RDA
Sodium	121.04 ± 0.03	145.00	120
Calcium	136.2 ± 0.14	635.00	400
Phosphorus	9.2 ± 0.2	400.00	ND
Magnesium	148.3 ± 0.2	-	40
Potassium	403.1 ± 0.05	635.00	500

Table 7: Mineral content of weaning food blend compared to commercial weaning food celelac®

Value were recorded as mean ± S.D of three determinant. Values in the same row with different superscript are significant different ($P \leq 0.05$).

RCG – Rice, Cowpea, Groundnut (70:10:20), Cerelac® - Nestle Nigeria Plc, ND - Not Determinant; RDA – Recommended Dietary Allowance.

Discussion

Proximate composition

Fermentation of rice increased the carbohydrate levels of rice. The increase observed in the protein and carbohydrate contents of rice, cowpea and groundnut might be attributed to loss in dry matter mainly fiber. This shows that fermentation increases the protein and carbohydrate quality of the rice. An increase in carbohydrate content was noticed during the fermentation of rice and it is in agreement with the report of Ikemefuna [21].

The weaning food blend has moisture content of 6.41 which is low. Low moisture content showed that the weaning food blend will have long span and low in microbial activity that causes spoilage in foods [22]. The blend is a good source of fiber which is very vital in the stomach where it delays digestion of food. Fibre also helps in detoxification of some toxins produced by bacteria in the small intestine and in the excretion of soft bulky stool.

The weaning food is a good source of protein which is a body building food and is essential for child’s growth as its deficiency leads to primary diseases like kwashiorkor and marasmus. As a good source of energy i.e. the carbohydrate, protein and fats contents are high or good. Carbohydrate is an energy giving food and is essential for child growth as its deficiency leads to malnutrition in children. The blend has low fat content; spoilage can be caused by foods high in fat [23].

Anti-nutrient

Phytic acid

Reduction in the phytic acid during the process of fermentation is caused by the enzyme phytase which breaks down phytic acid [24].

Tannins

The reduction of tannins in the fermented rice, steamed cowpea and roasted groundnut respectively could also be as a result of soaking. Tannins are water soluble in nature [25]. Therefore reduction in tannin content may be attributed to leaching out of phenols into the medium which can be eliminated with the discarded soaking water. Since polyphenolic compounds are present on the outer periphery of the grain, their passing out in the soaking medium is possible [26].

Vitamin

The increase in the vitamin B1 and B2 of RCG is similar to the report of Saleh., *et al.* [27] who reported an increased in the B1 and B2 content. The decrease observed could be as a result of the nature of the raw material, method of determination, microflora and temperature [27] reported similar findings.

Mineral elements

Low content of calcium and potassium reported in this study is similar with the report of Sule., *et al.* [28] who founded that cereals and poor in the mineral. The high level of Sodium and Magnesium in the weaning food blend could be due to effect of fortification of rice with cowpea and groundnut [29].

Conclusion

A high nutritive infant weaning food was formulated in this study. The processing of rice, cowpea and groundnut into flour prolonged the shelf-life of the weaning food blend. The formulated weaning food blend has met the RDA of infants 0 - 1 year in terms of Protein, vitamins, some mineral element content and also enhanced the bioavailability of nutrients.

Recommendation

It is recommended that foods high in calcium like fish and milk may increase the calcium content of the formulated weaning food.

Bibliography

1. Steinkraus KH. "Nutritional significance of fermented foods". *Food Research International* 27 (1994): 259-267.
2. Gazhim S., *et al.* "Effects of feeding a complementary diet formulated from rice, banjara beans and sesame on in vivo studies in weaning rats".
3. Magda SM Dalia ME. "Nutritional evaluation of weaning food blends fortified with some carotenoids rich vegetables". *Journal of Applied Science and Research* 9.3 (2013): 1573-1582.
4. Livingstone., *et al.* "Development and nutritional quality evaluation of weaning foods based on malted, popped and roller dried wheat and chicken". *International Journal of Food Science Technology* 28 (1993): 35-43.
5. Sanni AL., *et al.* "Influence of processing conditions on the nutritive value of Ogi-baba, a Nigerian fermented gruel". *Plant Foods for Human Nutrition* 56 (2001): 217-223.
6. Onofiok NO and Nnanyelugo DO. "Weaning foods in West Africa: Nutritional problems and possible solutions" The United Nations University". *Food Nutrition Bulletin* 19.11 (1992): 1-13.
7. WHO. Six reports on the World Health Situation. Part One. Global analysis. Geneva. (1980).
8. Onweluzo JC and Nwabugwu CC. "Development and evaluation of weaning foods from pigeon pea and millet". *Pakistan Journal of Nutrition* 8.6 (2009): 725-730.

9. Modu S., *et al.* "Evaluation of the nutritional value of a composite meal prepared from pearl millet and cowpea Bayero". *Journal of Pure and Applied Science* 31.1 (2010): 164-168.
10. Adebayo OA., *et al.* "Production and quality evaluation of complementary food formulated from fermented sorghum, walnut and ginger". *Journal of Applied Bioscience* 54 (2012) 3901-3910.
11. Jelliffe DB and Jelliffe EFP. "Human Milk. Nutrition and the World resources crisis". *Science* 188 (1975): 557-561.
12. McLaren DS. "Nutrition Planning: The Poverty of holism". *Nature* 267 (1977): 742-753.
13. Abbey BW and Nkanga UE. "Production of highly quality weaning products from Maize-Cowpea-Crayfish mixtures". *Nutritional Research International* 37: (1988) 95-957.
14. Edema MO and Sanni Al. "Micropopulation of fermenting maize meal for sour maize bread production in Nigeria". *Nigerian Journal Microbiology* 20.2 (2006): 937-946.
15. Akingbala JO., *et al.* "A laboratory procedure for the preparation of Ogi, A Nigerian fermented food". *Journal Food Science* 46 (1981): 1523-1526.
16. Udensi EA., *et al.* "Production and evaluation of the nutritional quality of weaning food formulation from roasted millet and *Mucuna cochinchinesis*". *Sky Journal of Food Science* 1.1 (2012): 1-5.
17. Daves RM. "Physical properties of groundnut grains". *Research Journal Applied Science Engineering Technology* 1.2 (2009) 10-13.
18. AOAC. Association of official and analytical chemist. Official Methods of analysis. Washington DC. 16th Edition 2.44 (2000) 22-33.
19. Davies NT and Reid H. "An evaluation of phytate zinc availability form soya based textured-vegetable protein meat substitutes or meat extenders". *British Journal of Nutrition* 41.3 (1979) 579.
20. Price LM and Buttler LG. "Rapid visual estimation and spectrophotometric determination of tannin content of sorghum grains". *Journal of Agrac and Food Chemistry* 25 (1977): 1268-1273.
21. Ikemefuna, CO. "Fermented foods". *Nutritional Quality of Plant Foods* 2 (1998): 160-198.
22. Ijarotimi OS and Keshino OO. "Determination of amino acid, fatty acid, mineral functional and choking properties of germinated and fermented popcorn (*zea mays Everta*) flour". *European Journal and of Food Research and Review* 2011.2 (2013): P102-122.
23. Akinrele IA. "Fermentation studies on maize during the preparation of a traditional African starch-cake food". *Journal of food Science and Agriculture* 21 (1970) :619-625.
24. Laminu H., *et al.* "Evaluation of the chemical composition, anti-nutrients and mineral element level of a composite meal from pearl millet, wheat, cowpea and groundnut". (2015).

25. TI Mbata, *et al.* "Studies on the microbiological, nutrient composition and antinutritional contents of fermented maize flour fortified with bambara groundnut (*Vigna subterranean L*)". 3.6 (2009): 165-171.
26. Akande KE and Fabiyi EF. "Effect of processing methods on some nutritional factors in legumes seed for poultry feeding". *International Journal of Poultry Science* 9.10 (2010) 996-1001.
27. Saleh S., *et al.* "Effects of fortification of rice with banjara beans and sesame on chemical composition mineral elements and vitamin contents of a complementary meal". *ECronicon Nutrition* 1.2: (2015)35-40.
28. Sule EF., *et al.* "Chemical and nutritional value of maize and maize products obtained from sebaded market in Kaduna state Nigeria". *African Journal of Food Science and Technology* 5.4 (2014): 100-104.
29. Iken JE and Amusa NA. "Consumer acceptability of seventeen popcorn maize (*Zea mays L.*) varieties in Nigeria". *African Journal of Agricultural Research* 5.5 (2010) 405-407.

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