Studies On the Determination of Mineral Element, Vitamin and Proximate Composition in Ndaleyi (Traditional Meal) Fortified with Cowpea

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ABSTRACT
Background: *One of the major health challenges affecting infants in developing countries is protein-energy-malnutrition which occurs during weaning. Weaning foods prepared from fermented cereals such as ndaleyi is of poor nutritional value. There is need to complement these cereals with legumes which are a good source of protein that which help alleviate the problems of protein-energy-malnutrition and enhance growth in infants.*

OBJECTIVE*: To determine the vamin, mineral content and proximate composition of the weaning food.*
METHODS*: Weaning food was formulated from a cereal-legume combination from pearl millet and cowpea. Thepearl millet was fermented to produce "Ndaleyi" while the cowpea was roasted. The weaning food blend was formulated as follows pearl millet (70%) and cowpea (30%). Standard procedures were used for analysis of the parameters.*
RESULTS*: The result showed that vitamin B_1 (45.25±1.17µg/g), B_2 (30.2±1.37 µg/g) and B_6 (28.11±1.30 µg/g) of the weaning blend were higher than frisogold® used as standard (0.6), (0.45) and (0.5) respectively. The weaning food had a Magnesium (376.11±0.51mg/100g), Sodium (571.53±1.02mg/100g), zinc (149.142±1.06mg/100g) and iron (6.16±0.51). Results of the fat (9.3±0.02%), carbohydrate (86.1±0.03%) and energy (407.4±0.030kcal/100g) of the weaning food blend has met that of frisogold®. The protein content of the weaning food blend (13.3±0.04%) is close to frisogold® (16.8).*

CONCLUSION*: The results from this study has showed that fortification of ndaleyi with cowpea greatly improved the nutrients quality of the weaning food blend produced.*

Keywords: Pearl millet, Cowpea, Vitamin, Mineral element, Ndaleyi.

INTRODUCTION

The best food for an infant is the breast milk which has been designed by nature to contain all of the necessary nutrients that a developing infant needs. In many West African countries, exclusive breast feeding is usually adequate up to 3 - 4 months of age, but after this period it may become increasingly inadequate to support the nutritional demands of the growing infant [20]. When the child is undergoing rapid growth, physiological maturation and development breast milk is no longer sufficient to meet the nutritional needs of the infants, there is the need to introduce other foods to the infant alongside breast milk [21]. The infant is gradually introduced to a semi solid gruel which should ideally be easily digestible, of high energy density and low bulk to supplement the infants" feeding early in life [21]. Poor nutrition during this critical period of life may increase the risk of growth faltering and may have adverse health and mental development in the infant [12]. Traditional weaning foods in Nigeria and most parts of West Africa consist of single monocereal grains prepared from either fermented millet, maize or sorghum into gruels referred to as, "Akamu" or "Ogi" which is of poor nutritional value [17]. About 40% of the Nigerian population live below poverty line and cannot afford commercial weaning foods for their infants or good quality animal source of protein [1]. Protein energy malnutrition is a major problem that frequently occurs during the important transitional phase of weaning in infants, thereby affecting the physical and mental growth of many infants in developing countries. Protein energy malnutrition s a syndrome characterized by its progressive onset and a series of symptoms and signs that encompass a continuum from clinically marasmus or kwashiorkor. Estimates that about 150 million children less than five years of age in developing countries are malnourished and additional 200 million have stunted growth. The problem of protein energy malnutrition can be prevented by introducing weaning foods of the correct protein quality and quantity at the right stage of the weaning period [9]. Cereals are often used as the main ingredients in complementary weaning food because they are highly digestible. Cereal grains are rich in carbohydrate but deficient in essential amino acids such as lysine thus making their protein quality poorer than that of animal [16]. In the case of the pearl millet a traditional food known as Ndaleyi which is a pure resistant starch was used together with cowpea during the formulation. Ndaleyi a fermented sun dried agglomerated powder produced from pearl millet or sorghum is one of the most popular food consumed in Nigeria, mostly by the Kanuri people of Borno state. Millet is a very important food grain and economic crop in areas where it is cultivated extensively. It is known by several other names such as Italian millet, German millet, Chinese millet, Hungarian [6]. Cowpea (*Vigna unguiculata*) is another indigenous food commodity in Africa, which is consumed in various forms. It is probably the most popular grain legume in West Africa [4]. Cowpea belongs to a class of foods known as legumes [24]. Traditional cereal foods play an important role in the diet of the people of African particularly in cereals is one of the main raw materials used in the production of popular food and affordable cost [3].

MATERIALS AND METHODS

Sources of the Material

The millet and cowpea were obtained and authenticated by a seed breeder at Lake Chad Research Institute Maiduguri, Borno State.

Sample preparation

Preparation of pearl millet(Ndaleyi)

Ndaleyi was prepared using the method described by [19]. One hundred grams (100 g) of maize (cereal) was cleaned and steeped into 200 ml of distilled water in a 1:2 ratios for 120 hours. At the end of the 120 hours, the top water was decanted and 200 ml of distilled water was added and milled into a slurry. The slurry was then sieved through a nylon cloth to remove the bran. The filtrate was then allowed to settle for 24 hours and the top water decanted. The ndaleyi was sun-dried to a constant weight and was packed into airtight container and stored at 4°C until used for weaning food formulation and analysis.

Preparation of Cowpea

One hundred gram (100g) of the cowpea was cleared of dirt and soaked in distilled water for 20 minutes. The cowpea was then duhulled using a pestle and motor. It was then washed to separate then hust, after which it was dried to a constant weight. The cowpea was roasted and ground into a fine powder [23].

Formulation of the weaning food blend

The weaning food blend was formulated in a 70:30 i.e 70g of millet flour to 30g of cowpea flour.

Determination of mineral element

The technique makes use of absorption spectrometry to assess the concentration of an analyte in a sample. It requires standard with known analytic 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 shimazocorp was used for the determination of Ca, P, K, Fe, Zn and Mg.

Procedure

The gram (2g) of the sample was weighed into a crucible and incinerated at 600°c for 2hours. The ashes sample will be transferred into 199ml volumetric flask and 100ml of distilled water will be added into it and reading will be taken of the AAS.

The appropriate lamps and corrects wavelength for each element were specified in the instruction manual.

Determination of Vitamins

Material: Reagent and glass were all reagents used in this work wares of analytical grades and distilled water was used thought out the experimentation. The glass wares were washed with liquid soap rinsed water before and after used. Centrifuge ultrasonic machine, UV/visible spectrophotometer, glass wares, 0.1% TFA (Trifluoroacetic and Ethanol) (95%) and weighing balance [5].

Extraction of Sample for Vitamin Determination

One gram (1g) of sample was accurately weighed using weighing balance and transferred to a centrifuge test tubes. 10m/s 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 centrifuge for 30minutes at 2500RPM. The supernatant was then collected and filtered using ash less filter paper.

The filterate was then scanned using uv-vis spectrophotometer at different wavelength for each of the vitamin (B_1=233nm, B_2= 266nm, B6=290nm) and vitamin C=244nm). the vitamin and the absorbance was then recorded for each of the vitamin, and the concentration of the sample was calculated using Beer-Lamberf format.

A=abc

Where a= Absorbance Wavelength.
a= molar absorpturity
b= path length of the cuvette
c=concentration.

Proximate Analysis

Chemical analysis (proximate analysis) the moisture contents, crude protein, ash, crude fat, carbohydrate, dry matter, and energy of the samples were determined using the Association of Official Analytical Chemist [5].

Crude Protein Content

Crude protein content was determined using Keljdedal method. 1g of sample was weighed in to a tube and 1 Keljdedal tablets were added 10ml of concentrated sulphoric acid (Conc H_2So_4) was added on to the tube and digested at 420°C for 3-5 hours. After cooling 80m1 of distilled water was added in to digested solution. About 50m1 caustic soda (NaOH) was added on to 50m1 of digested and diluted solution and placed on heating section of the distillation chamber, 30m1 of 4% boric acid plus bromo cresol green and methyired as an indicator was put in to conical flask and placed underneath the distillation chamber for collection of ammonia, the solution changed from orange to green color About 0.1 normal solution of hydrochloric acid (HC1) was weighed in to burette. The conical flask containing the solution was titrated until the color changes from green too pink, the burette reading was taken.

The crude protein was calculated using the formula;

$$\%\text{ crude protein} = \frac{\text{A-BxNxFx.25xl00}}{\text{Mg of sample.}}$$

Where
A= ml of acid used for titrating the sample
B= ml of acid used for titrating blank sample (o)
N= Normality of acid used for titration
F= Factor= 14007 6.25= constant
100= conversion to

Moisture Content

The moisture content used was determined by oven drying method 1.5kg of well mixed sample was accurately weighed in clean, dried crucible (W1). The crucible was allowed in an oven at 100-l05^{0}c for 6-12 hours until constant weight was obtained Then the crucible was placed in the desiccator for 30mm to cool After cooling it was weight again (W2) the percent moisture was calculated by following formula

$$\%\text{Moisture} = \frac{W_1 - W_2 \times 100}{\text{Wt of sample}}$$

where W1= Initial weight of crucible + sample
W2= Final weight of crucible + sample
Note= Moisture free sample were used for the analysis

Dry Matter Content

Dry matter content of the sample was determined by weighing log of sample into petri dish while placed in hot oven at l05°C for 24 hours and then removed and placed in desiccators to cool after you re-weigh.

The dry matter content was calculated using the formula:

$$\frac{W_1 - W_2 \times 100}{W_2 - W_2}$$

Where W = Weight of petri dish with sample in grams before oven dried.

W_2 = Weight of petri dish with sample in grams after oven dried.

W_1 = Weight in grams of empty petri dish

Crude Fat Content

Dry extraction method was used for fat determination. It consists of extraction of dry sample with some organic solvent, since all the fat materials e.g fats, phospholipids, sterols, fatty acids, carotenoids, pigments, chlorophyll etc are extracted together Therefore, the results are frequently referred to as crude fat Fats were determined by intermittent soxhlet extraction apparatus. Crude fat was determined by either extract method using soxhlet apparatus. Approximately 1g of moisture free sample was wrapped in filter paper, placed in fat free thimble and then introduced in the d with petroleum ether and in to the apparatus turned on water and heater to start extraction. After 4-6 siphoning allow ether to evaporate and disconnect beaker before last siphoning. Transferred extract into evaporated either ether on water bath then placed the dish in an oven at 105^{0}C for 2 hours and cooled it in a dissicator. The percent crude fat was determined by using the following formula:

$$\%\text{ crude fat} = \frac{\text{Wt of ether extract 100}}{\text{Wt of sample.}}$$

Ash Content

To determine the ash content, 1 g of sample was weighed in to crucible and dried at 1 05C for 24hour then cooled in a desiccator for 1 5minute and reweighed. It was then charred at 600C in muffle finance for 2-3 hours. Then cooled in desiccator for 1 5minute and reweighed

Formula

$$\text{Ash} = \frac{\text{loss in weight due to drying}}{\text{Initial weight of sample}}$$

Carbohydrate Content

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

% Carbohydrate = (% mct %+% cp=cf)

Energy Content

The energy of each sample was calculated using the formula by [5].

Energy(kcal) /100g = [(% available carbohydrates x 4) + (% protein x 4) + (% fat x 9)]

Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA). All the determination was 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 vitamin content of her weaning food blend and commercial weaning food frisogold® is presented in table 1. The level of vitamin B_1, (45.21±1.17μg/g), B_2 (30.74±1.37 μg/g), B_6 (28.11±1.30 μg/g), were higher than the commercial weaning food frisogold® (0.6), (0.45) and (0.5).

The mineral element content of raw and processed ndaleyi and cowpea is presented in table 2. A significant decrease was observed in

Table 1: The vitamin content of weaning food blend compared to commercial weaning food frisogold® (μg/100g).

Parameter (ug/100g	Samples	
	70:30 Blend	Commercial Weaning food Frisogold®.
Vitamin B_1	45.21± 1.17	0.6
Vitamin B_2	30.74± 1.37	0.45
Vitamin B_6	28.11± 1.30	0.5
Vitamin C	0.16±0.15	ND

Values are recorded as mean ± SEM of three determinants.
frisogold® - NAFDAC approved, ND – Not determined

Table 2: The mineral element content of raw and processed of Ndaleyi millet and cowpea (mg/100g)

Parameter (mg/100g)	Samples			
	Ndaleyi		Cowpea	
	Raw	Processed	Raw	Processed
Calcium	163.07±0.31^{a}	50.34±2.25^{b}	383±0.32^{c}	206±0.05^{d}
Magnesium	177.45±0.04^{a}	70.29±0.83^{b}	211.28±0.93^{c}	88.20±0.05^{d}
Sodium	112.12±0.29^{a}	55.48±0.63^{b}	108.25±0.09^{c}	60.20±0.05^{d}
Phosphorus	399.23±0.04^{a}	104.40±2.81^{b}	197.11±0.21^{c}	120.12±0.01^{d}
Iron	9.27±0.24^{a}	5.43±0.29^{b}	11.69±0.08^{c}	8.04±0.01^{a}
Potassium	325.36±0.23^{a}	28.33±0.59^{b}	27.70±0.05^{b}	19.04±0.01^{c}
Zinc	60.43±0.74^{a}	30.21±1.01^{b}	18.28±0.08^{c}	12.68±0.09^{d}

Values are recorded as mean ± SEM of three determinants. Values in the same row with difference superscripts are significantly different.

Table 3: The mineral content of the weaning food blend compared to the commercial weaning food frisogold® (mg/100g).

Parameter	Samples	
	Blend 70:30	Commercial Weaning food Frisogold® (g/100g)
Calcium	53.08±0.51	350
Magnesium	376.11±0.05	39
Sodium	571.53±1.02	120
Phosphorus	85.11±0.00	330
Iron	6.16±0.15	7.5
Potassium	442.90±1.08	495
Zinc	149.42±1.06	1.7

Values are recorded as mean ± SEM of three determinant

Table 4: Proximate Composition of (Raw) Unprocessed and Processed Fortified Ndaleyi and Raw Cowpea and Processed Cowpea

Parameter	Sample			
	Ndaleyi		Cowpea	
	Raw	Processed	Raw	Processed
Moisture%	4.96±0.10^{a}	2.46±0.05^{b}	5.21±0.05^{a}	2.16±0.10^{b}
Crude Protein %	12.99±0.03^{a}	10.48±0.25^{b}	25.70±0.01^{c}	4.96±0.10^{d}
Ash %	2.004±0.04^{a}	2.20±0.04^{a}	1.6±0.1^{a}	1.0±0.04^{c}
Crude fat %	7.96±0.58^{a}	5.7±0.04^{b}	4.12±0.13^{c}	2.33±0.57^{d}
Carbohydrate %	68.05±0.10^{a}	85.1±0.01^{b}	58.56±0.35^{c}	59.03±0.25^{c}
Dry matter %	78.3±0.02^{a}	81.3±0.03^{b}	78.6±0.03^{a}	75.02±0.04^{c}
Energy (Kcal/100g	395.80±0.70^{a}	391.8±0.058^{b}	374.12±0.79^{c}	394.86±0.79^{a}

Values are recorded as mean ± S.D of three determinations

Table 5: Proximate Composition of Weaning Food Blend Compared to Commercial Weaning Food frisogold®

Parameter	Weaning Food 70:30	Commercial Weaning Food
Moisture %	7.3±0.02	4.0
Crude Protein %	13.3±0.04	16.8
Ash %	1.9±0.6	2.5
Crude fat %	9.3±0.02	8.3
Carbohydrate %	86.1±0.03	63.0
Dry matter %	86.1±0.03	87.7
Energy (Kcal/100g	409.4±0.30	400.1

Values are recorded as mean ± S.D of three determinations Cerelac® - Nestle Nigeria Plc.

the calcium, magnesium, sodium, phosphorus, iron, potassium and zinc between the raw and processed ndaleyi and cowpea.

The mineral element content of the weaning food blend compared to commercial weaning food frisogold® is presented in Table 3. Calcium (53.08±0.51mg/100g) and potassium (442.90±1.08mg/100g) content of the weaning food blend were lower than that of the commercial weaning food blend frisogold® calcium (350) and potassium (495). However, the level of magnesium (376.11±0.05mg/100g), zinc (149.42±1.06mg/100g) and sodium (571.53±1.03mg/100g) were higher than the commercial weaning food frisogold® (39), (1.7) and (120) respectively. Iron and potassium content of the weaning food blend were close as compared to the commercial weaning food frisogold®.

The proximate composition of raw and processed ndaleyi and cowpea is presented in Table 4. Significant decrease was observed between the moisture of raw and processed ndaleyi and cowpea raw ndaleyi (4.96±0.10%), raw cowpea (5.21±0.05%) and processed ndaleyi (2.46±0.05%) and processed cowpea (2.16±0.10%). Significant decreases were observed in the protein content of the raw and processed ndaleyi and cowpea. Raw ndaleyi (12.99±0.03%), raw cowpea (25.70±0.01%) and processed ndaleyi (10.48±0.25%) and processed cowpea (4.96±0.10%). There was a decrease in the fat content of ndaleyi and cowpea (8.7±0.04%), (2.33±0.57%) after processing as compared to the raw samples (7.96±0.58%) and (4.12±0.13%) respectively. The carbohydrate content of the raw and processed sample showed significant decreases. An increase was observed in the energy content of cowpea after processed.

The proximate composition of the weaning food blend compared to the commercial weaning food frisogold® is presented in table 5. The weaning food blend had a low moisture content (7.3±0.02%) The protein content of the weaning food blend (13.3±0.04%) is close to the commercial weaning food frisogold® (16.8). Also the energy content of the weaning food blend (409.4±0.03%) is higher than that of the commercial weaning food frisogold® (400.1±0.02%). The fat content of the weaning food blend (9.3±0.02%) was comparable to the commercial weaning food blend frisogold® (8.3±0.12%).

DISCUSSION

The high concentration of vitamin in the weaning food blend (enchanced ndaleyi) is due to the fortification of pearl millet and cowpea. This is in line with particular report of [8].

Edible weaning food are vital components of human diet comprising essential biochemicals important for human metabolism. Looking at the result, increase in the content of mineral element of the pearl-millet could be attributed to the increase in the ash content during fermentation of the pearl-millet respectively, [2] [18]. And also supplementation of ndaleyi with cowpea improved the mineral element content of the weaning food blend. This is also in agreement with the work of [13]. In quantitative terms this means the process of fermentation can change a diet of low iron bioavailability into a diet of high iron availability [22].

Zinc plays a role in normal growth and development of immunity, gene expression, cell regulation and cell differentiation [11]. Magnesium is important in DNA and RNA synthesis, while iron is essential element for the formation of red blood cells and also plays an important role in the transport of oxygen [14].

The low level of calcium, iron and potassium in the weaning food blend when compared with frisogold could be attributed to the fact that commercial weaning food are usually fortified with micronutrient in order to meet the [10] guidelines for infant complementary food formulation [12].The decrease observed in the protein content during fermentation was attributed to a possible increase in the number of micro-organism that use protein for metabolism. During fermentation, micro-organism hydrolyze protein and it complexes to release free amino acid for synthesis of new protein. This result agrees with the report of [17], [7] who reported that fermentation did not change the protein content but the protein quality of cereals. The process of roasting of the cowpea did not alter their protein content and this is in agreement with the report of [15].

The decrease in the fat content of the fermented pearl millet might be due to the increased activities of the lipolytic enzymes which hydrolyze fat of fatty acid and glycerol. Similar observation was made by [15], [13]. The protein content may be due to the combined processing effects that is roasting of cowpea and fermentation of millet. This is in line with earlier report of [17].

Conclusion

The weaning food blend was found to be a good source of fat, carbohydrate, protein, iron, sodium, zinc, magnesium, vitamins B_1, B_2 and B_6. However, the level of calcium, potassium and phosphorus were low.

Recommendation

It is recommended that addition of milk, crayfish, fruits may improve the calcium, potassium and phosphorus contents of the weaning food blend.

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