Production and evaluation of weaning meal from fermented red maize fortified with cowpea

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ABSTRACT

A weaning food blend was prepared from an improved variety of maize (Marggi Red) and cowpea. Standard method was used for the analysis. The protein content of the weaning blend (12.68±0.45) was not able to meet the recommended Dietary Allowance of infants of weaning age. The Calcium content of the weaning food blend (50.08±0.09) was compared favorably with commercial weaning food frisocrem® (52.00). Processing resulted in increase in-vitro protein digestibility (77.91±0.29 to 83.40±1.96) at one hour and (83.93±0.12 to 87.86±0.05) at six hours of the composite meal.

Key words: red maize, cowpea, nutritional value.

INTRODUCTION

Weaning is a gradual process of introducing solid 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 (Salmon et al., 2008). In Nigeria, traditional weaning foods consist of monocereal grains, prepared from either millet, maize or sorghum referred to as “Ogi” or “Kamu” which is of poor nutritional value (Hellstrom et al., 1981). The major problems associated with infant during transitional phase of weaning is the protein energy malnutrition (PEM), which is associated with wasting condition resulting from a diet inadequate either protein or energy (calories) or both. This can visualized as either Kwashiorkor or Marasmus (Pollitt, 1995).

The supplement of these locally available cereals with legumes, which are good sources of protein rich foods, will give rise to weaning food that gives the infant enough energy and nutrient for its nutritional requirements (Marero et al., 1988).

AIMS AND OBJECTIVE OF THE STUDY

(i) To produce a weaning food from fermented red maize, fortified cowpea that will be adequate to meet the nutritional requirement of infants during weaning period.

(ii) To evaluate the chemical composition, mineral element level and in in-vitro protein digestibility of the weaning food blends.

Maize yields more flour, with much less bran than wheat. However, it lacks the protein gluten of wheat and therefore, makes baked food poor rising capability (USDA Nutrient Database, 2009).

Maize and cornmeal (ground dried maize) constitute a staple food in many regimes of the world, introduced in to Africa by Portuguese in the 16th century, maize has becomes African's most important staple crop (FAO, 2009). Maize meal is made in to a thick porridge in many cultures from polenta of Italy, the angu of Brazil, the mamaliga of Romania, to mush in the USA or the food called mealic pap in South Africa and Sadza, nishima and ugali in other parts of Africa.

In Nigeria Maize is prepared and consumed in a multitude of ways vary from one ethnic group to the other, for instance, Maize grains are prepared by boiling or roasting as paste (‘eko’), ‘aba do’ and elekute in some part of the country. Maize is an all-important crop which provides an avenue for making various types of foods. It is also used as a raw material in many industries (Osagie et al., 1998).

‘Tuwo’ (Yoruba), ‘tuwo-masara’ (Hausa), ‘Okon’ (Egun) etc is a very important and popular stable food among various ethnic groups in Nigeria from Maize. ‘Maasa’ or Wainna are thick porridges while ‘Maasa’ is small size, Wainna is big eating with sugar sprinkled on it or with pumking soup are all prepared from maize in Nigeria, Wainna cakes also be
made with mixture of cassava flour (*Manihot esculenta*) and millet flour (Lancaster et al., 1982). Other uses of Maize includes ‘cous cous’, Akple, Ukejuka, Uwate, Nakia, Dambu, Alubosa, Abari and Egbo are produced from maize cereal grains that can either be cooked, roasted, fried ground, pounded or crushed to prepared in to this various food items (Abdulrahaman et al., 1997).

Most importantly, cowpea seed is nutrition’s component in the human diet, as well as a nutritious livestock – feed green manure and cover crop for maintenance of productivity of soils. The dried seeds may be grounded in to meal or flour, which is used in a number of ways. The fresh seeds and immature pods are eaten as vegetables. They may be frozen or canned. The young shoots and leaves are eaten as spinach and provide one of the most widely use pot herbs in tropical Africa (Sinha et al., 1999).

In Nigeria cowpea (*Vigna unguiculata*) are an important grains legumes and source of protein in the diets. Cowpeas are used extensively to fortify cereal – based weaning foods (Uwaegbute, 1991). They are also processed in to paste or flour and used as a food ingredient or starting material for a variety of local foods (Mc Watter, 1983).

The protein in cowpea seed is rich in the amino acids lysine and tryptophan, compared to cereals grains, however, it is deficient in methionine and cystein when compared to animal proteins. Therefore, cowpea seeds is valued as a nutritional supplement to cereals and an extender of animals. The nutrient content of mature cowpea seed is estimated as protein 24.8%, fat 1.9%, fiber 6.3%, carbohydrate 63.6%, thiamine 0.0074%, Riboflavin 0.00042% and Niacin 0.00281% (Singh, 2003).

Legumes such as cowpea are a particular rich source of natural anti oxidant such as protease inhibitor, Amylase inhibitor, flatus factor, saponins, cynogenic glycoside etc (Singh, 2003).

Although, the natural lactic acid fermentation improved the contents of certain B-group vitamins considerable variations occurs depending on the nature of the raw materials, microflora, temperature and the nature for the method of determination for these vitamins.

The microbial fermentation of cereals and cereal-legume bleeds improves their relative nutritive value, availability of protein, amino acids (lysine, threonine, tryptophan, and methionine), carbohydrates, contains B group vitamins and minerals. The fermentation of cereals and legumes decreases or eliminate certain antinutrient like phytates, protease inhibitors, flatus factors and lectins.

### MATERIALS AND METHODS

#### List of chemicals used for proximate analysis

Sulphuric acid, Kjedahl tablet, sodium hydroxide, boric acid, hydrochloric acid, petroleum ether, trichloroacetic acid, glycy lacetic acid, nitric acid, filter paper, Monak desiccator (Scotland), Muffle furnace, beakers, burretes, crucibles, Soxhlet extractor, round bottom flask, digesting tube, distilled water, indicator (methyl orange and bromcresol green),pipettes, conical flask, distiller, Petri dishes, measuring cylinder, funnels, pair of tongs.

#### List of chemicals used for *in vitro* protein digestibility

Phosphate buffer (pH 7.5), 11% trypsin, 0.1N HCl, neutralized formalin, filter paper, test tubes.

#### List of material used for mineral element analysis

Muffle furnace, beaker, distilled water, Whitman filter paper, atomic absorption spectrometer.

#### List of material used for titratable acidity (TA)

Phenolphthalein, 0.1N sodium hydroxide, beaker, restort stand, 10 ml pipette, burette, pH meter.

#### Collection of sample

Red maize *Zea mays* L, (Marggi Red) and cowpea *Vigna Unguiculata* (Biu Local) were purchased at Maiduguri Monday Market, Nigeria and identify by Dr. O, Oluwana, Head of cereals grains from Lake Chad Research Institute (LCRI), Maiduguri, Nigeria.

#### Preparation of the Kamu from red maize

The ‘Kamu’ (Ogi) was prepared (Figure 1) by the method described by Akingbala et al. (1981). One hundred grams (100 g) of clean Red Maize (raw grain) were soaked in water for one hour to get rid of foreign matter and damage grains and steeped in 200 cm³ of distilled water (1:2 ratios) for 72 h (3 days) at the end of the 0, 28, 48 and 72 h the pH and titratable acidity was taken, and finally the top water was decanted and 200 cm³ of distilled water was added and milled with warring blender for 4 min at rheostate setting of 120. The slurry obtain was served through nylon cloth to separate bran after which the water was decanted and the Kamu was sun dried to a constant weight.

#### Preparation of the cowpea (Biu local)

One hundred grams (100 g) of the cowpea was cleaned of dirt and soaked in distilled water for 20 min. The cowpea was then diluted using a pestle and mortar then washed to separate the husk, after which it was dried to constant weight.
weight and roasted. The cowpea was then ground in to a find powder.

**Preparation of the weaning food blend**

The blending of the weaning meal was done in the ratio of 70:30 as described by Akapunam (1984) that is 70 parts of fermented Red Maize (Kamu) and 30 parts of milled cowpea were mixed together by using blender.

**Sieving analysis**

The sieve analysis was obtained using British Standard sieves, wire mesh series (B.S 410: 1969). This British Standard provide a wide range of fine mesh size ranging from 16 mm to a minimum of 38 microns. In this process it involves gyratory movement of grains in relation to sieve mesh, at the same time a reciprocating up and down movement is performed on the nest of sieves so that the action jolts the grains at all possible angles. The shaker generally hold up to nine or ten sieves including a collecting pan and lid set under vibration until a sufficient grains has been sieved then the process stop and determined the various sizes of grains retained.

**Hardness of grain**

The degree of hardness of grains is obtained by using Ward’s Natural science establishment Inc. Rodester New York method by comparing with that of ten standards, nine of which are included in this set. A given grains would, for example, be described as having “hardness number 4” or by those of the scale, remembering that a harder grains will
cause a scratch mark an softer one only. These standards are Talc, Selenite, Calcite, Fluorite, Apalite, Microline, Quartz, Topaz, Diamond.

**pH measurement (using pH meter)**

pH measurement was done using share analytical method of food analysis (2010), by placing the sample in to clean beaker and dip the electrode of pH meter until the reading become stable then the value is read.

**Measurement of titratable acidity (TA)**

Titratable acidity was measured using share analytical method of food analysis (2010), by pipetting 10 ml of the sample in to a 50 ml beaker, add 3 drops of phenolphthalein indicator, filled the burette with 0.1 ml NaOH standard solution. Taking note of the initial reading, titration was done by slowly rotating the burette stop cock. The beaker was swirled so that the sample and NaOH would mix very well until the solution become pin for 30 s then the final burette reading was read to an accuracy of 0.1 ml. To calculate the volume required for the titration, the initial reading was subtracted from the final reading. It is computed as follows:

\[
\text{TA (g/100 ml)} = \frac{V (N) \times \text{meq.wt} \times 100}{1000 
\times V}
\]

Where: \( V \) = is volume of sodium hydroxide used, \( N \) = Normality, \( \text{meq.wet} = \) is milliequivalent weight of standard, \( V \) = is sample volume.

**Proximate analysis**

The proximate composition is determined by AOAC (2000) method.

**Determination of moisture**

The direct oven method (AOAC, 2000) was used for this analysis. Ten grams of each sample was weighed using electric balance and placed in a Petri dish of known weight. The sample was then allowed to dry in the air oven set at 108°C for 8 h. The dish and sample were cooled in a desicators and then weighed. This procedure was repeated until a constant weight was obtained. The moisture content of each sample was calculated as follows:

\[
\text{% moisture} = \frac{\text{Wt of orig. sample} - \text{Wt of orig. dried sample}}{\text{Wt of the orig. sample}} \times 100
\]

**Ash determination**

Ash was determined by the method of AOAC (2002). Two grams of each sample was added in separate crucible and placed in a muffle furnace and then ashed at 560°C for three hours. The sample were removed from the furnace, cooled in desiccator to room temperature and weighted. Percentage ash was calculated using the formula below:

\[
\% \text{Ash} = \frac{\text{Wt of crucible + Ash} - \text{Wt of empty crucible}}{\text{Initial Wt of sample}} \times 100
\]

**Fat determination**

The ether extract was determined using Soxhlet apparatus. Two grams of the sample was weighed in to a thimble and 200 ml of petroleum ether was measured into a conical flask. The solution was heated at 45°C at 1 h interval for 2 h. The flask was removed, reweighed and percentage fat sample is determined using the formular:

\[
\% \text{fat} = \frac{\text{Wt of fat}}{\text{Wt of sample}} \times 100
\]

**Crude protein determination**

Crude protein content was analyzed using Kjeldahl procedure, 2 g of samples was weighed into a digestion tube and 2 tablet of Kjeldahl were added, 2 ml of concentrated sulphuric acid (conc. H₂SO₄) was added, on to the tube and digested at 420°C for 3 h. After cooling 80 ml of distilled was added into digested solution. About 50 ml of 40% caustic soda (NaOH) was added on to 50 ml of digested solution and then placed on heating section of the distillation chamber, 30 ml of 4% boric acid, plus bromocresol green and methyl red indicator was put into 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 HCl was weighed in to burette. The conical flask containing the solution was titrated until the colour change from green to pink. The burette reading was taken. The crude protein was calculated using the formular:

\[
\% \text{Protein} = \frac{(A - B) \times N \times F \times X \times 100 \times 6.25}{Mg \ of \ sample}
\]

Where: \( A = \) Ml of acid used for titrating sample, \( B = \) Ml of acid used for titrating blank, \( N = \) Normality of acid used for titration, 100 = conversion to percentage.
Crude fiber determination

Two grams of the sample was placed in a 450 ml conical flask and 50 ml of trichloroacetic acid reagent (TCA) was added, the mixture was boiled and refluxed for 40 min. The flask was removed and cooled to room temperature. Filter paper was used to filter the residue. The residue obtained was washed at 610°C and reweighed then the filter paper plus the sample were folded together and dried at 30-60°C in an oven for 24 h, reweighed then washed at 610°C and reweighed flask was removed, reweighed and percentage fat sample is determined using the formular:

\[ \% \text{fiber} = \frac{\text{Wt of fiber}}{\text{Wt of sample}} \times 100 \]

Determination of carbohydrate

This was determined by differences:

\[ \% \text{carbohydrate} = 100 - (\% \text{moisture} + \% \text{Ash} + \% \text{protein} + \% \text{crude fiber}) \]

Determination of energy value

This was obtained using the atwater factors (physiological fuel values) of 4kcal, 4kcal and 6kcal per gram of carbohydrate, protein and fat content of the samples respectively.

Determination in-vitro protein digestibility (Nills, 1979)

One milliliter of 11% trypsin was introduced into each test tubes. Four milliliter of phosphate buffer of pH 7.5 was added to each test tube 1 ml of 0.1 N HCl was added and allowed to stand to equilibrate 1 ml of 1% 'Kamu' was added to all the rest tubes (labeled as digestibility at 1 and 6 h). The reaction in each of the test tube was stopped with 5 ml of neutralized formation at 60 min and 6 h. The content of the test tubes were then filtered using filter paper. The filter papers were dried in an oven at 108°C for 3 h.

The Nitrogen of the undigested sample was determined by the Kjedahl method.

\[ \text{% in vitro protein digestibility} = \frac{\text{CP1-CP2}}{\text{CP1}} \times 100 \]

Where: CP1 = total protein of unprocessed grain, CP2 = Total protein after digestion with trypsin.

Mineral element analysis

Twenty grams of each sample was weighed using electric weighing machine. The sample was then ashed in a furnace at arshing temperature of 550°C. After the arshing, it was weighed to be 2 g out of which 1 g of ashed sample 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 wormed over water bath for 35 min 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 wavelength using Atomic absorption spectrometer (model AA Analyst 400) of Perkin Elmer Company product to determine the various minerals element present in the samples.

Water absorption capacity (WAC)

Water absorption capacity was determined by the method of Celgla et al. (1977) with slight medications. A known volume (10 ml) of water was pipette in to the beaker, carefully stirred and allowed to equilibrate for hour at room temperature (23 – 25°C). After complete water absorption, the sample was further treated with 0.01 ml water portion, at 10 min interval before usual observation. The volume that gave a complete absorption of water (no visible free water) is compute as:

\[ \text{WAC} = \text{Initial weight} - \text{Final weight} \] (after absorption of water).

RESULTS

Physical characteristics

Table 1 present the grain diameter (mm) for maize at different mesh sizes range between 0.00 – 28.92 with mesh size 6.70 having the highest grain size of 28.92 and also the cowpea exhibited a similar trend of grain diameter range 0.00 – 27.36 and mesh size 6.70 having highest diameter of 27.36. Table 2 show a hardness number of 5- apotile while cowpea show 4- flourite.

Table 3 show the pH and titratable acidity of “Kamu” from maize. A decrease in pH with an increase in titratable acidity was exhibited during the fermentation process. Table 4 shows the proximate composition of the raw and process maize and cowpea. There is no significant difference in the moisture content of the raw and processed maize. The protein and fat content of the processed maize is significantly higher than that of the raw maize and thus the moisture content of the cowpea showed a significant difference. While the Ash, shows a significant decreased. Table 5 present the proximate composition of the
Table 1. Sieve analysis.

<table>
<thead>
<tr>
<th>Mesh (mm)</th>
<th>Grains diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maize</td>
</tr>
<tr>
<td></td>
<td>Cowpea</td>
</tr>
<tr>
<td>16</td>
<td>0.00</td>
</tr>
<tr>
<td>11.20</td>
<td>0.00</td>
</tr>
<tr>
<td>8.00</td>
<td>11.38</td>
</tr>
<tr>
<td>6.70</td>
<td>28.92</td>
</tr>
<tr>
<td>4.10</td>
<td>9.59</td>
</tr>
<tr>
<td>3.35</td>
<td>0.00</td>
</tr>
<tr>
<td>2.00</td>
<td>0.00</td>
</tr>
<tr>
<td>1.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Weaning food blend compared with commercial weaning food frisocrem. The moisture content compared favourably and the protein of the blend does not meet the protein content of the frisocrem.

Table 2. Grains hardness (N).

<table>
<thead>
<tr>
<th>Grains</th>
<th>Hardness number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>5 – Apotile</td>
</tr>
<tr>
<td>Cowpea</td>
<td>4 – Flourite</td>
</tr>
</tbody>
</table>

Table 3. pH and titratable acidity (TA).

<table>
<thead>
<tr>
<th>Time</th>
<th>pH</th>
<th>Titratable acidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6.10</td>
<td>0.000031</td>
</tr>
<tr>
<td>24</td>
<td>4.50</td>
<td>0.000062</td>
</tr>
<tr>
<td>48</td>
<td>4.70</td>
<td>0.000112</td>
</tr>
<tr>
<td>72</td>
<td>4.30</td>
<td>0.00016</td>
</tr>
</tbody>
</table>

A decrease in the pH (Table 3) with an increase in titratable acidity was exhibited during the fermentation process, and this is similar to the report of (Akinrele, 1970). The acidic nature of the product could be due to the production of lactic acid produced by microorganism associated with maize fermentation (Newman et al., 1984).

Table 4 shows that there is no significant difference in the moisture and ash content between the raw and the processed maize. The protein of the processed is significantly higher than that of the raw maize this could be as a result of improvement in the protein content of the maize during fermentation. This is similar to the report of Nanson and Field (1986). The improvement to the fat content of the processed may be due to increase in activity of lipolytic enzymes in the fermentation medium which hydrolyzes fat to glycerol and fatty acids. The free fatty acids are used by the fermenting organisms for the synthesis of new lipids (Ezeokenkwo, 2004).

Table 6 presents the mineral element composition of the raw and processed maize and cowpea. There is significance increase in the level of Ca, Na, P, and Fe in the processed maize while there was a significant decrease in the level of Ca, Mg, Na, and P in the processed cowpea.

Table 7 shows the mineral element composition of the weaning food blend compared with commercial weaning food frisocrem®. Though it provide one third of the RDA (14%) as reported by WHO (FAO/WHO/UNU, 1985) and National Institute of Nutrition (ICDS, 1992) for children and rural mothers, while fiber and Ash content was not detected.

DISCUSSION

Physical characteristics

The sieve analysis of the grains (Table 1), in diameter (mm) at different mesh sizes ranged between the highest grain of 28.92 at mesh size 6.70 of the maize as well as the cowpea exhibited a similar mesh size in diameter of 6.70 retaining the highest grain of 22.36, while the maize show a hardness number of 5-apotile and the cowpea show 4-flourite in Table 2.

pH and titratable acidity (TA)

The proximate composition (Table 4) shows that there is no significant difference in the moisture and ash content between the raw and the processed maize. The protein of the processed is significantly higher than that of the raw maize this could be as a result of improvement in the protein content of the maize during fermentation. This is similar to the report of Nanson and Field (1986). The improvement to the fat content of the processed may be due to increase in activity of lipolytic enzymes in the fermentation medium which hydrolyzes fat to glycerol and fatty acids. The free fatty acids are used by the fermenting organisms for the synthesis of new lipids (Ezeokenkwo, 2004). The moisture content of the cowpea shows a significant decreased in the processed cowpea than the raw cowpea.

The protein content of the weaning blend (Table 5) is compared low with respect to the commercial weaning food frisocrem®, though it provide one third of the RDA (14%) as reported by WHO (FAO/WHO/UNU, 1985) and National Institute of Nutrition (ICDS, 1992) for children and rural mothers, while fiber and Ash content was not detected.

Mineral element composition

The increased in the content of Ca, Na, P and Fe in the processed maize could be as a result of improvement in the mineral content of maize during fermentation (Reddy and Salunkhe, 1980). The increase in the level of Fe could be due to the reduction of phytic acid during fermentation since lactic acid fermentation changes a diet of low iron bioavailability (Suanberg and Sandberg, 1988). The decrease in the content of Ca, Mg, Na and P of the processed cowpea could be attributed to the loss in ash content during dehulling of cowpea (Akingbala et al., 1981). The blend ratio of the weaning food (Table 7) shows that
Table 4. Proximate composition of raw and processed maize and cowpea.

<table>
<thead>
<tr>
<th></th>
<th>Maize</th>
<th>Cowpea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raw</td>
<td>Processed</td>
</tr>
<tr>
<td>Moisture</td>
<td>4.10 ± 0.17(^a)</td>
<td>3.80 ± 0.03(^a)</td>
</tr>
<tr>
<td>Ash</td>
<td>1.50 ± 0.56(^a)</td>
<td>1.50 ± 0.03(^a)</td>
</tr>
<tr>
<td>Protein</td>
<td>6.98 ± 0.12(^a)</td>
<td>8.74 ± 0.02(^b)</td>
</tr>
<tr>
<td>Fat</td>
<td>7.10 ± 0.03(^c)</td>
<td>12.00 ± 0.36(^c)</td>
</tr>
<tr>
<td>Fiber</td>
<td>6.00 ± 0.22(^a)</td>
<td>8.48 ± 0.05(^b)</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>82.50 ± 2.40(^a)</td>
<td>71.46 ± 0.05(^b)</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>430.00 ± 1.49(^a)</td>
<td>365.88 ± 0.36(^b)</td>
</tr>
</tbody>
</table>

Values are recorded as mean ± SD of three determination, values in the same row with difference superscript are significantly different (P < 0.05).

Table 5. Proximate composition of weaning blend compared with commercial weaning food frisocrem®.

<table>
<thead>
<tr>
<th></th>
<th>Maize/cowpea (70:30) mg/100 g</th>
<th>Commercial weaning food Frisocrem (rice) mg/100 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>1.90 ± 0.02</td>
<td>2.0</td>
</tr>
<tr>
<td>Ash</td>
<td>1.00 ± 0.02</td>
<td>ND</td>
</tr>
<tr>
<td>Protein</td>
<td>12.68 ± 0.09</td>
<td>16.00</td>
</tr>
<tr>
<td>Fat</td>
<td>13.33 ± 0.45</td>
<td>ND</td>
</tr>
<tr>
<td>Fiber</td>
<td>12.33 ± 0.18</td>
<td>13.20</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>63.79 ± 0.10</td>
<td>65.10</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>414.00 ± 0.27</td>
<td>455</td>
</tr>
</tbody>
</table>

70 parts of processed maize to part of cowpea, ND – Not detected, Value recorded as mean ± SD of three determinations.

Table 6. Mineral composition of raw and processed maize and cowpea.

<table>
<thead>
<tr>
<th>Mineral element</th>
<th>Maize</th>
<th>Cowpea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raw</td>
<td>Process</td>
</tr>
<tr>
<td>Ca</td>
<td>311.53 ± 2.31(^a)</td>
<td>366.27 ± 0.40(^b)</td>
</tr>
<tr>
<td>Mg</td>
<td>153.39 ± 1.32(^a)</td>
<td>149.42 ± 0.32(^b)</td>
</tr>
<tr>
<td>Na</td>
<td>139.75 ± 0.53(^a)</td>
<td>225.60 ± 0.02(^b)</td>
</tr>
<tr>
<td>P</td>
<td>128.50 ± 0.09(^a)</td>
<td>212.70 ± 0.03(^b)</td>
</tr>
<tr>
<td>Fe</td>
<td>4.45 ± 0.03(^a)</td>
<td>5.98 ± 0.06(^b)</td>
</tr>
<tr>
<td>K</td>
<td>37.50 ± 0.03(^a)</td>
<td>22.70 ± 0.02(^b)</td>
</tr>
<tr>
<td>Zn</td>
<td>13.55 ± 0.05(^a)</td>
<td>12.46 ± 0.01(^b)</td>
</tr>
</tbody>
</table>

Values recorded as mean ± SD of three determination, Values in the same row with different superscript are significantly different (P < 0.05).

The Ca content compared favorably with the commercial weaning food frisocrem® and the level of Na, Fe, P and Zn is compared closer, while Mg is not detected.

**In vitro protein digestibility**

The processing process helps in increasing the **in vitro** protein digestibility significantly, and this is due to in level of anti nutrient (Scheinfeld and Mokashi, 2001). The heat treatment of cowpea also helps in increasing the digestibility of the weaning food (C.A.C 1999).

**Conclusion**

The values of the proximate and the elemental analysis does not meet the recommended dietary allowance of
infants of weaning age, however the elemental analysis compared closer, and the protein content provide one third of the RDA as recommended by World Health Organization and National Institute of Nutrition.

**RECOMMENDATION**

There is the need to improve on the protein content of the weaning food blends as well as the Ca and Zn since they are essential for the growing child and thus, this can be achieved by the addition of source of protein like fish in the formulation.

**REFERENCE**


Lee Drive, J.K. and B.S. Kadam. (2008), Critical reviews in food science and nutrition, Food Science 28: 348-400.


**Table 7.** Minerals element of weaning blend compared with commercial weaning food.

<table>
<thead>
<tr>
<th>Mineral element</th>
<th>Maize/cowpea 70:30 (mg/100 g)</th>
<th>Commercial weaning food (frisocrem (rice) mg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>50.08 ± 0.09</td>
<td>52</td>
</tr>
<tr>
<td>Mg</td>
<td>386.48 ± 1.40</td>
<td>ND</td>
</tr>
<tr>
<td>Na</td>
<td>598.77 ± 1.40</td>
<td>665</td>
</tr>
<tr>
<td>P</td>
<td>398.39 ± 1.03</td>
<td>425</td>
</tr>
<tr>
<td>Fe</td>
<td>6.90 ± 0.09</td>
<td>9</td>
</tr>
<tr>
<td>K</td>
<td>450.30 ± 1.01</td>
<td>500</td>
</tr>
<tr>
<td>Zn</td>
<td>149.86 ± 0.22</td>
<td>180</td>
</tr>
</tbody>
</table>

Table 8. In vitro protein digestibility of raw and processed maize and cowpea.

<table>
<thead>
<tr>
<th></th>
<th>Raw</th>
<th>Processed</th>
<th>Raw</th>
<th>Processed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digestibility at 1 h</td>
<td>77.99 ± 0.29a</td>
<td>83.40 ±1.96b</td>
<td>89.51 ± 0.21c</td>
<td>93.32 ± 0.38d</td>
</tr>
<tr>
<td>Digestibility at 6 h</td>
<td>83.93 ± 0.12a</td>
<td>87.86 ± 0.05b</td>
<td>90.56 ± 0.16c</td>
<td>96.66 ± 0.12d</td>
</tr>
</tbody>
</table>

Values are recorded as mean ± SD of three determination, value in the same raw with different superscript are significantly different (P<0.05).

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