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Assessment 0f Proximate, Mineral Elements and Amino Acids Profile of Weaning Food Formulated From a Local Variety of *Pennisetum Glaucum*, Roasted *Sesanum Indicum* and *Euastacus Spp*

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Abstract
Sprouted cereal and legume complementary weaning food were prepared from a local variety of Millet, Sesame seed and crayfish, the complementary flour blends were mixed into various ratios 60:20:20 as MSC (60 parts of millet: 20 parts of sesame and 20 parts of crayfish), 65:35 as MS (65 parts of millet and 35 parts sesame) and 75:25 MC (75 parts of millet, and 25 parts of crayfish) respectively, hence compared with commercial weaning food celarac Cl. A standard methods were used for the analysis .Crude protein, crude fat, crude fiber of the formulation increase significantly ($p \leq 0.05$) which ranged from 20.10±0.15, 17.52±0.02 and 9.22±0.06 compared to the reference value of 18.50±0.34, 8.31±0.30 and 0.11±0.01 respectively. Moisture and ash content values were higher compared to the reference values as 8.25±0.025 and 4.78±0.08 to 5.58±0.01 and 1.94±0.01. Elements composition of sodium 114.71±1.33, iron 4.72±0.05, calcium 389.14±0.03 and zinc 3.03±0.03 were significantly higher than the reference value 15.86±0.08, 1.62±0.01, 110.62±0.39 and 1.28±0.01 respectively. While the values of Magnesium, Phosphorous, and potassium are lower compared to the reference value. Amino acids content showed a significant increase in the contents of lysine 3.95±0.01, methionine 2.43±0.01 and tryptophan 3.75±0.02 to that of the reference value 2.70±0.0.01, 1.24±0.01 and 2.27±0.01. Functional properties with WSI and FC are significantly low compared to the formulated diets as 288.00±1.00 and 360.00±1.00 to 391.00±1.00 and 502.00±1.00 respectively.

Key words: Sprouted, formulation, weaning food, millet, sesame and crayfish.

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1.0 Introduction

The prevalence of protein energy malnutrition (PEM) is one of the major nutritional problems afflicting infants and young children in most developing countries today. The menace manifest to various disease conditions like kwashiorkor and marasmus which are associated with general loss of muscles mass, loss of subcutaneous fat, stunted growth, damaged immune system, chronic diarrhea, intellectual disability and lead to deaths among children (Amankwa*et al.,* 2008).These occur as a result of ignorance and low income earning by parents in the rural areas (Oluwale, 2008). And thus, the commercial weaning foods are expensive and not affordable due to poverty especially among people leaving in the rural areas. In Nigeria, about 87 million of the population lives in extreme poverty (WHO, 2018). Locally available weaning foods in most developing countries particularly in Nigeria comprises of monocereal grains made from single Maize, Millet, Sorghum, Wheat or Rice known as "Ogi or Akamu" with low nutritional values as a result of lack of essential amino acids like lysine and tryptophan. However, Sulphur containing amino acids like cysteine and methionine are also lacking in leguminous crops. Processing techniques and complementary formulation of cereals with legumes and animal proteins like crayfish or with both is very essential to enhance the nutritional quality as well as to increase the palatability, digestibility and acceptability among individual as weaning meal for infants (Modu *et al., 2010).* Breastfeeding is an adequate food for the infants during the first trimester. Breast milk contains the entire food nutrient that needs to take care of the wellbeing of the infants for proper growth and development in addition to immunological components (UNICEF, 2018). Virtually, at the age of 4 to 6 months of development, the infants demand for higher energy calories and protein diets increases as they are growing, breast milk alone can no longer meet the nutritional requirements of the infants, therefore, complementary feeding is an essential practice alongside breastfeeding to provide the infant's appropriate nutrition and good health status (WHO, 2001).The general dietary fairness containing complementary food is an important aspect in prevention of infant's malnutrition, mortality, morbidity, hypovitaminosis and mineral deficiencies *(*Elemo *et al.,* 2011*).* In Nigeria, weaning is a gradual process of introducing semi-solid food to infant's diet alongside breastfeeding, up to the time the infant gastrointestinal tract will develop and become accessible to main family menu (Onofiok and Nnanyelugo, 2008). This study is aimed at producing a nutritious and affordable weaning food from locally available raw materials such as millet, sesame and crayfish that will be able to meet up the gap of nutritional inadequacy caused as a result of poverty, working and schooling breastfeeding mothers in Nigeria.

2.0 Materials and Methods

Millet *((Pennisetum glaucum)),* Sesame *(Sesanum indicum)* and crayfish *(Euastacus spp*) were purchased from Machina Local Government area of Yobe State. The samples were identified in the Department of Biological Sciences, University of Maiduguri, Borno State.

2.2 Methods

2.2.1 Sample Preparations

The millet was sprouted according to methods described by (Abasiekong*et al.,* 2010). Slightly modified, about 1000 g of millet sample was soaked in a plastic bucket containing 3 litres of tap water and steeped for twenty four hours at room temperature (36 -37 °C).The steep water was then discarded by decantation and steep grains will begin to germinate within seventy-two hours by spreading on a clean tray pan. Hence, sundried for two to three days by putting it in asterilized tray pan. Millet grains was then milled using miller (Hunt No. 2A Premier Mill Huntand Co, UK) to an average particle size of less than 0.3mm. The milled grain was then sieved through a fine mesh (0.5 mm) to obtain the millet flour.

Sesame was prepared according to (Oladele*et al.,* 2009) with slight modification. Exactly 500 g of sesame was sorted and steeped in water for 20 minutes to remove dirt. It was then dried and roasted for about 10 to 15 minutes which was finally grounded into fine powder (Milling) and sieved.

Crayfish was prepared according to the method of (Onabanjo *et al.,* 2009). 500g of crayfish was weighed and cleaned of dirt, dried thoroughly, soaked in warm water for 5 minutes to prevent bad smell and spread on a tray and dried in an oven for 1 hour at 50 ^{0}C to ensure uniform drying. The crayfish was then milled and sieved with a 500-micron mesh sieve. The flour was kept in an airtight container for the formulation.

2.2.2 Formulation of Weaning Food

Millet, Sesame and Crayfish were mixed thoroughly in the ratios of 60:20:20 MSC (60 parts of millet: 20 parts of sesame and 20 parts of crayfish), 65:35 MS (65 parts of millet and 35 parts sesame) and 75:25 MC (65 parts of millet, and 25 parts of crayfish) respectively as A, B and C, as described by Abasiekong*et al.,* (2010). Using a blender model type (Rotary mixer HR 2000/A, Holland).

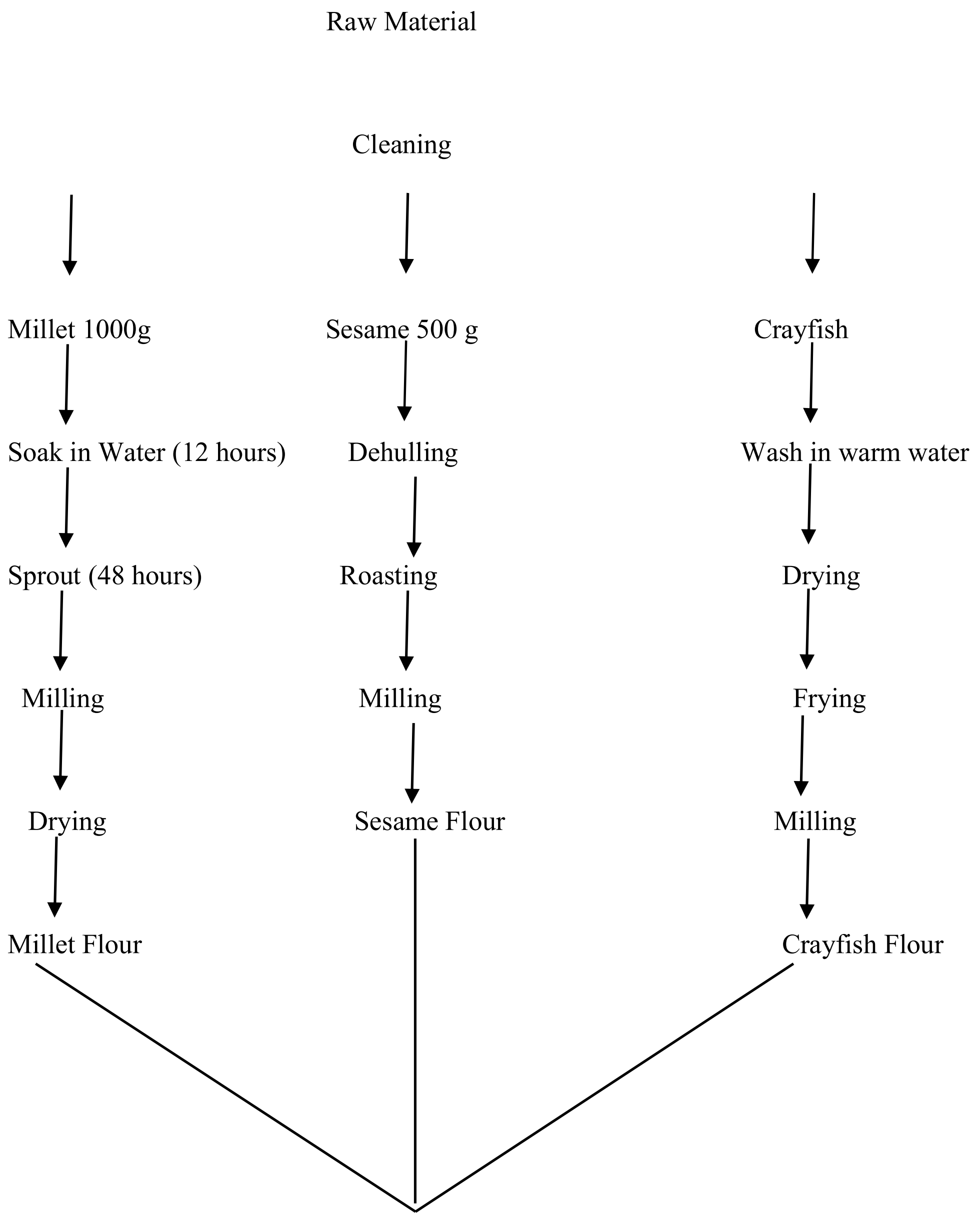

Figure: 1 Flow chart of Mixing and Evaluation of Nutritional Composite Profile

2.2.3 Proximate Analysis.

The proximate composition analysis were carried out according to standard method described by AOAC, (2000) to determine the moisture content, ash content, crude protein, crude fibre, fat content, the energy (Kcal) as well as carbohydrate composition of the blends.

2.2.4 Determination of Mineral Elements

Atomic absorption spectrophotometer (AAS) AA 6800 series shimazocorp were used for the determination of Ca, Na, K, Fe, Mg, F and Zn. Two grams of sample were weighed into a crucible and incinerated at six hundred (600^0C) in a muffle furnance for three (3) hours. To the ash sample and exactly ten (10.0mls) of 6NHCl will be added to the ashed sample covered and placed on a water bath and boil for ten minutes. The sample are removed and filtered into 100ml volumetric flask. The filter paper was washed down, the volume then made up to 100 mls using deionized water. About ten mls of the digested sample was transferred to the test tubes and then aspirated to the AAS, reading are recorded in ppm (AOAC, 2000).

2.2.5 Determination of Amino Acids Profile

The defatted samples were utilized to estimate amino acids. The sample (30mg) was hydrolyzed with 6N HCI at 110°C for 24h. Amino acid analysis was performed on reverse phase-high pressure liquid chromatography (HPLC) (Buck scientific BLC 10/11 USA) equipped with UV 338nm detector. A C18, 2.5 x 200mm, 5um column and a mobile phase of 1:2:2 (100mM sodium phosphate, pH 7.2: Acetonitrile: methanol) was used at a flow rate of 0.45 mL/minute and an operating temperature of 40^{o}c. Mixed standards were analyzed in a similar manner for identification. Peak identification was conducted by comparing the retention times of authentic standards and those obtained from the samples, these data were integrated using peak Simple chromatography data system processor; (Buck SCi.chromatopac data processor).

3.0 RESULTS

Table1: Proximate Composition Per 100g of the Formulated Weaning Food

Formulations	MSC	MS	MC	CL
Crude Protein	20.10±0.15^{a}	11.07±0.20^{b}	13.63±0.21^{c}	18.50±0.34^{d}
Crude Fiber	9.22±0.06^{a}	8.77±0.10^{b}	9.29±0.08^{b}	0.11±0.01^{c}
Crude Fats	17.52±0.02^{a}	9.52±0.06^{b}	9.86±0.04^{c}	8.31±0.30^{d}
Moisture (%)	8.25±0.05^{a}	6.89±0.49^{b}	9.94±0.14^{c}	5.58±0.01^{d}
Ash	4.78±0.08a	2.69±0.30^{b}	1.26±0.24^{b}	1.94±0.01^{b}
Carbohydrate	44.81±7.52^{a}	61.06±5.77^{b}	65.88±6.59^{c}	65.56±5.45^{d}
Energy Value (Kcal)	417.32±0.32^{a}	374.200±0.51^{b}	406.78±0.12^{b}	411.03±0.01^{d}

Values are recorded as Mean±SD of the three determinants, values in the same row with difference superscript are significantly different ($p \leq 0.05$)

Table 2: Mineral Elements Composition Per 100g of the Formulated Weaning Food

Formulations	MSC	MS	MC	CL
Sodium (Na)	114.71±1.33^{a}	33.48±0.18^{b}	39.85±0.17^{c}	15.86±0.08^{d}
Magnesium (Mg)	9.20±0.05^{a}	7.37±0.04^{b}	8.59±0.04^{b}	27.80±0.29^{c}
Phosphorus (P)	106.72±0.43^{a}	134.46±0.60^{b}	180.41±0.64^{c}	322.68±3.26^{d}
Potassium (K)	161.06±0.74^{a}	176.77±0.90^{b}	267.15±1.13^{c}	424.03±4.46^{d}
Iron (Fe)	4.72±0.05^{a}	2.28±0.01^{b}	1.99±0.01^{b}	1.62±0.01^{b}
Calcium (Ca)	389.41±3.86^{a}	116.04±0.62^{b}	217.89±0.61^{c}	110.62±0.39^{d}
Zinc (Zn)	3.03±0.03^{a}	0.82±0.01^{b}	1.24±0.04^{b}	1.28±0.01^{b}

Values are recorded as Mean±SD of the three determinants, values in the same row with difference superscript are significantly different ($p \leq 0.05$)

Table: Three (3) Amino acids Profile Per 100g of the Formulated Weaning Food

Formulations	MSC	MS	MC	CL
Histiden	1.13±0.01ª	1.64±0.01ª	1.86±0.01ª	1.79±0.57ª
Isoleucine	2.85±0.02ª	1.82±0.02ª	2.07±0.02ª	1.77±0.01ᵇ
Leucine	5.69±0.02ª	5.35±0.01ª	5.53±0.2ª	5.12±0.02ª
Lysine	3.95±0.01ª	2.95±0.01ª	3.24±0.02ª	2.70±0.01ᵇ
Methionine	2.43±0.01ª	1.57±0.01ª	1.82±0.02ª	1.24±0.01ᵇ
Phenylalanine	3.02±0.02ª	2.52±0.01ª	2.29±0.02ᵇ	2.46±0.01ᵇ
Threonine	1.85±.01ª	1.93±0.01ª	2.29±0.02ª	2.85±0.01ª
Tryptophan	3.75±0.02ª	2.88±0.01ª	3.06±0.02ª	2.27±0.01ᵇ
Valine	1.75±0.01ª	2.88±0.01ª	3.06±0.02ᵇ	3.75±0.02ᵇ
Arginine	4.95±0.01ª	3.82±0.01ª	4.19±0.01ª	3.28±0.02ᵇ
Alanine	3.28±0.02ª	3.65±0.01ª	3.88±0.01ª	4.49±0.01ᵇ
Aspartic	5.35±0.01ª	5.72±0.01ª	5.95±0.01ª	6.83±0.01ᵇ
Cysteine	1.73±0.15ª	1.92±0.01ª	2.35±0.01ª	2.76±0.01ᵇ
Glutamic	7.64±0.01ª	8.42±0.01ª	9.19±0.02ᵇ	9.75±0.01ᵇ
Glycine	4.28±0.01ª	8.22±2.12ᵇ	4.93±0.02ª	5.65±0.01ª
Proline	2.19±0.01ª	2.47±0.01ª	3.08±0.01ª	3.73±0.01ᵇ
Serine	3.43±0.01ª	3.74±0.01ª	3.82±0.01ª	4.23±0.02ᵇ
Tyrosine	2.84±0.01ª	3.88±0.02ª	3.18±0.01ª	2.95±0.01ᵇ

Values are recorded as Mean±SD of the three determinants, values in the same row with difference superscript are significantly different (p≤0.05)

Table: Four (4) Functional Properties Per 100g of the Formulated Weaning Food

Formulation	MSC	MS	MC	CL
WAC	391.00±1.00^{a}	208.00±1.00^{b}	222.00±1.00^{c}	288.00±1.00^{d}
WSI	313.00±100 ^{a}	302.60±1.00^{b}	305.27±0.6^{b}	112.67±0.90^{c}
pH	7.00±1.00^{a}	7.07±0.90^{a}	7.30±1.00^{a}	7.27±0.64^{a}
FC	9.22±1.02^{a}	7.62±0.92^{a}	12.22±0.69^{b}	4.11±0.84^{c}
SD	502.00±1.00^{a}	344.00±1.00^{b}	366.00±1.00^{c}	360.00±1.00^{d}

Values are recorded as Mean±SD of the three determinants, values in the same row with difference superscript are significantly different (p≤0.05)

WAC= Water absorption capacity, WSI= Water solubility index, FC= Fume capacity, SD= Swelling density

4.0 DISCUSSION

Table 1 shows the proximate composition of complementary weaning food for infant of weaning age. The protein contents of sprouted millet, sesame and crayfish blend ratio (MSC) flour blend for weaning food used in the formulation has higher values of protein, fat, ash and energy calories when compared with the control values (the commercial weaning food celerac) which goes in line with standard requirements for infants formulated diets (FAO/WHO 2000). The significant increase in these values was attributed to sprouting techniques samples were exposed to, which was found to improve food qualities as well as promote normal growth, maintain and replace essential nutrient loss, provide efficient energy and initiate normal metabolic processes. Moisture values was found to be within the range of 6.89±0.49 to 8.25±0.05 and 9.94±0.01 respectively, which was significantly greater ($P \leq 0.05$) than to that of the reference value celerac (5.58±0.01%). The significant difference ($P \leq 0.05$) exist in the moisture contents of the formulation of MS, MSC and MC. However, the moisture values of the current study were within the normal range of (5 to10%) as recommended by Mohamed et al., (2004). The differences that arise within the moisture contents of the formulation may be attributed to the drying technique employed for the formulated sample of the weaning food flour (Bintuetal., 2015).The content of the protein formulated diets were increased ($P \leq 0.05$) with supplementation quality, which subsequently increased from 11.07±0.20, 13.63±0.21, and 20.10±0.15 for diets MS, MC, and MSC, respectively. The protein values of the formulated weaning food MSC was significantly ($P \leq 0.05$) greater than that of the reference commercial weaning food CL 18.50±0.34. As in (Table 1). The supplementary weaning foods feeding programs mostly recommended within 17-20% protein content according to (Bintu BP et al., 2015). An adequate amount of protein are required for infants during weaning age, the food are advisably to be obtained from legumes and vegetable source (FAO/WHO/ UNU, 1985). The protein values of the formulated weaning diets were greater than the 16% credited by (Adepeju, 2016), and below the 23%, recommended value by the National Academy of Science (1989). In a similar manner, the protein contents of the formulated diets were greater than the value range of 14.8 and 15.6% as reported by (Adeola et al., 2010). The daily recommended intake of energy calorie and proteins for weaning infant and younger children under 2 years of age are ranged between 14 and16 grams of protein content as well as (820 to1360 Kcal) according to (FAO, 2015).The crude fat content of the weaning food formulation were at the ranged of 9.52±0.06, 9.94±0.14 and 17.52±0.02 respectively, in the formulation diet MS, MC and MSC as shown in table (Table 1). The three formulation diets possess higher ($P \leq 0.05$) content of crude fat beyond the control value which obtained 8.31±0.30. According to the codex standard for young children and infants crude fat cereal based food recommended fat range should not exceed 3.3g/100Kcal (codex 2006). These values are equivalent to 9.52, 9.94 and 17.52% for the formulation MS, MC, and MSC respectively. However, the crude fat value for this work is within the reference value of the codex standard 2006. The increase in MSC sample was due to the fact that the presence of sesame seed which is an oilseed, the fat content was able to meet the recommended dietary allowance of infants by (FAO/WHO 2000). The low fibre contents of the control weaning formulation diets was 0.11.±0.01 will support adequate absorption and digestibility of the blends by the infant's gastro intestinal tract as recommended by (Desikachar, 1980). The value of the ash with respect to diets MC was lower to that of the control value but it falls within the normal recommended dietary value for weaning food formulation which must not exceed 5 percent. (Nada *et al.*, 2015). The contents of the carbohydrate are 48.81±7.52, 67.43±5.77 and 63.51±6.59 for MSC, MS, and MC respectively, of the three formulation diets MS has lower carbohydrate value compared to the control and obtained by taking the difference. This shows the energy calorie value of the A (MSC) formulation diets is significantly higher than the control. The mineral elements analysis showed a significant difference between all the formulations. Formulation diet MSC possesses the highest contents of Na, Fe, Ca and Zn among all the formulation diets and the control diet commercial weaning food has the greatest amount of P and Mg. The Fe of the formulation diets MSC, MS and MC was within the range of 1.62±0.01 to 4.72±0.05 mg/100 g which was slightly higher to the control diet. The Mg and P contents of Control diet was higher compared to the formulation diets. All the three formulated diets were adequate and close to the weaning food recommended standard credited by the Food and Organization for infant's foods (FAO, 2001). Complementary weaning foods are essential sources of macro and Micro nutrients for growing infants. Iron in particular is an essential component of red blood cells, calcium helps in building strong teeth and bones while phosphorus, zinc and magnesium were all needed for cognitive function and metabolic processes and must needed to supplement alongside making nutrients dense weaning food infant (Nada *et al.*, 2015). Table 3 shows the amino acids content of a complementary weaning food prepared from sprouted millet fortified with sesame and crayfish. The MSC dried formulation contain almost all the essential amino acids specifically tryptophan and lysine which are found to be rare amino acids in most common cereals as credited by Ikujenlola *et al* (2018). Lysine and tryptophan were 3.95±0.01 per 100 g crude protein and 3.75±0.02 per 100 g crude protein respectively. Addition of sesame and crayfish has led to increased amount of the amino acids of the formulated diets. Thus, the predominant amino acid was glutamic acid 7.64±0.01 to 9.75±0.01 per 100 g. While the lowest amino acid was cysteine 1.73±0.15 to 2.76±0.01 per 100g. In table four (4), functional properties of the formulated weaning food which entails the ability of an ingredients of food substances to behave in terms of food preparation, food cooking as well as how they affect the whole finished foods in terms of how it taste, looks and feels. The significant increase in the values of WAC and SD (391.00±1.00 and 502.00±1.00) of the formulated weaning food is due to the capacity of food substance to associate with water in limiting condition and ability of water to absorbed on surface of macromolecule to colloid like pectin, starch, cellulose and proteins as observed by (Hannington *et al.,* 2020). Similarly, water absorption is a critical function of protein in food product like baked, soup and dough as well as the increase in the values of WSI and FC (313.00±1.00 and 9.22±1.02) of the control diet commercial weaning food Celarac (CL) is attributed to the level of exposure of internal structure starch molecules available in the diet to action of water in terms of solubility as credited by Hannington *et al* (2020).

5.0 Conclusion

The study concludes that the supplementary weaning food of cereals with more than one source will improve the protein quality, crude fat, crude fiber, amino acids and energy calories. The nutritional density evaluated was found to be highly nutritious when compared with popularly known commercial weaning food celarac, this entails the millet supplemented with sesame and crayfish is a potential complementary weaning food that can be affordable, cheap and easily exploited as weaning food for breastfed infant by their mothers in developing country like Nigeria.

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