

EFFECT OF AMINO ACID PROFILE, MICROBIOLOGICAL QUALITY AND SENSORY EVALUATION OF COMPLEMENTARY FOODS MADE FROM MILLET (*Pennisetum glaucum*), TIGER NUT (*Cyperus esculentus*) AND CRAYFISH (*Evastacus* SPECIES)

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ABSTRACT

Amino Acid Profile, Micro biological Quality and Sensory Evaluation of Complementary Food Made from Millet (*Pennisetum glaucum*), Tiger Nut (*Cyperus esculentus*) and CrayFish (*Evastacus* Species)”. Millet was soaked in clean water for 48 hours to ferment without changing the water after which it was washed from the water and sun dried for another 48 hrs. After drying properly, it was milled into fine powder. Crayfish and dried tiger nut were also cleaned properly and milled into fine powder. All samples were weighed and blended into different ratio. Sample A (100:0:0), sample B (70:20:10), sample C (60:30:10), sample D (50:40:10), sample E (50:50:0) of fermented millet, tiger nut and crayfish respectively. Amino Acid analysis of the formulated complementary foods showed that the complementary food had eighteen Amino Acid compositions which were grouped into Essential, Non-Essential and conditional Amino Acid respectively. Glutamic acid had the highest composition with (19.23± 0.02), (17.42± 0.01), (15.12 ±0.01), (16.50 ± 0.20) and (13.63 ± 0.20) in sample A, B, C, D and E respectively, Leucine was the concentrated Amino Acid with (9.82±0.01), (8.97±0.02), (8.00±1.00), (8.43±0.25), (7.76±0.02) in samples A, B, C, D, and E respectively. The micro biological analysis result showed that all samples were free of total fungi except for sample E which had total coliform (0.3×10^4). The sensory qualities of the formulated complementary foods were accepted but sample B had the highest overall Acceptability with (7.65±0.001). There was no significant difference ($p < 0.05$) in colour, texture, flavor and overall acceptability.

Key words: Amino acid profile, micro biological quality, sensory evaluation, complementary foods.

INTRODUCTION:

Around the age of 6 month, an infant's need for energy and nutrients starts to exceed what is provided by breast milk, and complementary foods are necessary to meet those needs. An infant of this age is also developmentally ready for other foods. This transition is referred to as complementary feeding (WHO, 2024). Optimal nutrition in the first year of life is therefore crucial in laying foundation of good nutrition and health of children. Nutritionally, it has been proven that breast milk is an adequate food for infants during the first six months of life (Lutter and Rivera, 2003). Breast milk alone cannot longer be sufficient both in quality and quantity to meet the nutritional requirements of infants after six months, hence appropriate complementary foods should be introduced (UNICEF, 2009).

Most families in Nigeria and other developing countries cannot afford commercial complementary food to wean infants due to high level of poverty, and thereby engage in

weaning the children on cereals gruels (Ikpemeetal; 2012). Scientifically it had been proven that cereals, gruels, are common weaning food in developing countries, have low energy and protein density (Hotz and Gibson, 2001; Igyoretal; 2011) due to high volume of water relative to its solid matter contents during preparation to increase the energy density of the gruel, more of the solid matter are needed which will make the gruel too thick and viscous for infants to eat and too large for their stomach capacity (Ikilenla and Fashakin, 2005).

Infants are therefore unable to fulfill their energy and other essential nutrient requirements (Ikilenla and Fashakin, 2005). Hence, there is increase in protein energy malnutrition among weaning aged children. Food processing techniques such as germination, fermentation, drying and milling have the potentials to enhance the nutrient bio availability, nutrient density, food safety, storage, palatability and convenience of supplementary food suitable for infants' mixtures (Miba et al; 2007). Germination and fermentation of cereals are affordable and widely practiced processing technique in Africa (Ongole et al; 2013). Fermentation enhances the nutrients of food through biosynthesis and bioavailability of vitamins and essential amino acid improving the protein quality and fiber digestibility (Gabriel and Akharaiyi, 2007; Isarotimi, 2012). Germination in the food, thereby increasing nutrient bio availability density and acceptability of the food (Sangonis and Machado, 2007; Obizaba and Egbuna, 1972).

Pearl millet (*Pennisetum glaucum*) is one of the most important drought tolerant crops in the semi-arid tropic's regions of the world. It is staple food in most population in Asian and African countries (Burton et al; 1972). As a cereal of human food pearl millet contributes a great part of dietary nutrients for large segment of people in Africa and Asia and is often considered highly palatable and a good source of protein, minerals and energy (Abdalla et al; 1998).

Tigernut (*Cyperus esculentus*) is an under-utilized tuber of family Cyperaceae, which produces rhizomes from the base of the tube that is somewhat spherical (Devries and Feuke, 1999). Tigernut is rich in mineral, predominantly, phosphorus and potassium and also vitamin C and E (Abaejoh et al; 2006). The present study is therefore aimed at producing weaning complementary food from fermented and germinated, pearl millet flour, tigernut flour and crayfish mixes using a combination of traditional processing techniques and evaluate the proximate and mineral composition of the formulated diets.

Crayfish which is classified as animal polypeptide is a fresh water crustacean resembling small lobster and it is commonly found in Nigeria coastal water. Crayfish is relatively cheap, affordable and readily available throughout the year. A review of nutritional value, the true digestibility, net protein utilization, high content of essential amino acid and protein efficiency is favorable compared to case in (FAO, 1985, WHO, 1998, UNU, 2002, Ibironke et al; 2014). It is very low in carbohydrate but rich in calcium, potassium, copper, zinc and iodine (Zaglon and Eltadawy, 2009; Ibironke, et al; 2014).

Statement of Problem

At six month of age, breast milk is no longer enough to meet the nutritional needs of infants therefore; there is need for complementary food to be added to the diet of the child. Several commercial weaning foods marketed in Nigeria are unaffordable for people of low socio- economic class, especially those in the rural areas; there has been an observed increase in malnutrition children especially among the low-income people. Hence, the production of complementary food using locally traditional processing method such as germination and fermentation of certain food products becomes very necessary as it will greatly reduce malnutrition among the low-income people. Therefore, this study is aimed at producing complementary food from pearl millet (pennies tumglaucum), tiger nut (cryperusculentus and crayfish (Evastacu species).

Significance of the Study

This study will be an eye-opener to mothers especially the low-income earners on how to provide nutritive diet in an easy and good way for their children. Children will obtain adequate nutrition needed for proper growth and development of the body system. Home economics teachers as well, can use this research to impact knowledge on the students. Likewise, students and youths in general can build on the findings and make themselves more skillful to gain employment. Companies will also have skillful and creative employees.

Objectives of the study

The main objective of the study is to determine the proximate and mineral composition of millet, tigernut and crayfish. Specifically, the study was to:

- i. Process and blend pearl millet, tigernut and crayfish.
- ii. Determine proximate composition of the formulated prepared blend.
- iii. Evaluate the mineral contents of the formulated complementary food.

METHODOLOGY

Research Design

This study adopted experimental research design.

Area of study

This study was carried out at Jalingo metropolis

Population of the study:

Population of the study included all nursing mother in Jalingo metropolis estimated to be about 50 according to the registration record from post-natal unit in the primary health centers within Jalingo.

Sampling technique

Simpler and om sampling technique was used to sample nursing mothers who carried out the sensory evaluation of the study

Sampling Size

According to Yamane (1967), to determine sampling size, the formula below was used

$$n = \frac{N}{1+N(e)^2}$$

Where

n= Sample size

N= Total Population

e= Precision or Margin error

$$n=? N= 50, e= \frac{10}{90} = 0.1$$

$$n= \frac{50}{1+50(0.1)^2}$$

$$n=33$$

Unit to be evaluated

a. Kona Clinic Jalingo

$$n= \frac{20}{50} \times 33$$

$$=13$$

b. Danburam Clinic Jalingo

$$n= \frac{30}{50} \times 33$$

$$=20$$

Instrument for data collection

Two instruments were used for data collection

- i. Flow chart for the production of flours of pearl millet, tigernut and crayfish.
- ii. The sensory evaluation assessment attributes (S.E.A.A) was developed by the researcher which was used in the sensory evaluation of the formulated diets.

Validation

The two instruments were given to three experts in Home Economics Department in the Taraba State University for content and face validation.

Data collection and analysis

The formulated diet was subjected to proximate analysis on crude fiber, moisture, protein, ash and fat.

Material and Method

Materials

Pearl millet (*Pennisetum glaucum*), tiger nut (*Cyperus esculentus*), crayfish were purchased from as hopin Jalingo Market, Taraba State, Nigeria. Unwanted seeds and dirt were removed from the pearl millet, tiger nut and crayfish. The pearl millet was washed and soaked for 48 hours to ferment. After which the pearl millet was sun dried for another 48 hours. The fermented and dried pearl millet was milled using milling machine and the nit was mixed with ground tiger nut and grounded crayfish and then it was packaged in clean containers for analysis. All laboratory reagents that were used for the analysis in this work are all of analytical quality.

Methods

Processing of fermented pearl millet (*Pennisetum glaucum*), Pearl millet was cleaned by removing stones, dirt and other unwanted seeds. Afterward it was washed and soaked for 48 hours to ferment. After the pearl millet has fermented, it was then washed again and sun dried for another 48 hours after it has dried properly. It was milled into fine powder using a milling machine.

Processing of Tiger Nut

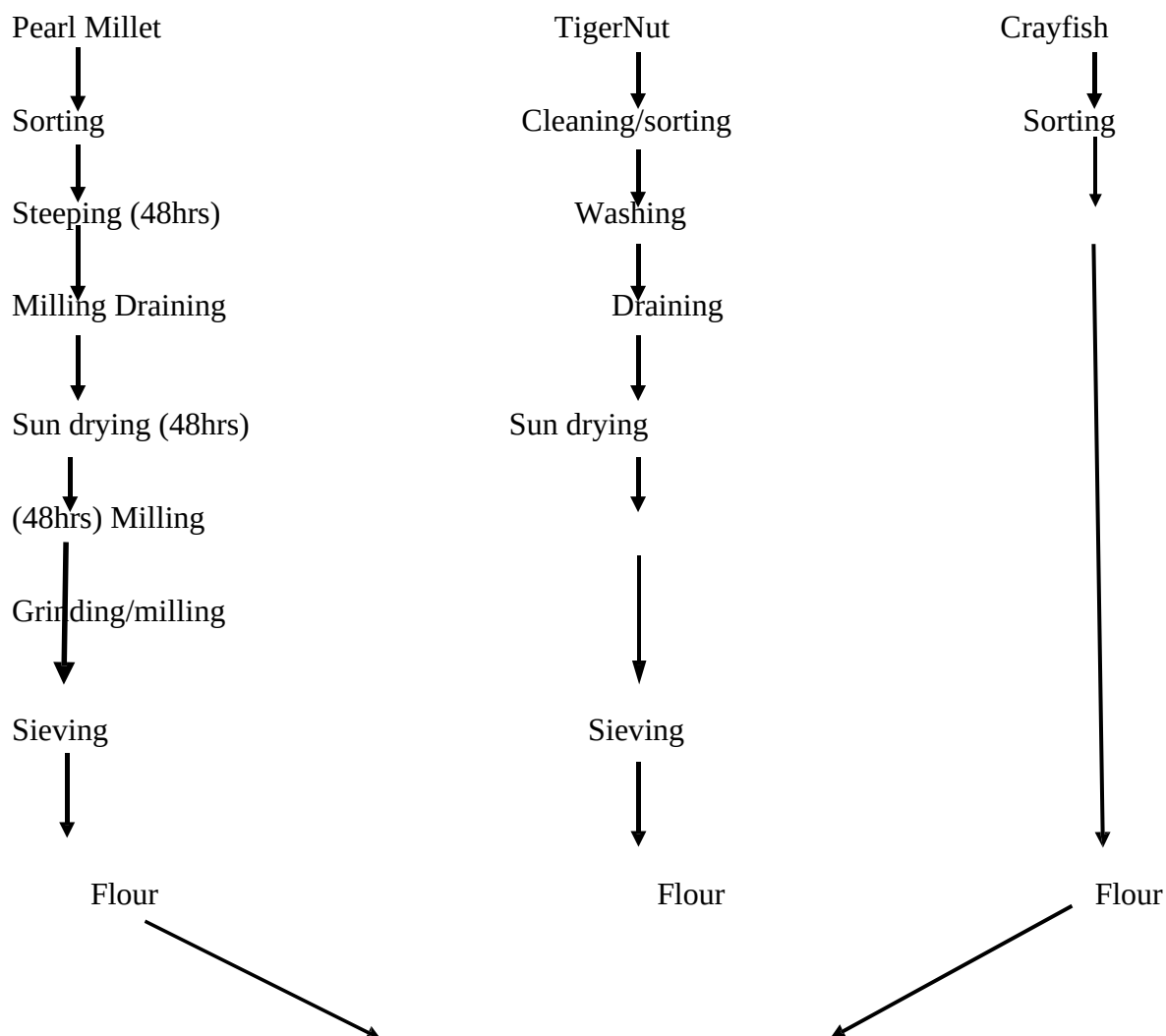
Tiger nut seeds was cleaned by removing stones, dusts and other unwanted seeds afterwards, it was washed and sun dried for 48hours until all the moisture is dried out, after which it was milled into fine powder.

Processing of Crayfish

Crayfish (*Procambarus clarkia*) was cleaned by sorting and removing all dusts and unwanted particles in the crayfish afterwards it was crushed (ground into powder).

Preparation of Pearl Millet, TigerNut andCrayfishBlend

The pearl millet powder was combined with the tiger nut powder and cray fish powder in different proportions. The flow chart below shows the preparation of these blends.



Mixing of pearl millet powder, tiger nut powder and Crayfish powder in different proportion/ratio Packaging

Fig. 1: Flow chart for the production offer mented pearl millet, tigernut and crayfish.

Fig. 2 Pearl Millet Flour (PMF)



Fig. 3 TigerNut Flour (TNF)



Fig. 3 CrayfishFlour (CFF)



Fig. 4 Cray FishFlour (CFF)

Table 3.1: Product Formulation(DietFormulation)

Diet	Pearl Millet %	Tiger nut %	Crayfish%
A	100	-	-
B	70	20	10
C	60	30	10
D	50	40	10
E	50	50	-



Fig 5 sampleA =100% Pearl milletflour-100:0:0



Fig. 6 SampleB=70:20:10 (pearl millet, tigernut and crayfish respectively).



Fig. 7 SampleC=60:30:10 (pearl millet, tigernut and crayfish respectively).



Fig. 8 SampleD=50:40:10 (pearl millet, tigernut and crayfish respectively).



Fig. 9 SampleE=50:50:0 (pearl millet, tigernut and crayfish respectively).

Plate1= Five (5) samples of the complementary food for sensory evaluation.

Amino Acid Analysis

Amino acid profile of fermented pearl millet tiger nut and crayfish was determining dusing the Techni consequentiall multiple-sample amino acid analyser. Prior to analysis, samples were hydrolysed for 22hrs at $105 \pm 5^{\circ}\text{C}$ with 6MHCL by the method of (Spacemanetal. 1985) as reported by (Arongundadeetal. 2009). The amino acid score was calculated with reference to amino acid composition of the whole egg (Hidvegi, 1984), as well as FAO/WHO, 2007) reference amino acid pattern.

Microbiological Analysis

All microbiological analyses were carried out based on procedures recommended in the international commission on microbiological specification for foods (1996). Appropriate serial dilutions of formulated complementary foods were carried out and 0.1ml of the selected dilution was spread on triplicate plates using sterile glass spreader. This technique was used for the enumeration of total viable count. The total micro bial load was determining dusing nutrient agar while coliform and fungi were determined using MacConkey agar and deoxycholate citrate agar respectively.

SensoryEvaluation

The various formulations were subjected to sensory evaluation, which were evaluated by 33 panellists. The products were reconstituted, coded and served hot to the semi trained and untrained panel lists consisting of nursing mothers. The formulation was rated for colour, taste, smoothness/texture, flavour consistency and overall acceptability. The panel lists were made to assess the samples and record their observations using 9-point hedonicscale where 9 =like extremely, 8=like very much, 7 =likes lightly, 5=neither like nor dislike, 4= dislikes lightly, 3 =dislike moderately, 2=dislike every much, 1=dislike extremely. This sensory evaluation was carried out in two post-natal clinics at Jalingo metropolis.

Plate 2 Educating the nursing mothers on the importance of the complementary foods and also how to prepare the complementary foods (pap)for their children.

Plate 3 mixing one of the samples

Plate 4 Nursing mothers being keenly watched for preparation of the diet (pap) while the research assistant explain the method of preparation in their local language for a better understanding.

Plate5 Taking the prepared Pap for sensory evaluation among the nursing mothers

Plate 6 mothers carrying out the sensory evaluation of the prepared complimentary food while the researchers watch and assistants help some mothers complete the sensory evaluation assessment form.

Statistical Analysis

Data obtained were subjected to analysis of variance (ANOVA) and difference among the parameters were tested by the least significant difference (LSD) at $P < (0.05)$.

RESULTS AND DISCUSSIONS

Amino Acid Composition is shown in Table 1 below; amino composition of the formulated complementary food contains essential, non-essential and conditional amino acid. In non-essential amino acid, Alanine ranged from $7.15 \pm 0.01\text{g}/100\text{g}$ in sample A to 3.87 ± 0.03 in sample E, Aspartic Acid ranged from $8.10 \pm 0.10\text{g}/100\text{g}$ in sample A to $8.25\text{g}/100\text{g}$ in sample E, Serine ranged from $4.45\text{g}/100$ in sample A to 3.35 ± 0.10 in sample E, Glutamic acid had the highest composition in the formulated diet ranging from 19.23 ± 0.02 in sample A to 29.01 in sample E. In conditional essential Amino acid pro line ranged from 6.53 ± 0.25 in sample A to 3.45 ± 0.03 in sample E, Glycine ranged from $3.85 \pm 0.01\text{g}/100\text{g}$ in sample A to $3.44 \pm 0.03\text{g}/100\text{g}$ in sample E. Arginine ranged from $5.43 \pm 0.20\text{g}/100\text{g}$ in sample A to $5.16 \pm 0.03\text{g}/100\text{g}$ in sample E, Cysteine ranged from $2.42 \pm 0.20\text{g}/100\text{g}$ in sample A to 1.03 ± 0.02 in sample E, Tyrosine ranged from $3.62 \pm 0.02\text{g}/100\text{g}$ in sample A to $3.27 \pm 0.20\text{g}/100\text{g}$ in sample E, Arginine had the highest compositions in conditional amino acid.

In essential amino acid, Lysine ranged from $3.72 \pm 0.04\text{g}/100\text{g}$ in sample A to $3.61 \pm 0.04\text{g}/100\text{g}$ in sample E, Threonine ranged from $3.77 \pm 0.00\text{g}/100\text{g}$ in sample A to $3.16 \pm 0.00\text{g}/100\text{g}$ in sample E, Valine ranged from $5.55 \pm 0.002\text{g}/100\text{g}$ in sample A to $3.52 \pm 0.01\text{g}/100\text{g}$ in sample E, Methionine ranged from $2.41 \pm 0.20\text{g}/100\text{g}$ in sample A to $1.92 \pm 0.03\text{g}/100\text{g}$ in sample E, Isoleucine ranged from $9.82 \pm 0.01\text{g}/100\text{g}$ in sample A to $3.21 \pm 0.02\text{g}/100\text{g}$ in sample E, Leucine ranged from $9.82 \pm 0.001\text{g}/100\text{g}$ in sample A to $7.76 \pm 0.02\text{g}/100\text{g}$ in sample E, Phenylalanine ranged from 5.85 ± 0.00 to 4.08 ± 0.00 in sample E, Histidine ranged from $2.56 \pm 0.02\text{g}/100\text{g}$ in sample A to $2.11 \pm 0.02\text{g}/100\text{g}$ in sample E and Tryptophan ranged from $2.00 \pm 0.00\text{g}/100\text{g}$ in sample A to $0.97 \pm 0.02\text{g}/100\text{g}$ in sample E thereby making tryptophan the amino acid with the least $0.97 \pm 0.02\text{g}/100\text{g}$ in sample E thereby making tryptophan the amino acid with the least composition in the formulated complementary diet and Leucine the amino acid with the most concentration. Composition in the formulated complementary diet and Leucine the amino acid with the most concentration.

Table1: Amino Acid Composition of Formulated Diet Prepared from Fermented Pearl Millet, Tiger Nut and CrayfishBlend

Non-essential	SampleA	SampleB	SampleC	SampleD	SampleE
amino acids (TNEAA)					
Alanine	7.52±0.01	5.84±0.03 ^d	4.78±0.02 ^d	5.23±0.03 ^d	3.87±0.03 ^d
Aspartic acid	8.10±0.01 ^c	8.43±0.02 ^c	7.75±0.02 ^c	7.81±0.02 ^c	8.25±0.01 ^c
Serine	4.54±0.03 ^e	4.86±0.04 ^e	3.63±0.02 ^e	4.10±0.10 ^e	3.35±0.10 ^e
Glutamic acid	19.23±0.02 ^b	17.42±0.01 ^b	15.12±0.01 ^b	16.50±0.20 ^b	13.63±0.02 ^b
ΣNEAA	39.28±0.01 ^a	36.36±0.04 ^a	31.36±0.03 ^a	33.54±0.02 ^a	29.01±0.10 ^a
Conditional Essential Amino Acid (CEAA)					
Proline	6.53±0.25 ^b	4.86±0.03 ^d	4.06±0.06 ^d	4.35±0.04 ^d	3.45±0.03 ^c
Glycine	3.85±0.01 ^d	5.56±0.03 ^c	4.45±0.04 ^c	5.04±0.03 ^c	3.44±0.03 ^c
Arginine	5.43±0.20 ^c	6.54±0.03 ^b	5.52±0.03 ^b	6.18±0.02 ^b	5.16±0.03 ^b
Cysteine	2.42±0.20 ^f	2.06±0.04 ^f	1.38±0.01 ^f	1.57±0.02 ^f	1.03±0.02 ^e
Tyrosine	3.62±0.02 ^e	3.96±0.03 ^e	3.27±0.02 ^e	3.78±0.02 ^e	3.27±0.20 ^d
ΣCEAA	21.92±0.01 ^a	22.9±0.01 ^a	18.67±0.02 ^a	20.94±0.03 ^a	16.86±0.30 ^a
Essential Amino Acid (EAA) +Histidine					
Lysine	3.72±0.04 ^d	4.77±0.03 ^b	4.34±0.49 ^b	4.33±0.20 ^c	3.61±0.04 ^c
Threonine	3.77±0.00 ^d	3.72±0.00 ^e	3.33±0.00 ^d	3.50±0.00 ^e	3.16±0.00 ^f
Valine	5.55±0.02 ^c	4.33±0.02 ^c	3.92±0.05 ^{bc}	3.97±0.00 ^d	3.52±0.01 ^d
Methionine	2.41±0.20 ^e	2.42±0.17 ^f	2.31±0.16 ^e	2.31±0.16 ^f	1.92±0.03 ^h
Isoleucine	9.82±0.01 ^a	3.57±0.15 ^e	3.47±0.40 ^{cd}	3.47±0.25 ^e	3.21±0.02 ^e
Leucine	9.82±0.01 ^a	8.97±0.02 ^a	8.00±1.00 ^a	8.43±0.25 ^a	7.76±0.02 ^a
Phenylalanine	5.85±0.00 ^b	4.88±0.00 ^b	4.43±0.00 ^b	4.61±0.00 ^b	4.08±0.00 ^b
Histidine	2.56±0.02 ^e	3.98±0.01 ^d	2.30±0.20 ^e	2.36±0.02 ^f	2.11±0.02 ^g
Tryptophan	2.00±0.00 ^f	1.78±0.00 ^g	1.14±0.01 ^f	7±0.02 ^g	0.97±0.02 ⁱ
ΣEAA	40.17	37.48	32.8	34.49	30.3

A=100%Fermentedpearlmillet,B=70%Fermentedpearlmillet+20%Tigernut+10%

Crayfish,

C=60%Fermentedpearlmillet+30%Tigernut+10%Crayfish,D=50%Fermentedpearl millet + 40%Tiger nut
+10%Crayfish, E =50%Fermentedpearl millet + 50%Tiger nut.

Table 1 shows the summary of amino acid composition of formulated diet prepared from fermented pearl millet, tiger nut and crayfish. Acidic amino acid includes Aspartic acid, glutamic acid while the basic amino acid includes Arginine, Lysine while the rest amino acid is neutral. Aromatic amino acid Tryptophan, Tyrosine, Phenylalanine while Sulphur containing amino acid includes Methionine and Cysteine. The biological value (BV) refers to the percentage of a protein nitrogen that is absorbed and available for use by the body for growth and maintenance.

Table2: Summary of Amino Acid Composition of Formulated Diet Prepared from Fermented Pearl Millet, Crayfish and Tiger Nut

AMINO ACID DESCRIPTION	A	B	C	D	E
Total amino acids (TAA)	101.37	97.01	82.84	88.97	76.27
Total essential amino acid (TEAA)with Histidine	40.17	37.48	37.08	34.49	30.03
Total essentialamino acid (TEAA) without Histidine	37.61	34.48	30.05	32.13	28.19
%TNEAA with Histidine	39.63	38.64	39.59	38.77	39.73
%TNEAA without Histidine	37.10	35.54	36.82	36.11	36.96
Total non-essential amino acid (TNEAA)	39.28	36.54	31.36	33.54	29.01
%TNEAA	38.75	37.67	37.86	37.69	35.15
TEAA/TNEAA	01.02	01.03	01.04	01.03	1.03
Essential aromatic aminoacids (EArAA)	14.02	13.63	11.15	12.22	10.23
Total neutral amino acids(TNAA)	62.37	56.86	48.00	51.71	43.51
%TNAA	61.53	58.61	57.94	58.12	57.05
Total acidic amino acids (TAAA)	27.23	25.84	22.96	24.31	21.88
%TAAA	26.87	26.64	27.72	27.32	28.69
Total basic acids	11.77	14.31	11.88	12.95	10.88
%TBAA	11.61	14.75	14.34	14.56	14.27
Total sulphur containing amino acids	04.82	04.46	03.58	03.87	02.95
%in Cysteinein TSAA	50.20	46.19	38.83	40.57	34.92
Essential aliphatic amino acid	33.89	27.63	24.16	25.19	21.08
BV	49.39	59.40	67.38	64.52	88.82

A=100%Fermentedpearlmillet,B=70%fermentedpearlmillet+20%tigernut+10%

crayfish,C=60% fermentedpearlmillet+30%tigernut+10%crayfish,D=50%fermented pearl millet +40%tiger nut +10% crayfish, E =50%fermented pearl millet +50%tiger nut.

Table 2 shows the composition of crude protein of the formulated diet prepared from fermented pearl millet, tiger nut and crayfish and the percentage of RDA of amino acid metper 100g of the formulated diet. Arginine has the highest RDA% in sample B with 327% while isoleucine has the least RDA% with 76% in sample E.

The amino acid profile of the prepared as complementary foods (ferment pearl millet tiger nut and crayfish table 1 showed little variation in the content of total essential amino acid (EAA) and non- essential amino acid (NEAA) Glutamic acid was the most abundant amino acid in sample A B C D E with (19.23g/100g), (17.42.g/100g) (15.12g/100g). (16.50g/100g). (13.63g/100) levels respectively. The second most abundant amino acid is aspartic acid (8.10g/100) (8.43g/100). (7.75g/100. (7.81g/100). (825g/100). The most concentrated essential amino acid in the complementary food is Leucine with values of (9.82g/100g) (8.97g/100g) (8.00g/100g) (8.43g/100g) (7.76g/100g) respectively while the least is tryptophan with (2.00g/100g) (1.78g/100g) (1.14g/100g) (1.47g/100g) (0.97g/100g). Glutamic was found to be the major non-essential amino acid in the study. The nutritive value of a protein depends primarily on the capacity to satisfy the needs for nitrogen and essential amino acids (Abah, 2019; Oshodi.1998). The five samples of the complementary food contain high concentration of lysine in the range of (3.72g/100) (4.77g/100g) (4.34g/100g) (4.33g/100g) (3.61g/100) total protein Lysine is a nutritionally critical amino acid and an essential amino acid that is lacking in all of the world's main cereal crops. (Mburu.2011). The total essential amino acids (TEAA) values (with histidine) in sample A, B, C, D, E was (39.63%) (38.64%) (39.59%) (38.77%)(39.73%) respectively. The ratio of total essential amino acid to non-essential amino acids in the five sample was (1.02) (1.03) (1.03)(1.03) (1.04) respectively. Essential aliphatic amino acid (E.A.A.A) is leucine Leucine. Valines were present in the sample. Also, the percentage of total acidic amino acid (T.A.A.A) as was found to be greater than the percentage of total basic amino acids (T.B.A.A) in the five samples indicating that the protein is mainly acidic in nature. The biological value was (49.39). (59.40) (67.38) (64.52) (88.82) respectively.

Table 3 shows the amino acid score of the formulated complementary food. This method is used to evaluate the quality of protein based on both the amino acid requirement of humans and their ability to digest it. Isoleucine has the highest amino acid score with 175 in sample A while Valine has the least amino acid score with 58 in sample C.

Table3: Amino Acid Composition (g/100g) crude protein of the prepared complementary food and percentage of RDA of amino acid met per 100g of prepared complementary foods.

AMINO ACID	RDA	A	%RDA	B	%RDA	C	%RDA	D	%RDA	E	%RDA
Threonine	2.6	3.77	145	3.72	143	3.33	128	3.50	135	3.16	122
Valine	4.2	5.55	132	4.33	103	3.92	93	3.98	95	3.51	84
Methionine	2.2	2.40	109	2.40	109	2.19	99.5	2.30	105	1.92	87
Isoleucine	4.2	4.52	108	3.60	86	3.40	81	3.47	83	3.21	76
Leucine	4.8	9.81	204	8.99	187	8.00	167	8.40	175	7.76	162
Lysine	4.2	3.71	88	4.77	114	4.08	97	4.40	105	3.61	86
Arginine	2.0	5.50	275	6.54	327	5.50	275	6.19	309	5.16	258

A= 100% Fermented pearl millet, B= 70% fermented pearl millet + 20% tiger nut + 10% crayfish, C=60% fermented pearl millet +30% tiger nut+ 10%crayfish, D= 50% fermented pearl millet + 40% tiger nut + 10% crayfish, E =50% fermented pearl millet +50% tiger nut.

Table 4 shows the micro biological composition of the formulated diet with sample 4 having a high coliform count 0.3×10^4 followed by sample E with 0.3×10^3 while the rest sample had Zero coliform count, sample E had total fungi count of 0.5×10^3 while the rest sample recorded zero fungi count.

Table4: Amino Acid Score in Formulated Diet Prepared from Fermented Pearl Millet, Tiger Nut and Crayfish

LAA	Egg ref(gg)	SampleA	SampleB	SampleC	SampleD	SampleE
Cys	1.8	1344	114.44	77.22	87.22	57.22
HIS	2.4	106.67	166.25	95.83	98.33.	87.92
ILE	5.6	175.18	64.29	60.71	61.96	57.32
LEU	8.3	118.19	108.33	96.39	101.20	93.49
LYS	6.3	58.89	75.71	64.76	69.84	57.30
MET	3.2	75.00	75.00	68.44	71.88	60.00
PHE	5.1	114.71	95.69	86.86	90.39	80.00
THR	5.1	73.92	72.94	65.29	68.63	61.96
TRP	1.8	111.11	99.44	63.89	81.67	53.89
TYR	4	90.25	99.00	81.75	94.50	77.50
VAL	7.6	73.03	56.97	51.58	52.37	46.18
CS		1131.39	1028.05	812.73.	878.00	732.79
DASS		68.75	53.44	55	77.5	68.75
PBY		49.39	99.40	67.382	64.52	88.82

A=100%Fermented pearl millet B=70% fermented pearl millet+ 20% Tiger nut+ 10% crayfish.

C=60% fermented pearl millet +30% Tiger nut +10% crayfish D=50%fermented pearl millet, 50%Tigernut.

Table 5 shows the sensory result of the formulated diet with sample B having the highest overall acceptability with 7.65=00.00makingitmore acceptable than other formulated sample and sample D with the least overall acceptability with Tiger nut and cray fish 6.95. =0.03.

Table5: Micro biological Quality of Complementary Food Prepared from Fermented Millet

Sample. Total viable Count (cfu/ml) Total fungi count (usf/ml) Total coliformcount (cfu/ml)

A	1.65×10^2	Nil	0.3×10^{41}
B	0.2×10^2	Nil	Nil
C	0.15×10^2	Nil	Nil
D	1.4×10^2	Nil	0.3×10^2
E	0.7×10^2	0.5×10^2	Nil

A(100:0.0) =100% pearlmilletB(70.2010)=70% fermentedpearlmillet+20%Tigernut+ (10% crayfishC(60:30:10=60% fermentedpearmillet+30% Tiger nut+ 10%crayfishD (50:40:10) =50% Fermented pearl millet+ 40% Tiger nut+10illet+50ermented pear % crayfishE(50:50)=50%Tigernut.

Microbiological Analysis

Microbial Analysis was conducted inprepared samples (fermented pearl millet. Tiger nut and crayfish) to determine if the blend sare whole some, to also as certain the safety of the product for consumptionin table5 food product for consumption should have micro bial count below 1×10^4 cfu/g. the international micro biological standard recommend limit of bacterial contaminant for food to be less than 10^6 cfu/g (Anon, 1974) where as (Rombountand Nouts 1995) Revealed that bacterial count obtained in plants foods were in the order of 1.2×10^8 cfu/g. All the results showed satisfactory results except for sample A with total coliform of 0.3×10^4 which is unfit for consumption. A high level of total variable count was observed in sample A (1.65×10^2) with zero or nil fungi count. This includes the presence of probiotics which helps in metabolism in the lumen. High coliform count indicates presences of possible contamination and presence of potential disease causing bacterial in sample A which must have been caused by improper drying or storage. Absence of total fungi and total coliform in other sample were obtained as a result of high standard of personal hygiene and quality maintenance of good manufacturing practice observe during the food formulation process.

Table6. Sensory Evaluation of Formulated Diet Prepared from Pearl Millet, Tiger Nut and Crayfish

Sample	Taste	Color	Texture	Aroma	General	Acceptability
A		7.55±0.02 ^b	7.15±0.02 ^b	6.86±0.03 ^b	6.80±0.00	7.55±0.03
B		9.95±0.03 ^b	7.70±0.20 ^b	7.40±0.20 ⁴	7.60±0.00	7.65±0.00
C		6.83±0.02 ^c	7.25±0.03 ^b	6.53±0.25 ^c	7.00±0.00 ⁴	7.00±2.00 ⁺
D		6.75±0.03 ^d	7.15±0.03 ^b	6.66±0.02 ^{bc}	6.75±0.00 ⁴	6.95±0.03 ⁴
E		6.67±0.02 ⁴	7.77±0.15 ⁴	6.75±0.03 ^{BC}	6.96±0.01 ⁴	7.13±0.15 ⁴

At(p<0.05).A(100:0:0)=100%fermented pearlmillet.B(70:20:10)=70% fermented pearl millet+20%Tigernut+10%crayfishC (60:30:10)=60%fermentedpearlmillet+30%Tiger nut+10%crayfishD(50%.40:10)=50Fermentedpearmillet+40%Tigernut+10%crayfish. E (50:50) =50%fermented pearl millet +50%Tiger nut.

Sensory Evaluation

The sensory evaluation of samples prepared from fermented pearl millet, Tiger nut and crayfish blend is shown in Table6 the mean sensory score on a 9-point hedonic scale for Taste Color, Texture Aroma and Overall Acceptability of the overall food sample was assessed by the semi-literate and literate panel list. In Taste Sample B had the highest score (7.95±0.03) while it least score in taste was sample E with (6.67±0.02) Sample B had the highest score in texture with (7.40±0.20) while it least score was sample C with (6.53±0.25). Sample B had the highest score in aroma with (7.60±0.00) while it least score was sample D with (6.75±0.00) sample B had the overall acceptability mean score with (7.65±0.00) while the least accepted was sample D with (6.95±0.00) there by making sample B more acceptable than the any other formulated sample. The taste of sample B was assessed higher than other formulated sample, texture assessed as smooth, than other sample because texture is essential because it determines amount of food an infant can consume, in fact allow more smooth texture of food than cause or tough food. The acceptability result obtained from samples assessed by the panelist shows that all samples was accepted, but the panel is show some significantly high presences (p<0.05) for sample B compared to other formulated samples.

CONCLUSION

It is expedient to conclude that, complementary food formulations in this study were based on locally available low-cost food materials commonly consumed in Taraba State. The results showed that the formulated complementary foods are nutrient-dense with good sensory properties. The formulated blends are potentially available for use as complementary food for children between 6-24months. Sensory evaluation done on the formulated food revealed that addition of crayfish and tiger nut to fermented pearl millet improve the formulated complementary food organoleptic quality and contributed to its acceptability. From the discussion, it can also be concluded that locally available and nutritious complementary foods made from pearl millet, tiger nut and crayfish blend will potentially and effectively solve the problem of nutrients deficiencies in a growing child.

RECOMMENDATIONS

- i. Nursing mothers should be encouraged to feed their infants on proper complementary food blends.
- ii. Cereals based food should not be prepared alone but blended with other classes of food protein, legume source gets better. g. (pear millet, tiger nut and crayfish) in order to meet the nutritional needs of infants and to increase the nutrient quality in the food.
- iii. The traditional ways of processing food should be employed in the formulation of complementary foods in order to increase its nutrient value.
- iv. Different approaches should be offered to families especially nursing mothers on how to feed their infants with improved food formulations using low cost readily and locally available materials and traditional techniques in food processing.
- v. Work shops on supplementary food production using locally available raw materials should be held for nursing mothers in different localities in Taraba State..

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