Applied Sciences Research Periodicals
November 2023, Vol. 1, No. 8, pp. 07-17

Amino Acid, Antinutritional and Sensory Properties of Ready to Eat Snack from Cassava, Soybean and Cricket Composite Flour

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Abstract:
The amino acid, antinutritional and sensory properties of formulated ready to eat snacks prepared from yellow cassava, soybeans and cricket (protein source) composite flour was obtained using simultaneous equation and material mass balance method, it was determined and compared statistically with two proprietary snacks sold in the market. Essential amino acid profile showed that the formulated snack was significantly lower than the two proprietary snacks while the antinutritional properties were significantly higher in the formulated snack than the proprietary snack, but fell under the 0.50 safe permissible unit for antinutrient in formulated snacks, making bio-unavailability of calcium and magnesium needed for bone development minimal. Sensory evaluation showed that the formulated snacks did not differ significantly (p = 0.05) from the two proprietary snacks in colour flavour, taste smell, texture and overall acceptability. Sensory panellists had a high preference for the formulated snacks than the two proprietary snacks because the egg and soybeans component were mildly perceivable. The formulated snacks mostly complied with Emergency Food Product (EFP) recommendation for snacks. It therefore recommended that substitution of cassava flour, soybean flour and cricket flour using simultaneous equation and material mass balance equation in snacks formulation should be embarked upon by snacks industries as this will help in conserving national foreign exchange and improving the national value of snacks

INTRODUCTION

The formulation and deployment of Emergency food product (EFP) may hold potential in tackling protein energy malnutrition (PEM) among children, refugees and internally displaced persons in war torn and disaster-prone areas. This is because emergency food products are intended to provide a compact self-contained, high-energy, nutrient-dense emergency food for school children, refugees and internally displaced persons (IDP) and victims of disasters for a short duration at the initial stages of an emergency (Burgess 2005). Protein energy malnutrition (PEM), which may cause disease such as kwashiorkor, marasmus, and immune deficiencies, can be explained by several factors, the main one being the lack of quantitative and qualitative protein intake (Amal et al 2012). For children from 4 - 6 month, these conditions are usually due to the fact that breast milk no longer meets the needs for energy, protein and micronutrients including calcium, iron, Zinc, and vitamin A (Zoumas et al 2002). An EFP should contain 10-20 % of protein, 5-15 % of fat and 50-70 % of carbohydrates, 5-10 % of ash and 1-29 % moisture (Amal et al 2012). Furthermore, the EFP must be safe, palatable, and easy to dispense, easy to use and nutritionally complete (Zoumas et al 2002). There are many alternative forms of EFP one among them is bakery food product, snacks (Vanlaanen 2010).

snacks are an excellent food for the incorporation of different nutritionally rich ingredients, thus making it a useful tool in meeting the nutritional requirements of increasing global population (Adegoke *et al* 2017). Snacks have become very popular in Nigeria among all age groups particularly children and babies both in rural as well as urban areas owing to their sweet taste and this is perhaps because it comes ready to eat, low cost among other processed foods, varied taste, easy availability, good eating quality and relatively long shelf life (Adegoke *et al* 2017). Snacks are nutritive snacks made from unpalatable dough that has been transformed into appetizing product through the application of heat in the oven (Olaoye *et al*, 2007). In Nigeria, ready-to-eat baked products consumption is continually growing and there has been increasing reliance on imported wheat to sustain this trend (Akpapunam and Darbe 1999). Nigeria, moreover, grows staple crops other than wheat such as cassava, yam, sweet potatoes and cereals that can be used in baked foods (Chinma and Gernah 2007). It would therefore be economically advantageous if imported wheat could be reduced or even eliminated and the demand of baked foods such as snacks could be met by the use of domestically grown alternatives to wheat (Chinma and Gernah 2007). Snacks made from staple crops are high in carbohydrates, fats and calorie but low in protein, fiber and vitamin and mineral which make it unhealthy for daily use (Serrem et al, 2011). Moreover, snacks have only about 6-7 % space protein (Agarwal *et al*, 1990). This may be enhanced through incorporation of protein-rich food source such as soy bean, and cricket flours.

Cassava (*Manihot esculenta*), is a perennial woody shrub with edible root (Omolara and John, 2017). It grows in tropical and sub-tropical regions and is known by different names in different parts of the world, such as yuca, manioc and mandioca (Omolara and John 2017). Cassava is highly drought tolerant with the ability to grow on marginal lands where cereals and other crops do not grow well; it can also grow in soils where the nutrient levels are low. Because cassava roots can be stored on the ground for a long time (from 24 - 36 months in some varieties), the harvest is usually delayed until market processing, or other conditions are favorable (Fauquet and Fargette *1990*). It is a major staple food in Nigeria, consumed daily by more than 100 million people, it is known to be highly perishable and thus often processed immediately after harvest into gari, akpu, achicha and furaka (Olatunde *et al*, 2016). It is also an important source of calories to millions of people particularly in the tropics (Lasekan *et al*, 2016). The major limitations of cassava include low protein, low mineral and vitamin contents together with cyanide toxicity (Ihekoronye *et al*, 1985). The cassava amino acid such as methionine, lysine and tryptophan are also low in quality (Badifu *et al,* 2000). The commonly available white cassava can provide most of the body's daily energy requirements; it lacks micronutrients, such as vitamin A, that are essential for a healthy and productive life (Ayankunbi *et al*, 1991). Populations which eat a lot of white cassava do not receive adequate intake of good quality protein and such populations are prone to protein malnutrition, which may cause diseases such as kwashiorkor, marasmus, immune deficiencies and eye damage that can lead to blindness and even death (Ayankunbi *et al.*, 1991). Recently, new varieties of cassava have been produced and pro-vitamin A cassava which is rich in β-carotene is one of such varieties. Pro-vitamin A cassava is currently been used as an aid in reducing the prevalence of dietary vitamin A deficiency due to its high β-carotene content (Ihekoronye *et al*, 1985). According to (Omodamiro *et al*., 2019), pro-vitamin A cassava have the potential of providing up to 40 % of the vitamin A recommended daily requirements of children and women. Therefore, incorporation of soya bean and cricket flour into cassava flour for the production of snacks may hold potential for increasing the protein caloric value, amino acid, mineral and vitamin content of the resulting product (Badifu *et al.,* 2000).

Soybean (*Glycine max*) is among the major industrial and food crops grown in every continent and have long been recognized as a plant food that when compared with other plants, is relatively high in protein (40 %), lipid (20 %), minerals (5 %) and B vitamins for human nutrition (Lee *et al*.,2007). Moreover, most of the oilseeds contain 40-50 % oil, whereas soybean contains 18 % of oil (Badifu *et al,* 2000). The amino acid profile of soy protein is excellent among plant proteins (Tasnim *et al*., 2015). Hence, it is superior to other plant proteins as it contains most of the essential amino acids except methionine (Tasnim and Suman 2015). Soy protein directly lowers serum cholesterol levels (Mirrahimi *et al*., 2010). Soybeans also contain biologically active proteins such as enzymes, trypsin inhibitor hemagglutinins, and cysteine proteases very similar to papain (Tasnim *et al*., 2015). Soy food is quite important to us as they reduce the risk of heart disease improve mental health and physical abilities, memory power and hemoglobin level of children (Tasnim and Suman 2015).

Crickets (*Gryllus assimilis*) are large insects that live underground where they feed on the roots of plants in the soil (Oibiokpa *et al*., 2017). They are rich in essential nutrients; Cricket protein is considered complete proteins because it contains all the essential amino acids such as leucine, isoleucine, valine, methionine, tryptophan, threonine, lysine, histidine and phenylalanine. These are considered "essential" because it must be through diet (Ayieko and Millicent 2010). Cricket is a source of branched chain amino acid (BCAAS) crucial for muscle growth (Belluco *et al.,* 2013). It provides the following essential minerals; zinc, copper, iodine and manganese that are required by the body (Belluco *et al.,* 2013).it is also a good source of vitamin B_2 and B_7 rich in chitin, a probiotic fiber that may support gut health. It is a seasonal insect but can be reared in other state like Kano, Niger and Gombe States (Belluco *et al.,* 2013).

Malnutrition and hunger have become serious problems in Nigeria (Zoumas *et al*., 2002). The country's population which depends on staple foods such as cassava is prone to malnutrition which causes diseases such as kwashiorkor, marasmus and immune deficiencies. It has also been a problem because both men, young and old are suffering from insufficient and qualitative protein intake (Zoumas *et al*., 2002). For children and babies from 4 - 6 months, these conditions are usually due to the fact that breast milk no longer meets the needs for energy, protein and micronutrients including calcium, iron, zinc and vitamin A (Zoumas *et al*., 2002). Also there appear to be a growing need for an indigenous nutrient dense emergency food product (EFP) that can help curtail the problem of malnutrition experienced by affected population seeing as there is a growing number of internally displaced persons (IDP) and refugees arising from herders/farmer clashes, natural disasters, communal clashes e. t. c. The aim of this research was to produce and evaluate the amino acid, antinutritional and sensory properties of ready to eat snacks from cassava, soybean and cricket composite flours.

MATERIALS AND METHODS

Sources of Materials and Equipment

Soybean seeds, freshly harvested yellow cassava cultivar root and edible cricket was procured from the local farmer and cricket sellers, all in Gboko town, in Benue State, and was taken to the Department of Biological Science, Benue State University, for identification by the botanist and zoologist respectively.

Processing of Cassava Roots into Flour:

The method of international institute of tropical agriculture IITA (Messinger-Rapport *et al.,* 2009) was adopted. Three kilogram of cassava roots was washed manually, peeled with a knife, washed again and cut into chips. The chips were soaked for 9 h in tap water at ambient temperature. The water was changed at intervals of 3 h after which the chips was rinsed and dried in an air. It was milled into flour using hammer mill and the resultant flour was sieved into a particle size of 80 μm. The flour was packaged in low density polyethene bags and stored for further use (Chinma *et al.*, 2007).

Fresh cassava Roots
↓
Washing
↓
Grating finely
↓
Dewatering
↓
Drying (oven drying at 60 °C 24 h)
↓
Milling (hammer mill)
↓
Sieving (280 μm)
↓
Cassava flour

Figure 1: Flow chart for the production of cassava flour (**Chinma *et al*., 2007**)

Processing of Soy Bean Flour:

The soya bean was processed into flour as outlined in the flow chart in Figure 2. The process ensures effective removal of most of the anti-nutritional factors.

Soybean seeds
↓
Cleaning (manual handpicking)
↓
Washing and soak in water for 14 h
↓
Straining and blanch at 80 °C for 30 min
↓
Dehulling and wash severally with tap water
↓
Boiling for at 100 °C for 30 min and oven-dried at 55 °C for 6 h
↓
Roasting and mill (hammer mill)
↓
Sieve (with 300 μm mesh selves)
↓
Soybean flour

Figure 2: A flow chart for the Preparation of soybean flour

Processing of Cricket into Flour:

The cricket was processed into flour using the procedure shown in the flow chart below.

Cricket
↓
De-winged
↓
Removal of feaces
↓
Wash with tap water
↓
Drained
↓
Spread (oven dry at 50 °C for 6 h)
↓
Milled
↓
Sieved (250 μm mesh sieve)
↓
Cricket flour

Figure 3: Flow chart for the production of cricket flour (Shittu *et al.*, 2007)

Determination of Amino Acid Profile of the Formulated and Two Proprietary Snacks

About 30 g of the sample was dissolved in 10 mL of 6 N hydrochloric acid containing 0.1 % of phenol. The sample was hydrolyzed under nitrogen at 110 °C for 24 h. After cooling and adjusting pH to 2.2 using NaOH, 0.5 mL of leucine was added as an internal standard. The sample was filtered through a 0.2 μm filter and 20 μl of the filtrate was analyzed by high performance liquid chromatography equipped with sodium oxidized column, cation exchange resin followed by post-column derivatisation of the amino acids to ninhydrin and spectrometric detection at 570 mm. The amino acids to be determined are essential amino acids such as; Valine, Tyrosine, Tryptophan, Cystine, Leucine, Iso-leucine, Lysine, Methionine, Phenylalanine, and threonine, and non-essential amino acids such as; Arginine, Histidine, Alanine, Aspartic, Glutamic, Glycine, Proline and Serine.

Evaluation of Anti- Nutrient Factors of The Formulated and Two Proprietary Snacks

Determination of Cyanogenic Glycoside:

The alkaline pictrate method described by Oke was adopted. Five grams (5.0 g) of samples was weighed and dissolved in 50 mL distilled water in corked conical flasks. The mixtures were allowed to stay overnight and then filtered. The extracts (filtrates) were collected and labeled. Different concentration of hydrogen cyanic acid (HCN) was prepared. The absorbance was taking in a spectrophotometer at 490 nm and the cyanide standard curve was plotted. One milliliter (1 mL) of sample filtrate and standard cyanide solution was measured into three (3) test tubes respectively and 4 mL of alkaline pictrate solution was added and incubated in a water bath for 15 min. After color development (reddish brown), the absorbance of the sample in the test tubes was taken in a spectrophotometer at 490 nm against a blank containing only 1 mL distilled water and 4 mL alkaline pictrate solution (1 g of pictrate and 5 g of sodium carbonate (Na_2CO_3) was dissolved in a warm water in 200 mL flasks and made up to 200 mL with distilled water). The cyanide content for the sample was extrapolated from the cyanide curve.

Determination of Phytate:

The phytic acid was determined using the procedure described by Markkar (Olaoye *et al.*, 2005). Two grammes (2.0 g) of sample was weighed into 250 mL conical flask. 100 mL of 2 % concentrated HCL acid will be used to soak sample in the conical flask for 3 h and then filtered through a double layer of hardened filter papers. 50 mL of filtrate was placed in 250 mL beaker and 100 mL of distilled water was added to give proper acidity. 10 mL of 0.3 % ammonium thiocyanate solution was added into solution as indicator. The solution was titrated with standard iron chloride solution. The end point color was slightly brownish - yellow which persisted for 5 min. The percentage phytic acid was calculated.

Determination of Oxalate:

Oxalate was determined by using the method described by Oke (Olaoye *et al.*, 2005). One gram (1.0 g) of sample was placed in a 250 mL volumetric flask, 190 mL of distilled water and 10 mL of 6 M HCL was added. The mixture was warmed on a water bath at 90ºC for 4 h and the digested samples were centrifuged at a speed of 2,000 rpm for 5 min. The supernatant was diluted to 250 mL. Three (3) 50 mL aliquots of supernatant were evaporated to 25 mL, and then the brown precipitate was filtered off and washed. The combined solution and washings were titrated with concentrated ammonia solution in drops until Salmon pink color of methyl orange changed to faint yellow. The solution was heated on a water bath to 90 ºC and the oxalate was precipitated with 10 mL of 5% calcium chloride ($CaCl_2$) solution. The solution was allowed to stand overnight then centrifuged. The precipitate was washed into a beaker with hot 25 % H_2SO_4, diluted to 125 mL with distilled water and after warming to 90 ºC it was titrated against 0.05 m $KMnO_4$. The oxalate content is given by the relationship that 1 Ml of 0.05 M $KMnO_4$ solution $_{= 0.00225}$ g oxalate (Omolara *et al.*, 2017).

$$\text{Oxalates content (mg/100 g)} = \frac{\mathrm{T}\times[\mathrm{Vme}]\,[\mathrm{DF}]\times 2.4\times10^{2}}{MEXMf}$$

$$\text{Saponin content} = \frac{\text{weight of dry residue}}{weightofsample}\,x\,100$$

$$\text{Xannine content} = \frac{\text{weight of dry residue}}{weightofsample}\,x\,100$$

$$\text{Cyanogenic glycoside} = \frac{\text{weight of dry residue}}{weightofsample}\,x\,100$$

$$\%\ \text{phytate} = \frac{\text{100xAu xcxvt}}{wxAsx1000xva}$$

Where

w = Weight of sample
au = Absorbance of sample
as = Absorbance of standard phytate solution
c = Concentration of standard phytate (mg / ml)
vt = Total extract volume
va = Volume of extract used

Where: T = titer of $KMnO_4$, Vme = Volume-mass equivalent (i.e 1 mL of 0.05 M $KMnO_4$ solution is equivalent to 0.00225 g anhydrous oxalic acid), DF = Dilution factor, VT/A VT = Total volume of filtrate (75 mL), A = Aliquot used (25 mL), ME = molar equivalent of KMnO4, Mf = Weight of sample use

Determination of Trypsin Inhibitor:

The method outlined by Kakade (Olaoye *et al*., 2005) was employed. Two grams (2 g) of sample was weighed into a screw cap centrifuge Tube. Ten milliliter (10 mL) of 0.1 M phosphate buffer was added and the contents was shaken at room temperature for 1 h on a shaker. Each suspension obtained was centrifuged at 5000 rpm for 5 min and filtered through Whatman No. 42 filter paper. The volume of the filtrate was adjusted to 2 mL with phosphate buffer in test tubes. The test tubes were transferred to a water bath, maintained at 37 ºC. 6 mL of 5 % TCA solution was poured into one test tube to serve as a blank. 2 mL of casein solution was added to the test tubes, which was previously kept at 37 ºC, then incubated for 20 min. The reaction was stopped after 20 min by adding 6 mL of TCA solution to the experimental tubes and was shaken. The reaction was allowed to proceed for 1 h at a room temperature. The mixture was filtered through Whatman No 42-filter paper. Absorbance of filtrates from sample and trypsin standard solutions was read in a spectrophotometer at 280 nm.

Determination of Tannins:

The method described by Markkar (Olaoye *et al*., 2005) was adopted. Briefly, 400 mg of sample was placed into two conical flasks and 40 mL diethyl ether containing 1% acetic acid (v/v) was added, then the mixtures was properly mixed to remove the pigment materials. the supernatant was carefully discarded after 5 min and 20 mL of 70 % aqueous acetone was added and the flasks was sealed with cotton plug covered with aluminum foil, then kept in electrical shaker for 2 h for extraction. Each content in the flasks was filtered through Whatman filter paper and samples (filtrates) were used for analyzing. 50 mL of tannins extract from sample was taken into test tubes and the volume was made up to 1.0 mL with distilled water. 0.5 mL Folic ciocalteu reagent was added and mixed properly. Then 2.5 mL of 20% sodium carbonate solution was added and mixed. The mixture was kept for 40 min at room temperature, after which absorbance was taken using spectrophotometer and concentration was estimated from the tannic acid standard curve.

Determination of Saponins:

Five grams (5 g) of samples was weighed and mixed with 100 mL of 20 % ethanol. The suspension was heated and stirred continuously on a water bath for 4 h at about 55 °C. The mixture was filtered and the residue was re-extracted with 100 mL of 20 % ethanol. The combined extract was concentrated on a water bath to a volume of about 40 mL. The concentrate was washed with diethyl ether and extracted with n-butanol and the n-butanol extract was washed with 5 % aqueous sodium chloride. The residual solution was first heated in a water bath and then dried in the oven to constant weight. The saponin content was calculated in percentage (Olaoye *et al*., 2005).

Sensory Evaluation of the Formulated and Two Proprietary Snacks

The formulated snacks and 2 other proprietary Snacks brands were subjected to sensory evaluation. A total of twenty (20) untrained panelist drawn from the Benue State University, Center for Food Technology and Research (CEFTER) at the Benue State University, Makurdi, Benue State. Based on their familiarity with the product. The panelist was used for the evaluation. The parameter that was evaluated include taste, colour, flavor, texture and general acceptability.

The coded sample was served in clean white plastic plates at room temperature, in individual booths with adequate florescent lights. Sample was presented to the panelists at random and one at a time. They eat the samples and check how much they like or disliked each one and rate them as such. The panelist was given enough water to rinse their mouth between each sample. The nine-point hedonic scale (Chinma *et al*., 2007) was used for the evaluation.

Statistical Analysis

The result of the analysis was expressed as mean ± standard deviation and SPSS Statistical Package version 22.0 was used to analyze the variances using one-way analysis variance (ANOVA) post-hoc test was used to determine the differences between and within the different biscuit formulations and to compare with two (2) proprietary biscuits brands obtained from the market. The analysis was done at 95 % confidence level

RESULTS AND DISCUSION

The Derived Blend Proportions for Raw Flour.

Table 1 shows a detailed solution to the simultaneously equation and mass balance equation from which the blend proportions for the legume's tubers insect blend (cassava, soya-bean and cricket blend) and the final formulated food.

Table 1: Derived blend proportions for raw flour from simultaneous equation and material mass balance

Feed materials	Blend proportions (%)
Soybean	50.95
Cricket	25.11
Cassava	23.94

Blend Proportions of Components in Formulated Snacks

Table 2. shows that if the legumes tubers insect composite must meet emergency food product recommendation of 7 % fat and 20 % protein, then it must comprise 50.95 % soy-bean, 25.11 % cricket and 23.94 % cassava. The proportion of soybean flow is required in the composite is highest (50.95 %) followed by cricket because soybean flour is highest in protein and cricket is higher in fat and as such, both must complement tubers flour with the same nutrients

Table 2: Recipe for ready to eat food making

Ingredient	Blend proportions (%)
Cassava, soybean and cricket (CSC)	86.5
Sugar	2.5
Vegetable oil	3.0
Butter	2.5
Baking powder	3.0
Egg	2.5

Comparative Anti-Nutrient Analysis of Snacks

Anti- nutrient content of the formulated food in table 3 Shows that the anti - nutrient content in the formulated Snacks is higher than that of the proprietary snacks sold in the market except tennis which is lesser, but all fall within range of 0.50 safe permissible limits for anti-nutrients in formulated snacks. The implication is that the chances of anti-nutrient chelation of divalent mineral nutrients such as ca and mg that are needed for bone development leading to their bio-unavailability will be minimal.

Table 3: Antinutritional Contents of Ready to eat Samples

S/N	Parameter	Formulated (%)	Control "A" (%)	Control "B" (%)
1.	Tannins	$0.10^{ab} \pm 0.01$	$0.21^{ac} \pm 0.02$	$0.39^{bc} \pm 0.04$
2	Phenol	$0.45^{ab} \pm 0.04$	$0.69^{ac} \pm 0.03$	$0.92^{bc} \pm 0.04$
3	Oxalate	$0.49^{a} \pm 0.01$	$0.15^{b} \pm 0.01$	$0.10^{ab} \pm 0.01$
4	Flavonoids	$0.91^{ab} \pm 0.03$	$0.61^{ac} \pm 0.03$	$0.50^{bc} \pm 0.03$
5	Alkaloids	$0.47^{ab} \pm 0.03$	$0.24^{ac} \pm 0.01$	$0.39^{bc} \pm 0.03$

All values are triplicates means ± standard deviation. Different superscript along row depicts significant difference ($P \geq 0.05$).

Comparative Assessment of Amino Acid Profile of Snacks

Table 4 shows the result of the essential amino acid for the formulated snack is less than that of the proprietary snacks. The essential amino acid help to breakdown saturated fatty acid which cause cancer, obesity and type 2 diabetes

Table 4: Amino acid Profile of Ready to eat Samples

S/N	Parameter	Formulated (mg/100g)	Control "A" (mg/100g)	Control "B" (mg/100g)
1.	Leucine	$4.95^{ab} \pm 0.08$	$5.18^{ac} \pm 0.06$	$6.82^{ab} \pm 0.04$
2	Isoleucine	$3.16^{a} \pm 0.03$	$4.68^{ab} \pm 0.04$	$4.17^{ab} \pm 0.04$
3	Lysine	$2.05^{a} \pm 0.08$	$3.96^{ab} \pm 0.09$	$4.91^{ab} \pm 0.06$
4	Phenylalanine	$2.99^{ab} \pm 0.06$	$3.52^{ac} \pm 0.06$	$3.21^{bc} \pm 0.02$
5	Tryptophan	$0.21^{ab} \pm 0.02$	$0.84^{ac} \pm 0.04$	$0.61^{bc} \pm 0.04$
6.	Valine	$1.26^{ab} \pm 0.01$	$2.15^{ac} \pm 0.06$	$1.06^{bc} \pm 0.02$
7.	Methionine	$0.92^{ac} \pm 0.04$	$0.74^{ac} \pm 0.02$	$1.90^{bc} \pm 0.02$
8.	Histidine	$2.81^{a} \pm 0.04$	$2.17^{ac} \pm 0.02$	$2.42^{bc} \pm 0.04$
9.	Proline	$4.02^{ac} \pm 0.09$	$3.18^{ac} \pm 0.03$	$2.60^{bc} \pm 0.05$
10	Arginine	$5.61^{a} \pm 0.04$	$8.11^{a} \pm 0.05$	$7.26^{a} \pm 0.06$
11.	Tyrosine	$2.99^{a} \pm 0.02$	$4.25^{ab} \pm 0.04$	$3.92^{ab} \pm 0.05$
12	Cysteine	$1.06^{a} \pm 0.02$	$0.66^{ab} \pm 0.01$	$0.80^{ab} \pm 0.02$
13.	Alanine	$1.97^{a} \pm 0.06$	$2.46^{ab} \pm 0.02$	$2.03^{b} \pm 0.06$
14.	Glycine	$4.11^{a} \pm 0.04$	$3.60^{ab} \pm 0.03$	$4.62^{ab} \pm 0.06$
15	Glutamic Acid	$10.22^{a} \pm 0.33$	$8.90^{ac} \pm 0.04$	$10.45^{bc} \pm 0.09$
16	Threonine	$1.90^{ab} \pm 0.04$	$0.99^{ac} \pm 0.04$	$1.54^{bc} \pm 0.04$
17.	Serine	$2.31^{a} \pm 0.03$	$4.05^{ab} \pm 0.09$	$4.60^{ab} \pm 0.03$
18.	Aspartic Acid	$6.51^{ac} \pm 0.08$	$6.01^{ac} \pm 0.04$	$5.62^{ba} \pm 0.04$

All values are triplicates means ± standard deviation. Different superscript along row depicts significant difference ($P \geq 0.05$).

Sensory Evaluation of Snacks

Table 5 showed the sensory evaluation of formulated snacks and two proprietary snacks sold in the market the taste, colour texture, overall acceptability of the formulated snacks does not differ significantly ($P= 0.05$) from those of the proprietary snacks sold in the market. Most judges observed that the formulated snacks could be improved by further reducing its particle size to give it a much fine texture.

Table 5: Mean Sensory Scores of Ready to Eat Samples

S/N	Parameter	Control "A"	Control "B"	Formulated
1.	Colour	$7.98^{a} \pm 0.99$	$4.88^{ab} \pm 1.96$	$8.00^{b} \pm 1.07$
2	Texture	$7.75^{a} \pm 0.89$	$5.13^{ab} \pm 1.64$	$7.13^{b} \pm 0.99$
3	Smell	$7.88^{a} \pm 1.25$	$5.88^{b} \pm 2.42$	$7.50^{a} \pm 2.07$
4	Taste	$8.00^{a} \pm 1.41$	$6.13^{b} \pm 2.62$	$7.50^{c} \pm 1.41$
5	Flavour	$7.87^{a} \pm 1.25$	$6.50^{b} \pm 2.78$	$7.00^{a} \pm 1.41$
6	Total Acceptability	$7.75^{a} \pm 0.71$	$6.50^{b} \pm 2.51$	$8.00^{c} \pm 1.41$

All values are triplicates means ± standard deviation. Different superscript along row depicts significant difference ($P \geq 0.05$).

CONCLUSION AND RECOMMENDATION

The study successfully formulated a highly nutritious snacks from yellow cassava, soybean and cricket obtained from Gboko Local Government, Benue state, Nigeria. The formulated snacks mostly complied with Emergency Food Product (EFP) recommendation for snacks. The studied made remarkable contribution to knowledge as it has developed an efficient new formula with which locally grown feed materials can be blend into a potential nutritious low-cost emergency food product. Sensory assessment showed that the formulated snacks did not differ significantly ($p = 0.05$) from the two proprietary snacks sold in the market. But judges had a higher preference for the formulated snacks because of the residue flavor of the egg and soybean component were still slightly perceived. This study indicates that biscuit with higher protein content can be produced composite flour of cassava, soybean and cricket flours.

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