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Production and Chemical Assessment of Ready to Eat Snacks Produced from Cassava, Soyabean and Cricket Composite Flour

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Abstract:
Formulated snack was produced from yellow cassava, soybeans and cricket (protein source) composite flour using simultaneous equation and material mass balance method. The formulated snack was statistically compared with their respective means in two proprietary indigenous products sold in the market using proximate composition, vitamins and minerals properties. The formulated snack was found to compete favourably with both proprietary snacks as its proximate composition (protein; 15.50 ± 0.13, carbohydrates; 62.30 ± 1.03, crude fats; 12.36 ± 0.59, crude fibre; 1.83 ± 0.05, ash; 4.78 ± 0.40; moisture; 5.31 ± 0.06).The formulated food complied with the emergency food product (EFP) recommendation for each proximate food component in snacks formulation except in carbohydrate and protein which was 5 % higher and 23 % less than the EFP benchmark for carbohydrate and protein respectively. The mineral composition varied amongst the product. The water soluble and Fat-soluble vitamin in the formulated snack were found to be higher except for B5, making it an excellent source of micronutrient. The studied made remarkable contribution to knowledge as it has developed an efficient new formula with which locally grown food materials can be blend into a potential nutritious low-cost emergency food product. 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.

Keywords: snacks, soybean, cassava, cricket, flour

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 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). 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 and 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). Soybean contains isoleucine such as genistein and diadzein and the minor one called glycitein which are said to have potential anti-cancer effect, and they also retard bone loss in premenstrual and postmenstrual women, soluble fiber in soy foods control blood sugar (Tasnim and Suman 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).

The aim of this study was to developed and evaluate the proximate, vitamin and mineral properties of ready to eat food (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 were obtained from a local farmer and cricket sellers, in Gboko, Benue State, and were prepared for various analyses

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 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 ^{o}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 (hammer mill)
↓
Sieved (250 µm mesh sieve)
↓
Cricket flour

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

Proximate Analysis of the Formulated and Two Proprietary Snacks

Proximate analysis was performed on the cassava, soybean and cricket flours as well as formulated biscuit. Moisture content, ash, crude fiber, crude fat and crude protein were determined in duplicates using standard methods prescribed by Association of Official Analytical Chemist (AOAC) (Mepba *et al*., 2007). Total carbohydrate was determined by difference (Olaoye *et al*., 2005). Folloing the proximate analysis of cassava, soya bean and cricket flours, the cassava-oybean-cricket composite flour was formulated and baked into snacks.

Moisture Content Determination:

Five grams (5 g) of each sample was weighed accurately into a pre-weighed clean dry dish provided with an easily removable lid. The uncovered dish was placed with its lid open in a well-ventilated oven maintained at 105 °C for 6 h. The lid was replaced and transferred to desiccators at a room temperature to cool for 30 min, weighed immediately and the dish with the sample was replaced in the oven for 2 h. The steps were repeated until decreases in mass between successive weights which do not exceed 0.5/g (fresh weight basis). The loss in weight was recorded as the moisture content. The percentage moisture was calculated using equation (1)

$$\%\ Moisturecontent\ = \frac{W_1 - W_2}{W_1 - W_0} \times 100 \quad (1)$$

$W_0 =$ Initial weight of sample
$W_1 =$ Weight (g)of the sample
$W_2 =$ Weight (g)of the dish, lid and the sample
$W_1 - W_2 =$ Weight of sample prepared for drying

Ash Content Determination:

Three grammes (3 g) of the sample was weighed into an empty porcelain crucible that has been previously ignited and weighed. The sample was ignited over a hot plate in a fume cupboard to remove organic matter. The crucible was then placed in a muffle furnace maintained at a temperature of 600 °C for 6 h. After ashing, it was then be transferred directly to desiccators and weighed immediately.

$$\%\ Ash\ = \frac{(Weightofthecrucible + Ash) - (Weightofemptycrucible) \times 100}{Weightofsample} \quad (2)$$

Crude Fat Determination:

Three grams (3 g) of the dried sample from the moisture determination (section 2.3.1) was transferred into a 20 x 80mm paper thimble and plugged with cotton wool before being placed in a soxhlet extractor. Two hundred and fifty milliliters (250 mL) of petroleum ether (60-80 °C) were measured into a previously dried and weighed round bottomed flask and the firmly attached to the soxhlet extractor. The extraction was performed for six hours (6 h) on low heat after which the flask was removed and the petroleum ether evaporated over a steam bath. The flask was dried in an oven for an hour at 105 °C with the door of the oven not latched. This was later cooled in desiccators and weighed. The difference in weight of the flask gave the weight of the crude fat present in the sample. This was expressed as a percentage of the total weight of sample (Olaoye *et al.*, 2005).

$$\%\ Fat\ = \frac{Weightlossofsample\ (extractedfat)}{Originalweightofsample} \times 100$$
$$= \frac{W_2 - W_3}{W_2 - W_1} \times 100 \quad (3)$$

Determination of Crude Fibre:

The defatted sample (left in the thimble) was transferred into a 750 ml Erlenmeyer flask and 0.5 g asbestos added. Two hundred milliliters (200 mL) of boiling concentrated sulphuric acid were added to the flask and the flask connected to a cold finger condenser and boiled for twenty minutes (20 min). The content of the flask was filtered and the residue washed with boiling water until the washings was no longer acidic (when tested with litmus paper). The sample and asbestos were washed back into the flask with 200 mL boiling concentrated NaOH solution and again attached to the cold finger condenser, boiled again for twenty minutes (20 min), after which it was filtered and washed thoroughly with boiling water. The residue was transferred into a bonch crucible, washed with 15 mL ethanol and dried for 1 h at 100 ˚C. The Gooch crucible and its contents was allowed to cool in desiccators and then weighed. The crucible was placed in a muffle furnace and heat at 600 °C and kept constant for twenty minutes (20 min) to allow the sample to ash before being removed and cooled again in desiccators. The weight was measured and the difference in weight of the crucible containing the sample before and after ashing gave the crude fiber content of the sample and this was expressed as a percentage of the sample used (Olaoye *et al.*, 2005).

The percentage crude fibre was calculated thus:

$$\%\ Crudefiber\ = \frac{W_1 - W_2}{Weightofsample} \times 100 \quad (4)$$

Where:
W_1 = Weight of crucible and residue
W_2= Weight of final ashed sample

Crude Protein Determination:

Digestion: three grammes (3 g) of food sample and 0.5 g of selenium catalyst tablet was separately weighed into a digestion tube. Twenty-five milliliters (25 mL) of concentrated H_2SO_4 were added and the flask shaken so that the entire sample was thoroughly wet. The tube was placed on the digestion burner and heated slowly until boiling ceased and the resulting solution

became clear. This was cooled to room temperature. The digested sample was transferred quantitatively into a 100 mL volumetric flask and made up to the mark (Mepba *et al*., 2007).

Distillation: To flush out the apparatus before use, distilled water was boiled in the steam generator of the distillation apparatus, with the connections arranged to allow circulation through the inner decomposition flask and out through the condenser, for 30 min. The stop cock of the funnel on the steam jacket was removed and 10 mL of the digested sample solution poured into it. Fifteen milliliters (15 mL) 40 % NaOH (excess) was added to the decomposition flask. The funnel stopcock was closed. To drive the liberated ammonia into the collection flask, steam was forced through the decomposition chamber by shutting the stopcock on the steam trap outlet. The boric acid turned bluish-green as soon as it came in content with ammonia. The distillation was allowed to continue for another 4 min. The end of the condenser was rinsed with a little distilled water, and distilled for another 20 s after which the burner was removed from the steam generator.

Titration: The distillate was titrated with 0.1M HCl solution. The acid was added until the solution became colorless. Further addition of the acid turned the solution pink. The same procedure was followed for the blank without the sample. The following equation was used to determine the nitrogen concentration of the sample.

$$\%\ Nitrogen = \frac{100 \times C \times 14 \times Vt}{W \times 1000 \times Va} \times T \quad (5)$$

Where V_t is the volume of the digest (sample) and V_a is volume of digest actually distilled 14 is the molecular weight of nitrogen, W is the weight of sample, C is concentrated of HCl used and T is the titer value obtained. The nitrogen content determined was converted to protein content using the appropriate conversion factor bellow: (Olaoye *et al*., 2005).

$$\%\ \text{crude protien} = \%\ \text{Nitrogen} \times 6.25$$

Carbohydrate Content Determination:

Carbohydrate content of the sample was calculated by subtracting the sum of the values of the other nutrients from 100 % (Olaoye *et al*., 2005).

$$\%Carbohydrate = 100\% - (\%\ moisture + Ash + Crudefat + CrudeFibre + Protein) \quad (6)$$

Formulation and Fortification of Snacks

After the proximate compositions of all flours [cassava (CF), soy beans (SF) and cricket (CrF)] have been determined, as earlier described in section 2.3. The blend proportion for cassava, soybeans and cricket flours that was combined to give the snack flour (SF) was obtained using simultaneous equation and material mass balance methods. The blending proportion used was carefully chosen to accommodate as closely as possible, the recommended proximate composition of an EFP (35 % protein, 10 % fat and 50 % carbohydrates, 5 % of ash) and by extension those of proprietary biscuits sold in the market. (Bertini *et al*., 2006). This was done by combining the solutions to a set of simultaneous equations for the limiting macro nutrients (in this case, protein and fat) in the cassava, soybean and cricket flours in a material mass balance equation (Olaoye *et al*., 2005)

The derived percentage proportions (for cassava, soybean and cricket flours) were then fitted in a mass balance equation equated to 100 % snacks flour (SF).

Finally, to formulate the snacks, Q % of the compounded snacks flour (SF) above was fitted into another mass balance equation containing the specific percentages of all the other ingredients that should contained in the final snacks composite (e.g., sugar, butter, baking powder, fat and egg) as shown below, thus providing the actual weight quantities of each ingredient that was contained per 100 g of the formulated snacks (Olaoye *et al*., 2005).

$$100\% \text{ Snacks flour (SF)} = X\ \%\ CF, + Y\ \%\ SF + Z\ \%\ CrF \quad (1)$$

$$100\ \%\ \text{Formulated snacks (final product)} = Q\%\ SF + S\ (2.5\ \%) + F\ (3.1\ \%) + B\ (2.5\ \%) + BP\ (3.1\%) \quad (2)$$

Where:
CF, SF, CrF, S, F, B, BP, designate cassava flour, soya bean flour, cricket flour, sugar, fat, butter and baking powder respectively. X, Y and Z are the respective percentage blending proportions of the respective flours

Determination of Mineral Content of the Formulated and Two Proprietary Snacks
The food samples were prepared for minerals determination by dry ashing and acid-digestion (Iqbal *et al*., 2006). One gram of sample was weighed into glazed porcelain crucible and the sample was ashed for 2 h at 550 °C in a muffle furnace and allowed to cool. The ash was transferred into a 250 mL beaker, to which 15 mL of concentrated nitric acid was added. The beaker was placed on a hot plate set at 100 °C until the acid evaporates to dryness. An aliquot (10 mL) of distilled water was added to the beaker and the sample filtered into a 100 mL volumetric flask and made ssup to the mark. The mineral content of the digested sample was analyzed using atomic absorption spectrophotometer (shimadzu 6800), such minerals as calcium, magnesium, iron, zinc, potassium and sodium was determine using atomic absorption spectrophotometer (Olaoye *et al*., 2005).

Determination of Vitamin Content of the Formulated and two Proprietary Snacks
Water-soluble and fat-soluble vitamins were determined using reversed-phase HPLC (RPHPLC) and non-aqueous reversed-phase HPLC (NARP-HPLC) respectively. It is because the technique allows the use of an aqueous mobile phase for water-soluble vitamins and fat-soluble vitamins can be determined using organic solvent mobile phases so that the vitamins are soluble throughout the analysis. The ultimate 3000 dual-pump HPLC system was used as it employs a valve-switching technique to combine RP- and NARP-HPLC on one HPLC system for simultaneous determination.

Sample Preparation
Samples for Water-Soluble Vitamins:
Sample was crushed into fine powder with porcelain mortar and pestle. Water soluble vitamins B_1 (Thiamin), B_2 (Riboflaving), B_3 (Niacin), B_5 (Pantothenic acid), B_6 (Pyridoxine), B_7 (Biotin), B_9 (Folic acid), B_{12} (Cobalamin) and vitamin C (Ascorbic acid) was extracted by alkaline hydrolysis. Ten grams (10 g) of the sample powder was dissolved in 60 mL 2 M KOH in 100 mL volumetric flask. Strongly agitated for 10 min, allowed to stand for 10 min in a dark cupboard and later made up to

100 mL with deionizer water. The solution was centrifuged and saved in a dark amber bottle prior to injection into the HPLC system.

Samples for Fat-Soluble Vitamins:

For the extraction of fat-soluble vitamins, A, D, E and K. Ten grams (10 g) of sample powder was vigorously agitated in 50 mL of methanol-Dichloromethane (1:1, v/v) solvent for 10 min and allowed to stand for 10 min in a dark cupboard after which it was made up to 100 mL and centrifuge at 3000 rpm for 5 min. The supernatant was decanted into a dark amber bottle pending injection into the HPLC machine. Each prepared sample solution was stored by refrigeration in the dark at 4 °C and filtered through a 0.2 μm filter (Millex-GN) prior to injection into the HPLC column.

Preparation of Standards

Standard for Water–soluble Vitamins:

Standards of vitamin B_1 (Thiamin), B_2 (Riboflaving), B_3 (Niacin), B_5 (Pantothenic acid), B_6 (Pyridoxine), B_7 (Biotin), B_9 (Folic acid), B_{12} (Cobalamin) and vitamin C (Ascorbic acid) was prepared by accurately weighing 1 mg of the vitamin powder, dissolving it in 5 mL deionised water and making it up to 10 mL to form standard solutions of 0.1 mg/mL for each vitamin, respectively. But due to the limited solubility of vitamin B2 in water, its standard solution was prepared using 1 M KOH instead of deionised water. Also due to the limited stability of vitamin C and vitamin B their standard solutions were prepared at the time of use.

Standards for Fat-Soluble Vitamins:

Standards of vitamin A (retinol acetate and palmitate), D, and vitamin E was prepared by accurately weighing 1 mg of the vitamin powder, dissolving it in 5 mL methanol and making it up to 10 mL in a volumetric flask to give 0.1 mg/mL standard solutions of each vitamin respectively. Vitamin K standard was prepared using acetone instead of methanol. Standard solutions were stored at 4 °C in the dark when not in use.

Composition of vitamins in formulated snacks and that of proprietary snacks sold in the market from Table 4.6 it can be seen that for the water soluble vitamins, formulated snacks is highest in vitamins than the proprietary snacks except what B5 formulated is less than one of the proprietary impand fat-solution vitamins is also highest in vitamins than the proprietary snacks this implies that the formulated snacks is an excellent source of micronutrient for refugees who possess only a hinted bowel since it is micronutrient dense.

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

Proximate Composition of Cassava, Soy-Bean and Cricket Flours

The results of the proximate composition of the flours are reported in table 1. The percentage moisture content of the various flour samples varied. Values were significantly different at P >0.05. Processing methods affected the percentage moisture content of the flours. Cassava flours

recorded the highest moisture content of 8.08 ± 0.06 %, follow by cricket flour of about 5.57±0.06 % and soy bean had the lowest moisture content of 4.79±0.02 %. soy-bean flour recorded the highest protein content of 26.40 ± 0.04 %, follow by cricket flour of 23.50± 0.12 % and cassava had the lowest protein content of 2.70± 0.04 %. The high protein content in soy-bean and cricket flours used in formulation of snacks will result in high nutritious food product that will help in tackling malnutrition in our country. Also, from the result recorded, cricket had high fat content and ash content, the ash content represents the mineral level in the food which is higher than that of cassava and soy-bean flours. The carbohydrate content of cassava is recorded higher than other flours, this implies the energy content of the food. Incorporation of this flours will yield a high nutritious emergency food product that will help to fight malnutrition in our country.

Table 1: Proximate Composition of cassava, soyabean and cricket flours

S/N	Parameter	Cassava Flour (%)	Soybeans Flour (%)	Cricket Flour (%)
1.	Moisture Content	$10.08^{a} \pm 0.06$	$4.79^{b} \pm 0.02$	$5.57^{c} \pm 0.06$
2	Crude Protein	$2.70^{a} \pm 0.46$	$26.40^{b} \pm 0.04$	$23.50^{c} \pm 0.12$
3	Crude Fat	$0.48^{a} \pm 0.06$	$4.08^{b} \pm 0.04$	$6.40^{c} \pm 0.02$
4	Crude Fiber	$1.50^{ab} \pm 0.09$	$1.20^{ab} \pm 0.04$	$0.01^{ab} \pm 0.11$
5	Ash	$2.49^{a} \pm 0.05$	$5.23^{b} \pm 0.04$	$8.47^{a} \pm 0.04$
6	Carbohydrate	$82.75^{a} \pm 0.37$	$58.30^{b} \pm 0.45$	$56.06^{c} \pm 0.32$

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

The Derived Blend Proportions for Raw Flour

Table 2 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 snack.

Table 2: 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 3 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 %) follow 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 3: Recipe formulation for ready to eat snacks

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

Characterization and Comparison of Formulated Snacks with Proprietary Snacks

The formulated and proprietary snacks sold in the market were compared as show below proximate composition of formulated snack and proprietary snacks and EFP Recommendation From the results in Table 4, the following can be inferred for the under listed food

Moisture Content:

The moisture content of the formulated snacks (5.65 %) was higher than the moisture content in both proprietary snacks (5.53 % and 5.09 % respectively) but congealable with emergency food product (EFP) recommendation (1-29 %). The implication is that the formulated snacks may likely have a shorter shelf life than any of the proprietary snacks as it will be more susceptible to microbial degradation.

Ash Content:

The ash content of the formulated snacks (4.99 %) was higher than the ash content in both proprietary and complies with EFP recommendation ($p \leq 0.5$) the value obtained is similar to the range of value reported in a similar study, by Anandito RBK (2018) (5-10 %). The implication is that the formulated snacks is acceptable and contains more minerals than the two proprietary snacks

Crude Fibre*:*

The crude fibre content of the formulated snacks (1.83 %) was lower than the crude fibre in both proprietary snacks (3.05 % and 2.52 % respectively) the value obtained is less than the range value reported by Anandito RBK (2018) 5.02 %. The implication is that the formulated snacks will not inhibit mineral absorption more via adsorption.

Crude Fat:

The crude fat content of the formulated Snacks (12.36 %) was less than the fat in both proprietary Snacks (13.02 and 16.05 %). The value obtained is far below the range of value reported by Anandito RBK 2018 (35-45 %)

The implication is that when fed to refuges the formulated Snacks can sufficiently provide the energy required from fat, while serving as transport vehicle for fat soluble vitamin

Crude Protein:

The crude protein of the formulated snacks (15.95 %) was higher than the value in both proprietary snacks. The value obtained was also within the range of value reported in a similar study by Anandifo RBK (2018) (10-15 %) The implication is that the formulated snacks which contain higher value of protein would produce even better outcomes.

Total Carbohydrate:

The total carbohydrate content of the formulated snacks (62.24 %) was 4 % less than one of the proprietary snacks but higher than the other one (61.4 %). the value obtained is higher table the range of value reported by Anandifo RBK (2018) (50-55 %).

The implication is that it is uncertain if the formulated snacks will provide sufficient carbohydrate energy for refuges fed with it.

Table 4: Proximate Composition of ready to eat Samples

S/N	Parameter	Formulated (%)	Control "A" (%)	Control "B" (%)
1.	Moisture Content	$5.65^{a} \pm 0.47$	$5.53^{a} \pm 0.08$	$5.09^{b} \pm 0.05$
2	Crude Protein	$15.95^{a} \pm 0.13$	$9.66^{b} \pm 0.33$	$8.71^{c} \pm 0.04$
3	Crude Fat	$12.36^{a} \pm 0.59$	$16.05^{b} \pm 0.13$	$13.22^{c} \pm 0.33$
4	Crude Fibre	$1.83^{a} \pm 0.05$	$3.05^{a} \pm 0.09$	$2.52^{b} \pm 0.04$
5	Ash	$4.93^{a} \pm 0.05$	$4.59^{b} \pm 0.05$	$4.98^{c} \pm 0.05$
6	Carbohydrate	$62.30^{a} \pm 1.03$	$61.14^{b} \pm 0.24$	$66.07^{c} \pm 0.55$

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

Comparative Nutrient-Mineral Assessment of Formulated and Proprietary Snacks

Mineral composition of the formulated Snacks and that of proprietary Snacks sold in the market in Table 5 shows that the compositions of Ca, K, Na, Fe Zn in the formulated Snacks 402.72, 941.52, 1745.00, 212.80, 124.41 and 13.99 mg/100 g respectively) some were higher than their corresponding amongst in both proprietary snacks. When snacks contain one or more of these micronutrients, the total amount of vitamin and/or minerals contained in mg/100 g of the food dry matter basis should be at least 50 % of the reference daily requirements.

Table 5: Comparative nutrient-mineral assessment of formulated and proprietary Snacks

S/N	Parameter	Formulated mg/100g	Control "A" mg/100g	Control "B" mg/100g
1.	Calcium	$402.72^{a} \pm 6.36$	$591.68^{b} \pm 5.83$	$408.79^{a} \pm 5.04$
2	Potassium	$941.52^{ab} \pm 4.77$	$1280.00^{ac} \pm 42.43$	$459.49^{bc} \pm 3.79$
3	Sodium	$1745.00^{a} \pm 49.49$	$1941.50^{ac} \pm 54.45$	$1562.50^{bc} \pm 24.75$
4	Magnesium	$212.80^{ab} \pm 4.00$	$435.02^{ac} \pm 7.26$	$284.09^{bc} \pm 5.81$
5	Iron	$124.41^{a} \pm 4.04$	$182.37^{ab} \pm 4.26$	$81.39^{c} \pm 2.59$
6	Zinc	$13.99^{a} \pm 0.17$	$8.81^{ab} \pm 0.37$	$6.09^{ab} \pm 0.18$

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

Comparative Vitamin Analysis of Formulated and Proprietary Snacks

Composition of vitamins in formulated snacks and that of proprietary snacks sold in the market from Table 6 shows that the water soluble vitamins in formulated snacks is highest in vitamins than the proprietary snacks except what B_5 formulated is less than one of the proprietary and fat-solution vitamins is also highest in vitamins than the proprietary snacks this implies that the formulated snacks is an excellent source of micronutrient for refugees who possess only a hinted bowel since it is micronutrient dense.

Table 6: Some Vitamin Contents of Ready to eat Samples

S/N	Parameter	Formulated (%)	Control "A" (%)	Control "B" (%)
1.	Vitamin C	$18.59^{a} \pm 0.17$	$11.52^{ab} \pm 0.39$	$10.14^{ab} \pm 0.12$
2	Vitamin B_2	$10.06^{a} \pm 0.26$	$6.36^{ab} \pm 0.11$	$5.80^{ab} \pm 0.25$
3	Vitamin B_5	$0.53^{ab} \pm 0.02$	$0.30^{ac} \pm 0.02$	$0.66^{bc} \pm 0.03$
4	Vitamin B_6	$2.08^{ab} \pm 0.05$	$1.82^{ac} \pm 0.04$	$1.34^{bc} \pm 0.01$
5	Vitamin B_9	$0.70^{ab} \pm 0.02$	$0.39^{ac} \pm 0.03$	$0.53^{bc} \pm 0.03$
6	Vitamin A	$0.82^{a} \pm 0.04$	$0.46^{ab} \pm 0.02$	$0.50^{ab} \pm 0.02$

7	Vitamin D	$0.24^{a} \pm 0.02$	$0.08^{ab} \pm 0.01$	$0.09^{ab} \pm 0.01$
7.	Vitamin E	$0.62^{a} \pm 0.04$	$0.34^{ab} \pm 0.04$	$0.31^{ab} \pm 0.03$
8.	Vitamin K	$0.12^{ab} \pm 0.01$	$0.06^{ac} \pm 0.01$	$0.08^{bc} \pm 0.01$

All values are triplicates means ± standard deviation. Different superscript Along row depicts significant difference (P ≥ 0.05).

CONCLUSION AND RECOMMENDATION

A nutritious snack was produced from yellow cassava, soybean and cricket flours. The proximate composition of the formulated snacks was found to be comparable with the proximate composition of the two proprietary snacks sold in the market, there was mostly no significant difference between among the samples (P = 0.05). The formulated snacks mostly complied with emergency food product (EFP) recommendation for snacks. The study showed that biscuit with higher protein content can be produced from composite flour such as Cassava, soybean and cricket flours. Also, the soybean flours could be used to fortify conventional flours which are low in protein and consumption of foods based on this soybean flour would be an important step towards alleviating protein energy malnutrition in the developing counties.

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