PROXIMATE, MICROBIAL AND SENSORY PROPERTIES OF MOI-MOI PRODUCED WITH CRAYFISH AND GRASSHOPPER

Abstract

The research assessed the proximate, microbial and sensory properties of moi-moi produced with crayfish and grasshopper (*Zonocerus variegatus*). Cowpea seed, crayfish and grasshoppers were processed into flours using standard procedures. Cowpea-crayfish flour and cowpea-grasshopper flour were formulated with the ratios: 90:10, 85:15, 80:20 and 75:25 respectively. Proximate properties showed the range of values for Protein: 5.50-12.80, Fat: 5.27-8.07%, Carbohydrate: 28.30-38.87%, Moisture: 40.00-52.67%, Ash: 1.32-4.27% and Fiber: 1.63 -8.50%. Microbial analysis indicated bacteria count range of 4.1×10^5 - 8.5×10^5 CFU/g; fungal 2.1×10^5 - 4.2×10^5 CFU/g and coliform 1.6×10^5 -3.8×10^5 CFU/g. Sensory attributes of the moi-moi samples were evaluated and the result ranged from 6.27-7.60 for colour, 6.33-7.13 for texture, 5.60-7.73, 6.13-7.00 for flavour and 6.20-7.60 for overall acceptability. The study established that moi-moi produced with crayfish and grasshopper contains high amount of nutritive value when compared with moi-moi produced only with cowpea flour. The result of the sensory evaluation showed no significant difference (p>0.05) between the samples indicating that moi-moi produced with grasshopper is acceptable.

Keywords: steeping, moi-moi, grasshopper flour, microbial

Introduction

Moi-moi is a popular ready to eat steamed gel from cowpea paste (Uzuegbu and Eke, 2000) and West Africa (Olapada *et al.,* 2002). The cowpea paste were processed by mixing wet milled dehulled beans flour with water, vegetable oil and seasonings into a homogenous slurry or paste that was wrapped or packaged in leaf or other packaging materials like aluminum foil and steamed. Cowpea is the foremost grain legume in Nigeria and other West African countries which is consumed as moi-moi, akara, danwake or cooked together with a cereal grain usually rice, or with a root or tuber such as yam, cocoyam and potatoes (Agbara *et al.,* 2018). These cowpea-containing meals are the major source of protein to Nigerians of the low-income group (Menozzi *et al.,* 2017; Haruna and Usman, 2013). Entomophagy, the practice of eating insects, is common in several tropical countries with the alarming world population growth that is not at the same rate of the world food supply. It is essential that affordable sources of protein and other nutrients, which could be obtained from seafood's like crayfish and edible insects, most of which are underutilized, be found for human food. Consumption of insects is generally considered safe, if they are properly processed and insect consumption is a part of tradition in some tropical countries (Chakravarty *et al.,* 2014). In this context, different nutrients contained in edible insects been studied to demonstrate the health benefits of insect consumption or its specific use. Several authors have specifically reported protein content in a range of 43.9% to 77.1% for different species of grasshoppers and crickets (Ramos-Elorduy *et al.*, 2002; Ssepuuya *et al.,* 2016; Rutaro *et al.,* 2018; Torruco-Uco *et al.,* 2019;). Some edible insects are orthoptera, including grasshoppers, crickets, and locusts (Cerritos, 2009). Grasshoppers and crickets are common insects in Indonesia, Thailand, and Africa. Different studies have reported analysis of macronutrients, amino acid profile, protein content, lipids, vitamins, and techno-functional properties of various insects (Ramos-Elorduy *et al.,* 2002; Soares de Castro *et al.,* 2018; Zielińska *et al.,* 2018; González *et al.,* 2019; Schmidt *et al.,* 2019; Torruco-Uco *et al.*, 2019). It has been acknowledge as a forward step in solving the problem of malnutrition and hunger in countries with low income and growing population as a substitute source of proteins (Van Huis *et al.,* 2013). Therefore, the aim of this research is to produce moi- moi with grasshopper and crayfish flour and thereafter evaluate the proximate, microbial and sensory attributes of the moi-moi samples.

MATERIALS AND METHODS

Sources of Raw Materials

Cowpea (*Vigna unguiculata*), palm oil, crayfish, groundnut oil, dried pepper, onions, stock cubes and salt were purchased from Eke Awka market in Awka south Local Government, Anambra state, Nigeria while the Grasshopper was purchased from Maiduguri, Borno state, Nigeria.

Preparation of Moi-moi

Moiomoi was prepared from blends of cowpea and grasshopper, and also cowpea and crayfish flour using Akusu and Kiin-Kabari (2012) method. Cowpea flour was partially substituted with 0% grasshopper and crayfish (ASP), 10% grasshopper (DSP), 15% grasshopper (CSO), 20% grasshopper (GSS), 25% grasshopper (IGP), 10% crayfish (AGP), 15% crayfish (FDA), 20%

crayfish (DSS) and 25% crayfish (SSA). The flours were mixed gradually in a bowl with pepper (Tatashe), onions, salt, bouillon cubes and vegetable oil using a wooden spatula.

Table 1: Recipe for the production of Moi-moi

Ingredients	Quantity
Cowpea	300 g
Dried pepper (ground)	30 g
Onions	60 g
Stock cube	5 g
Salt	2 g
Groundnut oil	140mls

Source: Beleya and Eke (2020).

Processing of Crayfish flour

The crayfish flour was prepared using the Ikese *et al.* (2017) method with slight modification on the method. The dried crayfish was sorted to remove dirt and unwholesome materials. It was milled with a blender (model no BLG-620) and sieved before packaged in an airtight container.

Processing of Grasshopper flour

The method described by Maria and Luis (2017) with little modification was used for the processing of the grasshopper flour. The live grasshoppers were processed by blanching them in hot water at a temperature of 60^{o}C for 10 min, the wings and inedible parts were removed. The clean grasshoppers were oven dried at a temperature 70^{o}C for 5hr. The dried grasshoppers were milled, sieved and packaged in an airtight container.

Proximate Analysis

Moisture content was done using gravimetric method described by Maria and Luis (2017). A measured weight of the sample (5.0 g) was weighed into a previously weighed moisture can. The sample in the can was oven dried at 105°C for 3 hr. Later, cooled in a desiccator and weighed. It was done repeatedly at hourly interval until there were no further diminutions in the weight (that is, constant weight was obtained). Protein determination was done by Kjeldahl method described by Chang (2013). The total nitrogen was determined and multiplied with factor 6.25 to obtain protein content. Sample (0.5 g) was mixed with 10 mL of concentrated H_2SO_4 in digestion flask. Ash determination was done by the furnaces incineration gravimetric method described by James (2015) and AOAC (2012). Briefly, 5.0 g of the processed sample was measured into a previously weighed porcelain crucible. The sample was burnt to ashes in a muffle furnace at 550°C. When it has become completely ashed, it was cooled in desiccator and weighed. The crude fat was determined by solvent extraction gravimetric method described by Kirk and Sawyer (2016). Five grams of sample was wrapped in a porous paper (Whatman filter paper) and put in a thimble. Crude fiber was determined by the method of James (2015). Sample (5.0 g) processed sample was boiled in 150 mL of 1.25% H_2SO_4 solution for 30 minutes under reflux. The boiled sample was washed in several portions of hot water using a two-fold cloth to trap the particles. Carbohydrate content was determined using the method of James, (2015). 45 ml of each of the sample extracts was diluted to 450 ml with distilled water. 1 ml of each of the diluted filtrate was pipetted into different test tubes while 1 ml of water was pipetted into a test tube as a blank and 1 ml of glucose into a test tube as a standard.

Microbial Analysis

The total microbial load of the samples was determined using the procedures of APHA (2001). We dispensed 9ml of peptone water in several mercenary bottles, autoclaved (121^{o}C, 15 minutes) and cooled. 1g of each differently processed moi-moi samples were infused.

Sensory Evaluation

The coded moi-moi samples were presented to twenty-five (25) semi-trained panelists on disposable plates with disposable spoons. The attributes assessed were appearance, aroma, taste, mouth feel, texture and general acceptability on a nine-point Hedonic scale, where one represents dislike extremely and nine liked extremely, five neither liked nor disliked. Potable water was provided for mouth gaggling before proceeding to the next sample.

Statistical Analysis

Means of the data obtained for all determinations were subjected to Analysis of variance (ANOVA). Duncan's Multiple Range Test was used to identify significant difference among treatment means at ($p<0.05$) using Statistical Package for Social Sciences (SPSS) version 23.0.

Results and Discussion

Table 2 shows the proximate composition of moi-moi produced from cowpea flour with crayfish and grasshopper blends. Results revealed that the moisture content of the moi-moi ranged between 40.00 -52.67% with sample IGP (75% cowpea: 25% grasshopper moi-moi) recording the highest while sample DSS (80% cowpea: 20% crayfish blend moi-moi) was lowest. Samples (DSP, CSO, GSS, IGP, AGP, FDA, DSA and SSA) showed no significant difference ($p>0.05$) while sample ASP showed significant difference ($p<0.05$). It was observed that the moisture content of the samples reduced with increase in the level of addition of crayfish blend. Moisture content of the samples showed no significant difference ($p>0.05$) amongst one another.

The protein content of the moi-moi samples had a range of 5.50-12.80 % with sample AGP (90 % cowpea and 10 % crayfish) recording the highest value of 12.80 % while sample ASP (100% cowpea flour moi-moi) has lowest value. Result of the study revealed that quantity of protein increased with the addition of crayfish and grasshopper blend. There was no significant difference ($p>0.05$) in the protein content of the moi-moi samples. Ash content of the moi-moi samples ranged between 1.32-4.27 % with sample DSS (80 % cowpea and 20% crayfish) showing the highest while sample ASP (100% cowpea flour moi-moi) as lowest. Ash content of samples showed no significant difference (p>0.05).

Ash content from this study (1.32 – 4.27%) is similar to 1.39-1.90% for cowpea/maize moi-moi reported by Akusu and Kiin-Kabari (2012). It was higher than 0.67-0.91% for cowpea and Asparagus flour moi-moi reported by Nwosu (2011). Crude fiber content of the moi-moi samples ranged between 1.63-8.50% with sample CSO (85% cowpea and 15% grasshopper) showing the lowest and sample ASP (100% cowpea flour) as highest. There was no significant difference in the crude fiber content of moi-moi samples (p>0.05). Crude fiber content obtained from this study is higher than 0.75-0.83% for cowpea/Asparagus bean flour moi-moi reported by Nwosu (2011). The fat content ranged between 5.27-8.07% with sample GSS (80% cowpea and 20% grasshopper) recording the highest and sample ASP (100% cowpea flour moi-moi) as lowest. There was no significant difference in sample CSO (85% cowpea and 15% grasshopper) and FDA (85% cowpea and 15% crayfish). There was significant difference (P<0.05) in the fat content of the samples. Fat content of moi-moi obtained from this study is higher than 1.91-4.06% for cowpea/soybean flour moi-moi formulations Ogundele *et al.* (2015) reported. Carbohydrate content of the moi-moi samples ranged between 28.30-38.87% with sample ASP (100% cowpea flour) recording the highest and sample IGP (75% cowpea and 25% grasshopper) as lowest. There was significant value (p>0.05) in all the samples. Carbohydrate content of moi-moi obtained from this study is higher than 15.87-34.72% reported by Akusu and Kiin-

Kabari (2012) for cowpea/maize flour moi-moi. It is slightly lower than 54.71-59.37% reported by Nwosu *et al.* (2014) for African yam bean and cowpea flour blend moi-moi.

Table 2: Proximate Composition of Moimoi Samples

Samples	Protein (%)	Fat (%)	Carbohydrate (%)	Ash (%)	Moisture (%)	Fiber (%)

ASP	$5.50^{f} \pm 0.10$	$5.27^{d} \pm 0.06$	$38.87^{a} \pm 0.01$	$1.32^{f} \pm 0.00$	$48.00^{c} \pm 1.00$	$1.04^{a} \pm 10.82$
DSP	$6.68^{e} \pm 0.29$	$7.88^{b} \pm 0.06$	$31.28^{g} \pm 0.01$	$2.51^{c} \pm 0.10$	$49.68^{b} \pm 0.58$	$1.97^{a} \pm 0.11$
CSO	$7.57^{e} \pm 0.28$	$6.26^{e} \pm 0.15$	$29.80^{h} \pm 0.01$	$2.60^{c} \pm 0.10$	$52.15^{a} \pm 1.15$	$1.63^{a} \pm 0.05$
GSS	$8.17^{cd} \pm 0.15$	$8.07^{a} \pm 0.06$	$32.28^{f} \pm 0.01$	$2.29^{d} \pm 0.06$	$47.34^{c} \pm 0.58$	$1.85^{a} \pm 0.00$
IGP	$7.18^{de} \pm 0.11$	$7.18^{c} \pm 0.06$	$28.33^{i} \pm 0.01$	$2.55^{c} \pm 0.06$	$52.67^{a} \pm 1.15$	$2.09^{a} \pm 0.06$
AGP	$12.80^{a} \pm 0.10$	$6.83^{d} \pm 0.06$	$34.14^{c} \pm 0.01$	$1.50^{e} \pm 0.10$	$40.33^{e} \pm 0.01$	$4.40^{a} \pm 0.10$
FDA	$8.00^{ed} \pm 1.00$	$6.27^{f} \pm 0.15$	$34.91^{b} \pm 0.01$	$1.60^{e} \pm 0.10$	$44.12^{d} \pm 0.00$	$5.10^{a} \pm 0.10$
DSS	$11.00^{b} \pm 1.00$	$7.06^{c} \pm 0.06$	$33.88^{d} \pm 0.01$	$4.26^{a} \pm 0.06$	$40.00^{e} \pm 1.00$	$3.80^{a} \pm 0.00$
SSA	$9.00^{c} \pm 1.00$	$6.17^{e} \pm 0.06$	$34.22^{e} \pm 0.01$	$3.54^{b} \pm 0.06$	$43.00^{d} \pm 1.00$	$4.07^{a} \pm 0.06$

Values are represented as means standard deviation of three (3) replicates. Data in the same column bearing different superscript differed significantly ($p<0.05$).

Keywords:
ASP = 100% cowpea (control), DSP = 90% cowpea and 10% grasshopper, CSO = 85% cowpea and 15% grasshopper, GSS = 80% cowpea and 20% grasshopper, IGP = 75% cowpea and 25% grasshopper, AGP = 90% cowpea and 10% crayfish, FDA = 85% cowpea and 15% crayfish, DSS = 80% cowpea and 20% crayfish, SSA = 75% cowpea and 25% crayfish.

Microbial Load of Moi-moi Samples

The microbial load of the moi moi samples are reported in Table 3. The value of bacteria growth ranged from $4.1 \times 10^{8} – 8.5 \times 10^{8}$ CFU/g. Sample SSA (75% cowpea flour and 25% crayfish) had the lowest while sample DSS (80% cowpea flour and 20% crayfish flour) had the highest. There was no significant difference ($p>0.05$) for sample SSA, GSS, CSO, AGP and DSS while sample ASP, DSS and FDA were significantly different ($p<0.05$). Fungal had mean values ranging from $2.1 \times 10^{8} – 4.2 \times 10^{8}$ CFU/g. It was shown that sample DSS (80% cowpea flour and 20% crayfish flour) had the highest fungal growth while sample ASP (100% cowpea) had the lowest growth for fungi. The value of the coliform count ranged from $1.6 \times 10^{8} – 3.8 \times 10^{8}$ CFU/g. Sample SSA (75% cowpea flour and 25% crayfish flour) had the least coliform growth while sample ASP (100% cowpea flour) had the highest coliform growth. There was no significant difference ($p>0.05$) among the samples. The sample DSS (80% cowpea and 20% crayfish) which had the highest fungal growth and sample GSS (80% cowpea and 20%

grasshopper) which recorded no growth were significantly different ($p<0.05$). Three genera of different organism were isolated from the samples including bacteria, fungi and coliform indicating that the food samples were contaminated with mixed microbes.

Table 3: Microbial Load of Moi-moi Samples

Sample	Bacterial count (CFU/g)	Fungal count (CFU/g)	Coliform count (CFU/g)
ASP	7.6×10^5	2.1×10^5	2.6×10^5
DSP	7.2×10^5	3.5×10^5	2.0×10^5
CSO	6.7×10^5	4.0×10^5	2.1×10^5
GSS	4.4×10^5	2.3×10^5	0
IGP	7.0×10^5	3.0×10^5	2.2×10^5
AGP	7.2×10^5	3.0×10^5	3.0×10^5
FDA	6.1×10^5	2.2×10^5	1.7×10^5
DSS	8.5×10^5	4.1×10^5	3.8×10^5
SSA	4.1×10^5	0	$1.68\ 10^5$

Values are represented as means standard deviation of three (3) replicates. Data in the same column bearing different superscript differed significantly ($p<0.05$).

ASP = 100% cowpea (control), DSP = 90% cowpea and 10% grasshopper, CSO = 85% cowpea and 15% grasshopper, GSS = 80% cowpea and 20% grasshopper, IGP = 75% cowpea and 25% grasshopper, AGP = 90% cowpea and 10% crayfish, FDA = 85% cowpea and 15% crayfish, DSS = 80% cowpea and 20% crayfish, SSA = 75% cowpea and 25% crayfish.

Sensory Evaluation of Moi-moi Samples

Result presented in Table 4 showed the sensory evaluation of various combinations. The mean values are 5.60-7.73 for taste, 6.13-7.00 for flavor, 6.33-7.13 for texture and 6.20-7.93 for general acceptability.

The values of sensory properties ranged from 6.27-7.60 for color with sample ASP (100%cowpea) as the lowest and sample FDA (85% cowpea and 15% crayfish) as the highest. Colour is not a major attribute for moi-moi because it could vary based on types and quantity of ingredients added during processing. However, there were no significant difference (p>0.05) among the samples. The color of the samples ranged from 6.27(like slightly)-7.60(like moderately). Moi-moi produced from cowpea with crayfish were more prefer by the panelist. Evaluation of texture was based on the hand feeling, appearance and consistency of a substance. These are important discriminative attribute of moi-moi, which affects the moisture, mouthfeel and appearance of the product. The mean score range between 6.33 and 7.13 with sample SSA having the least score and sample ASP (control) having the highest score of 7.13.

Since there was uniformity in the type and quantity of ingredients added, the variation in taste depend on the composition of the raw materials (i.e., cowpea, grasshopper and crayfish) used in preparation of the samples. The result ranges from 5.60 to 7.73. Sample SSA had the highest score (7.73) while sample DSP had the lowest score (5.60). There was no significant difference in the score for taste, which indicated that moi-moi produced with grasshopper was still acceptable with the taste. The values of flavor of the moi-moi ranged from 6.13-7.00 with sample ASP (control) as the lowest and sample FDA (85% cowpea and 15% crayfish) as the highest. There was no significant difference (p>0.05) among all the samples.

The general acceptability of the samples mean rating ranged from 6.20-7.60 with sample DSP (90% cowpea and10% grasshopper) having the least acceptability while sample SSA (75% cowpea and 25% crayfish) had the highest rating by the panelists However, there were no significant difference (p>0.05) among all samples. The acceptability of all samples ranged from liked slightly to like moderately.

Table 4: Sensory Evaluation of Moi-moi Samples

Sample	Colour	Taste	Flavour	Texture	Overall Acceptability
ASP	$6.27^{d} \pm 1.03$	$6.00^{de} \pm 0.84$	$6.27^{bcd} \pm 0.70$	$6.53^{bc} \pm 0.74$	$6.40^{de} \pm 0.63$
DSP	$6.73^{bcd} \pm 1.09$	$5.87^{de} \pm 0.63$	$6.13^{d} \pm 0.83$	$6.33^{c} \pm 0.48$	$6.20^{e} \pm 1.01$
CSO	$7.06^{abc} \pm 0.70$	$5.60^{e} \pm 0.73$	$6.13^{d} \pm 0.74$	$6.47^{bc} \pm 0.74$	$6.60^{cde} \pm 0.51$
GSS	$7.47^{a} \pm 0.74$	$6.33^{cd} \pm 0.81$	$6.20^{cd} \pm 0.77$	$6.67^{abc} \pm 0.90$	$6.27^{e} \pm 0.70$
AGP	$7.40^{ab} \pm 0.73$	$6.80^{bc} \pm 0.94$	$6.67^{abcd} \pm 0.72$	$6.93^{ab} \pm 0.60$	$7.13^{bc} \pm 0.83$
IGP	$7.40^{ab} \pm 0.98$	$7.13^{ab} \pm 0.91$	$6.87^{ab} \pm 1.12$	$7.00^{ab} \pm 0.84$	$7.13^{bc} \pm 0.83$
FDA	$7.53^{a} \pm 0.99$	$7.20^{ab} \pm 1.08$	$7.00^{a} \pm 0.75$	$6.67^{abc} \pm 0.82$	$7.60^{ab} \pm 1.12$
DSS	$6.67^{cd} \pm 0.72$	$6.67^{bc} \pm 0.61$	$6.87^{ab} \pm 0.63$	$6.93^{ab} \pm 0.46$	$6.93^{e} \pm 0.80$
SSA	$7.60^{a} \pm 0.73$	$7.73^{a} \pm 0.70$	$6.80^{abc} \pm 0.68$	$7.13^{a} \pm 0.52$	$7.93^{a} \pm 0.88$

Values are represented as means standard deviation of three (3) replicates. Data in the same column bearing different superscript differed significantly ($p<0.05$).

Keywords:
ASP = 100% cowpea (control), DSP = 90% cowpea and 10% grasshopper, CSO = 85% cowpea and 15% grasshopper, GSS = 80% cowpea and 20% grasshopper, IGP = 75% cowpea and 25% grasshopper, AGP = 90% cowpea and 10% crayfish, FDA = 85% cowpea and 15% crayfish, DSS = 80% cowpea and 20% crayfish, SSA = 75% cowpea and 25% crayfish.

CONCLUSION

In conclusion, the incorporation of crayfish and grasshopper in the making of moi-moi had significant effect on the proximate and sensory properties of the product. The results of the study revealed that moi-moi produced with crayfish and grasshopper flour has better nutritive value when compared with moi-moi produced only with cowpea flour. There was an increase in the ash, crude protein, crude fiber and carbohydrate content of the moimoi with a decrease in moisture content as the addition of crayfish blend increased. The result of the sensory evaluation showed that no significant difference exists between the samples indicating that moi-moi produced with grasshopper is acceptable.

References

1. Agbara, G. I., Haruna, B., Chibuzor, E.C. and Agbara, H. N. (2018). Physicochemical, microbial and sensory properties of Moi-Moi as affected by processing method. *International Journal of Food Science and Nutrition* **3** (5):86-92.

2. Akusu, O. M. and Kiin-Kabari, D. B. (2012). Protein quality and sensory evaluation of moimoi prepared from cowpea-maize flour blends. *African Journal of Food Science* **6** (3):47-51.

3. APHA, (2001). Compendium of Methods for Microbiological Examination of foods. 4th ed. American Public Health Association, Washington DC, USA.

4. Beleya, E. A. and Eke-Ejiofor, J. (2020). Proximate, Mineral and Sensory properties of Moi-moi and Epiti wrapped with different local leaves in Nigeria. *Journal of Food and Nutrition* **4** (2):13-19.

5. Chakravarty, J., Gosh, S., Jung, C. and Meyer, V.B. (2014). Nutritional composition of *Chondacris rosea* and *Brachytrupes orientalis*. *Journal of Asia-Pacific Entomology* **17** (3):407-415.

6. Chang, S. K. C. (2013). *Protein Analysis*. In: Food Analysis, Nielsen, S.S. (Ed.). Kluwer Academic Plenum Publisher, New York.

7. González, C. M., Garzón, R. and Rosell, C. M. (2019). Insects as ingredients for bakery goods. A comparison study of *H. illucens, A. domestica and T. molitor* flours. *Innovative Food Science and Emerging Technologies* **51** (1):205–210.

8. Haruna, I. M. and Usman, A. (2013). Agronomic efficiency of cowpea varieties (*Vigna unguiculata L. Walp*) under varying phosphorous rates in Lafiya, Nassarawa State, Nigeria. *Asian Journal of Crop Science* **5** (2):209-215.

9. Ikese, O., Okoye, A.P., Chudi. And Simon, T.U. (2017). Proximate Analysis andFormulationofInfant Food from Soybean and Cereals Obtained in Benue State, Nigeria. *International Journal of Food Science and Biotechnology* **2** (5):106-113.

10. James, C.J. (2015). *The Analytical Chemistry of Foods*. Chapman and Hall Press, New York. p. 86.

11. Kirk, B. and Sawyer, S. (2016). Pearson's Food Composition and Analysis. Longman Press, England. P. 34.

12. Maria, J. F. and Luis, P. (2017). Constraints of HACCP Application on Edible Insect for Food and Feed. *Journal of Food Science and Technology* **2** (1): 5.

13. Menozzi, D., Sogari, veneizani, M., Simoni, E. and Mora, C. (2017). Eating novel foods; an application of the theory of the planned behavior to predict the consumption of an insect -based product. *Food Quality and Preference* **59**:27-34.

14. Nwosu, J. N. (2011). Proximate composition and acceptability of moi-moin made from cowpea (*Vigna unguiculata*) and Asperagus Beans seed (*Vigna sesquipedahs*). *World Rural Observation* **3** (3):1-5.

15. Nwosu, U.L., Elochukwu, C. U. O and Onwurah, C. O. (2014). Physical characteristics and sensory quality of bread produced from wheat / African oil bean flour blends. *African Journal of Food Science* **8** (6):351-355.

16. Ogundele, G., Ojubanire, B. and Bamidele, O. (2015). Proximate composition and organoleptic evaluation of cowpea (*Vigna uguculata*) and soybean (*Glycine max*) blends for the production of Moi-moi and Ekuru (steamed cowpea paste). *Journal of Experimental Biology and Agricultural Sciences* **3** (2):207-212.

17. Olapade, A.A., Ozumba, A.U., Solomon, H.M., Olatunji, O. and Adelaja, S.O. (2002). Characterization of common Nigerian cowpea (Vigna unguiculata L. Walp) varieties. *Journal of Food Engineering* **55** (2):101-105.

18. Ramos-Elorduy, J.., Avila González, E., Rocha Hernandez, A. and Pino, J. M. (2002). Use of *Tenebrio molitor* (Coleoptera: Tenebrionidae) to recycle organic wastes and as feed for broiler chickens. *Journal of Economic Entomology* **95** (1): 214-220.

19. Rutaro, K., Malinga, G. M., Lehtovaara, V. J., Opoke, R., Valtonen, A., Kwetegyeka, J., Nyeko, P. and Roininen, H. (2018). The fatty acid composition of edible grasshopper Ruspolia differens (Serville) (Orthoptera: Tettigoniidae) feeding on diversifying diets of host plants. *Entomological Research* **48** (6):490–498.

20. Schmidt, A., Call, L. M., Macheiner, L. and Mayer, H. K. (2019). Determination of vitamin B 12 in four edible insect species by immune affinity and ultra-high-performance liquid chromatography. *Food Chemistry* **281** (2):124–129.

21. Soares de Castro, R. J., Ohara, A., Gonçalves Dos Santos Aguilar, J. and Fontenele Domingues, M. A. (2018). Nutritional, functional and biological properties of insect proteins: Processes for obtaining, consumption and future challenges. *Trends in Food Science and Technology* **76** (4):82–89.

22. Ssepuuya, G., Mukisa, I. M. and Nakimbugwe, D. (2016). Nutritional composition, quality, and shelf stability of processed Ruspolia nitidula (edible grasshoppers). *Food Science and Nutrition* **5** (1): 103–112.

23. Torruco-Uco, J. G., Hernández-Santos, B., Herman-Lara, E., Martínez-Sánchez, C. E., Juárez-Barrientos, J. M. and Rodríguez-Miranda, J. (2019). Chemical, functional and thermal characterization, and fatty acid profile of the edible grasshopper (*Sphenarium purpurascens*). *European Food Research and Technology* **245** (2):285–292.

24. Uzuegbu, J.O. and Eke, O.S. (2000). *Basic Food Technology, Principle and Practice.* (Maiden edition). Osprey Publication. Centre, Owerri. Pp 85.

25. Van Huis, A., Ilterbeeck, V.J., Klundr, H., Mertens, E., Italloran, A., Mui, R.G. and Vantomme, P. (2013). *Edible insects: future prospect for food security*, FAO Forestry paper 171, Rome. p: 67-105.

26. Zielinska, E., Karas, M. and Baraniak, B. (2018). Comparison of functional properties of edible insects and preparation thereof. LWT-*Food Science and Technolog*y **91**:168-174.