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COMPARATIVE PROXIMATE AND MINERAL COMPOSITIONS BETWEEN BEANS SEED AND DRIED EDIBLE GRASSHOPPER

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ABSTRACT
Recent problems linked to meat consumption have led to renewed interest in vegetarian diets. This research was aimed to analyse and compare the minerals and proximate contents of grasshopper and beans seed in order to explore their nutritional values in human and animal diets. The standard procedures were followed to analyse the proximate compositions and mineral concentrations of the substrates. The mineral content was analysed by Atomic Absorption Spectrophotometer (AAS) and by Flame Spectrophotometer. The results shows that beans and grasshopper samples are rich in nutrients: crude protein content of 35.40% and 38.65% (w/w), crude lipid of 26.07% and 24.27% (w/w), carbohydrate contents are 19.83% and 20.74% (w/w), ash contents of the substrates are 5.29% and 7.58% (w/w), moisture contents were found to be 8.02% and 4.34% (w/w) respectively The mineral determination showed that beans and grasshopper samples contained (2.243 ± 0.363 mg/kg) and (1.132 ± 0.009 mg/kg) of calcium, (0.185 ± 0.028 mg/kg) and (875 ± 0.015 mg/kg) of iron, (0.242 ± 0.025 mg/kg) and (0.662 ± 0.065 mg/kg) of magnesium. This study concluded that grasshopper have high protein content and excellent production efficiency compared with other conventional food groups and could be used in the management of protein-energy malnutrition.
Keywords: Beans, Comparative, Grasshopper, Mineral nutrients, Proximate nutrients.

INTRODUCTION

Recent problems associated with meat consumption have led to renewed interest in vegetarian diets. This phenomenon was reinforced by the fact that physicians have pointed out that consumers eat too many animal products (rich in saturated fat) and not enough plant foods (Adebowale, 2005). Food insufficiency and malnutrition have been the major problem of the developing countries, including Nigeria. Any approach to help fight this problem will go a long way in pushing the wheel of development in our country. Plant protein products are gaining increased interest as ingredients in food systems throughout many parts of the world; the success of utilizing plant proteins as additives depends greatly upon the favourable characteristics that they impart to food (Adebowale, 2005). Plants proteins are now regarded as versatile functional ingredients or as biologically active components more than as essential nutrients in the developed countries (Marcello and Gius, 1997). Plant food diets increase the level of fibre intake which reduces the risk of bowel diseases (Sirtori and Lovatt, 2001). The partial replacement of animal foods with legumes is claimed to improve overall nutritional status. Bean (*Phaseolus vulgaris*) has recently become popular in the West African sub-region due to its high protein content. It is an annual leguminous crop and is grown to provide food for humans, feeds for animals and raw materials for industries (Guillon and Champ, 1996). Insects are institutionally accepted as a food in many regions and historically consumed, providing sufficient nutritional value for humans (Zielinska *et al*., 2018). However, the rapid increase in food production through technological advancement has largely eliminated insects from our diets (Gao *et al*., 2018). The reappearance of insects as a viable food group can be attributed to their nutritional, environmental, and economic value (Nongonierma and FitzGerald, 2017). In general, insects have high protein content and excellent production efficiency compared with other conventional food groups (Kohler *et al*., 2019). This characteristic is particularly valuable given that future protein consumption is expected to increase, but food supply declines (Gao *et al.*, 2018). An interest in edible insects has increased rapidly because the Food and Agricultural Organization (FAO) has begun promoting insects as viable dietary options for humans (van huis *et al.*, 2013). However, lingering negative perceptions of insects hamper global market expansion and limit insects as a mainstream dining option, which may be related to the fact that people are sceptical to novel foods due to general neophobic tendencies (Dobermann *et al.*, 2017). This research is aimed to compare the proximate and mineral compositions of dried edible grasshopper and beans seeds.

MATERIALS AND MEHODS

Samples Collection and Preparations

The dried grasshopper and bean seeds were purchased from Yar kutungu market, in Katsina Local Government Area. Katsina State, Nigeria. The grasshopper and bean seeds were then taken to the Department of Biological Sciences and Crop Science, Usmanu Danfodiyo University Sokoto, Nigeria for authentication and identified as *Zonocerus variegatus* and *Phaseolus vulgaris* (Linn.) respectively. The wings of the grasshopper were removed and discarded then ground to powder using mortar and pestle. The bean seeds were handpicked to remove extraneous materials and soaked in water to remove shaft after which it was dried and ground into a fine powder using an electric mill. The samples were finally transferred to laboratory for further processing and analysis.

Proximate Analysis of Grasshopper and Bean Seeds Samples

Assessment of proximate composition of grasshopper and bean seed samples were carried out in accordance with A.O.A.C. (1990) methods. The parameters determined include moisture content, ash content, lipid content, crude fiber and carbohydrates content.

Determination of Crude Nitrogen Contents by Kjeldahl Method

Grasshopper and beans samples 1.5g each were weighed separately into a dried 500cm^3 Macro-Kjeldahl flask then 20cm^3 of distilled water was added, the flask was swirled for few minutes and allowed to stand for 30 minutes. Two tablets of mercury catalyst were added together with 10cm^3 of concentrated H_2SO_4 using a measuring cylinder. The flask was cautiously heated at a temperature between 50 to 65 ^oC on the digestion stand until a clear digest was obtained.

$$\text{Sample nitrogen} + H_2SO_{4(aq)} \longrightarrow (NH_4)_2SO_{4(aq)} \quad \ldots\ldots\ldots\ldots (1).$$

The flask was allowed to cool, and then 50cm^3 of distilled water was slowly added to the flask. Ten (10) cm^3 of the digest was made alkaline by adding 20cm^3 of 40% NaOH solution and transferred into another clean macro kjedahl flask (750cm^3) for distillation. Two (2) cm^3 of H_3BO_3 indicator solution was added into a 250cm^3 Erlenmeyer flask which was then placed under the distillation apparatus. Four (4) cm^3 of the distillate was collected and then distillation stopped.

$$(NH_4)_2SO_{4(aq)} + 2NaOH_{(aq)} \longrightarrow 2NH_{3(g)} + 2H_2O_{(l)} + Na_2SO_{4(aq)} \ldots\ldots\ldots (2.1).$$

$$NH_{3(g)} + H_3BO_{3(aq)} \longrightarrow \overset{+}{NH}_{4(aq} + H_2\overset{-}{BO}_{3(aq)} \ldots\ldots\ldots (2.2)$$

The nitrogen content was estimated by titrating the ammonium borate formed with a standard solution of 0.01M H_2SO_4 and the end point was observed when the color changed from green to pink. This was done in triplicate and the initial and final burette readings were recorded.

$$H_2SO_{4(aq)} + H_2\overset{-}{BO}_{3\,(aq)} \longrightarrow H_3BO_3 + H\overset{-}{SO}_4 \ldots\ldots\ldots (3)$$

% Nitrogen content of the sample was calculated using equation (4)

$$\% N = \frac{Tv \times M\ (0.01) \times NF(0.014) \times V50}{\text{the weight of sample} \times \frac{m}{s}\ \text{of aliqout}} \times 100 ..(4)$$

The percentage crude protein was calculated using equation 4.1 as follows:

$$\%\ \text{Crude Protein} = \%\ N\ X\ 6.25 \ldots\ldots (4.1)$$

Where: Tv = average volume of the acid used, M = concentration of the acid, NF = nitrogen factor, M/s = volume of the aliquate used

Total percentage carbohydrate was determined by difference, Abdulrazak *et al.*, (2014). This involved adding the total values of crude protein, crude fat, crude fibre, moisture and ash constituents of the sample and subtracting it from 100. The value obtained was the percentage carbohydrate constituent of the sample.

Sample Digestion

The wet digestion of the samples (bean and dry grasshopper) were carried out in accordance with A.O.A.C. (1990) methods and the procedure described by Sani *et al.*, (2014), with little modifications. Grasshopper and beans samples 0.5g each was taken in a separate digesting glass tube and $12cm^3$ 5M trioxonitrate (v) acid (HNO_3) was added to the samples and the mixture was kept overnight at room temperature. Then 4.0 cm^3 perchloric acid ($HClO_4$) was added to each digestion glass tube and the mixture was kept in the fumes block for digestion. The temperature was increased gradually, starting from 50ºC up to 250-300ºC. The digestion was completed in about 70- 85 minutes as indicated by the appearance of white fumes. The mixture was left to cool down and the contents of the tubes were transferred to 100 cm^3 volumetric flasks and the volumes of the two contents were made up to 100 cm^3 with distilled water and filtered. The wet digested solution was transferred to plastic bottles labelled accurately. The prepared sample was analysed for the mineral elements using by Atomic Absorption Spectrophometry (AAS) and Flame Atomic Emission Spectrophotometry (FAES).

Mineral Assessment

The samples were analysed using agilent Atomic Absorption Spectrophotometer (Buck Scientific model 210VGP). Standard calibration was prepared for the individual elements analysed. Blanks and samples were aspirated in to flame following the manufacturer's instruction. The absorption measurements of the elements for bean seeds and grasshopper samples were recorded and presented in Table 2. The concentrations of minerals recorded in terms of "ppm" were converted to milligrams (mg/kg) according to equation (5), as follows:

$$concentration\ of\ Metal = \frac{Readout\ (ppm)}{Concentration\ of\ Sample\ X\ DF} 10^6 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where DF is the dilution factor.

RESULTS

The proximate compositions of the substrates (beans seed and dry grasshopper) were presented in Table 1. The results show that both the two samples are rich in nutrient especially the crude protein content of 35.40% and 38.65% (w/w) which is similar to that obtained by Edema *et al*., (2005), but higher than the value reported by Sani *et al*., (2014), respectively. Also determined from the sample were crude lipid of 26.07% and 24.27% (w/w), carbohydrate contents are 19.83% and 20.74% (w/w) respectively. The ash contents of the substrates are 5.29% and 7.58% (w/w) respectively in which the former is higher than 4.56% reported by (Edema *et al*., 2005). The moisture contents of the bean seeds and dry grasshopper were found to be 8.02% and 4.34% (w/w) which are slightly different from that reported by Edema *et al*., (2005) and (Onwuka, 2005) respectively. The difference in value may be due to the processing methods. The crude fibre contents of bean and grasshopper are 5.40% and 4.42% (w/w) in which the former is comparable to the value reported by Kure *et a*l., (1998) of 5.447% and the latter is lower than the value reported by (Onwuka, 2005). The carbohydrate contents of the substrates are 19.83% and 20.74% (w/w) in which that of beans are lower than the range given by Eshun, (2012) of 34.97% - 39.86% values.

Table 1: Proximate Composition of Beans and Grasshopper Samples

Parameters	Beans (%)	Grasshopper (%)
Crude Protein	35.40 ± 0.43	38.65 ± 0.314
Ash	5.29 ± 0.04	7.58 ± 0.382
Crude Fibre	5.40 ± 0.09	4.42 ± 0.454
Crude Lipid	26.07 ± 0.12	24.27 ± 0.235
Moisture Content	8.02 ± 0.04	4.34 ± 0.1504
Carbohydrate content	19.83 ± 0.53	20.74 ± 0.656

Results are mean of triplicate measurement ± SD

Figure 1 shows the interval plot of the proximate analysis of bean seeds and grasshopper samples at 95% confidence limit. All the parameters were linked with mean connect line with an error bar at each point showing the standard deviations.

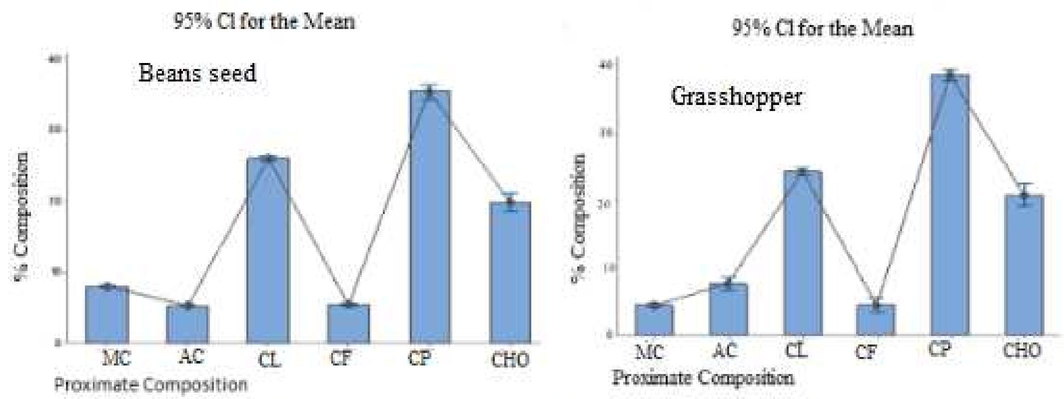

Figure 1: Interval plot Showing Proximate Composition of Bean seeds and Grasshopper Samples
Where: MC – moisture content, AC – Ash content, CL – Crude Lipid CF – Crude Fibre, CP – Crude Protein, CHO - ContentCarbohydrate

The analysis revealed that the grasshopper has higher protein contents of 38.65% than beans seeds with 35.40% this suggest that grasshopper could serve as a promising protein source and has the potential to meet increasing global demand (Rumpold and Schlüter, 2013). Insect protein could contribute daily protein requirement of human as recommended by National Research Council (Onyeike, *et al*., 1995). This means that it could be used in improving the palatability of foods in which they are incorporated. The moisture content of grasshopper and beans seeds was found to be 4.34% and 8.02% respectively, this indicates high shelf life of the substrates hence long storage would not lead to spoilage due to their low moisture contents hence, implies low susceptibility to microbial attack. The high crude lipid contents of 26.07% and 24.27% suggests that bean seeds and grasshopper respectively may be a viable source of oil, going by their crude lipid contents. The ash contents of beans seeds (5.29%) and grasshopper (7.58%) samples is an indication that the substrates could be important sources of mineral elements. The high carbohydrate contents of 19.83% in beans sample suggests that the sample could be used in managing protein-energy malnutrition also the result of the carbohydrate content in grasshopper sample (20.74%) was higher than the values reported by Singh et al., (2000). Carbohydrate content could be assumed due to the chitinous nature of the grasshopper.

Mineral Composition

The mineral compositions (calcium, iron, magnesium, zinc, sodium, cadmium and lead) in mg/kg of the samples were presented in Table 2. The result showed that calcium and sodium concentrations are more abundant in beans sample compared to grasshopper sample while the concentrations of iron, magnesium and zinc are higher in grasshopper sample, lastly lead and cadmium were not detected in both the samples.

Table 2: Mineral Composition of Beans and Grasshopper Sample

Parameters	Beans (mg/kg)	Grasshopper (mg/kg)
Calcium	2.243 ± 0.363	1.132 ± 0.009
Iron	0.185 ± 0.028	1.875 ± 0.015
Sodium	0.0463 ± 0.018	0.0247 ± 0.002
Magnesium	0.242 ± 0.025	0.662 ± 0.065
Zinc	1.384 ± 0.234	1.705 ± 0.033
Cadmium	ND	ND
Lead	ND	ND

Results are mean of triplicate measurement ± SD

The calcium content in bean seeds sample of 2.243 mg/kg was found to be higher than the range of values reported by Edema *et al*., (2005). The presence of calcium content in the samples suggests that the substrates could be used in complementary foods to help build the bones and teeth since calcium is one of the main components of teeth and bones (Mehas and Rodgers 1997). The iron content in grasshopper sample of 1.875 mg/kg was also found to be higher than the value of 1.84 mg/kg reported Sani *et al*., (2014). The absence of lead and cadmium may be that there was no industry close to where the beans were cultivated around the areas. The high magnesium concentrations of 0.662 mg/kg in grasshopper sample complement the high crude protein contents as magnesium is involved in making proteins and releasing energy and helps hold calcium in the enamel of the teeth (Mehas and Rodgers 1997).

CONCLUSION

The study has revealed the proximate composition and mineral concentrations of grasshopper and beans seed. The results of this study indicate that grasshopper have high protein content and excellent production efficiency compared with other conventional food groups. Also the samples are rich in fats and carbohydrates and are therefore inexpensive source of macronutrients which can be used in intervention programme aimed at alleviating protein-energy malnutrition. The mineral contents (Zn, Fe, Ca, Mg and Na) indicate that the substrates could be important sources of minerals for humans.

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