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Comparative Study of Nutrients and Anti-Nutrients Composition of Commonly Consumed Edible Grasshopper (*Chorthippus brunneus)*, Locust Beans (*Parkia Biglobosa*) and Soya Beans (*Glycine max*) in Katsina State

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Abstract
The purpose of this study is to evaluate the nutrients, anti-nutrients and minerals composition of edible grasshopper (Chorthippus brunneus), locus beans and soya beans. The evaluations of nutrients and anti-nutrient composition of Chorthippus brunneus, Parkia biglobosa and Glycine max were analyzed using standard methods of A.O.A.C. and Kjedahal methods. The proximate analysis revealed that crude protein ranged between 24.667±3.512 to 39.561±2.553 with Chorthippus brunneus having the highest value and Parkia biglobosa and Glycine max having the lowest values. The Chorthippus brunneus had a considerable low carbohydrate contents compared to P. biglobosa and G. max carbohydrate value. However, the mean energy/caloric values ranged from 474 to 522 Kcal/Kg. Crude fat values were moderate, ranging from 11.763±1.035 to 15.26±0.761 with G. max having the highest value and C. brunneus the lowest. The anti-nutrients of the insects and the legumes were generally below toxic level in man. Moisture, ash and crude fibre were very high in C. brunneus compared to Parkia biglobosa and Glycine max. These Chorthippus brunneus therefore, could serve as additional promising sources of protein and fat for poultry and teeming population. The mineral compositions of the inscts (mg/kg) were considerably lower than that of locus beans and soya beans.
Key: *Chorthippus brunneus,Glycine max, Nutritional composition, Parkia biglobosa,*

INTRODUCTION

The rapid growth of the world population requires proportionate increases in food production. However, it is difficult to increase productivity to a level that satisfies food demand, mainly because of limited availability of new farm land (DeFoliart, 2002; Verkerk *et al.*, 2007) This has led to shortage of food particularly animal protein. Therefore, it has become essential to look for new sources of animal protein. Some food resources which were neglected like edible insects are re-emerging and information about their nutritive values is becoming significant. Insects have played an important part in the history of human nutrition in Africa, Asia and Latin America (Ramos-Elorduy *et al.*,1997; Kampmeier, and Irwin, 2009).

In Katsina State of Nigeria, insects have been part of the cultural diet for many decades. During the past few years there has been renewed global interest in insects as food and an estimated 2,000 insects species are consumed around the world (Odaibo, 2009). Many insects such as Grasshopper (*Chorthippus brunneus)*, locusts and termites are still being enjoyed as delicacies in many part of Nigeria, particularly in the rural areas of Katsina State (Odaibo, 2009).

According to Owen (1973), insects are sources of many different minerals and essential proteins. Since insect reproduce very fast and very easily, they can, therefore contribute to meeting protein needs of rural populace, and thus be considered as an alternative in efforts to increase food security for poor nation. The high fat and protein content of insects make them an ideal food additive for chiefly carbohydrate diets. The collection of edible insects is also a good source of income especially for women in rural areas of Katsina state and may serve as a biological pest control, safeguarding forest habitat, prevent erosion, preserves water source and protects countless other forest species.

The high cost of animal protein has greatly affected malnutrition in our society. Therefore, edible insect such as grasshopper can serve as an animal substitute for protein production.

Since these sources have been utilized by the populace, this study was aimed at evaluating the nutrient composition as well as anti-nutrient composition and mineral element of grasshopper which is usually consumed across the State and compared it with Locus beans and Soya beans.

MATERIALS AND METHODS

Study Area

The study was conducted between January to August, 2020 in Katsina the capital town of Katsina State, Nigeria. Katsina city is located on coordinates 12°, 15^0 North and 7^0 to 30^0 East, with a total population of 5,801, 584 (National Population Commission, 2006) and covers an area of 24,192km^2 with an elevation of 519m above sea level. It has with an international boundary in the north to Niger republic, it also shares border in the east with Kano and Jigawa state, in the west with Zamfara state and in the south with Kaduna state.

Sample Collection

The dried sample of grasshopper was purchased from Chake market (Himata) in Katsina Local Government area of Katsina State, Nigeria. It was then taken to the Biological Science laboratory, Al-qalam University Katsina, Nigeria for analysis.

Preparation

The dried sample was ground into powder using motor and pestle for proximate and minerals analysis.

Determination of Moisture Content

Six (6) gram of the grinded sample was weighed into a previously weighed crucible. The crucible was then placed in hot-oven set at 100 ºC to dry to a constant weight for 24h. The crucible was removed from the oven and transferred to desiccator, cooled for ten minutes and weighed. The same procedure was repeated until constant weight was obtained. The moisture content was then calculated as percentage moisture according to the methods of (Owoso and Ogunmoyela, 2001).

The percentage is obtained by the formula:

$$\%Moisture = \frac{W2 - W3}{W2 - W1} X100$$

Determination of Crude Fat

Crude fat was quantified according to AOAC (1999; No. 920.85) method. Extraction of fat was done with soxhlet extracting machine (HT 1043 extraction unit, Tecator, Hoganas, Sweden), using petroleum ether (40-60 boiling points) as the extractor. A 250ml extraction flask was washed and dried in an oven at 105^0C, and weighed. 30g of the ground sample was weighed into a labeled porous thimble. The thimble mouth was covered with white clean cotton wool. 200ml of petroleum ether was added into 250ml extraction flask. The covered porous thimble was placed into the condenser and the apparatus was assembled for extraction, which continues for 6hrs. The porous thimble was removed and the extraction flask was placed on the water bath to make it free from petroleum ether. The weight was taken as (W3). Percentage fat was calculated as follows:

$$\%Fat = \frac{W3 - W2}{W1 - W0} X100$$

Where: W0 = Weight of empty porous thimble, W1 = Weight of thimble + ground sample, W1 - W0 = Weight of ground sample, W2 = Weight of empty extraction flask, W3 = Weight of extraction flask + oil

Determination of Ash Content

Ten (10) grams of the sample was weighed into a porcelain crucible. This was transferred into the muffle furnace set at 550 ºC and left for 1h.after which the sample was removed and placed in a desiccator containing silica gel. The percentage ash was then calculated according to the methods of Udo and Ogunwale (1986).

$$\%Ash = \frac{W3 - W1}{W2 - W1} X100$$

Determination of Protein Content

Concentrated sulphuric acid (20 ml) was introduced into the micro-Kjeldahl flask containing 2 g of ground sample. Two Kjeldahl catalyst tablets were added and digested for 4 h, cool overnight in a fume cupboard and the contents diluted with water to 250 cm. A distillation unit was then used and the percentage nitrogen determined according to the Kjeldahl techniques of the (AOAC,1990).

$$\%Nitrogen = \frac{NA\ X\ TV\ X\ 0.014\ X\ D.F}{Volume\ of\ aliquot\ X\ weight\ of\ sample} X100$$

Where; NA = Normality of acid (0.01N), TV = Titer value, DF = Dilution Factor, Volume of aliquot = 10ml

Determination of Carbohydrate (CHO)

Two (2) grams of the samples were collected and dried in the oven at 70ºC, of ground and defatted. The soluble sugars were extracted with 80% ethanol (v/v) following the methods of Omafuvbe *et al*. (2004). The total soluble sugar was determined by the anthrone reagent method of Morris (1948) and reducing sugar was determined by the calorimetric method (Somogyi, 1945) using standard curve of glucose.

Determination of Crude Fibre

Two (2) grams of the sample were ground and diluted in 100 ml distilled water in a conical flask. 20 ml of 10% sulphuric acid were added and boiled gently for 30 min. The sample was then cooled and filtered. The filtrate was subjected to treatment using 10% sodium hydroxide. The residue was passed through 20 ml of ethanol and petroleum ether and then dried at 105 C. The sample was weighed and ashed at o 100 C for 90 min cooled and reweighed and the o percentage of crude fibre calculated (Owoso *et al.*, 2000).

$$\%Fibre \frac{W2 - W3}{W1} x\ 100$$

Determination of Free Fatty Acid

The extracted oil (0.1 g) was weighed into a clean dry conical flask; then 10ml of 95% Ethanol and 1cm3 of phenolphthalein indicator were added. This was then titrated with 0.1m NaOH, with constant shaking until a pink - colour persisted for 30minutes

$$\%FFA = \frac{VXMX2.82}{W}$$

Where; FFA = Free Fatty Acid, V = Titer value, W= Weight of the sample

Determination of Phytate Content

Four (4) grams of the sample was soaked in 100ml of 2% HCl for 5 hours and then filtered. A portion (25ml) of the filtrate was taken into the conical flask and 5.0ml of 0.3% NH_4SCN solution was titrated with a standard solution of $FeCl_2$containing 0.00195g Fe/ml until a brownish yellow colour persisted for 5minutes. 1ml = 1.10mg Phytin-Phorsphorus. The phytate content was calculated by multiplying the value of Phytin-Phosphorus by 3.55.

$$\text{Conc.of phytate (mg/100g)} = \frac{TVXEqv.Wt\ X\ D.F\ X\ 3.55\ X\ 1000}{W}$$

TV = titre value, Eqv. Wt = equivalent weight, D.F = dilution factor, 1000 = conversion factor to mg/100g of sample and W = weight of sample

Determination of Oxalate Content

A quantity (2.5g) of the sample was extracted with 100ml of 2% HCl, 5ml of conc. NH_3 and precipitated with $CaCl_3$ as calcium oxalate. The precipitate was then washed with 20ml of 25% $H_2O_4$and dissolved in hot water, and then titrated with 0.05N $KMnO_4$ to determine the conc. of oxalate until a pink end point was observed. (1ml of 0.05N $KMnO_4$= 0.045g oxalic acid)

$$\text{Conc.of oxalate (mg/100g)} = \frac{TVXEqv.Wt\ X\ D.F\ X\ 3.55\ X\ 1000}{W}$$

TV = Titre Value, Eqv. Wt = Equivalent Weight, D.F = Dilution Factor, 3.55 = Phytin-Phosphorus Factor, 1000 = Conversion Factor to mg/100g of sample and W = Weight of Sample

Determination of Tannin Content

Sample (0.5gram) was weighed into a plastic bottle. 100ml of distilled water was added and shaken for 1hr in a mechanical shaker. This was filtered into 10ml volumetric flask and made up to the mark then 1ml of the filtrate was pipetted into test-tube and mixed with 0.4ml of 0.1M FeCl2 in 0.1N HCl and 0.008M potassium ferrocyanide. The absorbance was measured at 550nm within 10 minutes.

$$Conc.of\ tannin \left(\frac{mg}{100g}\right) Cu = \frac{Au}{AS}\ X\ CS\ X1000$$

AU = absorbance of unknown sample, AS = absorbance of standard, CS = concentration of standard, CU = concentration of unknown sample and 1000 = conversion factor to mg/100g.

Analyses of Some Mineral Composition

One gram of sample was weighed into a crucible, burned on hot plate until the smoke subsides completely and then made to ash in a muffle furnace at 500°C for 6 hours. The crucible was transferred into a desiccator and allowed to cool. The ash sample was dissolved in 1ml of concentrated nitric acid. The dissolved ash sample was evaporated to dryness on a hot plate. 5ml of 5M hydrochloric acid was added and transferred to 100ml standard volumetric flask. It was then made up to mark with distilled water and filtered. The prepared sample was analyzed for the mineral elements (Zn, Fe, Ca, Mn, Na, K and Cu) using Atomic Absorption Spectrophotometry.

Data Analysis

Data on the nutritional composition of the different insect species were analyzed using Sigma Stat 3.5 analytical software. Analysis of Variance (ANOVA) was performed and differences between means were separated using Least Significant Difference (LSD) test at 5% ($P<0.05$) level of significance. Results were reported as means ± standard deviations.

RESULTS AND DISCUSSION

All the samples have significantly different nutritional composition except the protein contents of Glycine max and *Chorthippus brunneus* which are not significantly different

at the 5 % level. This similarity in protein content may be due to high consumption of various dietary protein foods by the *Chorthippus brunneus*. The *Chorthippus brunneus* has the highest amount of moisture while the *Parkia biglobosa* and *Glycine max* have the lowest moisture content as show in (table 1.0). The results obtained for the proximate composition of *Chorthippus brunneus, Parkia biglobosa* and *Glycine max* are somewhat different from what was previously reported by (Aduku, 1993), (Melik, 1969 and Bedford, 1980).

The high moisture content in the *Chorthippus brunneus* implies that it cannot be stored for a very long time since moisture which is an important medium for multiplication of microorganisms is very high in *Chorthippus brunneus* sample. The high ash content is indicative that the *Chorthippus brunneus* could be important sources of minerals, compared to lower ash contents of *Parkia biglobosa* and *Glycine max*. The high protein content of 39.561±2.553 of the *Chorthippus brunneus* suggests that it could be used in the management of protein deficiency cases such as Kwashiorkor, compared to lower protein for *Parkia biglobosa*. The lower crude fat content suggests that the *Chorthippus brunneus* may not be a viable source of oil, going by their crude fat contents when compare to high crude fat observed in *Parkia biglobosa* and *Glycine max* as show in (table 1.0).

The *Chorthippus brunneus, Parkia biglobosa* and *Glycine max* samples contained relatively low fibres, but the presence of fibre in foods is known to be beneficial. Fibre has some physiological effects in the gastrointestinal, tract. These effects include variation in faecal water, faecal bulk and transit time and elimination of bile acids and neutral steroids which lower the body cholesterol pool (Aduku, 1993).

The carbohydrate contents in the *Chorthippus brunneus* is relatively high but lower than what was obtained in *Parkia biglobosa* and Glycine max. This suggests that the insect could be used in managing protein-energy malnutrition since there is enough quantity of carbohydrate to derive energy from in order to spare protein so that protein can be used for its primary function of building the body and repairing worn out tissues rather than as a source of energy (Melik, 1969 and Bedford, 1980).

The study revealed that the insect under study have high nutritional qualities. The protein content of the insect has been studied and compared with the protein content of Locus beans and Soya beans. The result of the proximate analysis of *Chorthippus brunneus* from this study is similar to that obtained by others (Aduku, 1993; Melik, 1969; Bedford 1980). However, the value of proximate analysis of *glycine max* and *Parkia biglobosa* were lower than that of *Chorthippus brunneus*. These differences may be due to high consumption of various dietary foods by the insect. The results of this study also confirm the fact that insects are indeed a good source of protein and other nutrients. The consumption of non-toxic insect should therefore be encouraging.

TABLE 1: Proximate Composition of *Chorthippus brunneus*, *Parkia biglobosa* and *Glycine max*

Parameters (%)	*C. brunneus*	*P. biglobosa*	*G. max*
Crude Protein	39.561 ± 2.553^{b}	24.667 ± 3.512^{a}	38.333 ± 6.807^{b}
Crude Fat	11.763 ± 1.035^{b}	13.68 ± 3.257^{a}	15.26 ± 0.761^{a}
Crude Fibre	4.703 ± 1.535^{a}	3.175 ± 0.209^{a}	2.953 ± 0.0971^{a}
Ash content	6.607 ± 0.930^{b}	2.96 ± 0.286^{a}	3.773 ± 0.448^{a}
Moisture Content	11.00 ± 0.600^{c}	4.363 ± 0.342^{a}	8.547 ± 1.005^{b}
Carbohydrate	25.57 ± 6.606^{b}	51.962 ± 7.343^{a}	29.36 ± 7.457^{b}

Key: Values are means of 3 triplicate determination ± S.D, means with different superscript along the same horizontal array differ significantly (P< 0.05).

The oxalate content recorded was the lowest compared to tannins and phytate. On the other hand, *Parkia biglobosa* had the least percentage concentration of phytate and oxalate compared to *Chorthippus brunneus* and *glycine max* as show in Table 2.0. The concentrations of all the antinutrients in the insect and the legumes happened to be within acceptable levels.

TABLE 2: Anti Nutrient Composition of *Chorthippus brunneus*, *Parkia biglobosa* and *Glycine max* (mg/100g)

Parameters	*C. brunneus*	*P .biglobosa*	*G. max*
Phytate	0.0247±0.0025[b]	0.0345±0.0022[a]	0.0127±0.0145[b]
Oxalate	0.0873±0.0037[b]	0.0433±0.0065[a]	0.0563±0.0028[a]
Tannin	0.0971±0.0027[c]	0.0761±0.0012[a]	0.0571±0.0091[b]

Key: Values are means o 3 triplicate determination ± S.D, means with different superscript along the same horizontal array differ significantly (P< 0.05).

TABLE 3: Mineral Composition of *Chorthippus brunneus*, *Parkia biglobosa* and *Glycine max* (mg/100g)

Mineral element	*C. brunneus*	*P. biglobosa*	G. max
Zinc (Zn)	1.187±0.005[a]	1.857±0.0666[a]	3.080±0.0100[b]
Iron (Fe)	3.43±0.2140[c]	16.247±0.0577[a]	12.41±0.0529[b]
Calcium (Ca)	30.97±0.010[b]	3.138±0.00608[a]	2.87±0.01000[a]
Magnesium (Mg)	7.997±1.469[b]	11.897±1.423[a]	9.597±1.289[a]
Manganese (Mn)	0.533±0.577[b]	0.353±0.123[a]	0.235±0.201[a]
Sodium (Na)	89,837±0.781[c]	110.509±0.149[a]	172.837±0.613[b]
Potassium (K)	12.893±0.0232[b]	21.66±0.0954[a]	15.763±0.0862[b]
Copper (Cu)	0.456±0.00512[a]	0.377±0.00577[a]	0.887±0.00577[b]

Key: Values are means o 3 triplicate determination ± S.D, means with different superscript along the same horizontal array differ significantly (P< 0.05).

The high calcium content in the insect 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 when compared to low contents in locus beans and soya beans. Calcium also plays a role in blood clotting (Mehas *et al.*, 1997). Magnesium is involved in making proteins and releasing energy and helps hold calcium in the enamel of the teeth.

Iron is used in the management of iron deficiency anaemia since iron is a vital part of red blood cells that carry and release oxygen (Mehas *et al.*, 1997). Phosphorus is closely linked with calcium. The two minerals combine to form calcium phosphate, which gives bones their rigid structure (Mehas *et al.*, 1997).Sodium is needed in the body in a small amount to help maintain normal blood pressure and normal function of muscles and nerves. Zinc helps the immune system fight off invading bacteria and viruses. The body needs zinc to make proteins and DNA, the genetic material in all cells and also helps in wound healing and the breakdown of carbohydrates. Also, zinc is below the permissible level of 50 and 100mcg/g in grains and beans (USDA, 2003).

CONCLUSION

The study has established the proximate nutrients, antinutrients and minerals (calcium, sodium, zinc, magnesium, manganese, potassium, copper, iron and phosphorus) concentrations of *Chorthippus brunneus, Parkia biglobosa* and Glycine max. The results of this study indicate that the insect is rich in proteins, fats and carbohydrates and are therefore inexpensive source of macronutrients which can be used in intervention programme aimed at alleviating protein-energy malnutrition. The flour from the locus bean and soya bean has good protein contents and could be used to fortify flours with low protein content such as maize and rice. The mineral contents indicate that the flour samples could be important sources of minerals for humans and farm animals and they also contained tolerant level of anti -nutrients.

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