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Evaluation of Proximate Compositions of
Some Edible Insects in Zaria Kaduna State Nigeria*Muinat, M. I.¹ and Tariq, A. M.²¹Department of Biology, Federal College of Education Zaria, Nigeria²Department of Biological Sciences, Federal University Gusau, Nigeria

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ABSTRACT

The present study was carried out to evaluate the proximate compositions of some edible insects in Zaria. Five edible insects were sampled for this study, Crickets (*Branchytropes memberanacoeus*), Dung beetles (*Helicropis angulifera*), Termites (*Macrotermes nigeriensis*), small Grasshopper (*Zonocerus variegatus*) and large Grasshopper (*Kraussaria angulifera*). Cricket species were recorded to have the highest value for moisture (4.18%) and Ash (11.62%). Big grasshopper had the highest value for Carbohydrate (34.08%). Termites had the highest percentage of crude protein (58.99%) and crude fiber (7.09%). Proximate composition values obtained for edible insects sampled for this work were all significant ($P \leq 0.05$) except for Crude Protein. It is therefore recommended that more Termites (*Macrotermes nigeriensis*) should be consumed for protein and crude fat (lipid) derivation. The lipids content recorded for termites in this work were higher than those of Chicken (1.5%) and Fish (2.7-5.0%).

Keywords: Entomophagy, Proximate composition, Edible Insects, Zaria.

1.0 INTRODUCTION

Entomophagy is a concept used to describe the act of eating insects as a means of food, according to Paiko *et al.* (2012). For centuries, people around the world have been consuming insects as a daily part of their diets. While in many westernized cultures the earliest of Entomophagy was, and still is, taboo; however, in many parts of the world, insect eating is not a new phenomenon. From ants to beetle larvae eaten by tribes in Africa and Australia to the common, crispy-fried locusts and beetles enjoyed in Thailand as part of their subsistence diets, insect-eating is estimated to be practiced regularly by at least 2 billion people worldwide (UNFAO, 2013). It can be classified into two categories; insects used as nutrient supply and some as condiments. Insects have played significant roles in the history of human feeding in Africa, Australia, Asia, and America. Some of the more significant classes include grasshopper, caterpillars, beetle grubs, and occasionally adult winged termites (some of which are quite large in the tropics), bee, wasps, and ant brood (larva and pupa), as well as winged ant cicadas and a number of aquatic insects; such as Caddis fly, Stoneflies, Dragonflies, Damselflies.

Insects are typically not included as emergency food to fend off hunger, but are used as a regular part of the diet during the year or as available seasonally. Virtually all insects are considered by many forest managers to be an unwanted pest, as many species inflict massive damage and mortality to valuable commercial trees, but edible insects are a food resource that Third World populations continue to extensively exploit (De Foliart, 2002; and Latham, 2001).

Most Nigerians have had a direct or indirect experience with entomophagy, although it is more prevalent in rural than urbanized areas as elsewhere in Africa, the more educated are more reluctant to admit that indigenous customs, including eating of insects, still exist. (Fasoranti and Ajiboye, 2003) believed that insects can help significantly in reducing protein deficiency in the country and that entomophagy should be promoted through education, they also stress the need for the development of mass-rearing method rather than continued reliance on harvesting natural

populations. Most insects consumed in Nigeria are available for collection during the rainy season.

Proximate composition, common terminology in Food Science refers to the six (6) components of moisture, crude protein, ether extract, crude fiber, crude ash, and carbohydrate. Proximate compositions should always add up to 100% as any deviation from 100% displays the resolution of the chemical test (Anon, 2017). It is not uncommon to see small variations in the way each test is performed by chemists or Food scientists. These variations accumulate, may overlap, and affect the final result. Although considerable work has been done on the proximate and nutrient composition of edible insects in Nigeria so far research has not been conducted on Proximate Composition of Edible Insects in Zaria. The present work focused on the proximate composition of certain edible Insects in Zaria. It also centered on the food classes present in them and will promote the continued consumption and exploitation of these alternative cheap sources of lesser-known food items and for possible domestic and industrial uses. The objective of this study was to evaluate the

proximate compositions of some edible Insects in Zaria.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study was carried out in Zaria. Zaria is made up of two local governments; Sabon Gari comprises seven wards and Zaria Local Government comprises thirteen wards. Zaria is located on a geographical map on latitude $11^{\circ}7'$, $11^{\circ}12'N$, and longitude $7^{\circ}41'E$ and $7^{\circ}46'E$ Zaria Local Government comprises of wards. (Mamman *et al.*, 2000). Relative humidity in Zaria is between 63.2-68.8% with an average rainfall (155.9-182.1mm) and temperature range of 25-30.2°C and with a low evaporation rate of 154.2-163.91mm (Igono and Aliyu 1982; Eden, 2009). The vegetation of Zaria is within the guinea savannah (Kaduna State Government, 2006). The community cultivates tomatoes, maize, sweet potatoes, beans, rice, sugarcane, millet, and pepper. Livestock such as cows, sheep, goats, cats, dogs, and poultry are kept in medium to small scale farms/pens where they are attached to people.

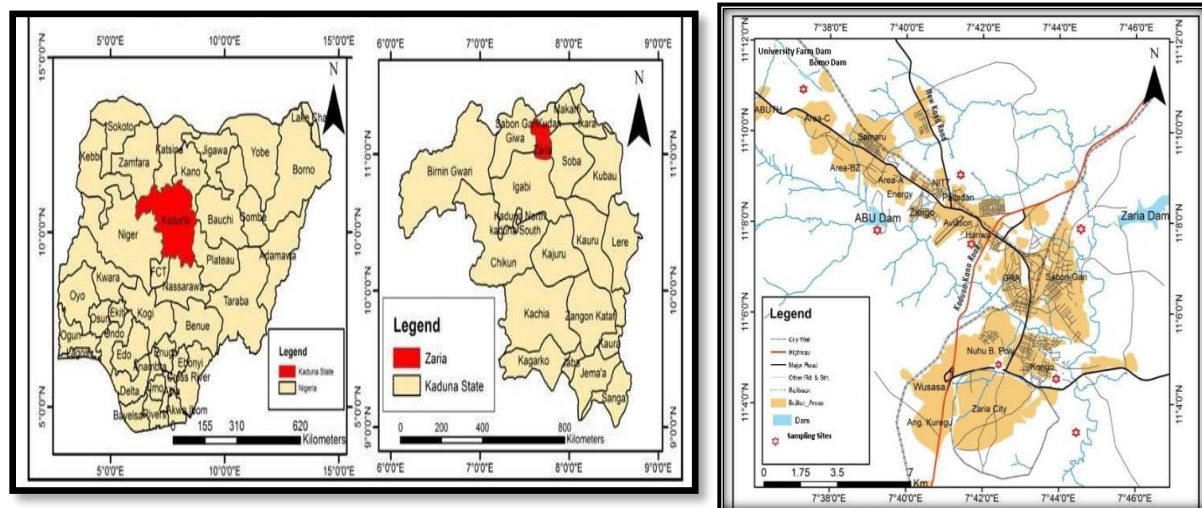


Fig. 1: Study Area Map Showing Sample Sites

Source: Adapted and Modified from the Administrative Map of Kaduna State (Ahmad, 2017)

2.2 Collecting Equipment/Instruments

Equipment used for collecting insect samples are outlined as follows;

- Killing bottle
- Hand lens
- Penknife or scalpel
- Entomological forceps
- Scissors
- Glass or plastic tube
- Sweep net and insect net
- Beating tray
- Notebook and pencil
- Pair of a rubber boot

2.3 Study Population and Sampling

The Study Population comprises edible insects that were previously determined as edible by (Fasoranti and Ajiboye, 2003, Banjo *et al.*, 2006, Ekop *et al.*, 2007, Mba and Elekina, 2007, Agbidye, *et al.*, 2009, Ekpo *et al.*, 2010). The collection points of the insects were noted. Eight locations within Zaria were purposively selected to ensure a fair representation of the region and four out of the eight were randomly selected for sampling and insect collection. The sampling was done using based on the Agroecosystem (Shika Area), Open-field (Nuhu Bamali Polytechnic Annex Area), Residential Area (Tudun Wada Area) Wetland (Kongo/Dakace Area).

2.4 Sample Collection

Termites were collected using light traps suspended over water buckets and basins to collect them as they drop. They are collected in yards next to the road and open fields (Field survey, 2017). Crickets were collected from soil and underground tunnel which they build mostly in farmland and forest area (field survey, 2017). Grasshoppers were collected by handpicking and use of sweep net in an area where green plants are abundant. (Field survey, 2017). Beetle larvae were collected from humus deep soil (Field survey, 2017). ✓

Samples collected were dried in an oven at 105°C for 5 hours. The dried samples were milled into a fine powder using porcelain (Mortar and pestle) and were transferred into an airtight container or further laboratory analysis (Agomo, 2011). ✓

2.5 Samples Identification

Samples collected were identified by comparing them with archived samples at the Department of Crop Protection, Institute of Agricultural Research, Ahmadu Bello University, Zaria and the use of

available identification keys such as Kacie, (2010), Sara Mitchel, (2010),

2.6 Samples Preservation

Representatives of Insect collected and identified were preserved dry. However, insects' larvae such as Pallid Emperor moth, Dung beetles, Emperor moth were preserved by immersion in 70% ethanol.

2.7 Experimental Design

A sampling of an insect was made at least once a week in each of the sampling sites from June to November.

2.8 Laboratory Analysis

The samples of edible insects collected were analyzed at the Parasitology and Entomology Laboratory Department of Zoology, Ahmadu Bello University, Zaria, National Research Institute for Chemical Technology (NARICT), and Central Research Laboratory, Ilorin Samples were subjected to the following analyses.

2.9 Proximate Analysis

The insect samples were killed by freezing at 0°C for 24 hours. The frozen samples were then allowed to thaw at room temperature, the inedible portions were removed and the edible portions dried in an air-ventilated oven (Mettler) at 50°C for 72 hrs. The dried samples were ground into powder using an iron hand-grinding machine and stored in air-tight bottles for further analysis. The analyses of the samples were done in triplicate.

Moisture, protein, fat, ash, carbohydrate, and crude fiber were determined according to the Association of Official Analytical Chemists (AOAC, 2005).

2.9.1 Estimation of Moisture

i. This was done based on the difference between the net weight and the weight after drying to a constant (at 100°C for 24 hours).

ii. The crucibles were washed and dried to constant weight at 100°C.

iii. They were later removed and cooled in a desiccator and was weighed (W1)

iv. 2g of the grounded sample was placed in the weighed moisture dish (W2)

v. The crucible container containing the sample was kept in an oven at 100°C for 24 hours and then was weighed.

vi. It was kept back in the oven and was reweighed after 3 hours to ensure constant weight (W3).

The moisture contents were calculated as % moisture = $\frac{(W_2 - W_3)}{W_2 - W_1} \times 100$

2.9.2 Determination of Ash

Crucible was cleaned and dried, the oven, and was corked in the desiccator, and weighed (W1).

2g of the grounded samples was placed in the crucible and weighed (W2). They were transferred into a furnace and set to 55°C. The sample was incinerated in a furnace for 8 hours.

The crucible containing the ash was added and was cooled in the desiccator and was weighed (W3).

The percentage (%) ash was calculated as =

$$\frac{W_3 - W_1 \times 100}{W_2 - W_1}$$

W3= Weight of crucible containing(plus)Ash

W2= Weight of samples

W1= Weight of crucible (AOAC,2005)

2.9.3 Estimation of Carbohydrate (Nitrogen Free Extract)

Nitrogen Free Extract (NFE) represents soluble carbohydrates and other digestible and easily utilizable non-nitrogenous substances in feed. NFE is determined by mathematical calculation. It is obtained by subtracting the sum of percentages of all the nutrients already determined from 100.

%NFE/ Carbohydrate was estimated as = 100- (%moisture + %CF + %CP + %Lipids(EF) + %Ash).

%Moisture= Estimated value of Moisture contents (%) from insect samples

%CF= Estimated Crude Fiber value (%) from insect samples

%CP= Estimated Crude Protein value (%) from insect samples

%EF= Estimated value of Lipid (Crude fat)/ Ether extract from insect samples

%Ash= Estimated value of Ash contents (%) from insect samples

2.9.4 Determination of Crude Protein

Crude protein is determined by measuring the nitrogen content of the feed and multiplying it by a factor of 6.25. This factor is based on the fact that most protein contains 16% nitrogen. Crude protein is determined by kjeldahl method. The method involves: Digestion, Distillation and Titration.

a. Digestion: About 20g of the sample was weighed into a filter paper and put into a Kjeldahl flask, a speck of selenium tablet with 25mls was added with 1g of CuSO₄ respectively. twenty milliliters 25mls of concentrated H₂SO₄ was added and then digested in a fume cupboard until the solution becomes colorless.

b. Distillation: Markham distillation apparatus was used for distillation. Steam up the distillation apparatus and add about 10mls of the digest into the apparatus via a funnel and allow it to boil. Add 10mls of sodium hydroxide from the measuring cylinder so that ammonia is not lost. Distil into 50mls of 2% boric acid containing screened methyl red indicator.

c. Titration: The alkaline ammonium borate formed was titrated in the receiver with 0.01M HCL until the solution becomes colorless. The titre value which is the volume of the acid was recorded. The volume of acid used is fitted into the formula which becomes

$$\%N = \frac{(14 \times VA \times 0.1 \times W)}{1000 \times 100}$$

VA = volume of acid used w= weight of sample

The percentage crude protein was calculated as follows:

%Crude protein= %N x 6.25 (AOAC,2005).

2.9.5 Estimation of Crude Fat (Lipids)

Estimation of crude fat consists of 3 major components

1. An extractor: comprising the thimble which holds the sample
2. Condenser: for cooling and condensing the ether vapor
3. 250ml flask

Procedure

About 150ml of an anhydrous diethyl ether (petroleum ether) of boiling point of 40-60°C was placed in the flask. 2-5g of the sample was weighed into a thimble and the thimble was plugged with cotton wool. The thimble with content was placed into the extractor; the ether in the flask was then heated. As the ether vapor reaches the condenser through the side arm of the extractor, it condenses to liquid form and drop back into the sample in the thimble, the ether soluble substances were dissolved and are carried into solution through the siphon tube back into the flask. The extraction continued for at least 4 hours. The thimble was removed and most of the solvent was distilled from the flask into the extractor. The flask was then disconnected and placed in an oven at 65°C for 4 hours cool in desiccator and was then weighed.

$$\% \text{ Crude fat (Lipids)} = \frac{\text{Weight of flask + Extract} \times 100}{\text{Weight of Sample}}$$

2.9.6 Determination of Crude Fiber

The organic residue left after sequential extraction of feed with ether was used to determine the crude fiber. however, if a fresh sample is used, the fat in it could be extracted by adding petroleum ether, it was stirred three times and then allowed to settle and decant.

3.0 RESULTS

A careful study of the data in the table below shows the moisture contents of edible insects sampled to be generally low. Cricket of *Brachytrupes membranaceous* species was slightly higher (4.18%) while the least value was recorded for Dung beetle larvae of *Helicopris staudingeri* species (2.74%). The Ash contents of the different insect species studied ranged from (0.65-11-62%). The value of ash contents for cricket was significantly the highest (11.2%) while small grasshopper of *Zonocerus variegatus* has the lowest value (0.65%). The carbohydrate contents were highest for large grasshopper of *Kraussaria angulifera* followed by small grasshopper of Crude protein values for the five insect species for this study are ranged from 43.32-58.99%, Termites having the highest value of 58.99% followed by

The fat-free material was then transferred into a flask/beaker and 200mls of pre-heated 1.25% H₂SO₄ was added and the solution was gently boiled for about 30mins, maintaining constant volume of acid by the addition of hot water. The buckner flask funnel fitted with whatman filter was pre-heated by pouring hot water into the funnel. The boiled acid sample mixture was then filtered hot through the funnel under sufficient suction. The residue was then washed several times with boiling water (until the residue is neutral to litmus paper) and transferred back into the beaker. Then 200mls of pre-heated 1.25% Na₂SO₄ was added and boiled for another 30mins. It was then Filter under suction and was washed thoroughly with hot water and twice with ethanol. The residue was dried at 65°C for about 24hrs and weighed. The residue was transferred into a crucible and placed in muffle furnace (400-600°C) and ash for 4hrs, then cooled in desiccator and weighed.

2.10. DATA ANALYSIS

The proximate compositions of the edible insects sampled were analyzed using Analysis of Variance (ANOVA) to determine the significant differences. All variables were tested at 0.05 level of significance.

Zonocerus variegatus. with (22.68%) and the least value was recorded in Termite of *Macrotermes nigeriensis* species (1.48%).

The lipid contents of edible insects obtained from this study ranged from 7.96- 30.12% with Dung beetle larvae having the highest value (30.12%) and small grasshopper having the lowest value (7.96%). Crude fiber values for the five insects are also tabulated in Table1. The values ranged from 1.97%-7.09%. the termite has the highest value (7.09%) while dung beetle larvae have the lowest value (1.97%). The p-value was significant for all proximate composition of insects studied with the he exception of crude protein. cricket 51.82% and small grasshopper has the lowest percentage of 43.32%.

Table 1: Proximate Composition of Some Edible Insects in Zaria

Samples	Moisture Content %	Ash Content %	Carbohydrate %	Calorific Value	Crude Protein %	Crude Fat %	Crude Fiber %
BGO	4.04±0.21 ^{ab}	0.70±0.03 ^c	34.08±1.17 ^a	1732.00±13.26 ^c	49.74±1.12 ^a	8.81±0.37 ^d	2.63±0.14 ^b
DBO	2.74±0.32 ^c	4.36±0.21 ^b	8.88±1.07 ^b	2151.03±2.62 ^a	51.92±0.24 ^a	30.12±0.44 ^a	1.97±0.13 ^c
CO	4.18±0.07 ^a	11.62±0.35 ^a	11.26±1.23 ^b	1702.57±13.07 ^c	54.30±0.17 ^a	16.12±0.81 ^c	2.52±0.04 ^b
TO	3.21±0.21 ^{bc}	5.32±0.53 ^b	1.48±0.19 ^c	1805.85±16.97 ^b	58.99±4.97 ^a	18.90±0.55 ^b	7.09±0.00 ^a
Total	3.54±0.24	5.50±1.49	13.93±4.62	1847.86±67.84	53.74±1.62	18.49±2.90	3.55±0.78
p Value	0.026*	0.000*	0.000*	0.000*	0.207ns	0.000*	0.000*

Key: BG= Big grasshopper DB=Dung beetle C= Cricket T= Termite.

4.0 DISCUSSION

The moisture content of edible insects studied ranged from 2.74-4.18%. the moisture contents value of insects was quite low in this study. The Big grasshopper (*Kraussaria angulifera*) was of higher percentage (4.04%) while dung beetle (*Helicopris staudingeri*) had the least percentage (2.74%). Adult insects tend to have fewer moisture contents than their nymph counterparts and this trend was evident as all samples evaluated were adults. The moisture content of the entire insects was generally low. This indicates that they can all be preserved for a reasonable period of time without the risk of microbial deterioration and spoilage. The long shelf-life promised here is an added advantage over other sources of protein like beef, egg, fish, which are easily prone to spoilage on careless keeping. Also, relatively low moisture content of Dung beetle (*Helicopris staudingeri* species) in this study, is an indication that it is free of bacterial spoilage during storage. This also indicates that they can all be preserved for a reasonable period without the risk of microbial deterioration and spoilage. (Adeshina,2012).

The Ash contents of edible insects studied ranged from 0.70-11.62%. Cricket has the highest value for Ash contents (11.62%) while Big grasshopper has the lowest (0.70%). The value of ash contents for this study was within the range (except for Grasshopper) obtained for termites, (*Trinerviter mesgerminates*), (5.39%-13.90%) by Ajakaiye and Bawo (1990) but lower than the value obtained for *Chrysichthys species*, (17.9%) by Mba (1980) and higher than the values reported for grasshopper (4.30 -6.40%) by Ekpo *et al.* (2010). Since the ash content of a sample is a reflection of the minerals it contains. There is a consensus among researchers that ash content of a given sample correlates the

mineral contents of the sample. It stands to suggest that the four insects studied here can give a fair source of mineral elements as earlier reported by Ene (1963) and could be particularly useful for children and pregnant and lactating women. The high ash contents of cricket (*Brachytrupes membranaceous*) in this study indicates that they are good sources of mineral elements and is of nutritional importance as a previous report has indicated that when leaves are to be used as food for humans, they should contain about 3.0% ash contents.

The carbohydrate percentage contents of edible insects ranged from 1.48-34.08% when compared between the four groups of insects, differed significantly at 95% confidence interval. Insects are therefore not a good source of carbohydrate as revealed in this work. The low percentage of carbohydrates in termites (*Macrotermes nigeriensis*) recorded in this study indicates that the insect is not a good source of carbohydrate. The human adult needs 400-500g carbohydrate intake as starch. A similar observation was also made by Ekop *et al.* (2010) in their study on the Proximate and Anti nutrient composition of Four edible insects in Akwa Ibom State, Nigeria and Adeshina (2012) in his work on Proximate and anti-nutritional composition of two common edible insects: yam beetle (*Heteroligusmeles*) and palm weevil (*Rhynchophorus phoenicis*).

The crude protein percentage of edible insects sampled for this study, ranged from 49.74- 58.99%. Termite (*Macrotermes nigeriensis*) was recorded with the highest value (58.99%) obtained in this work for the four insects that are lower than those for periwinkle 55%. Available data, however,

shows that edible insects contain protein in the range 22.1 to 74.4% Amadi (2017); Ekpo and Onigbinde (2005); Wachukwu, *et al.* (2002); Agbideye, *et al.* (2009). This protein range by Order translates to: Lepidoptera ($\geq 38 +$ to 74.4%), Coleoptera larva (22.1 to 30.3%), Coleoptera adult (26.9 to 32.7%), Isoptera (35.1%) and Orthoptera (65.6%). Moisture data for *C. forda* larva, *B. membranaceus* and *M. natalensis*. Edible Insects sampled for this study indicate high protein rich contents and are recommended for consumption for protein derivation. It also indicated that the insects can be of value to man and animal ratio and can equally replace higher animal protein usually absent in the diet of rural dwellers in developing countries (Banjo *et al.*, 2006). Similar findings were carried out by Pornpimol (2009), in their study on Fatty acids and Proximate composition of eight Thai Edible terri-colous insects. Also, mba (1980) also reported that insects can contribute effectively as an alternative source of protein to the recommended human daily protein requirement of 23-58% (National Research Council, 1980).

The lipid (Crude fat) percentage provides the ready source of energy for the body. The lipid (Crude fat) contents obtained for the study ranged from 8.81-18.90%. termites (*Macrotermes nigeriensis*) were recorded with the highest value (18.90%). The high lipid (CF) content of Termites (*Macrotermes nigeriensis*) showed that these insects were rich in lipids, and this accounts for its palatability when fried or roasted as mentioned by Womeni *et al.* (2009), the lipid contents of insects were higher than those of chicken (1.5), fish (2.7-5.0), and

5.0 CONCLUSION

This study revealed that, edible insects sampled were rich in proximate compositions. The values for proximate compositions obtained were within the recommended limits of FAO and WHO (2013) for Foods Standards Program. The highest values for crude protein and crude fat (lipids) were found for termites (*Macrotermes nigeriasis*). It is therefore recommended that all the species of insects sampled for this study are good for human consumption, more Termites should be consumed

unprocessed milk (2.1-3.7). Indeed, lipids are necessary in food because they increase palatability and retain the flavor of food (Aiyesanmi and Oguntokun, 1996). The lipids in insects sampled for this study, could therefore help to enhance the flavor and palatability of foods, as well as playing a structural and functional role in the organism. The data in the study varied significantly among the edible insects studied. All the insects can provide. supplementary dietary fat in feed formulation for animal husbandry. This study agrees with Ekpo *et al.* (2009).

The crude fiber percentage of edible insects sampled for this study ranged between 1.97-7.09%. Termites (*Macrotermes nigeriensis*) were observed with the highest value of crude fiber content (7.09%), compared to the work of Ekpo *et al.* (2010) on their findings of Proximate and Nutritional Composition of four Edible Insects in Akwa Ibom State; the values of crude fiber range from 2.20-3.00%. These values are moderate of high contents and this could be due to little amount of chitin found normally in insects. Oduor *et al.*, (2008), also reported that chitin and chitosan yield differ with species. The physiological role of crude fiber in the body is to maintain an internal distention for the proper peristaltic movement of the intestinal tract (Oduor *et al.*, 2008). A diet very low in fiber could therefore lead to constipation which might bring discomfort to the body system with running stool (Groff *et al.*, 1999). Diets with high fiber content have been used for weight control and fat reduction, as they give a sense of satiety even when small food is eaten (Ekpo, 2004).

for the derivation of protein and lipids since the contents are greater than that of chicken (1.5%) and fish (2.7-5.0%).

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