



Proximate and Mineral Potential of Sun-Dried Short Horn Grasshopper (*Zonocerus variegatus*) Consumed in Paikoro Local Government, Niger State, Nigeria

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ABSTRACT

The proximate, mineral and anti-nutritional compositions of the short-horn grasshopper (*Zonocerus variegatus*) have been investigated using known analytical methods. Results of the proximate composition indicated moisture content of 5.10 %, crude protein content of 18.39 %, fat content of 10.5 %, ash content of 2.30 %, carbohydrate content of 31.51% and 32.20 % fiber content. High proportions of sodium, potassium, calcium, magnesium and phosphorus (115.50, 132.50, 39.58, 52.25 and 126.30 mg/100g) were recorded respectively. Moderate amounts of iron, manganese and zinc were also detected. Results of anti-nutritional analysis revealed low contents of cyanide and oxalate. K/Na ratio of 1.15 ± 0.1 so obtained suggests that the insect could be a potential source of diet for the management of hypertension. The high values of protein and carbohydrate suggest that *Zonocerus variegatus* has potential for exploitation to combat nutritional deficiencies that are of public health concerns. The insect could form a base for new food products of considerable nutritive values.

Keywords: Nutritional potential, *Zonocerus variegatus*, anti-nutritional, proximate composition.

INTRODUCTION

Insects serve as food sources and contribute significantly to local economies. They are not only sold widely in the small markets but many of the favorites have made their way to big markets and restaurants of the developing worlds. Early reports revealed that in Mexico, white Magueh worm (larva of the Hesperiid, *Aegiale hesperiaris*) is being exported to the United States and Europe. Thailand also exports giant water bug and canned silkworm pupae (*Bombyx mori*) to the Asian community shops (Ramos-Elordy, Moreno, Prado, Perez, Otero and de Guevera, 1998). In Southern Africa, the Mopane worm (*Gonimbrasia belina*), a large edible caterpillar is an important source of protein for many indigenous South Africans. There are industries in South Africa, Botswana and Zimbabwe that are involved in canning and processing of Mopane worms. They are often sold at open markets, supermarkets and bus termini and in some instances the marketing chain is quite long (Dreyer and Wehmeyer, 1982). In Nigeria insects widely consumed include termites, crickets and cone-headed grasshoppers. Reports have shown that some of these insects which are even regarded as pests such as termites, have high nutritional qualities and

very rich in different minerals such as K, Ca, Mg, Zn, P and Fe (Banjo, Lawal and Sangonuga, 2006).

Adeduntan and Bada (2004) reported the consumption of the African silkworm, *Anaphe veneta*, by the rural dwellers in Ondo, State, Nigeria. In many rural markets, edible insects are displayed in various containers with the prices, depending on the quantity in the container. In some cases, edible insects are prepared in the form of snacks and displayed for sale alongside other meat products like poultry eggs, pork and even fruits (Agbidiye, Otuya and Akindele, 2009). Grasshopper (*Zonocerus variegatus*) belongs to the Order – *Orthoptera*. They are referred to as short – horned grasshoppers to distinguish them from bush crickets. In many places around the World, grasshoppers are eaten as a good source of protein and lipids (Andrew, 2008). Grasshoppers have antennae that are almost always shorter than the body. Those species that

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make easily heard noises do so by rubbing the hind femurs against the forewings or abdomen (stridulating), or by snapping the wings in flight. Many species of grasshoppers are herbivores feeding on varieties of plants. They have short antennae and conspicuous compound eyes. As locusts, they swarm in millions in their gregarious stage and wreak havoc on crops as they consume foodstuff on their path (Christopher, 2002). The short horn grasshopper (*Zonocerus variegatus*) is a source of delicacy and forms a part of the food culture of the local Gbagyi, Koro and Kadara communities in Paiko and Kafin- Koro districts of Paikoro Local Government of Niger State.

In Niger State, only a few of these edible insects have been analyzed for their nutritional composition. Information on the quality of the nutrients in most of the popularly consumed insects is inadequate. Lack of such information is standing in the way of the utilization of these relatively rich protein and lipid sources for the dietary requirements of man. This study is an attempt to assess the proximate composition, some anti-nutrient factors and mineral content of grasshopper (*Zonocerus variegatus*) commonly found in Paikoro Local Government Area, Niger State, Nigeria. This will provide a baseline data and a reference point for the study of nutritional potentialities of other edible insects which will encourage greater exploitation to meet other malnutrition needs. The results will also serve as prerequisite for promoting consumption and commercialization of these insects.

METHODOLOGY

Sun-dried adult grasshopper samples (*Zonocerus variegates*) were purchased from Tsohon Kasuwa (a popular food market) in Kafin-Koro, Paikoro Local Government area of Niger State, Nigeria. They were taken to the Department of Biological Sciences, Federal University of Technology, Minna, for taxonomic identification by an entomologist. The non-edible wings of the whole insects were plucked off manually, made into powder using pestle and mortar and stored in labeled air-tight plastic bottles for analysis.

Proximate and Mineral analysis

The moisture, ash and crude fiber contents were determined using the methods recommended by the Association of Official Analytical Chemist

(AOAC, 2000). Crude protein was analyzed using micro- Kjeldahl \ method (AOAC, 2000) and the Nitrogen (%N) was determined by using a Nitrogen Protein conversion factor of 6.25. Fat (lipid %) content was obtained by extracting 5 g of the powdered sample with chloroform: methanol (2: 1) mixture as described by Folch, Lees and Stanley, 1975. The solvent was evaporated on a rotary evaporator and the oil obtained was dried in an oven at 60°C to remove all traces of solvent. Percentage Nitrogen free extract (Carbohydrate) was obtained by difference. All determinations were in triplicate.

Sodium and Potassium were determined using Gallenkamp flame Photometer analyzer, while Calcium, Magnesium, Iron, Manganese, Zinc and Copper were determined using Buch 211 Atomic Absorption Spectrophotometer. Phosphorus content was determined using the phosphovanadomolybdate colorimetric method and the results read on JENWAY 6100 spectrophotometer.

RESULTS AND DISCUSSION

Table 1. Proximate composition of adult variegated grasshopper (% dry matter)

Parameters	Values (%)
Moisture	5.10 ±0.15
Ash	2.30 ±0.30
Crude protein	18.39 ±0.25
Crude lipid	10.50 ±0.51
Crude fibre	32.20 ±0.20
Carbohydrate	31.51 ±0.10

Values are means ± SD of three determinations.

Table 2. Result of some anti-nutrient factors of adult variegated grasshopper (mg/100g)

Parameters	Concentration (mg/100g)
Cyanide	3.20 ± 0.06
Phytate	0.28 ± 1.05
Total Oxalate	26.40 ± 0.50
Tannins	0.430 ± 0.20

Values are means ± SD of three determinations.

Table 3. Mineral composition of adult variegated grasshopper (mg/100g)

Parameters	Composition (mg/100g)
Sodium	115.50 ± 0.07
Potassium	132.50 ± 0.08
Total Oxalate	26.40 ± 0.50
Tannins	0.430 ± 0.20
Calcium	39.58 ± 0.03
Magnesium	52.25 ± 0.25
Iron	19.15 ± 0.15
Manganese	4.95 ± 0.30
Zinc	1.05 ± 0.20
Copper	0.70 ± 0.05
Lead	ND
Phosphorus	126.30 ± 0.50
K/Na	1.15 ± 0.01
Ca/P	0.31 ± 0.01

Values are means±SD of triplicate determinations.

The results of the proximate composition of *Zonocerus variegates* is indicated in Table 1. The moisture content of the insect recorded was 5.10 ± 0.15%. Subhachae, Oranut, Lirong and Duo, (2010), reported higher moisture content of 8.6 ± 0.1 and 12.8 ± 0.1% for two varieties of edible ants. Low moisture content indicates a good shelf life characteristic. The low moisture content of the insect shows that this insect can be stored for a long period before deterioration. The ash content was low (2.30 ± 0.03%). It has been reported that edible ants have low ash content of 2.96% (Subhachae *et al.*, 2010). The quantity of ash in a sample supposedly indicates the amount of minerals. The ash content obtained in this work indicated that the insect could be a good source of minerals. The crude protein, crude lipid, fiber and carbohydrate contents obtained were 18.39 ± 0.4%, 10.5 ± 1.0%, 32.20 ± 0.20% and 31.51 ± 0.11% respectively. Protein content of 33.41 ± 0.20 % for *Macrotermis bellicosus* consumed in Southern Nigeria have been documented by Ekpo, Onigbinde and Asia, 2009.

Crude protein content as high as 30% has been reported by Ife and Emeruwa, 2011, for larvae of *Oryctes monoceros*. The reported protein values of beef meat (22.6%), chicken (18.83%) as well as fish which range from 15.55% in cat fish to 23.33% in tuna fish by Onimawo and Egbekun (1995) are in agreement with the protein value in this work. This insect could

serve as food protein source contributing significantly to the recommended human daily protein requirement of 23-56 % reported by National Research Council (1989), for man and animals, particularly in developing countries where the cost of conventional protein sources are expensive. The lipid, fiber and carbohydrate contents are also high in this insect which is similar to crude fibre content of 26.4 ± 1.4% for edible black ants recorded by Subhachae *et al.*, (2010). This insect can be used to complement animal roughages. The result of the mineral profile of the insect is indicated in Table 3. Since the ash content of a sample is a reflection of the minerals it contains, it is not surprising that this insect is moderately rich in minerals as earlier shown by the low ash content in Table 1. The concentrations of sodium, potassium and phosphorus were higher than all the minerals determined. Sodium, potassium and phosphorus concentration of 115 ± 0.07, 132.5 ± 0.08 and 126.30 ± 0.50 mg/100g dry weight were obtained respectively. Akintawo and Ketiku, (2000) reported higher Sodium content of 210 mg/100g for *Cirina forda*. The RDA for sodium is 1500 mg for an adult. The amount of sodium found in this insect is encouraging because sodium assists in maintaining the proper acid-balance and in controlling osmotic pressure that develops between the blood and cells due to ionic concentration differences. Potassium is an essential mineral nutrient and plays an important role in the synthesis of amino acids and proteins.

Teffo, Toms and Eloff (2007), recorded a value of 55.3 mg/100g potassium for edible Stink-bug. The value of 64.02 ± 0.02 mg/100g for Potassium obtained by Omotoso (2006) for *Cirina forda* is also lower than the value for grasshopper obtained in this work. Potassium intake has been found to lower blood pressure by antagonizing the biological effect of sodium. A high intake of potassium has been reported to protect against increasing blood pressure and other cardiovascular risks (Langford, 1983). A K/Na ratio of less than 1.0 is recommended. The K/Na ratio found in this insect therefore suggests that they could be a potential component of diets for the management of hypertension. The concentration of phosphorus, 126.30 ± 0.50 mg/100g is close to the value of 131.2 mg/100g for Grasshopper reported by Banjo *et al.*, (2006). Paiko, Jacob, Salihu, Dauda, Suleiman and Akanya, (2014) also

reported a value of 111.0 mg/100g dry weight for *C. forda*. This insect is a good source of phosphorus. Phosphorus like calcium is involved in calcification of bones and teeth and plays a vital role in the oxidation of nutrients in the form of phosphate groups in ATP. The Calcium content (42.16 mg/100g) reported by Banjo *et al.*, (2006) for grasshopper is very similar to a value of 39.58 mg/100g detected for grasshopper in this work. Sun-dried ants from Zhejiang were found to contain 49.1 ± 0.7 and 65.3 ± 1.3 mg/100g Ca and Mg respectively (Subhachae *et al.*, 2010), results which are very close to Calcium and magnesium contents of 39.58 ± 0.03 mg/100g and 52.25 ± 0.25 mg/100g respectively obtained for grasshopper in present work. Banjo *et al.*, (2006) in their own work found Calcium content of 42.16 mg/100g for grasshopper, result similar to 39.58 ± 0.03 mg/100g for grasshopper in this work. Calcium is important in the diets of children and adults for effective bone and teeth development. It is needed for the formation of muscles, heart and digestive system development. The amount of calcium in this insect suggests that their consumption can increase the calcium in the body and contribute tremendously to the blood clotting process.

The Magnesium concentration found in *Z. variegates* in this work was 52.25 ± 0.25 mg/100g). Omotoso, (2006) in a separate study recorded value of 62.31 ± 0.01 mg/100g Mg for *Cirina forda* larva. It was observed that differences in mineral contents may be due to variations in the dietary habits of the insects or as a result of different ecotypes. Differences may also be due to the age of the insects. Calcium and Magnesium play significant roles in photosynthesis, carbohydrate metabolism and act as binding agents of cell walls. Calcium assists in teeth development while Magnesium plays vital role in regulating the acid-alkaline balance in the body (Fallon and Enig, (1999). The Iron content of 19.15 ± 0.15 mg/100g was obtained in this work. Lower values of Iron content for moth caterpillar and grasshopper have been reported by Banjo *et al.*, (2006). Iron can serve as an antioxidant and can prevent cardiomyopathy and growth retardation (Chaturvedi, Shrivastava and Upreti, 2004). The amount of iron in the insect is encouraging because iron facilitates the oxidation of carbohydrates, proteins and fats. According to Buss, Torti and Torti (2003), Iron is an

antioxidant. Iron is one of the mineral elements which may be lacking in an average diet and so there is the need to be conscious of taking diets rich in iron especially the vulnerable group. The Manganese and Zinc concentrations of *Z. variegatus* are 4.95 ± 0.30 and 1.05 ± 0.20 mg/100g respectively. In a recent report, Ife and Emeruwa (2011) reported concentrations of 1.21 and 7.00 mg/100g for manganese and zinc respectively in the larva of *Oryctes monoceros*. Akinnowo and Ketiku (2000) reported values of 7.0 mg/100g of manganese in *Cirina forda*. The level of Zinc is low in this insect as found in this work. Zinc deficiency can lead to loss of appetite and impaired immune function. Reports have shown that Zinc deficiency causes hair loss, diarrhea, delayed sexual maturation, impotence and eye and skin lesions (Ryan-Harsman and Aldori, 2005). Copper concentration was very low (0.70 ± 0.50 mg/100g).

Subhachai, *et al.*, (2010) however reported values of 2.4 ± 0.5 mg/100g mean concentration of copper in sun-dried edible ants. Copper forms part of several enzyme systems including cytochrome oxidase and tyrosinase. Copper stimulates the immune system to fight infections as well as promote healing. It is associated with iron and catalyzes oxidation-reduction mechanisms concerned with tissue respiration (Fox and Cameron, 1980). Lead was not detected in this insect. Lead is very toxic. It is a potent neurotoxin and has a cumulative effect on vital organs (Ekpo, Udoh and Akpan, 2010). The absence of lead in this insect could be an advantage since its consumption would not result in any deleterious health effects. Therefore, it is necessary to monitor the level of lead over time for better clarification of its presence in these insects since human activities get sophisticated day by day thereby polluting the terrestrial environment. The results of the anti – nutrient content of *Z. variegatus* is shown in Table 2. The results reveal low values of Cyanide, Phytic acid and Tannins (3.20 ± 0.5 , 0.28 ± 1.05 , and 0.43 ± 0.02 mg/100g) respectively. The cyanide content found in this insect is far below the toxic range of 50 – 200mg/100g suggested by NRC (1989). Cyanide is toxic and high levels of cyanide have been associated with cerebral damage and lethargy in man and animals (Ekpo *et al.*, 2010). The amount of phytic acid found in this insect is also low. Phytic acid binds some elements such as

calcium, magnesium, iron, manganese and zinc to form complexes which cannot be digested easily thereby decreasing the bioavailability of these elements for absorption (Erdman, 1979). The results of cyanide, phytic acid and tannins concentrations in this insect pose no health risks. The total oxalate content of 26.40 ± 0.50 mg/100g obtained in this work is higher than the value of 2.1 mg/100g oxalate reported for *O. monoceros* by Ife and Emeruwa (2011). Oxalate binds Calcium present in foods thereby rendering calcium unavailable for its normal functions of maintaining strong bones, teeth and impulse transmission (Ladeji, Akin and Umaru, 2004).

Conclusion

The results obtained from this study revealed that the short-horn grasshopper (*Zonocerus veriegatus*) consumed by the local communities in Kafin-Koro and Paiko districts is a good source of protein and carbohydrate as well as some mineral elements such as sodium, potassium, calcium and phosphorus which could improve growth and development. The low content of some anti-nutrients also reveal that the insect could be exploited as an additional source of dietary supplement for human and animal feed formulations.

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