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Assessment of Proximate and Mineral Status of Rhinoceros Beetle Larva, *Oryctes rhinoceros* Linnaeus (1758) (Coleoptera: Scarabaeidae) from Itokin, Lagos State, Nigeria

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ABSTRACT

Larvae of Rhinoceros beetle (*Oryctes rhinoceros*) Linnaeus, 1758 (Coleoptera; Scarabaeidae) is well relished as snacks or main meal in Southwest Nigeria but little is known about its proximate and nutritional composition. The beetle larvae were therefore collected from Itokin, Lagos State, Nigeria and analysed using standard procedure of the Association of Analytical Chemists. The proximate analysis revealed that the sampled beetle larvae contain 16.97+0.04% moisture, 12.92+0.02% ash, 1.16+0.06% crude fibre, 48+0.05% crude protein, 20.35+0.08% carbohydrate and 0.06+0.61% fat. The ash content is a pointer that the insect has high mineral content hence the mineral element analysis was carried out using the Atomic Absorption Spectrophotometer (AAS). Following acid digestion the larva sample was analyzed for Calcium (Ca), Sodium (Na), Iron (Fe) and potassium (K), respectively. The results showed that the *O. rhinoceros* sample analysed contain 0.03+0.004 (mg/100 g) Ca, 0. 0.17+0.03 (mg/100 g) K, 21.82+0.60 (mg/100 g) Na, 4.10+0.07 (mg/100 g) Fe. The values were within the recommended daily allowance for these minerals. These results indicate that the beetle larva has huge potential as a base for new food/feed products of extensive nutritive value.

Key words: Taxonomy, proximate composition, rhinoceros beetles, supplement, enzyme formation, mineral element

INTRODUCTION

The Rhinoceros beetle *Oryctes rhinoceros* Linnaeus, 1758 (Coleoptera: Scarabaeidae), so called as a result is a pest of coconut in most part of the world, particularly in Southern Asia but in Africa, especially in Nigeria, it lives in and feeds mostly on oil and *Raphia* palms (Ayejuyo *et al*., 2001; Okaraonye and Ikewuchi, 2009). Old stems of coconut, *Raphia* and oil palms, also serve as breeding sites for the beetle (Ayejuyo *et al*., 2001; Okaraonye and Ikewuchi, 2009). Except for damage to coconut palms, the larvae are harmless (Thomas *et al.*, 2005; Voet *et al.*, 2006; Kurian *et al.*, 1983). Their larval stage is long (about two years). Eggs are laid and larvae develop in decaying logs or stumps, piles of decomposing vegetation or sawdust, or other organic matter (Ekpo and Onigbinde, 2005; Bedford, 1980). The eggs are deposited into the soil by the female during the warmer seasons (Nishida and Evenhuis, 2000). After a month the egg hatches and it enters the larval stage. The larval stage can last several years depending on the species. Other species of Rhinoceros Beetles have three instars, which mean they molt three times (Voet *et al.*, 2006). The larva stays underground for six months to one year. While they are there they grow and molt twice before entering the pupa stage. Human entomophagy in Africa has been documented earlier (Ayejuyo *et al.*, 2001). In Lagos State, they are found in places like, Itoikin along Ikorodu-Ijebu-ode expressway, Epe, Owode-Ajegunle and also in Ikorodu and Badagry. Previously, Rhinoceros beetle larvae were fried and eaten as a bush delicacy but now they are made available in commercial quantity in local markets where people in urban areas can purchase them. These larvae popularly consumed in the south western region of Nigeria among the Yoruba tribes and are usually called Ipe while in Ijaws tribes it is known as osori and also called tam in Ogoniland. The popular name for this pest in the Ibo land which is the Southern part of Nigeria is Utukuru (Ekpo and Onigbinde, 2005; Okaraonye and Ikewuchi, 2009). It is either consumed raw, boiled, smoked or fried. It may be eaten as part of a meal or as a complete meal (Ayejuyo *et al.*, 2001). The consumption of this species is also well prominent in Edo and Delta state. Meanwhile, global environmental health concerns calls for research to determine the level of pollutant in these animals as well as other consumables food since human depend mostly on their protein (Nwude *et al.*, 2011).

The objective of this study was to investigate the nutritional composition of the larva, with a view to revealing its potential for use as food supplement and formulation of new food/feed products.

MATERIALS AND METHODS

Sample description: The samples of *Oryctes rhinoceros* larva were collected from Itokin, a town in the South Western axis of Nigeria, which is on the boundaries of Lagos and Ogun States, about 20 km from Ijebu-Ode in Ogun State and also about 15 km to Ikorodu in Lagos State, it lies on latitude 60°N and longitude 30°E and has an elevation of 141 ft. Lagos. Five samples were collected over a period of five weeks. The samples were collected and kept in well ventilated plastic containers and were conveyed to the laboratory, where they were utilized within 24 h. The samples were dried except the ones for moisture content and were crushed using pestle and mortar previously washed with acid. The homogenized samples were later dried for 3 h in the oven at 105°C. Proximate analysis of the samples was carried out in triplicates, according to standard methods (AOAC, 1999) in order to determine the moisture, crude protein, ash, crude fat and total carbohydrate.

The concentration of the Calcium, Iron, Potassium and Sodium element in each sample was determined by a BUK scientific, VGP 210 model flame atomic absorption spectrophotometer after acid digestion as described by AOAC (AOAC, 1999). The sample was incinerated to a white ash at 550°C in a muffle furnace for (2 h) cooled and the ashes were later transferred into a 100 mL beaker. About 50 mL of concentrated trioxonitrate (v) acid (HNO_3) was added to the sample ash in the beaker. The beaker was covered with a water glass and allowed to digest for 2 h to prevent foaming then cooled (Pearson, 1976). About 10 mL of hydrochloric acid was added to the sample ash and boiled for 4 h on a hot plate at 80°C. The samples were refluxed with 40 mL of distilled water and filtered using Whatman no 4 filter paper and a glass funnel. The sample filtrate was brought up to 100 mL with distilled water in a 100 mL volumetric flask.

RESULTS AND DISCUSSION

The proximate composition of the *O. rhinoceros* larva by percentage is shown in Table 1. From the proximate composition of the larva analysed, crude protein has the highest percentage (Fig. 1) followed by the carbohydrate, then the moisture while fat content was the least. The low value obtained for the moisture content revealed a short shelf life for the larva and the statistical investigation showed that there exist no significant different between the level of the minerals analyzed in the larva. A strong correlation was observed between the mineral elements investigated in the analyzed samples as shown in Table 3.

The crude protein content observed here for *Oryctes rhinoceros* larva is higher than those reported for cow milk, egg, termite, *Rhynchophorus phoenicis* and beef but lower than those of caterpillar and locust (Shils and Young, 1988; Ekpo and Onigbinde, 2005). The high percentage of protein as show in Fig. 1a is an indication that the rhinoceros beetle larva is very rich in protein and can supplement the daily need of the body, being 23-56 g day^{-1} (Aremu *et al.*, 2007; Chaney, 2006a, b). The high level of crude protein in the larva is relevant in the food value available for enzyme formation, antibodies and possibly some hormones (Singh, 2004; Ige *et al.*, 1984). Ash has been reported to be a measure of the mineral content in a sample (Alinnor and Akalezi, 2010). The ash content is also relatively high, when compared with reported values for meats, meat products, poultry and egg (Scott, 1980). It contained a moderate quantity of crude fibres which is lower than what was reported by Ogungbenle *et al.* (2009) for flour. Crude fibre has been reported to enhance nutritional performance as well as act as catalyst in digestion and absorption in the intestines (Ogungbenle *et al.*, 2009). Insects are known to be rich sources of various macro and trace elements. These elements are probably accumulated for future use in adult exoskeletal and connective tissue formation. Ash content of 12.92% was obtained which is a

Table 1: Proximate composition of *Oryctes rhinoceros* larva

Sample	Moisture (%)	Crude fat (%)	Ash (%)	Crude protein (%)	Crude fibre (%)	Total carbohydrate (%)
1	17.01	0.60	12.90	47.00	1.21	21.28
2	16.99	0.59	12.70	46.20	1.09	20.43
3	16.96	0.61	13.10	49.90	1.23	19.83
4	16.89	0.63	12.92	48.40	1.08	19.84
5	17.00	0.60	13.01	48.50	1.21	20.35
Mean	16.97	0.61	12.92	48.00	1.16	20.35
SD	±0.04	±0.05	±0.02	±0.05	±0.05	±0.08

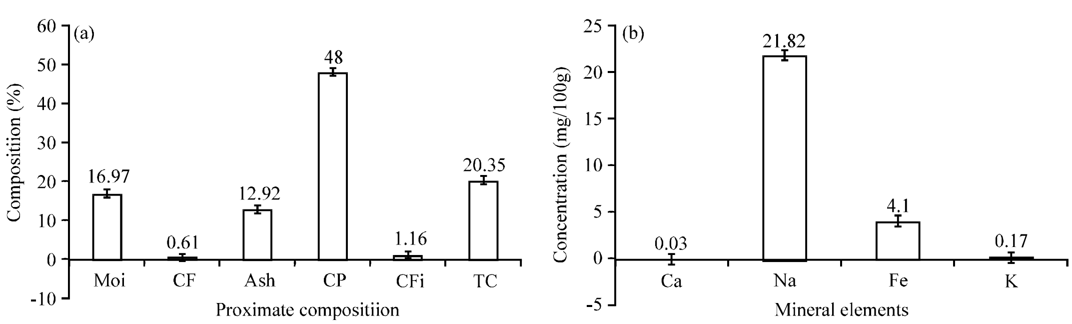

Fig. 1(a-b): Graphical representation of (a) proximate and (b) mineral composition of *Oryctes rhinoceros* larva, Moi: Moisture content, CF: Crude fat, CP: Crude protein, CFi: Crude fibres and TC: Total carbohydrates

Table 2: Mineral profile of *Oryctes rhinoceros* larva

Sample	Calcium (mg/100 g)	Sodium (mg/100 g)	Iron (mg/100 g)	Potassium (mg/100 g)
1	0.04	22.10	4.08	0.12
2	0.03	20.80	4.03	0.19
3	0.03	22.30	4.19	0.16
4	0.03	22.10	4.14	0.18
5	0.03	21.80	4.08	0.18
Mean	0.03	21.82	4.10	0.17
SD	±0.06	±0.60	±0.07	±0.03

Table 3: Correlations of variation between the mineral element in the *Oryctes rhinoceros* larva sample

		Correlations			
		Ca	Na	K	Fe
Ca	Pearson's correlation	1	0.409	769.000	-0.175
	Sig. (2-tailed)		0.495	0.128	0.779
	N		5.000	5.000	5.000
Na	Pearson's correlation		1.000	-0.575	0.815
	Sig. (2-tailed)			0.310	0.093
	N			5.000	5.000
K	Pearson's correlation			1.000	-0.227
	Sig. (2-tailed)				0.713
	N				5.000
Fe	Pearson's correlation				1.000
	Sig. (2-tailed)				

measure of the mineral elements present in samples acting as a pointer that the larva should contain more mineral elements (Alinnor and Akalezi, 2010; Scott, 1980). The obtained moisture content is higher than that reported for caterpillar but lower than those for termite, cow milk, egg and *Rhynchophorus phoenicis* (Chaney, 2006b). This high moisture content is an indication that *O. rhinoceros* has *a* short shelf life. Moisture content of food is usually used as a measure of the stability and susceptibility to microbial contamination as well as an index to water activity of the food (Ayo *et al*., 2010). Therefore, dehydration would generally improve the shelf life/preservation of the larva and, in addition increase the relative concentrations of the other food components (Singh, 2004). The carbohydrate content is moderately high but higher than those reported for *Rhynchophorus phoenicis*, caterpillar, termite, cow milk and egg. However, fibre and fat content obtained were found to be lower than that reported for some insects such as termites (Ekpo and Onigbinde, 2005).

The sample of the *Oryctes rhinoceros* were analysed for some mineral element utilizing atomic emission spectroscopy and a higher value of 21.82 mg g^{-1} was recorded for sodium as shown in Fig. 1b and Table 2 compared to other mineral elements present in the sample. The order of concentration values of this mineral element is Na>Fe>Ca>K. All these minerals are essential minerals required by the body for its proper functioning. The value obtained for sodium fall within the required daily allowance for food. However, sodium exhibit various function that are essential to body immune system sodium is an element that is vital to human life when in combination with potassium and chlorine and form a very important part of blood plasma. Sodium also allows our bodies to maintain the right blood chemistry and the correct amount of water in our blood and as well allow our muscles to contract normally. In the absence of sodium, our cells could not get the nutrients they need to survive. Sodium aid proper digestion of food consumed into he body system. Normal functioning of our nervous system also depends on this important element. The loss of sodium via sweat can result in dehydration, weakness and mental confusion. Many athletes drink sports drinks that contain a lot of sodium, like Gatorade, to prevent this from happening (NRC, 1989). Other mineral element such as Fe, Ca and K also exhibit various functions in the body system (Nelson, 1987).

The average value obtained for iron in the analysed sample is 4.10 mg g^{-1} which is higher than earlier report by Ayejuyo *et al.* (2001) but is within the recommended daily allowance hence can argument the daily requirement for iron. Iron exhibit many functions in the body and is used by the body to make tendons and ligaments. It is also important for maintaining a healthy immune system and aid digestion of certain things in the food that we consume. Iron obtained from our diet is an essential part of haemoglobin enabling the transport of oxygen thereby enabling efficient functioning of blood in our body system. When there is iron deficiency it results in tiredness, decreased alertness and attention span as well as prevents the muscles from functioning properly. If the lack of iron in the bodies is severe, "iron deficiency anaemia" may result, which essentially means that the blood will carry insufficient oxygen to the body. Iron deficiency anaemia is probably the most common nutritional disease in the world, affecting at least five hundred million people (NRC, 1989).

It can be said that the rhinoceros beetle is rich in minerals especially in sodium and can supplement the body needs of sodium and that of Iron. It is rich in Iron which is a component of haemoglobin, myoglobin, cytochrome, non-heme proteins, myeloperoxidase (Chaney, 2006b) etc. The iron content of the larva can supplement the daily requirements for iron and manganese, respectively. The low level of calcium and potassium obtained in this work however indicates that it will be insufficient for growing children, older women and individuals prone to osteoporosis. Calcium is one of the most abundant elements in our bodies and accounts for 2 to 3 pounds of our total body weight. It is very important in building and maintaining strong bones and teeth as well as for many other things. It helps control things like muscle growth and the electrical impulses in your brain and is also necessary in maintaining proper blood pressure and is responsible for clotting of blood. Calcium also enables other molecules to digest food and make energy for the body as a result increase in calcium intake in our diet is believed to lower high blood pressure and prevent heart disease and also used in treatment of arthritis (NRC, 1989).

Furthermore, the average concentration of potassium in the analysed sample was found to be 0.18 mg g^{-1} which is lower than earlier report (Ayejuyo *et al.*, 2001). Potassium is an extremely important element in the human body and as been reported as an important mineral that help in maintaining electrolyte balance in human (Appiah *et al.*, 2011). Our bodies are made up of millions of tiny cells, such as brain cells, skin cells, liver cells etc. These cells make up the different organs in our bodies, such as the brain, skin, or liver. Potassium is very essential to cells and without it, we could not survive. Cells are the small building blocks of the human body. Cells have many ways by which they can control what (and how much) enters and leaves. When a nerve cell does this, it actually pumps out chemicals, which give the message to the next nerve cell and eventually to the brain. Potassium helps control the release of those chemicals and without potassium, the nerve cell couldn't send those messages to your brain. But it is not just nerve cells that depend on potassium but most, if not all, of our cells depend on it. It is also important to know that in the plant kingdom, potassium is one of the 3 main elements that make plant life possible. The obtained value is lower than the acceptable range recommended by WHO for food products which revealed that *Oryctes rhinoceros* will be insufficient for growing older women, children as well as person prone to osteoporosis and colon cancer (Nelson, 1987).

Conversely, statistical analysis (Table 3) using Pearson correlation coefficient analysis at 95% level of confidence showed a strong correlation between Ca and Fe, Na and Fe in the *Oryctes rhinoceros* larva sampled with r value of 0.769 and 0.851, respectively. This shows that there is a common source of these mineral elements in the studied *O. rhinoceros* larva.

CONCLUSION

It can be concluded from the result that the larva could form a base for new food/feed products of considerable nutritive value, especially in view of its high protein content hence the consumption of *O. rhinoceros* as food should be encouraged as a supplement for protein.

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