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Nutrient Composition, Mineral Analysis and Anti-nutrient Factors of *Oryctes rhinoceros* L. (Scarabaeidae: Coleoptera) and Winged Termites, *Marcrotermes nigeriensis* Sjostedt. (Termitidae: Isoptera)

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Original Research Article

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ABSTRACT

Introduction: The palm beetles, *Oryctes rhinoceros* L. (Scarabaeidae: Coleoptera) and Termites, *Macrotermes nigeriensis* Sjostedt, (Termitidae: Isoptera) are prominent edible insects in Nigeria.
Aim: Nutrient analyses were carried out on the winged reproductive termites, *M. nigeriensis* and the larvae of palm beetles, *O. rhinoceros* to determine the nutrient composition, mineral composition and the antinutrient / secondary metabolites composition of the two insects.
Methods: The insects were collected from the campus of Ekiti State University Ado-Ekiti, and taken to the laboratory where they were oven-dried at 60º for 4 h. The proximate, mineral and antinutrient/secondary metabolites compositions were determined using official methods of analyses of AOAC (Association of Official Analytical Chemists) and atomic absorption spectrophotometric respectively.
Results: Results show that *M. nigeriensis* and *O. rhinoceros* are full of nutrients and minerals that are vital to health. *M. nigeriensis* contained 4.52% moisture content while *O. rhinoceros* had 5.42%.

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Ash content was 3.24% in *M. nigeriensis* while *O. rhinoceros* had 11.83%. The protein, fat, fibre and carbohydrate contents of *M. nigeriensis* are 37.54%, 48.03%, 5% and 2.06% respectively. In *O. rhinoceros,* the protein, fat, fibre and carbohydrate contents are 52%, 10.84%, 17.94% and 1.97% respectively. All the important mineral salts were present in both insects. Iron (Fe) was present at levels that commensurate with the daily recommended allowance (8.57 mg/00 g – 10.59 m/100 g) in *O. rhinoceros* and *M. nigeriensis* respectively. Phosphorus was highest in *M. nigeriensis* with a value of 103.47 mg/100 g. This mineral was followed in value by potassium (27.57 mg/100 g and the least was copper (0.01 mg/100 g). Lead (Pb) was not detected in any of the insects. In *O. rhinoceros,* phosphorus (75.57 mg/100 g) was highest, followed by potassium (25.44 mg/100 g) and the least was copper (0.01 mg/100 g). The levels of antinutrient/secondary metabolites are so insignificant to cause any problem.

Conclusion: *M. nigeriensis* and *O. rhinoceros* are nutrient-rich insects that can supply adequate quantities of the various classes of food to animals. The insects are also rich in minerals which are important for the normal development of the body. The levels at which antinutrient / secondary metabolites occur is not a threat to animals that feed on these two insects.

Keywords: Oryctes rhinoceros; Macrotermes nigeriensis; fibre; flavonoids; pulverize.

1. INTRODUCTION

The Class Insecta, being the largest in animal kingdom has so many Orders which include the Isoptera, Coleoptera, Hemiptera, hymenoptera Orthoptera, and Lepidoptera, just to mention a few. Some of these orders serve as food to man and other animals. Insect consumption is an age-long practice that has been with so many cultures and tribes world-wide [1]. There are strong representations of Coleoptera, Hymenoptera, Orthoptera and Lepidoptera in the diets of humans and other primates [2]. Some of these insects are available at certain seasons of the year. However, the most extreme form of manipulating the environment to increase the availability of insects is done through the farming of domesticated species [2]. Bees and silkworms, the most fully domesticated insects, are farmed principally for their products. However, these insects and so many other insects are edible [3, 4,5,6,7]. Interestingly, other species of insects are being domesticated in several countries. Some of these species, including water beetles (*Hydrophilus* sp. Muller (Hydrophilidae: Coleoptera) and *Cybister* sp. Curtis (Dytiscidae: Coleoptera) in China and crickets (*Gryllus bimaculatus* L. (Gryllidae: Orthoptera)and *Acheta domesticus* L. (Gryllidae: Orthoptera) in Thailand [8].

Oryctes rhinoceros, though a key pest of all palms, is also one of the most popular edible insects in Nigeria. The insect is common in coastal areas where palm trees are found. The insect is cosmopolitan and their most favoured breeding sites include standing or fallen palms that may have died due to old age or water logging. Termites are also consumed in all the regions of Nigeria. The insect though, seasonal is cherished by both the young and the old. Termites are notable pests of wooden materials [9]. Winged termites *M. nigeriensis* and the larvae of *O. rhinoceros* were analyzed to determine their nutrient compositions, mineral qualities and their anti-nutrient compositions with a bid to recommend them as food supplements for those who cannot afford beef and fish products.

2. MATERIALS AND METHODS

2.1 Collection and Preparation of *O. rhinoceros* Larvae and Winged Termites, *M. nigeriensis*

The winged termites, *M. nigeriensis* and the larvae of *O. rhinoceros* used for this work were obtained from the campus of Ekiti State University, Ado-Ekiti, Ekiti State of Nigeria. Ado-Ekiti is a town which is situated in the tropical humid region of Nigeria. The town lies on latitude 7º 38’ 0’ North of the Equator and longitude 5º 13’ 0’ East of Greenwich Meridian and 456 meters above the sea level. The larvae were handpicked from a fallen oil palm tree, into a plastic container which was used to convey them to the laboratory. The winged termites were taken from a termitarium in the campus. They were allowed to stay for 3 h in the laboratory. Both the larvae of *O. rhinoceros* and the winged termites were asphyxiated in a refrigerator for 4 h and later oven-dried at 60ºC for 4 h. They were pulverized separately with a blender and kept in air-tight bottles and put in refrigerator until needed for analyses.

2.2 Analyses of the Nutrient and Mineral Compositions of *O. rhinoceros* and Winged Termites, *M. nigeriensis*

Protein content was determined by micro-kjeldahl method [10]. Saura-Calixto et al. [11] method was employed in the determination of the crude fibre content. Carbohydrate was determined by difference, through subtracting the total of all other food components from 100. Protein solubility was determined by Biuret method, using Standard Bovine Serum (BSA). The moisture, ash, fat and mineral contents were determined by employing the method explained by [11]. Sodium and potassium were determined by flame photometric method (FP640 model) while phosphorus was determined by the phosphovanado-molybdate reagent method reported by [11] using Spectronic 20 colorimeter. Other minerals such as magnesium, iron, calcium, zinc, manganese, lead and copper were determined with atomic absorption spectrophotometer (Buck 210 model).

2.3 Analyses of Anti-nutrient / Secondary Metabolites Composition of *O. rhinoceros* and Winged Termites, *M. nigeriensis*

Tannin was determined by the method reported by Makkar and Goodchild [12]. Young and Greaves [13] method was employed in phytin determination. Oxalate was determined by the method reported by Day and Underwood [14]. Alkaloid was determined by the method reported by Harbone [15] while Bohm and Kocipal-Abyazan [16] method was adopted in flavonoid determination. The saponin content was determined by adopting the method reported by Obadoni and Ochuko [17].

2.4 Data Analysis

The data collected were subjected to analysis of variance (ANOVA) and where significant differences existed, treatment means were compared at $p \leq 0.05$ significant level using Tukey Test.

3. RESULTS

Table 1 below shows the result of the nutrient composition of *M. nigeriensis* and *O. rhinoceros*. The moisture content of *M. nigeriensis* was 4.52% while that of *O. rhinoceros* was 5.42%. Fat content was highest in *M. nigeriensis* while it was 10.84% in *O. rhinoceros.* The protein contents of *M. nigeriensis* and *O. rhinoceros* were 37.54% and 52.00% respectively. Ash content was higher in *O. rhinoceros* (11.83%) than in *M. nigeriensis* (3.24%). Carbohydrate was the least class of food in both insects. *M. nigeriensis* had 2.06% while *O. rhinoceros* had 1.97% carbohydrate respectively.

Table 1. Nutrient composition of *M. nigeriensis* and *O. rhinoceros*

Parameters (%)	*M. nigeriensis*	*O. rhinoceros*
Moisture content	4.52±0.21	5.42±0.11
Ash content	3.24±0.10	11.83±0.14
Protein content	37.54±0.31	52.00±1.00
Fat content	48.03±0.50	10.84±0.31
Fibre content	5.00±0.02	17.94±0.20
Carbohydrate content	2.06±0.01	1.97±0.01

Each value is a mean±Standard deviation of quadruplicates

The results of the mineral salts composition of *M. nigeriensis* and *O. rhinoceros* are shown in Table 2. Phosphorus was the highest mineral salts in both insects. *M. nigeriensis* had 103.47 mg/100 g of phosphorus while *O. rhinoceros* had 75.57 mg/100 g. High content of iron (Fe) was obtained in *M. nigeriensis* (10.59 mg/100 g) and *O. rhinoceros* (8.57 mg/100 g). The sodium content of *M. nigeriensis* was 15.69 mg/100 g while that of *O. rhinoceros* was 21.37 mg/100 g. The calcium content of *M. nigeriensis* was 23.67 mg/100 g and that of *O. rhinoceros* was 12.54 mg/100 g. The quantities of zinc, magnesium, potassium, manganese and copper in *M. nigeriensis* were 15.50 mg/100 g, 12.50 mg/100 g, 27.57 mg/100 g, 1.26 mg/100 g and 0.01 mg/100 g respectively. However, in *O. rhinoceros,* the quantities of zinc, magnesium, potassium, manganese and copper were 10.10 mg/100 g, 10.13 mg/100 g, 25.44 mg/100 g, 0.39 mg/100 g and 0.01 mg/100 g respectively. Lead (Pb) was not detected in any of the insects.

The result for the anti-nutritional contents is shown in Table 3. Phytate was the highest antinutrient in *M. nigeriensis* (15.21 mg/100 g) and *O. rhinoceros* (16.10 mg/100g). Phytin-phosphorus was 4.29 mg/g in *M. nigeriensis* while *O. rhinoceros* had 4.53 mg/g. Tannin and oxalate contents of *M. nigeriensis* are 0.59 mg/100 g and 1.03 mg/g respectively while in *O. rhinoceros* the tannin and oxalate contents were 0.64 mg/100 g and 1.09 mg/g respectively. In *M. nigeriensis,* the saponin, alkaloids and flavonoid contents were 1.47 g/100 g, 0.32 g/100 g and

0.19 g/100 g respectively. In *O. rhinoceros,* the saponin, alkaloids and flavonoid contents were 1.34 g/100 g, 0.19 g/100 g and 0.24 g/100 g respectively.

Table 2. Mineral composition of *M. nigeriensis* and *O. rhinoceros*

Minerals (mg/100 g)	*M. nigeriensis*	*O. rhinoceros*
Na	15.69±0.31	21.37±0.22
K	27.57±0.25	25.44±0.31
Ca	23.67±0.03	12.54±0.34
Mg	12.50±0.14	10.13±0.11
P	103.47±1.52	75.57±0.53
Zn	15.50±0.14	10.10±0.11
Fe	10.59±0.04	8.57±0.03
Mn	1.26±0.01	0.39±0.10
Cu	0.01±0.01	0.01±0.01
Pb	ND	ND

Each value is a mean ± Standard deviation of quadruplicates, ND = not detected

Table 3. Antinutrient composition of *M. nigeriensis* and *O. rhinoceros*

Parameters	*M. nigeriensis*	*O. rhinoceros*
Tannin (mg/100 g)	0.59±0.03	0.64±0.03
Phytate (mg/100 g)	15.21±0.30	16.10±0.21
Phytin phosphorus (mg/g)	4.29±0.02	4.53 ±0.02
Oxalate (mg/g)	1.03±0.01	1.09±0.01
Saponin (g/100 g)	1.47±0.01	1.34±0.01
Alkaloids (g/100 g)	0.32±0.02	0.19 ±0.01
Flavonoid (g/100 g)	0.19±0.01	0.24±0.01

Each value is a mean ± Standard deviation of quadruplicates

4. DISCUSSION

The results obtained from the nutrient analyses of the two insects used in this study showed that they are good sources of food nutrients and minerals. The protein contents obtained in *M. nigeriensis* (37.54%) and *O. rhinoceros* (52%) were high. These results showed that the two insects are rich in protein. The protein content obtained in *M. nigeriensis* was higher than the value (20.94%) earlier reported in the insect [18] and also higher than the value (36.7 g/100 g) reported in *Macrotermes bellicosus* Smeathman (Termitidae: Isoptera) [19]. The protein content reported by Paul and Dey [20] for the sexual form (87.33%) and worker form (81.66%) of subterranean termites, *Reticulitermes* sp. Holmgren (Rhinotermitidae: Isoptera) are higher than the values obtained in *M. nigeriensis*. The protein content of *O. rhinoceros* was higher than the protein range of 42.29%-51.13% and 42.30% reported in the same insect [21,22]. Higher protein contents have been reported in boiled (66.24%) and fried (67.75%) tree locust, *Anacridium melonorhodon* Walker (Acrididae: Orthoptera) [23]. Insects contain so much nutrients that are useful to animals. Raubenheimer and Rothman [2] reported that the insects consumed by humans are generally nutrient dense while those consumed by non human primates have high protein-to-fat ratios. Bukkens [24] reported that edible insects are high-quality foods, excellent sources of proteins, fat, and micronutrients. He reported further that their amino acid compositions that are generally balanced for humans. Rumpold and Schluter [7] reported that edible insects provide energy, proteins and the amino acids requirements of humans. Insects are rich in several micronutrients such as copper, iron, magnesium, manganese, phosphorus, selenium and zinc as well as riboflavin, pantothenic acid, biotin and folic acid [7]. Termites are rich in proteins and because of this fact; they are able to supply most of the essential amino acids to animals. Sogbesan and Ugwumba [25] reported that termite meals can supply the essential amino acids requirements of fish, *Heterobranchus longifilis* (Valencienes 1840). Protein helps to form the structural components of the body cells, tissues and it is needed within many biological processes such as the formation of enzymes, hormones, blood and antibodies which fight infections as well as building blocks of DNA [26, 27,28]. Incorporating *M. nigeriensis* in the diets of pregnant women and children will supply appreciable quantity of the daily allowance of protein recommended [29,30].

Fat content of *M. nigeriensis* (48.03%) was higher than the value (34.23%) reported in the same insect [18]. The fat content of *O. rhinoceros* (10.84%) was lower than the value (17.30%) earlier reported in the same insect [22]. The fat contents obtained in both insects are higher than the value reported in *Cirina forda* Westwood (Saturniidae: Lepidoptera) [4]. The quantity of fat reported in *Macrotermes subhyalinus* Smeathman (Termitidae: Isoptera) by [25] is also lower (10.6%-22.2%) than that of *M. nigeriensis.* Fat is a major source of fuel in the body and it is important in the cell structures as well as in supplying some oil-soluble vitamins such as vitamins A, D, E, K and betacarotene (antioxidants) to animals. Omotoso [4] reported that lipids are vital in the structural and biological functioning of cells and that they help in the transport of nutritionally essential fat-soluble vitamins.

The ash contents of *M. nigeriensis* (3.24%) was 2 times lower than the value (7.60%) earlier reported in the same insect [18] but higher than the value of 1.2 g reported in *M. bellicosus* [19]. The ash content of *O. rhinoceros* (11.83%) compares favourably with the values (12.70%) and (12.70%-15.35%) earlier reported in the same insect [21,22]. Both *M. nigeriensis* and *O. rhinoceros* are rich in minerals, since ash content is an indication of how rich a food substance is in mineral salts. Ash content which ranged from 2% in queen ants to 12% in june beetles, *Phyllophaga* sp. Harris (Scarabaeidae: Coleoptera) have been reported [31]. Apart from being a measure of the total amount of minerals present in a food substance, ash is the inorganic residue that remains after water and organic matters have been removed by intense heating. The moisture content of both insects are low, indicating that they can be stored for a long time without spoilage since the presence of more water in any food item quickens food spoilage as a result of microbial action. Higher moisture content has been reported in *M. nigeriensis* [18].

The fiber content of 5% obtained in *M. nigeriensis* compares favourably with the value (5.71%) earlier reported in the same insect [8]. Moreover, Ajakaye and Bawo [32] reported the value of 5% fiber in *Trinervitermes germinatus* Wasmann (Termitidae: Isoptera). The fiber content of*O. rhinoceros* (17.94%) is higher than the value reported in the chinese black ant, *Polyrhachis vicina* Roger (Formicidae: Hymenoptera) (13.2%) [33]. The fiber contents of each of the four insects studied by Finke [34] are higher than the values obtained in *M. nigeriensis* and *O. rhinoceros.* Fiber is important for the easy movement of the bowels. There are two types of fibers namely, soluble and insoluble fibers. Fibers add bulk to stools and move them through the alimentary canal swiftly, reducing the contact time with potential toxins in the colon. If *O. rhinoceros* is included in the diets, it may greatly assuage constipation, which is one of the problems facing pregnant women. Fiber keeps and improves the digestive system, helps to prevent heart diseases, weight gains and some cancers [35,36].

Carbohydrate content is lower in *M. nigeriensis* (2.06%). Carbohydrate content of 0.2 g-0.3 g/100 g has been reported in *M. bellicosus* (0.2-0.3 g/100 g) [19]. The carbohydrate content obtained in *O. rhinoceros* was 1.97%. Higher values have been reported in soldier flies larvae (8 g/kg) and 7%-20% in some terrestrial insects [34,37]. The powder of the insects under study may be incorporated into carbohydrate diets to improve its nutritive values. Carbohydrate is the main source of energy to living organisms.

The result of the mineral analyses revealed that each of the insects is rich in all the important mineral salts. Phosphorus was highest in *M. nigeriensis* with a value of 103.47 mg/100 g. In *O. rhinoceros,* the phosphorus content was75.57 mg/100 g. Phosphorus contents were much higher than calcium levels in the two insects. Similar findings have been reported in other insects [38,39,40]. The mineral salt contents of the four insects studied by Finke [34] were consistently higher than the values obtained in *O. rhinoceros* and *M. nigeriensis*. *O. rhinoceros* had more sodium, potassium, calcium, magnesium, iron, phosphorus and manganese than the values earlier reported by [21]. *M. nigeriensis* also had more calcium, magnesium, iron, zinc and manganese than the values reported in *Reticulitermes* sp. [20]. Lead (Pb) was not detected in any of the two insects. The levels of iron, zinc, copper, and manganese were variable but these values were not similar to those reported for feeder insects [38]. Calcium is a major constituent of bone and it plays essential roles in vital functions such as nerve conduction, muscle contraction, blood clotting, and membrane permeability [29]. Higher intake of milk and other calcium-rich foods have been reported to cause reduction in osteoporotic fractures [41].

Phosphorus is an essential component of the bone mineral and it also plays an important role in many chemical reactions in the body. It is present in soft tissues as soluble phosphate ion; in lipids, proteins, carbohydrates, and nucleic acid in an ester or anhydride linkage. It is present in enzymes as a modulator of their activities [29]. Energy for metabolic processes are derived largely from the phosphate bonds of adenosine triphosphate (ATP), creatine phosphate, and similar compounds [29]. Addition of these insects into the diets of growing children will contribute to their bone formation and development. Magnesium is another important mineral which modulates numerous biochemical and physiological processes in the body. As the complex Mg-ATP2, magnesium is essential for all biosynthetic processes, glycolysis, formation of cyclic-AMP, energy-dependent membrane transport, and transmission of the genetic code (42). Iron content of 10.59% obtained in *M. nigeriensis* was higher than the value (9.56%) earlier reported in the same insect [18]. Iron is a constituent of hemoglobin, myoglobin, enzymes and it is an essential nutrient for humans [43].

Zinc is a component of various enzymes that help maintain structural integrity of proteins and regulate gene expression. Zinc metalloenzymes include ribonucleic acid polymerases, alcohol dehydrogenase, carbonic anhydrase and alkaline phosphatase [44]. The biological functions of zinc canbe catalytic, structural or regulatory. More than 85% of total body zinc are found in skeletal muscles and bones [44]. Copper is an essential nutrient for all vertebrates and some lower animal species [45]. Several abnormalities have been observed in copper-deficient animals, which include anemia, skeletal defects, and degeneration of the nervous system, defects in pigmentation and structure of hair or wool, reproductive failure, myocardial degeneration, and decreased arterial elasticity [45]. There are a number of important copper-containing proteins and enzymes, some of which are essential for the proper utilization of iron [45]. Manganese has been shown to be an essential element in every animal species studied. Signs of deficiency include poor reproductive performance, growth retardation, congenital malformations in the offspring, abnormal formation of bone and cartilage, and impaired glucose tolerance [46]. Sodium helps in the distribution of fluids in the tissues and it is very important in nervous coordination. Sodium is the principal cation of extracellular fluid and it is the primary regulator of extracellular fluid volume [47]. Both the body content of sodium and its concentration in the body fluids are under homeostatic control, and the volume of extracellular fluid is thus normally determined by its sodium content [47].

Anti-nutrients or secondary metabolites occurred in *M. nigeriensis* and *O. rhinoceros* at insignificant levels which cannot pose a threat to animals. Tannin contents in *M. nigeriensis* (0.59 mg/100 g) and *O. rhinoceros* (0.64 mg/100 g) are lower than the range reported in sorghum (0.13-7.2%) [48]. The range of tannin consumed in India has been put at 1.5-2.5 g/day while that of USA has been put at 1 g/day [49]. The daily intake of catechin and proanthocyanidin dimers and trimers has been estimated to be 18–50 mg/day, with the main sources being tea, chocolate, apples, pears, grapes and red wine [50]. Plant tannins are good antioxidants in medicinal plant, food and fruits [51]. Tannins have cardioprotective, anti inflammatory, anti carcinogenic, anti mutagenic, anti tumour, anti bacteria, antiviral and immune modulatory activity [51]. Tannins have also been described as anti hyperglycemicagents in diabetic rats [52, 53]. However, the secondary metabolites found in the two insects under this study must have been from (their food) plants since both insects depended on plants for their survival. Legumes and beans have been reported to have large quantities of condensed tannin [54,55]. Kumari and Jain [51] reported that most of the active compounds in black tea are tannins which are 90% catechins. Epigallocatechin gallate (EGCG) is a component of catechins and its activity as anti oxidant has been reported to be 25-100 times more potent than that of vitamins C and E [56]. Phytate was highest in *M. nigeriensis* and *O. rhinoceros.* The lowest metabolite in *O. rhinoceros* was alkaloids. The values of all the metabolites reported in *M. bellicosus* are lower than those obtained in the two insects under study [19].

Phytate is a naturally occurring compound in seeds and grains [57]. Phytic acid is the primary storage of phosphorus in seeds. It has antioxidant and, anti-cancer activity. It also reduces the cholesterol level and blood sugar level of animals. Phytate has been reported to have significantly resulted in the lowering of serum cholesterol and triglyceride levels [58]. Phytate has also been reported to cause significant reduction in mammary carcinoma [59, 60]. Flavonoid was lowest in *M. nigeriensis.* Flavonoids have anti-inflammatory, anti-allergic and anti-cancer activities in man. They are powerful anti-oxidants and the main sources of natural flavonoids are citrus fruits, berries, onions, parsley, legumes, green tea, and red wine [61,62]. More specifically, anthocyanins are found in wine and bilberry, flavans are found in apples and tea, flavanones are found in citrus, and isoflavones are found in soya products. Average intake in the U.S. is approximately 150-200 mg/day [62]. Flavonoids have become more important since discoveries that concluded flavonoids have healthy benefits to humans, specifically antiviral, anti-allergic, antiplatelet, anti-inflammatory, anti-tumor and antioxidant activities [62].

Saponins serve as means of protection in plants. They are antifeedants in plants and they protect plants. They stimulate the immune systems in animals and they also help in lowering the blood cholesterol levels. They reduce cancer risks in man as well as serving as powerful antioxidants. A high saponin diet can be used in the inhibition of dental caries and platelet aggregation in the treatment of hypercalciuria in humans and as antidote against acute lead poisoning [63]. The oxalate content of *M. nigeriensis* (1.03 mg/g) and *O. rhinoceros* (1.09 mg/g) are lower than the mean daily intake of oxalate in English diets (70-150 mg) [64]. These values are also lower than the values reported in snail, *Limicolaria aurora* Jay (Achatinidae) (381 mg total oxalate/100 g dry weight) and mollusk, dogwhelk, *Thais cattifera,* (1686 mg/100 g dry weight) [65,66] respectively. Sweet potato, *Ipomea batata* has been reported to contain 278-574 mg / 100 g fresh weight of oxalate [67]. Oxalate is highest in the leaves, followed by the seeds and lowest in the stems [68]. Oxalate restricted the availability of magnesium, iron, sodium, potassium and phosphorus [64]. Cooking has been reported to cause reduction in oxalate contents of food [64]. It has been reported that soaking significantly reduced the total phenols, flavonoids, tannins, vitamin E, β-carotene and antioxidant activity in raw sorghum [69].

5. CONCLUSION

Palm beetle, *O. rhinoceros* is a rich source of protein (being the highest food component in the insect), minerals, fibre and fat. *Marcrotermes nigeriensis*is rich in fat, protein, fibre and mineral salts. The levels of antinutrient / secondary metabolites in each of the insects are lower when compared with what other food sources contributed. The two insects are rich in antioxidants as well as fiber. Moreover, they can be used to substitute animal proteins such as beef and mutton. Inclusion of these two insects in the diets has tendencies for enriching the body with mineral salts as well as for increasing bowel movements.

COMPETING INTERESTS

The author hereby confirm that there is no conflicting or competing interest concerning this article, as it is solely sponsored and conducted by the author.

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