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Evaluation of nutritional and anti-nutritional values of *Oryctes rhinoceros* larvae in Ondo State, Nigeria

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Abstract
A large number of insect species are potential sources of valuable nutrients for humans and animals but inadequate information about their nutritional values makes them to be under-utilized by humans. This study was conducted to determine the nutritional and the anti-nutritional values of *Oryctes rhinoceros* larvae and samples were obtained from Ese-Odo Local Government Area of Ondo state. The proximate and the anti-nutrient compositions were analyzed. The high protein content obtained in this study makes it vital and essential as an alternative source of conventional protein-rich food especially for individuals suffering from malnutrition because of protein deficit. Phytate was revealed as a major anti-nutrient in this study but still fell below the lethal dose limit. Thus, it makes the larva consumable irrespective of the phytic acid toxicity. *Oryctes rhinoceros* larva can be supplemented in our diets to take care of the problem of malnutrition due to high cost of protein and other nutrient rich food particularly among the rural populations throughout the developing countries.

Keywords: Nutrients, anti-nutrients, malnutrition, *Oryctes rhinoceros*

Introduction
Insects are the biggest animal group on earth; the immense biodiversity harboured by the class insect is reflected in the well-known fact that this single class has more species than all the species of all other classes of animals combined. Indeed, they constitute as much as 80% of the animal kingdom (Premalatha, 2011) [27]. They have played an important part in the history of human nutrition in Africa, Australia, Asia and in America (Ifie and Emeruwa, 2011) [17]. Insects are of ecological importance in the forest ecosystem and their abundance and diversity are of great interest to entomologists. The role played by arthropods in the decomposition processes and continuous release of nutrient to the forest soil is of great importance (Adeduntan and Olusola, 2013) [3]. In developing countries and among various cultures scattered throughout the world, they remain a vital and preferred food and an essential source of protein, fat, minerals and vitamins (Durst and Shono, 2010) [20]. In West and Central Africa, they are included in the diet throughout the year or in seasons of occurrence (Banjo *et al.*, 2006) [7]. The global demand for food security and safety coupled with increased cases of poor feeding as a result of inadequate and high cost of protein diets, especially in Africa and other developing countries of the world have necessitated the consumption of insects as a food alternative that enriches the basic diet of man (Braide and Nwaoguikpe, 2011) [9]. It is disheartening to know that malnutrition is one of the huge problems facing the world today especially the developing nations. Due to inadequate diets, a third of the world's children fail to reach their physical and mental potential and many are made vulnerable to infectious diseases that account for half of their deaths (WHO, 1992) [32]. This has brought about the need of the populace to search for suitable and acceptable protein supplements of high biological value that could be used for supplementary and mixed feeding of infants and young children and as part of the adult diet. In fact, nutritionists represent the leading group of researchers in food insects, motivated by a desire to remedy the problems associated with protein-deficient diets (Johnson, 2010) [18, 20].
Oryctes rhinoceros larva is a rich source of good protein, energy, iron and relatively rich and safe oil; especially in view of the fact that insect oils have very low cholesterol contents. The oil is safe for consumption by individuals predisposed to dyslipidemia, diabetes mellitus and cardiovascular diseases (Okaraonye and Ikewuchi, 2009) [22].

As long as protein-energy malnutrition is widespread in the rural parts of Nigeria, the search for low cost, nutritious and easy to prepare locally available complementary food will continue (Solomon *et al*., 2008) [30]. Therefore, it becomes necessary to look for new source of animal protein (like *O. rhinoceros* larva), which are rich in nutrients (Mitsuhashi, 2010) [20]. However, the basic information on their proximate composition and anti-nutrients are not sufficient. Based on these reasons, this study was aimed at evaluating some of the nutritive constituents of *O. rhinoceros* in order to ascertain its impact to the populace that consume it.

Methods

Study area

The research was conducted in Ondo State which is located in the southwestern geopolitical zone of Nigeria and bounded in the North by Ekiti and Kogi states, in the East by Edo state, in the west by Osun and Ogun states and in the south by the Atlantic Ocean. Ondo state lies between longitude 7° 17' N and latitude 5° 10' E. The state is located entirely within the tropics. The tropical climate of the state is marked by two seasons: rainy season (April-October) and dry season (November-March). The annual rainfall varies from 2000 mm in the southern areas to 1150 mm in the northern areas. The annual temperature ranges between 21 ^{0}C to 29 ^{0}C and humidity is relatively high. The state enjoys luxurious vegetation with high forest zone (rain forest) in the south and sub-savannah forest in the northern fringe.

Method of data collection

Samples were collected and taken to laboratory for the necessary analyses. The analyses of the nutritional and the anti-nutritional values of the *O. rhinoceros* larvae was carried out in the Animal Production and Health Department laboratory, Federal University of Technology, Akure, Ondo state. The samples were divided into two parts “A” and “B”. Part “A” was used to determine the proximate composition, while part “B” was used to examine the Anti-nutrient composition.

The Samples were spread out on laboratory tray and dried in an oven at a controlled temperature of about 60-80 ^{0}C to avoid nutrient denaturing. The drying process took about two days when a constant weight was obtained. After drying, they were transferred to the desiccator to cool and then weighed. Thereafter, ground samples were used for proximate and anti-nutrient analyses.

Nutritional analyses

The samples were analyzed for proximate composition (moisture content, protein, carbohydrate, fibre, fat and ash) by the standard procedures of Association of Official Analytical Chemists (A.O.A.C, 1999). However, protein content was obtained by multiplying the nitrogen content by 6.25. Carbohydrate (Nitrogen free extracts) was determined by subtracting the sum of the weights of protein, fibre, fat and ash from the total dry matter.

Proximate analysis of the samples were carried out in three replicates, in order to determine the moisture, crude protein, ash, fibre, crude fat, ash and total carbohydrates.

Anti-nutrients determination

Phytate was determined according to the method of Wheeler and Ferrel (1971) [31]. Oxalate was determined by the method reported by Day and Underwood (1986) [12]. Bohm and Kocipal Abyazan (1994) [8] method was adopted in flavonoid determination. Alkaloid was determined by the method reported by Harbone (1973) [16]. However, extraction (using sonicator) method was used to determine the tannin content. It involves weighing 0.2 g of the finely ground sample into beakers of 20 ml capacity and adding 10 ml of 70% aqueous acetone to it. The beakers are placed in an ice bath and the samples are subjected to ultrasonic treatment for 3 minutes.

Method of data analysis

The proximate and the anti-nutrient compositions were analyzed using Mean and standard deviation of triplicate determinations.

Results

Result for the nutritional composition of Oryctes rhinoceros larva

Table 1 shows the result of the nutrient compositions of *O. rhinoceros* larva. The result showed that the moisture content of the *Oryctes rhinoceros* larva was 7.07%. The Fibre content of the larva was revealed to be 9.72%. Also, the larva contains 15.35% fat content. Protein content was the highest (55.77%). Ash content present in larva was 8.02% while Carbohydrate was the least class of food in the insect. *O. rhinoceros* larva had 4.08% carbohydrate content.

Table 1: Proximate nutritional composition of *Oryctes rhinoceros* larva

Components	Values (%)
Moisture Content	7.07 ± 0.08
Fibre	9.72 ± 1.13
Fat	15.35 ± 0.74
Protein	55.77 ± 0.86
Ash	8.02 ± 0.53
CHO	4.08 ± 0.41

Values are Means ± SD of triplicate determinations

Result for the anti-nutritional composition of Oryctes rhinoceros larva

The result for the anti-nutritional compositions is shown in Table 2 below. The oxalate content of the *O. rhinoceros* larva was 1.94 mg/g. Phytate content was the highest (28.43 mg/g). The Alkaloid and the flavonoid contents present in the larva were 4.04 mg/g and 5.40 mg/g respectively. Tannin was the least anti-nutritional composition of the insect. *O. rhinoceros* larva had 2.99 mg/g of tannin.

Table 2: Anti - nutritional composition of *Oryctes rhinoceros* larva

Components	Values (mg/g)
Oxalate	1.94 ± 0.05
Phytate	28.43 ± 0.41
Alkaloid	4.04 ± 0.32
Flavonoid	5.40 ± 0.35
Tannin	2.99 ± 0.12

Values are Means ± SD of triplicate determinations

Discussion

The moisture content (7.07%) was higher than the value of 5.42% reported by Omotosho (2015) [24] for the same *O. rhinoceros* larva. Moisture content of food is usually used as a measure of the stability and susceptibility to microbial contamination (Scott, 1980) [29]. The fibre content of the *O. rhinoceros* larva in this study was moderately high. This could be attributed with the physiological role of fibre in maintaining proper peristaltic movement of the intestinal tract (Oduor *et al*., 2008) [21]. The fibre content of 9.72% obtained in this study was higher than 5.00% reported for *Marcrotermes nigeriensis* but lower than 17.94% reported for *O. rhinoceros* (Omotosho, 2015) [24]. Fat are essential in the structural and biological functioning of cells and they help in the transport of nutritionally essential fat soluble vitamins (Omotoso, 2006) [23]. However, the fat content of 15.35% reported in this study was much lower compared to the 66.61% reported for *Rhynchophorus phoenicis* (Ekpo, 2011) [14]. Protein content (55.77%) was highest in this study.The implication of this high protein content is that the larval meal can contribute significantly to the daily protein requirement of humans which is about 23-56g (Chaney, 2006) [10]. It can help in combating protein deficiency and also in the development of the muscle, glands and tissues (Pyke,1979). The relatively high protein content can be compared with the protein value of 50.79% of the same insect in a study carried out by Okaraonye and Ikewuchi (2009) [22]. The high dry weight observed is an indication that this insect can be of value in man and animal diet, particularly in developing countries where the cost of convectional protein sources are expensive. Also, the protein content reported in this study is higher than the value of 72.93 gkg^{-1} reported for Ant by Adeduntan (2005) [2]. The Ash content (8.02%) recorded herein was lower compared to 11.83% recorded in a previous research using the same insect larva (Omotosho, 2015) [24]. The carbohydrate content of 4.08% was much lower than 20.10% and 20.23% reported for *Heteroligus meles* (yam beetle) and *R. phoenicis* respectively (Adesina, 2012) [4]. Carbohydrates are most valuable among other food components and the daily adult intake should be 500 g per day (FAO, 1992) [15]. However, the low carbohydrate content reported in this study suggests that the larva is not an energy giving food.

The presence of toxic substance otherwise known as anti-nutritional factors is one of the major drawbacks limiting the direct use of some food (Agbede and Aletor, 2005) [5]. The oxalate content of 1.94 mg/g obtained from this work suggested that, it could be safe for consumption as far as its oxalate content fell below the lethal dose limit. The lethal dose of oxalates is between 200 and 500 mg/100g (Pearson, 1973) [26]. The high phytate content of 28.43 mg/g recorded in this study was lower than the 3159.02 mg/100g reported for cricket by Adeduntan (2005) [2]. Also, the value of 4.04 mg/g recorded for Alkaloid was higher than the 0.32 mg/100g reported for *M. nigeriensis* and 0.19 mg/100g reported for *O. rhinoceros* in a previous study (Omotoso, 2015) [24]. Pal and Verma (2013) [25] reported that flavonoid has healthy benefits to humans, specifically antiviral, anti-allergic, anti-platelet, anti-inflammatory and anti-tumor activities. The flavonoid content of 5.40 mg/g obtained in this study makes the larva consumable to satisfy these benefits. The tannin content of 2.99 mg/g recorded in this study is lower than that of meal bug (1150 mg/100g) examined in a study by Adeduntan (2005) [2]. Tannin usually form insoluble complexes with protein, thereby interfering with their bioavailability. This affects its binding ability with proteins of saliva and mucosal membranes (Mechansho *et al*., 1987) [19]. Aletor (1993) [6] reported that high level of tannins (76-90 gkg $^{-1}$Dm) could be detrimental if consumed.

Conclusion

The results obtained from this study shows that *Oryctes rhinoceros* larva is a good source of protein and other nutrient supplements. Also, the result for the anti-nutrients compositions show that the larva is safe for consumption and has no any negative effect on man and his animals. An increase in world-wide of the mass of this larva through cultivation with modern techniques would decrease the pressure exerted on the convectional sources of proteins. Since malnutrition in developing countries has been as a result of nutrient deficiency especially proteins and minerals which may be due to high cost of foods rich in these nutrients, the larva can be supplemented in our diets to take care of this problem.

Conflict of interest statement: None declared.

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