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Protein Quality of Edible Larvae of Beetles (*Orycte spp.*) from Palms and Compost in Niger Delta, Nigeria

Thomas CN[1]
Kiin-Kabari DB[2*]

[1]Department of Biological Sciences, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria
[2]Department of Food Science and Technology, Faculty of Agriculture, Rivers State University, Port Harcourt, Nigeria

Abstract

Nutritional value of Palm Beetle Larvae (PBL) (*Oryctes monoceros*) and Compost Beetle Larvae (CBL) (*Oryctes boas*) was investigated. The proximate composition revealed that *O. boas* larvae were higher than *O. monoceros* in crude protein (7.74±0.03%:6.57±0.07%), ash (9.52±0.25%:1.07±0.02%) and carbohydrate (5.79±0.47%:4.90±0.05%). *O. monoceros* was higher than *O. boas* in fat content (2.36±0.00%:1.90±0.00%) and moisture (82.74±1.02%: 73.78±0.56%), respectively. *O. boas* provided average total energy of 123.60 kcal/100 g, which was higher than 70.96 kcal/100 gm of *O. monoceros.* Amino acid profiles of the two larvae showed similarity in the composition and distribution of a total number of eighteen (18) amino acids in each species. The larvae of *O. boas* had higher protein quality than *O. monoceros* as it possessed higher concentrations of sixteen (16) amino acids, which included eight (8) essential amino acids (leucine, valine, lysine, threonine, phenylalanine, isoleucine, methionine and tryptophan) and eight non-essential amino acids which included histidine, arginine, tyrosine, cysteine, aspartic acid, alanine, glycine and serine. The larvae of *O. monoceros* had higher concentrations of only two non-essential acids (glutamic acid and proline) than *O. boas.* The presence of the eight essential amino acids plus methionine, cysteine and histidine which are "limiting factors" in many food stuffs have made those edible larvae valuable natural resources for infant food formulation and feed for livestock production. Hence, production of protein isolates and its utilization in complimentary foods should be investigated.

Keywords: Protein quality, Amino acids, Composition, Edible larvae, *Oryctes monoceros*, *Orycte boas*.

Introduction

In most African countries, edible insects provide about 5-10 percent of the protein intake of the population [1]. Nevertheless, because of their nutritional value, they are still considered as very significant food resource for human populations. Rumpold and Schluter [2] compiled nutritional composition of 236 edible insects on dry matter bases and discovered that many edible insects provide satisfactory amounts of energy and protein, thereby meet-up the amino acid requirements for humans and are high in monounsaturated and/or polyunsaturated fatty acids; as well are rich in micronutrients (copper, iron, zinc, magnesium, phosphorus, manganese and selenium) plus riboflavin, pantothenic acid, biotic acid and folic acid in some cases. In many developing countries and among various cultures throughout the world, insects remain a vital and preferred food as an essential source of proteins, fats, minerals and vitamins [3]. Some edible insects have nutrient values that can

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***Corresponding author:** Kiin-Kabari DB, Department of Food Science and Technology, Faculty of Agriculture, Rivers State University, Port Harcourt, Nigeria. Tel: +2348037757473; Email: kabaridavid(at)yahoo.com

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be compared with that of meat and fish while others have higher proportions of protein, fat and energy value [4]. In West and Central Africa, insects are not used as emergency food against starvation but are included as a normal part of the diet throughout the year or in seasons of occurrence [5].

Considering the popularity of edible insects, it is not surprising that scores of species have been prominent items of commerce in town and village markets of Africa, tropical and semi-tropical regions of the world [6]. In several areas of Zimbabwe, South Africa and Nigeria, many families make fairly good living from selling insects as reported by many researchers [7-10]. Nigeria also has its own share of edible insects and caterpillars, most of which are gathered from bushes and farmlands by women and children, processed and eaten or sold in school premises and open markets. Nowadays, insects are consumed like a daily supplement, an occasional dish or a substitute product during food shortage. A study in 1961 estimated that insects represent 10% of the origin of animal proteins [11]. This proportion varies accordingly in different regions [12,13]. A 10% increase worldwide of protein mass through entomophagy would eliminate the problem of malnutrition and decrease the pressure exerted on other sources of protein [14]. In Nigeria, studies have shown that entomophagy contributed significantly to a reduction of protein deficiency [15,16,8]. Scientific knowledge has demonstrated that the biological and nutritional value of a food protein is dependent on its amino acid composition update. Therefore, it is important to understand the quantitative and qualitative requirements of humans for amino acids in relation to some commonly consumed insects in order to ascertain what extent of essential amino acids are supplied to the human body and their relative contribution to health of those who are utilizing these insects as food [17]. The objective of the study was to determine the amino acid profiles and the quality of protein of two edible insects-Palm Beetle Larvae (*O. monoceros*) and Compost Beetle (*O. boas*) which are pests of oil and raffia palms in the Niger Delta region of Southern Nigeria.

Materials and Methods

Sources of materials

The larvae of palm bettle (*O. monoceros*) were collected from infested palms of the swamps of the humid, fresh water ecosystem of Anyama Ijaw Community in Southern-Ijaw Local Government Area of Bayelsa State, Nigeria. The infested trunks of the palms were cut-open with axe and cutlass. The larvae were harvested manually from the tunnels in the decaying tissues of the palm and put into labeled plastic containers. The larvae of the compost beetle (*O. boas*) were also collected by digging decomposed waste sites and put into separate plastic containers. The samples were taken for analysis in Food Science Laboratory of Rivers State University, Port Harcourt, Nigeria.

Methods

The proximate compositions of the larvae were determined by AOAC (Association of Official Agricultural Chemists) [18] standard methods. Moisture determination was by drying method; ash content was obtained through the use of muffle furnace (450-600°C); Kjeldahl method was used for protein determination while the carbohydrate was determined by difference. The energy values were calculated using Atwater factors.

Sample preparation for amino acid analysis

The Amino acid profiles of the larvae were determined using the methods described by Benitez [19]. The samples were dried in the oven at a temperature of 105±2°C for 6 hours and ground using a mill in order to increase the surface area. The samples were defatted using chloroform/methanol mixture ratio of 2:1 after 4 grams of the sample was placed in soxhlet extraction thimble and refluxed with gentle heating for 15 hours [18].

Hydrolysis of the Sample

About 0.2 gm of the defatted sample was weighed into glass ampoule, 7 mL of 6NHCL was added and oxygen was expelled by passing nitrogen into the ampoule. The glass ampoule was then sealed with Bunsen burner flame and put in an oven preset at 105°C±5°C for 22 hours. The ampoule was allowed to cool before broken open at the tip and the content was filtered to remove the humins. It should be noted that tryptophan which was destroyed by 6NHCL was recovered using alkaline hydrolysis method with 4.2 m sodium hydroxide [20]. The filtrate was then evaporated to dryness using rotary evaporator. The residue was dissolved with 5ml to acetate buffer (pH 2.0) and stored in plastic specimen bottles kept in the freezer [20].

Loading of the hydrolysate into analyzer

Sixty (60) micro litre of the hydrolysate was loaded into the PTH Amino acid analyzer model 120A (USA). This was dispensed into the cartridge of the analyzer which had been designed to separate the free acidic, neutral and basic amino acids of the hydrolysate concentration of the amino acids to produce a profile. The results which were obtained in g/100 gm were converted to mg/100 gm.

Results and Discussion

The results of the proximate composition of the two edible larvae showed a protein content ranging between 6.57±0.07%-7.74±0.34% for *O. monoceros* and *O. boas,* respectively at fresh weight as presented in Table 1. However, the compost beetle (*O. boas*) were higher (7.74±0.07%) compared to the protein value of 6.57±0.34% obtained from the palm beetle larvae (*O. monoceros*). The protein content was lower when compared to what had been reported for other edible insects by many researchers [21,22]. This could be because the results in this study were reported in fresh weight basis. This same observation applied to other components of the proximate composition in this study.

The amino acid profiles of the larvae of palm beetle (*O. monoceros*) and compost beetle (*O. boas*) is shown in Table 2A while the quantitative compositions of the essential amino acids of the two edible larvae compared to the recommended daily allowances [23] is presented in Table 2B. The amino acid profiles of the larvae for the two beetles showed that the larvae of *O. boas* had higher amount of leucine (7,060 mg/100 gm), valine (5,430 mg/100 gm), lysine (6,260 mg/100 gm), threonine (4,380 mg/100 gm), phenylalanine (4,700 mg/100 gm), methionine (2,560 mg/100 gm), tryptophan (810 mg/100 gm), histidine (2,300 mg/100 gm) and cysteine (970 mg/100 gm) when compared to *O. monoceros* larvae which had leucine (6,500 mg/100 gm), valine (5,290 mg/100 gm), lysine (4,640 mg/100 gm), threonine (4,160 mg/100 gm), methionine (2,240 mg/100 gm), tryptophan (760 mg/100 gm), histidine (2,110 mg/100 gm) and cysteine (850 mg/100 gm). These results are in agreement with the work of the United States Institute of Medicine [23] which stated that each gramme of protein food consumed should provide 25 mg of isoleucine; 51 mg of lysine; 47 mg of phenylalanine; 27 mg of threonine; 7 mg of tryptophan; 18 mg of histidine and 32 mg of valine. Therefore, when the concentrations of the various amino acids (gm/100 gm) were converted to milligrams/100 gm; it provided amounts higher than the recommended. However, glutamic acid and proline were observed to be higher in *O. monoceros* larvae than *O. boas*. It was also observed that *O. boas* had a lower amount of phenylalanine and cysteine when compared to the recommended daily allowance as reported by USDA [24] and Maia [23] while phenylalanine, methionine and cysteine were lower in *O. monoceros*. All other amino acids investigated in this work compared favorably or exceeded the recommended daily allowance. Therefore, the two edible larvae can be said to have quality protein because it can provide satisfactory amounts of many essential amino acids. These larvae can also be used in infant food formulation because of the high amount of histidine when they are commercially produced by a sustainable method.

Furthermore, the quantitative values of the amino acid profiles showed that the larvae of these beetles are better sources of high quality protein than even beef which is a known conventional high quality protein [25,24]. Considering the high contents of protein and energy of these larvae as well as other edible insects like *R. phoencis,* locust and termites; their potential use as part of Fortified Blended Foods (FBFs) to ameliorate the prevalence of protein-energy malnutrition in many African nations is recommendable. The indigenous people of different cultures in Africa should be informed of appropriate methods of hygienic preparation

Table 1: Proximate Composition of *O. monoceros* and *O. boas*. Keys: PBL = Palm Beetle Larvae (*Oryctes monoceros*); CBL = Compost Beetle Larvae (*O. boas*).

Sample	Moisture Content (%)	Ash (%)	Fat (%)	Crude Protein (%)	Crude Fiber (%)	Carbohydrate (%)	Energy Kcal/100 gm (Wet weight)
PBL MEAN ($\bar{x}$)	82.74±1.02	1.07±0.02	2.36±0.06	6.57±0.07	0.88±0.11	4.90±0.05	70.96
CBL MEAN ($\bar{x}$)	73.78±0.56	9.52±0.25	1.90±0.00	7.74±0.34	1.28±0.00	5.79±0.47	123.60

Table 2A: Amino acid profiles of *O. monoceros* and *O. boas* larvae.

Essential Amino Acid	*O. monoceros* Concentration (mg/100 gDM)	*O. boas* Concentration (mg/100 gDM)
Leucine	6,590	7,060
Valine	5,290	5,430
Lysine	4,640	6,260
Threonine	4,160	4,380
Phenylalanine	3,990	4,170
Isoleucine	3,960	4,190
Methionine	2,240	2,560
Tryptophan	760	0,810
Cysteine	850	0,970
Non-Essential Amino Acid		
Histidine	2,110	2,300
Arginine	5.85	6,190
Tyrosine	3,780	3,950
Aspartic acid	7,750	8,000
Alanine	4,700	5,000
Glutamic	15,290	14,230
Glycine	5,010	5,460
Serine	4,480	4,990
Proline	5,990	4,470

Table 2B: Quantitative Composition of essential amino acids in *O. boas* and *O. monoceros* larvae.

Amino Acid	*O. boas* (mg/100 gDm)	*O. monoceros* (mg/100 gDm)	Recommended Daily Amounts (mg/100 gm) (Maia, 2018)
leucine	7,060	6,500	5,500
Valine	5,430	5,290	3,200
Lysine	6,260	4,640	5,100
Threonine	4,380	4,160	2,700
Phenylalanine	4,170	3,990	4,700
Isoleucine	4,190	3,960	2,500
Methionine	2,560	2,240	2,500
Typtophan	810	760	700
Histidine	2,300	2,110	1,800
Cystine	970	850	2,500

of these beetles, especially *O. boas* being harvested in large numbers from the abundant naturally decaying organic wastes in our environment [26]; which could be a major animal protein source in sustainable feed production. This will contribute to food and feed security in 2050, as advocated by FAO [27].

Conclusion

This study has confirmed that the two species of edible larvae of beetles are good sources of supplementary protein. Although, the two species of larvae contained considerable amounts of essential amino acids (inclusive of methionine, cysteine and histidine) which are limiting factors in many food stuffs. The *O. boas* larvae were found to have higher protein quality than *O. monoceros* which is attributed to the higher amounts of sixteen amino acids contained by *O. boas*; whereas *O. monoceros* was higher in glutamic acid and proline only. Therefore, there is need to conduct further studies on the use of these larvae for infant food formulation for humans and feed for livestock production in line with recommendation of Food and Agriculture Organization.

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