Nutritional Potentials of Edible Larvae of Longhorned Beetle (A*pomecyna* p*arumpunctata Chev.)* (Coleoptera: Cerambycidae) in Niger Delta, Nigeria

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Abstract
Nutritional potentials of edible larvae of Longhorned beetle (Apomecyna parumpunctata) was investigated. Proximate composition of the edible larvae had protein (16.24%), fat (13.26%) and high moisture content (60.45%) with average energy of 212.32kcal/100g. The larvae had low amounts of three essential minerals (calcium, magnesium and sodium) ranging between 4.7-16mg/100m/Dm and lower amounts of potassium and phosphorus (1.52mg/100g/Dm). Fatty acid composition of the larvae showed highest amounts of monounsaturated fatty acids (MUFA) oleic (50.26%), nervonic (2.57%, erucic (2.57%) and palmitoleic (1.40%); followed by saturated fatty acids (SFA) palmitic (24.60%), behenic (2.03% and myristic (1.83%). There were low amounts of polyunsaturated fatty acids (PUFA) which are good for health of the heart; linoleic (12.28%) known as Omega 6 – acid; linolennic (0.21%), docosahexaenoic (0.21%) and eicosadienoic (0.25%) which are known as Omega 3–acids. The fats obtained occasionally by the consumption of roasted larvae are relatively good for health because it had PS ratio of 0.43 which has lower risk for heart disorders than the common saturated oils.

Keywords: *Nutritional, edible larvae, Longhorned beetle (Apomecyna parumpunctata)*

Introduction

The total number of entomophagus insect species worldwide is not certain. However, the must common insects consumed as food by man globally are the beetles (31%) which constitute about 40% of all known insect species. There are many kinds of edible beetles, including aquatic beetles, wood-boring larvae and dung beetles (larvae and adults) (Ramos-Elorduy *et al*, 2009). It is interesting to mention that the long horned beetles are among such edible insects that are less known (Hammond, 1992; and Jacob *et al*, 2016). The adults of the longhorned beetles are identified by their extremely long antennae or "horns" measuring at least two-third or even more than the total length of the body (Buglife, 2017). The larvae which are "round headed" are active "wood borers" thereby creating large tunnels inside the woody tissues of decaying trunks or stumps of economic trees, such as the bush mango (*Irvingia gabonensis*) popularly known as "Ogbono tree which grows in the humid rainforest ecosystems of Niger Delta of southern Nigeria, Gabon, Sierra Leone and other similar ecological zones in tropical Africa reported by Natural Resources Institute (NRI, 1996). Earlier reports showed that the larvae of these beetles are used as traditional food in some tropical countries including Gabon, Senegal, Congo and Tanzania (Bergier, 1941). The increasing awareness of entomophagy has revealed that several ethnic groups in the Niger Delta in southern Nigeria (Ijaws, Igbos, Ogonis and Ikwerres) are utilizing the larvae of the beetles as human food. The indigenous Ijaw people of Niger Delta utilize the edible larvae of the cerambycid, beetles by roasting it in fire and spicing with little salt. It is then consumed as a traditional delicacy in combination with common staple foods like garri, bread or any other available carbohydrate. Unlike the highly cherished delicious food insects such as the African Palm Weevil (*Rhynchophorus phoenicis)*, termites, locusts and the honey produced by bees; the larvae of cerambycid beetles are referred to as "accidental or occasional food resource often collected in small number from decaying trunks or stumps of *Irvingia gabonesnsis* and related economic trees by hired rural labour who are engaged in gathering large quanta of semi-hard wood for firewood (charcoal), lumbering of timber, canoe carving and furniture making. There are about 20,000 species of longhorned beetles reported as cosmopolitan in distribution throughout all the climatic zones of the world, but over 60 species are known in the United Kingdom, while about 1,200 species occur in North America. Generally, there is paucity of information on the African cerambycid beetles; hence reference has been made to the foreign species. However, an outline classification of a typical African species include kingdom animalia, phylum arthropoda, class insecta, order coleoptera, superfamily chrysomeloidea, family cerambycidae, genus *Apomecyna spp; Species: Apomecyna parumpunctata (Catalogue, 2018).* The distribution of the African species (*A. parumpunctata*) include Nigeria, Tanzania, Sierra Leone, Democratic Republic of Congo, Uganda, Togo, Sudan, Rwanda, Cte d'lvioire, Guinea, Gabon, Angola, Senegal and Cameroun (Catalogue, 2018). The specific objective of this study was to investigate the nutritional value of the larvae of the African Longhorned beetles to know the amount of nutrients supplied to humans when consumed as food and to ascertain the need for further studies on the biology and possibility of breeding the larvae in the laboratory for commercialization and feed production, to boost agricultural productivity as advocated by FAO/ United Nations (Van Huis *et al*, 2013).

2.0 Materials and Methods

The larvae of the African cerambycid beetles were searched for by hired labour that used sharpened axe to cut out the dead and decaying tissues of the trunk of *Irvingia gabonensis* in the swampy wetland rainforest at Anyama-Ijaw community in Southern-Ijaw Local government Area of Bayelsa State, Nigeria. The harvesters brought sizeable portions of the wood which had large tunnels to the laboratory, where sharp cutlass was used to cut-open the tunnels to remove the larvae by hands-in gloves and put into Petri-dishes which were labeled and photographs were taken. Chemical analyses were carried out in the Department of Food Science and Technology in the Rivers State University, Port Harcourt, Nigeria.

Chemical Composition

The chemical compositions of larvae of long horned beetles were determined by AOAC (2006) standard methods. Moisture determination was by drying method, ash content was obtained through the use of muffle furnace (450-600^{0}C). Kjeldahl method was used for protein determination, while the carbohydrate was determined by the difference. The Energy values were calculated using the factors (4.0) for carbohydrate and crude fibre; 4.1 for protein and 9.0 for lipids (Fox and Cameroon, 1989), while Atomic Absorption spectrophotometer (AAS) techniques were used for the determination of the mineral elements of the samples (Pomeranz and Meloan, 1971). The fatty acid profiles of the larvae were analyzed through gas chromatography (Model 7890A Agilant, USA) with flame-ionization detector (FID). The individual fatty acids in the oils were determined using the A.O.A.C (2006) methods. Fatty acid methyl esters (FAME) were prepared from the extracted oils. In 50ml round bottom flasks, 50mg of each sample was kept in separate flasks and 3 ml of methanolic sodium hydroxide solution (0.5mol/1/solution of NaOH in methanol) was added. The reaction medium was refluxed for 10 min; 3ml of acetyl chloride was added; mixture was refluxed again for 10 minutes and then cooled to ambient temperature, 8ml hexane and 10ml of distilled water were added and allowed to stand for 5 min to establish a top phase solution. The upper organic phase was recovered into a vial for GC analysis.

Identification and Quantification

Identification of individual fatty acids was based on a comparison of the retention times and chromatographic profiles measured in the sample, with the retention times and profiles shown in the chromatograms of the (external) standard oils. The content of individual fatty acids was expressed as a percentage of the total content of all acids in the sample.

Results

The results of proximate composition of Long-horned beetle (table I) showed that the larvae of *A. parumpunctata* mean protein of 16.24%, fat of 13.26%, ash of 2.92%, crude fibre of 5.36%, carbohydrate of 1.24%, moisture content of 60.45% and average energy of 212.32kcal/100g.

The results in table 2 have shown that the larvae of *A. parumpunctata* are low source of some essential minerals because it provides only 4.7-16mg/100g/Dm for calcium, magnesium and sodium; while it was lower in potassium and phosphorus (1.53mg/100g/Dm).

The results of fatty acid composition of the larvae of *A. parumpunctata* (table 3) showed the presence of four different types of saturated fatty acids (SFA) (Myristic 1.83%), palmitic (24.6%), stearic (2.45%), behenic (2.03%). It also had four monounsaturated fatty acids (MUFA) (Palmitoleic 1.40%), (Oleic 50.26%), Erucic (2.57%) and Nervonic (2.57%) and four types of polyunsaturated fatty acids (PUFA) Linoleic (12.28%), Linolennic (0.21%), Eicosadienoic (0.25%) and docosahexaenoic (0.61%).

Plate 1: Longhorned Beetle Larvae
(*A. parumpunctata*), (*Mag. x 1*)

Table 1: Proximate composition of wood beetle larvae (*A. parumpunctata*)

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Crude fibre (%)	CHO (%)	Energy Kcal/100g
A	61.15	2.85	16.81	12.63	5.44	0.78	122.96
B	59.4	2.99	16.76	13.89	5.28	1.69	
Total	129.4	5.84	32.57	26.52	10.72	2.47	
Mean	60.45	2.92	16.24	13.26	5.36	1.24	

Table 2: Mineral composition of larvae of wood beetle (*A. parumpunctata*)

Mineral (mg/100g/Dm)	Wet Weight	Dry weight
Calcium	6.68	15.7
Magnesium	5.74	13.5
Sodium	2.00	4.72
Potassium	0.64	1.52
Phosphorus	0.60	1.52

Table 3: Fatty acids profile of larvae of Longhorned beetle (*A. parumpunctata*)

Fatty acid	%	Characterization
Myristic (C14.0)	1.83	SFA
Myristoleic (C14:1)	-	-
Palmitic (C16:0)	24.60	SFA
Palmitoleic (C16:1)	1.40	MUFA
Stearic (C18:0)	2.45	SFA
Oleic (C18:1)	50.26	MUFA
Linoleic (C18:2)	12.28	PUFA(Omega-6)
Linolennic (C18:3)	0.21	PUFA (Omega -3)
Arachidic (C20:0)	-	-
Eicodenoic (C20:0)	-	-
$E_i$cosadienoic (C20:3)	0.25	PUFA
Behenic (C22:0)	2.03	SFA
Erucic (C24:1)	2.57	MUFA
Nervonic (C24:1)	2.57	M UFA
Docosahexaenoic (C22:6)	0.61	PUFA
PUFA/SFA ratio =	0.43	

Key: SFA = saturated fatty acid; MUFA = Monounsaturated fatty acid
PUFA = polyunsaturated fatty acid
PS = PUFA/SFA

Discussion

The results in table 1 have revealed that the larvae of *A. parumpunctata* are good sources of supplementary proteins (16.24%), fat (13.26%) and moisture (60.45%), but they are low source of some essential minerals because it provides only 4.7-16mg/100g/Dm for calcium, magnesium and sodium; while it was poor in potassium and phosphorus (1.52 mg/100g/Dm) as shown in table 2. These values are considered to be quite low when compared to the daily recommended intakes for a 25 year old male for potassium (4700mg/100g/Dm); sodium

(1,500mg/100g/Dm); calcium (1000mg/100g/Dm); magnesium (400mg/100g/Dm) and phosphorus (100mg/100g/Dm) (Bukkens 1997; 2005 and FAO, 2012d). The larvae have high conversion efficiency, as they chewed large portions of decaying wood (which has low nutritional value) and converted it to appreciable proportion of protein and fat to benefit humans and livestock which consume them. The wood-boring larvae are also important ecological agents that facilitate decomposition and recycling of nutrients from the decaying woods to the natural ecosystem. On the other hand, the adults of the Longhorned beetles are active agents of pollination of flowers which eventually develop to become food resources for humans and animals (Buglife, 2017). The fatty acid profile (table 3) has also revealed that the quality of fats obtained by the consumption of the larvae are relatively good for health, because it has high supplies of oleic acid (50.26%) which is monounsaturated fatty acid (MUFA), followed by appreciable amounts of Linoleic acid(12.27%) which is polyunsaturated fatty acid (PUFA). The possession of essential fatty acids which are known as Omega-6 and 3 respectively are highly recommended for consumption by diabetic and hypertensive patients in order to manage the risk of heart disorders (Mann, 1993). The PS ratio of the Longhorned beetles was 0.43% which have lower risk factor for causing heart diseases than the common saturated fats of palm oil and margarine which have PS ratio of 0.2. It is therefore; moderately good for consumption even by diabetic and hypertensive patients that are prone to coronary heart disorders (Womeni *et al*, 2009). The utilization of these larvae as human food is further hampered by its limited availability because harvesters cannot gather large numbers, coupled with the strenuous hard labour required in breaking up large trunks of decaying trees or stumps in the forest to obtain it for food. In addition, the long duration of 1-3 years required to complete the life cycle by some species of the adult females, has made it unprofitable and unsustainable for domestication in the laboratory for human food or feed for animals.

Conclusion

This study has confirmed that the larvae of the African Longhorned beetle (*A. parumpunctata*) is among the lesser known edible insects in tropical Africa, which are fair supplementary source of proteins (16.24%) and fat (13.26%), but low suppliers of essential minerals (calcium, magnesium, sodium, potassium and phosphorus) to the body whenever they are consumed occasionally after roasting. Unlike other commonly eaten insect larvae, such as the African palmweevils (*R. phoenicis*), termites and locusts which supply high quality fats to the human body; the quality of fat of longhorned beetle (*A. parumpunctata*) was found to be lower than the fats of *R. phoenicis* because it had PS ratio of 0.43, which was lower than the PS ratio of 0.8 of *R. phoenicis*. This implies that consumption of the larvae of longhorned beetles does not aggravate heart disorders. The larvae of the longhorned beetles (*A. parumpunctata*) do not have prospects for domestication and commercialization for human consumption and feed formulation, due to the prolonged duration of lifecycle and the challenge of high risk of collecting it from the hard-woods in the forest, plus hard-labour required to harvest it in small numbers, thereby making it unprofitable and unsustainable. However, they are notable agents for recycling of nutrients from dead and/or decaying economic trees to the natural ecosystem. Pollination of flowers is a major activity of the adults for food production. The adult stages (male & female) of this species of the longhorned beetle were not captured during the period of this study (Nov. 2017 – April 2018). This may be due to the prolonged duration of the larval stage which was reported to last about 1 – 3 years (Buglife, 2018). This is a pioneering research on the Nutritional aspects of the edible larvae of longhorned beetle found in the Niger Delta area of Nigeria. It is therefore recommended that studies be carried out on the lifecycle, molecular biology, taxonomy and conservation of the insect from extinction due to incessant pollution occurring in the Niger Delta region of Nigeria, through oil exploration activities.

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