



Proximate and mineral analysis of red palm weevil (*Rhychophorus ferrugineus*) larvae

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Abstract

The larvae of the red palm weevil (*Rhychophorus ferrugineus*) are consumed majorly by the rural people in Nigeria. They are commonly known as Red Palm Weevil (RPW) belonging to the Family Curculionidae and Order Coleoptera. Evaluation of the nutritive value of this larva becomes important as the insect larva could form a base for new food/feed product of considerable nutritive value. This study was conducted at analytical Laboratory of Olusegun Agagu University of Science and Technology, Okitipupa (OAUSTECH) to investigate the mineral content and proximate compositions of fresh and roasted larvae of red palm weevil. Data collected was subjected to t-Test. Significance difference ($p < 0.05$) were observed in moisture content, ash, protein and fat but no significant difference ($p > 0.05$) was observed in crude fiber and carbohydrate between fresh and roasted larvae. Moisture content, ash, protein, fat, crude protein and carbohydrate for fresh larvae were 56.03%, 0.43%, 10.29%, 33.05%, 0.18%, and 0.48% respectively while 30.55%, 3.65%, 14.15%, 21.54%, 3.70% and 25.87% represent values for roasted larvae respectively. Significance difference ($p < 0.05$) was observed between the fresh and roasted larvae in all the mineral considered while Lead and Cadmium were not detected. It could be concluded that the larvae of the palm weevil is highly nutritious.

Keywords: food, composition, roasted, fresh, significance, nutritious

Introduction

The high rate of malnutrition reported especially among the low-income groups all over the world is of great concern (Gbogouri *et al.*, 2013) [13]. Yet, there are many underused food source that could be exploited to reduce or combat this nutritional deficiency. One of which is the use of edible insects

Edible insects have been in the diet of man since time immemorial, at some times eaten as emergency food, at others as staple food or as a delicacy. Members of the class insecta are important sources of food to many animal species including man (DeFoliart, 2013; Adedire and Aiyesanmi, 1999) [7, 2].

Among the most important Orders of insects consumed in Nigeria are *Coleoptera*, *Hymenoptera*, *Isoptera*, *Lepidoptera*, *Odonata*, *Orthoptera* and they are highly priced (Fasoranti and Ajiboye, 2008). Notable examples of these are the red palm weevil, *Rhychophorus phoenicis*, termites, *Macrotermes nigeriense* (queen, king and reproductive), and variegated grasshopper, *Zonocerus variegatus* (Mercer, 2003; Adedire and Aiyesanmi, 1999) [2]. *Rhychophorus* spp. is a major pests of date palms, coconut palms, oil palms and sugarcane (Aldryhim *et al.*, 2003) [3]. *Rhychophorus ferrugineus* which inhabits oil palms and coconut is a large insect, measuring over 25 mm in length and found in wide geographical areas spanning many different climates such as Africa, Southern Asia, and Southern America. The weevil is attracted to dying or damaged parts of palms, cut or split palm trunks and can also attack undamaged palms as well as decaying sugarcane (Faleiro 2006) [10].

The larva *Rhychophorus ferrugineus* is a cherished food among many communities in Nigeria and around the world, especially in those places where palm (oil, raffia and

coconut) are cultivated on commercial basis. In Nigeria, it is a cherished delicacy among the people of the Niger Delta, Eastern states and Ondo state. It can be seen hawked along major roads and markets in Okitipupa and Ilaje in Ondo state and in other parts of Nigeria. It is widely consumed raw, boiled, fried, smoked, used in the preparation of stew and soups, as part of a meal or as a complete meal.

The larva of *Rhychophorus ferrugineus* is also used for medicinal purposes. For example, the Itsekiri's in Delta state believe that the live larva could cure a certain ailment in infants with symptoms like twitching of the hands and feet, restlessness and others Ekpo *et al.* (2010) [14].

Scientific Classification of Red Palm Weevil

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Curculionidae

Subfamily: Rhynchophorinae

Genus: *Rhychophorus*

Species: *ferrugineus*

The life cycle of *Rhychophorus ferrugineus* is reported to vary from 45-139 days depending on the environmental and geographical conditions and is spent inside the palm tree itself (Briscoe *et al.*, 2011). Report have shown that many of the edible insects contain satisfactory amount of nutrients (protein, carbohydrates, acid and minerals) that are required by humans (Rumpold *et al.*, 2013) and it accounts for about 5-10% of the consumed protein in the diets of communities where entomophagy is practiced (Ayieko *et al.*, 2008).

Table 1: Common names of *Rhynchophorus ferrugineus* (F) larva by the different ethnic groups in Nigeria

Ethnic Group	Common Name
Ondo (Ilaje/Ikale)	Uton
Edo (Benin)	Nten
Ekiti	Uton
Edo (Esan)	Ikolo
Oyo (Ibadan)	Okhin
Osun (Ilesha)	Awon
Delta (Urhobo)	Ekuku
Akwa Ibom (Ibibio)	Edon
Dealta (Isoko)	Odo
Imo (Idemili)	Elughulu / Akpangwo
Anambra (Ukwa)	Eruru
Imo (Ihiala)	Nza
Delta (Aniocha)	Nzaolubu
Benue (Idomas)	Eko – al

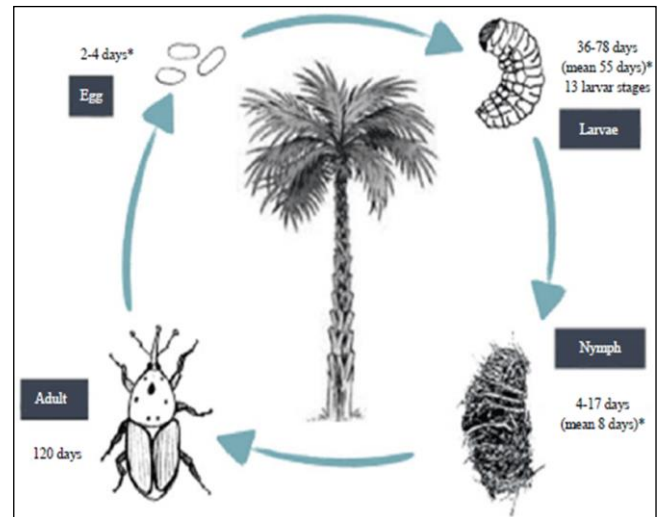
Source: Ekpo *et al.*, (2010) [14]



Plate 1: Larva of Red Palm Weevil (*Rhynchophorus ferrugineus*)

Red palm weevil (*Rhynchophorus ferrugineus*) has four life - stages (complete metamorphosis), which includes eggs, larva, pupa, and adult stage. In general, all types of palm trees support the growth and development of the red palm weevil during all stages of its life. The life cycle begins when the female weevils lay about 300 creamy white eggs (2.6 mm in length and 1.1 mm of width) inside cracks and crevices on the palm trunk. Gravid female weevils are attracted to young date palms less than 20 years old (Abraham *et al.*, 2008) for egg laying which is enhanced due to palm tissue volatiles emitted on fresh injuries on the palm resulting from frond shaving and offshoot removal. The eggs hatch in from 2 to 5 days. The resulting conical legless larvae continue to grow in the palm trunk for 1 to 3 months. They feed primarily on palm tissue and move inwards towards the soft heartwood at the center of the palm trunk. A complete larva (50 mm in length and 20 mm of

width) has a yellowish-white body and a reddish-brown head with strong mandibles that help bore the palm trunks. When fully grown, the larva forms a cocoon about 35 mm long and 15 mm wide. After 14 to 21 days in pupal stage, the insect becomes an adult (imago) 35 mm long and 12 mm wide, reddish-brown in colour with black spots on the thorax, a long proboscis, and a pair of antenna on the front of its head. Adult male weevils are characterized by a tuft of bristles on the dorsal tip of the snout. Adult weevils feed outside the palm trunks and can live an average of 98 days (between 29 to 153 days). The adult only moves out in search for another host for food when the infested tree is completely destroyed (Faleiro *et al.*, 2014).



Source: Briscoe, (1999)

Fig 1: Life cycle of *Rhynchophorus ferrugineus*

Materials and Methods

Data Collection

A total number of 100 live larvae of red palm weevil, *Rhynchophorus ferrugineus* were purchased at the main market of Okitipupa, Ondo State, Nigeria. Each of the larvae weight ranged from 0.6g to 1.6g. The samples were divided into two parts: One part was prepared raw and the other part was roasted. The live larvae were killed, by asphyxiating them in a deep freezer for 48 h, blended with an electric blender. The second part was roasted 20minutes using hotplate at a temperature of 105°C. After cooling, it was then grounded using mortar and pestle. The two samples of the fresh and roasted were taking to analytical laboratory of the school for proximate and mineral analysis,

Proximate Analysis

Proximate Analysis, can be regarded as a close examination, identification and quantifying of nutritional values of compounds. Proximate values were reported in percentage. (FDA, 2018)

Determination of Moisture Content

The ground samples were weighed and placed in an oven and heated at a constant temperature of 65 °C for 2 days. This removes the water, so loss in weight represents the water and the remaining portion is the dry matter. After drying was completed, the samples were removed from the oven and placed into a desiccator to cool to room temperature and weighed afterwards. Moisture free samples

were then used for further analysis. Dry matter content was calculated using the formula below:

$$\text{Dry matter \%} = \frac{(\text{crucible} + \text{dried sample}) - \text{weight of crucible}}{\text{weight of fresh sample}} \times 100$$

Determination of Crude Ash

After the determination of the moisture content the same sample was placed into porcelain dishes and then taken into the furnace at temperature of 550 °C for 4 hours. The water, protein, fat and carbohydrates are completely removed by this process. When four hours elapsed the dishes were removed and cooled in a desiccator. The ash was then calculated as:

$$\text{ash \%} = \frac{(\text{crucible} + \text{ash}) - \text{weight of empty crucible}}{\text{weight of dried sample}} \times 100$$

Determination of Crude Protein

Crude protein was analyzed using the kjeldahl method. Half a gram of dried ground sample was weighed on an analytical balance into a kjeldahl digestion flask. One gram of a catalyst mixture (Na₂SO₄ mixed with anhydrous CuSO₄ in a ratio of 10:1) was added. Five milliliters of concentrated H₂SO₄ was also added. The digestion flasks were then placed in the digester and the temperature was set at 350°C for 2 hours. Digestion converts any organic nitrogen compounds in the sample into ammonia and other organic matter to CO₂ and H₂O.

After 2 hours of digestion, the flasks were then removed and allowed to cool. When cooling was complete the content in the flask was diluted by distilled water and a concentrated NaOH (40%) added to neutralize the acid and to make the solution slightly alkaline. The amino was then distilled into receiving flasks that consisted of a standardized strong acid (0.1N H₂SO₄) for reaction with ammonia. The excess acid was then back titrated with standard NaOH. Nitrogen % was then calculated as follows:

$$\text{Nitrogen \%} = \frac{(\text{Vml} - \text{VmlBLANK}) \times 0.1\text{NHCL} \times 0.014}{\text{Weight (0.5g)}} \times 100$$

The % of nitrogen was then converted to % of protein by using the conversion factor 6.25.

$$\% \text{Protein} = \% \text{Nitrogen} \times 6.25$$

Determination of Crude Lipid

The lipid in fraction of a food is insoluble in water but soluble in organic solvents such as diethyl ether, petroleum spirit or a mixture of chloroform and methanol. In this analysis the total lipid content of our sample was determined gravimetrically by extraction in diethyl ether for 40 minutes at a temperature of 90 °C. When the extraction process was completed, the samples were then put in an oven at a temperature of 70 °C for 30 minutes. After that the samples were then cooled at room temperature in a desiccator and weighed. The % crude fat was then calculated as below:

$$\% \text{ crude fat} = \frac{\text{original weight of the sample} - \text{weight of the sample after extraction}}{\text{Original weight of the sample}} \times 100$$

Determination of Crude Fibre

The sample was digested with boiled H₂SO₄ (1.25%), then vacuum filtered and washed. The ceramic fibre was used as the filtration aid and fritted glass crucible for drying and ignition purposes. Subsequently the same sample was digested again by boiling with dilute alkali (1.25% NaOH) vacuum filtered, washed and dried. The dried residue was ignited and crude fibre was estimated as the loss in mass on ignition of the dried residue.

$$\text{Crude fiber \%} = \frac{\text{Loss in weight on ignition} - \text{loss in weight of ceramic fiber blank}}{\text{weight of the sample}} \times 100$$

Total Carbohydrate

Total carbohydrate was determined by the method of AOAC (Association of Official Analytical Chemist), 2008. The total carbohydrate content for the samples was determined by subtracting all the values of proximate analysis from 100.

$$\% \text{ Carbohydrate} = 100 - (\text{crude fiber} + \text{ash content} + \text{crude lipid} + \text{crude protein} + \text{moisture content})$$

Mineral Analysis

Half a gram of dried sample and 5 ml of concentrated nitric acid was added to a 50 ml folin digestion tube to prepare the samples for digestion. The samples mixtures were then digested by heating at 350°C for 8 hours and then treated with hydrogen peroxide for 2 hours. This was then left to cool for 1 hour. After cooling, the samples were then prepared for analysis by putting them into 50 ml volumetric flasks and then diluted to the 50 ml mark. concentrations of Ca, P, Na, K, Mg and Fe were determined at specific wavelengths for each element by an Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) using a Thermo Jarrell Ash IRIS instrument (Thermo Jarrell Ash Corporation, Franklin, MA). The instrument was calibrated against standards (Junsei Chemical Co., Ltd., Tokyo, Japan) of known concentration.

Statistical Analysis

The data obtained were analyzed using student t- test to separate significance difference of P ≤ 0.05% between the means (SAS, 2003).

Results and Discussion

The proximate analysis of fresh (live) and roasted larva of red palm weevil (*Rhychophorus ferrugineus*) was presented in Table 2. The result revealed that significant difference (p<0.05) was observed in moisture content of (56.03%) in fresh and (30.55%) in roasted larvae. The roasted larvae (3.65%) contained more ash content than fresh larvae (0.43%). There was significant difference (p<0.05) in crude protein content of roasted (14.15%) and (10.29%) in fresh larvae. Similar trend was also observed in fat content. There was no significant difference between the fresh larvae (0.18%) and the roasted larvae (3.70%) of the fiber content. The carbohydrates content of the fresh larvae (0.48%) was lower to roasted larvae (25.87%) with no significant difference (p>0.05).

Table 2: Proximate Composition of Fresh and Roasted larva (*Rhychophorus ferrugineus*)

Parameters (%)	Fresh larva	Roasted larva	Overall mean	S.E.M
Moisture	56.03 ^a	30.55 ^b	43.29	7.36
Ash	0.43 ^b	3.65 ^a	2.04	0.94
Protein	10.29 ^b	14.15 ^a	12.22	1.12
Fat	33.05 ^a	21.54 ^b	27.30	3.32
Crude Fiber	0.18	3.70	1.93	1.02
Carbohydrates	0.48	25.87	13.18	7.33

Means with different superscripts on the same row are significantly different ($p < 0.05$).

The mineral profile of fresh and roasted larvae of red palm weevil (*Rhychophorus ferrugineus*) was presented in Table 3. The result revealed a significant difference ($p < 0.05$) in all the mineral compositions with higher values observed in fresh larvae apart from sodium. There was no significant difference ($p > 0.05$) in potassium content between the fresh (199588ppm) and roasted larvae (17146ppm). The values, 329.540ppm and 65.350ppm were recorded for iron in the fresh and roasted larvae respectively. In the same trend, 42722.3ppm and 709.1ppm were observed for Calcium while 184.790ppm and 155.265ppm was observed for zinc. Lower value was observed in copper (20.930ppm), phosphorus (3579.50ppm) and magazine (170ppm) for roasted larvae respectively. Lead and cadmium was below detection level in both the samples

Table 3: Mineral profile of Fresh and Roasted larva (*Rhychophorus ferrugineus*) larvae

Parameters(ppm)	Fresh larva	Roasted larva	Overall mean	S.E.M
Sodium	10624.28 ^b	23429.57 ^a	17026.93	3696.57
Potassium	199588 ^a	17146 ^a	108367.27	84960.99
Iron	329.540 ^a	65.350 ^b	197.445	76.2663
Calcium	42722.3 ^a	709.1 ^b	21715.72	12129.90
Zinc	184.790 ^a	155.265 ^b	170.028	8.53486
Copper	53.7960 ^a	20.930 ^b	37.36	9.49026
Phosphorus	7876.360 ^a	3579.50 ^b	5727.93	1240.40
Manganese	80.93 ^a	7.170 ^b	44.05	21.2937
Lead	ND	ND		
Cadmium	ND	ND		

Key: Means with different superscript on the same row are significantly different ($p < 0.05$) ND: Not detected

This current study reports the nutritional value of red palm weevil (*Rhychophorus ferrugineus*). The moisture content has a high value of 56.03% in fresh and 30.55% in roasted larvae which was found to be in agreement with previous reports by Edijala *et al.*, (2009) [8], Ekpo and Onigbinde (2005) [9], Womei *et al.*, (2012) obtained a moisture content of 35.12% but was higher than the 28.20% values reported by Banjo *et al.*, (2006) [6].

The ash content of the larvae was higher in roasted than, in fresh larvae. The ash content is similar to the result of 3.02% previously reported by Ekpo and Onigbinde (2005) [9].

The protein content of the larvae was 10.29% and 14.15% for fresh and roasted larva. This was in conjunction with 14.20% reported by Olowu *et al.* (2012) [21]. The high protein content of the larva shows its potential to serve as a means of combating protein deficiency. A meal fortified with the larva can contribute significantly to the daily human requirement usually about 23-56g FAQ/WHO/UNN

(1991); Chaney (2006). The larva is more proteinous when roasted than eaten raw. Proteins are very important in human and animals for the building and the repair of worn-out tissue in the body.

The larva is shown to be rich in fat. Fats content of the larvae respectively is 33.05% for fresh and 21.54% for roasted, this values are higher than the values reported by Okunowo *et al.*, (2017) [20]; Banjo *et al.*, (2006) [6] and contradict the 66.61% of roasted larvae reported by Ekpo and Onigbinde (2005) [9] and 62.15% of fresh larvae reported by Edijala *et al.* (2009) [8].

The crude fiber content was 0.18% in fresh and 3.70% in roasted larvae which was in agreement with the result 3.92% reported by Banjo *et al.*, (2006) [6]. Carbohydrate content of this study was higher in roasted larvae 25.87% than previously reported by Edijala *et al.*, (2009) [8]; Ekpo and Onigbinde, (2005) [9] of 19.32% but lower in fresh 0.48% than the values of 2.45% reported by Banjo *et al.*, (2006) [6]; Olowu *et al.*, (2012) [21]

Minerals play enormous roles in human metabolic processes (WHO 2004). The larvae contained an appreciable amount of minerals while Lead and Cadmium was not detected in either of the treatment. The sodium (Na) content of the larvae has a high value of 10624.28ppm and 23429.57ppm in fresh and roasted respectively, which are important in the maintenance of osmotic balance between cells and interstitial fluid (Soetan, *et al.*, (2010) [16]. The larvae has a value of potassium (K) in fresh larvae 199588ppm and roasted larvae 17146ppm which is in conjunction with the value of 198867ppm reported by Soetan *et al.*, (2010) [16].

Iron (FeO) has a value of 329.540ppm in fresh and 65.350ppm in roasted larva which was in agreement with the value of 338.421ppm reported by Foua Bi *et al.* (2015). Iron is a trace element essential for the functioning of cells and is a fundamental constituent of red blood cells because it allows the transport of oxygen. Iron deficiency is common worldwide, especially in pregnant women and people with anemia (WHO, 2006) [18]. Calcium content was 42722.3ppm for fresh and 709.1 ppm for roasted larvae, it is lower than 5377.11ppm previously reported by Banjo *et al.*, (2006) [6]. Zinc and Copper are co-factor found in the structures of certain enzymes and are indispensable, numerous biochemical pathways (Soetan *et al.*, 2010) [16]. Zinc is necessary for the immune system of the body to function properly. It is also essential in cell formation, wound healing and in the breakdown of glucose Phosphorus is always higher in mineral salt obtained in grub eaters because the larvae always derive the mineral salt from the grub they eat. Phosphorus deficiency causes lower body weight. Maganese content of the larvae is a component of arginase and pyruvate carboxylase (Chaney, 2006).

The result of this work showed that Red Palm Weevil Larvae (*Rhychophorus ferrugineus*) is a good source of protein, fat, sodium, potassium and phosphorus and relatively rich and safe oil as insect's oils have been reported to contain low cholesterol content. They contain significant micromolecules (minerals) potentials such as Iron, Zinc, Calcium and many other elements. The mineral contents elaborate the nutritional value of the larvae in promoting good health. They may be explored as source of food, particularly in the developing countries like Nigeria. The consumption the processed red palm weevil larvae as an alternative source of animal protein are highly

recommended and encouraged. It is necessary in this period when the cost of meat, egg and fish are high in the market.

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