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Assessment of nutritional qualities of palm weevil larvae from *Elaeis guineensis* Jacq and *Raphia ferinifera* (Gaertn.) Hyl.) in Amukpe, Delta State, Nigeria

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Abstract

This study was carried out to assess the nutritional qualities of the larva of *Rhynchophorus phoenicis* collected from rot oil palm trees (*Elaeis guineensis* Jacq) and Raphia palm trees (*Raphia farinifera* (Gaertn.) Hyl.) at Amukpee, Delta State, Nigeria. Samples of fresh *Rhynchophorus phoenicis* larvae collected at different locations in the study area were subjected to analysis for their nutritional mineral qualities using standard laboratory methods. The results showed that variations occurred in composition of nutrient, proximate and mineral compositions of the different samples. *R. Phoenicis* obtained from raphia palm and oil palm trees recorded higher values of moisture contents in fresh samples with 52.21% and 50.10% respectively. Dry matter composition also recorded higher values in fresh samples of both palm species. From the results, no significant difference ($P > 0.05$) was spotted in vitamin A and C of *R. Phoenicis* across the different palm trees with higher values recorded in fresh samples accordingly. Vitamin C results obtained from raphia palm tree samples recorded statistically higher value of 3.23ppm for fresh compared to 2.4ppm recorded for oil palm tree species. The mineral composition varied in the different palm trees. The composition of copper showed that oil palm tree samples recorded higher value of 0.95ppm, 0.87ppm and 0.69ppm for roasted, dried and fresh samples. Also, phosphorus composition obtained from raphia palm tree samples recorded higher values of 5.66ppm, 4.84ppm and 4.34ppm of phosphorus for roasted, dried and fresh samples. Considering the nutritional values of these oil palm weevils, the consumption of these larvae should be incorporated into our daily meal as complementary cheap diet in our society.

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Introduction

Edible insects have played a nutritional role in the diet of people in many parts of the world and are currently being promoted as an inexpensive alternative source of protein in underdeveloped countries due to the rising cost of conventional animal protein and the foreseen future deficit in its supply. Nutrient and chemical analysis of these grubs revealed the presence of protein, carbohydrates, saturated and unsaturated oil and fatty acids at about 31- 61% wet weight (Ukoroije, 2019). Minerals found include sodium, zinc, iron, copper, manganese, potassium, calcium, phosphorus and magnesium in low, moderate and high content levels (Okaraonye and Ikewuchi, 2008). The larvae are proven to contain the richest source of animal fat and high energy value of 234.9KJ/100g of larvae (Oliveria *et al.* (1976). Chaney (2006) reported the larvae of *R. phoenicis* has higher protein compared to termites, milk obtained from cattle, eggs and beef. Hence, larval meal can significantly improve protein requirements for human daily.

It is also rich in essential amino acids such as histidine, methionine and phenylalanine (FAO/WHO/UNU, 1991). Its high content of unsaturated fatty acids is an indicator that the oil is safe for consumption by individuals prone to dyslipidemia, diabetes mellitus and cardiovascular diseases since its intake reduces the risk of these attacks (Martirosyan *et al.,* 2007). Vitamins found in high amount include thiamine and riboflavin (Thomas and Briyai, 2019).

Factors such as climatic condition, geographical variations, meal preferences of these insect are mainly responsible for the variations usually recorded in their nutrient compositions. Also, variations to so extent has also been recorded in their trace metal composition, this is well obvious in species of same genus. *R. phoenicis* larvae usually feed on palm species by boring holes on the trunks while the adults feed on terminal buds. They are considered main pests infesting *Arecaceae* as well as plants such as pawpaw, sugarcane, banana and cacao (Rochat *et al.,* 2017).

Several studies have been conducted on the nutritional status of larvae of the palm weevil, these studies has turned out positive in terms of their contributions to human health, with emphasis on their abundance in locally sourced and traditional diets (Alamu *et al.,* 2013). In general, larvae of palm weevil have shown to harbor essential nutrients including iron, fat, zinc and amino acids (Chinweuba *et al.,* 2013). Palm weevil larvae have shown significantly to offer macro and micronutrient compared to beef and chicken (Payne *et al.,* 2016). Although these studies suggest their potential to combat under-nutrition, though their nutrient content is subject to significant variation caused by factors such as feed, lifecycle and geography (Laar *et al.,* 2017).

Several research on nutrient and mineral contents of *R. phoenicis* larvae obtained from Raphia palm tree, have been documented by other authors, including Okoli *et al.* (2019), Agbemebia *et al.* (2020), Ojianwuna *et al.* (2021), Adobeze and Enemor (2022). However, these studies have not provided adequate nutrient compositions and proper comparison of nutritional contents of *R. phoenicis* larvae obtained from Raphia and oil palm. However, this study therefore gives a comparative assessment of the nutritional composition of *Rhynchophorus phoenicis* larva collected from rotted oil palm and Raphia palm trees within Amukpe community in Delta State, Nigeria.

Materials and methods

Study Area

Amukpe community, the study area is located in Sapele Local Government Area, Delta State and lies within Longitude 05°41'27" E to 05°42'05" E and latitude 05°51'55" N to 05°52'03" N. the area occupies about 500sq kilomitres across mainland, mangrove, swamp and rivers with a terrain of flat and low land with no hills, mountains and rocks. The surrounding forest is predominantly made up of *Entandrophragma cylindricum* commonly known as Sapele mahogany, Rahpia palm and other aquatic vegetation. The community is an agrarian area with an estimated population of 174,273.

The occupants are farmers, artisanal fishermen with pockets of civil servants and traders (Jaboro and Omonigho, 2019; Ilondu and Lemy, 2018).

Larvae (Edible Worm) Collection

Samples of fresh *Rhynchophorus phoenicis* larvae were collected at different location in Amukpe, Sapele, Delta State. The investigation was carried out from June to December, 2022. The study was done by visiting farmlands and building sites for oil palm samples and swamps for raphia palm sample. Suspected palm trees were excavated and spotted larvae were handpicked and stored in clean containers and thereafter transferred to a cool box containing starchy pulp. A total of two hundred and forty (240) larvae of *Rhynchophorus phoenicis* consisting of 120 from rot palm trees (*Elaeis guineensis*) (Plate 1) and 120 from raphia palm (*Raphia fenirifera*) (Plate 2) were used for this study. Collected samples were transported to the Advance Research Center of Delta State University, Abraka for analysis of their nutrient and trace metal contents.

Plate 1. Collection of fresh larvae of *R. phoenicis* from rot oil palm tree. A: Collection of fresh larvae of *R. phoenicis,* B: Freshly collected *R. phoenicis* larvae.

Plate 2. Collection of fresh larvae of *R. phoenicis* from rot raphia palm tree.A: Collection of fresh larvae of *R. phoenicis,* B: Freshly collected *R. phoenicis* larvae.

Sample Preparation

Samples of fresh *R. phoenicis* collected were asphyxiated in refrigerator at -10°C for 3 hours. The samples were prepared in three (3) parts of 100 g each. The weights of samples were determined using electrical weighing scale (Contech). The first part was utilized freshly, the second part was oven dried at 60°C for 5 hours while the third part was roasted for 15 minutes using hotplate at a temperature of 105°C. The second and third part (dried and roasted) were crushed to powder form using porcelain mortar and packaged separately in aluminium foil and stored at ambient temperature (25°C) in the laboratory prior to use. The first part was blended afterward using electric blender. The crude extracts were stored in airtight container in the refrigerator for later use in the analysis. All samples were prepared in triplicate.

Determination of Nutritional Quality

The nutritional parameters (fat, protein, minerals, vitamins and carbohydrates) of the two species of edible insect larvae were determined using the Association of Official Analytical Chemists (AOAC, 1990) method. Fat (lipid) determination was carried out using the Soxhlet method. Protein content was determined using the Kjeldahl method. Composition of carbohydrate was determined as follows: % Carbohydrate= [100–% (protein + fat + moisture + ash + fiber)]. Energy content of the samples was calculated using the Atwater factors described by Oibiokpa *et al.* (2017).

Data Analysis

Graphpad Prism for windows version 7.01 (GraphPad Software, San Diego, CA, USA) was used for all statistical analyses of the data. Mean and standard deviations (SD) of parameters determined was calculated for each spice sample and the results presented as mean ± SD. Data obtained were subjected to one-way Analysis of Variance (ANOVA).

Results

Results obtained from analysis of *R. Phoenicis* obtained from rot oil palm trees (*Elaeis guineensis*) and raphia palm (*Raphia finifera*) in Sapele, Delta State, Nigeria, for their proximate contents, mineral contents and metal compositions are presented below. Table 1 shows the results of the proximate composition of fresh, dried and roasted samples of *Rhynchophorus Phoenicis* obtained from rot oil palm trees (*Elaeis guineensis*) and raphia palm (*Raphia finifera*) in Sapele, Delta State, Nigeria. From the results it was observed that variations in composition of proximate content across the different sample types for moisture (%), dry matter (g/100g), ash (g/100g), lipid (g/100g), carbohydrate (g/100g), protein (g/100g), fibre (g/100g) and energy (Kcal/100g) respectively. There were no significant difference ($P < 0.05$) between the proximate contents of oil palm trees and Raphia palm trees.

It was observed that moisture content was higher in fresh samples of *R. Phoenicis*, followed by dried samples while the least was recorded for roasted samples. Raphia palm recorded higher values for fresh (52.21%), dried (27.32%) and roasted (10.68%) samples respectively, compared to oil palm samples of *R. Phoenicis* which recorded 50.10%, 21.63% and 10.22% for fresh, dried and roasted samples of *R. Phoenicis* respectively. Dry matter composition was higher in roasted samples of *R. Phoenicis*, followed by dried samples while the least was recorded for fresh samples for both palm species. The values obtained from oil palm trees recorded values of 89.67g/100g, 92.36g/100g and 94.27g/100g for fresh, dried and roasted samples while samples obtained from raphia palm recorded values of 89.57g/100g, 91.70g/100g and 92.78g/100g respectively for *R. Phoenicis* (Table 1).

The composition of vitamins A and C in different samples of *R. Phoenicis* obtained from rot oil palm trees (*Elaeis guineensis*) and raphia palm (*Raphia finifera*) in Sapele, Delta State, from the results showed that vitamin A and C varied respectively across the different palm samples and the different status of *R. Phoenicis* used for the study. Vitamin A compositions were higher in roasted samples of *R. Phoenicis*, followed by dried samples while the least was recorded for fresh samples for both palm species.

Table 1. Proximate composition of fresh, dried and roasted *Rhynchophorus phoenicis* obtained from rot oil palm trees (*Elaeis guineensis*) and raphia palm (*Raphia finifera*) in Sapele, Delta State, Nigeria.

Nutrients	Status	*Rhynchophorus phoenicis*		P-Value
		Oil Palm Trees	Raphia palm	
Moisture (%)	Fresh	50.10±0.49	52.21±0.86	0.8786
	Dried	21.63±1.36	27.32±3.53	
	Roasted	10.22±1.08	10.68±2.06	
Dry Matter (g/100g)	Fresh	89.67±1.09	89.57±0.57	0.6700
	Dried	92.36±1.21	91.70±0.26	
	Roasted	94.27±1.19	92.78±0.76	
Ash (g/100g)	Fresh	0.98±0.31	1.58±0.29	0.4869
	Dried	2.18±0.29	2.98±0.40	
	Roasted	3.12±0.40	3.76±0.73	
Lipid (g/100g)	Fresh	12.47±0.97	13.11±2.30	0.5685
	Dried	17.60±0.96	21.83±3.83	
	Roasted	21.22±0.28	24.21±3.67	
Carbohydrate (g/100g)	Fresh	5.74±0.31	5.91±0.64	0.8767
	Dried	8.2±0.41	7.66±0.45	
	Roasted	10.62±0.92	10.07±0.14	
Protein (g/100g)	Fresh	31.19±1.24	25.27±4.20	0.6102
	Dried	36.60±1.33	33.26±1.58	
	Roasted	39.80±1.10	40.62±3.23	
Fibre (g/100g)	Fresh	4.43±1.56	4.80±0.91	0.5952
	Dried	5.5±1.45	6.15±1.85	
	Roasted	8.3±0.66	11.19±2.98	
Energy (Kcal/100g)	Fresh	142.97±3.18	177.16±2.81	0.7861
	Dried	249.60±4.81	251.0±1.98	
	Roasted	286.56±4.08	299.60±3.10	
X^2		3.1365	3.1224	
P value		0.0051^{NS}	0.0053^{NS}	

X^2 = chi square; ns = significant (P > 0.05)

The results obtained from raphia palm tree samples recorded values of 1.51ppm, 1.41ppm and 1.42ppm while oil palm samples recorded values of 1.13ppm, 1.44ppm and 1.84ppm for fresh, dried and roasted samples of *R. Phoenicis* respectively (Table 2). The results showed that vitamin C composition were higher in fresh samples of *R. Phoenicis*, followed by dried samples while the least was recorded for roasted samples for both palm species. The results obtained from raphia palm tree samples recorded higher value of 3.23ppm for fresh sample with lower values of 2.32ppm and 1.57ppm for dried and roasted samples compared to 2.4ppm and 1.72ppm for dried and roasted samples of *R. Phoenicis* recorded for oil palm tree species *R. Phoenicis* respectively. The results showed that there were no significant difference (P < 0.05) between Vitamin A and C contents of oil palm trees and Raphia palm trees (Table 2).

Table 2. Vitamin A and C composition of fresh, dried and roasted *Rhynchophorus phoenicis* obtained from rot oil palm trees (*Elaeis guineensis*) and raphia palm (*Raphia finifera*) in Sapele, Delta State, Nigeria.

Vitamins	Status	*Rhynchophorus phoenicis*		P-Value
		Oil Palm Trees	Raphia palm	
Vitamin A (ppm)	Fresh	1.13±0.51	1.51±0.76	0.9161
	Dried	1.44±0.49	1.41±0.35	
	Roasted	1.84±0.48	1.42±0.24	
Vitamin C (ppm)	Fresh	3.14±0.45	3.23±0.32	0.9446
	Dried	2.4±0.35	2.32±0.34	
	Roasted	1.72±0.19	1.57±0.44	
X^2		6.5867	6.3949	
P value		0.0012^{NS}	0.0013^{NS}	

Key: ppm = Part per million

X^2= Chi square; ns = Significant (P > 0.05)

The composition of minerals in the different samples showed that the composition of magnesium, iron, calcium, zinc, copper and phosphorus varied significantly with no detectable values for lead and cadmium in all samples examined for both the oil palm trees (*Elaeis guineensis*) and raphia palm (*Raphia finifera*) trees in the study area. The results showed that there were no significant difference ($P < 0.05$) between the mineral contents of oil palm trees and Raphia palm trees. Magnesium was higher in roasted samples of *R. Phoenicis*, followed by dried samples while the least was recorded for fresh samples for both palm species. The results obtained from raphia palm tree samples recorded higher value of 3.13ppm, 2.61ppm and 2.18ppm for roasted, dried and fresh samples compared to the values of 2.43ppm, 2.11ppm and 1.96ppm recorded for roasted, dried and fresh samples of *R. Phoenicis* recorded in oil palm tree species respectively (Table 3).

Iron contents were higher in roasted samples of *R. Phoenicis*, followed by dried samples while the least was recorded for fresh samples for both palm species. The results obtained from oil palm tree samples recorded higher value of 90.94ppm, 86.54ppm and 81.14ppm for roasted, dried and fresh samples compared to the values of 90.82ppm, 82.71ppm and 77.21ppm recorded for roasted, dried and fresh samples of *R. Phoenicis* recorded in raphia palm tree species respectively (Table 3).

Table 3. Mineral composition of fresh, dried and roasted *Rhynchophorus phoenicis* obtained from rot oil palm trees (*Elaeis guineensis*) and raphia palm (*Raphia finifera*) in Sapele, Delta State, Nigeria.

Minerals	Status	*Rhynchophorus phoenicis*		P-Value
		Oil Palm Trees	Raphia palm	
Magnesium (ppm)	Fresh	1.96±0.07	2.18±0.20	0.1987
	Dried	2.11±0.18	2.61±0.17	
	Roasted	2.43±0.33	3.13±0.25	
Iron (ppm)	Fresh	81.14±36.40	77.21±34.05	0.6178
	Dried	86.54±37.93	82.71±35.66	
	Roasted	90.94±39.42	90.82±37.10	
Calcium (ppm)	Fresh	18.90±5.72	19.53±6.00	0.8705
	Dried	20.20±4.65	20.47±4.27	
	Roasted	23.56±4.71	23.63±4.90	
Zinc (ppm)	Fresh	6.89±2.75	6.80±2.59	0.7781
	Dried	8.93±3.72	8.74±3.31	
	Roasted	10.49±3.85	12.57±5.65	
Copper (ppm)	Fresh	0.69±0.02	0.58±0.11	0.0244
	Dried	0.87±0.06	0.23±0.10	
	Roasted	0.95±0.11	0.34±0.23	
Phosphorus (ppm)	Fresh	4.04±3.89	4.34±4.19	0.6874
	Dried	4.66±4.47	4.84±4.61	
	Roasted	5.42±5.13	5.66±5.31	
Lead (ppm)	Fresh	ND	ND	
	Dried	ND	ND	
	Roasted	ND	ND	
Cadmium (ppm)	Fresh	ND	ND	
	Dried	ND	ND	
	Roasted	ND	ND	
X^2		2.8177	2.8760	
P value		0.0118^{NS}	0.0104^{NS}	

Key: ppm= Part per million, ND= No data, X^2 = Chi square, ns= significant ($P > 0.05$)

Discussion

The results of the nutrient, proximate and mineral composition of larvae of *R. phoenicis* sourced from rot oil palm trees (*Elaeis guineensis*) and raphia palm (*Raphia finifera*) in Sapele, Delta State, Nigeria showed that the moisture ranged between 50.10-52.21% for fresh samples, 21.63-27.32% for dried sample and 10.22-10.68% for roasted sample. These values were higher compared to the results of Agbemebia *et al.* (2020) who reported 6.32% for dried larvae and 7.33% for roasted larvae of *.hynchophorus phoenicis*. The ash content of *R. phoenicis* was observed to range between 0.98-1.58, 2.18-2.98 and 3.12-3.76 in the present study.

This was higher than the results of Okunowo *et al.* (2017) who recorded value of 1.00% for dry larvae and roasted larvae.

The results obtained for ash content is also higher compared to the one previously reported by Ekpo and Onigbinde (2005) and less than the 7.70% reported for roasted larvae (2009). This may thus suggest that the larva is rich in mineral content. This study recorded protein composition in of *R. phoenicis* to range between 25.27-31.19, 33.26-36.60 and 39.80-40.62% respectively for fresh, dried and roasted samples. This result is similar to the proteins contents of insects between 45.6 to 79.6% of dry matter according to Malaisse, 2000). The lipid (fat) content recorded in the study ranged between 12.47-13.11, 17.60-21.83 and 21.22-24.21%. These results were lower compared to the fat content of the larvae of palm trees of 60.16 % for dry larvae and 6.29 % for roasted larvae obtained by Agbemebia *et al.* (2020).

On the other hand, the fat content in this study was within the value of fresh matter previously reported in the literature (Banjo *et al.,* 2006) Malaisse (2000) reported a fat content of insects between 8.1 to 35.0% of dry matter. The carbohydrates contents obtained ranged between 5.74-5.91, 7.66-8.2 and 10.07-10.62% for fresh, dried and roasted larvae of *R. phoenicis* of both oil palm and raphia palm respectively. Energy composition ranged between 142.97-177.16, 249.60-251.0 and 286.56-299.60Kcal/100g for fresh, dried and roasted larvae of *R. phoenicis* of both oil palm and raphia palm respectively. This value is higher than 1.2% of dry matter reported by Nzikou *et al.* (2010). The vitamin content of this study ranged between 1.13-1.84 for vitamin A and 1.57-2.32 for vitamin C. Vitamins play essential roles in biological processes as well as in enhancing the functioning of the immune system (Van-Huis *et al.* 2013). Edible insects have been reported as a good source of vitamins, although the number of vitamins in them may vary depending on the species (Van-Huis *et al.*, 2013).

Conclusion

This study has shown that *Rhynchophorus phoenicis* is a species of edible insect commonly consumed in some parts of Delta State, Nigeria.

The study evaluated the nutrient and mineral composition of *R. phoenicis* sourced from both oil palm and raphia palm trees. The results showed that the nutrient and chemical composition varied across the different sources. The study also showed that the different status termed as fresh, dried and roasted varied in terms of their nutrient and chemical compositions. The studies therefore conclude that drying and roasting of larvae should be practiced as the results showed that the dried and roasted *R. phoenicis* were higher in nutrient and mineral contents.

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