

Nutritional composition of *Rhynchophorus palmarum* L. 1758 (Coleoptera: Curculionidae) larvae in palm trees of the Mezquital Valley, Hidalgo, Mexico

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ABSTRACT

Objective: To determinate the nutritional composition of larvae of the *Rhynchophorus palmarum* L. 1758 (Coleoptera: Curculionidae) beetle in palm trees of the Mezquital Valley, Hidalgo, Mexico.

Design/Methodology/Approach: In January 2020, 250 g of South American Palm Weevil (*Rhynchophorus palmarum*) larvae were collected from damaged Canary Island date palms (*Phoenix canariensis*). The larvae were gathered at the Universidad Politécnica de Francisco I. Madero, located in Tepatepec, Hidalgo, Mexico. They were placed in a plastic jar and later in a freezer for conservation and transportation to the Departamento de Nutrición Animal y Bioquímica, Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autónoma de México, where their nutritional composition was evaluated by proximate chemical analysis.

Results: In their proximate composition, the larvae of *R. palmarum* presented a protein concentration of 25.52% (dry basis) and of 9.04% (wet basis), ether extract of 19.77%, dry matter of 35.74%, humidity of 64.26%, ashes of 0.70%, crude fiber of 1.64%, nitrogen-free extract of 4.58%, calcium of 0.20%, and phosphorus of 0.31%.

Study Limitations/Implications: No previous research about the use of this insect as human food in Mexico was found.

Findings/Conclusions: We conclude that these larvae can be exploited for human and livestock food (as a protein and energy supplement) and even to enrich and prepare conventional foods for society.

Keywords: worm, beetle, protein, food, entomophagy.

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INTRODUCTION

The polyphagous feeding habit of *Rhynchophorus palmarum* L. allows it to develop its life cycle in various crops, such as sugarcane (*Saccharum officinarum*), oil palm (*Elaeis guineensis*), pineapple (*Ananas comosus*), coconut (*Cocos nucifera*), and banana (*Musa × Paradisiaca*). During their life period (30.7 ± 14.3 days), females cause direct damage, laying 245 ± 155 eggs that



hatch in 2-4 days. The eggs are deposited in a hole in the palm trunk made by the female with its rostrum. In its turn, the larva enters the stem and feeds exclusively on living tissues for a period of 52 to 62 days, causing the death of the host, as a result of the destruction of the apical meristem. This insect can also cause indirect damage, because it is a vector of the *Bursaphelenchus cocophilus* nematode, which causes the disease known as red ring, an additional limitation to the production and performance of its hosts (Rodríguez- Currea *et al.*, 2017). Likewise, Sumano *et al.* (2012) reported this insect as a severe pest of coconut (*C. nucifera* L.) and oil palm (*E. guineensis* Jacq.) crops in the neotropics.

Meanwhile, Vargas *et al.* (2013) showed that some of the insects considered as pests have a high nutritional quality: they provide proteins and supplements such as minerals and vitamins. In some cases, they are raised and sold to the population who considers them a delicacy. Additionally, Tejada-de Hernández (1992) reported that, based on the study of the chemical composition of food, we can determine not only the proportion of the elements and macromolecules that make them up, but also infer their nutritional quality and lay the foundations for a greater knowledge, therefore increasing their appreciation. This is an important factor, in the case of products (such as insects) that can be attractive for consumption by both humans and animals. Invertebrate consumption can provide significant amounts of animal protein, especially to indigenous communities during the most difficult times of the year.

Espinosa *et al.* (2020) report that the consumption of insects is known as entomophagy and that it is part of the culture of some countries —such as Mexico, Thailand, and China. According to these authors, Ecuador is another country where lemon ants and this beetle (*R. palmarum* L.) are consumed. *R. palmarum* L. is native to the Ecuadoran Amazon region and has become one of the country's traditional dishes. Another similar concept is anthro-entomophagy, mentioned by Sancho *et al.* (2015). This activity constitutes the main nutritional and food resource of 130 countries in Africa and the Americas, where the largest population of active entomophages lives. There are 113 registered entomophagous countries, with more than 3,000 ethnic groups that consume at least 1,500 species of insects in their diet. Based on this information, we determined the nutritional composition of the larvae of the *Hynchophorus palmarum* L. 1758 (Coleoptera: Curculionidae) beetle in palm trees of the Mezquital Valley, Hidalgo, Mexico.

MATERIALS AND METHODS

In January 2020, larvae of the South American Palm Weevil (*Rhynchophorus palmarum* L. 1758) were collected from damaged Canary Island date palms (*Phoenix canariensis*) in the gardens of the Universidad Politécnica de Francisco I. Madero, located in Tepatepec, Hidalgo, Mexico (Figure 1).

Palm trees over 6 m high with stress symptoms were felled with a chainsaw. Once the central leaves were cut, the galleries were exposed and the larvae were collected (Figure 1). Subsequently, they were deposited in a plastic jar and placed in a freezer for conservation and transport to the Departamento de Nutrición Animal y Bioquímica, Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autónoma de México (UNAM), where they were analyzed. The nutritional composition and concentrations of calcium



Figure 1. Larvae and galleries of the *R. palmarum* weevil.

and phosphorus of 250 g of fully developed larvae —4 cm long, 2 cm wide, and an average weight of 9.2 g— were evaluated through a proximate analysis. Each analysis was performed in triplicate and the averages were calculated.

The results are presented as a wet basis, which was determined by drying them in an oven at 50 °C for 72 h; the dry matter content was calculated by difference. The crude protein was evaluated using the Kjeldahl method, the ether extract was obtained using a Soxhlet extractor, and the ash content was determined by the calcination method using a Linbert TZ45T muffle. Crude fiber was determined by two digestions —one acid and the other alkaline— in an ANKOM 200/220 fiber analyzer and the nitrogen-free extract was calculated by difference: the protein, fat, mineral salt, and crude fiber percentages are subtracted from 100% of the dry matter (AOAC, 1990). Gross energy was determined using the methodology described in *Standards for Bomb Calorimetry and Combustion Methods* (Tejada, 1992). The determination of calcium (Ca) was made by the precipitation method —forming calcium oxalate— and the concentration of phosphorus (P) by the ammonium phosphomolybdate method by visible UV (AOAC, 1990).

RESULTS AND DISCUSSION

Figure 2 shows the specimens of larvae, pupae, adults, and cocoons of the black palm weevil females and males found at the study site.

Table 1 shows the proximate chemical composition on a wet basis of the South American Palm Weevil larvae and compares them with three edible Lepidoptera larvae in the state of Hidalgo, Mexico. *R. palmarum* larvae have 25.52% crude protein and are surpassed by *C. redtenbacheri* (31.23%), *A. remingtoni* (33.69%), and *A. hesperiaris* (37.79%). As can be seen,



Figure 2. South American Palm Weevil (*Rhynchophorus palmarum*) larvae, pupae, adults, and cocoons; the weevil is a pest of the Canary Island date palm (*Phoenix canariensis*) in the Mezquital Valley, Hidalgo, Mexico (A, female; B, male).

these insects have a high nutritional value (Ramos *et al.*, 2012; Rodríguez-Ortega *et al.*, 2020). We determined that the concentration of digestible protein in the South American Palm Weevil larva is lower (17.68%) than the concentration reported for the Lepidoptera *A. remingtoni* larva (33.69%).

On the one hand, the South American Palm Weevil larva contains 4.58% nitrogen-free extract (Table 1), a slightly higher percentage than *A. hesperiaris* (4.21%), but lower than *C. redtenbacheri* (5.46%) and *A. remingtoni* (6.07%). On the other hand, insects in the larval stage accumulate a greater amount of fat, which they use during their metamorphosis into beetles. This phenomenon was observed in the South American Palm Weevil larvae analyzed, which registered 19.77% of ether extract (Table 1).

The ash concentration was 0.7%, a value slightly lower than the larvae of the other insects (Table 1). These results are similar to those reported by Espinosa *et al.* (2020), who also indicate that the ash represents the total content of minerals in food. Minerals are essential for several body functions. They act as catalysts in a large number of metabolic reactions: for example, calcium is a constituent of bone tissue and iron is an important part of the blood. Therefore, their intake is indispensable, because human beings cannot synthesize them.

Consequently, the mineral concentration of insect larvae is very attractive when used as food. In this case, it can be used as a supplement in the feed fortification for animal consumption or in the preparation of new food products for society (Rodríguez-Ortega *et al.*, 2016). Table 1 also shows the Ca (0.02%) and P (0.31%) concentrations; these values are exceeded by the percentages of the other insects, except Ca in *Comadia redtenbacheri*. These concentrations can cover a person's daily needs, depending on their age, sex, activity performed, and physiological state; these results match the findings of Ramos-Elorduy *et al.* (1998). The humidity concentration was similar to that reported by Maceda *et al.* (2021), who fed larvae with three types of plant tissue.

Additionally, Ramos-Elorduy *et al.* (1990) point out that 100% of the insects they have analyzed provide more energy than chicken, 95% more than wheat and rye, 87% more than corn, 84% more than vegetables, 70% more than fish, lentils, and beans, 63% more than beef, and 50% more than soybean, among other conventional foods. Comparing

Table 1. Nutritional composition of South American Palm Weevil (*Rhynchophorus palmarum*) larvae and three edible Lepidoptera (*Agathymus remingtoni*, *Aegiale hesperiaris*, and *Comadia redtenbacheri*) larvae in the state of Hidalgo, Mexico.

	<i>Rhynchophorus palmarum</i> (%)	<i>Agathymus remingtoni</i> (%)	<i>Aegiale hesperiaris</i> (%)	<i>Comadia redtenbacheri</i> (%)
Variable		Rodríguez-Ortega <i>et al.</i> (2020)	Ramos <i>et al.</i> (2012)	Ramos <i>et al.</i> (2012)
Dry material	35.74	35.76	NA	NA
Humidity	64.26	64.24	77.15	58.30
Crude protein (Nitrogen × 6.25)	9.04	12.05	8.64	10.09
Ethereal extract	19.77	15.97	7.98	23.43
Ash	0.70	0.82	1.05	0.87
Crude fiber	1.64	0.85	0.96	1.85
Nitrogen free extract	4.58	6.07	4.21	5.46
Calcium**	0.02	0.40	0.02237	0.01269
Phosphorus**	0.31	0.56	0.57	0.33
Crude protein**	25.52	33.69	37.79	31.23
Pepsin digestible protein 0.2%**	17.68	30.84	NA	NA
True protein**	22.68	NA	NA	NA

NA=Not analyzed. Methods: humidity (AOAC 2015 934.01), protein (AOAC 2015 2001.11), ether extract (AOAC 1990 920.39), ash (AOAC 2015 942.05), crude fiber (AOAC 2015 962.09). **Results are expressed on a dry basis.

our data with the findings of those authors, we were able to determine that these beetle larvae have good protein, fat, and mineral percentages and should be considered as part of entomophagy diets. The Food and Agriculture Organization of the United Nations (FAO) established in 2013 that the consumption of insects—which has been part of the traditional diet of millions of people—is an alternative nutrient source (especially of protein) (Espinosa *et al.*, 2020).

Finally, the good nutritional characteristics of the larvae of *R. palmarum* position them as a food rich in digestible proteins and with a good caloric content, representing a food alternative for humans or for livestock.

CONCLUSIONS

In Mexico, particularly in the state of Hidalgo, there are no reports of *Rhynchophorus palmarum* as an edible insect and it is only considered a new pest of the *Phoenix canariensis* palm tree. However, according to the results reported in this research, we conclude that, as a result of their high nutritional value, these larvae can be exploited as human or livestock food, used as a protein and energy supplement, and even consumed to enrich and prepare conventional foods for society.

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