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Nutrient composition, mineral content and the solubility of the proteins of palm weevil, *Rhynchophorus phoenicis* f. (Coleoptera: Curculionidae)

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Abstract: Adult (ADS) and larva stages of palm weevil *Rhynchophorus phoenicis* were analyzed for their nutritional potentials using proximate and mineral contents as indices. The early larva stage (ELS) contains the highest moisture content of 11.94% while ADS has the least value of 4.79%. The late larva stage (LLS) has the highest protein content of 10.51% while ADS contains 8.43%. Ash content is highest in ELS with a value of 2.37% and lowest in ADS with a value of 1.43%. ELS and LLS have the highest (22.14%) and lowest (17.22%) fibre contents respectively. The values of potassium, magnesium and iron in ELS were (455.00±21.21), (60.69±2.57) and (6.50±3.40) mg/kg while LLS recorded (457.50±10.61), (43.52±1.37) and (6.00±1.10) mg/kg and ADS recorded (372.50±24.75), (53.31±1.88) and (22.90±3.70) mg/kg. Chromium, phosphorus, nickel, calcium, lead, manganese and zinc were also detected. Copper was not detected in any of the samples. In all the developmental stages the protein solubilities were pH dependent with the minimum protein solubilities occurring at acidic pH while the maximum protein solubilities occurred at alkaline pH.

Key words: *Rhynchophorus phoenicis*, Proximate composition, Mineral analysis, Solubility, Early larva, Late larva
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INTRODUCTION

Members of the class insecta are important sources of food to many animal species including man (DeFoliart, 1992; Adedire and Aiyesanmi, 1999). Edible insects are important sources of high protein to rural dwellers and many city dwellers in Nigeria (Fasoranti and Ajiboye, 1993). 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, 1993). Notable examples of these are the palm weevil, *Rhynchophorus phoenicis*, termites, *Macrotermes nigeriense* (queen, king and reproductives), *Cirina forda*, and variegated grasshopper, *Zonocerus variegatus* (Ashiru, 1988; Mercer, 1994; Adedire and Aiyesanmi, 1999). *Rhynchophorus* spp. are major pests of date palms, coconut palms, oil palms and sugarcane (Vidyasagar *et al*., 2000; Aldryhim and Al-Bukiri, 2003). Though they are very destructive, their nutritional potentials have endeared them to man. Another larval species which is highly cherished is the palm weevil, *Rhynchophorus phoenicis* which inhabits oil palms and coconut. *Rhynchophorus phoenicis* is a large insect, which usually measures over 25 mm in length and is found in wide geographical areas spanning many different climates such as Africa, Southern Asia, and Southern America (Kalshoven and Laan, 1981). 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.

This study determines the proximate composition, mineral potentials and the solubility potentials of the proteins of the palm weevil, *R. phoenicis*. The possibility of using *R. phoenicis* for domestic and industrial purposes is also discussed.

MATERIALS AND METHODS

Insect collection

Live larvae and adults (ADS) of palm weevil, *R. phoenicis* were purchased from the main jetty terminal market at Igbokoda, Ondo State, Nigeria. The larvae were classified into early and late larvae stages (ELS and LLS) based on head capsule measurement, weight, body length, body width and circumference (Table 1). The larvae and adults were killed, by asphyxiating them in a deep freezer for 48 h. The samples were dried separately in a Gallenkamp oven at 60 °C to a constant weight according to the procedures described by Adedire and Aiyesanmi (1999). The oil extracted during drying was put in a bottle and kept in the laboratory until required for analysis. The dried samples were pulverized with laboratory pestle and mortal and stored inside containers until required.

Proximate composition

The moisture content, ash and crude fat of the larvae and adults were determined by the methods of AOAC (1990). Crude protein was estimated by Kjeldahl method as described by Pearson (1976). Crude fibre was assayed by the method reported by Joslyn (1970). The nitrogen-free extract (i.e. the soluble carbohydrate) was calculated by difference. Each of these parameters was determined in triplicates.

Mineral content determination

The mineral components of *R. phoenicis* were determined using the method described by Oshodi (1992). The insects were ashed at 550 °C in a muffle furnace for hours. The ash content was dissolved in 10% HCl and made up with distilled water to 100 ml mark in a standard flask. Some of the minerals present such as magnesium, iron, manganese, potassium, calcium, zinc, chromium, copper, lead and nickel were analyzed by alpha 4 atomic absorption spectrophotometer. Sodium and potassium were estimated by Corning 405 flame photometer (AOAC, 1990). Phosphorus was analyzed by employing vanadomolybate method and absorption was read on CECIL CE 3041 colorimeter (AOAC, 1990). Three determinations were made for each treatment.

Determination of protein solubility

The methods described by Ige *et al*.(1984) and Oshodi and Ekperigin (1989) were used to determine the protein solubility of the samples. Two hundred milligrammes of each of the samples was dissolved in distilled water and the pH was adjusted to the desired value with 0.1 mol/L HCl/NaOH. The tubes containing the mixture were then centrifuged at 4000 r/min and the protein content of the supernatant was determined using Biuret method. Determinations were done in triplicates.

Statistical analysis

All the experiments were conducted in triplicate. Data were subjected to Turkey test. Significance of mean differences was accepted at $P \geq 0.05$.

RESULTS AND DISCUSSION

Proximate analysis

The dimensions of the larvae and adult palm weevils used for this study are presented in Table 1. The proximate composition of the weevil is given in Table 2. The moisture content of the weevil ranged from 4.79% in ADS to 11.94% in ELS. The ELS contained more ash content (2.37%) than any other developmental stage while the adult had the least value of 1.43%. The crude fiber content was highest in ELS and lowest in LLS stage. The highest protein

Table 1 Dimensions of the larval and adult stages (ELS, LLS and ADS) of *R. phoenicis* used

Sample	Weight (g)	Body length (cm)	Body width (cm)	Head region (cm)	Circumference (cm)
ELS	2.59±0.14	2.54±0.04	0.77±0.04	0.65±0.04	3.07±0.06
LLS	8.14±0.14	4.61±0.06	2.05±0.04	1.10±0.01	5.47±0.08
ADS	6.98±0.13	5.70±0.04	1.59±0.02	2.88±0.05	4.49±0.04

Note: Each value is a mean±standard error

Table 2 Proximate composition of larval and adult stages of *R. phoenicis*

Components	ELS (%)	LLS (%)	ADS (%)
Moisture	11.94±0.20[c]	8.40±0.10[b]	4.79±0.26[a]
Ash	2.37±0.15[b]	2.33±0.23[b]	1.43±0.40[a]
Crude fat	61.45±0.41[b]	62.13±1.80[b]	52.40±0.96[a]
Crude fiber	22.14±0.15[b]	17.22±0.01[a]	21.80±0.01[b]
Protein	9.10±0.01[b]	10.51±0.01[c]	8.43±0.06[a]
Carbohydrate (by difference)	4.93±0.02[a]	7.82±0.01[b]	15.97±0.03[c]

Means followed by different letters in a row show significant difference $P\geq0.05$ (Turkey's test)

content of 10.51% occurred in LLS while ADS had the lowest value of 8.43%. The protein contents of ELS and LLS stages were significantly different ($P\geq0.05$) from that of ADS. Fat is the major food component of *R. phoenicis*. The highest value of 62.13% occurred in LLS while ELS and ADS contained 61.45% and 52.40% respectively. The ELS stage had the lowest carbohydrate value of 4.93% while the highest value of 15.97% was obtained in ADS stage. The moisture contents of all the stages were lower than the values reported by Adedire and Aiyesanmi (1999) for *Zonozerus variegatus* [(35.07%±0.85%)~(53.26%±4.61%)] and *Acheta domesticus* (73%) by Pennino *et al*.(1991). However, the values observed in ELS and LLS stages were higher than the values reported for *Anaphe venata* (6.61%) by Ashiru (1988). Low moisture content is a desirable quality in food processing industries since low moisture contents reduces food spoilage. The ash content of the weevil indicated that the larval stages contain more minerals than the adult. The ash contents of the weevil are comparable with the values reported by Pennino *et al*.(1991) for *Tenebrio molitor* (2.5%) and Ashiru (1988) for *A. venata* (3.21%). The minerals in the samples can be particularly useful to pregnant and lactating women. The trend of fibre from ELS to ADS probably is an indication that fibre is converted to energy-rich substances during eclosion. The protein contents of all the developmental stages are higher than the value reported by Mercer (1994) for *R. ferrugineus* (6.10%), but compare favourably with the values reported for *Acheta domesticus* (10.3%) by Pennino *et al*.(1991). However, the value reported for *Euxoa auxiliaries* (24.40%) by White and Kendall (1993) is higher than the values reported for palm weevils. The highest values of insect protein have been reported for first instar stage (53.10%) and fourth instar stage of grasshoppers (52.50%) (Adedire and Aiyesanmi, 1999). The fat content of ADS stage compares with the value obtained in *Gallena mellonella* (56%) by Pennino *et al*.(1991). Fat is essential in the diets because it increases the palatability of foods by absorbing and retaining their flavours (Aiyesanmi and Oguntokun, 1996). Fat is also vital in the structural and biological functioning of cells. The carbohydrate contents of the weevil are lower than the value reported by Ajakaiye and Bawo (1990) for termites, *Trinervitermes germinatus* (19.47%~53.62%). The value of 4.93%±0.02% obtained for early larva compares favourably with the value reported for *Colorado pandora* (4.30%) by Fowler and Walter (1985).

Mineral

Mineral analysis of the weevil showed that all the developmental stages have minerals such as chromium, manganese, magnesium, calcium, phosphorus, iron, zinc, nickel, sodium, potassium and lead (Table 3). Copper was not detected in any of the developmental stages. The ADS stage has the highest value of 22.90 mg/kg for iron. Phosphorus was highest in LLS (6.52 mg/kg) while nickel was highest in the ADS (0.70 mg/kg). The values of manganese in ELS and ADS compared favourably (0.49 mg/kg and 0.50 mg/kg respectively) while LLS recorded 0.30 mg/kg. All the developmental stages of palm weevil are very rich in minerals. The highest value of 457.50 mg/kg observed for potassium in LLS is lower than the values reported for all the instar stages of *Z. variegatus* which ranged between 637.86 mg/10 g and 1117.67 mg/10 g (Adedire and Aiyesanmi, 1999). Magnesium and sodium recorded their highest values of 60.69 mg/kg and 17.00 mg/kg in ELS. The iron content of ADS is higher than the values reported for the third, fourth, fifth instar stages and the adult of *Z. variegatus* (Adedire and Aiyesanmi, 1999). The levels of minerals present in the samples indicate that they will be good sources of minerals for young, pregnant and lactating mothers. Daily requirements of essential minerals can be derived from the consumption of these weevils. Minerals are very essential for the normal development and functioning of the body systems of organisms.

Table 3 Mineral composition (mg/kg) of larval and adult stages of *R. phoenicis*

Elements	ELS	LLS	ADS
Na	17.00±1.00	15.67±0.58	13.67±0.58
K	455.00±21.21	457.50±10.61	372.50±24.75
Ca	0.28±0.01	0.27±0.01	2.63±0.02
Mg	60.69±2.57	43.52±1.37	53.31±1.88
Fe	6.50±3.40	6.00±1.10	22.90±3.70
P	4.89±0.05	6.52±0.12	4.71±0.02
Zn	0.47±0.13	0.31±0.13	0.56±0.10
Mn	0.49±0.04	0.30±0.12	0.50±0.08
Cr	0.49±0.06	0.24±0.15	0.18±0.05
Ni	0.30±0.30	0.30±0.50	0.70±0.10
Pb	3.92±2.60	1.81±3.29	2.19±1.67
Cu	ND	ND	ND

Each value is a mean of three replicates±standard deviation; ND: Not detected

Solubility

The results of the effects of pH on protein solubility (Fig.1) showed that the highest solubility of ELS occurred at pH 11 while the least was observed at pH 3. In LLS the highest solubility was observed at pH 8 while the least value was observed at pH 2. In ADS the minimum and maximum protein solubility occurred at pH 2 and pH 10 respectively. In each of the developmental stages, there are three isoelectric points (ELS pH 3, 5, 7 and 10; LLS pH 2, 5 and 9; ADS pH 2, 5 and 8 respectively). The ELS has the highest solubility in alkaline media. As in the case of variegated grasshopper high solubility of ELS of *R. phoenicis* was recorded in this study (Olaofe *et al.*, 1998). This same trend was observed in LLS and ADS stages. The isoelectric point values of LLS are pH 2, 5 and 9 while that of ADS are pH 2, 5 and 8. These isoelectric points are close to the values reported by Ige *et al.*(1984) for some Nigerian oil seeds (i.e. pH 6 and 8). The possession of 3 isoelectric points showed that each of the developmental stages of palm weevil has more than one major protein constituents.

R. phoenicis is an essential source of different food components and nutrients. The knowledge of the protein solubility and the mineral content of this organism makes it an important food item which needs industrial application. The developmental stages of this weevil could be used in the preparation of animal feeds (e.g. poultry, goat, fish) and other feed formulations.

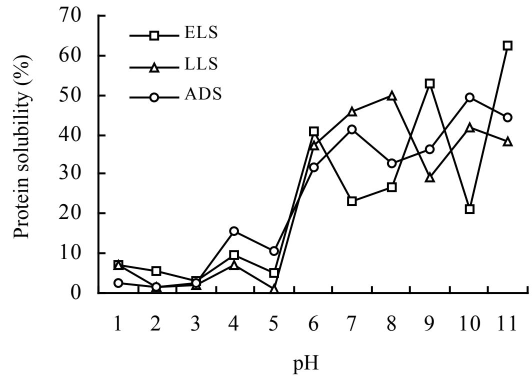

Fig.1 Protein solubility curve of all the developmental stages of *R. phoenicis*

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