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Nutrient composition, functional properties and anti-nutrient content of *Rhynchophorus Pheonicis* (F) Larva

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Abstract

Proximate and chemical analyses were carried out on the larva of *Rhynchophorus phoenicis* (F) and the observed results used to assess it nutritionally. A high fat content (25.30±0.20% wet weight) rich in the essential fatty acids were observed, while all the essential amino acids were detected in varying amounts in the protein component. Macro-elements like sodium (773.49±1.02 mg/100g), calcium (60.81±0.32 mg/100g) and potassium (26.65±0.24 mg/100g) as well as micro-elements like copper (1.26±0.04 mg/100g), cadmium (0.039±0.022 mg/100g) and zinc (10.57±0.89 mg/100g) were present in significant amounts in the insect larva. The insect contained phytic acid (1.35 ± 0.21 mg/100g) and tannin (1.04±0.79) as the major antinutrients, but the values were rather low and could not be considered toxic. The results of the functional properties such as water absorption capacity (127.33±0.20), oil absorption capacity (102.00±0.68), emulsion activity (44.71±0.69), emulsion capacity (45.05±0.60), emulsion stability (43.88±0.67) and foaming capacity (10.60±0.27) show that the insect larva could form a base for new food /feed products of considerable nutritive value, especially if some level of defatting is done to further increase the relative proportion of the protein component.

Key Words: *Rhynchophorus phoenicis,* Nutrient Composition, Functional Properties

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Introduction

The larva of the beetle *Rhynchophorus phoenicis* (F) is a delicacy in many parts of Nigeria and other countries in Africa where it is found. The larva is known by various names by the different ethnic groups (Table 1) who strongly believe it to have high nutritive as well as certain pharmaceutical potentials. The mode of preparing it for eating differs from one geographical locality to another. In some places, it is boiled (Ilesha) while others smoke, fry or simply eat it raw (Ibibio's in Akwa Ibom state, Ibo's in Anambra state). It may be consumed as part of a meal or as a complete meal with Tapioca or bread (Urhobo's in Delta state, Ibibio's in Akwa Ibom state). Some tribes (Urhobo's and Isoko's, both in Delta state) strongly recommend it for their pregnant women, probably as a source of essential nutrients [1-3]. The use of the larva of *Rhynchophorus phoenicis* is believed to extend beyond the nutritional value. Traditionally, many claim that the larva has medicinal properties. For example, the Itsekiri's in Delta state believe that the live larva could cure a certain ailment in infants which presents such symptoms as the twitching of the hands and feet, restlessness and other such movements. To effect a cure for these conditions, the larvae are left in water which is then used to wash the child for several days at the end of which the larvae are crushed together with alligator pepper and administered orally to the child [1, 3]. The biochemical basis for this treatment is not known.

Table 1: The common names of *Rhynchophorus phoenicis* (F) larva as known to the various ethnic groups in Nigeria

ETHNIC GROUP (TRIBE AND / OR STATE)	NAME
Ibibio (Akwa Ibom)	Nten
Bini (Edo)	Orhu
Itsekiri (Delta)	Ikolo
Esan (Edo)	Okhin
Yoruba, Ibadan (Oyo)	Awon
Yoruba, Ilesha (Oyo)	Ekuku
Urhobo (Delta)	Edon
Isoko (Delta)	Odo
Ibo, Idemili (Imo)	Elughulu / Akpangwo
Ibo Ukwa (Anambra)	Eruru
Ibo, Ihiala (Imo)	Nza
Ibo, Aniocha (Delta)	Nzaolubu
Idomas (Benue)	Eko - ali

Evaluation of the nutritive value and antinutrient content of this larva becomes important as the insect larva could form a base for new food/feed product of considerable nutritive value.

Materials and Methods

Live larva of *Rhynchophorus phoenicis* (F) was collected at Illushi, a fishing terminal at the bank of River Niger in Edo State. The species were specifically identified in the Entomology Department, Nigerian Institute for Oil Palm Research (NIFOR), Benin City, Nigeria. The larvae were transported to the laboratory together with their wet/moist feed of raphia palm pith in a well ventilated plastic container and were used within twelve hours of collection.

Proximate and Chemical Analysis

Lipid from the larva was extracted by the method of Bligh and Dyer [4]. Moisture and ash were estimated using the method of AOAC [5]. Crude protein value was quantified using the modified Kjeldahl method of William [6]. The amino acid profile of the larval sample was determined using the method of Spackman *et al* [7] in a Technicon Sequential Multisample Amino Acid Analyzer (TSM). Fatty acid methyl ester (FAME) was prepared using the method of Gunstone [8] while the GLC equipment used was a Pye Unicam Series 104 GCD equipped with flame ionization detector (F.I.D) and connected to a Hitachi model 056 recorder (Hitachi Ltd, Tokyo, Japan). The stationary phase comprised of 10% polyethylene glycol adipate (PEGA) on acid washed and silanized chromosorb W (100-120 mesh) packed in a 1.5x4mm (I.D) glass column of length 5ft. The carrier gas (nitrogen) flowed at 35 ml/min while injection, oven and column temperature was 185^{o}C. The fatty acid peaks were identified by reference to co-chromatographed authentic fame standards (Sigma chemicals). The mineral elements in the larva were determined using an atomic absorption spectrophotometer. Carbohydrate values were determined by difference.

Functional properties

The modified method of Adeyeye *et al* [9] was used to determine the foaming capacity, emulsion stability and least gelation properties of the sample. The method reported by Beuchat [10] was used to determine the oil absorption, water absorption, emulsion capacities as well as the emulsion stability of the sample.

Anti-nutrient analysis

Estimation of Phytin-phosphorus (Phytin-P) was by the colorimetric procedure of Wheeler and Ferror [11] as modified by Reddy *et al* [12]. Phytic acid was calculated by multiplying Phytin-P by a factor of 3.55 [13]. Oxalate content was determined according to the procedure of Day and Underwood [14]. Tannin content was determined by the qualitative method of Markkar and Goodchild [15] as modified by Enujiugha and Ayodele-Oni [16]. Trypsin inhibitor content of the larva was determined using the method of Roy and Rao [17]. The activity of the enzyme trypsin was assayed using casein as substrate and this activity was measured in the larval extracts. All analyses were carried out in triplicates.

Statistical Analysis

Results of the estimations are reported as Mean ± SEM. Statistical analysis was performed using students t-test and $P \leq 0.05$ being considered statistically significant.

Results

Table 2 shows the proximate composition of *Rhynchophorus pheonicis* (F) larva. The moisture value of the larva is quite high (61.85%) while the lipid value 25.30% (wet weight) increases to 66.61% on dry weight basis. Dehydration and defatting is seen to increase the relative concentration of the other nutrients encompassed in the proximate composition.

Table 2: Proximate composition of *Rhynchophorus phoenicis* larva (% wet weight)

Nutrient	Wet weight	Dry weight	Lean weight
Moisture	61.85±0.18	-	-
Lipid	25.30±0.20	66.61±0.35	-
Protein	8.38±0.31	22.06±0.26	66.09±0.28
Carbohydrate	2.10±0.10	5.53±0.17	16.56±0.11
Ash	2.20±0.08	5.79±0.13	17.35±0.08

Results represent the Mean ±SEM of three estimations.

Table 3: Fatty acid composition *of Rhynchophorus phoenicis* Larva (% fatty acid)

Fatty acid	**% composition**
Lauric (C12:0)	0.20 ± 0.03
Myristic (C14:0)	3.20 ± 0.12
Palmitic (C16:0)	32.40 ± 0.58
Palmitoleic (16:1)	3.30 ± 0.20
Stearic (18:0)	3.10 ± 0.13
Oleic (C18:1)	40.10 ± 0.72
Linoleic (C18:2)	13.00 ± 0.20
Linolenic (18:3)	3.50 ± 0.10
Arachidonic (C20:4)	1.20 ± 0.04

Results represent the Mean ±SEM of three estimations.

Table 4: Degree of saturation of *Rhynchophorus pheonicis* larval oil

Fatty acid	Degree of Saturation
TUFA	61.10
TSFA	38.90
MUFA	43.40
PUFA	17.70

TUFA = Total unsaturated fatty acid; TSFA = Total saturated fatty acid; MUFA = Monounsaturated fatty acid; PUFA = Polyunsaturated fatty acid

Table 5: Amino acid composition of *Rhynchophorus phoenicis* (F) larva (g/100g protein)

Lysine	3.99 ± 0.03
Histidine	3.44 ± 0.14
Arginine	5.06 ± 0.12
Aspartic acid	7.02 ± 0.10
Threonine	3.10 ± 0.13
Serine	3.27 ± 0.04
Glutamic acid	12.91 ± 0.70
Proline	2.11 ± 0.24
Glycine	2.95 ± 0.08
Alanine	3.05 ± 0.11
Cysteine	2.20 ± 0.35
Valine	2.80 ± 0.17
Methionine	2.05 ± 0.31
Isoleucine	3.45 ± 0.03
Leucine	6.22 ± 0.54
Tyrosine	2.02 ± 0.09
Phenylalanine	4.13 ± 0.67
Tryptophan	2.51 ± 0.15

Results represent the Mean ±SEM of three estimations.

Table 3 shows the fatty acid composition of *Rhynchophorus phoenicis* larva. Palmitic, Oleic and Linoleic acids are the major fatty acids in the larval oil which is highly unsaturated as shown in Table 4. The total unsaturated fatty acids in the larval oil is 61.10%. This value when compared to oils from most conventional sources is quite high.

Table 5 shows the amino acid composition of *Rhynchophorus pheonicis* larva. All the essential amino acids were present in the protein portion of the larva with leucine, lysine and henylalanine constituting the main essential amino acids.

The mineral composition of the larva of *Rhynchophorus phoenicis* larva is shown in Table 6. Sodium, magnesium and iron were the major elements in the larva.

Table 6: Mineral composition of *Rhynchophorus phoenicis* (F) larva (mg/100g)

Iron	65.23 ± 0.15
Zinc	10.57 ± 0.89
Manganese	1.16 ± 0.09
Lead	0.21 ± 0.08
Cadmium	0.039 ± 0.022
Magnesium	127.16 ± 5.13
Calcium	60.81 ± 0.32
Copper	1.26 ± 0.04
Sodium	773.49 ± 1.02
Potassium	26.65 ± 0.24

The functional properties of *Rhynchophorus pheonicis* (F) larva is shown in Table 7. These relatively high levels of emulsion capacity and emulsion stability suggest that *Rhynchophorus pheonicis* (F) larva would be highly desirable for preparing comminuted meats.

Table 7: Functional Properties of *Rhynchophorus pheonicis* (F) larva

Parameters	**Percentage**
Water absorbtion capacity (WAC)	127.33±0.20
Oil absorbtion capacity (OAC)	102.00±0.68
Emulsion activity	44.71±0.69
Emulsion capacity	45.05±0.60
Emulsion stability	43.88±0.67
Least Gelation	5.84±0.52
Foaming capacity	10.60±0.27
Foaming stability	3.21±0.75
Bulk density	0.68±0.04

Table 8 shows the antinutrient content of *Rhynchophorus pheonicis* larva. The values observed are low indicating the relative safety of using *Rhynchophorus pheonicis* larva as food.

Table 8: Antinutritional composition of *Rhynchophorus pheonicis* (F) larva

Antinutrient	**Amount (mg/100g)**
Phytic acid	1.35 ± 0.21
Oxalate	0.08 ± 0.00
Tannin	1.04±0.79
Lectin	0.61 ± 0.02
Trypsin inhibitor	0.85 ± 0.01

Results represent the Mean ±SEM of three estimations.

Discussion

The moisture content of the insect studied was observed to agree with published data for insects of various species. Table 2 shows the moisture value (%) for *Rhynchophorus phoenicis* larva. Davis [18] had earlier reported a moisture value (%) of 70.0 and 60.4 respectively for the larva and adult beetle of *Lachnosterna species*. Bodine [19] reported a moisture value of 79% for the larva of *Chortophaga viridifasciata,* while studies by Ludwig and Landsman [20] gave the moisture content for the larva of *Popillia japonica* in the range 78-81%. Moisture values for some other insects include: 67.4% for the adult beetle of *Popillia japonica* [21], 69% for newly emerged housefly (*Musca domestica*) [22], 7.9% for larva of soldier fly *Hermetia illuceus* [23], 5.2% for house cricket-*Acheta domesticus* [24], 6.61% for *Anaphe venata* [25], 60.7% for *Bombyx mori* [26], 80.0% for *Antheraea mylitta* [27], *Oryctes rhinoceros* larva [2], *Imbrasia belina* larva [28] . Leung [29] had earlier reported moisture values for palm weevil larva (9.10%), crickets (76.0%) and termites (1.70%), but did not specify the particular species of insects on which these analyses were carried out. Generally, insect larvae tend to contain more moisture than their adult counterparts.

Rhynchophorus pheonicis larva is usually used as food supplement by those who feed on it. It is consumed as part of a meal or as a complete meal. When compared with conventional animal food supplements such as beef, chicken, pork, and fish which have a moisture content of 40-70% [30], the larva of *Rhynchophorus phoenicis* is seen as high moisture food supplement. The high moisture content observed in *Rhynchophorus phoenicis* larva implies that most of the essential nutrients in the insect larva will be in forms that are easily available to the body when the larva is consumed as food. However, dehydration generally increases the relative concentrations of the food components (Table 2) and in addition improves the shelf-life/ preservation of the insect larva.

Fat is the chief form in which energy is stored in insect larva [31,32,33]. It is usually present in greatest amounts in the mature larvae before metamorphosis [34]. According to Fast [34], although fat content can reach as high as 41% wet weight, three-fourths of insect species studied contained less than 10% of wet weight as lipid. Those insects with fat content greater than 10% are primarily phytophagous. The lipid value of *Rhynchophorus pheonicis* (Table 2) is in agreement with this statement. Fast [35] reported a lipid value of 22.3% (wet weight) for *Rhynchophorus palmarum.* Lipid value reported for some insects are 3.1% and 4.0% respectively for the larva and adult beetle of *Lachnosterna* species [18], 2.1% for the Japanese beetle, *Popillia japonica* Neuman [21], 15.5% in the pupae of housefly *Musca domestica* [36]. Teotia and Miller [22] repeated the work done by Calvert *et al* [36] and reported the same results except that the lipid content was a little lower. 7.54% was reported for adult honey bees *Apis mellifera* L [37], 7.21% (dry weight) for dried melanoplus [38], 23.22% (dry matter basis) for *Anaphe venata* [25]. Leung [26, 29] reported lipid values of 36.10, 16.94, 22.08 and 55.24 (%dry weight) for *Bombyx mori,* palmweevil larvae, Crickets and Termites respectively. Ukhun and Osasona [39] reported a lipid value of 46.1% (moisture free basis) for *Macrotermes bellicosus*. Comparatively, the lipid value of this edible insect is higher than that found in most insects for which data is available and in lipids derived from conventional foods of animal origin [34, 40]. Malnutrition in developing countries is as much, or more, a problem of calories deficiency as of protein deficiency [41]. The consumption of this insect could go a long way in taking care of the calorie needs in such communities as a 100g sample will supply enough of the daily energy needs of very active people [42]. This is particularly relevant in the developing countries where much energy is expended in doing works that are usually done by machines in the industrialized countries. Available data shows that of the insects analysed so far, 50% had a higher caloric value than soybeans, 87% were higher than corn, 63% were higher than beef, 70% were higher than fish, lentils and beans, while 95% were higher than wheat, rye or teosintle. [25, 43-46].

Gas liquid chromatographic analysis confirms the high level of unsaturation in the insect larval oil (which is fluid at room temperature), with palmitic and oleic acids as the major fatty acids in the larval oil. The level of unsaturation in *Rhynchophorus phoenicis* larval oil is higher than for palm oil and coconut oil which are common household oils. Insect fatty acids are similar to those of poultry and fish in their degree of unsaturation, with some groups being higher in linoleic and/or linolenic acids which are the essential fatty acids [47]. Nutritionally, a high level of saturated fatty acids in foods might be undesirable because of the linkage between saturated fatty acids and atherosclerotic disorders [48]. The presence of the essential fatty acids such as linoleic, linolenic and arachidonic acids further points to the nutritional value of the insect oil as edible oil. One implication of the high fat content in the insect is that it may increase susceptibility of the undefatted insect larva to storage deterioration via lipid oxidation [49]. This may then be accompanied by increased browning reactions concurrent with reduced lysine availability [50]. Another implication of the high fat content is that defatting the insect will markedly increase the relative proportions of the other nutrients encompassed in the proximate composition. This means that greatly increased protein content can be achieved by defatting the insect larvae as can be seen in the protein value of the defatted sample.

Rhynchophorus phoenicis larva is an internally feeding larva. The insect is phytophagous, and so its mineral composition would be greatly influenced by the mineral composition of its host plant. This is analogous to the observation that the trace element content of plants vary widely and is dependent on the composition of the soil on which the plants grow [51, 52, 53, and 54]. Table 2 shows the ash content of the insect larva while Table 6 shows the mineral composition of the insect expressed in mg/100g. Several studies have been carried out to determine ash and mineral composition of some insects. McHargue [38] determined the ash content in *Melanoplus* species and reported a value of 5.61%. Other insects for which ash value data are available include, larva and adult beetle of *Lachnosterna* species with values of 2.0% and 1.6% respectively [18], *Popillia japonica* -1.5% [21], *Hermetia illucens* -14.6% [23], *Macrotermes bellicosus* -10.2% [39], *Anaphe venata* -3.21% [25], *Bombyx mori* -3.80% [26], *Imbrasia belina* -6.2 (gm/ 100g) [55]. Insects are known to be rich sources of various macro and trace elements. These minerals are probably accumulated for future use in adult exoskeletal and connective tissue synthesis. These minerals are nutritionally important in mammals as they are used in a variety of ways which include the formation of soft tissue [56, 57, 58, 59], the formation of rigid body structures [60, 61, 62, 63, 64, and 65], and as components of body fluids [66, 67]. For example, in Angola, the caterpillar, *Usta terpsichore* M and W was found to be a rich source of iron, copper and zinc. 100g of the insect provided more than 100% of the daily requirement of each of these minerals [44]. Winged adults of the termite, *Macrotermes subhyalinus,* are high in magnesium and copper [41]. In *Rhynchophorus phoenicis,* the iron, zinc, sodium, copper, manganese, lead and cadmium levels (mg/ 100g), meet the RDA values for these minerals. Increased intake of the insect larva will supply most of the macro and trace element requirements of these local communities where the insect is consumed. The high content of iron and zinc in many edible insects is of particular interest. Iron deficiency is a major problem in women's diet in the developing world, particularly among pregnant women, and especially in Africa [68]. This problem which has affected about 2.1 billion people including 42% of all women causes lost work productivity, impaired cognitive development, increased susceptibility to infections and excess morbidity during pregnancy and delivery [69]. Zinc deficiency has been known to cause poor growth and impairment of sexual development [70]. This deficiency has affected 35% of the world's children of ages 0 – 5 years [69]. Vegetarians anywhere are at risk of zinc deficiency, the possible inclusion of this insect in their diet will take care of such needs. Insects generally are observed as a rich store of trace elements, of which its deficiencies now affect nearly half of the world's population [71]. Cereal based diets provide only meager amounts of these essential trace elements. The small amounts of these micronutrients are found in the aleurone layer cells associated with bran and germ which are removed during milling, therefore cereal-based foods tend to be deficient in trace elements [72]. Until recently, interest in cadmium and lead has been centered on their properties as highly toxic cumulative poisons in tissues, but Schwartz [73, 74] has shown that at very low concentrations, they are required for growth in mammals.

The high crude protein content of the insect (Table 2) is suggestive of the potential of the insect specie in combating protein deficiency. Davis [18] reported a value of 11.1 and 20.1% (wet weight) for the larva and adult beetle of *Lachnosterna* species while Fleming [21] reported a crude protein value of 22.1% (wet weight) for the Japanese beetle *Popillia japonica* Newman. Calvert *et al* [36] reported a crude protein value of 63.1% (dry weight) for *Musca domestica* pupae. Calvert *et al* [75] further conducted proximate analysis of newly emerged housefly (*M. domestica*) and reported a crude protein content of 75% (dry weight). Hale [76] noted that dried larvae of the soldier fly *Hermetia illucens* had a crude protein value of 45.2% while Newton *et al* [23] reported a value of 42.1% for same larva, on dry matter basis. Koo *et al* [77] reported a crude protein of 51.7% for face fly, *Musca autumnalis* (De Geer). Ryan *et al* [37] reported that adult honey bees (*Apis mellifera* L) have a crude protein value of 49.8%, Landry *et al* [78] reported crude protein values for *C. promethean, H. cecropia, and M. sexta* as 49.4, 54.7 and 58.0% respectively. DeFoliart *et al* [79] reported a crude protein value of 58% (dry weight) for Mormon cricket (*A. simplex*) while Nakagaki *et al* [24] reported a crude protein value of 62.0% (dry weight) for house cricket (*Acheta domesticus* L). Ashiru [25] reported a crude protein value of 60.03% (dry weight) for *Anaphe venata* while Ukhun and Osasona [39] reported a crude protein value of 34.8% (moisture free) for *Macrotermes bellicosus* , for *Imbrasia belina* larva, Onigbinde and Adamolekun [55] reported a crude protein value of 52.7%. The protein values observed justifies the cultural perception of the high nutritional value attached to entomophagy. These results show that the protein values for these insects are superior to that of beef and chicken as well as other conventional animal protein sources [40]. Proteins provide the chief structural elements of the muscle, glands and other tissues, but in larvae most of the proteins are found in the haemolymph [33]. The fate and physiological role of these proteins are not fully defined, although it seems probable that they play a major role in insect metamorphosis [80]. All the amino acids commonly found in proteins have been identified in insects, which are known to have the same amino acid requirements as mammals [31, 81]. Table 5 shows the amino acid composition of the insect larva under study. All the amino acids known to be essential to man are found present in varying proportions in the protein portion of the insect. Of particular interest is the high level of leucine, lysine and threonine observed in the insect. Lysine and threonine are limiting amino acids in wheat, rice, cassava and maize based diets that are prevalent in the developing world [82, 83], while leucine and histidine have been reported to enhance the growth of infants and young children [84]. Fisher [85] revealed that among the rat, rabbit and chicken, the requirement pattern of the growing rat is most similar to that of a growing child, pointing out that neither requires arginine. He further showed that the requirement pattern of the child for sulphur amino acids and for lysine resembled that of the rat more than those of either rabbit or chick. The inclusion of this insect into the staple diets of these third world communities would boost their nutritional value. The values of the sulphur amino acids though not so high yet they meet the RDA values for these amino acids. Mature insects as a source of protein, on one hand, is of somewhat lower quality than animal products because of the indigestibility of chitin [43, 86]. Despite this, the consumption of insects can to a substantial degree supplement the predominantly cereal diet with many of the protective nutrients [86]. Removal of chitin increases the quality of insect protein to a level comparable to that of products from vertebrate animals. It should be noted however that in insect larvae, most of these nutrients are in the haemolymph and could be easily absorbed in case of ingestion as food or feed. Comparison of the amino acids composition of these insects with conventional animal foods indicate that the supply of some of the essential amino acids were superior to those found in these conventional foods [87]. These insects' proteins may constitute a cheaper source of protein supplement easily available and affordable to the natives within the localities where the insects are found.

The result on the functional properties of *Rhynchophorus pheonicis larva* is shown in Table 7 indicating that the least gelation concentrate of *Rhynchophorus pheonicis larva* is 5.84%. This value is close to the value reported for bovine plasma protein concentrate, (BPPC, 6%) by Aladesanmi *et al* [88]. This result will enhance the use of *Rhynchophorus pheonicis larva* in various food applications such as in comminuted sausage products and in new product developments where gelation may be needed to provide increased gel strength. The water absorption capacity was (127.33±0.20). This shows that *Rhynchophorus pheonicis larva* can easily be incorporated into aqueous food formulations. Oil absorption capacity averaged (102.00±0.68). Oil absorption capacity is important since oil acts as flavour retainer and increases the palatability of foods [89]. The emulsion capacity was 45.05±0.60 while emulsion activity and emulsion stability were 44.71±0.69 and 43.88±0.67 respectively. These relatively high levels of emulsion capacity, emulsion activity and emulsion stability suggest that *Rhynchophorus pheonicis larva* would be highly desirable for preparing comminuted meats. Foam formation and foam stability are functions of the type of protein, pH, processing methods, viscosity and surface tension [90]. The foaming capacity and foaming stability of *Rhynchophorus pheonicis larva* were (10.60±0.27) and (3.21±0.75) respectively. Akubor and Chukwu [91] reported that foams are used to improve the texture, consistency and appearance of foods. The bulk density was 0.68±0.04%.

The result of the anti-nutrient composition of *Rhynchophorus pheonicis larva* is shown in Table 8. Phytic acid averaged 1.35±0.21 mg/100 g while the oxalate value was 0.08±0.00 mg/100 g. These values are lower than those reported in some proteinous foods. Vijayakumari *et al* [92] reported that 513 mg of phytic acid is present in 100 g of *P. chilensis* which is a legume that is very rich in methionine and cystine [93]. The tannin content of the larva was found to be 1.04±0.79, while the lectin and trypsin inhibitor values were 0.61±0.02 and 0.85±0.01 mg/100g respectively. These antinutrient results when compared to values reported for many conventional food sources are found to be quite low.

This insect larva may constitute a cheaper source of essential nutrients that is easily available and affordable to the natives within the localities where the insect larva are found. The results also show that the insect larva could form a base for new food /feed products of considerable nutritive value, especially if some level of defatting is done to further increase the relative proportion of the protein component.

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