

# African palm weevil, *Rhynchophorous phoenicis* Fabricius (Coleoptera: Curculionidae): An alternative mini livestock in Southern Ghana

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**Abstract:** The African palm weevil *Rhynchophorous phoenicis* Fabricius larva is a popular delicacy among the Akans of Ghana and consumption of this insect is an important tradition in the Birim South, East Akim and Kwahu West districts of Southern Ghana. Closed and open-ended questionnaires were administered in these districts to investigate peoples' perception about entomophagy and its potential in combating food insecurity. The African palm weevil larva was the major edible insect identified to be widely consumed by the 500 respondents in all the districts. A paltry 8.3% indicated that entomophagy was primitive. About 87.5% of the respondents consumed the larvae, 11.3% consumed the adult and 1.2% preferred the pupae. In terms of consumption patterns, 54.1% of the respondents regularly consumed the larvae as part of their diet, 27.8% and 10.5% consumed it for nutrition and flavour respectively whilst 7.6% consumed it out of curiosity. Consumption of the palm weevil larvae has the potential to contribute to the alleviation of malnutrition and food insecurity in Southern Ghana.

**Keywords:** *Rhynchophorous phoenicis*, entomophagy, malnutrition and larva.

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## 1. INTRODUCTION

Insects have been consumed in Ghana probably for several centuries with ethnic groups such as the Akans being the pioneers (R. Anim, personal communication, 28<sup>th</sup> November 2015). Entomophagy is practiced in all the ten regions of Ghana (Anankware *et al.*, 2015). Different insect species are consumed in different regions based on their ecological preferences and factors that affect their seasonality (Anankware *et al.*, 2016). For example, the larvae of the night butterfly (*Cirina butyrospermi* Vuliot) which feeds on the Shea tree (*Vitellaria paradoxa* Gaertn) is mostly consumed in the three Northern regions of Ghana while *Rhynchophorous phoenicis* Fabricius is a popular delicacy among the Akans in Southern Ghana (Anankware *et al.*, 2016). Although the wing termite is the most readily available edible insect in Ghana, the palm weevil larva is reported to be the most widely consumed insect in the country (Anankware *et al.*, 2016). An unreasonable perception about entomophagy in Ghana is not justified from the point of nutrition. *R. phoenicis* is superior to chicken, beef and fish in terms of nutrients with a proximate composition of 23.44% crude protein, 3.35% crude fiber, 54.20% ether extract and 5.01% of carbohydrate (Opara *et al.*, 2012). The insect is arguably one of the most nutritious mini livestock, packed with protein, iron and other micro nutrients positioned to address a wide range of population health challenges like anaemia and kwashiorkor affecting pregnant women and children respectively on the African continent (Anonymous, 2014); since livestock and arable agriculture production will not be able to address these in the next 50 years (FOA, 2013). The negativity surrounding the consumption of insects in Western culture contributes towards the misconception that entomophagy in African settings is a survival mechanism prompted by starvation (Van Huis, 2013). Despite the current trends in developing new food product, eating of insects has always been unacceptable to the developed countries (FAO, 2010). Many people in the Western societies, regard entomophagy as disgusting and primitive behaviour (FAO, 2013) and it is the main reason why the butterfly moths are not very popular in Los Reyes Metzontla in

Mexico, because they strongly believe that, they resemble snakes (Acuña *et al.*, 2011). In the middle East where sheep, goats, pigs and cattles were first domesticated, insects are seen as minor food source and not competitive food items (DeFoliart, 2003) which has contributed to the reason why insect rearing has been neglected in agricultural research (FAO, 2013). Moreover, when new food products are introduced in an area, it induces fear (Pliner and Salvy, 2006). Schösler *et al.* (2012) described a case in Europe where edible insects were rejected due to lack of knowledge on their origin and post-ingestional consequence. Similar studies with some students in America showed that majority of the students were able to touch the insects with their hands and not their lips (Schösler *et al.*, 2012). According to Pliner and Salvy (2006) although it is not impossible to disabuse this claim, it requires a reasonable convincing approach to change this mentality. Shrimp and lobsters were poor man's meat in Europe some years ago, but now a popular and expensive delicacy on the continent (Van Huis, 2013). Promoting entomophagy in Ghana demands an innovative approach. In countries such as the Democratic Republic of Congo, Congo and Zambia where consumption of insects is well established, edible insects are well packaged, preserved and retailed (Van Huis, 2013). However, in countries such as Ghana where entomophagy is fast growing among the people, whereas 37 percent of children are malnourished while 57 percent of them under five years are anaemic ([https://www.unicef.org/ghana/health\\_nutrition\\_7522.html](https://www.unicef.org/ghana/health_nutrition_7522.html)), there was the need to determine whether *R. phoenicis* has the potential as a mini livestock to combat food insecurity in the face of increasing population and dwindling resources.

## 2. MATERIALS AND METHODS

### STUDY AREA:

The survey was conducted in the Birim South district, East Akim and Kwahu West municipalities of the Eastern Region of Ghana (Figure. 1) from November to December, 2015. These are rain forest areas with notably long rainy seasons and a high relative humidity for most parts of the year. The average temperatures for Kwahu West, Birim South and East Akim are 26°C, 26°C and 25°C respectively with an average relative humidity of 75% throughout the year (<http://www.statsghana.gov.gh>). There are diverse traditional dishes from each ethnic group and clan in the Eastern region. Staples food in the Eastern region includes cassava, cocoyam, maize and plantain and it vary according to the season, time of the day, and occasion. Eastern region main dishes unlike other cunalyes, are organized around a starchy staple such as rice, fufu, banku, kenkey, yakeyake, akyeke with sauce or soup saturated with fish, snails and meat.

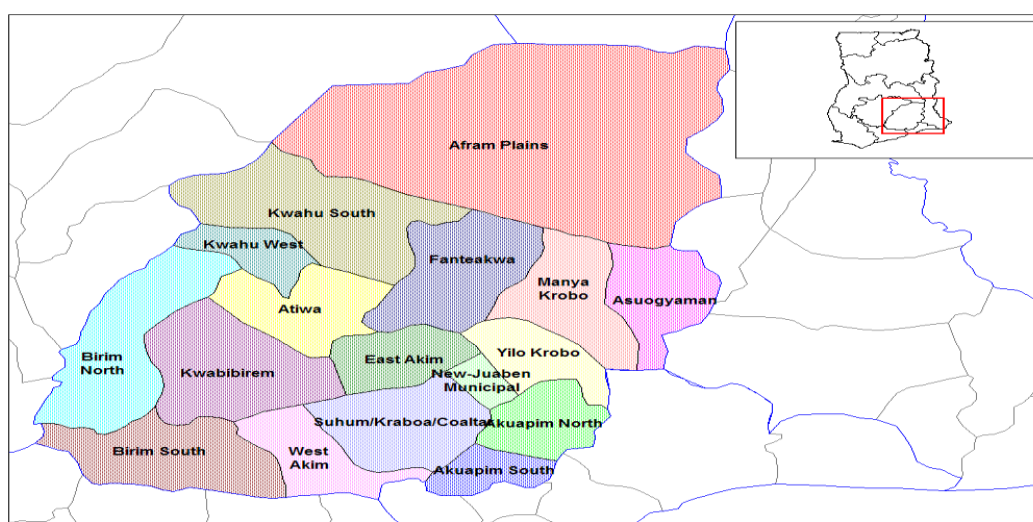


Figure 1: A map of the Eastern Region of Ghana showing areas where the survey was conducted.

### SAMPLING TECHNIQUES AND DATA COLLECTION:

Three communities were selected in each municipality/district and a total of 500 respondents were randomly interviewed. Achiasse, Anamase and Bieni were selected from the Birim South district with a total of 199 respondents interviewed. In the East Akim municipality, 165 respondents were interviewed, mainly from Amanfrom, Odumase and Potroase whilst

135 were from the Kwahu West municipality and from communities such as Fodoa, Jejeti and Apesika. A purposive sampling technique was used to select these communities for the study as these areas have high incidence of palm and coconut plantations. Closed and open ended questionnaire were administered by ten (10) well trained field enumerators within the age ranged of 20 – 30 years for a period of two month from 1<sup>st</sup> November to 31<sup>st</sup> December 2015. These field enumerators were selected based on their experienced and were trained intensively for two days to administer face to face interviews in the three selected communities with some monthly incentives. Percentage and analysis of variance was employed to determine the age, sex, educational level of respondents as well as perceptions, stage at which the insects are consumed, methods of harvesting, processing and preservation techniques used in Southern Ghana.

### 3. RESULT AND DISCUSSION

#### BACKGROUND OF THE RESPONDENTS:

The five hundred respondents interviewed consisted of 41.2% males and 58.8% females. The age groups were 18 - 29 years (29 %), 30 - 39 (30.8 %) and 40 - 60 (40.2 %). The descriptive analysis showed that 74.2% of the respondents had formal education out of which 31.9% had tertiary education and 17.1 and 25.2% having primary and senior high school education respectively. About 25.8% of the respondents in the three districts had no formal education. All respondents referred to the *R. phoenicis* larvae as “Akokono” in the local Akan language. A high number (78.4%) of the respondents sourced their larvae from the wild, whilst 21.6% purchased them from the market. Only 47% of farmers availed themselves for the study in the three districts, of which 27% hailed from Birim South and were within the age range of 30 and 50 years. East Akim and Kwahu West had 13% and 7% of farmers interviewed respectively. Respondents in this survey included farmers (47%), civil servants (28%) and traders (25%)

#### PERCENTAGE OF RESPONDS FROM THE SURVEY:

Scio-demographic characteristics	Perception	Seasonal availability	Reasons for consumption	Mode of harvesting	Mode of processing	Mode of preserving
Disgusting	8.3	*	*	*	*	*
Good	15.7	*	*	*	*	*
Interesting	76	*	*	*	*	*
Rainy season	*	50.2	*	*	*	*
Dry season	*	10.2	*	*	*	*
All year round	*	39.2	*	*	*	*
Nutritional value	*	*	27.8	*	*	*
Food habit	*	*	54.1	*	*	*
Flavour	*	*	10.5	*	*	*
Curiosity	*	*	7.6	*	*	*
Traditional gathering	*	*	*	30.1	*	*
Trapping	*	*	*	8.9	*	*
Use of sound	*	*	*	61	*	*
Boiling	*	*	*	*	44.2	*
Frying	*	*	*	*	33.2	*
Grilling	*	*	*	*	10.2	*
Roasting	*	*	*	*	12.4	*
Freezing	*	*	*	*	*	62.3
Drying	*	*	*	*	*	7.6
Salting	*	*	*	*	*	12.8
Smoking	*	*	*	*	*	17.7

**PERCEPTION OF INDIVIDUAL RESPONDENTS:**

The table shows that 8.3% of the 500 respondents regard the consumption of palm weevil as disgusting/primitive. This confirmed a study by FAO (2013) that 0.25% of people in Western societies and even Africa regard entomophagy as disgusting and primitive behaviour. Different stages of *R. phoenicis* were consumed by respondents in the three districts based on their distribution and factors that affected their seasonality, although the daily use of *R. phoenicis* was limited by their availability and high perishable nature. Researching into a suitable growth medium for sustainable breeding and a conventional cooking method is paramount in advancing entomophagy in Southern Ghana. Entomophagy in Southern Ghana is gradually becoming interesting, drawing the attention of research institutes, restaurants, food industries and individual insects farmers as well as policy makers, creating a possible market in the near future. The major barrier for 8.3% of the respondents not accepting *R. phoenicis* as food is due to the lack of attractiveness and low sensory quality of the insects. However depending on the geographical distribution of the communities, *R. phoenicis* can be prepared with familiar food product such as snacks using insects' flour as an ingredient. Entomophagical practices in Ghana demands an innovative approach and also disabusing people's minds of the negative impressions they have about entomophagy and processing the insects into other meat product like sausage. In countries like DR Congo and Zambia where consumption of insects has become part of their culture, edible insects are well packaged and preserved to counter Western diet (Van Huis, 2013). The traditional use of this insect as food continues to be widespread among the youth in the districts as it provides significant nutrition, economic, and ecological benefits for the rural folks. The nutritional content of *R. phoenicis* has been publicised to the make the youth aware of its benefits. Some respondents also stressed on the medical values of the palm weevil larva in combating anaemia especially among pregnant women. Elsewhere in Kenya where malnutrition is prevalent, studies have shown that wheat buns enriched with *R. phoenicis* are preferred by the locals over ordinary bread as they provide a significant nutritional contribution, especially during times of drought and famine (Van Huis, 2013).

**SEASONAL AVAILABILITY OF R. PHOENICIS:**

The table shows the seasonality of occurrence of *R. phoenicis*. The analysis revealed that 50.2% of the respondents indicated that, *R. phoenicis* larvae were mostly abundant during the rainy season due to ample source of food during that period. In the tropical areas, variation in insect's abundance is well documented but there is little information about the factors that depicts their seasonality (Wolda, 1980). However, Wolda and Fisk (1981) reported that, climatic conditions considerably affect seasonal availability of insects and one of the significant factors in Southern Ghana is the dynamics in elements of weather especially the change from dry to the rainy season. The seasonal pattern of the abundance of *R. phoenicis* is synchronized with availability of food resources which vary with climate. Seasonal climatic conditions exert a strong influence on insect abundance. In an ecosystem with clear distinction between rainy and dry seasons, climatic variables are known to be good indicators of population behavior of insects (Wolda, 1988). Herbivorous insects in temperate areas show a remarkable variation in abundance and activity, mainly in response to changes in climatic factors (Wolda, 1988; Speight *et al.* 1999). Such variation also occurs in the tropics, but it is more complex, although it is clear that rainfall, rather than temperature or photoperiod, is more important (Louton *et al.* 1996). *R. phoenicis* is restricted to certain localities in Southern Ghana due to frequent variations in climatic factors. Coleopteran species, being the largest edible insects groups, are abundant between the months of June and September (Chakravorty *et al.*, 2011). The abundance of this insect is influenced by the availability of food (Wolda, 1988) which negatively affects most herbivorous insects especially in the dry season, when there is less food for them to feed (Braby, 1995). Braby (1995) reported that, this variation in availability of food makes the caterpillars of *Picnotema* species (Lepidoptera: Zygaenidae) mostly dormant from the beginning of the wet season to the second half of the dry season. This factor affects the vegetation which influences the richness, diversity, abundance and distribution of *R. phoenicis*. According to Aman *et al.* (2000) *R. ferrugineus* adults were mostly harvested from early May to late November with three peaks in the middle of June, late July, and early September. Some group (10.6%) of the respondents in this study highlighted that, *R. phoenicis* larvae could be found at the onset of the dry season. According to Alpizar *et al.* (2002), the survival rate of silky cane weevil (*Metamasius hemipterus* Sericeus) (Coleoptera: Curculionidae) in the dry season was high due to the declined action of bacteria and fungi on the cocoon. Furthermore, 39.2% of respondents stated that, the weevil could be found all year round due to the frequent changes in the weather. This confirms the findings of Kyerematen *et al.* (2014) who posited that the

high abundance of insect species in forest plantations was probably due to the availability of abundant food sources. These findings confirm that of Anankware *et al.* (2016) who said that palm weevil larvae are available all year-round in palm growing communities but their abundance is always recorded from May to October.

#### **REASONS FOR CONSUMPTION OF *R. PHOENICIS*:**

The knowledge of consumption of *R. phoenicis* was transferred to the current generation by the older generation and it has become a food habit in the districts. Respondents often prepare the larvae with some local dishes like fufu and soup, roasted yam and grounded pepper and rice and stew. According to 54.1% of the respondents, consumption of the larvae is a tradition (food habit) in most homes in all the three districts in Southern Ghana. This figure is higher than what was reported by Niaba *et al.* (2012) who stated that 25.7% of respondents consumed termites as a tradition in Cote d'Ivoire. Furthermore, 27.8% of the respondents indicated that, the larva was very nutritious and good for the human body because of its medicinal nature in remedying protein and iron deficiencies among children and pregnant women. Furthermore, the cholesterol level of *R. phoenicis* is very low and its however good for consumption for the middle age men and older men and women. Adeoye *et al.* (2014) however reported that 10% and 15% of the respondents interviewed in Itokin and Epe respectively in Nigeria, especially the overweight and diabetic patients, used *R. phoenicis* in their diet as it has the potential of maintaining weight and treating diabetic patients. However, the result showed that, 7.6% of the respondents consumed the larvae out of curiosity whilst 10.5% of the respondents' source of motivation for consuming the *R. phoenicis* was its flavour which boost their appetite and entice them to eat it. These figures were lower than what was reported by Niaba *et al.* (2012) who reported that 17.7% of the respondents consumed winged termites out of curiosity as against 42.2% who consumed the winged termites because of their flavour.

#### **MODE OF HARVESTING *R. PHOENICIS*:**

Harvesting of the larvae was reported to be very difficult due to the burrowing nature of the insect. The descriptive analysis showed that 61.0% of the respondents gathered the larvae by digging the inner core of the dead palm trees after the palm wine had been tapped from the tree. Muafor *et al.* (2015) revealed that, in areas like Abong-Mbang and Mbalmayo in Cameroon, the larvae were systematically harvested from the wild by splitting an infested raphia/palm tree and extracting them from it with the hand. Trapping of the adults was the only means of harvesting by the 8.9% of the respondents in all the districts whilst 30.1% used the sounds produced by the insect to indicate the presence of the larvae in its ecosystem. The larvae make a cryptic sound when feeding. According to Muafor *et al.* (2015) collectors of African palm weevil larva carefully listened to the sound and vibration produced by feeding grubs (larvae). This method was very popular in some villages in the Southern parts of Cameroun (Dounias, 1999) as collectors in areas like Ntoug and Abong-Mbang saw it as an efficient way of detecting and harvesting the larvae. Over the past decade, some communities are innovating a more sustainable ways of acquiring *R. phoenicis* with little harm to the vegetation and environment while promoting easy access to the insects. It was observed during the field surveys, that palm wine tappers innovatively used stunted oil palm trees to trap palm weevils and harvest larvae. A hole was bored into the trunk of the palm plant (without felling the tree). They expose the trunk of the tree; where oil palm weevils feed and oviposit into the exposed inner. The eggs hatch and develop into palm weevil larvae which are then harvested by the farmers

#### **MODE OF PROCESSING *R. PHOENICIS*:**

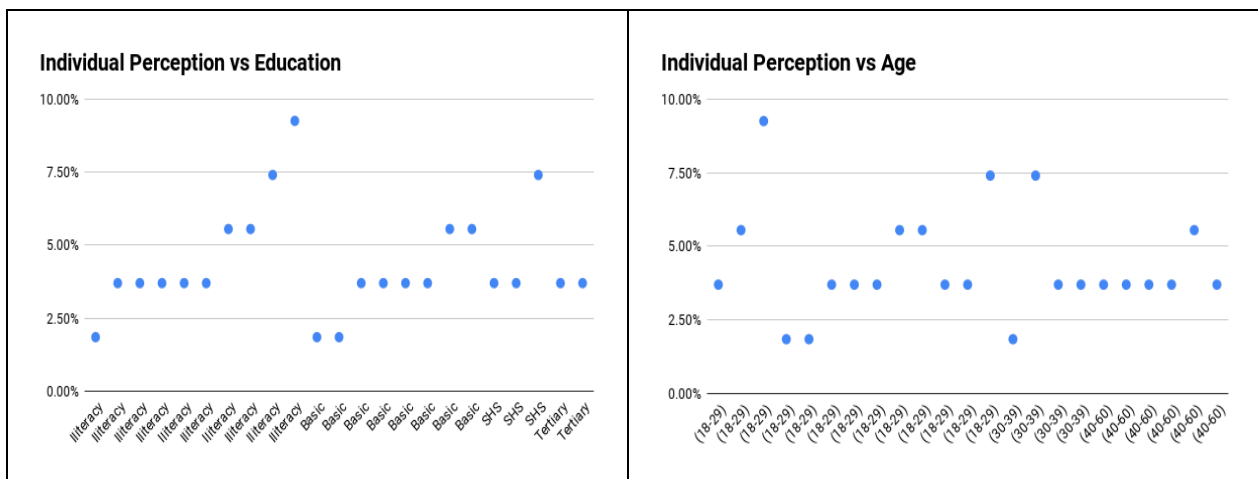
The palm weevil larva was reported to be prepared in different ways including boiling, frying, grilling and roasting. According to De Foliart (1993), some locals in Africa pierced the larvae in the abdomen with a sharp stick and wash in water to drain off the white fatty liquid from their body before they were boiled or fried in vegetable oil for consumption. The results from the present study showed that consistently, 44.2% of the respondents indicated that, the larvae were best eaten when boiled whilst 33.2% prefer to eat fried larvae. Respondents indicated that boiling and frying enhances palatability, juiciness and taste of *R. phoenicis*. However, these may lead to a loss of major macro and micro nutrient in boiled meat and this is in tandem with the findings of Adams and Erdman (1988) who stated that the degree of boiling considerably affected the nutritional contents of meat. Consumers with reflective attention on the implications of food choices indicated that 10.2% and 12.4% of the respondents in this study preferred to roast and grill *R. phoenicis* respectively for consumption. According to Ogbuagu *et al.* (2011) raphia palm larvae were mostly roasted, grilled and garnished with lettuce, green pepper and carrot and consumed with palm wine whilst others also replaced meat with roasted larvae when taking rice in Nigeria.



**METHODS OF PRESERVING R. PHOENICIS:**

Several methods of preservation such as freezing, drying, salting and smoking were used by the respondents to increase the shelf life of the palm weevil larvae. The analysis showed that, 7.2% of the respondents preserved their harvested or freshly purchased palm weevil larvae, pupae and adults by drying, whilst 12.8% preferred salting. These are traditional ways of reducing biological activity in *R. phoenicis*, preventing bacterial growth and enhancing the shelf life of the larvae, pupae and adults. According to Adeoye *et al.* (2014), 5% and 52% of the respondents in Itokin and Epe in Nigeria preserved freshly harvested insects by drying and salting respectively. In this survey, 62.3% preferred to keep their larvae in a refrigerator whilst 17.7% will rather smoke the larvae to increase their shelf life. Bacterial grow rapidly in spoiled meat when they find favourable temperature, increasing their numbers and causing illness to people who consume them. How refrigeration of meat slow bacterial growth preventing food spoilage. Refrigeration slows biological and chemical processes in meat and loss of quality (Zhao *et al.*, 1998). Smoking is very important for a complete elimination or dehydration of water from the insect for better conservation since high moisture content in the insect serves as a catalyst of reactions of spoilage of *R. phoenicis* larvae, pupae or adults. Thermal heating and smoking remain a faster process of dehydration. These values were also above those obtained by Adeoye *et al.* (2014) in Itokin and Epe in Nigeria where 5% of the respondents preserved their insects in a refrigerator, whilst 6% rather preferred to smoke the insects.

**SCIO-DEMOGRAPHIC CHARACTERISTICS:**



The analysis showed that age did not influence perception about the consumption of *R. phoenicis* as the various age group of 18 -19, 20 – 39 and 40 – 60 years had fair knowledge of *R phoenicis* in terms of the stages of consumption, how it was harvested, processed and preserved in all the three districts. The younger generation were more familiar with *R. phoenicis*, despite majority of them have not had the opportunity to harvest the larvae, they knew about the harvesting, processing and preservation methods of *R phoenicis*. This shows why entomophagy in recent times in Southern Ghana is gaining ground. Consumers’ perception of a food item is motivated by previous experiences, how the item is marketed and how the society react towards the item. Besides, considering the current food insecurity situation in Southern Ghana, *R. phoenicis* being an ancient diet in the region, it will make a valuable contribution to the calories and protein of many peoples’ diets in the three districts. The government of Ghana has given its support to Ghanaians to go into production of palm weevil larva as a means of eradicating poverty, which has pave way for some individuals and NGOs to go into full time production of the larvae. A shift from traditional harvesting to mass production of *R. phoenicis* which is currently ongoing by Annepaare Farms and Aspire Food Group in Southern Ghana, have the potential to provide animal protein to humans through direct consumption or indirectly making snacks such as biscuits and cookies to entice the younger generation. Moreover perception and educational background of the respondents did not significantly impact on the consumption of *R. phoenicis* in the three districts, even though some respondents were not familiar with the idea of eating *R. phoenicis* as a mini livestock. Familiarities with food products influence consumer’s choice and its remains the largest barrier to the acceptance of *R. phoenicis* as a viable food source among the Akans in Southern Ghana. Schösler *et al.* (2012) investigated consumer’s perception and readiness to accept different type of meat substitutes in the Netherland. Fictive pizza containing insect protein and dishes with fried mealworms or locust were among the food investigated. Insects protein incorporated into pizza was highly rated among consumers compared to the other tested option. Gender

significantly ( $P < 0.05$ ) affected the consumption of *R. phoenicis*. The survey revealed that women consumed more of the larvae than men in Southern Ghana. Urging the consumption of *R. phoenicis* as a panacea to food insecurity empowering women can significantly increase improve rural livelihoods and reduce hunger and malnutrition in Southern Ghana.

#### **NUTRITION VALUE OF R. PHOENICIS:**

A section of the respondents' motivation for consumption of *R. phoenicis* was the nutritional value of the larva. The proportion of protein and fat in *R. phoenicis* are much greater than that of beef and fish with high energy content (Anankware *et al.*, 2015). Generally insects such as *Rhynchophorous* species and caterpillars are rich in minerals such as calcium, zinc, iron, and magnesium and phosphorous as well as vitamins (Aremu *et al.*, 2006). Several works have also indicated that due to their high nutritional value, 100gms of insects can provide more than 100% of the daily requirements of vitamins and minerals in human (Srivastava *et al.*, 2009). In some regions in Africa, caterpillar flour is mixed with other food to solve problems of malnutrition in children. The red ant is essentially rich in calcium for building strong bones in the anaemic and weaker individual (Srivastava *et al.*, 2009). *R. phoenicis* larvae have 17 amino acids excluding glutamic acid (15.20g/100g) and tryptophan as the predominant amino acids. The larvae have high values of leucine (8.04g/100g), phenylalanine (5.24g/100g), lysine (8.32g/100g) and arginine (6.47g/100g) compared to the lower values of lysine from certain leguminous crops such as cowpea (2.8g/100g) (Aremu *et al.*, 2006) and soybean (6.40g/100g) (Iwe, 2003). Pellett and Young (1990) observed that, these appreciable amino acids plays a crucial role in the human body compared to those obtained from beef and goat. Nutritional values of different insects.

#### **PROSPECTS IN SOUTHERN GHANA:**

Over 90% of Ghanaian daily protein requirement are imported from overseas, making it unsustainable in our food system (Anankware *et al.*, 2015). Consumption of meat in Africa and the rest of the world has dramatically increased in recent times (Kenis, 2014) while the search for an alternative protein source like the palm weevil holds an answer to food and nutritional insecurity crisis in Ghana. Although insects like grasshoppers, Crickets and the Africa Palm weevil larvae feed on agricultural products which serve as food for human consumption, they provide a substantial amount of protein for humans. A list of edible insects worldwide is given at <http://www.ent.wur.nl/UK/Edible+insects/Worldwide+species>, but traditional knowledge on the associated problems, distribution, economic potential and their utilization is very limited in Ghana. Most insect's species used as food over the years in Ghana are either not properly documented or are not published. Fortunately, Anankware *et al.* (2015) embarked on a nationwide survey to identify major edible insects in the ten regions of Ghana. This has resulted in a successful module for rearing black soldier fly *H. illuscens* and house fly, *M. domestica*

## **4. CONCLUSION**

Majority of the respondents believe that *R. phoenicis* has the potential to significantly reduce food insecurity in Southern Ghana once measures are taken to disabuse people's minds on the negative impressions they have about entomophagy. Improved rearing and processing techniques are possible ways of ensuring the continuous supply of edible insects all year-round. AnePaare Farms is currently rearing the African Palm weevil and the black soldier fly larvae for human consumption and animal protein respectively in Ghana. An increased in population growth in Southern Ghana abusively demand an alternative food source to supplements the arable and conventional meat production and its subsequent impact on food security and sustainability will inadvertently lead to a reduction in poverty and hunger in the area. Entomophagy is a definite answer to these problems since insects are easy to rear in large quantities thus making them a rich yet cheaper source of protein.

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