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Identification and classification of common edible insects in Ghana

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Abstract

A survey was conducted to identify and taxonomically classify the major neglected and underutilized edible insects of Ghana as the basis for developing programmes for their enhanced utilisation for human food and animal feed. Two thousand questionnaires were administered using key informant interviews, focus group discussions and direct observations to randomly selected respondents in all the ten regions of Ghana. Edible insects from the different study sites were collected and identified in the laboratory. A total of nine different species of major edible insects belonging to four orders were identified. The nine edible insects in Ghana are: the larvae of palm weevil (*Rhynchophorus phoenicis* Fabricius), termites (*Macrotermes bellicosus* Smeathman), ground crickets (*Scapteriscus vicinus* Scudder), field crickets (*Gryllus similis* Chapman), house cricket (*Acheta domesticus* Linnaeus), grasshoppers (*Zonocerus variegatus* Linnaeus), Locusts (*Locusta migratoria* Linnaeus), caterpillars of the shea tree (*Cirina butyrospermi* Vuillot) and the larvae of the scarab beetle (*Phyllophaga nebulosa* Harris). The scarab beetle (2%), field cricket (5%), shea tree caterpillar (8.7%), house cricket (9.5) and the locust (10) were the least consumed insects whereas the larvae of the palm weevil (47.2%), termites (45.9%), ground cricket (33.3%) and grasshopper (30.5%) were the most consumed insects in Ghana. Northern Ghana currently dominates in entomophagy; especially the Upper West and Upper East regions where eight out of the nine identified insects are consumed. Whereas termites were consumed in all the ten regions of Ghana, the palm weevil larvae were consumed mainly in the middle belt and Southern Ghana; where the palm tree thrives. The other insects are consumed mainly in the Northern parts of Ghana. Termites, field crickets, ground crickets, house crickets, grasshoppers and locusts are consumed by almost all tribes in Ghana.

Keywords: Identification, classification, edible insects, entomophagy

1. Introduction

The total number of entomophagous insect species worldwide is still unknown. The most common insects consumed worldwide are beetles in the order Coleoptera (31%) [1]. This is not surprising given that the group contains about 40% of all known insect species [2]. The consumption of caterpillars (Lepidoptera), especially popular in sub-Saharan Africa, is estimated at 18% [3]. Bees, wasps and ants (Hymenoptera) are third at 14% and are especially common in Latin America. Following these are grasshoppers, locusts and crickets (Orthoptera) (13%); cicadas, leafhoppers, planthoppers, scale insects and true bugs (Hemiptera) (10%); termites (Isoptera) and dragonflies (Odonata) (3%); flies (Diptera) (2%); and other orders (5%) (Figure 1). Lepidoptera are consumed almost entirely as caterpillars and Hymenoptera are consumed mostly in their larval or pupal stages. Both adults and larvae of the Coleopterans are eaten, while the Orthoptera, Isoptera and Hemiptera orders are mostly eaten as mature adults [4].

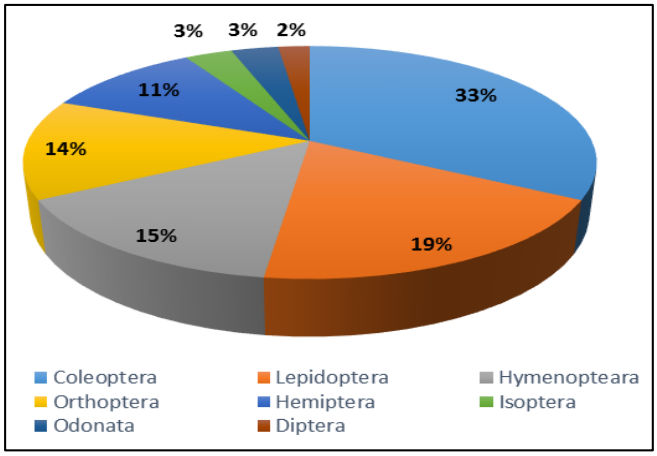

Fig 1: Worldwide percentage distribution of entomophagous insects by order

Classification in biology means the arrangement of the individual living organisms into groups, and the groups into a system, in which the data about them determine their position in the system and thereafter reflected by that position [5]. Classification of living things is an effort to interpret nature. It attempts to bring together the kinds that are alike and closely related and to separate those that are unlike and unrelated [5].

The earliest classifications of insects were based largely on habits, habitats and certain gross anatomical features that contribute to define the facies, or general aspects of the different kinds [5]. Classification of insects in accordance with their natural relationships requires not only anatomical characteristics but also facts pertaining to the physiology, biology, distribution, ecology, and sometimes cytology, of the species.

Prior to this study, there existed no published work that provided an empirical delineation of the various edible insect species consumed by the various ethnic groups in Ghana, hence necessitating this study which sought to identify and classify existing edible insects in Ghana. Knowledge of the number, composition and diversity of the entomophagous species of Ghana will help entomologists as well as consumers understand the kind of edible insects in the country. It will also help consumers know the seasonality and location of each species. This will go a long way to put Ghana on the map of entomophagous countries.

2. Materials and Methods

A survey utilising direct observations, questionnaire administration, key informant interviews and insect collection was conducted throughout the ten regions of Ghana from June to November, 2014 to obtain primary data on the types of edible insects found in the study sites.

2.1 Sampling and selection of respondents

To ensure validity and fair representation of responses, various probability sampling methods were adopted and applied in choosing and administering the pretested questionnaires to respondents. Multi-stage sampling was adopted in selecting respondents for the field survey. Initially, the ten geographic regions of Ghana were used as clusters which were further divided into sub-clusters (Districts and Metropolitan Assemblies). The 216 administrative districts of Ghana were categorised into urban and rural districts. Two districts (one rural and one urban) were selected from each region from which inhabitants were randomly selected and interviewed. At the district level, an urban and a rural community were selected and simple random sampling used to select respondents for the interview (Table 1). The 200 questionnaires allocated to each region were prorated and administered based on the population of the selected communities.

Table 1: Regional, communal and gender distribution of respondents in the survey

Region	Urban community	Rural community	No. of males interviewed	No. of females interviewed
Ashanti	Kumasi	Doyina	120	80
Brong-Ahafo	Kintampo	Jema	114	86
Central	Cape coast	Kakum	110	90
Eastern	Koforidua	Kade	110	90
Greater Accra	Adenta	Chokor	110	90
Northern	Tamale	Sagnarigu	110	90
Upper East	Navrongo	Chaina	110	90
Upper West	Wa	Yaala	110	90
Volta	Ho	Klefe	110	90
Western	Secondi	Nzulezu	110	90
Total			1114	886

Two thousand respondents were interviewed throughout the country, based on calculations made using national population figures from the 2010 population and housing census. The sample size calculation was done using the Slovin formular as illustrated below:

Sampling frame (persons 18 years and above) = 13,632,299

Adopted formula: $n = \frac{N}{1+N(a^2)}$

Where;

n = sampling size, *N = sampling frame*, 1 = *constant*, a = *margin of error*

Source: Sloven, 1960.

Sample size: $n = \frac{N}{1+N(a^2)}$

N = 13,632,299 a = 0.023

$\frac{13,632,299}{1+13,632,299\,(0.023^2)}$ = 2,000 Respondents

2.2 Sources of data collected

Primary data were obtained from the field survey using four techniques namely key informant interviews, questionnaire administration, direct observations and insect collection.

2.1.1 Key Informant Interviews: Key informants provided vital insights on various areas that edible insects could be found in the field. Key informants were mainly opinion leaders and elderly indigenes who had stayed in the target communities for very long periods (over 30 years). Ten key informants were selected in each district using purposive sampling.

2.1.2 Questionnaire administration: Structured questionnaires were used to obtain information on edible insects in all the ten regions of Ghana. A common set of pre-tested questionnaires with open and close ended questions were administered to respondents. This was done using face-to-face administration conducted by trained enumerators from the local communities. The enumerators translated the questions into the local dialect to enhance understanding of

respondents. Pictures and real samples of various edible insects identified from literature were also used to help respondents identify the insects being mentioned. To enhance the depth of information solicited, enumerators probed further for clarification on some responses and the interviewees were asked for explanation on issues such as why some insects were no longer consumed.

2.1.3 Direct observations: In the field, direct observations of activities and available insects in the various localities were recorded. Where appropriate, some key informants assisted to observe available edible insects and their habitats. Pictures were taken to verify and support the results of responses obtained from the responders in various communities. In some cases, the researcher had the opportunity to observe how some edible insects were prepared and consumed.

2.3 Insect collection, identification and classification

Samples of edible insects were collected as part of the survey and insects collected were stored in 70% alcohol and taken to the laboratory for identification.

A mix of primary data and taxonomical characters were used in identifying and classifying the various edible insect species of Ghana. Taxonomic characters were mainly from archival sources and published literature. Classification was achieved by comparing sampled insects with archived samples at the African Regional Post-graduate Programme in Insect Science (ARPPIS) laboratory of the University of Ghana, Accra, Ghana and the entomology laboratory of the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

2.4 Data Analysis

Data were analysed using Statistical Package for Social Science (SPSS) (20) and Microsoft Excel. The completed questionnaires were cleaned and some information verified. The responses were then entered into a pre-coded SPSS template.

Based on the nature of the research questions (where, how, why), descriptive and exploratory approaches were used to delineate and describe the existence and use of edible insects in various localities of Ghana.

3. Results

3.1 Taxonomical classification of the edible insects in Ghana

A total of nine different species of major edible insects belonging to four orders and nine families were identified in the nationwide survey (Table 2; Plates a-i).

Table 2: Major edible insects of Ghana

Order	Family	English name/ Common name	Scientific name	Local name in Ghana	Stage consumed
Coleoptera	Curculionidae	Palm weevil larva	*Rhynchophorus phoenicis* (Fabricius)	Akokono in Twi/Akan	Larva & Adult
	Scarabaeidae	Scarab beetle larva	*Phyllophaga nebulosa* (Harris)	Chibio nabra in Kasem	Larval
Lepidoptera	Saturniidae	Shea tree caterpillar	*Cirina butyrospermi* (Vuillot)	Kantuli in Frafra and Dagari	Larva
Orthoptera	Acrididae	Locust	*Locusta migratoria* (Linnaeus)	Gbamedor In Ewe	Adult
	Pyrgomorphidae	Grasshopper	*Zonocerus variegatus* (Linnaeus)	Manchogo in Kasem	Adult
	Gryllidae	House cricket	*Acheta domesticus* (Linnaeus)	Chari in Kasem	Adult
	Gryllidae	Field cricket	*Gryllus similis* (Chapman)	Paan-ta-kyiiraa in Dagaari	Adult
	Gryllotalpidae	Ground cricket	*Scapteriscus vicinus* (Scudder)	Tiga chari in Kasem	Adult
Isoptera	Termitidae	Termite	*Macrotermes bellicosus* (Smeathman)	Kwena in Kasem	Adult

Plate a: *Phyllophaga nebulosa*

Plate b: *Cirina butyrospermi*

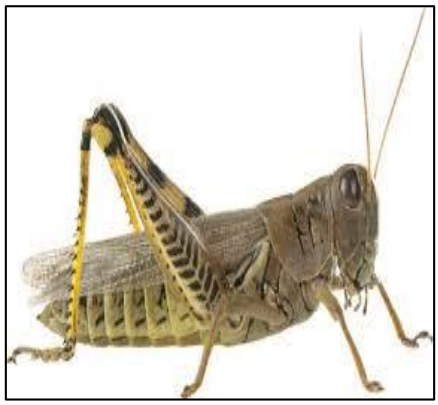

Plate c: *Zonocerus variegatus*

Plate d: *Scapteriscus vicinus*

Plate e: *Rhyncophorus phoenicis*

Plate f: *Locusta migratoria*

Plate g: *Acheta domesticus*

Plate h: *Macrotermes bellicosus*

Plate i: *Gryllus similis*

3.2 Seasonality of edible insects

The seasonal occurrence of the major edible insects in Ghana is illustrated in Table 3. The scarab beetle larva is mostly harvested at the onset of the rains (May to July) in cow dung, compost and/or decomposing organic substrates. This insect is consumed among the Dagaartis, Sissalas and Walas in the Upper West Region and the Frafras in the Upper East Region. Some Dagombas and Bimobas in the Northern Region of Ghana also consume it. With the exception of the palm weevil larva, all the other edible insects are only available from April/May (the onset of the rainy season) till the end of the year. The *Macrotermes bellicosus* for instance is available for harvesting only in June and July.

The shea tree caterpillar is available in only the three Northern regions of Ghana where the shea tree (*Vitellaria paradoxa* Gaertn, formerly *Butyrospemum parkii*) thrives. The caterpillar is consumed by the Dagartis, Sissalas, and Walas in the Upper West Region, the Frafras, Kasena/Nankana, Moshies and Kusasis in the Upper East Region and the Dagombas, Bimobas, Gonjas and Mamprusis in the Northern region.

The palm weevil larva is consumed by the Akans in the Central, Western, Eastern and the Ashanti Regions as well as the Ewes, Gas and Bonos in the Volta, Greater Accra and Brong-Ahafo regions, respectively. The palm larva is available all year round in all palm growing communities but its abundance is always recorded from May to October.

Table 3

Insect	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Palm weevil larva	→	→	→	→	→	→	→	→	→	→	→	→
Scarab beetle larva					→	→	→	→				
Shea tree caterpillar								→	→	→		
Locust					→	→						
Grasshopper				→	→	→	→	→	→	→		
House cricket				→	→	→	→	→	→	→	→	→
Ground cricket				→	→	→	→	→	→	→	→	→
Termite						→	→	→				
Field cricket				→	→	→	→	→	→	→		

Legend: Jan (January), Feb (February), Mar (March), Apr (April), May (May), Jun (June), Jul (July), Aug (August), Sep (September), Oct (October), Nov (November), Dec (December).

3.3 Availability and consumption of edible insects in Ghana

In Ghana, nine edible insects were found to be consumed by at least thirty percent (30%) of the respondents in the survey. The termite (94.7%) was the most readily available insect whiles the shea tree caterpillar was the least available with 37% (Figure 1). In terms of consumption, the palm weevil larva with 47.2% was the most consumed insect followed by the termite (45.9%), ground cricket (33.3%), grasshopper (30.5%), locust (10%), house cricket (9.5%), shea tree caterpillar (8.7%), field cricket (5%) and the least consumed being the scarab beetle larva (2%) (Figure 1).

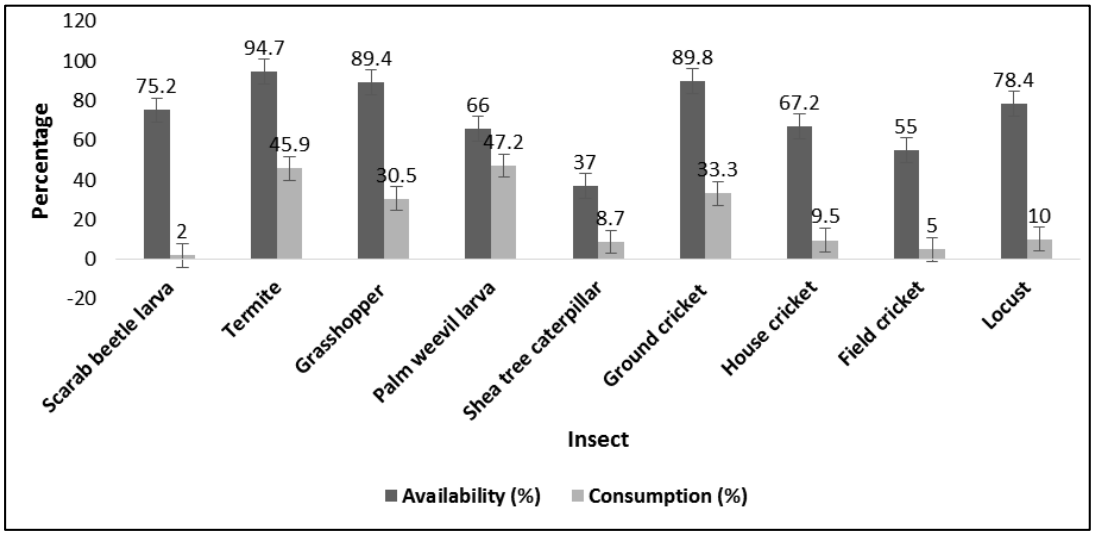

Fig 1: Availability and consumption of insects as food

With regards to insects as feed for animals, four were mentioned, namely; the black soldier fly, termites, ants and the house fly. All of the respondents confirmed the availability of the ant and the house fly whilst 56.8% and 98% confirmed the availability of the black soldier fly and the termite, respectively. For their usage as feed, 91.3% of the respondents argued for the use of the house fly whiles 66.7%, 12.3% and 1.2%, responded positively for the use of ants and the black soldier fly, respectively (Figure 2).

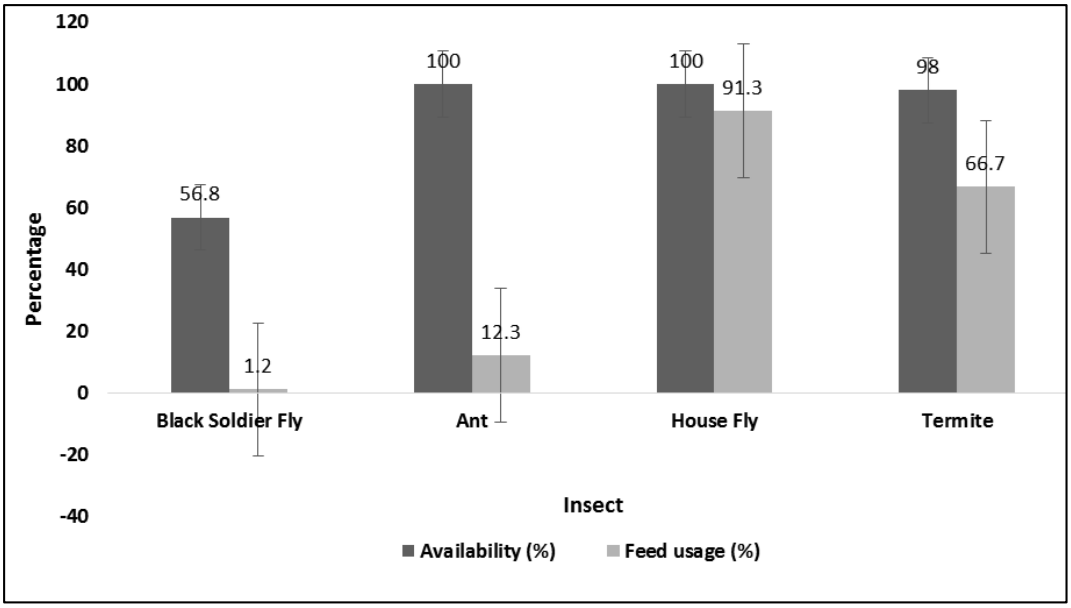

Fig 2: Availability and Use of Insects as Feed for Animals and Fish in Ghana

4. Discussion

The nationwide survey identified nine major edible insects in Ghana. Orthopterans dominate the edible insects in Ghana with five species belonging to four families, Coleopterans have two whiles Isoptera and Lepidoptera have only one species each. This is in contrast to the report by [1] that Coleopterans were the world's most commonly consumed group of insects, accounting for 31%. Whiles their findings may be true for the broader world, it's untrue for Ghana. This also differs from the results of other surveys across Africa and even in West Africa by the International Centre for Insect Physiology and Ecology (ICIPE) in Kenya, which indicated Lepidopterans (caterpillars) as the most commonly consumed group of insects [6]. Our survey results, however, are similar to those

recorded by [7] who also recorded a higher number of edible orthopterans in Africa.

In similar studies in Southern Africa, for instance, [8] identified 27 edible insects in Botswana whiles [9] found 38 edible insects in Zambia, Zimbabwe and the Democratic Republic of Congo; mainly among the Bemba speaking people. According to [10], 21 species of insects are consumed by the Ngandu people of the DR Congo whiles [11] documented 96 different insect species among the indigenous Gbaya people of Central Africa [6]. [12] Reported 250 edible insects across Africa. In a current study by ICIPE, 470 edible insects were identified across Africa [6]. In that same survey, whiles Central and Southern Africa were leading with 256 and 164 edible insect species, respectively, West Africa recorded a low 91 species. The ICIPE survey, which started two years after the commencement of this research recorded seven edible insects in Ghana whiles [13] identified a paltry five. Whereas the ICIPE survey merely sent out questionnaires to entomologist across Africa (of which I was one), this research targeted the indigenous people at the grassroots level in each region of Ghana.

The field survey revealed that insects formed part of the traditional diet of most communities and the nine edible insects were found to be consumed by various ethnic groups in Ghana. Aside directly consuming insects as food, the use of insects as feed for animals is an aged practice among many tribes in Ghana and more pronounced in rural communities? Four insects were identified as feed for animals. Among these, flies and termites were the popular insects consumed by animals (mostly cats, fish and birds).

The consumption of insects is not dependent on only taste and nutritional value, but also on customs, ethnic preferences and prohibitions [3]. The harvesting of insects in Ghana is mostly done by children and women, except the palm weevil larva which is done by men due to the long distances to the harvesting areas (forests) and the difficulty of felling palm trees and the harvesting procedures for the larva. Harvesting methods depend on the behaviour of the insect. Nocturnal insects (termites and house crickets) are mostly lured by light into traps, the ground and field crickets by their chirping sound and the palm weevil larva by the deep cuts artificially inflicted on palm trees. The ground cricket and field cricket are dug out of holes.

Traditionally, a basin (big bowl) is filled with water and placed under a lamp or other light sources in the evening after rainfall to attract termites. The light attracts the reproductive termites which come out for nuptial flights and are trapped in the water or collected by hand into the water to prevent them from escaping. Roasted/fried termites can be purchased in many towns of Northern Ghana notably Navrongo, Sirigu, Chaina and Sandema in the Upper East region and Wa, Nandom and Tumu in the Upper West region. Roasted/fried termites contain 32-36% protein [14]. The grasshopper and the house cricket can also be caught in this manner or harvested early in the morning when they are less mobile due to their low body temperature [3]. Other minor edible insects were identified to be consumed in some communities but many of these are no longer consumed. These include dragonflies, the giant water bug, *Lethocerus indicus* (Lep. and Serv.) and cockroaches (*Periplaneta australasiae* Fab.); which were reported by a few people. The cockroach was mainly used for medicinal purposes. However, the consumption of the stinking blattid cockroaches is reported in Cameroon [15] and in China. Whereas the honey brood and termite were consumed in all the ten regions of Ghana, the palm larva was consumed mainly in the middle belt and Southern Ghana; where the palm tree thrives. The other insects are consumed mainly in the Northern part of Ghana. Termites, field crickets, ground crickets, house crickets, grasshoppers and locusts are consumed by almost all tribes in Ghana.

Although nine edible insects were identified in the survey, it was only one species; the palm weevil larva that was being semi-reared for food. It involved artificially inflicting wounds/cuts on felled palm trees for the adult female palm weevil to lay eggs which hatch into larvae that grow into market-size of about 6-10 g within 3 or 4 weeks. Aspire Food Group, Ghana has also introduced palm rearing kits in Ghana which are currently being used in rearing palm weevil larvae at homes in the Ashanti and Brong-Ahafo regions of Ghana.

The bee (honey brood) is a common insect consumed by all ethnic groups in the country. This is partly due to the fact that bees are found in all parts of the country and honey (from bees) is a common product consumed globally. Some people are able to harvest bee larvae together with honey throughout the year. In fact, the bee should have been added to the group of major edible insects in Ghana, unfortunately, there were some discrepancies in the data collection; as to whether the respondents were referring to bee products or the bees themselves (both adults and larvae). According to [16], when honey is harvested, honey, wax, combs and larvae can be separated, but their combinations including the bees themselves are consumed.

Although four insect species were identified in the survey as feed for animals, it was only the termite that was reportedly semi-reared for animal feed. The termite tunnel or mound is usually fed with either straw or cow dung in a gourd/bowl. As the termites infest and feed overnight, they are harvested early morning through trapping.

This work is intended to establish the basis for research for development (R4D) in Ghana in the area of insects as food and feed. In this study, nine major edible insects were identified and classified. The research has established an edible insect database to serve as a catalogue for people interested in entomophagous-related works. In this case, people will find it more convenient to research into specific areas of interest without painstakingly conducting a nationwide identification survey. Some of these edible insects can be reared as food since they are already a delicacy in many communities. Poultry and fish feed is very expensive in Ghana due to the fact that, the main protein sources (fish meal and soy meal) are imported. Knowledge drawn from this survey will provide alternative protein sources for the feed industry in Ghana and for other countries dependant on imported fish meal and soy. Further studies should be conducted to identify the factors that influence entomophagical practices in Ghana and how they can contribute to improve nutrition and food security in Ghana. This will go a long way to improve our understanding of their ecology and how to sustainably rear them for human food and animal feed.

5. Acknowledgement

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