CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Tropical AgriSciences

Consumer Attitudes towards Edible Insects in Ghana

MASTER'S THESIS

Prague 2022

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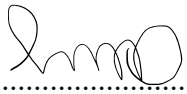
Declaration

I hereby declare that I have done this thesis entitled Consumer attitudes towards edible insects in Ghana independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague date: 21.04.2022



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Nicholas Ganyo Amenuku

Acknowledgements

My very first thanks go to the Lord God Almighty who is my Father, my God and my All in all. He is indeed a Sovereign God, and He does not change, and He will forever remain God. I will be nobody without God. I thank Him for His abundant grace, mercies, and His unfailing love upon me throughout this journey and I express my profound gratitude to Him. May His name be worshipped forever and ever more. Amen

I am grateful to my supervisor; Ing. Petra Chaloupkova, PhD for her time, efforts and detailed supervision invaluably enriched this study. She always made herself available anytime I called on her and I am grateful. I greatly appreciate the tireless effort of Dominic Nyendu for his support and help towards the success of this study. I also appreciate the Faculty of Tropical AgriSciences for the mobility support scholarship for data collection in Ghana for my thesis work. I really appreciate the financial support given me.

Finally, God bless my sister Eva Ocloo for her motherly care and support in everything. May God bless everyone whose name could not be mentioned here due to lack of space, I therefore say thank you all.

Abstract

Edible insects are considered a healthier and more sustainable meat substitutes and protein source. Many studies have been conducted to determine factors influencing consumer behaviour towards edible insects' consumption among consumers worldwide. However, no study has been conducted in Ghana to examine factors influencing edible insects' consumption in Ghana while Ghana has a long history of consuming insects. In this study, we examined consumer attitudes towards edible insects' consumption with focus on respondents from Accra, the capital city of Ghana. Sampled size was 329 respondents through purposive and snowball sampling technique using questionnaires survey. Descriptive statistics and Probit model were used to examine factors influencing insects' consumption by the respondents in Accra Metropolitan district. The study indicated majority of respondents were familiar with entomophagy and had favourable perception towards edible insects. The most preferred species were palm weevil, termites, and ground crickets. The most significant socio-economic factors of the respondents influencing consumption of edible insects were identified, particularly age and household size of the respondents had significant influence on consumption of edible insects by the respondents. Whiles gender, Household income and price were not statistically significant to influence consumption of edible insects.

Edible insects play a crucial role in food security in Ghana as it serves as an important source of rich nutrients and efficient in feed conversation, greenhouse gas emissions, water, and soil use.

Key words: Consumer behaviour, entomophagy, food security, questionnaire survey.

1 Contents

List of tables

List of figures

List of the abbreviations used in the thesis

FAO……. Food and Agriculture Organization

EI……. Edible insects

GMO…… Genetically modified organism

1. Introduction

According to Hwang et al. (2020), the human race will experience a shortage of food availability and water by the year 2050 as a result of the increase growth of the world's population, increase in production cost of animal protein, environmental pollution from human activities, and the current structure of agriculture which creates food and feed insecurity. These factors in a large extent will negatively affect the production and availability of food and water for the entire world. This will intend lead to malnutrition and poor standard of living of people. As a result, edible insect is regarded as one of the major sources of important food resources for the future which in various ways can contribute positively to the global environment, human health and livelihood (Huis 2019). For this purpose edible insects (EI) have been gaining global attention such as the media, research institutions, the food and restaurant industry and policy makers (Hwang et al. 2020). The word "Entomophagy" means consuming insects and it is derived from the Greek word *entomon* (insects) and *phagein* (to eat) (Sogari et al. 2018).

Furthermore, there are some common species of edible insects consumed worldwide. Some of these EI are caterpillars popular in Sub-Sahara Africa, bees, wasps, and ants are especially common in Latin America. There are equally some other edible insects such as grasshoppers, locusts, crickets, cicadas, leafhoppers, planthoppers, scale insects, true bugs, termite, dragonflies and others (Anankware et al. 2016). Also, equally important is to mention that in Ghana there are some common species of edible insects consumed. Some of these insects belonging to four orders are larvae of palm weevil (*Rhynchophorus phoenicis, Fabricius*), termites *(Macrotermes bellicosus, Smeathman)*, ground crickets *(Scapteriscus vicinus, Scudder)*, field crickets *(Gryllus similus, Chapman)*, house crickets *(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 nebulosi, Harris)* (Anankware et al. 2016). These are some of the commonly consumed insects across the ten regions of the country which now sixteen regions even though it is not consumed by every home in the country.

However, edible insects provide a lots of important health benefits and as an important source of food nutrient for humanity. Based on these, according to Mishyna & Chen (2020), since the year 2013, the Food and Agriculture Organization (FAO) has recognized the potential and the importance of using edible insects as food and feed and also supports a number of topics relating to edible insects, as well as knowledge generation and sharing through publications and creation of awareness regarding the roles and importance of edible insects worldwide. This will help to increase the knowledge base of the importance of edible insects and to encourage the consumption and use of edible insects.

Edible insects are noticed to be an important source of protein and lipids. A study conducted by Mishyna & Chen (2020), stated that protein content differs among and within insect from 13 to 77%, with protein digestibility of 76% to 98%, that is lower than many animal proteins, but higher than plant proteins. Edible insects contain 10% - 50% fat. Insects helps as an vital source of protein, minerals, vitamins, energy and can reduce cost than animal protein for poor rural households and the consumption of insects reduces the level of malnutrition more specifically among rural communities (Govorushko 2019). The benefits of the adoption of insects can be viewed from three perspectives: human health, environmental benefits, and socioeconomic benefits.

Even though the practice of eating insects is common in Ghana, there is no available study about factors influencing edible insects consumption in Ghana, and hence the need to conduct a study to determine the factors influencing edible insects consumption in Ghana and how they can contributes to improve nutrition and food security in Ghana (Anankware et al. 2016). This study examines consumer behaviour and attitude towards edible insect consumption among respondents in Accra, the capital city of Ghana.

2. Literature Review

2.1 Global overview of edible insects' consumption

The world has seen a massive increase in global population growth which also leads to high demands for food production and consumption. It is projected that by the year 2050, the population of the world would be 9 billion people (Fern 2021) and the need for an alternative sources of protein is important since the conventional sources, such as, beef, poultry and pork would not be sufficient to meet the demand of the increasing population growth (Sulzbacher et al. 2019). Over 27% of the world protein intake is animal-based protein, their production is extremely inefficient and unsustainable (McLeod & United 2011). With this growth, there is the need to produce adequate food and availability of protein to feed the population (Huis 2019). It has been projection that by the 2050, meat which serves as protein would face challenges due to demand and limited access to adequate land for livestock production. As an alternative to meat-based protein, a lot of attention is drawn to insect consumption which serves as an alternative for protein (House 2016)..

Currently, it is estimated that there are about one million (1million) known species of insects and a total number of between 6-10 million representing over 90% of animal life forms. All over the world some of the most commonly consumed insect species are in biological order of (Coleopera; 31%), caterpillars (Lepidopera; 18%), and bees, waps ants (Hymenopter; 14%), grasshoppers, locusts, and crickets (Orthopera; 13%), cicadas, grasshoppers, mealworm (Hemiptera; 10%), termites (Isoptera) and dragonflies (Odonata; 3%), flies (2%) and another genus (5%) (Orkusz et al. 2020).

2.2 Global development towards insect consumption

Insect is an important source of food for humans and can contribute to global commodity trade and market. The resettlement of people around the world may have help entomophagy to regain its former respectability and inform people in the tropics about its importance in the tropics (FAO 2010). Edible insect as a nutrient-rich food, can contribute to human balance diet for good health. It also enhances environmental awareness and as

an important source of food. Economically, insects help to improve upon food and income security for the poor through farming, commercialisation, and consumption of insects.

Ghana is one the countries in the world that consumes edible insects as a source of food. Edible insects are consumed in all the regions of Ghana. According to Anankware et al. (2016), edible insects were collected from different study sites and were identified in the laboratory. The study identified nine different species of major edible insects which are listed in Table 1 below. Out of the total nine identified species, eight of them are currently consumed in the Upper West and Upper East regions of the country. The palm weevil larvae were consumed in middle part and the southern part of the country where the termites are consumed in all regions of the country. Termites, filed crickets, ground crickets, house crickets, grasshoppers and locust are consumed by all tribes in Ghana.

Table 1. Edible insects consume in Ghana

Name of species	Latin name	% of consumption
Larvae of palm weevil	*Rhynchophorus phoenicis*	47.2
Termites	*Macrotermes bellicosus Smeathman*	45.9
Ground crickets	*Scapteriscus vicinus Scudder*	33.3
Field crickets	*Gryllus similis Chapman*	5
House crickets	*Acheta domesticus Linnaeus*	9.5
Grasshoppers	*Zonocerus variegatus Linnaeus*	30.5
Locusts	*Locusta migratoria Linnaeus*	10
Shea tree Caterpillars	*Cirina butyrospermi Vuillot*	8.7
larvae of the scarab beetle	*Phyllophaga nebulosi Harris*	2

Source: (Anankware et al. 2016)

2.3 Nutritional value of edible insect consumption

The habit of eating edible insects is considered in some parts of the world as a traditional diet for group of people. About two billion people in the world mostly in the tropical and subtropical countries consumes edible insects as a traditional food of about 1,900 edible insect species (Menozzi et al. 2017). Many countries in Central America such as is Mexico, Asia (i.e., Japan, Thailand, and China) and Africa are noted for long

history of familiarity with edible insects whiles on the other hand this is not the case with Europe with exception of just few countries. More so, according to Menozzi et al. (2017), in (2013) the United Nations' Food and Agriculture Organization (FAO) has highlighted the difficulties of using edible insects for individual consumption in order to ensure long-term food security. The FAO has acknowledged the potential benefits and importance of employing edible insects, as well as knowledge development and sharing through media like publications and raising awareness of edible insect's global role. Edible insects remains as a source of rich nutrients and also efficient in the area of feed conversion, greenhouse gas emissions, water and soil use in comparison with most species of domestic animals (Mishyna & Chen 2020).

Notwithstanding, it is important to note that edible insects provide protein and lipid which are important for development and the growth of the human body. Edible insects are well known to be good source of protein and lipid whereby protein content varies among and within insects orders from 13% to 77% (Mishyna & Chen 2020). One can notice that edible insect consumption will be an additional source of protein and to reduce the level of malnutrition among the populace. These is also associated with protein digestibility of 76% to 98% which is lower in comparison with animal proteins, but higher than many plant protein (Ramos-elorduy et al. 1997). Edible insects also has a level of fat content of about 10 to 50% which is equally important for the body development (Hlongwane et al. 2020). Also according to Mishyna & Chen (2020), the study looked at the mineral compositions of edible insects and discovered that they include specific micronutrients such as calcium, iron, magnesium, manganese, phosphorus, selenium, and zinc, as well as key vitamins such as riboflavin, pantothenic acid, biotin, and folic acid. It has also been explained that the food value of edible insects depends to some extent the degree on the composition of what the animals themselves have eaten which can result to what comprises the diets of the insects raised for human or other animals consumption could be modified to the very best form to improve the nutritional value (Glover & Sexton 2015).

2.4 Economic and environmental importance of edible insects

Regarding edible insects production, there is a higher feed conversation ratio to the conventional sources of animal protein, it requires less water and space of land use,

and emit lower level of greenhouse gases, which provide bases for a higher consideration for as a more sustainable and viable source of food and feed source (Oonincx et al. 2015). This helps preserve nature in sustainable way for the generations unborn. Malnutrition as a matter of fact is as a result the prevalence of poverty in our communities most especially developing and low-income countries which have health complications on human development and human resource. There is an increase in the cost of livestock products such as milk and meat which makes it difficult for large families to have access to these vital products for daily survival. It has been proved that the intake of milk and meat is three times higher in developed countries than developing countries; South Asia and Sub-Saharan Africa are far below the level (Ghosh et al. 2020). With the introduction of edible insects would reduce the cost of living in developing countries as a result a reduction in the level of malnutrition among the poor. Insects to a large extent can offer economical and sustainable animal protein. High feed adaptation effectiveness leads to less demand for water and fewer diseases and utilizable parts (lack of bones) make insects a suitable source (Ghosh et al. 2020). This elaborates on the health benefits of edible insect consumption, less amount water, a reduction disease control, and health condition of people.

More so, for instance termite in Africa leads to increase in plant species diversity because some plant species can only grow on termites' mounds. For example edible mushroom, Termitomyces, emanates from termite mounds and is a delicacy for countries such as Ivory Coast, Congo, Nigeria, and Cameroon (van Huis 2017).

Edible insects are usually less costly to produce. They can be grown in a short time by using relatively small land space and minimal animal feeding and cost of maintenance is low making it cost-effective. The non-denaturing dying methods used in lab-scale studies, such as freeze-dying, super-critical CO_2 and microwave drying, are too expensive to be used at the industrial level. However a study indicated that the drying method had a significate impact on the functional properties of Rhynchophorus phoenicis protein (Gravel & Doyen 2020). This implies that the choice of method may involve a trade-off between profitability and functional properties at every step of the process.

2.5 Challenges of using insects as food

The consumption and the use of insects brings about many advantages to society. It is also important to note that even though edible insects bring many advantages not all insects are safe for consumption. In both developing and less developed world, there are clear or established laws and legislation regarding production and consumption of edible insects. But in the developed countries, there are no well formulated complaint actions and execution (Govorushko 2019). To select insects for human consumption one must consider some possible risk such as microbial, chemical, allergenic, parasitical, and toxicological risk. There is a level of risks associated with consumption of insects at the stage of development when insects are not well developed or incorrect culinary preparation.

In addition, among the challenges are microbiological contamination, chemical contamination, malabsorption of nutrients, hematic and growth alterations. For instance, cossid moth Comadia redtenbacheri Hammershmidt was traditionally used as food in Mexican cuisine. However most the larvae which were sold shows signs and symptoms of bacterial infections which transfers potential risk to human health. Most noted are Acinetobacter calcoaceticus, Pseudomonas aerugineosa, Bacillus cereus and others (Govorushko 2019). There are instances of histamine poisoning due to ingestion of fried insects. Grasshoppers and silkworm pupae have a high concentration of histidine is decarboxylated by bacteria to histamine, a heat stable toxin. It has been observed that the ingestion is responsible for reported poisoning (Chomchai & Chomchai 2018). Also, yellow mealworms can be grown on diets composed of organic by-products and these diets can be contaminated with mycotoxins that can be a reason for poisoning (Broekhoven et al. 2017).

In Nigeria, most specifically in the Southwestern part of the country, African silkworm pupae (Anaphe spp.) reportedly poisons consumers each year as a result of the heat-resistant enzyme thiaminase cause abnormalities in locomotory functions (Govorushko 2019). To avoid intestinal constipation caused by large spines on the tibia, the legs must be removed when consuming locusts and grasshoppers.

Edible insects creates so much opportunities to improve foods and develop new food products (Belluco et al. 2013). In a study by Tao & Li (2018) stated that FAO report

in 2010 and 2013 reported positive attitudes and strong interest in edible insects and related foods across numerous cultures. The report also indicated that numerous factors affect the large-scale production and consumption of insect-based foods. In the report, it recommends the need for understanding consumer dynamics, comprising consumer perceptions and attitudes, environment concerns, communication channels, motivation and personal values are vital factors to consider promoting edible insects and products among non-consuming populations. Edible insects to a large extent can create a potential risk to the public if individuals and companies market insects-based products who's associated with risks are not sufficiently evaluated and regulated by governmental agencies. According to Van Huis (2013), indicated that consumers are highly concern about self-care and also personal health and therefore needs adequate information about the safety and quality of new foods. So therefore, consumers are reluctant to accept foods from edible insects if there is a failure on the part of the government to perform its role. All stakeholders need to perform their various roles to promote the safety and quality standard of insects-based food.

2.6 Insects as animal feed

Over the years as the human population increases, there has been a high demand for animal protein to feed the population and as a result put pressure on natural resources and ecosystem to produce enough animal protein (Verbeke et al. 2015). This request for the use of insects as animal feed since insects have a higher nutrient that can improve the performance of domestic animals. In commercial farming feed and feed production total cost reportedly account for 50-70%.

Fodder production globally in 2016 amounted to 1,032.2 million metric tons. The production of feed for various categories of animal in the same units was as follows: for poultry 451.6, pigs is 272.4, ruminant is 221.1, aquaculture animals 39.9, pets 25.0, horse 7.9 and the others is14.4 (Govorushko 2019).

The nutritional properties of insects are high, and they can be successfully substituted for many ingredients used in the production of feed (fish, soybeans). Some species recognized for commercial production are the black soldier flies (*Hermetia illucens*), common housefly (*Musca domestica*), silkworms (*Bombyx mori*), and yellow

mealworm (*Tenebrio molitor*) would be useful commercial production (Oonincx et al. 2015).

Furthermore, for poultry production, there are a number of listed prospective insects which can be used as feed and some of these insects are crickets, termites, grasshoppers, cockroaches, stink bugs, cicadas, aphids, scale insects, psyllids, beetles, caterpillars, fleas, bees, wraps, and ants (Govorushko 2019). For instance, an example can be cited from some villages in Guinea, Togo, Burkina Faso, and India where live termites are used to feed fowl, including chickens, and used to feed ostriches in farms. Maggots in some countries such as Nigeria, Togo, Cameroon, Russia, and South Korea are successful in using maggot as feed for poultry. The maggot are both fed both in fresh form as dried form and dried form can be stored and transported (Hong 2015). Some studies have indicated that maggot can be used as substitute for fish meal in the production of broiler chicken (Al-qazzaz 2016).

In aquaculture, many fish species feed on insects as food but their contribution to household fish production is insignificant. Termites (*Kalotermes flavicollis*), mealworms, grasshoppers (*Acrididae*), silkworms (*Anaphe panda*), black soldier fly larvae (*Heretia illucens*), and common housefly larvae (*Musa domestica*) are some commonly considered insect species for feeding fish (Govorushko 2019).

2.7 Edible insect species

The number of edible insects' species is currently unknown. Approximately 2000 species are consumed by humans today (Yen 2015). There is a lack of knowledge on edible insect species, and depending on availability and individual diet choices, certain edible insects can be found in locations where they are not collected (Hanboonsong & Durst 2014). Furthermore, a larger number of this species may be exploited for human consumption in the future (Yen 2015).

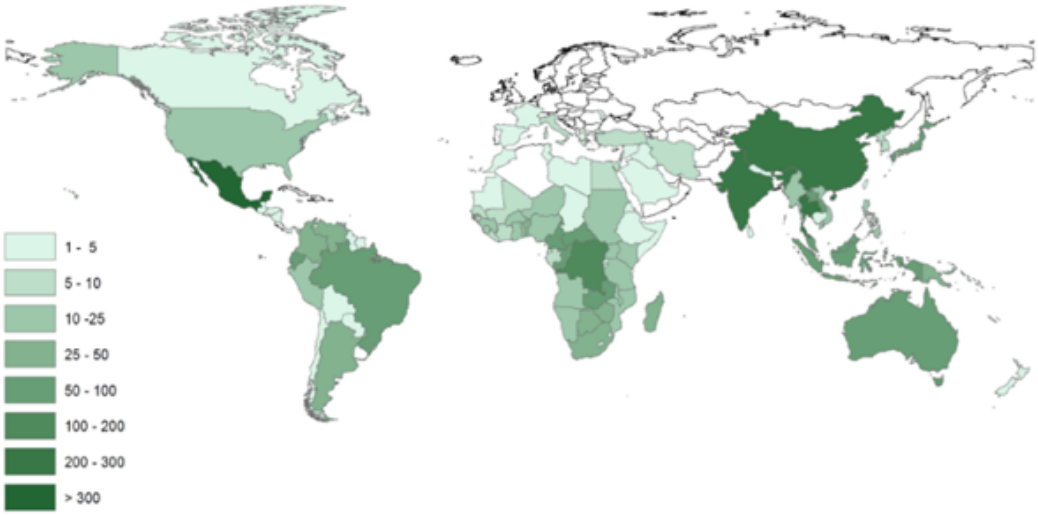


Figure 1: Recorded number of edible insect species, by country in 2017

Source: Wageningen University & Research 2020

2.8 Edible insects' production

Edible insects' consumption is becoming popular in recent years. According Madau et al (2020), insects or insect-based meals are consumed by over 2 billion people in over 100 nations. The distribution of edible insects is concentrated in tropical areas, and western countries are increasing their consumption. There are now three methods for producing edible insects: wild gathering, semi-cultivation, and farming. Only 2% of the world's insect production is farmed, with wild-harvested insects accounting for 92% of overall production, semi-cultivated insects for 6%, and farmed insects accounting for 2% (Yen 2015).

Wild collection

Some common edible insect species dwell together in the same environment, in a variety of environments ranging from aquatic ecosystems to land, woodland, and agricultural fields. Some pest species, such as caterpillars, reside in roots (Witchetty grubs), tree branches and trucks (cicades), or soils (dung beetle) (Van Huis 2013). Edible

insect gathering is particularly popular among the village's residents as a source of food, revenue, and pest control (FAO/WUR 2012). For example, in a Laos community, collecting insects and selling them accounted for 23 percent of total household revenue (Van Huis 2013).

Semi-cultivation

Semi-cultivation of edible insects is based on a better understanding of insect biology and ecology, allowing people to capture insects more efficiently and successfully with a variety of techniques. According to Van Huis (2013), Semi-cultivation is similar to the traditional term for a cultivation process that uses human labor to promote organism growth. In the semi-cultivation method, insects are rarely kept in captivity but rather in the wild, where they are harvested in large groups once they have reached favourable growth stages. Mexican caviar, for example, is a delicacy made from the eggs of aquatic true bugs. Indigenous people use the semi-cultivation approach to harvest genuine insect eggs from their natural environments. A long U-shaped grass bundle is used as a tool to set in the lake for female bugs to lay eggs on, which may then be readily retrieved by shaking the eggs off the bundle (Van Itterbeeck & van Huis 2012).

Farming

Insect farming is not a new concept; silkworms have been grown for over 4,000 years for the tenacity of their by-product (silk) (Reverberi 2020). The concept of insect farming for human consumption grows out of a growing awareness of the problem. Cricket farming is one of the most frequent insect farming methods, with different species being cultivated in various geographical locations around the world, typically on small-scale farms. Cricket farming is more common in Asian countries than in western countries (Hanboonsong et al. 2013). In Thailand, for example, there are about 22,340 cricket farmers who produce about 7,500 tonnes of cricket for commercial purposes.

2.9 Availability and consumption of edible insects in Ghana

In Ghana, edible insects formed part of traditional diet of majority of the communities and are indicated to be consumed by various ethnic groups in the country. Nine major edible insects were found to be consumed in Ghana and aside it been used as food for human consumption, many tribes in the country uses edible insects as feed for animal consumption which according to studies is an aged practice in Ghana (Anankware et al. 2016). The Ghanaian society is found to be among countries which consumes insects as food and as well for feed. Flies and termite are some of the insects used as feed for example cats, fish, and birds.

Ghana is a country of many cultural diversity and customs, ethnic preferences, and prohibitions. Therefore, the consumption of insects is not only based on nutritional value but also on customs, ethnic preferences and prohibitions (Anankware et al. 2016). Ethnicity and cultural values influence the practice and consumption of insects among the people of Ghana. Harvesting of insects in the country is mostly done by women and children with the exception palm weevil larvae which is usually done by men due to the long distance of the harvesting areas and the difficulty of felling the palm trees and the harvesting methods for the larvae. This makes it difficult for women and children. As to harvesting nocturnal insects, for instance termites and house crickets, harvesting is mostly done by luring by light into traps, the ground and field crickets by their chirping sound and the palm weevil larvae by the deep cuts artificially inflicted on palm trees. The ground cricket and field cricket are dug out of holes.

More so, traditionally, in the evening after rainfall, a basin is filled with water and placed under a lamp or other light source to attract termites. The reflection of the light attracts the reproductive termites which come out for nuptial flights and trapped in the water or collected by hand into the water to prevent them from escaping. The termites are fried or roasted and can be purchased in many towns of Northern Ghana mainly in towns such as Navrongo, Sirigu, Chaina and Sandema in the Upper East region, and Wa, Nandom and Tumu in the Upper West region. With nutritional content, roasted/fried termites contain 32-36% protein (Anankware et al. 2016). Harvesting of grasshopper and house cricket can also be done in early hours of the morning when they are less mobile due to their low body temperature. Dragonflies, the giant water bug, and cockroaches which are consumed by a few people in some communities are no longer consumed. The

cockroach was mainly used for medicinal purposes. However, it is indicated that the consumption of the stinking blatted cockroaches is reported in Cameroon and in China. All the regions in Ghana consumes the honey brood but the palm larvae were consumed mainly in middle belt and the Southern part of Ghana. The other type of insects is mainly consumed in the Northern part of the country. Notably termites, filed crickets, ground crickets, house crickets, grasshoppers and locust are eaten by almost every tribe in the country.

According to Anankware et al. (2016), all the nine insects identified in the survey, only one species; the palm weevil is being semi-reared for food. The process involves artificially inflicting wounds on felled palm trees for the adult female palm weevil to lay eggs which hatch into larvae that grow into market-size of about 6-10g within 3 or 4 weeks. In the Ashanti and the Brong-Ahafo regions of Ghana, Aspire Food Group has taken the initiative to introduced palm rearing kits in Ghana which are currently being used in rearing palm weevil larvae at homes. In Ghana all the ethnic groups in the country consumed honey brood. This is because bees are found in all the regions of the country and honey from bees is globally consumed. Bee larvae and honey can be harvested throughout the year.

2.10 Perceived risk of insects' consumption

Perceived risk according to Hwang et al. (2020), can be referred to as "subjectively determined expectation of loss". Risk can equally be explained as the possibility that product will not offer the expected benefits. In the hospitality industry, perceive risk has received a lot of attention whereby it has been used to explain consumer behaviour (Zhang 2018). From the literature, it refers to perceive risk of edible insect restaurants as the subjectively determined expectation of loss because of visiting them. The degree and extent of risk perception for a new product is stronger and usually when there is little information available about the product (Bettman 1986). When there is a direct food consumption the level of perceive risk become higher for the product or services (Hwang et al. 2020). Therefore, since edible insect relate to food consumption it is expected that the level of perceive risk will be higher and the concept of eating edible insects since it is new to societies with cultural background where eating edible insects is not part of their culture.

In addition, Mitchell (2017) state that perceive risk has several facets and should be considered a multi-dimensional concept. The research indicate that consumers perceive multi-dimensional risk in wine consumption in restaurants and showed that perceive risk, for instance, financial risk, social risk, functional risk, and physical risk were important. Also according to Hwang et al. (2020) states that in a more recent study by Hwang and Choe (2019) explore the various types of perceive risk by the use of drone food delivery services and found that financial risk, time risk, psychological risk and performance risk are important. Hwang et al. (2020) also reported seven types of perceive risk suggested by previous studies both individually and collectively: financial risk, social risk, psychological risk, logical risk, time-loss risk, health risk, environment risk, and quality risk. These types of perceive risk is important for consideration in food consumption which consumers takes into consideration when making purchasing decisions.

2.11 Effects of perceived risks on the image of edible insect

First of all, image can be referred to as the overall perception such as belief and impressions that consumers have about a specific or particular product (Crompton 1979). The attributes of product can build a product image about that particular product (Song et al. 2019). It pre-informs consumers about the product and enables consumers to make purchase decision. Good attributes lead to easy consumer product adoption and the vice versa. A study shows that perceive risk and image of food products is negatively associated (Bardin et al. 2017). The study investigated the association between risk perception and product attributes towards genetically modified foods (GMO) and found out that the higher the degree of general risk perception consumers reported, the higher than their attitudes towards genetically modified food negatively. The relationship between perceive risk of genetically modified foods and attitude are significantly negative (Hwang et al. 2020). Consumers perceive risk of consuming food with additives was found out to play a major role in forming image of the additive food. The extent to which individuals perceived the risk the more negative impression they have about additive food (Chen 2017). It has also been proven that hygienic and environmental risks were negatively related in regards to consumer's image regarding food-truck dining (Hwang et al. 2020).

More so, in specific regards to edible insects, according to (Hwang et al. 2020), Bakar et al. (2016) conducted a study and found out that the image of insect consumption varies according to four dimensions of risk. This risk dimensions are functional risk, social risk, physical risk, and psychological risk negatively impact on consumers' final decision making about consumption of insect food products. This shows these types of risk have negative effect on the consumer purchasing decision for edible insect and leads to lower patronage for insect-based food. Also according to Chen (2017) a similar research was done by Balzan et al. (2016), who investigated Italian consumers' willingness to eat insect-based foods, indicate that social risk is one of the most important and one major determinants of eating insects-based food. An experiment was conducted by Chen (2017) by showing Danish and Italian participants videos on the benefits of consuming insect has reduced participants' perceived risks of insects consumption. This helped to create positive perception in the minds of the participants and as a result create positive image of edible insect consumption for the participants. This creates a favourable image for edible insects. In a very recent study by Orsi et al. (2019) examined the factors influencing the acceptance of processed edible insects in Germany. The study indicate that when people think that eating insects is risky, unhygienic and transmits diseases, they create negative or bad impression about the consumption of edible insects (Orsi et al. 2019). These serves as factors hindering the consumption of edible insects since most consumers have negative perception towards its consumption.

2.12 Factors that determine consumer attitude towards edible insects

Because of an evolutionary adaptation to avoid the potential hazards of consuming novel foods, consumers are sometimes hesitant to try new unknown foods (food neophobia). Consumer attitudes have a significant impact on several aspects of human eating behaviour, including food preferences and meal selections (Mishyna & Chen 2020). The historical context of a country also influences attitudes about adaption and consumption of edible insects. For example, in nations where there is no lengthy tradition of eating insects, neophobia has a significant impact on consumer readiness to accept unusual and disgusting foods like insects. As a result of the consumer's unfamiliarity with insects-based foods, they have a negative attitude toward trying them (Payne et al. 2016). Consumers' approval of a product is influenced by a variety of beliefs

and attributes about the product, which are carefully considered before making a purchasing choice (Hartmann et al. 2015).

Food neophobia

Food neophobia is a term used to describe when a person refuses to eat new or unfamiliar foods (Orsi et al. 2019). The majority of research that looked into consumers' acceptance of insects included a food neophobia test (La Barbera et al. 2018). According to recent studies, there is a negative relationship between consumers' willingness to eat insects in western countries when it is associated with other explanatory variables such as perceived healthiness, convenience to the customer, gender, before consumption, and disgust sensitivity (Hartmann & Siegrist 2016). As a result, neophobia is seen to be a necessary element in predicting consumer propensity to eat insects in Western countries. When compared to other important variables like subjective and objective knowledge, empirical analysis has been found to be a better predictor (Quality et al. 2016).

Age

In a strategic marketing, age is one of the vital demographic factors to consider. Age contribute greatly to consumer decision making and consumer choice of product since it has influence on consumers' behaviour (Slabá 2019). People of different age groups think differently, and this influences their purchases and consumption decision making. In the age group of older people the level of interpersonal relationships makes them to consult intensively media for information (Gregorie 2013). More so, word-of-mouth serves as an important source of information and this largely has positive or negative effects on consumption and purchase behaviour (Gregorie 2013). According to Peng et al. (2016), the emotion-focused condition influenced older persons to buy more than the information-focused condition..

Consumer attitudes about edible insects and their age are related to some extent. For example, due to age differences, older individuals are more familiar with many types of food because of their exposure to various cultures around the world. Younger people, on the other hand, are more interested and willing to try new things. In a study by Verbeke (2015) on the ability to deal with insects adoption as a meat substitute revealed that a ten-year age gap could result in a 27 percent reduction in the willingness to adopt insects as a food source. According to Bartkowicz (2017), the youth under the age of 20 years old

in China have negative reactions to traditional meat substitutes with edible insects, however the age group above 21-40 years old supports the idea for a variety of reasons, including health benefits.

Gender

In marketing, consumption and purchasing behaviour, gender plays an important role which present different marketing approaches for companies to adopt to target gender (Perju-mitran & Elisabeta 2015). In contrast to males, women prefer courteous and delicate verbal communication, whilst men prefer quick and straightforward verbal communication (Kraft et al. 2012). According to Verbeke (2015), women are more internally focused and prefer to be inspired by confidence messages that are relevant to their interests, and they are more prone to extra information, whereas men are more externally focused, appreciate the utility of information, and show a strong desire to become loyal customers. Gender was discovered to play a significant role in the consumption of edible insects. Females in Belgium were 2.17 times less likely than males to replace meat in their diet with insects (Verbeke 2015). In the same vein, males are more apprehensive about trying new foods than women. According to Sulzbacher et al. (2019) in a Tri-city, twice as many men as women expressed interest in eating edible insects as an alternative source of food, and Brazilian men consumers have even stronger drive to eat edible insects.

Price

Price is considered as one the most vital marketing mix. Price communicate both the quality and value of the product to the customers which can influence their purchase decisions. Pambo et al. (2016) stated that pricing has an impact on both the purchasing power and future purchases of a specific group of consumers because price is one of the most essential factors to consider when purchasing food. In western countries, insect-based cuisine is more expensive than vegetarian or meat-based diet. In a Western country like the Netherlands, a park of insect-based burgers costs around 4 Euros, while vegetarian burgers cost only 2-3 Euros (House 2016). In the purchase of dietary supplements and functional foods, pricing is a prominent and crucial aspect that contributes to their increased consumption in the Western world. (Chaloupkova & Verner 2020).

Taste

In consumption, consumers are largely influenced by the taste of the food which pre-informed them towards their purchase decisions. A study by House (2016) showed people have a more favourable attitude toward the taste of food containing insects, with the majority of participants stating that the flavour of edible insect-based food is acceptable. A similar research was conducted by Sogari et al. (2016), the findings of the study indicated that Italian consumers have a favourable attitude toward insect-based foods.

Degree of processing

When it comes to eating habits, most people think about the type of food they're eating. Insects as food are divided into two categories: processed foods and unprocessed foods. Cookies and chips are examples of processed foods, while cricket mealworm, scorpion, and other unprocessed foods are examples of unprocessed foods (Melgar-lalanne 2019). Within Germany, consumers' willingness to consume insects is higher for processed foods than for raw foods. When comparing Germany and China, Chinese respondents do not distinguish between processed and unprocessed food items, which could be due to their traditional diet and familiarity with edible insects (Hartmann & Siegrist 2017).

Household composition and family circumstances

Household composition and family circumstance can influence the consumption of insect. According to House (2016) According to a study conducted in the Netherlands, the majority of people who live alone (82 percent) are more likely to include insects in their diet than those who live in groups. According to the study, 57 percent of those who shared a meal agreed that insects might be introduced to their meals. There was a similar study by Pambo et al. (2016) in Kenya shows that children below the age of 18 years readily accepted edible insects in the food than without. In some part of the world, insects serves as a major source of protein for babies whereby mothers dry and grind termite into flour to mix with porridge (House 2016). Average monthly household income in Ghana is 3670 cedis[1] and that of Accra is 5,253 cedis (Ghana Statistical Service 2019).

[1] Ghana national currency

Mindfulness and disgust

Some cultures perceive insects as disgusting. Some European countries based on their culture have negative perception towards insects; therefore, perceives it as dirty, disgusting, or dangerous pest; disease vectors; or sheer nuisances instead of as nutritious food item. Several studies shows that there is a negative impact of disgust on willingness to eat insects, resulting in their rejection even before they actually tasting insect products (Verbeke 2015). The sensation of disgust related to insect food often derives from culturally induced rejection and adverse expectations (Mancini et al. 2019). Studies indicated that there is a great negative impact of disgust on the willingness to eat insects (Sogari et al. 2016). Moreover, a study according to Adámek et al. (2018), indicates that European markets has shown a slight increase in consumers' positive perceptions about insects as a source of protein in food products and also reported that there is positive increase in willingness to consume insects in Belgium.

2.13 Consumption of insects in some selected countries

Edible insects' consumption in Kenya

In Kenya, more specifically in the western regions of the country, the consumption of insects is common among the communities (Christensen et al. 2006). As their regular diet, insect form part and some of their diets are side dish, a snack, or an ingredient in composite dishes. Due to seasonality of these insects, its consumption is concentrated in some months of the year (Ayieko 2010). A study conducted by Halloran et al. (2014) noted that there are pilot attempts, in western, eastern and central (Machakos, Nairobi and Kiambu countries) regions of Kenya, to rear insects through adequate development and using simple technologies for small-scale production to ensure all year round availability. There is availability of different variety of edible insects in the local communities. The region is endowed with different species such as grasshoppers, crickets, locust, termites, and a few edible lake flies. The insects are kept in a clean container and later air-dried for about 14 days to ensure sufficient moisture loss. The harvested insects are mostly consumed 'whole' (where the insects are visible), while fresh or fried and salted (Kinyuru 2009). The study observed that some mothers in the western part of Kenya dry and grind termite into powder and use it as a sprinkle in baby porridge.

Edible insects' consumption in Nigeria

In Nigeria, specifically Kogi State is not left out in insects' consumption. A study conducted by Nelson (2018) listed some indigenous species of insects in Kogi State, Nigeria, such as cricket (98.7%), termite (90.4%), palm weevil (69.9%), yam beetle (35.9%), caterpillars (34.6%), silkworm (11.6%) and locust (3.9%) as the most acceptable indigenous species of insects being consumed by the people of Kogi State. Insect consumption serves as a nutritional supplement and needs for the people of Kogi State. It also noted that none of the participants admitted consuming bee and grasshopper. Insect consumption is found among all the major ethnic groups in the region, for instance Igalas, Yorubas, Ebira and Bassa communities as well as religions with slight difference in gender and age (Nelson 2018). The research also shows that more than half the respondents, (58.3%) have had knowledge of the nutritional value of edible insects.

Table 2. Indigenous species of insects consumed by the people of Kogi State

Species	Cricket	Termite	Palm weevil	Yam beetle	Caterpillars	Silkworm	Locust
Level of acceptance (%)	98.7	90.4	69.9	35.9	34.6	11.6	3.9

Source: Nelson 2018

Edible insects' consumption in Italy

A study in Italy indicate that only a few consumers state that they certainly would not eat insects whereas others said they were willing to try them (Balzan et al. 2016). This shows that the Italian consumers are more likely to accept insects as food. With the issue of attitude, the contribution factor which the respondents cited as basis to reject insects as food besides disgust were appearance, odours, and taste. This research is in line with Verbeke (2015), which states that food neophobia seem to be the most important factor that determines the readiness of consumers to adopt insects as normal food. Tradition was considered as one of the determinants of eating insects in Italy (Balzan et al. 2016). In the study the participants did not judge entomophagy as a "primitive people" or as a disgusting practice but also as an aspect of culture. The respondents also acknowledged social influences as one the factors that determine the intention to consume edible insects.

This is to say that other people influence their consumption of edible insects. With regards to perceived risk consequences, the participants indicated that they have heard about the health benefits related to eating of insects but only mentioned protein as the positive health benefits of eating edible insects. On the negative side they mentioned flies and cockroaches. The participants also believed that insects food should be guaranteed like other animal for human consumption (Balzan et al. 2016).

3 Aims of the thesis

According to Hwang et al. (2020), as a result of the increase growth of the world's population, the would be shortage of food and water by the year 2050 which would create food insecurity and Ghana is not an exception. Edible insects is regarded as an alternative source of food source for future which can contribute to global food security (Huis 2019).

The main objective of this study is to determine consumers' attitudes towards edible insect with focus on the respondents from Accra, the capital city of Ghana. Specifically, the study seeks to answer the following specific objectives:

- To describe respondents familarity with selected edible insects species.
- To examine the perception of the people towards edible insects in Ghana.
- To determine factors influencing insects consumption by the respondents.

Table 3. Factors influencing the consumption of insects

Factors	Authors	Country	Description
Gender	Verbeke 2015	Belgium	Female were 2.17 times less likely to replace meat with insects in their diet
	Sulbacher et al., 2019	Brazil	Brazilian male consumers demonstrate stronger motives in consuming edible insects
Age	Verbeke 2015	Belgium	Younger people are more likely to eat insects than older people.
	Liu et al., 2020	China	Older people are more likely to eat insects than younger people.
	Anankware et al., 2016	Ghana	According to consumers insect is delicious
Household size	Liu et al., 2020.	China	Consumer purchase decision is influence by household size.
	House 2016	The Netherlands	The lone consumer is more like to buy insects
Household income	House 2016	The Netherlands	Positive perception towards edible insects.
	Liu et al., 2020	China	Consumer purchase decision is influenced by household income.
Taste	Sogari et al., 2016	Italy	Positive consumer perception towards the taste of insect products.
	House 2016	The Netherlands	Positive perception towards edible insects.
Price	Pambo et al., 2016	Western Kenya	Price of insects affects both the purchasing power and future purchasing of a particular group of consumers
Mindfulness and Disgust	Sogari et al. 2018	Western and Eastern Societies	Understanding edible insects as food in western and eastern societies

The following hypothesis were formulated based on previous researches:

$H_{1:}$ Age is the main factor that influences the consumption of edible insects (Verbeke 2015).

H_2: Gender influences consumption of insects (Sulzbacher et al. 2019).

H_3: Household size influences consumption of insects (Liu et al. 2020).

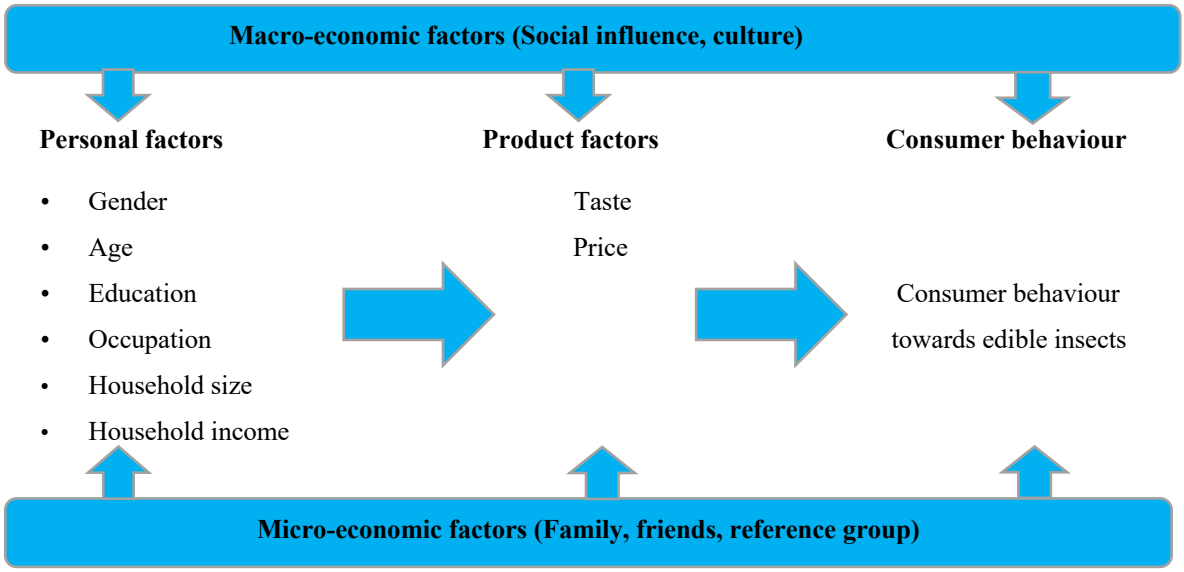
4 Methodology

4.1 Conceptual design

The acceptance and consumption of entomophagy by consumers is largely influenced by some major factors which are grouped into four main factors. These factors are macro factors, micro factors, personal factors, and product factors. The degree to which consumers accept and consume entomophagy is to a very large extent influenced by consumers' culture and attitudes. People adopt goods and services based on their macro-economic factors. For example, some cultures prohibit or encourage consumption of some certain goods and services. One of these macro-economic factors in relation to entomophagy is social influences. For the variables that relate to microeconomic factors is household size. The factors that comprise personal factors are factors such as age, gender, education, occupation, and household income. Factors related to personal food systems includes price, and taste.

Consumers' purchase and consumption decisions are influenced by product price and quality. Price and quality informs the consumer about if the product taste good means the product is of good quality and also are offered at a reasonable price (Hoek 2010). According to Lensvelt & Steenbekkers (2014), consumers are more attracted to organic food than those with additive and artificial ingredients..

Figure 2. Model of consumer acceptance of entomophagy

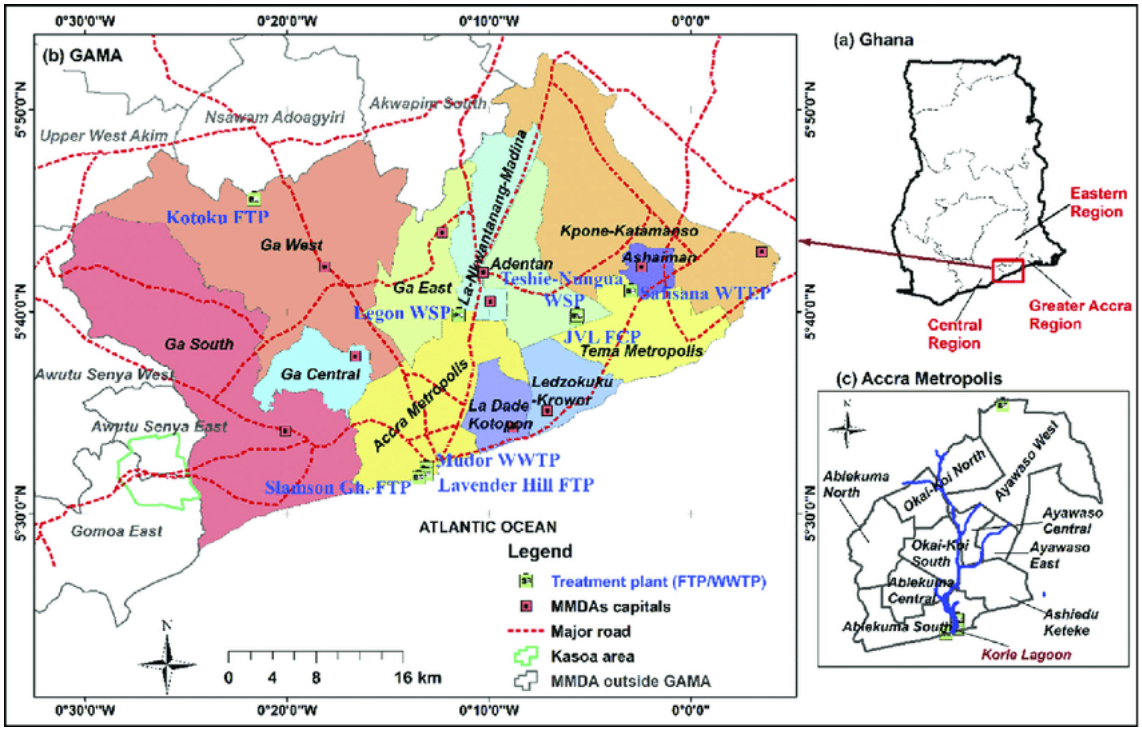


4.2 Study area

To determine consumer behaviour and attitude towards edible insect consumption in Ghana with focus on respondents from Accra, the capital city of Ghana. To pre-assess respondents' knowledge about the listed insect species available in Ghanaian market, pre-research was conducted in Accra metropolis. This was done by a convenient sampling of the people living Accra metropolitan district mostly in the markets. We listed nine species and the most consumed insects are larvae of palm weevil, termite, ground crickets, filed crickets, grasshoppers, locusts, caterpillars of the shea tree, and the larvae of the scarab beetle. This information helped in the formulation of questionnaire design targeted at describing respondents' knowledge and familiarity of edible insects.

Questionnaire administration and data collection was done in Accra Metropolitan District of the Greater Accra region of Ghana which is the study area of the research. Accra Metropolitan District comprises of a mixture of all tribes in Ghana who came from all the sixteen regions of Ghana. The research targeted about 400 participants, but the total collected responses was 329 valid responses. It cut across all the Ghanaian cultures which gives more diverse responses to the questionnaire from the participating respondents. Even though data was collected in every part of the district, some of the most targeted areas are Ablekuma North, Okai-Koi North, Okai-Koi South, Ayawaso West, Ayawaso Central, Accra Central and other parts of the city.

Figure 3: Map of study area



Source: Sagoe et al. 2019

4.3 Sampling strategy

To acquire a good and diversified data, data was collected in all the suburb of Accra metropolitan district. This work is targeted at the citizens of Ghana. The data was collected through Face-face interview and the questionnaires were self-administration. The study uses multi-stage sampling technique after it was divided into two stages; firstly, we used purposive selection of Accra metropolitan district. We purposively selected Accra metropolitan district because it consists of the central business centre where major food markets are located and since it is a metropolitan district, it has a diverse mixture of cultures because of the people from different tribes and regions resides there. Also, convenience sampling technique was used to make easy for data collection since I am from Accra and familiar with Accra.

Secondly, we use snow-ball sampling technique which is characterised by chain-referral sampling strategy. This strategy helps us to relied on referrals from respondents. The research targeted about 400 participants, but the total collected responses was 329 valid responses.

4.4 Questionnaire design

For this work, the questionnaire was divided into five parts with 18 questions. The first part which is the brief introduction to my thesis and part 2 is the familiarity with edible insect consumption. This provides us with the necessary information about consumer knowledge about edible insect species and respondents' familiarity. Questions were asked about which insect they have already consumed and have often they consumed it. To determine consumer attitude towards edible insects' consumption, part 3 was allocated to examine consumer attitudes edible insects, their perception and factors influencing their purchase decisions. About part 4, we evaluated consumer of beliefs and diet whereby questions were asked about what they consider important when making choice regarding food from edible insects. The last part, which is part 5, examined consumer background which provides us information about their age, gender, level of education, household size, household income, occupation and city of birth which helped in our analysis.

4.5 Data analysis

After a successful administration of questionnaire through face-face questionnaire survey, 329 responses were received from the participants in the Accra metropolis. For data cleaning, data was manually keyed into Microsoft excel and was also used for descriptive statistics analysis and for chart construction. The study also used IBM SPSS software to conduct descriptive statistics, Pearson Chi-square test, and Probit regression model.

The first and the second objectives were achieved using descriptive statistics such as tables, frequencies, and percentages.

The third objective was achieved using Probit regression model on SPSS to analyse the factors influencing consumption of edible insects. This was arrived at by comparing the association between consumer preference.

The Probit regression model was stated as follows:

$$Y = \begin{cases} 1 & Y^{*}>0 \\ 0 & \text{otherwise} \end{cases} = \begin{cases} 1 & X^{T}\beta+\varepsilon_i \\ 0 & \text{otherwise} \end{cases}$$

When Y^{*}= the latent dependent variable i.e consumer attitude (1 for positive or more embracing attitude, 0 otherwise)

X_1=Gender (Female=0, Female=1)

X_2=Age (<19 years, 19-30, 31-59, >=61)

X_3=Household size (1-2=1, 3-5=2, >5=3)

X_4=Household income (Below GHC 1,999=0, GHC 2,000-3,999=1, GHC 4,000-5999=2)

GHC 6,000-7999=3, GHC 8,000-9,999=4, GHC 10,000 and above=5

X_5=Price= Perception of edible insects' price (Cheap=1, Expensive=2)

β= Coefficient of Independent Variable

ε_i = the random error term

Table 4: Variable description

Variable	Description	Measure	Expectation
Gender	Sex of respondents:	Dummy	+/-
	Male=1, female=0		
Age	Age of respondents:	Continues	+/-
	Below 19, 19-30, 31-59, 60+		
Household size	Respondents number of people per household:	Continuous	+/-
	1-2=1, 3-5=2, >5=3		
Household income	Respondents' household income into categories:	Continuous	+
	Below GHC 1,999=0		
	GHC 2,000-3,999=1		
	GHC 4,000-5999=2		
	GHC 6,000-7999=3		
	GHC 8,000-9,999=4		
	GHC 10,000 and above=5		
Price	Perception of edible insects' price	Dummy	+
	Cheap=1, expensive=2		

5 Results

5.1 Socio-economic characteristics of the respondents

The total number of respondents who took part in this questionnaire are 329 respondents and their socio-economic characteristics are presented in Table 5 below. Observing from basis of gender, the total number of male and female stood at 49% and 51% respectively. A greater proportion of the respondents fall within the ages of 31-59 with the percentage of 53 followed by the ages of 19-30 years with a percentage of 32. Respondents of the ages of 60+ years and above form 12% and the last but not the least is ages below 19years who are 4% of the total respondents.

To their level of education, 27% of the respondents who form the majority are high school graduates followed by 23% who are bachelor's degree holders, 19% holds vocational skills, 18% with no formal education and 13% are postgraduates. When it comes to their occupation, both unemployed and employed in non-agriculture are 23% each which form the majority and self-employed in non-agriculture are 20%. For self-employed in Agriculture, employed in Agriculture, government officer, students and housewife are 17%, 0%, 11% and 0% respectively. 47% of the respondents who participated in the questionnaire are small household members with maximum of less than 5 people, and 53% are large household size of 5 or more members.

This is reflection of the Ghanaian culture and with a large family or household size according to Ghana statistical serves. For household income, majority of the respondents fall below the average household income in Accra which is 5,252.25 cedis. From the table (Table 5), any household income group which fall below 4,000-5999 cedis is considered below the average income class in Accra. Majority of the respondents fall below the average household income, that is 68% and 18%.

Table 5: Socio-economic characteristics of the respondents

Gender	Frequency	Percentage (%)
Male	162	49
Female	167	51
Age		
<19	13	4
19-30	105	32
31-59	173	53
60+	38	12
Education level		
No formal education	59	18
High school	89	27
Vocational Training	61	19
Bachelor's Degree	76	23
Postgraduate Degree	44	13
Occupation		
Unemployed	76	23
Self-employed in Agriculture	57	17
Self-employed in non-agriculture	66	20
Employed in Agriculture	0	0
Employed in non-agriculture	76	23
Government officer	36	11
Student	18	5
Housewife.	0	0
Household size		
1-2 members	35	11
3-5 members	118	36
>5 members	176	53
Household Income		
Bellow GHC 1,999	224	68
GHC 2,000-3,999	59	18
GHC 4,000-5,999	27	8
GHC 6,000-7,999	16	5
GHC 8,000-9,999	1	0
GHC 1,0000 and above	2	1

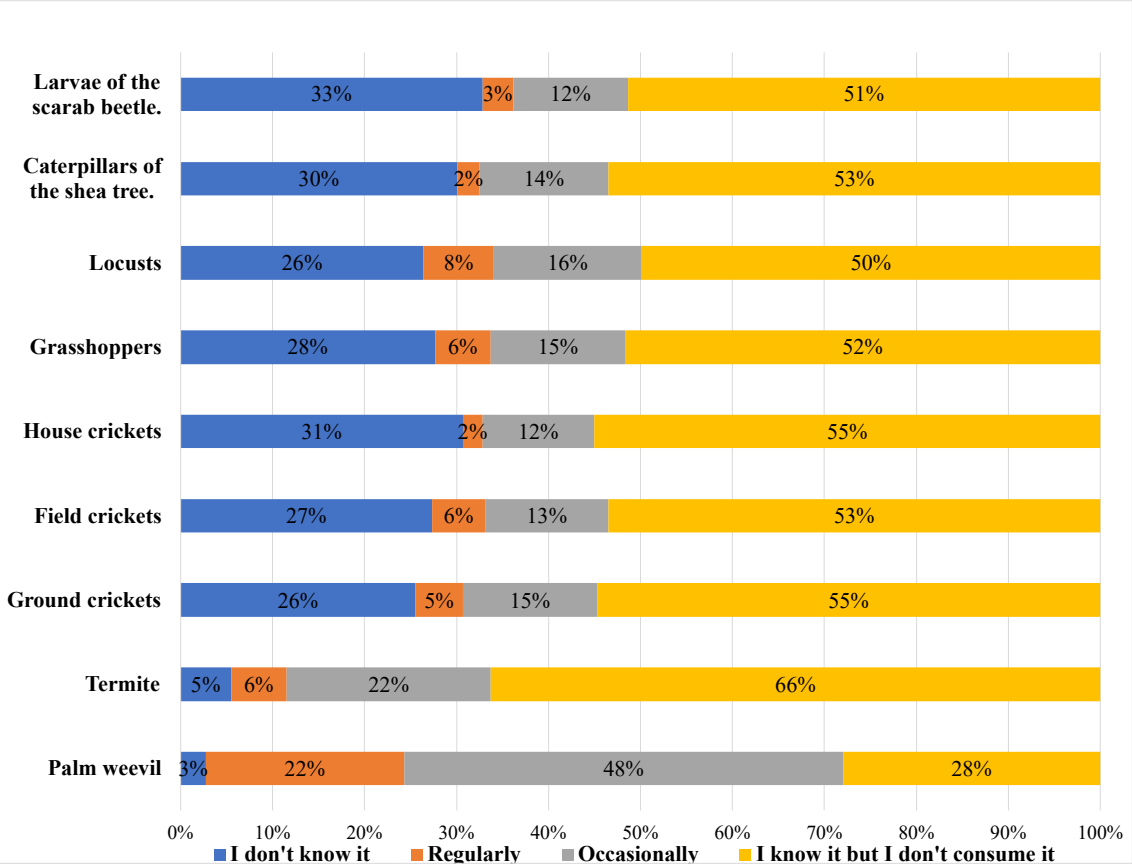
Note: N=329. Exchange rate: 1 Euro = 8.17 cedis. Assessed on 05.04.2022

5.2 Insects' species and respondents' familiarity

Our results shows that the respondents show high level of familiarity of the selected edible insects' species (Figure 4). Majority of them consume palm weevil. 48% of the respondents consume palm weevil occasionally, 22% consume it on a regular basis, 28% know about it but do not consume, and just 3% of the respondents do not know it. Palm weevil recorded the highest rate of awareness and familiarity among the nine listed species. This result agrees with a study conducted by Anankware et al. (2016) which indicate that palm weevil is the most consumed edible insects in Ghana. Termite recorded a high number of awareness as 66% of the respondents are familiar with it, 22% consumes occasionally, 6% consume on a regular basis and a few numbers of respondents (5%) do not know about it. There is also high prevalence of awareness about ground cricket and house cricket as a good number of respondents are aware about them. For ground cricket, 55% of the respondents know it but do not consume, 15% consume occasionally and 5% consume regularly and 26% do not know about it. 55% of our respondents are familiar with house cricket but do not consume, 15% consume occasionally. Respondents show favourable familiarity towards field crickets and caterpillars of the shea tree as 53% of the respondents for each species are aware about these species. 13% of the respondents consume house cricket occasionally, 6% consume regularly and 27% do not know it. Caterpillars of the shea tree recorded 14% of the respondents consuming occasionally, 2% consume regularly and 30% are not familiar with it. Good number of the respondents are aware about larvae of the scarab beetle with 51% are familiar with this species, 12% consume occasionally, 3% regularly and 33% are not familiar with it. 52% of the respondents are familiar with grasshoppers, 15% consume occasionally, 6% regularly, and 28% do not know it. There is average respond towards locust as 50% of the respondents are aware about locust but don does not consume while 16% consume occasionally, 8% consume regularly, and 26% do not know it.

Our results indicate there is high awareness of the selected edible insects' species among the respondents and the most consumed species are palm weevil and termite. Our respondents demonstrated awareness of entomophagy in Accra as it can be observed in Figure 4.

Figure 4: Common insect species consumed by the respondents



5.3 Consumer preference of edible insects' species and socio-economic characteristics of respondents

Considering the socio-economic characteristics of our respondent, Table 6 present consumption of each edible species by respondents on regular bases. Regarding gender, consumption of each species is not significant as it can be seen in table. But it can be observed from the table that male respondents seem to consume more of termite, grasshoppers, and locus. 60% of male respondents preferred termite, 60% preferred grasshoppers, and 60% preferred locusts. While Female respondents (63%) tend to prefer field cricket to other species.

The level of education is insignificant for each of the listed species as can be observed in the Table 6. The significant level of consumption of each the species is above 0.5 and hence not significant. Respondents with high school qualification prefer larvae of the scarab beetle whiles respondents with bachelor's degree and vocational training tend to prefer grasshoppers and house cricket respectively.

The occupation of the respondents for consumption of some of the insect's species are significant, palm weevil, termite, and field crickets. But all the other listed species are insignificant. Respondents who are employed in agriculture preferred house crickets and termites, and unemployed respondents tend to prefer ground crickets. Also, in the case of household income, all the listed insect's species are insignificant and household size of more than 5 members seems to consume more of the larvae of the scarab beetle and locus than all other species. Household size of 3-5 member consumes more of grasshoppers and 1-2 household members consumes more of ground crickets. Each household classification tends to prefer one species to other household group. Similarly, household income of the respondents for consuming each insect's species is not significant. Respondents with household income below 1,999 cedis prefer locus to other species of insects. This respondent (income below 1,999 cedies) tent to consume more of locus to all other listed species in Table 6.

Table 6: Relative values of edible insects' species consumption according to socio-economic characteristics of the respondents

Variable	Pw	Tm	Gr	Fc	Hc	Gh	Lc	Cs	Ls
			p-value/%						
Gender	**0.98**	**0.72**	**0.82**	**0.09**	**0.91**	**0.39**	**0.72**	**0.39**	**0.55**
Male	51	60	53	37	43	60	60	50	45
Female	49	40	47	63	57	40	40	50	55
Age	**0.98**	**0.80**	**0.06**	**0.92**	**0.81**	**0.53**	**0.61**	**0.78**	**0.90**
<19	0	0	0	0	0	5	4	0	0
19-30	30	35	53	37	43	55	54	43	27
31-59	60	45	41	58	43	30	25	57	55
60+	10	20	6	5	14	10	17	0	18
Education level	**0.82**	**0.88**	**0.07**	**0.63**	**0.27**	**0.66**	**0.15**	**0.40**	**0.19**
No formal education	23	15	18	16	14	15	24	38	0
High school	27	35	24	37	14	25	16	38	45
Vocational training	18	25	12	5	43	20	20	13	18
Bachelor's degree	20	15	29	26	14	40	40	13	18
Postgraduate degree	13	10	18	16	14	0	0	0	18
Occupation	**0.00***	**0.03***	**0.25**	**0.02***	**0.47**	**0.96**	**0.40**	**0.70**	**0.62**
Unemployed	25	25	35	21	14	20	28	38	11
Self-employed in Agriculture	15	15	18	5	14	10	12	0	9
Self-employed in non-agriculture	20	3	18	21	14	30	28	13	16
Employed in Agriculture	21	35	24	37	43	30	16	25	36
Employed in non-agriculture	8	5	0	0	0	5	12	13	11
Government officer	5	5	6	16	14	5	4	13	11
Student	6	12	0	0	0	0	0	0	6
Housewife.	0	0	0	0	0	0	0	0	0
Household size	**0.41**	**0.60**	**0.96**	**0.49**	**0.80**	**0.69**	**0.84**	**0.90**	**0.08**
1-2 members	10	16	31	13	20	11	16	24	7
3-5 members	40	32	40	50	40	60	14	10	20
>5 members	50	52	29	37	40	29	70	66	73

Household income	**0.81**	**0.95**	**0.92**	**0.93**	**0.87**	**0.70**	**0.51**	**0.93**	**0.47**
Below GHC 1,999	70	80	71	68	71	67	84	75	64
GHC 2,000-3,999	15	10	12	26	0	15	4	0	18
GHC 4,000-5,999	11	10	18	0	29	8	4	25	9
GHC 6,000-7,999	3	0	0	5	0	8	4	0	9
GHC 8,000-9,999	0	0	0	0	0	0	0	0	0
GHC 10,000 and above	0	0	0	0	0	2	4	0	0

Notes: palm weevil (Pw), termites (Tm), ground crickets (Gr), field crickets (Fc), house crickets (Hc), grasshoppers (Gh), locust (Lc), caterpillars of the shea tree (Cs), larvae of the scarab beetle. *$p<0.05$ is considered significant level

5.4 Reasons for insects' consumption

To know the reason that led the respondents to their first consumption of insects, majority of the respondents, that is 37% of the respondents indicated they first consumed insects because their families eat insects. This is followed by 25% of the respondents also highlighted they first experience insects because their friends consume insects. A relatively high percentage of the respondents highlighted they cannot remember the reason why they first eat insects. Because my families ate them was reported as the main reason that led to the consumption of insects.

For the age group below 19, the main reasons why respondents eat insect is because their families and friends ate insects while for the age group from 19-30, the reported reason for insect consumption among the respondents is because their families consume insects which is 11% and followed by because their friends ate insects which was 9%. Similarly, from the age group of 31-59 years of the respondents, the reported reason was they first experience insects because their families consume insects, which was 22% and the second reason was because their friends consume insects which was 12%. The respondents from the age of 61 and above, the reported reason was because their families consume insects and because my friends consume insects, and I don't remember as the second reason.

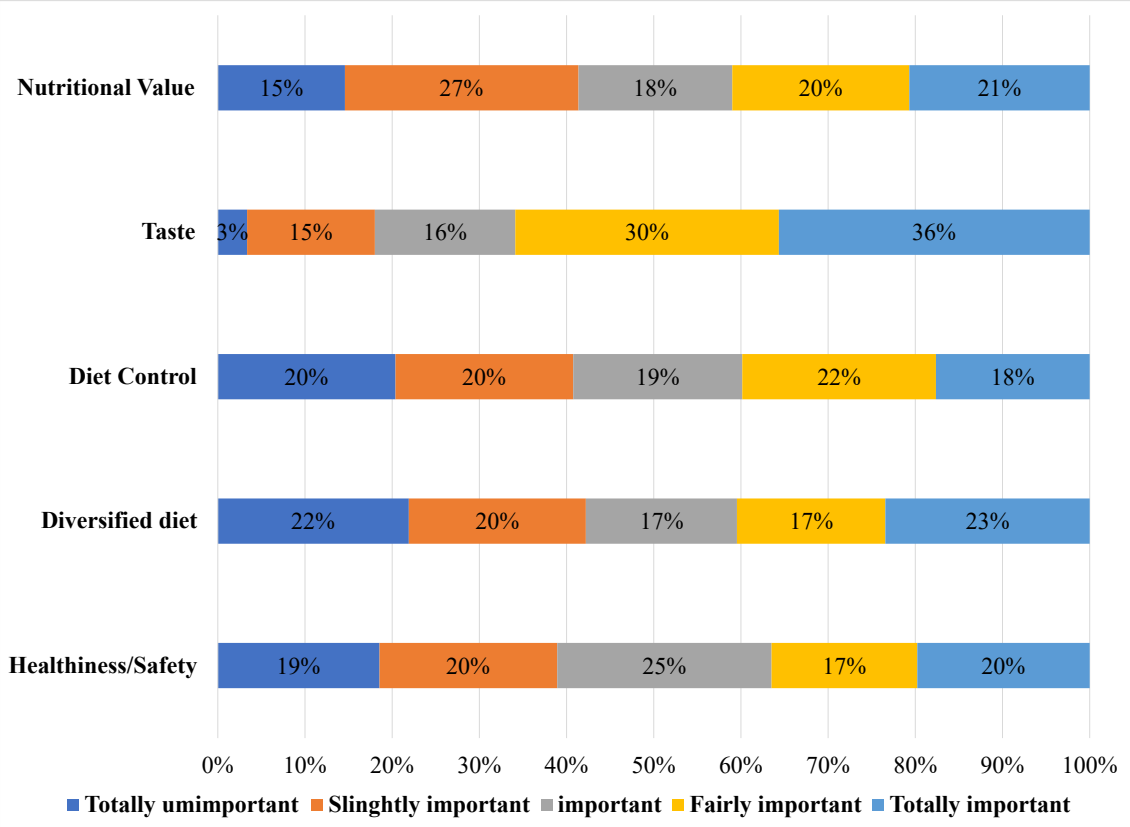
Table 7: The most frequent reasons for insect consumption reported by the respondents

Reason	< 19 %	19-30 %	31-59 %	≥60 %	Total %
Because my families eat them	1	11	22	4	37
It was a prank	0	6	7	1	14
Because my friends eat them	1	9	12	3	25
I don't remember the reason	0	8	9	3	20
other	0	1	2	1	4

5.5 Diet related reasons influencing choice for edible insects

To test for respondents' diet related reasons for eating edible insects, for healthiness/safety, 19% of the respondents regarded healthiness/safety as totally unimportant for consumption of insects, 20% of the respondents also regarded it slightly unimportant, 25% of the respondents valued it as important, 17% fairly important while 20% as totally important. For reason of diversified diet, 22% of the respondents perceived it as totally unimportant for the choice of eating insects, 20% of the respondents regarded it slightly unimportant, whiles 23% of the respondents regarded diversified diet as totally important. Also, for diet control, 20% respondents perceived it as totally unimportant, 22% of the respondents perceived diet control as fairly important whiles 18% perceived it as totally important. Furthermore, for taste as a reason of consumption of edible insects, 3% perceived taste as totally unimportant, 30% of the respondents regarded taste as fairly important and a total of 36% of respondents perceived taste as totally important for eating insects. More so, for nutritional value, 15% of the respondents perceived nutritional value as totally unimportant, 27% of the respondents regarded nutritional value as slightly unimportant, 18% of them perceived it as important, 20% of the respondents regarded it as important and 21% of the respondents perceived it as totally important. Taste was reported to be highest diet related reason influencing respondents' choice for edible insects.

Figure 5: Diet related reasons that influence choice for eating edible insects by the respondents



5.6 Consumer perception towards insect consumption

To analyse consumer perception towards edible insects, and to evaluate respondents' perception towards edible insects, 47% of the respondents strongly perceived insects as cheap and only 4% strongly disagree that insects is cheap. While 33% of the respondents somewhat disagree that insect is cheap. 33% did not take stand as to whether insects are cheap or not. They neither agree nor disagree. 2% somewhat agree to the statement that insect is cheap. Those who perceived insects as cheap is the highest. To the question of if insect is delicious, 47% strongly agreed with the statement that insect is delicious and this findings is in line with a study conducted by Anankware et al. (2016) in Ghana majority of the respondents perceived insects as delicious. Also, 19% of the respondents strongly agree that eating insects would affect their status, 16% somewhat disagree, 19% of them neither agree nor disagree, 23% somewhat agreed and 22% disagreed that eating insects would affect their status. This shows that the number of respondents who agree (19%) and those that somewhat agree (23%) with the statement that eating insects would affect their status are more than those that strongly disagree and

somewhat disagree. Similarly, to know respondents' perception about if insets is disgusting or not, 5% of the respondents strongly perceived insects as disgusting, 13% of the respondents somewhat perceived insects are disgusting, 28% of the respondents somewhat agree that insect is disgusting and 39% of the respondents strongly disagree that insect is disgusting.

Table 8: Perception of respondents on insects' consumption (%)

	Strongly disagree	Somewhat disagree	Neither nor disagree	Somewhat agree	Strongly agree
Insect is cheap	1	5	13	34	47
Insect is delicious	4	5	12	33	47
Eating insects would affect my status	22	23	19	16	19
Insect is disgusting	39	28	16	13	5

5.7 Factors influencing the consumption of insects

To determine the factors influencing consumption of insects, Probit regression model was utilised to generate and analysed results. To analyse results, a significant level of 0.05 *($p<0.05$)* used to test the hypothesis.

Observing from Table 9, among all the considered variables, two of the variables are statistically significant; that is age and household size of the respondents with a p-value of 0.034 and 0.015 respectively. This indicate that age has a positive relationship with consumer attitude towards insects' consumption among the respondents, and therefore influences consumer purchase decisions of edible insects. This might be because of the long history of entomophagy practice in Ghana whereby over the past years majority of the citizenry consumes insects from one generation to another generation where individual have had overtime experience with insects' consumption passed on to them by older generations. And this might be the use of edible insects as a source of food during the 1980s where the country experienced some level of famine. We therefore fail to reject hypothesis one (H_1) that age influences consumption of edible insects among the respondents and therefore conclude that age had a positive relationship with insects' consumption and therefore influences the consumption of edible insects by the

respondents. This implies that there is the need for adequate information stimuli about edible insects to the general populace to increase consumption among all ages and non-consuming population. This enhances food security in the country and help eradicate or reduce global food insecurity since edible insects serves as an alternative source of protein to animal meat-based source of protein for human consumption. This finding agrees with what other author found in previous studies that age and household income influences consumption of edible insects.

Household size statistically is significantly related to consumption of edible insects among the respondents. This might due larger household size characterising the respondents. Unlike the Western world where families are mostly characterised by small household size, Ghana for that matter most West African countries composed of larger family size and the practice of extended family culture usually led to high number of family members to feed and might encourage the practice of entomophagy among the respondents for that matter Ghana. Edible insects serve to prevent malnutrition among families. We therefore fail to reject the null hypothesis, that is hypothesis two (H_2) that household size of the respondents influences consumption of edible insects by the respondents and therefore conclude that household size influences edible insects' consumption in Ghana.

Gender has a p-value of 0.75 which is statistically insignificant therefore had no influence on the consumption of insects. This indicated that gender is not a significant factor to influence consumption of edible insects by the respondents in Ghana. Even though a previous study by Verbeke (2015) in Belgium which indicated that gender had a significant positive relationship with edible insects consumption, unlike Ghana, respondents' gender had no statistical influence on edible insects' consumption. This might be due to the geographical location of the two countries and cultural differences where individuals of different location and background behave differently. We therefore reject hypothesis three (H_3), that is, the hypothesis that gender influences edible insects' consumption among the respondents.

Household income had no statistically significant relationship with consumption of edible insects with a p-value of 0.543. This shows that household income of the had no statistical influence on consumption of insects among the respondents. Also, this might be because of long history of the practice of eating insects in Ghana where the level of income earned a household could have impact on the choice of eating insects. This

explained that income of household or family members had no influence on the consumption of edible insect in Ghana. This finding showed that household income of the respondents had no statistical influence on edible insects' consumption among the respondents.

Similarly, the p-value of price is 0.233 which is also statistically insignificant. This shows that price has no statistical influence on consumer attitude towards edible insects' consumption. A study conducted by Pambo et al. (2016) in Western Kenya indicated that the purchasing power and future purchasing of a group of consumers are influenced by price, the case of the respondents in Ghana differs where consumption of edible insects is not statistically influenced by the price of insects. Our findings indicated that price had no statistical influence on consumption of insects as can be observed in Table 9.

Table 9: Factors influencing the consumption of insects

Variables	Coefficient	Standard Error	Sig (*P-value*)
Gender	-0.044	0.1409	0.754
Age of respondents	0.011	0.0050	0.034*
Household size of respondents	-0.355	0.1579	0.015*
Household income of respondents	0.047	0.0768	0.543
Price	0.171	0.1433	0.233

Dependent variable: Preference of edible insects
Model: (Intercept), Gender, Age of respondents, Household size of respondents, household income of respondents, price. *p<0.05 significant level

6 Discussions

6.1 Respondents' knowledge and familiarity with consumption of edible insects

Insect is a potential source of vitamins and protein for human development. Several studies have been conducted all over the world to evaluate consumer knowledge and consumption of edible insects. The consumption of edible insects in countries such as China and Kenya indicated a high consumption rate of 88% of the respondents had eaten edible insect before unlike in counties such Italy, Australia, the Netherlands and Brazil where consumption is low (Balzan et al. 2016; Sogari et al. 2019; Sulzbacher et al. 2019). Our results showed that respondents are aware of entomophagy practice in Ghana as majority of the respondents are familiar with the listed insect's species. The study identified three of three insect's species (palm weevil, termites, and ground crickets) which most consumed by the respondents. Our results agrees with a study by Anankware et al. (2016) in Ghana where the most consumed insects in Ghana was palm weevil and termite. Similarly, ground cricket also recorded good results as 15% of our respondents consume ground crickets occasionally, 5% on regular basis, 55% are aware about it but do not consume, and 26% of respondents do not know it. In a nutshell, majority of the respondents know about all the nine listed species of insects which is accompanied by marginable percentage of consumption and less percentage of the respondents who do not know about edible insects.

In examining consumer preference of edible insect species and socioeconomic characteristics of our respondents based on regular consumption, our results indicate male respondents tend to prefer termite, grasshoppers, and locus whiles the female respondents preferred field crickets. This shows that the preference for insects' species among male and female respondents differs as each gender categories preferred different species to the other categories. More so, regarding preference of respondents based on respondents' level of education, respondents with high school qualification recorded a high preference for larvae of the scarab beetle whiles respondents with bachelor's degree, and respondents with vocational training recorded high preference for grasshoppers and house crickets respectively. Also, our respondents in household group of more than 5 members preferred the larvae of the scarab beetle and locust whiles household members of 3-5 members and

1-2 members prefer ground crickets and grasshoppers respectively. Our results also indicated respondents employed in agriculture had preference for house crickets and termites. Unemployed respondents had high preference for ground crickets. Low-income respondents (1,999 cedis) had high preference for locus to all other listed species.

6.2 Consumer perception towards edible insects' consumption

Taste is one the attributes of food that affect its consumption. A study conducted by Anankware et al. (2016) on food entomophagy practice in Ghana indicates that the unique taste of insects is depended on a special features of insects. According to Kouřimská & Adámková (2016), the sensory quality and taste of insect is affected by the stage of development, environment, feed and cooking methods of the insects. Our result is in line with this study whereby 36% of the respondents considered the taste of insects as the main reason for consuming insect. This findings correspond with a study by House (2016) which showed that 69% of the respondents liking taste of insects and will make future purchase. Our studies also indicate 37% of our respondents eat insects because their families eat insects.

Our results also indicated the respondents perceived insects as cheap and delicious. This results agrees with a previous study by Anankware et al. (2016) on edible insects consumption in Ghana where consumers positive perception for insects as delicious. According to Sogari et al. (2018), some studies were carried out in the Netherlands, Italy, and Belgium which highlighted that respondents express fear and disgust towards edible insects. Unlike Ghana, respondents disagree with the statement that regarding insects as disgusting but rather majority of our respondents have good perception towards insects.

6.3 Factors influencing the consumption of insects

Our results showed that age has a positive relationship with consumer attitude towards edible. It is statistically significant and has a positive impact on consumer attitude towards edible insects. This result is in line with a study Slabá (2019) which stated that age contribute greatly to consumer decision making and consumer choice of product since it has influence on consumers' behaviour. In China age had a positive effect on consumer purchase of edible insect and older people are more likely to consume insect than younger people (Liu et al. 2020). In a study by Verbeke (2015) on the readiness towards insects adoption as a meat substitute indicated that an age difference of ten years might lead to a

deduction in the readiness to adopt insect as a foodstuff by 27%. Older people swayed by the emotion-focused condition than the information-focused condition to purchase (Peng et al. 2016). This indicate that age significantly impact consumer consumption of edible insects and as such influence consumer behaviour among the respondents.

Comparing women to men, women prefer polite and soft verbal communication whiles men prefer short and direct verbal form of communication (Kraft et al. 2012). In marketing, consumption and purchasing behaviour, gender plays an important role which present different marketing approaches for companies to adopt to target gender (Perju-mitran & Elisabeta 2015). A study by Verbeke (2015), showed that in Belgium, gender was found to have a significantly positive influence on consumption of insect; where female were 2.17 time less likely to replace meat with insects in their diet. Brazilian men consumers demonstrate stronger motive in consuming insects (Sulzbacher et al. 2019). Unlike the case in Ghana, there is insignificant relationship between gender and consumer attitude towards edible insects. Therefore, the purchase and consumption of edible insect is not influenced by the gender of consumers and therefore has no impact on edible insects' consumption.

Consumer food purchase decision making is also influenced by consumer household size (Liu et al. 2020). The study showed that household with larger members, are older, and have higher income are more likely to purchase insects. The coefficient of his results regarding age, household size and household income are positive and statistically significant indicating when the respondents are older, have higher income and have larger household size, they are more likely to buy edible insects (Liu et al. 2020). Our result agrees with his studies whereby our results from the case of Ghana showed that the consumption of insect is influenced by household size and thereby has significant relationship with consumption edible insects.

Income plays a key role in consumer purchase decision making. Their decisions are affected by their income level and status. A study by Liu et al. (2020), showed that household income influences consumer purchase decision. From the findings, the study indicated that influence of household income on consumption of insects is statistically insignificant indicating that household income had no relationship with consumption of edible insects and statistically do not influence consumption. This might be due to geographical location and culture background of the two individual cases. People from

different background and location tends to behave in different ways and this might have different impact on individual purchase and consumption decision making in their everyday life.

Consumer purchasing decisions are influenced by price of the product. Price plays an important role in consumer choice of good. Price affect both the purchasing power and future purchasing of a particular group of consumers (Pambo et al. 2016). The study indicated that there would be a probability of 44% reduction in edible insects' consumption if there is an increase in the price of insects. Due to product price sensitivity, consumers would react negatively if there were high price or an increase in price of a product. While the case is different in Ghana as the consumption of insect's had no relationship with the price of insects. The result showed that price had no significant relationship with the consumption of insects. in a nutshell, consumption of edible insects among the respondents was not determined by the price of edible insects and therefore, edible insects' consumption was not influenced by price.

6.4 Limitations of the study

Even though the study provides a comprehensive insight to consumer behaviour towards edible insects' consumption among respondents in Ghana and includes the most consumed insects in Ghana and reasons for consumption, consumer perception towards insects' consumption and factors influencing consumer behaviour, on the other hand, is the lower number of respondents was willing to participate during data collection. The outbreak of the COVID-19, which is very contagious, challenging for everyone, and was associated with many deaths. Therefore, communicating personal experiences and perceptions of the illness could be sensitive for many respondents especially respondents who had personal experiences with COVID-19 outbreak in their families contributed to the unwillingness of the respondents to participate in data collection process.

Similarly, this study cannot be generalised for the entire Ghanaian population as data was collected from respondents in Accra and not the whole country. Therefore, the study recommends larger sample size and nationwide data collection in the future whereby the results can be generalised for the entire country.

7 Conclusions

Insects play a significant role in solving the prevailing global nutritional challenges. This is because, insects provide sufficient fats, micronutrients, and protein which would improve global health and food security. Our results showed that majority of the respondents were familiar with the selected edible insects' species and entomophagy consumption. The most consumed insects by the respondents were palm weevil, termite, and ground cricket. The most reported reasons for eating insects among respondents are tastes of insects, and because their families eat insects. The respondents had positive perception towards edible insects' consumption, and they showed favourable perception towards edible insects as they regard insects as cheap, delicious, and not disgusting. The findings showed that age of respondents and household size had positive influence on consumption of insects. While gender, household income, and price were statistically insignificant and therefore had no statistical influence on the consumption of edible insects among the respondents.

Our study recommend the need to understanding consumer dynamics, comprising consumer perceptions and attitudes, environmental concerns, communication channels, motivation, and personal values are vital factors to consider promoting edible insects and products among non-consuming population.

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Appendices

List of appendices

Appendix 1: Questionnaire

Part 1: Respondents' familiarity with edible insects' consumption

1. Which edible insects have you already consumed?

Name	I don't know it	Regularly	Occasionally	I know it but I do not consume
Palm weevil	☐	☐	☐	☐
Termite	☐	☐	☐	☐
Ground crickets	☐	☐	☐	☐
Field crickets	☐	☐	☐	☐
House crickets	☐	☐	☐	☐
Locust	☐	☐	☐	☐
Caterpillars of the shea tree	☐	☐	☐	☐
Larvae of the shea tree	☐	☐	☐	☐
Grasshopper	☐	☐	☐	☐

2. If you have eaten insects before, what is your most favourite insect?

Palm weevil ☐	Termite ☐	Ground cricket. ☐
Field crickets. ☐	House crickets. ☐	Grasshopper. ☐
Locust ☐	Caterpillars of the shea tree ☐	Larvae of the scarab beetle ☐

3. In what form have you eaten the insects?

Visible/whole insects (cooked) ☐	Powered (powder/flour) ☐
Visible/whole insects served in instant package ☐	Meat ☐

4. What were the reasons for eating them?

Because my families eat them ☐	It was a prank ☐	Because my friends eat them ☐
I don't remember the reason ☐	Other ☐	

If you chose other, please specify

Answer……

5. If you have eaten insects before, do you like it?

Yes ☐	No ☐

6. How did you get information about edible insects?

School ☐	Internet ☐	Farmers ☐	Restaurants ☐
Media ☐	Relatives ☐	Friends ☐	Market ☐

Part 2: Determinants of consumer attitude towards edible insects' consumption.

7. What is your perception on eating insects?

	Strongly agree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strong agree
Insects is disgusting	☐	☐	☐	☐	☐
Eating insect would affect my status	☐	☐	☐	☐	☐
Insect is delicious	☐	☐	☐	☐	☐
Insect is cheap	☐	☐	☐	☐	☐

8. What factors do you consider when making purchase about edible insects?

Gender ☐	Age ☐	Taste ☐
Household size. ☐	Household income ☐	Price ☐

9. How do you consider the price of insects?

Cheap	Expensive

Part 3: Evaluation of beliefs and diet

10. How important do you find the following when making a choice regarding foods from edible insects?

	Totally unimportant	Slightly important	Important	Fairly important	Totally important
Healthiness/Safety	☐	☐	☐	☐	☐
Diversified diet	☐	☐	☐	☐	☐
Diet control	☐	☐	☐	☐	☐
Taste	☐	☐	☐	☐	☐
Nutritional value	☐	☐	☐	☐	☐

11. Do you have any dietary restrictions?

Yes ☐	No ☐

If yes, please choose from the following:

Vegan ☐	Vegetarian ☐	Allergies ☐	Religious believes ☐	Other ☐

If you chose other specify.

Answer…….

12. How many times a week do you eat insects?

Daily ☐	4-6 times a week ☐	2-3 times a week ☐
Once a week ☐	A few times in a month ☐	A few times in a year ☐

Part 4: Background information

13. What is your gender?

Male ☐	Female ☐

14. What is your age?

Specify……

15. What is your birth city?

Accra ☐	Tamale ☐	Takoradi ☐	Ho ☐	Bolgatanga. ☐
Kumasi ☐	Sunyani ☐	Wa ☐	Koforidua. ☐	Other ☐

16. What is your highest completed education?

Self-employed in Agriculture ☐	Self-employed in non-agriculture ☐
Employed in Agriculture ☐	Employed in non-agriculture ☐
Government officer ☐	Student ☐
Housewife ☐	Unemployed ☐
Other ☐	

If chosen other, please specify.

Answer…….

17. How many people are living in your household?

Answer…….

18. What is your estimated monthly household income (Ghana cedis)?

Bellow 1,999 cedis. ☐	2,000-3,999 cedis. ☐	4,000-5999 cedis ☐
6,000-7,999 cedis ☐	8,000-9,999 cedis ☐	10,000 cedis and above ☐