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Consumer Attitude Toward Edible Insects Consumption in Cambodia

MASTER'S THESIS

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Declaration

I hereby declare that I have done this thesis entitled “Consumer Attitude Toward Edible Insects Consumption in Cambodia " 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

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Abstract

The growing world population poses a serious challenge in producing sufficient protein to feed the world. Animal-based protein production often associate with environmental issues such as deforestation, greenhouse gases emission and water pollution. Edible insects are regarded as an excellent and the most sustainable source of animal protein due to their high nutritional value and low production cost. This study was to examine the knowledge, behaviour, attitudes, and key factors influencing Cambodian consumer consumption and acceptance of insects and insect-based products. The data were collected through an online questionnaire of 216 respondents. The data were analysed using a Pearson Chi-squared test to determine the association between consumer preferences and independent variables (gender, age, education, occupation, household size, household income). Emphasis has been given to the detailed evaluation of gender-related differences concerning consumption and influential factors leading to insect consumption. The main findings suggest high consumption among the respondents, stating taste and price as the main driving factors. The consumption of insects mainly circulated around the whole visible form which indicates low food neophobia, whereas other innovative forms of consumption were absented. Respondents manifest a high willingness to change their current diets in exchange for food with better health benefits and low price. To the majority of our respondents, insect-based food should have the taste and look close to meat. The lower variety of insect products offering on the market in an insect-eating community illustrates a huge market gap for consumers. Therefore, insect-product diversifications should be encouraged, simultaneously promotion of entomophagy should be made available via marketing through the provision of tasty products, affordable price, and communicating nutritional value.

Key words: Consumer Attitudes, Edible Insects, Consumption, Cambodia

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1. Introduction

By 2050, the world population is projected to surge to 9.6 billion which will inevitably escalate the demand for food, namely animal-based protein (FAO 2011). Over 27% of world protein intake is animal-based protein, their production is extremely inefficient and unsustainable (FAO 2011). Livestock farming and meat consumption are highly associated with environmental impacts, the release of greenhouse gases and forest clearance for agricultural activities mainly for animal feeds (Orkusz et al. 2020). To combat conventional meat production environmental criticism, alternatives were suggested including edible insects (EI), algae, and meat production through vitro cultivation (Orkusz et al. 2020). EI has major potential to replace the existing contentious protein production thanks to its richness in protein, fat, minerals, vitamins, lower environmental impacts due to small cultivated requirements of land, feed and water, fewer greenhouse emissions and ammonia production, and last but not least, more efficient feed conversion rate compared to conventional livestock production (Roma et al. 2020). EI has integrated into at least 2 billion people' diet in Asia, Latin America, Africa and Australia while entomophagy is a fairly new concept in western societies (Orkusz et al. 2020) which is a hindrance for consumption and market development around EI-based food (Tan et al. 2015).

The introduction of EI into the human diet has seen increases in many parts of the world such as Europe (Hartmann & Siegrist 2017) especially as superfoods with the emerging market of healthy food products (Orkusz et al. 2020). Food neophobia largely influences the acceptance level of the people, lower food neophobia of people allows them to consume a wider range of new foods (Siegrist et al. 2013). Changes in attitudes toward food consumption might pave the ways for better food innovation. However, researches on acceptance and rejection of food containing EI is still limited, whereas new research would drive a better understanding of this phenomenon which could shape the eating habits and food industry.

2. Literature Review

2.1. Worldwide Consumption of Edible Insects

With the rapid growth of the world population, the demand for food needed to feed the people is simultaneously growing; therefore, doubled agricultural production is required to respond to the call. Conventional source of protein consumed by people mainly refers to meat which could potentially face challenges in the future due to the significant increase in demand (up to 76% increase from 2005 to 2050) with limited access to available agricultural land which livestock farming has already taken more than two-thirds of all agricultural land (Huis 2016). Facing global food security, attention on meat-based protein alternative is put on insect which is being considered as a new source of human food (House 2016).

Entomophagy is the practice of eating insects as food. Insect derives from the Latin word "*insectum*", meaning "with a notched or divided body" which translated to the fact that an insect body comprises of three parts (head, thorax, and abdomen). Insects are located in the arthropod group of animals. There are more than 1 million known species of insects; however, it is estimated that the total number of insects' species stand between 6-10 million which represents over 90% of animal life forms (Huis et al. 2013). Some of the most commonly consumed species of EI in accordance with its biological order are beetles (Coleopera; 31%), caterpillars (Lepidoptera; 18%), and bees, wasps, 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).

The history of entomophagy dated back to the ancient time where the earliest citation of this concept can be found in biblical literature (Huis et al. 2013). Insects are also known to be used in ancient Chinese medical practice which was recorded in "Compendium of Materia Medica" written by Li Shizhen, a sixteenth-century Chinese herbalist (Kumar et al. 2017). This has proved that entomophagy is not a newly evolved concept; nevertheless, consuming insects is still taboo in many societies.

2.2. Global Trend Toward Edible Insects Consumption

Despite being decried as pests; insects can be disguised as human foods or as a commodity in trade and commerce. Cultural estrangement caused by the movement or resettlement of people around the world may have help entomophagy to recapture its former respectability and broadening its significance in the tropics (Durst et al. 2010). EI contributes to humans balanced diet because it is a nutrient-rich food, a good source of protein that has the potential to boost human health. At the same time, EI may play a role in enhancing environmental awareness and help to foster positive conservative attitudes of people if insects are appreciated and depended on as valuable food sources. EI is also economically beneficial to the disadvantaged population by improving their food security and income security through consuming insects, farming insects and commercializing insects.

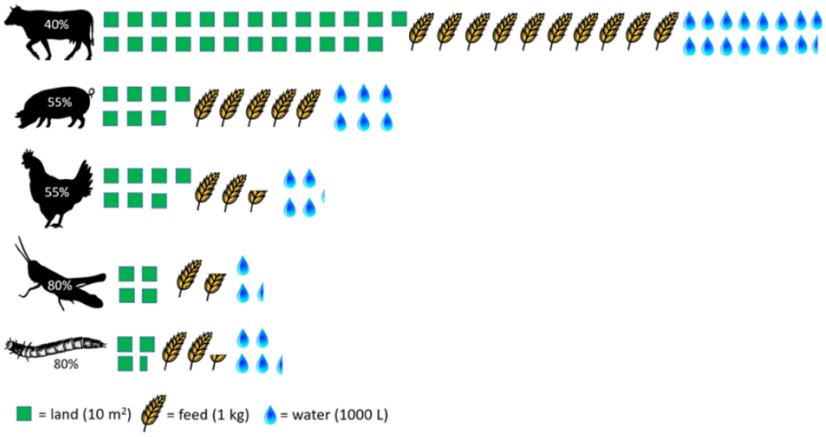
2.2.1. Environmental Concerns

To satisfy the rising global demand for meat products, large scale cultivation of animals is needed which produce severe consequences on the environment through greenhouse gas emissions and the resources use in the cultivation process (Kornher et al. 2019). Extensive growth in demand for protein has resulted from the rising in income in middle-income countries such as China, Brazil and India, which will aggravate the situation in the upcoming years.

Insects that are consumed mostly in developing countries are partly harvested directly from nature (Durst et al. 2010). Insects are generally clean and chemicals free; thus, it is considered to be healthy foods while some species are reputed to be used in medicinal properties (Durst et al. 2010). However, certain insects are being farmed as the demand grows. Oonincx et al. (2010) had a few small-scale experiments on insects farming to determine the endogenous greenhouse gas emissions and ammonia production during the whole farming process including the emission within the life cycle, inputs and outputs. Oonincx et al. (2010)'s experiment illustrated promising results, the level of effect on the environment from insect farming is relatively lower compared to some conventional livestock, while greenhouse gas emission in cricket production found to be lower in comparison to poultry production (Halloran et al. 2017). Land clearing for agriculture shares a big portion in putting up to global warming (Makkar et al. 2014) and

devastating biodiversity (Jansson et al. 2019); thus, the efficiency of land utilisation is important. Unlike conventional meat production, insect farming requires smaller space which contributes to environmental conservation (Jansson et al. 2019). Water is the principal element for the survival of life and scarcity of water is a crucial problem that the world is facing and it is predicted to get even scarcer in the future (Jansson et al. 2019). Insects indeed need less water for survival, it might need little or no water if the feeds contain enough water depending on the species (Józefiak 2016).

Figure 1 Amount of Land, feed, and water needed to produce 1 kg of edible weight



Source: Dobermann et al. 2017

Feed conversion ratios (defined as kg feed/kg growth) in insects is generally lower compared to most conventional livestock animals and fish (Jansson et al. 2019). The feed conversion rate for insects differs depending on the feed offered. Additionally, if conversion is converted into an edible weight ratio (approximately 80% in cricket, 55% in chicken and pig, 40% in cattle), insects are even more efficient than others (Jansson et al. 2019).

Table 1 Feed conversion rate (FCR) in insects and conventional livestock

	FRC (kg feed/kg growth)
Cricket	1.5-3.9
Chicken	1.8
Mealworm	2.0
Pigs (conventional crossbred pigs)	2.6
Pigs (Moo Lath breed, Laos)	4.5
Beef	> 4.5

(Source: Jansson et al. 2019)

2.2.2. Nutritional Value of Edible Insects

The nutritional value of insects is highly diverse because of their large variety of species. EI, even within the same group, the composition of nutritional value differs depending on the stages of metamorphic (egg, larvae, pupae or adults), the habitats and its diet (Afton et al. 2014). The nutritional composition of insects is also largely influenced by the preparation and processing techniques (drying, boiling or frying) used before consumption. Kouřimská and Adámková (2016) cited that crickets, palm weevil larvae, and mealworms have higher nutrition value score which is significantly healthier than the conventional source of protein including beef, reptiles and fish.

Table 2 Examples of the energy content of differently processed insect species, by region

Location	Common name	Scientific name	Energy content (kcal/100 g fresh weight)
Australia	Australian plague locust, raw	*Chortoicetes terminifera*	499
Australia	Green (weaver) ant, raw	*Oecophylla smaragdina*	1 272
Canada, Quebec	Red-legged grasshopper, whole, raw	*Melanoplus femurrubrum*	160
United States, Illinois	Yellow mealworm, larva, raw	*Tenebrio molitor*	206
United States, Illinois	Yellow mealworm, adult, raw	*Tenebrio molitor*	138
Ivory Coast	Termite, adult, dewinged, dried, flour	*Macrotermes subhyalinus*	535
Mexico, Veracruz State	Leaf-cutter ant, adult, raw	*Atta mexicana*	404
Mexico, Hidalgo State	Honey ant, adult, raw	*Myrmecocystus melliger*	116
Thailand	Field cricket, raw	*Gryllus bimaculatus*	120
Thailand	Giant water bug, raw	*Lethocerus indicus*	165
Thailand	Rice grasshopper, raw	*Oxya japonica*	149
Thailand	Grasshopper, raw	*Cyrtacanthacris tatarica*	89
Thailand	Domesticated silkworm, pupa, raw	*Bombyx mori*	94
The Netherlands	Migratory locust, adult, raw	*Locusta migratoria*	179

Source: Huis et al. 2013

Rompold and Schlüter (2013)'s study on 236 species of insects on their nutritional compositions has suggested that insects are a potential food and protein source. They are high in energy (**Table 2**) and protein contents (**Table 3**) which are superior to humans' diet, as well as sufficient amino acid that meet human's health requirements. Insects also provide satisfactory amounts of micro-nutrition such as copper, iron, magnesium, phosphorus, selenium, and zinc, as well as fibre (Rompold & Schlüter 2013). The protein found in insects is equivalent to cattle, reptiles and fish and even higher in some insects' species while the amount of protein itself is influenced by insects' feeds (Huis et al. 2013).

Sphenarium Purpurascens, a grasshopper species found in Mexico and Guatemala, shows an exceptionally high protein content of 35-48 g per 100 g of insect fresh weight when consuming in its adult form (**Table 3**).

Table 3 Comparison of average protein content among insects, reptiles, fish and mammals

Animal group	Species and common name	Edible product	Protein content (g/100 g fresh weight)
Insects (raw)	Locusts and grasshopppers: *Locusta migratoria, Acridium melanorhodon, Ruspolia differens*	larva	14–18
	Locusts and grasshopppers: *Locusta migratoria, Acridium melanorhodon, Ruspolia differens*	Adult	13–28
	Sphenarium purpurascens (chapulines – Mexico)	Adult	35–48
	Silkworm (*Bombyx mori*)	Caterpillar	10–17
	Palmworm beetles: *Rhynchophorus palmarum, R. phoenicis, Callipogon barbatus*	Larva	7–36
	Yellow mealworm (*Tenebrio molitor*)	Larva	14–25
	Crickets	Adult	8–25
	Termites	Adult	13–28
Cattle		Beef (raw)	19–26
Reptiles (cooked)	Turtles: *Chelodina rugosa, Chelonia depressa*	Flesh	25–27
		Intestine	18
		Liver	11
		Heart	17–23
		Liver	12-27
Fish (raw)	Finfish	Tilapia	16–19
		Mackerel	16–28
		Catfish	17–28
	Crustaceans	Lobster	17–19
		Prawn (Malaysia)	16–19
		Shrimp	13–27
	Molluscs	Cuttlefish, squid	15–18

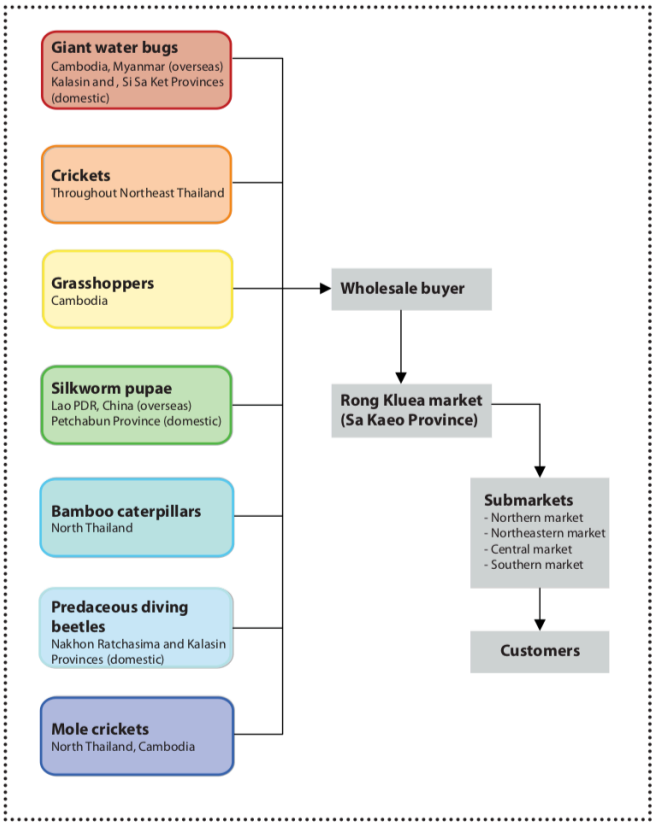
Source: Huis et al. 2013

2.2.3. Economic Benefits

The economic benefit of insects cannot be neglected and shreds of evidence can be found in many countries around the world especially in developing countries. An emerging trend is also expected in developed nations including countries in Europe and Asia. Southeast Asia is a region where EI trade come from and it can produce the clearest economic picture of insects (Dobermann et al. 2017). Well-established farms and trade routes are defined whereas imports and exports also occur within the market chain which proof the rising demand for insects (**Figure 2**). Therefore, it translates into income and employment opportunities for local people especially rural households if insects were to

be collected from the wild (Hanboonsong et al. 2013). In Thailand, insect farming is a good source of income for established farmers. In 2016, medium-sized farms which produce 4-5 cycles of 500-750 kg of crickets a year could earn roughly between 4,270-9,970 USD (Dobermann et al. 2017) in a country with the gross domestic product per capita of 5,994 USD (7,808 USD in 2019) (World Bank 2020). The market value of insects is expected to increase in the future driven by the increase of acceptance and consumer awareness from the global community of the vital role of insects in global food security. In South Korea, insects market value stood at approximately 145 million USD in 2019 and it is expected to quadruple to approximately 462 million USD in 2020 (Han et al. 2017). US, Belgium, France, UK, the Netherlands, China, Thailand, Vietnam, Brazil and Mexico are at the rise which the combined market value of insect consumption is about 33.5 million USD in 2015; whereas the predicted growth is so strong and suggested that it will climb up to 530 million USD in 2023 (Dobermann et al. 2017).

Figure 2 Distribution of edible insects on Thai market



Source: Hanboosang et al. 2013

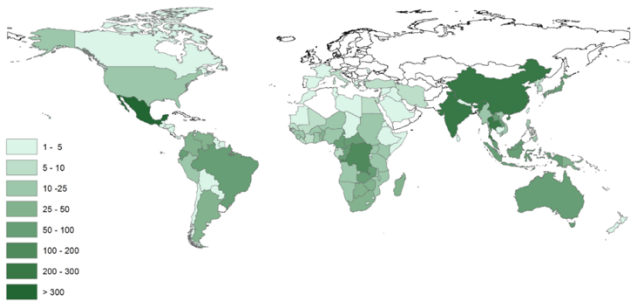
2.2.4. Animal Welfare

Intensively farmed animals should be respected in the animal production industry to some inspiration: freedom from hunger and thirst, discomfort, pain, injury, disease, fear and distress (Erens et al. 2012). In the wild, some insects live in crowded conditions with no parental care (Jansson et al. 2019); thus; adequate space and natural conditions can be replicated for farmed insects. For instance, locusts and mealworms reared in captivity are companionable and tend to cluster or high density as they were in the wild. In contrast to traditional meat production which required slaughter, insects' pain experiences and discomfort are neglected due to lack of study. Some studies suggest that insects have the cognitive ability to feel discomfort and suffering in some species (Crook & Walters 2011); however, conclusive evidence has not been produced yet. Nevertheless, insect-killing methods should be carefully chosen, by taking into account the pain and discomfort of insects and selecting the techniques that minimize or eliminate pain such as freezing or instantaneous methods including shredding.

2.3. Edible Insects Species

The number of EI species is still not known. There are around 2,000 species are consumed by humans in the present day (Yen 2015). The knowledge of edible species of insects is relatively small, depend on the availability and personal diet preferences which make certain EI populated in some areas without any collections (Hanboonsong & Durst 2014); however; a larger number of species could be utilised for human consumption in the future (Yen 2015).

Figure 3 Recorded number of edible insect species, by country in 2017



Source: Wageningen University & Research 2020

2.3.1. Common Edible Insects in Southeast Asian Countries

In Southeast Asia, there are between 150-200 species of EI including aquatic species which are consumed by local people (Huis et al. 2013). Availability of EI in nature differs from species to species, some are available year-round (mostly aquatic species) while others are seasonally available.

Table 4 Availability of edible insects in Cambodia, Laos, and Thailand

Common Name	Scientific Name	Availability by month
Bamboo caterpillar	*Omphisa fuscidenttalis Hampson*	Aug-Nov
Bombay locust	*Patanga Succincta L.*	Aug-Oct
Cicada	*Cicadidae*	Mar-May
Common cricket	*Gryllus bimaculatus De Geer /Teloegryllus testaceus Walker*	Jan-Dec
Domestic house cricket	*Acheta domesticus L.*	Jan-Dec
Dragonfly larvae		Jan-Dec
Dung beetles	*Scarabaeinae*	Jan-May
Giant water bug	*Lethocerus Indicus Lep. Serv.*	Jan-Dec
Grasshoppers	*Orthoptera*	May-Sep
Mole cricket	*Gryllotalpa africana Beauvois*	May-Jul
Oriental migratory locust	*Locusta migratoria manilensis (Meyen)*	Jun-Jul
Palm weevil larvae	*Rhynchophorus ferrugineus Oliver*	Jan-Dec
Predaceous diving beetle	*Cybister limbatus F.*	Jul-Oct
Red ant/weaver ant	*Oecophylla smaragdina F.*	Mar-May
Scale insect	*(Drosicha sp.) (Monophlebidae = Margarodidae)*	Jan-Mar
Scarab beetle	*Holotrichia sp.*	Apr-Jun
Short-tailed cricket	*Brachytrupes portentosus Licht*	Oct-Nov
Silkworm pupae	*Bombyx mori L.*	Jan-Dec
Stink bug	*(Tessaratoma quadrata) (Pentatomidae)*	Apr-Jun
Water Scavenger	*Hydrous cavistanum Bedel*	Jan-Dec
Water Scoprion beetle	*Laccotrephes rubber L.*	Jan-Dec
Thai Zebra Tarantula	*Haplopelma albostriatum*	-

Source: Huis et al. 2013; Hanboonsong et al. 2013.

2.3.2. Edible Insects Production

The consumption of EI as food is becoming increasingly popular in the last few years. It is estimated that approximately 2 billion people in more than 100 countries currently eat insects or at least insect food-based (Madau et al. 2020). The distribution is concentrated

in tropical regions, whereas the consumption in western countries is tending to increase. Three methods occur in EI productions: wild collection, semi-cultivation, and farming. According to Yen (2015), wild-harvested insects accounts for 92% of total world insect production, 6% for semi-cultivated insects and only 2% of the total production is farmed.

Wild collection

Some common EI coexists in the same environment as human. They live in various habitats, from aquatic ecosystems to land, to the forest as well as the agricultural fields. Some insects live and feed on farmed vegetation which commonly refers to as pest (caterpillars), live in roots (Witchetty grubs), branches and trunks of trees (cicadas) or soils (dung beetle) (Huis et al. 2013). The collection of EI from the wild is commonly practised by local people as food, source of income and sometimes as a pest management strategy (Vantomme et al. 2012). For example, in a village in Laos, insect collection and sales accounted for up to 23% of combined household income in that village (Huis et al. 2013). In Cambodia, Thai zebra tarantula (*Haplopelma albostriatum*), locally named a-ping, is a typically Cambodian delicacy in which most of the tarantulas are collected from the forests or cashew nut plantation (Münke 2012).

Semi-cultivation

Semi-cultivation of EI is developed from the understanding of particular insect species' biology and ecology which allows people to easily harvest them more efficiently with the use of different tools. Semi-cultivation resembles the traditional term of cultivation process which promotes the growth of organism with the help of human labour and skill (Huis et al. 2013). However, with semi-cultivation, insects are rarely grown in captivity but in the wild where they will be harvested collectively after reaching preferential stages of development. For example, the egg of aquatic true bugs (Hemiptera) is known as Mexican caviar, is a delicacy food in Mexico. The Semi-cultivation method is applied by local people to collect the true bug eggs from their natural habitats. Long U shaped grass bundle is used as the tool to place in the lake for female bugs to deposit their eggs on which later can be harvested easily by shaking the eggs off from the bundle (Itterbeeck & Huis 2012).

Farming

The insect farming concept is not new; silkworms have been farmed for their by-product (silk) for over 4,000 years (Reverberi 2019). However, the concept of insect farming for human consumption evolves around the degree of acceptance toward EI which is on the rise. The most common insect farming is cricket, different species are farmed in a different part of the world usually on small-scale farms, whereas cricket farming is more popular in Asian countries than in western countries (Reverberi 2019). In Thailand, there are approximately 22,340 cricket farmers who produce about 7,500 tonnes of cricket to supply into the market (Hanboonsong et al. 2013). Other Asian countries including Cambodia, Laos, Vietnam, Malaysia, Indonesia, also have recorded a number of cricket farming activities; however, the farming practices are differing country by country in term of species, feed and processing. In the case of Cambodian cricket production, the farm size is generally smaller compared to neighbouring countries while farmers' income generation and food safety standard are relatively low (Reverberi 2019).

2.4. Factor That Influence Consumer Attitude to Edible Insects

Gender

Gender plays a very crucial role in consumption and purchasing behaviour which trigger different marketing commutation approaches to be adopted by a company in response to target gender (Lakshmi et al. 2017; Perju-Mitran & Budacia 2015). Communication styles differ between the two genders. Women prefer more responsive, polite and soft verbal communication whereas men prefer short and direct verbal communication (Kraft & Weber 2012). Women are more internally focused; they favour inspire confidence messages which relevant to their interests and are more prone to extra information, whereas men are more externally focused, appreciate the usefulness of the information and manifest the strong intention to become loyal customers (Perju-Mitran & Budacia 2015).

Gender was found to have a significant positive influence on consuming EI. In Belgium, females were 2.17 times less likely to replace meat with insects in their diet

(Verbeke 2015). Similarly, men tend to be more curious about trying a new type of food than women. Twice as many men than women shown interest in having EI as an alternative source of food in a Tri-city study conducted by Bartkowicz and Gdyni in 2017, while Brazilian men consumers also demonstrate stronger motive in consuming insects (Schardong et al. 2019).

Age

Age factor has a huge impact on marketing strategy as age creates a critical difference in consumers' behaviour including their consumption choices, consumption habits and consumption patterns (Slebá 2019). Consumption and purchase decision vary in different age group. Gregoire (2003) addressed that the significant decrease of interpersonal relationships of older individual shifts them to consult intensively mass media for information. Additionally, source of information from other people also become signification important, consumption and purchase behaviour are largely influenced by regularly seen and consulted person (Gregoire 2003). Older adults are swayed by the emotion-focused condition than the information-focused condition to purchase (Peng et al. 2016).

Age and attitude toward EI are correlated to a certain degree. Older people tend to encounter new and extraordinary things in their lifespan which make them more familiar with the different eating concept from different part of the world. On the other hand, young people tend to be curious and brave to try new things, for instance, EI as food. Research conducted by Verbeke (2015) on readiness toward insect adoption as a meat substitute shown that a 10-year increase in age might decrease the readiness to adopt insect as a foodstuff by 27%. On the other hand, young Chinese consumers below the age of 20-year-old illustrate negative responses toward traditional meat substitution with EI while the idea was being supported more by 21-40 age group due to different reason such as health benefit (Bartkowincz & Gdyni 2017).

Price

Insect-based food is often higher in price in comparison to vegetarian or meat product especially in western countries which concept is relatively new and the availability is still limited. In the Netherlands, a pack of burgers made with insects cost about 4 EUR whereas vegetarian burgers cost only 2-3 EUR and 1-3 EUR for meat-based (House 2016). It affected the purchasing behaviour as well as the future purchasing of a

certain group of people (House 2016) because the price is one of the most important criteria when making food choice (Pambo et al. 2016). Price predominant customers are more to refuse insect-based food especially when the price is higher than quality (such as nutrition) predominant consumers (Pambo et al. 2016). Similarly, price is one of the attractive elements in dietary supplements and functional food purchasing trend which contribute to the growth in its consumption in the Western World (Chaloupkova et al. 2020).

Taste

Taste is one of the driving factors for consumers in some countries. The taste of EI is adored by Ghanaian consumers in which they described adult grasshoppers, house cricket, ground cricket, and locust as having very special taste when eating alone or used in preparing meals (Anankware et al. 2016). Grasshopper and termites are also known in northern Ghana as having unique taste and crispy texture when fried or roasted. House (2016)'s research in the Netherlands and Sogari et al. (2016)'s study in Italy also illustrated a more positive attitude toward the taste of insect-based food where a majority of people inspired that the taste of EI is acceptable which influence their future purchase of EI's products.

Degree of process

Form of food is relatively important when come to consuming decision. The form of having insect as food can be categorized into two: processed food item (cookie, chip which include small amount of insect flour) and unprocessed food item (cricket, mealworm, scorpion, etc.) (Melgar-Lalanne et al. 2019). Willingness to eat insects within Germany is more significant toward processed food items than unprocessed food items. In contrast, Chinese respondents do not have significant differences in their preference between processed and unprocessed food items which might be linked to their traditional diet or their familiarity with EI (Hartmann et al. 2018). Appearance might be the core factor that contributed to the hesitation of people trying out or adopting EI as food. Bartkowicz and Gdyni (2017) indicated that the appearance of insect-based food is the major barrier preventing consumption which was agreed by more than four-fifth of their Chinese respondents.

Household composition and family circumstance

Research on the EI in Kenya by Pambo and his team (2016) illustrated that households whose children as below 18 years old readily accepted EI in their diet than those without. The wild gathering could be one of the factors that contributed to finding because children are responsible for collecting it from the fields (wild) (Christensen et al. 2006). In some regions, EI is the source of protein for babies which mothers dry and grind termites into flour to mix with porridge (Pambo et al. 2016). Similarly, EI is blended for complementary feeding with cereal grain mostly for children.

House (2016)'s research in the Netherlands explained that people who live alone or cooked only for themselves (82%) can integrate insects into their diet easily than other groups of people. 57% of people who shared meals or cook for others agreed that insects could be included in their food (House 2016).

2.5. Experiences on Consumer Attitude Toward Edible Insects from Selected Countries

2.5.1. Consumption of Insects in Europe

According to Balzan et al. (2015)'s study, most people from northern Italy have never eaten EI before and shown curious reaction (about origin, purchase, appearance). A small number of people reject eating insects and negatively perceived insects due to their appearance, odours and taste. Habits and social influence are the factors that determine the intention to eat EI. Some participants in Northern Italy emphasised the idea of eating insects as "People would believe me crazy" or "I think I would eat them secretly" (Belzan et al. 2015), whereas the image of people who eat insects in Switzerland are generally more positive because people are more familiar with this idea since the introduction of Swiss legislation to permit the sale of insect products in 2017 (Hartmann et al. 2018). Research in the Netherlands has suggested that many people reported trying the insect product out of interest or curiosity (42%) while 33% of the respondents think that insects are more environmentally friendly and sustainable than conventional meats (House 2016) which correspond to researches conducted by Oonincx et al. (2010) and

Halloran et al. (2017) who study the effects of insects and conventional meat production on the environment. Insect goods are also believed to be nutritious and beneficial to meat-eater (lower in fat), vegetarian (who prepared to eat insects), or those with mixed diets (House 2016).

2.5.2. Consumption of Insects in China

The usage of EI in China can be traced back to more than 2,000 years in different forms (feed, food or medicine) for different purposes which could explain the higher level of acceptance to the consumption of EI compared to European countries (Feng et al. 2018). Over 20 common species of insects can be found in the markets and restaurants in China (Chen et al. 2009). Insects are consumed as food due to their delicious taste and organic because the supply mainly comes from nature with no pesticide, food addictive or other artificial materials (Chen et al. 2009). In some minority groups, EI is part of their custom which demonstrates the diversity in food culture within China. Additionally, health benefit from insects cannot be ignored whereas its presence in Chinese traditional medicine is predominant and some health functions have been proofed by modern scientific research (Feng et al. 2018).

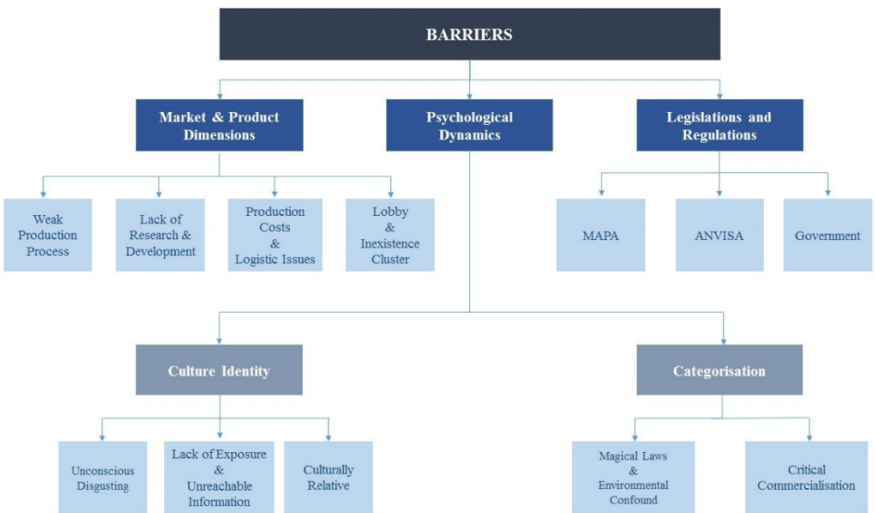
Bartkowinc & Gdyni (2017)'s research on Chinese consumer attitudes toward EI has disclosed a lot of perception of people toward EI as well as their willingness in including EI in their daily diet. Knowledge or information about EI in Chinese is mainly spread to the public through Internet (Social media), Colleagues, television and books where only a small percentage of people know about EI via their travel experiences (Bartkowincz & Gdyni 2017). Thanks to globalization and the rapid development of the internet, it might have a significant impact on consumer behaviour especially their level of acceptance toward EI. Seven motivation factors have been identified within this Bartkowincz & Gdyni (2017) research where four are the most highlighted by respondents which were lack of conventional source of protein, EI's nutritional value, availability, and low price of insect-based products. Appearance, disgust and mental state were the three major barriers in having EI as an alternative source of food. It is understandable that it is difficult for certain people to accept insects as food when insects are regarded as dirty, scary as their prejudices (Chen et al. 2009).

2.5.3. Consumption of Insects in Brazil

In South America, the entomophagy concept is scattered region by region even within the same country, particularly in Brazil. Northern and Southwestern Brazil have a strong desire for insect consumption thanks to their culture and well-established production of EI which allows the consumer to be more familiar with EI. Whereas in South and Northeast of the country shown very limited preference in insect consumption due to the traditional and cultural identity in food preference which is red meat, ideally beef (Schardong et al. 2019). Schardong et al (2019) indicated that education also plays an important role in purchasing and consumption attitudes of Brazilian consumers which mainly associated with the safety concern of EI where more people who have done postgraduates and postdoctoral studies perceived EI as safe, compared to people with lower educational background.

Coutinho (2017) has highlighted the barriers toward EI consumption of Brazilian customers and categorized it into three main dimensions: Market and Product, Psychology, and Legislations and Regulations. The availability and price of EI contributed to the weak in its demand, cultural identity and ideology on entomophagy also idle the progress in level of acceptance of EI among local people while certain laws also restricted the consumption, for instance: in Brazil legislation, insects are considered as "plague" (Coutinho 2017).

Figure 4 Barriers toward the consumption of edible insects among Brazilian consumers



Source: Coutinho 2017

2.5.4. Consumption of Insects in Australia

According to Sogari et al. (2019a)'s research, a low number of Australians are ready to adopt EI as a meat substitute. It might result from strong prejudice and lack of knowledge on EI which desist people from trying EI. However, a considerable proportion of Australian consumers are expected to have a neutral or position attitude toward entomophagy in the future especially among young people due to the awareness of climate changes and food sustainability together with the role of EI in these issues (Sogari et al. (2019a). The attitude toward each species of EI is different, cockroaches, spiders and scorpion are the least favourable as Australian consumers perceive them as pests rather than food, while crickets and ant are the most favourable (Wilkinson et al. 2018). Some identified factors have driven the willingness of Australian consumers to try EI such as price, quality, nutritional value, food safety and taste/flavour. Nonetheless, none of these factors has a big influence on Australian consumer to tilt their preference toward EI, their perception was neutral to all of the above factors. People who had previously eaten EI before are the most accepting of insects as food which accounted for 21% of all participants in research by Wilkinson et al. (2018).

3. Aims of the Thesis

The general objective of the thesis was to determine Cambodian consumers' attitudes toward Edible Insect (EI).

The specific objectives were to identify the EI species that are commonly consumed by Cambodian consumers and the reasons for the consumption of EI. The second objective was to discover the perception of the people toward EI insects in Cambodia. Finally, yet importantly, it was to determine the personal motivation factors that driven the purchase and consumption behaviours of Cambodian consumers and to examine whether price, taste, degree of processing play part in their consumption (Table 5).

Table 5 Summary of factors that affect insect consumption

Factors	Author(s), year	Country	Description
Gender	Verbeke, 2015	Belgium	Men are more likely to eat insects than women
	Bartkowicz & Gdyni., 2017	Poland	
	Schardong et al. 2019	Brazil	
	Gere et al., 2017	Hungary	
Age	Verbeke, 2015	Belgium	Younger people are more likely to eat insects than older people.
	Liu et al., 2019	China	Older people are more likely to eat insects than younger people.
	Anankware et al., 2016	Ghana	Insect is delicious.
Taste	House, 2016	The Netherlands	More positive perception toward the taste of insect.
	Sogari et al., 2016	Italy	More positive perception toward the taste of insect products.
	Hartmann et al., 2018	China	Neutral toward the degree of processing of insects.
Degree of process	Balzan et al., 2015	Italy	Prefer in less visible form.
	Gere et al., 2017	Hungary	
	Gmuer et al., 2016	Switzerland	
Household circumstance	House, 2016	The Netherlands	The lone consumer is more likely to buy insect products.
	Liu et al., 2019	China	Eat more insects if have a larger size of household.

Based on the literature review, the following hypothesises were identified.

Hypotheses:

H_1: Cambodian men are more likely to eat insects than women.

H_2: Curiosity is the main reason leading to insect consumption.

H_3: The taste of edible insects is the main driving factor for the consumption of insects.

4. Methods

Secondary data was the main source of information to formulate the general understanding of EI in the literature review which the majority of the information was represented by the available literature, scientific papers and reports, mainly published in the scientific database ScienceDirect. Reports published by the Food and Agricultural Organization of the United Nation were used to acquire the most recent information on the consumption of EI in different countries.

Primary data were collected to get the most promising response to their respective objectives. The questionnaire survey was formulated and distributed to Cambodian consumers through online platforms using the snowball data collection method.

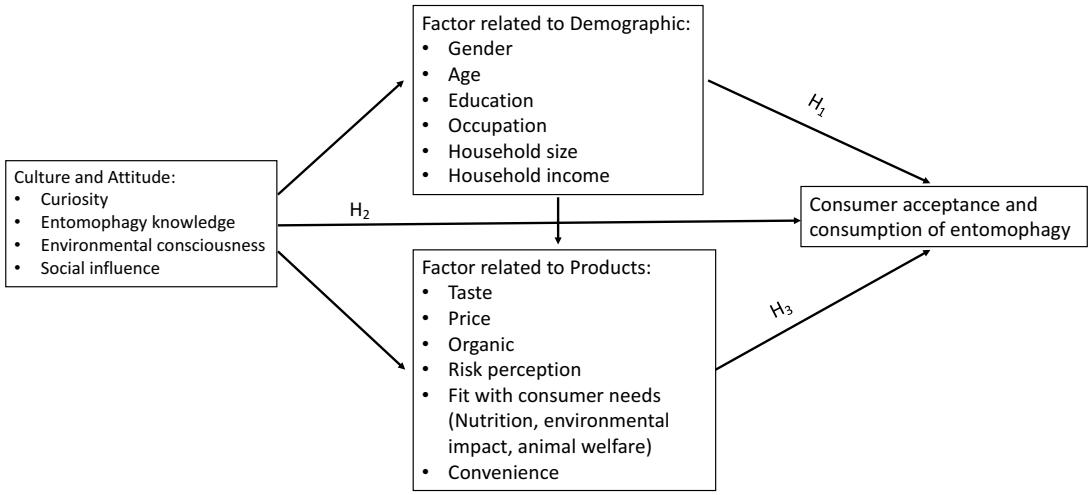
4.1. Conceptual Design

Consumer acceptance and consumption of entomophagy is directly and indirectly influenced by three main categorical factors, culture and attitude, factors related to demographic and factors related to products (Figure 5). The culture and attitude category is expected to play an important role in influencing the level of consumption and acceptance of entomophagy among the population. The culture and attitude category comprise of prior attitude factors (curiosity, fear, neophobia), knowledge related to entomophagy, environmental awareness, and social influences and acceptance of entomophagy. Demographic and product features are influenced by factors from the culture and attitude. Regarding demographic category, variables include gender, age, education, occupation, household size, and household income. For products related factors, variables include taste, price, traits that fit with consumers' expectation, and convenience.

The price and quality combination is very important to consumers which the food should taste good, are of good quality, and are offered at a reasonable price (Hoek 2010). Tangible and intangible benefits (environmental impact, economic factors) should be addressed to increase the acceptance level of consumer toward EI (Siegrist 2008). Risk perception which associates with food often has a negative impact on consumers' consumption and purchase behaviour (Siegrist 2008). Organic food attracts high attention from consumers than those with addictive and artificial ingredients (Lensvelt &

Steenbekkers 2014). Lastly, convenience also plays a very important which the product should be easily accessible by consumers, easy to store, and easy to consume (Pambo et al. 2016).

Figure 5 Conceptual model of consumer acceptance of entomophagy



4.2. Data Collection

Pre-research was conducted to identify the common EI species that are available in the market in Cambodia. The identification was done through the observation of available EI species at two random insect-selling stalls at Koh Pich and Phnom Penh's night market in Phnom Penh. Several insect species were identified including cricket, silk pupae, water scavenger, and giant water bug which the information was later used in the questionnaire aim to identify the commonly eaten species of insect and the most favourite species of insects.

To get the biggest data diversity possible, data were collected throughout Cambodia without any regional restriction of residency. The target group of the thesis is the citizens of Cambodia. The data collection was mainly distributed to the public using an online questionnaire which was developed using Google Form. The online questionnaire was sent out via two main channels, online social networks namely Facebook and Telegram, and the cooperation with two partners universities. The

universities were the Royal University of Agriculture located in Phnom Penh and the University of Battambang located in Battambang province. In total, we have collected data from 216 respondents.

4.3. Questionnaire Design

The questionnaire contained 23 questions which were divided into five sections. Section 1 was the introduction to my diploma thesis and the guarantee to keep their responses confidential. Section 2 was related to their previous experiences of eating EI. To provide ease of insect species identification, a picture for each highlighted species of insects was attached with the name. Similarly, pictures were also used in question 7 in which respondents were asked about the form of insects at the time of eating. Section 3 dedicated to consumers' perception toward EI, their consuming and purchasing behaviour, and factors that might influence them to eat EI again in the future. Section 4 concerned about people's daily dietary which included questions related to their choices of diet. Section 5 was oriented toward sociodemographic information including their age, gender, birthplace, education, occupation, household size, and monthly household income. An example of the questionnaire is attached in Annex 1.

After questionnaire formulation was completed, a pre-test was conducted among students from the "Tropical Products Marketing" course which was supervised by Dr. Petra Chaloupková in October 2020. Recommendations and suggestions from students were taken into account in improving the questionnaires before distributing them to target audiences.

The questionnaire was then translated into Khmer language using Memsource, a translation management system. Human quality control was also applied to ensure the quality and consistency of the translation.

4.4. Data Analysis

A total of 216 questionnaires were received from all sources of data collections. 170 responses were respondents from online social networks, 38 responses were from the students and staff of the Royal Universities of Agriculture, and 8 responses were the respondents from the University of Battambang.

Initially, all data was manually keyed into MS Excel for data cleaning purpose. MS Excel was also used for descriptive data analysis and chart construction. Data analysis was done using SPSS software version 27.0.0.0. It was used to conduct the Pearson Chi-squared test to determine the association between consumer preferences and independent variables (gender, age, education, occupation, household size, and household income) (Manditsera et al. 2018; Bartkowicz & Gdyni 2017; Chaloupkova et al. 2020). Emphasis has been given to the detailed evaluation of gender-related differences concerning the consumption of insects and the initial reason leading to insect consumption. The t-test was deployed to determine the significant differences between gender and insect consumption. Differences between independent variables were considered statistically significant at *p-value* set at 0.05. The ranking method was used to manifest the most reported reasons for the earliest experience of insect consumption.

5. Results

5.1. Socioeconomic Characteristics of the Respondents

There was a total of 216 respondents participating in this online questionnaire, a good proportion between male and female respondents was observed which stood at 53.7% and 46.3% respectively. The majority of the respondents were aged from 19-30 (84.7%) and 86.2% completed higher education (associate's degree, bachelor's degree, master's degree and PhD). A high number of students (43.1%) has been identified from the questionnaire, whereas only a total of 8.4% were reported to work in agricultural-related fields while the rest belonged to private and governmental sectors. Detailed data on the characteristics of all participants such as gender, age, education, occupation, household size, and household income are presented in the following sub-chapter.

5.2. Edible Insect Consumption

Entomophagy or the concept of eating as food were widely known by all participants. 97.2% of all respondents were reported to have eaten at least one species of insects before either on a one-time trial or regularly. The most commonly eaten species of insect was cricket as it was eaten by 79.2% of respondents, followed by red ant/weaver ant (69.4%), silk pupae (54.2%), water scavenger (50.9%), grasshopper (50.0%), Thai zebra tarantula (45.4%), giant water bug (34.7%) and mole cricket (32.4%). Additionally, cricket (41.4%), silk pupae (12.9%), and red ant/weaver ant (11.4%) were the top three most favourite insects highlighted by respondents while the rest of insects combined only value at 34.3%.

Socioeconomic factors of respondents influenced the consumption of EI which was shown via the analysis of collected data (Table 6). Pearson Chi-squared test was used to determine the association between characteristics of respondents and all named species of insects. Particularly, there are statistically significant differences ($p < 0.05$) between age and education in the consumption of EI. Regarding age, the youngest categories ate the least in almost all species of insects except cricket (83.3%) while 19-30 and 31-59 categories scored 80.9% and 84.2% respectively. At the same time, 19-30 age category had the highest consumption rate in grasshopper (53.9%), water scavenger (55.6%), and

silk pupae (59%), while the rest of the species were eaten most by 31-59 age category at 47.4% for mole cricket, 84.2% for cricket, 57.9% for Thai zebra tarantula, 84.2% red ant/weaver ant, and 42.1% for giant water bug (Table 6). The differences are identified within the educational categories in which the Associate's Degree or Bachelor's Degree category and Master's Degree or PhD category displayed higher levels of consumption in all species of insects compared to people who had completed up to high school study. There were significant differences between "up to High School" and "Master's Degree or PhD" categories in the consumption mole cricket (18.5%, 43.6%), giant water bug (14.8%, 46.2%), and water scavenger (18.5%, 69.2%) (Table 6).

Table 6 indicates a relationship between household income and mole cricket (*p-value* = 0.001), Thai zebra tarantula (*p-value* = 0.028), grasshopper (*p-value* = 0.017), and silk pupae (*p-value* = 0.033) had been identified as significant (where *p-value* < 0.05). A noteworthy difference can also be observed within the household income category in the consumption of certain species of insects between the lowest and the highest household income group, namely in the consumption of mole cricket (33.3% and 15.4%, respectively), Thai zebra tarantula (23.8% and 56.9%, respectively), grasshopper (66.7% and 35.4%, respectively), water scavenger (61.9% and 43.1%, respectively) and silk pupae (38.1% and 64.6%, respectively) (Table 6). The household size displayed a great similarity between the two categories (under 5 members and more than 5 member's households) with the marginal differences not exceeding 10% in all species of insects (Table 6).

Gender indicated less significant differences toward the consumption of insects as a whole as well as each respective species of insects. Men and women showed similar preferences when it came to eating insects. To understand better, t-test was used to determine whether men might eat more insects than women. However, the p-value stood at 0.312 which translated to not statistically significant. Therefore, hypothesis n.1 "Men are more likely to eat more insects than women" was rejected.

Table 6 Relative values of insect consumption to sociodemographic characteristics of respondents (*N* = 216)

Variables	Total Sample		In	Mc	Cr[1]	Ta	Ra[3]	Gr	Gw	Ws	Sp[2]
	N	%					*P/%*				
All Participants	216	100.00	97.2	32.4	79.2	45.4	69.4	50.0	34.7	50.9	54.2
Gender			0.310	0.142	0.768	0.107	**0.044**	**0.001**	0.126	**0.081**	0.331
Male	116	53.70	98.3	37.7	80.7	51.8	77.2	62.3	40.4	57.9	58.8
Female	100	46.30	96.0	28.1	82.3	40.6	64.6	38.5	30.2	45.8	52.1
Age			**0.022**	0.204	0.924	0.576	**0.006**	**0.041**	0.116	**0.001**	**0.034**
Below 19	14	6.51	85.7	16.7	83.3	41.7	33.3	16.7	8.3	0.0	25.0
19-30	182	84.65	97.8	33.1	80.9	46.1	72.5	53.9	36.5	55.6	59.0
31-59	19	8.84	100.0	47.4	84.2	57.9	84.2	47.4	42.1	52.6	42.1
60+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Education			0.673	0.119	0.954	0.330	**0.021**	0.263	0.152	**0.005**	0.243
Up to High School	29	13.43	93.1	18.5	77.8	40.7	51.9	33.3	14.8	18.5	44.4
Associate's Degree or Bachelor's Degree	147	68.06	97.3	32.9	82.5	46.2	72.7	55.2	36.4	53.1	58.7
Master's Degree or PhD	39	18.06	100.0	43.6	79.5	53.8	79.5	48.7	46.2	69.2	51.3
Vocational Training	1	0.46	100.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0	100.0
Occupation			**0.030**	0.171	0.646	0.266	0.160	0.930	0.235	0.122	0.480
Self-employed in Agriculture	6	2.78	100.0	50.0	83.3	83.3	100.0	50.0	83.3	83.3	66.7
Self-employed in Non-agriculture	11	5.09	100.0	9.1	100.0	54.5	72.7	45.5	18.2	27.3	36.4
Employee in Agriculture	12	5.56	100.0	41.7	75.0	58.3	83.3	66.7	33.3	75.0	50.0
Employee in Non-agriculture	51	23.61	100.0	45.1	76.5	49.0	68.6	54.9	31.4	62.7	58.8
Government officer	33	15.28	97.0	40.6	87.5	53.1	84.4	46.9	43.8	50.0	50.0
Student	93	43.06	96.8	25.6	81.1	38.9	63.3	50.0	35.6	45.6	55.6
Other occupation	10	4.63	88.9	25.0	75.0	37.5	87.5	50.0	25.0	50.0	87.5
Household Size			0.860	0.713	0.333	0.716	0.359	0.169	0.278	0.661	0.430
Under 5	79	36.74	97.5	35.1	77.9	48.1	67.5	45.5	31.2	50.6	51.9
5+	136	63.26	97.1	32.6	83.3	45.5	73.5	55.3	38.6	53.8	57.6
Household Income			0.851	**0.001**	0.567	**0.028**	0.130	**0.017**	0.863	0.460	**0.033**
Under $250	21	9.72	100.0	33.3	71.4	23.8	52.4	66.7	38.1	61.9	38.1
$250-$500	56	25.93	98.2	50.9	83.6	41.8	78.2	63.6	36.4	54.5	61.8
$501-$750	45	20.83	95.6	41.9	83.7	39.5	79.1	51.2	37.2	55.8	39.5
$751-$1,000	27	12.50	96.3	26.9	88.5	61.5	73.1	53.8	42.3	57.7	61.5
Above $1,000	67	31.02	97.0	15.4	78.5	56.9	66.2	35.4	30.8	43.1	64.6

Note(s): [1]Most favourite insect species, [2]Second most favourite insect species, [3]Third most favourite insect species, In = Insects, Mc = Mole cricket, Cr = Cricket, Ta = Thai Zebra Tarantula, Ra = Red ant/weaver ant, Gr = Grasshopper, Gw = Giant water bug, Ws = Water scavenger, Sp = Silk pupae

When asked about the reason that led to their first-time experience with EI, the majority of the participants highlighted that they ate insects out of curiosity (52.4%) while 23.8% were reported to eat insects because their family members eat them too. Curiosity was ranked as the most reported reason to engaged in insect consumption in the first place and it was consistently remained at the top of the rank in all group of gender and age of respondents. 49.1% of male respondents and 56.3% of female respondents were reported to initially eat insects because of curiosity, while 58.3%, 54.3%, and 42.1% were reported in the under 19, 19-30, and 31-59 age group respectively. A majority of female respondents (28.1%) found that family member is the second most influential reason leading to first-time experience with insect consumption while the "I do not remember when" was reported to be the second most mentioned reason among men. Similarly, "I eat them because my family members eat them" and "I do not remember when" were ranked second and third most frequently reported reason for first-time insect consumption in all three age groups. "It was a dare/prank", "I did not know what I was eating is insects", and "other reasons" were the 3 least mentioned reasons reported by the respondents for almost all gender and age groups (Table 7).

Table 7 The most frequently reported reasons for insect consumption with respect to gender and age of respondents

Variable	Insect Consumption	Gender					Age						
		Male		Female			Under 19		19-30		31-59		
Initial reasons for insect consumption	*p-value*	(%)	Rank	(%)	Rank	*p-value*	(%)	Rank	(%)	Rank	(%)	Rank	*p-value*
I ate them out of curiosity.	**0.012**	49.1	1	56.3	1	0.334	58.3	1	53.4	1	42.1	1	0.730
I don't remember when.	0.267	21.9	2	12.5	3	0.088	16.7	3	17.4	3	21.1	3	0.851
I eat them because my family members eat them.	0.385	20.2	3	28.1	2	0.311	25.0	2	22.5	2	31.6	2	0.898
I eat them because my friends eat them.	0.675	3.5	4	2.1	4	0.518	0.0	4	3.4	4	0.0	5	0.571
Other reasons.	0.702	2.6	5	0.0	6	**0.036**	0.0	4	1.1	5	0.0	5	0.586
I did not know what I was eaten is insects.	0.810	1.8	6	0.0	6	0.187	0.0	4	1.1	5	5.3	4	0.833
It was a dare/prank.	0.810	0.9	7	1.0	5	0.916	0.0	4	1.1	5	0.0	5	0.833

Despite the high percentage of insect consumption among our respondents, the form in which insects were eaten was found to concentrate in a single form "visible/whole insects (Cooked/Raw)" (98.1%). Table 8 illustrates an extremely lack of experiences in the consumption of EI in other forms in which only 6.2% with visible/whole insects in package (like a snack), 2.4% with an insect-based snack (e.g. protein bar, chip), 1.0% with insect powder, and 0.5% with meat alternative (e.g. insect burger patty, insect cake). Gender did not show any significant differences in consumption methods as a large number of males and females both enjoyed eating EI in visible/whole form (98.2% and 99.0% respectively) (Table 8).

Table 8 The most frequently reported form of insect consumption by respondents

Form of eaten insects	Total %	Male (%)	Female (%)
Visible/Whole insect (Cooked/Raw)	98.1	98.2	99.0
Visible/Whole insect in package (like snack)	6.2	8.0	4.2
Powder	1.0	0.0	2.1
Meat alternative (e.g. burger patty, cake)	0.5	0.9	0.0
Snack (e.g. protein bar, chip)	2.4	1.8	3.1

There is a noteworthy point when coming to the taste of insects. Insects were highly favoured by respondents which over 80% were reported to like the taste of EI. Only 17.8% of respondents did not appreciate the taste of insects and among this 17.8%, 59.5% were female.

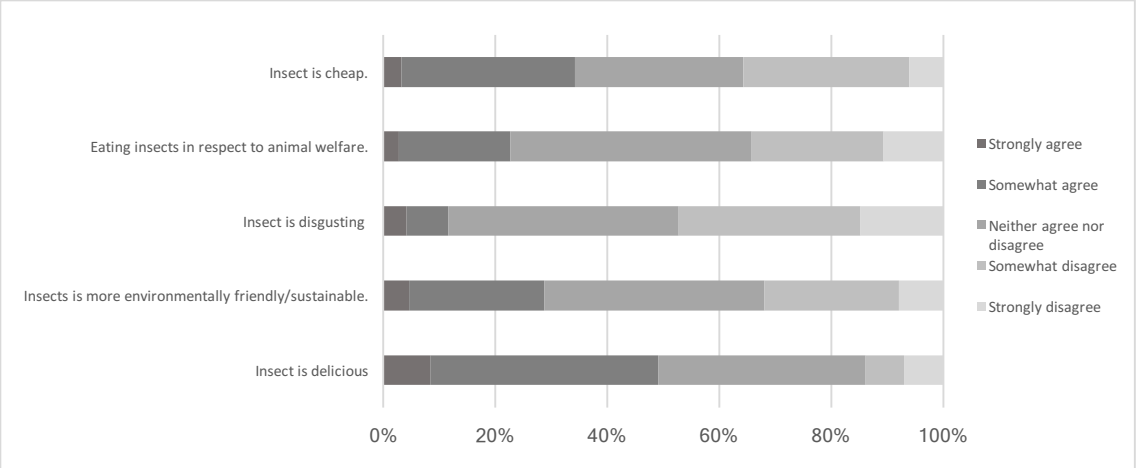
5.3. Consumer Attitude Toward Edible Insects

5.3.1. Perception on Edible Insects

The study also identified the respondents' perception of EI. Figure 6 illustrates the perception of the respondents toward the consumption of EI. The statement "Insect is disgusting" was strongly disagreed and agreed by almost 50% of the total respondents while 42% remained neutral. It corresponded to the high frequency of insects being eaten in whole/visible form by the respondents because people do not view it as unappetizing food but instead as delicious food. Insects were also regarded as delicious by about 50% of participants while about 13% were against this statement. The other three statements

were perceived similarly by accounting for about one-third of the total share for each provided option, agree, neutral and disagree, subsequently.

Figure 6 Respondents' Perception toward Insect Consumption

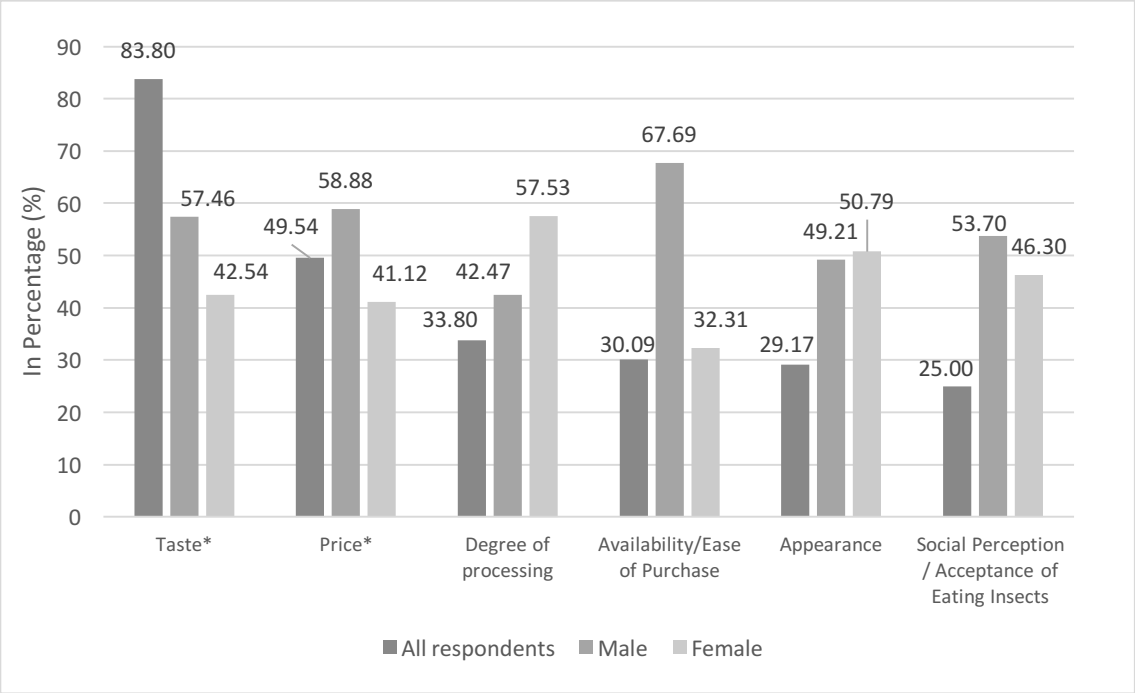


5.3.2. Factor Affecting the Consumption of Edible Insects

Participants shared their views toward the important factors that influenced the consumption of EI. However, most of them had agreed on one particular factor which is the taste of EI (83.8%). Based on descriptive statistics (Detail in Appendix 1), Hypothesis n. 3 was confirmed due to the determination that taste is one of the driving factors that influence the consumption of EI. Price was also underlined by 49.5% of participants as one of the important factors, followed by the degree of processing, availability/ease of purchase, appearance, and social perception/acceptance of eating insects at 33.8%, 30.1%, 29.2%, and 25.0% respectively.

The significant difference occurred in availability or ease of purchase factor in which 67.69% of men perceived it to be an important influential factor toward insect consumption, whereas only 32.31% of female agreed to this factor. Noticeable differences were also identified between male and female consumers in taste (57.46% and 42.54% respectively), price (58.88% and 41.12%), and degree of processing (42.47% and 57.53% respectively) which men were more sensitive than women to taste and price (Figure 7).

Figure 7 The most frequently reported factors affecting insect consumption with respects to the gender of the respondents



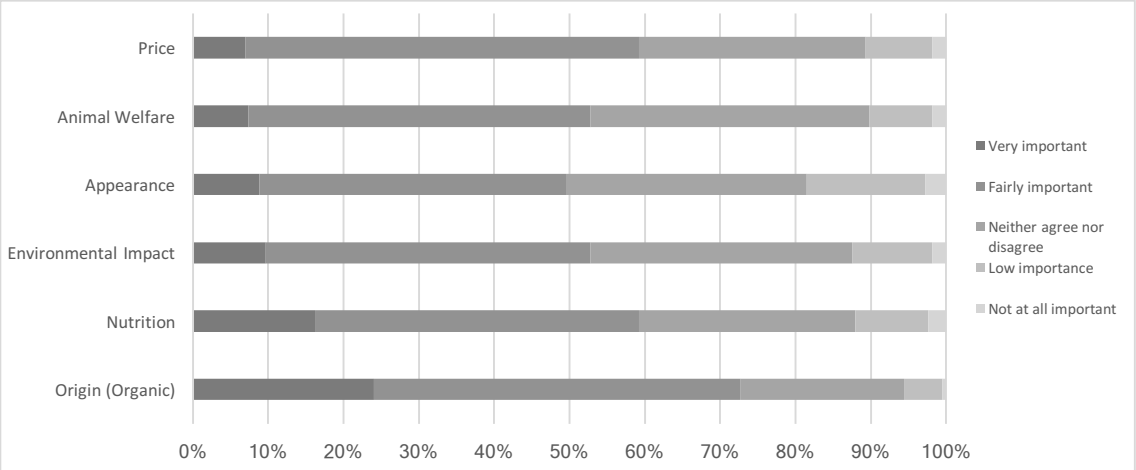
Note: *p<0.05

5.4. Future Consumption of Edible Insects

5.4.1. Ideal Characteristic of Daily Food Consumption

In daily food consumption, aside from the taste, a lot of aspects have been taken into account including the origin of the food, appearance, price, nutrition composition, animal welfare, and environmental impact out of food production. All characteristics of food were reported to be perceived as important (by the majority) by the respondents while less than 16% in all categories were perceived to be not or less important. Respondents agreed that the origin of their respective food choice is important, a quarter of respondents perceived it as very important while another 50% thought of it as fairly important. A tiny proportion of only 5.6% argued that the origin of food is not important when purchasing food. Among all characteristics, appearance was the least important criteria when it came to food choice agreed by 49.5% of respondents, yet it is still a high value. 18.5% voted it as low and not at all important while 31.9% had a neutral perspective toward the appearance of food (Figure 8).

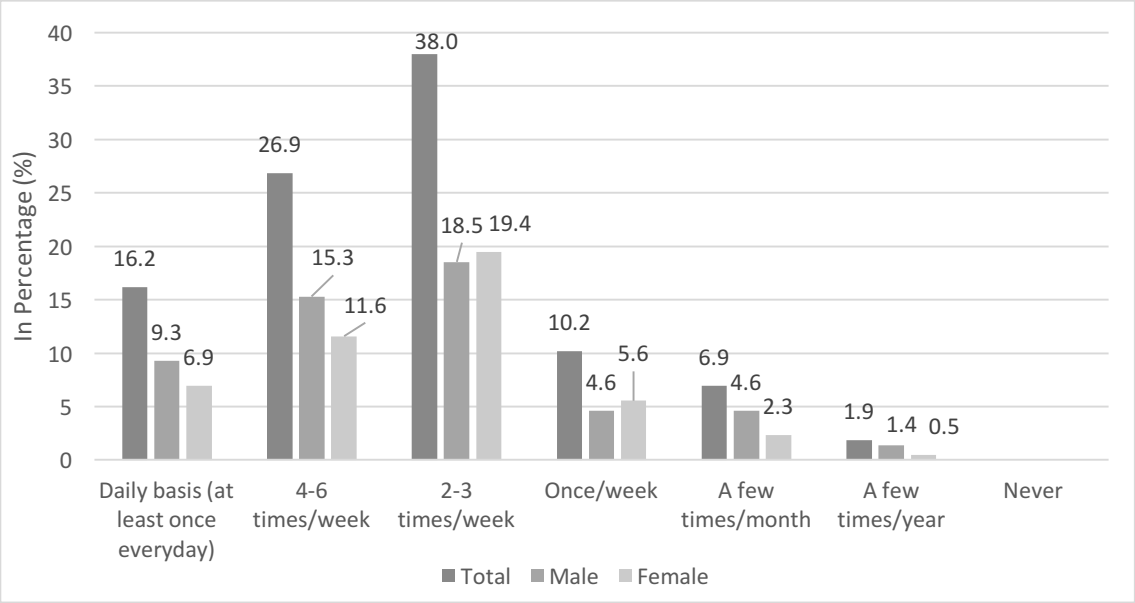
Figure 8 Respondents' perception of the importance of the characteristics of food



5.4.2. Red Meat Consumption

Insects could be a potential replacement for meat consumption in the future. It is important to understand the consumption behaviour of respondents to know how often they include red meat in their diet. In general, all respondents incorporated red meat into their diet in which no respondent has reported to have not eaten red meat within the last one year period. At the same time, a minority of respondents of about 20%, included red meat less often into their food by having it at most once per week. Over 80% of respondents had at least two meals that consisted of red meat per week. Over one-third (38.0%) had red meat between 2-3 times per week, 26.9% had it more frequently than other respondents of up to 6 times per week, while 16.2% were reported to have had red meat on a regular basis (Figure 9). Men seemed to eat red meat a little more often than women when it came to daily and 4-6 times/weeks' categories; however, there were no significant differences between the two genders in overall consumption frequency of red meat.

Figure 9 The frequency of red meat consumption with respect to the gender of the respondents

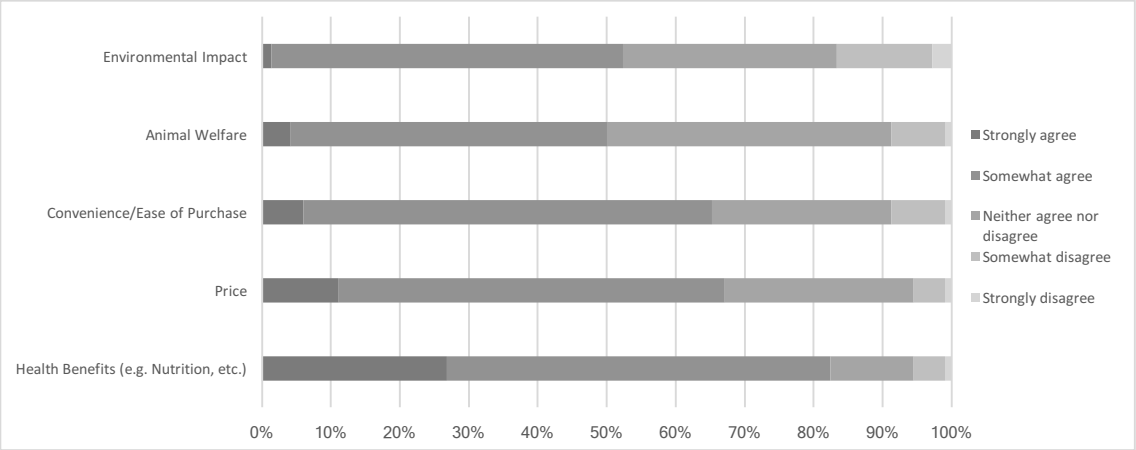


5.4.3. Factors That Might Influence the Change of Personal Diet

Respondents' perception toward each characteristic of food choice helps us to understand what they valued most when considering buying any food. In Figure 10, respondents demonstrated the conditions to be met to influence them to change their diets. A minority of disagreement was identified in all conditions. The majority of respondents valued the importance of health benefits in which 82.4% of them acknowledge it as an important influential factor for their daily diet to be changed while 26.9% of those shown strong agreement to "Heath benefit". Price and convenience/east purchase were also overwhelmingly agreed to be key factors in changing respondents' diets which were strongly agreed and somewhat agreed by 67.1% and 65.3% respectively.

In contrast, non-personal related factors including environmental impact and animal welfare were the least influential conditions compared to the other three options which were backed by 50.0% and 52.3% of respondents respectively. Additionally, the environmental factor was also the factor that was disagreed most by respondents by 16.7% among the five factors which all had less than 9% disagreement combined.

Figure 10 The reported factors that might influence respondents to change their personal dietary.

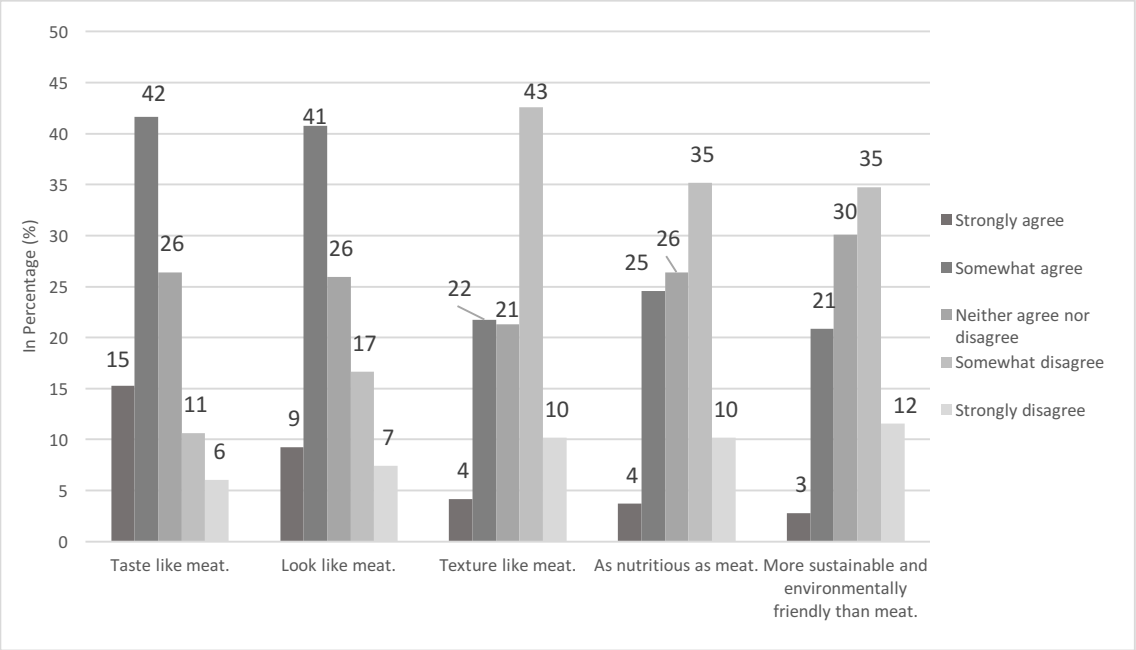


5.4.4. Perception Toward Insect-based Meat Alternative Food

Lesser consumption of innovated forms of insects was recorded among respondents in comparison to the traditional method of consumption (whole/visible form). Insect-based meat alternative products were rarely eaten (0.5%) by the respondents, in contrast to the whole/visible form of insects which were commonly consumed by 98.1% of the respondents.

When asked about the preferred attributes of insect-based meat alternative products, namely insect burger, divided options were recorded among the five options. More than half the respondents expected the insect burger to taste and look like meat (57% and 50%, respectively) (Figure 11). However, when it came to the texture of the insect burger, 53% of the respondents did not agree that it should be the same as meat. Insects and livestock have completely different meat texture, thus it is understandable that they should feel dissimilar. Similarly, respondents did not expect the meat alternative to be as nutritious as meat nor being more sustainable and environmentally friendlier than meat production. It was opposed by 45% from the nutrition point of view and 46% from the sustainable and environmental point of view.

Figure 11 Respondents' perception toward the attributes of insect-based meat alternative product (Insect burger)



6. Discussion

6.1. Consumption of Edible Insects

Insects play an important role in addressing the ongoing global protein and nutritional challenges. This is because sufficient levels of proteins, fat, and micronutrients to keep a healthy diet were recorded in insects (Liu et al. 2019). It could substantially improve global health and food security both directly through the direct consumption of insects and indirectly through the usage of insects in animal feeds (Dobermann et al. 2017).

Attitude toward insect consumption has been studied in many countries across the globe to understand the perception of insects as food, the consumption, and purchasing behaviour of local people to insects. The previous studies conducted in various countries, such as Australia, Brazil, Italy, the Netherlands and other European countries, confirmed that the consumption of EI among survey respondents was extremely low (Sogari et al. 2019a; Schardong et al. 2019; Balzan et al. 2015). In a survey conducted by Sogari et al. (2019a) in Australia, only 4.4% of all respondents mentioned having real experience with EI. On the contrary, studies in China and Kenya indicated a high prevalence of insect consumption of up to 88% of the respondents had at least eaten some kinds of insects (Feng et al. 2018; Pambo et al. 2016). The high frequency of insect consumptions in these two countries was closely related to the long historical culture of using insects for their pharmaceutical and nutritional value (Feng et al. 2018; Pambo et al. 2016). Our results showed that the majority of the Cambodian respondents (97.2%) had consumed insects before. Male and female respondents did not illustrate major differences in their consumption pattern as opposed to studies conducted in other countries where men were more likely to eat the insects up to 2.17 times more than women (Verbeke 2015; Bartkowicz & Gdyni 2017; Schardong et al. 2019). This indifference might be caused by the emergence of the insect as emergency relief food during the civil war that pushed millions of people into famine which turned insects into a popular protein-based food (VOA 2016).

If we focus on the preference of individual species among respondents, our study showed that cricket was one of the most commonly consumed species of insects among

our respondents. Similar preferences were confirmed among Thai consumers (Halloran et al. 2016). Despite having thousands of identified EI, two species of crickets were the only species of insects that are commercially produced to supply into the consumer market all year-round (Huis 2016). Whereas 92% of total insect production were wild-collected where specific species of insects were seasonally supplied to the consumers' market (Yen 2015). Therefore, the highest preference for cricket is highly related to their availability at the local markets.

6.2. Factors Influencing Edible Insects Consumption

6.2.1. Disgust

Several studies conducted in Belgium, Italy, and the Netherlands underlined the fear and disgust emotion toward EI (Sogari et al. 2019b). Concurrently respondents were also curious and wanted to try EI. Similarly, our results highlighted curiosity as the main reason for insect consumption for over 50% of the respondents. Additionally, over 98% of the respondents reported eating insects in visible/whole form either cooked or raw depending on the species. Insects are commonly found to be sold in whole visible form, served up deep-fried, crunchy and seasoned in Cambodia (Reuters Life 2007). This could explain why insect was perceived as disgusting by only a few of our respondents.

6.2.2. Degree of Processing

High level of food neophobia towards insects which lower the willingness to try or eat insect as food was identified in many different countries in Europe as well as China (Gere et al. 2018). Non-visible insect-based food such as powder or ground insects had lower neophobia levels (Gere et al. 2018), whereas the high rejection of insect-based food was reported when the heads and eyes of insects were present in the food (Lensvelt & Steenbekkers 2014). The feeling of disgust occurred in many studies which aim to understand the perception of people toward EI, repeatedly reported among researches conducted in Western countries including Dutch, Italian, Swiss, and American participants (Gere et al. 2018). On the other hand, a similar study conducted in Thailand highlighted the term "disgusting" less often (Tan et al. 2015). Likewise, only a minority of 11% of our Cambodian respondents agreed that insect is disgusting. Gere et al. (2018)

suggested that cultural differences might play an important role in consumption and acceptance patterns, regular consumption of insects within the society built confidence and facilitate the acceptance behaviour of insect consumption.

6.2.3. Taste

The taste and flavour of EI are diverse depending on the insect species in which ant and termites were described to have a sweet and almost nutty taste, cockroaches have mushrooms like taste and flavour, mealybugs to taste like fried potatoes and lastly dragonfly larvae and other aquatic insects to taste like fish (Elorduy 1998). Stage of development, environmental, feed and cooking methods affects the sensory quality and taste of EI (Kourimska & Adamkova 2016); therefore, affecting the perception of consumers toward insect consumption. About 50% of our respondents perceived insect to be delicious. About 84% of the respondents also regarded taste as the most influential factors that affect their insect consumption which corresponded to several previous studies. The study by Anankware et al. (2016) on entomophagy practices in Ghana pointed out the special feature of insect which is their unique taste. House (2016)'s study in the Netherlands found similar results regarding the importance of taste on the future purchase of insect-based food in this research. While 69% of the respondents reported liking or just being okay with insect-based food, the other 30% reported liking its taste and will make the future purchase (House 2016).

6.2.4. Price

Price plays an essential role in food choice especially among low-income consumers in which they were significantly more conscious about the price and the value of the products (Steenhuis et al. 2011). In our study, 69% of the respondents came from households with a monthly income of 1,000 USD and below, half of them agreed that the price of EI is an important factor that influences their insect consumption. It does reflect the willingness to purchase the insect or insect-based food if it were price at a considerately low price. Aung and Durr (2019)'s study on the marketing and consumption of EI in Myanmar has illustrated the hesitation of 27% of the respondents to consume insects due to the high price of the insects, in which a study by Huis (2013) has also found that EI's price in Myanmar had increased in recent years. Interestingly in the Netherlands,

consumers were willing to pay the premium price for insect-based food that has mandatory health claim (Magistris et al. 2015). In Kenya, consumers also showed a high willingness to pay for specific insect-based food for its nutritional value with food safety control attributes (Alemu et al. 2017).

6.3. Consumers´ Food Preferences

The changes in consumers' food choice in their daily dietary choices have been observed, with the increasing number of individuals favouring more sustainable products and consumption pattern such as consuming organic foods (Holloway et al. 2007; Rizzo et al. 2020). Several factors played important role in fuelling this trend, including the growing interest in environmental impacts of agricultural activities, the health dimension of food, and food safety (Rizzo et al. 2020). In our study, the respondents showed high interest in organic food, agreed by over 70% of the respondents. The main source of EI supplied on the market was from nature (Yen 2015); whereas, the farmed insect can be grown on organic side streams, converting low-value organic by-product into high-value protein (Huis 2020) which could ensure the organicness of EI. From a nutrition point of view, the majority of the respondents wanted their food to be as nutritious as possible.

Looking into the nutrition composition of insects, its nutritional value is compatible with conventional meat (FAO 2013) in which some species of insects possess an even higher amount of health beneficial value than beef, reptiles' meat and fish (Kourimska and Adamkova 2016).

Environmental impact was also one of the most important factors that were taken into the consideration by over 50% of the respondents when it came to food choice. The impact of food production on the environment has attracted attention from people all around the world, concerning the emission, land and water use in producing food (Dobermann et al. 2017). Insect productions were reported to have a lower water footprint compared to other livestock by taking into the percentage of edible parts (Miglietta et al. 2015). Likewise, insects were also found to produced fewer emissions than large livestock, at the equivalent of chicken production (Dobermann et al. 2017).

Three of the main important attributes that respondents paid attention to when came to food choices which were origin (organic), nutritional value, and environmental

impact were the traits that can benefit from insect consumption and production. Insects are organic or partially organic, high in protein and rich in other nutritional composition, and the rearing of insects is proofed to have less impact on the environment. Therefore, these benefits of insects can be used to promote and raise the awareness of insect consumption, encourage consumption as well as educate people to be more open toward EI. On top of this, our respondents had indicated the factors that will influence them to change their dietaries which were health benefits, price and ease of purchase. The respondents illustrated the willingness to switch to a new diet which is the positivity that could pave way for more insect consumption in the future. Additionally, their preferred conditions for them to change their diet is known; therefore, future food or insect-based food could be developed in a way that satisfied people wants by customizing it to meet their highlighted influential factors.

Our finding has shown an incredibly high percentage (81%) of our respondents who incorporated red meat into their diet at least twice a week. When came to questions related to insect-based meat alternative burger, divided opinions were recorded within the respondents. Over half of the respondents thought that meat alternative products should have the same taste and look like meat; whereas texture and nutrition were less important. These findings are consistent with those reported by Megido et al. (2016) in which the taste and appearance of meat-alternative products were also found to be more preferred by consumers during the comparison study between plant-based meat substitutes and insect-based meat substitutes. There are some advantages for insect-based meat alternative products such as nutrition, environmental impact, animal welfare, and more, which will need to communicate the issue of availability, attribute (taste, smell, appearance), and innovated products (Castro & Chambers 2018).

6.4. Limitations of the Research

This research is not without limitations. A large number of respondents were reported to be from Phnom Penh and Battambang province. Additionally, the majority of the respondents were identified as students. Physically data collection was switched to online data collection due to the worldwide pandemic of COVID-19 movement restriction. Two universities in Cambodia were contacted to facilitate this data collection process by distributing the online questionnaires to the students and staff. Most of the respondents

were students and belong to the young adult age group; therefore, the results associated with the age group might be largely influenced by young people ideology.

7. Conclusions

In this study, we reported consumer attitudes and preferences to the consumption of Edible Insects (EI). The result manifested a high prevalence of awareness of entomophagy and extremely high consumption of EI were reported among the Cambodian population. Cricket, red ant, and silk pupae were the most consumed species of insects highlighted by the respondents. Friendly perception toward insect consumption was recorded. The taste and price of EI were the two major factors that influence consumption. Additionally, respondents also showed intention to change their diets with the conditions of better nutritional value and more affordable price. These findings can contribute to the understanding of general attitudes and preferences regarding insect consumption in the Cambodian population, which can help to introduce new products to consumers' market, improve and tailor marketing strategies for the promotion of their consumption and education on the impacts of insect consumption to the world. The positive attitude to change the diet among the respondents illustrates a market opportunity for food producers to optimize the usage of EI as food to the market, thanks to its richness of nutrition and the possibility of insect mass production to take the advantage of benefiting from economies of scale. Improving the taste and keeping the price affordable could potentially boost sales. In addition, the majority of the consumption was made in whole visible form while other forms of consumption were rarely reported by the respondents. It exhibits a huge market gap of insect-based products within the food industry in Cambodia. The new innovative forms of EI consumption should be encouraged to fill the EI market gap while at the same time diversifying the food options for the consumers, creating jobs for the local, and generating economic benefits to the country.

Even though our findings identified specific local consumers' patterns and provided insights into the consumers' intentions, many aspects of consumer attitudes and preferences related to insect consumption and insect-based foods were still unknown. Future research should enlarge the scope of this study to cover a more diverse consumer sample as well as further investigate the influence of cultural differences on consumption and purchase behaviour. Lastly, future research could be extended to include data sample from other developing or less developed Asian countries to inspect the consumer acceptance of this cost-friendly protein source.

8. References

Afton H, Muenke C, Vantomme P, Huis AV. 2014. Insects in the human food chain: global status and opportunities. Food Chain **4**(2): 103-118. DOI: 10.3362/2046-1887.2014.011.

Alemu MH, Olsen SB, Vedel SE, Kinyuru JN, Pambo KO. 2017. Can insects increase food security in developing countries? An analysis of Kenyan consumer preferences and demand for cricket flour buns. Food Security **9**(3): 471-484. DOI: DOI: 10.1007/s12571-017-0676-0.

Anankware PJ, Osekre EA, Obeng-Ofori D, Khamala CM. 2016. Factors that affect entomophagy practices in Ghana. Journal of Insects as Food and Feed **3**(1): 33-41. DOI: 10.3920/JIFF2016.0007.

Aung MTT, Dürr J. 2019. Marketing and Consumption of Edible Insects in the Urban Center of Yangon, Myanmar. University of Bonn, Bonn.

Bartkowicz J, Gdyni AM. 2017. Tri-City Consumers Attitudes towards Eating Edible Insects as an Alternative Source of Food. Handel Wewnetrzny 2017 **1**(366): 156-166.

Belzan S, Fasolato L, Maniero S, Novelli E. 2015. Edible insects and young adults in a north-east Italian city an exploratory study. British Food Journal **118**(2): 318–326. DOI: 10.1108/BFJ-04-2015-0156.

Chaloupkova P, Petrtyl M, Verner V, Kokoska L. 2020. Dietary supplements versus functional foods: consumers' attitudes to their consumption. British Food Journal **122**(12): 3853-3868. DOI: 10.1108/BFJ-10-2019-0767.

Chen X, Feng Y, Chen Z. 2009. Common edible insects and their utilization in China. Entomological Research **39**(5): 299-303. DOI: 10.1111/j.1748-5967.2009.00237.x.

Christensen DL, Orech FO, Mungai MN, Larsan T. Friis H, Aagaard-Hansen J. 2006.

Entomophagy among the Luo of Kenya: a potential mineral source?. International Journal of Food Science and Nutrition **57**(3-4): 198-203. DOI: 10.1080/09637480600738252.

Coutinho JMS. 2017. Insects as a legitimate food ingredient: barriers & strategies [MSc. Thesis]. The Catholic University of Portugal, Lisbon.

Dobermann D, Swift JA, Field LM. 2017. Opportunities and hurdle of edible insects for food and feed. Nutrition Bulletin **42**: 293-308. DOI: 10.1111/nbu.12291.

Durst PB, Johnson DV, Leslie RN, Shono K. 2010. Forest insects as food: humans bite back. Food and Agricultural Organization of the United Nation Regional Office for Asia and the Pacific, Bangkok.

Elorduy JR. 1998. Creepy Crawly Cuisine: The Gourmet Guide to Edible Insects. Park Street Press, Rochester.

Feng Y, Chen X, Zhao M, He Z, Sun L, Wang C, Ding W. 2018. Edible insects in China: Utilization and prospects. Insect Science **25**(2):184-198. DOI: 10.1111/1744-7917.12449.

FAO. 2011. Major gains in efficiency of livestock systems needed. Food and Agricultural Organization of the United Nation, Rome. Available from http://www.fao.org/news/story/en/item/116937/icode/ (assessed November 2020).

Gere A, Zemel R, Radványi D, Moskowitz H. 2018. Consumer Response to Insect Foods. In Reference Module in Food Science: 1-6. DOI: 10.1016/b978-0-08-100596-5.21881-7.

Gregoire Y. 2003. The Impact of Aging on Consumer Responses: What Do We Know?. NA - Advance In Consumer Research **30**: 19-26.

Halloran A, Roos N, Flore R, Hanboonsong Y. 2016. The development of the edible cricket industry in Thailand. Journal of Insects as Food and Feed **2**(2): 21-100. DOI: 10.3920/JIFF2015.0091.

Halloran A, Hanboonsong Y, Roos N, Bruun S. 2017. Life cycle assessment of cricket farming in north-eastern Thailand. Journal of Cleaner Production **156**: 83-94. DOI: 10.1016/j.jclepro.2017.04.017.

Han R, Shin JT, Kim J, Choi YS, Kim YW. 2017. An overview of the South Korean edible insect food industry: challenges and future pricing/promotion strategies. Entomological Research **47**: 141-151. DOI: 10.1111/1748-5967.12230.

Hanboonsong Y, Durst PB. 2014. Edible insects in Lao PDR: building on tradition to enhance food security. Food and Agricultural Organization of the United Nation Regional Office for Asia and the Pacific, Bangkok.

Hanboonsong Y, Jamjanya T, Durst PB. 2013. Six-legged livestock: edible insect farming, collection, and marketing in Thailand. Food and Agricultural Organization of the United Nation Regional Office for Asia and the Pacific, Bangkok.

Hartmann C, Siegrist M. 2017. Insects as food: Perception and acceptance. Finding from current research. Ernahrungs Umschua **64**(3): 44-50.

Hartmann C, Ruby MB, Schmidt P, Siegrist M. 2018. Brave, health-conscious and environmentally friendly: Positive impressions of insect food product consumers. Food Quality and Preferences **68**: 64-71. DOI: 10.1016/j.foodqual.2018.02.001.

Hoek A. 2010. Will Novel Protein Foods Beat Meat? Consumer Acceptance of Meat Substitutes: A Multidisciplinary Research Approach [PhD Dissertation]. Wageningen University, Wageningen.

Holloway L, Kneafsey M, Venn L, Cox R, Dowler E, Tuomainen H. 2007. Possible food economies: A methodological framework for exploring food production-consumption relationships. Journal of Rural Studies **47**: 1-19. DOI: 10.1111/j.1467-9523.2007.00427.x.

House J. 2016. Consumer acceptance of insect-based foods in the Netherlands: Academic and commercial implications. Appetite **107**: 47-58. DOI:

10.1016/j.appet.2016.07.023.

Huis AV, Itterbeeck JV, Klunder H, Mertens E, Halloran A, Muir G, Vantomme P. 2013. Edible insects: future prospects for food and feed security. Food and Agricultural Organization of the United Nation, Rome.

Huis AV. 2016. Edible insects are the future?. Proceeding of the Nutrition Society **75**(3): 294-305. DOI: 10.1017/S0029665116000069.

Huis AV. 2020. Nutrition and health of edible insects. Current Opinion in Clinical Nutrition and Metabolic Care **23**(3): 228-231. DOI: 10.1097/MCO.0000000000000641.

Itterbeeck JV, Huis AV. 2012. Environmental manipulation for edible insect procurement: a historical perspective. Journal of Ethnobiology and Ethnomedicine **8**(3). DOI: 10.1186/1746-4269-8-3.

Jansson A, Hunter D, Berggren A. 2019. Insects as Food – an option for sustainable food production?. Swedish University of Agricultural Sciences, Uppsala.

Józefiak D, Józefiak A, Kierończynk B, Rawski M, Świątkiewicz S, Długosz J, Engberg RM. 2016. Insects – a natural nutrient source for poultry – a review. Annual of Animal Science **16**(2): 297-313. DOI: 10.1515/aoas-2016-0010.

Kornher L, Schellhorn M, Vetter S. 2019. Disgusting or Innovative-Consumer Willingness to Pay for Insect Based Burger Patties in Germany. Sustainability 2019 **11**(7): 1878. DOI: 10.3390/su11071878.

Kouřimská L, Adámková A. 2016. Nutrition and sensory quality of edible insects. NFS Journal **4**: 22-26. DOI: 10.1016/j.nfs.2016.07.001.

Kraft H, Weber JM. 2012. A Look at Gender Difference and Marketing Implications. International Journal of Business and Social Science **3**(21): 247-253.

Kumar PV, Rajashekhar M, Ramya N, Shahanaz VS. 2017. Entomophagy: A Viable Opportunity for Food Security. International Journal of Current Microbiology and

Applied Sciences **6**(10): 1135-1143. DOI: 10.17221/236/2019-CJFS.

Lakshmi VV, Niharika DA, Lahari G. 2017. Impact of Gender on Consumer Purchasing Behaviour. IOSR Journal of Business and Management **19**(8): 33-36.

Lensvelt E, Steenbekkers L. 2014. Exploring Consumer Acceptance of Entomophagy: A Survey and Experiment in Australia and the Netherlands. Ecology of Food and Nutrition **53**: 543-561. DOI: 10.1080/03670244.2013.879865.

Liu AJ, Li J, Gómez MI. 2019. Factors Influencing Consumption of Edible Insects for Chinese Consumers. Insects 2020 **11**(1): 10. DOI: 10.3390/insects11010010.

Madau FA, Arru B, Furesi R, Pulina P. 2020. Insects Farming for Feed and Food Production from a Circular Business Model Perspective. Sustainability 2020 **12**(13): 5418. DOI: 10.3390/su12135418.

Magistris T, Pascucci S, Mitsopoulos D. 2015. Paying to see a bug on my food: How regulations and information can hamper radical innovations in the European Union. British Food Journal **117**(6): 1777-1792. DOI: 10.1108/BFJ-06-2014-0222.

Makkar HPS, Tran G, Heuzé V, Ankers P. 2014. State-of-the-art on use of insects as animal feed. Animal Feed Science and Technology **197**: 1-33. DOI: 10.1016/j.anifeedsci.2014.07.008.

Manditsera FA, Lakemond CMM, Fogliano V, Zvidzai CJ, Luning PA. 2018. Consumption patterns of edible insects in rural and urban areas of Zimbabwe: taste, nutritional value and availability are key elements for keeping the insect eating habit. Food Security **10**: 561-570. 10.1007/s12571-018-0801-8.

Melgar-Lalanne G, Hernández-Álvarez A, Salinas-Castro A. 2019. Edible Insects Processing: Traditional and Innovative Technologies. Comprehensive Reviews in Food Science and Food Safety **18**(4): 1166-1191. DOI: 10.1111/1541-4337.12463.

Miglietta PP, Leo FD, Ruberti M, Massari S. 2015. Mealworms for food: a water footprint perspective. Water **7**(11): 6190-6203. DOI: 10.3390/w7116190.

Orkusz A, Wolańska W, Harasym J, Piwowar A, Kapelko M. 2020. Consumers' Attitudes Facing Entomophagy: Polish Case Perspectives. International Journal of Environmental Research and Public Health 2020 **17**(7): 2427. DOI: 10.3390/ijerph17072427.

Oonincx DGAB, Itterbeeck JV, Heetkamp MJW, Brand HVD, Loon JJAV, Huis AV. 2010. An Exploration on Greenhouse Gas and Ammonia Production by Insect Species Suitable for Animal or Human Consumption. Plos One **5**(12): 14445. DOI: 10.1371/journal.pone.0014445.

Pambo KO, Okello JJ, Mbeche RM, Kinyuru JN. 2016. Consumer Acceptance of Edible Insect' Foods for Non-Meat Protein in Western Kenya. United Nations Conference Center, Addis Ababa.

Peng H, Xia S, Ruan F, Pu B. 2016. Age Difference in Consumer Decision Making under Option Framing: From the Motivation Perspective. Front Psychol **7**: 1736. DOI: 10.3389/fpsyg.2016.01736.

Perju-Mitran A, Budacia AE. 2015. Gender Differences in Modelling the Influence of Online Marketing Communication on Behavioral Intentions. Procedia Economics and Finance **27**: 567-573. DOI: 10.1016/S2212-5671(15)01034-5.

Reverberi M. 2019. Edible insects: cricket farming and processing as an emerging market. Journal of Insects as Food and Feed **6**(2): 211-220. DOI: 10.3920/JIFF2019.0052.

Reuters Life. 2007. Fancy a Cambodian delicacy? Try crunchy crickets. Reuters, London. Available from https://www.reuters.com/article/us-cambodia-crickets-idUSSP33582220070606 (assessed March 2021).

Rizzo G, Borrello M, Guccione GD, Schifani G, Cembalo L. 2020. Organic Food Consumption: The Relevance of the Health Attribute. Sustainability 2020 **12**(2): 595-607. DOI: 10.3390/su12020595.

Roma R, Palmisano GO, Boni AD. 2020. Insects as Novel Food: A Consumer Attitude Analysis through the Dominance-Based Rough Set Approach. Foods 2020 **9**(4): 387. DOI: 10.3390/foods9040387.

Schardong IS, Freiberg JA, Santana NA, Richards NSPS. 2019. Brazilian consumers' perception of edible insects. Ciência Rural **49**(10): 1-12. DOI: 10.1590/0103-8478cr20180960.

Siegrist M. 2008. Factors Influencing Public Acceptance of Innovative Food Technologies and Products. Trends in Food Science and Technology **19**(11): 603-608. DOI: 10.1016/j.tifs.2008.01.017.

Siegrist M, Hartmann C, Keller C. 2013. Antecedents of food neophobia and its association with eating behaviour and food choices. Food Quality and Preference **30**(2): 293-298. DOI: 10.1016/j.foodqual.2013.06.013.

Slebá M. 2019. The impact of age on the consumers buying behaviour and attitude to price. Literra Scripta 2019 **12**(2). DOI: 10.36708/Littera_Scripta2019/2/11.

Sogari G, Menozzi D, Mora C. 2016. Exploring young foodies' knowledge and attitude regarding entomophagy: A qualitative study in Italy. International Journal of Gastronomy and Food Science 2017 **7**: 16-19. DOI: 10.1016/j.ijgfs.2016.12.002.

Sogari G, Bogueva D, Marinova D. 2019a. Australian Consumers' Response to Insects as Food. Agriculture **9**(5): 108. DOI: 10.3390/agriculture9050108.

Sogari G, Liu A, Li j. 2019b. Understanding Edible Insects as Food in Western and Eastern Societies. Pages166-181 in Bogueva D, Marinova D, editors. Environmental, Health, and Business Opportunities in the New Meat Alternatives Market. IGI Global Business Science Reference, Hershey.

Steenhuis IHM, Waterlander WE, Mul A. 2011. Consumer food choices: role of the price and pricing strategies. Public Health Nutrition **14**(12): 2220-2226. DOI: 10.1017/S1368980011001637.

Tan HSG, Fischer ARH, Tinchan P, Stieger M, Steenbekkers B, Trijp HCM. 2015. Insects as food: Exploring cultural exposure and individual experience as determinants of acceptance. Food Quality and Preference **42**: 78-89. DOI: 10.1016/j.foodqual.2015.01.013.

Vantomme P, Mertens E, Huis AV, Klunder H. 2012. Assessing the potential of Insects as Food and Feed in assuring Food Security. Food and Agricultural Organization of the United Nation, Rome.

Verbeke W. 2015. Profiling consumers who are ready to adopt insects as meat substitute in a Western society. Food Quality and Preference **39**: 147-155. DOI: 10.1016/j.foodqual.2014.07.008.

VOA. 2016. Once a Habit of Hardship, Insects Still a Popular Snack in Cambodia. VOA, Washington. Available from https://www.voanews.com/episode/once-habit-hardship-insects-still-popular-snack-cambodia-3716616#:~:text=Once%20a%20Habit%20of%20Hardship%2C%20Insects%20Still%20a%20Popular%20Snack%20in%20Cambodia,-March%2029%2C%202016&text=Eating%20insects%20became%20popular%20in,insects%20at%20very%20good%20price (assessed February 2021).

Wageningen University & Research. 2020. List of edible insects of the world. Wageningen University & Research, Wageningen. Available from https://www.wur.nl/en/Research-Results/Chair-groups/Plant-Sciences/Laboratory-of-Entomology/Edible-insects/Worldwide-species-list.htm (accessed August 2020).

Wilkinson K, Muhlhausler B, Motley C, Crump A, Bray H, Ankeny R. 2018. Australian consumers' awareness and acceptance of insects as food. Insects **9**(2): 44. DOI: 10.3390/insects9020044.

Yen AL. 2015. Insects as food and feed in the Asia Pacific region: current perspectives and future directions. Journal of Insects as Food and Feed **1**(1): 33-35. DOI: 10.3920/JIFF2014.0017.

Appendices

List of the Appendices:

Appendix 1: Descriptive statistic of factors influence insect consumption

	N	%	*p-value*
Taste	181	83.80	**0.023**
Price	107	49.54	**0.014**
Degree of processing	73	33.80	0.084
Availability/Ease of Purchase	65	30.09	0.103
Appearance	63	29.17	0.255
Social Perception / Acceptance of Eating Insects	54	25.00	0.633

Appendix 2: Online questionnaire

Consumer Attitude toward Edible Insects

My name is LIM Techhong, a student at the Faculty of Tropical AgriSciences (FTZ) at Czech University of Life Sciences, and I would like to invite you to take part in a survey, the results of which will contribute to a research project in order to complete my Master's degree study. The purpose of this survey is to understand the awareness of entomophagy within the society, your experiences on entomophagy, your level of acceptance toward edible insects and the factors that could influence the future introduction of this emerging industry into the consuming markets.
The online questionnaire will take approximately 10 minutes of your time to complete. Your information and response to the survey will be protected and all participants will remain anonymous.

If you have any questions or concerns about this research, please feel free to reach out to me LIM Techhong at xlimt001@czu.cz
* Required

I. Perception and historical consumption of insects.
Q1. Are you familiar with the concept of insects as a food source for humans?
- ☐ Yes
- ☐ No

Q2. Have you eaten insects before?
- ☐ Once
- ☐ Tried a few times
- ☐ Eat them often
- ☐ Never

Q3. What were the reasons for eating them?
- ☐ It was a dare/prank.
- ☐ I ate them out of curiosity.
- ☐ I do not remember when.
- ☐ I eat them because my family members eat them.
- ☐ I eat them because my friends eat them.
- ☐ I did not know I was eating them at the time.
- ☐ I never eat insects before.
- ☐ Other.

Q3a. If chosen Other, please specify.
Answer: …….

Q4. If you have eaten insects before, do you like the taste of insects?
- ☐ Like
- ☐ Do not like
- ☐ I never eat insects before.

Q5. What insects have you eaten before?

- Mole Cricket
- Cricket
- Thai Zebra Tarantula
- Red Ant/Weaver Ant
- Locust/Grasshopper
- Giant Water Bug
- Water Scavenger
- Silkworm pupae
- I never eat insects before.
- I do not know the name of the insect.
- Other.

Q5a. If chosen Other, please specify.
Answer: …….

Q6. If you have eaten insect before, what is your most favorite insect?

- Mole Cricket
- Cricket
- Thai Zebra Tarantula
- Red Ant/Weaver Ant
- Locust/Grasshopper
- Giant Water Bug
- Water Scavenger
- Silkworm pupae
- I do not have any particular favorite insect.
- I never eat insects before.
- I do not like any of them.
- Other.

Q6a. If chosen Other, please specify.
Answer: …….

Q7. In what form have you eaten the insects?

- Visible / whole insect (cooked or raw)
- Visible / whole insect served in instant package
- Powdered (powder or flour)
- Meat alternative (e.g. burger patty, taco, cake)
- Snack (e.g. protein bar, chip)
- I never eat insects before.

II. Factors affecting the consumer attitude of edible insects

Q8. What is your perception on insect consumption?

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Insect is disgusting.	□	□	□	□	□
Eating insects is environmentally friendly / sustainable.	□	□	□	□	□
Insect is delicious.	□	□	□	□	□
Insect is cheap.	□	□	□	□	□
Eating insects in respect to animal welfare.	□	□	□	□	□

Q9. What are the important factors that (might) influence your future purchase decision of insect?

- □ Taste
- □ Price
- □ Appearance
- □ Social Perception / Acceptance of Eating Insects (e.g. everybody around me eats insects, I should try too)
- □ Degree of processing products
- □ Availability or Ease of Purchase

Q10. In case of meat alternative products (e.g. Insect burger), what attributes should it have?

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Tasted like meat.	□	□	□	□	□
Looked like meat.	□	□	□	□	□
Has the same texture as meat.	□	□	□	□	□
As nutritious as meat.	□	□	□	□	□
More sustainable and environmentally friendly than meat.	□	□	□	□	□

III. Lifestyle and Diet

Q11. How important are below factors in your choice of food?

	Not at all important	Slightly important	Important	Fairly important	Very important
Nutrition	□	□	□	□	□
Sustainability/Environmental aspects	□	□	□	□	□
Animal welfare	□	□	□	□	□
Price	□	□	□	□	□
Appearance	□	□	□	□	□
Origin (Organicness)	□	□	□	□	□

Q12. Do you have any dietary restriction?

- Vegan
- Vegetarian
- Allergies
- Religious restriction
- None
- Other

Q12a. If chosen Other, please specify.
Answer: …….

Q13. Have you ever changed your diet in the past (Lasted more than at least 3 months)?

- Yes
- No

Q14. Do you agree that these factors made/might make you change your diet?

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Sustainability/Environmental aspects	□	□	□	□	□
Convenience	□	□	□	□	□
Animal welfare	□	□	□	□	□
Health benefit	□	□	□	□	□
Price	□	□	□	□	□

Q15. How many times a week do you eat red meat?

- Daily
- 4-6 times a week
- 2-3 times a week
- Once a week
- A few times a month
- A few times a year
- Never

IV. Personal Background
Q16. What is your age?
Answer: …….

Q17. What is your gender?

- Yes
- No

Q18. What is your birth state/province?

- Kampong Cham
- Kampong Chhnang
- Kampong Speu
- Kampong Thom
- Kampot
- Kandal
- Kep
- Koh Kong
- Takéo
- Tboung Khmum
- Battambang
- Banteay Meanchey
- Pailin
- Phnom Penh
- Preah Sihanouk
- Preah Vihear
- Prey Veng
- Pursat
- Mondulkiri
- Ratanak Kiri
- Siem Reap
- Stung Treng
- Svay Rieng
- Oddar Meanchey

Q19. What is your highest completed education?

- No Formal Education
- Primary School
- Secondary School
- High School
- Associate's Degree / Bachelor's Degree
- Master's Degree / PhD
- Vocational Training

Q20. What is your current occupation?

- Self-employed in Agriculture
- Self-employed in Non-agriculture
- Employee in Agriculture
- Employee in Non-agriculture
- Government officer
- Student
- Housewife/househusband
- Unemployed
- Retired
- Other

Q20a. If chosen Other, please specify.
Answer: …….

Q21. How many family members do you have?
Answer: …….

Q22. What is your estimated average household income per month?

- Under $250
- $250-$500
- $501-$750
- $751-$1,000
- Above $1,000