

CRICKETS AS FOOD:

The perceptions of and barriers to entomophagy and the potential for widespread incorporation of cricket flour in American diets

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“When you hear crickets chirping, what do you think of? Warm summer nights? Grassy fields? The awkward silence that happens when a joke falls flat?
When I think of crickets, I think of the future of food.”

-Megan Miller, founder of Bitty Foods

Abstract

Entomophagy, or the consumption of insects, is widely practiced on a global level, but is uncommon in the United States. There has been promising research on the nutrition, safety, and sustainability of crickets as food, as well as research on cultural perceptions of entomophagy in Western countries such as Belgium, the Netherlands, and Australia. This paper addresses the question: What are the current perceptions of and deterrents to entomophagy in America, and what should be the next steps to encourage a greater acceptance and consumption of food products made with cricket flour? This research found that entomophagy within the context of cricket flour was more appealing than entomophagy in general. The survey also showed relationships between respondents' gender and ethnicity and their views of entomophagy and cricket flour, as well as respective value placed on nutrition, taste, the environment, and familiarity while food shopping. The most common concerns about cricket flour were the taste and "it just grosses me out," followed by concerns about the cleanliness and potential disease of crickets. The biggest determinants of subjects' willingness to consider entomophagy and cricket flour were their levels of neophobia and food neophobia, and their previous knowledge or experience with entomophagy. High levels of food neophobia and neophobia in general were related to negative views of entomophagy and cricket flour, while previous knowledge and/or experience with entomophagy were related to positive views of entomophagy and cricket flour. The most promising means of promoting entomophagy were advocacy by well-known people, providing an opportunity to try a sample, ensuring that cricket flour products are similar to familiar foods, and the creation of legislation or certification procedures to widely establish the safety of insects as food. A tentative description of the most promising demographic for the acceptance of cricket flour is white males who value nutrition and the environment, with an openness to trying new things, who are not opposed to eating animal products, and with previous knowledge or experience with entomophagy.

Key Terms: entomophagy, consumer acceptance, food, disgust, cultural shift

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1 Introduction

1.1 Background

Many scientists have projected that by the year 2050, the world's population will have reached 9 billion people. With food security already a concern in many corners of the globe, including the United States, it's not only important, but necessary for Americans* to re-evaluate the way we eat. The way we eat is shaped by many factors. These include, but are not limited to where our food is coming from, how big of an impact it has on natural resources such as water, fuel, and space (i.e. land being deforested for agricultural use), and the even distribution of food, rather than regions of massive food consumption and waste, paired with areas of poor food access and nutrition. The way we eat includes our ideas of what we think is healthy, sustainable, or acceptable food. Today, the consumption of insects as food, or *entomophagy*, is not widely practiced in the U.S. However, it is estimated that worldwide, insects are part of the traditional diets of at least 2 billion people (van Huis et al., 2013).

Agriculture, and meat production in particular, can have significant impacts on human health and the health of ecosystems both nearby and distantly surrounding the land used to raise animals and crops. Because meat production, and especially beef production, has such a large carbon footprint, and because meat consumption is rising in developing areas of the world, the meat industry as a whole plays a large role in climate change (Premalatha et al., 2011). Meat production uses a huge amount of space, animal feed, and energy, and research suggests that alternatives to meat, including insects, are less demanding of these resources (Belluco et al., 2013). Because animal meat in general is considered by many to be the best source of

* Throughout this paper, the terms *America*, *American*, and *Americans*(') will be used in reference to the United States of America alone, rather than including Canada or Central and South America.

protein, iron, and other nutrients such as vitamin B₁₂ that are hard to find elsewhere, the capability of crickets to supply these important nutrients has also been investigated and shown to be promising (Rumpold et al., 2012). With the environmental and nutritional benefits of crickets already established, an important next step for those hoping to promote entomophagy in American diets is to consider the ways to increase the social acceptability of widespread insect and cricket flour consumption. In the past, Americans have come to accept once-foreign foods, such as garlic and sushi, as normal parts of their diets (Gabaccia, 1998); the dietary shift towards crickets might too be something that Americans take for granted one day.

1.2 Goals and Objectives:

The goal of this project is to explore the reasons that entomophagy, which is a common practice globally, has been mostly ignored or abhorred in American cuisine. Gathering, quantifying, and interpreting data on the perceptions and deterrents, as well as causes of interest in entomophagy, is crucial for developing effective adoption strategies in America. Through the use of a focus group, an online survey, and an identical in-person survey with an option to try a sample of a protein bar made with cricket flour, I have addressed the question: What are the current perceptions of and barriers to entomophagy in America, and what should be the next steps to encourage a greater acceptance and consumption of food products made with cricket flour?

While this builds on the existing knowledge of many other research projects, it was carried out with a subject pool that has not specifically been analyzed with respect to entomophagy, and even more specifically, with respect to cricket flour products: Americans. Although it is impossible to generalize the data to encompass all Americans, the research adds to the

information we have on American views of entomophagy, as well as discussing the best methods of moving forward with the integration of entomophagy in America.

In this paper I will tentatively gauge the most promising demographic for the adoption of entomophagy and cricket flour, and the most successful strategy or means of marketing for garnering interest and changing behaviors. Another goal is to assess how people's backgrounds, personal interests, and previous knowledge relate to their view on incorporating cricket products into their diet. For entomophagy to have a large positive environmental impact, it must transition from a niche market to a more widely accepted part of American culture, and the goal of this research is to determine the best way to do this.

2 Literature Review

2.1 *History and Current Global Practices*

Insects are part of the traditional diets of an estimated 2 billion people, with over 1,900 different species reported as food globally (van Huis, 2013). In many places they are seen as not just food, but as delicacies; in countries such as Thailand, Madagascar, and Mexico, they were once viewed as food only suitable for royalty and elites (DeFoliart, 1999). Currently, most entomophagy occurs in Africa, Asia, and Latin America, but it is found worldwide, including within the indigenous communities of Australia and the United States. According to the Food and Agriculture Organization of the United Nations (van Huis et al., 2013), “the most commonly eaten insect groups are beetles, caterpillars, bees, wasps, ants, grasshoppers, locusts, crickets, cicadas, leaf and planthoppers, scale insects and true bugs, termites, dragonflies and flies.” Caterpillars and termites are the most popular insect foods in Africa, and studies in several south-central African countries have shown that the value of caterpillars as a food source may actually be contributing to the desire to better preserve forests there (DeFoliart, 1999). Countries in Africa that are known to practice entomophagy include, but are not limited to: Angola, Democratic Republic of Congo, Zimbabwe, South Africa, Malawi, Nigeria, and Zambia, with each country consuming anywhere from 30 to over 65 species of insect as food (Defoliart, 1999). In Asia and Oceania, grasshoppers and locusts are among the most widely eaten insects, while options such as silkworms, wasps, caterpillars, and crickets are seen as delicacies. Countries in this region that partake in eating insects include India, Thailand, China, Japan, South Korea, Papua New Guinea, and Australia. In China, where both ants and the larvae of house flies are eaten, annual sales of ant food items were around \$100 million in 1999 (DeFoliart, 1999). In Latin America, the people of countries such as Colombia, Brazil, Paraguay, Peru, and Mexico also practice

entomophagy, with the most popular insects including palm weevil larvae, ants, grasshoppers, and locusts (DeFoliart, 1999). Most insect dishes are served fried—the most well-known probably being *chapulines*, or fried grasshoppers, a common dish in Oaxaca, Mexico)—and many are considered delicacies.

While in many places, insects for consumption are simply collected from the wild, crickets have been farmed in Thailand since 1998 (Hanboonsong, 2013). As of 2012, there were around 20,000 cricket farmers in the country (van Huis et al., 2013). In Australia, insects were once a staple in the Aboriginal diet. There has been a recent increase in the use of insects such as the high-valued witchetty grub in the tourist industry, as they are marketed as a native Australian food (DeFoliart, 1999). As insects have been a traditional source of food in around 100 countries worldwide (DeFoliart, 1999; Durst et al., 2010), the countries mentioned and the insects eaten there represent only a small portion of the global practice.

Within the past five years, new companies, kickstarters, restaurants, and food carts for insect products have sprung up all around the world. ExoTM, a company started in 2013 by two Brown University graduates and based in New York, sells cricket flour protein bars—as does a company called Crowbar Protein, based in Iceland and started in 2013. Don Bugito, a food cart that opened in San Francisco in 2011, sells a variety of pre-Hispanic Mexican-inspired insect dishes. Bitty Foods, started in 2013 and also based in San Francisco, sells cookies made with cricket flour, as well as plain cricket flour. Cricket Flours, an online distributor of cricket flours that was started in 2014, sells a vast selection of cricket products, ranging from instant oatmeal to brownie mix. It is because of the high protein content of crickets that they can be used to make protein bars; another added bonus for some is that cricket flour can

replace the wheat flour so commonly used in food products, making it a safe and nutrient-dense substitute for those with a wheat allergy or gluten intolerance.

2.2 Nutrition and Food Security

As stated by Premalatha (2011), it is ironic that “all over the world [millions of dollars] are spent every year to save crops that contain no more than 14% of plant protein by killing another food source [insects] that may contain up to 75% of high-quality animal protein.”

There are many species of cricket consumed worldwide, and specific analyses of different nutritional aspects of crickets have been done on several species, such as the field cricket (*Gryllus* genus), and the house cricket (*Acheta* genus). Thailand’s field cricket *Gryllus bimaculatus* (raw), contains 120 kcal/100g (van Huis et al., 2013), which is comparable to the 150 kcal/100g of skinless chicken breast. The composition of a single field cricket is around 58% protein, and 10% fat (Wang et al. 2004); in contrast, the composition of a single house cricket is around 65% protein, and 20% fat (Rumpold et al., 2012). Field crickets provide more than the minimum amino acid profile suggested by the World Health Organization in order to be an adequate source of essential amino acids (Wang et al., 2004). In one study, it was observed that the protein of the house cricket was superior to soy protein for amino acid intake when fed to rats (Finke et al., 1989).

Vitamin B₁₂, which occurs only in food of animal origin, and is vital for human health, is found in sufficient amounts in house crickets, at 5.4 µg per 100 g in adults and 8.7 µg per 100 g in nymphs; the recommended dietary amount is 2.4 µg daily (van Huis et al., 2013 & Baik, 1999). According to Rumpold et al. (2012), “it can generally be stated that the majority of insects show high amounts of potassium, calcium, iron, magnesium, and selenium,” as well

as zinc. *Acheta domesticus* contains about 6-11mg of iron per 100g (Rumpold et al., 2012); for comparison, ground beef contains about 2.2mg iron per 100g.

Insects, and specifically crickets, have long been overlooked as a source of essential nutrition in the Western world. Yet they provide comparable, if not higher—and sometimes substantially so—levels of calories, protein, iron, and vitamin B₁₂ than meat, showing the potential for people to receive the most sought-after health benefits of meat by eating cricket products.

2.3 Sustainability and Life Cycle Analysis

The U.S. Census Bureau (2012) estimated that the annual per capita consumption of meat in the U.S. was 106 pounds (Belluco et al., 2013). 70% of the agricultural land on the planet is dedicated to growing livestock or feed for that livestock (Premalatha et al., 2011), and 70% of the world's fresh water is used for agriculture (Pimentel et al., 2004). It has been argued by Sachs (2010) that agriculture is the number one cause of human-induced climate change. The livestock industry alone is responsible for what has recently been re-evaluated as 12% (rather than the previously widely-accepted number of 18%) of greenhouse gas emissions globally (Havlik et al., 2014). These greenhouse gasses are caused by on-farm fuel use, feed transport, animal transport and processing, manure, urine, and fertilizer production for feed. Aided by the fact that crickets do not produce methane as a by-product, which is a more potent cause of atmospheric warming than CO₂, crickets not only produce smaller amounts of greenhouse gasses, but produce less detrimental greenhouse gasses than cattle and pigs (van Huis et al, 2013).

The rearing of crickets does not require clearing out large tracts of land, in contrast to the expanses of grassland used to raise cattle. It can be done inside, and with considerably fewer

resources. Crickets, and insects in general, are *poikilothermic*, or cold-blooded, meaning their internal temperature is not regulated—thus, they expend much less energy and nutrients to grow than warm-blooded livestock such as cows, pigs, and chickens. It is because of this that crickets have a high feed conversion—for example, the production of 1 kg of live cricket mass requires as little as 1.7 kg of feed (Collavo et al., 2005). For reference, in order to produce 1 kg of chicken, pork, or beef, it requires about 2.5 kg, 5 kg, and 10 kg of feed, respectively (van Huis et al., 2013). To further compound this loss of energy from warm-blooded livestock, a much higher percentage of crickets' mass is edible: 80%, in comparison to 55% of chicken and pigs, and 40% of beef cattle (van Huis et al., 2013). Yet, although crickets have a higher percentage of biomass that can be eaten, it must also be kept in mind that the non-edible parts of cows can still be used to make other products such as leather.

The agricultural sector uses 70% of the world's freshwater, and the livestock sector is one of the largest sources of water pollution globally. Fertilizer and manure runoff contribute to dead zones in waterways, chemicals from tanneries and sediment from eroded pastures pollute waterways, and the constant use of antibiotics leads to antibiotic resistant strains of bacteria (Henning et al., 2006). According to Pimentel and others (2004), the life cycle assessment of water use of beef is 22,000 liters, or about 2,640 gallons of water for just one pound of beef. The numbers are smaller for poultry and pork, but are still large. The life cycle analysis of water use for crickets, and insects in general, has not been researched, but is expected to be substantially smaller, due to many factors including their high feed conversion and greater ability to withstand drought (van Huis, 2012). In addition, crickets can be fed with organic waste (including human and animal waste), providing not only a cheaper and less energy-intensive feed source for the crickets, but also a means of reducing environmental contamination by these wastes (van Huis, 2012).

Insects constitute about 80% of the entire animal kingdom, providing an abundant source of animal protein. Insects, including crickets, have rapid life cycles with high fecundity, reaching adulthood within a matter of days compared to the months taken by fowl and the years by ruminants (Nakagaki and DeFoliart 1991). Compounded with their high feed conversion, crickets provide a more efficient, lower impact source of protein than the high-polluting and resource-intensive meat production sector.

2.4 Safety, Legislation, and Logistics

As with all food products, the safety of consuming crickets is an important question to consider. When preparing crickets, traditional processing methods such as boiling, roasting, and frying are usually applied, and these high-heat preparations have the added benefit of ensuring the safety of the food (van Huis et al., 2013). The FAO has even stated, “Compared with mammals and birds, insects may pose less risk of transmitting zoonotic infections to humans, livestock and wildlife, although this topic requires further research” (van Huis et al., 2013). In an experiment by Klunder and others (2012), it was found that neither *Salmonella* nor *Listeria monocytogenes* bacteria were found in crickets, and it was concluded that “it is unlikely that [house crickets] attract microbial flora that pose risks to humans.” An instance has been documented where a cricket farming company suffered the rapid death of 50% of its crickets, and this is thought to have been caused by a virus sweeping the close-quartered “monoculture” of crickets in the Netherlands, an issue that is also faced with monocultures of agriculture (van Huis et al., 2013). It has also been found that crickets may absorb soil contaminants such as lead into the food chain (Belluco et al., 2013), and may be contaminated by pesticides if collected from agricultural land; therefore it is recommended that crickets for consumption be farm-raised rather than wild-caught (Hanboonsong, 2013).

Another concern posed by consuming crickets is the risk of an allergic reaction. It has been shown that there is an increased risk of an allergic reaction to crickets in individuals with a shellfish allergy. This is because crickets and shellfish are both within the *Pancrustacea* clade—composed of crustaceans and hexapods (six-legged insects). According to Lockwood (2004), when the Native Americans of what is now called Utah first tried shrimp, they referred to them as “sea crickets;” and in Australia, locusts, which are closely related to crickets, have been referred to as “sky prawns” as recently as 2004.

Because insects are for the most part not seen as a normal food in developed countries, there is currently no legislation regarding the safety of insects as a food source. The only imposed legislative references regarding insects and food are those prescribing a maximum limit of insect traces in foods such as grains, flour, peanut butter, fruit, spices, and chocolate (van Huis et al., 2013). It is partially because of this lack of legislation that it is difficult to market insects as food in America—because there is no legislation proving otherwise, crickets and other insects are believed to be inherently unsafe to eat. According to Van Huis and others (2013), “If insects were to become a more widely used ingredient in food and feed, a risk assessment would need to be carried out and an appropriate regulatory framework created.” Implementing legislation on the use of insects as food would help to both manage the safety of cricket products, and also to assuage any fears of insect products that the general public has.

In Thailand, where cricket farming is very popular, there are four types of breeding containers, ranging in size and composition depending on the scale and desired portability of the farm. There are concrete cylinder pens, concrete block pens, plywood boxes, and plastic drawers (Hanboonsong et al., 2013). The crickets are usually fed a combination of chicken

feed and supplementary fruits and vegetables; although they are able to subsist on organic waste, which could be a more cost-effective and less energy-intensive option. Pre-cooked crickets in Thailand are sold for up to 300 baht per kg, or about \$3.80 per pound. In comparison, beef sells for about \$4 per pound in the U.S. (US Department of Labor, 2016). If cricket farming became as widespread in the U.S. as it is in Thailand, this could be a potentially cheaper meat alternative.

In order for crickets to be a widely produced and consumed food product in America, there must be implemented appropriate food safety legislation, preventative measures to avoid wipeout of farm colonies (such as diversity of species and avoidance of over-crowding), and a proper infrastructure to raise, clean, prepare, and sell crickets on a mass-production scale.

2.5 Food Choice, Disgust, and a Cultural Shift

One theory of why there is such widespread wariness of edible insects is that the shift from hunting and gathering to a more sedentary agricultural lifestyle resulted in the perception of insects as pests and a threat to food (van Huis et al., 2013). Crickets are certainly not the most commonly consumed insects globally—it is estimated that Orthoptera, or grasshoppers, locusts, and crickets, make up about 13% of the global insect consumption (van Huis et al., 2013). However, it has been observed that the most successful ventures in entomophagy in Western countries have been with crickets and mealworms (Lensvelt & Steenbekkers, 2014; Megido et al., 2014). Megan Miller, founder of Bitty Foods, begins her 2014 TEDx talk in Manhattan with, “When you hear crickets chirping, what do you think of? Warm summer nights? Grassy fields? The awkward silence that happens when a joke falls flat?” (tedxmanhattan.org). Crickets do not have the same connotation of insects such as spiders and cockroaches, and therefore, despite their perhaps not-as-impressive nutritional makeup as

other insects such as larvae and caterpillars, they are a more feasible choice for Western countries and mindsets.

As pointed out by Rozin (2006), “The plain fact is that the biggest determinant of what an individual eats is availability. One eats what is there, and more critically, one does not eat what is not there.” This is important to note in regards to the global history of entomophagy. In some places, such as Zambia or South Africa, the abundant edible caterpillars have historically been the most easily obtained source of protein, and the consumption of these insects is inversely related to the consumption of meat (DeFoliart, 1999). In contrast, in more developed countries, meat is generally easily available, and in much higher quantities (Premalatha et al., 2011). Therefore, people eat what has been historically available, and for the most part in Western countries, this has not necessitated the option of edible insects. It has also been found by Rozin (2006) that food preferences are influenced by mere exposure: the more someone is exposed to something, the more one likes it, and by social influence: the approval or enjoyment of others can increase liking of a food. These are two factors that have historically worked against the implementation of entomophagy in America, but are also factors to keep in mind and utilize for the cultural shift necessary to promote the practice. For instance, endorsement by celebrities or admired public figures could have the potential to make a significant difference in the public’s perception of the consumption of crickets.

In another study, Rozin and others (2002) examined the effects that generation (broken into the categories of college students, their parents, and their grandparents), gender, and culture (broken into the categories of United States, France, and India) have on food choice. It was found that generation and culture were good predictors of food choice, with gender having a smaller effect. It was found that “Americans are the most worried about what they consume

and are the most ‘fat’ phobic,” that college students are the least concerned with health, and that females are overall somewhat more concerned with health. Because of Americans’ worry about their food consumption, one route that might be helpful for the implementation of entomophagy is for crickets to be marketed with an emphasis on their health benefits.

It is widely noted that for the most part, Western countries view entomophagy with disgust (van Huis et al., 2013). The emotional “disgust” reaction can be caused by things ranging from bad tastes to incest—yet all of these forms of disgust elicit a mental response in humans that leads to a sense of “offensiveness” and “contamination” (Rozin, 2009). Because of this, the thought of insects may tend to elicit notions of contamination and uncleanness. In a study by Vernon & Berenbaum (2004), it was shown that the fear of spiders and insects was closely intertwined with feelings of disgust—and that when fear of insects was lowered by positive experiences, such as learning about the anatomy of insects, or being informed that most spiders are harmless to humans, the disgust reaction to these insects was also lowered. Another possible route to promoting entomophagy could therefore be to decrease the fear and therefore disgust and sense of “contamination” of insects through encouraging positive experiences with them.

In relation to eating insects, it has also been found that the offer of monetary incentives changes the subject’s optimism about the experience, and generally will make people more willing to try insects (Ambuehl, 2015). This is something to consider regarding the effects of price on insect consumption—if insect products are substantially cheaper than meat products, this could shift opinions about entomophagy.

With the recent increase of interest in entomophagy in Western countries, there has been an increase in research on the perceptions and barriers to the practice. A 2016 study by

Hamerman looked at the participants of a program called “Bug Appetit” in New Orleans. A local museum runs a program which includes a buffet of edible insects, including food items such as “six-legged salsa” and “chocolate chirp cookies.” It was found that people with high levels of *animal reminder disgust*, or a propensity to feel disgust when cooking and preparing raw meat, were less likely to attend “Bug Appetit.” This study, among other reasons such as religion, might signal that vegetarians and vegans are less likely to consume crickets, although this requires further research.

There have been some studies specifically designed to either profile the most likely consumers of insects as a meat substitute or determine the best ways to promote entomophagy in Western countries. Two studies were carried out in Belgium (Megido et al., 2014 and Verbeke, 2014) while another was carried out in Australia and the Netherlands (Lensvelt & Steenbekkers, 2014). Megido and others (2014) found that Belgian subjects at an insect museum preferred crickets and mealworms that were prepared to be crispy, and with chocolate. It was also found that participants over the age of 45 were more willing to try different insect dishes. Verbeke’s (2014) study focused on profiling the most likely demographic to adopt insects specifically as a meat substitute. It was found that men had a higher likelihood than women, and that people who have previous knowledge of entomophagy have a 2.6 times higher likelihood. It was also found that food neophobia was the biggest determinant of subjects’ willingness to make the transition. Overall, the findings indicated that the most likely demographic in Belgium to adopt insects as a meat substitute is “younger males with a weak attachment to meat, who are more open to trying novel foods and interested in the environmental impact of their food choice.” In Lensvelt & Steenbekkers’ (2014) study involving Australian and Belgian consumers, it was found that the most important factor in promoting entomophagy (compared to price, quality, benefits, risks,

naturalness, trust, attitude, and culture) was the opportunity to actually try a sample of an insect food product—and that “people who have eaten insects before have a significantly more positive attitude toward entomophagy than people who have not, and are more likely to eat them again.” While these studies are looking at entomophagy in other Western countries, the goal of this experiment is to gauge consumer acceptance of cricket flour products in America.

3 Methods

3.1 Overview

The methods include a focus group, an online survey, and an identical in-person survey with an optional sample of a protein bar made with cricket flour. A ten-person, one hour focus group was held on the University of Michigan campus in Ann Arbor, Michigan, where the conversation was used to gauge the public perceptions, concerns, and acceptance of entomophagy. Topics discussed included the framing of entomophagy as an environmentally friendly protein source, a healthy protein source, or an exotic or “classy” food, as well as brainstorming ways to successfully promote cricket flour products. The goal of the surveys was to capture the perceptions of entomophagy, barriers to its implementation, and reasons for acceptance of the notion of entomophagy in general and cricket flour specifically. The online surveys included questions about each subject’s background, intentions while food shopping, general willingness to try new things, previous (or lack of) experience with entomophagy, and their willingness to consider entomophagy. This was followed by a debriefing on entomophagy and cricket flour, and ended by asking what concerns respondents would have about cricket flour products. The paper, in-person surveys were identical, but were also followed by offering the participants an optional food sample after taking the survey. These three methods of data collection were used to investigate the most common concerns about entomophagy, as well as the relationship between demographics, the framing of entomophagy, personal dispositions, and educational intervention in participants’ willingness to incorporate or accept entomophagy as an everyday practice in America.

3.2 Focus Group

Participants were obtained by posting flyers for a focus group about “perceptions of specific foods” around the city of Ann Arbor. Sites where flyers were posted included the University’s undergraduate library, various outdoor posting walls around the campus, the Michigan Union, a community posting board in a coffee shop close to the University, and a community posting board in a Whole Foods store a few miles from the University. Sites were chosen based on their high levels of traffic, and also based on which buildings and stores would allow flyers to be posted. Participants were offered a \$10 gift card of their choice from Starbucks, Amazon, Chipotle, Target, or Macy’s for participating. \$100 for the incentives was funded by the University of Michigan Honors Program. Out of the ten people in the focus group, seven were University of Michigan students, and three were non-students of varying ages. Eight of the participants were female and two were male. A basic outline of conversation topics was prepared beforehand and can be found in **Appendix 1**. Participants were asked about things they considered important while shopping for food, what their main sources of protein were, their thoughts about eating insects as a sustainable food source, their thoughts about food products made specifically from cricket flour, what concerns they had about cricket flour, and what they thought the best way to promote entomophagy was. Notes were taken during the focus group regarding the group’s answers and discussion, and a paper activity was performed and collected, involving the participants circling faces with different emotions, and documenting how their feelings about entomophagy changed after being informed about cricket flour products.

3.3 Online Survey

The online survey was created using Qualtrics, and was a 3-5 minute, 12-question survey focusing on participants' backgrounds, previous experience with entomophagy, neophobia, and willingness to try cricket flour products. **Appendix 2** shows the survey questions that were used in the in-person survey, which was identical to the online survey, but with an additional question at the end. The original complete survey included a question regarding the amount of money participants spent per month on groceries; however, because so many of the responses were from University students, many answered with "\$0" because they were on a meal plan included in their tuition—thus making the data for this question not an accurate representation of the actual money spent on food per month, and leading to the removal of this question for data analysis. The survey was dispersed in a snowball sample fashion: the link to the survey was posted on social media (Facebook), and was also sent out in an email by an advisor from the University's Program in the Environment. The advisor was able to send the link to the survey to a listserv of all students with a major or minor within the Program in the Environment, as well as other colleagues they decided to share it with. The Facebook link was posted multiple times, and was shared by others to their own social circles. The online survey obtained 533 responses, 475 of which were completed and used for data analysis.

The surveys looked at the demographics of age, gender, education, and ethnicity. Survey respondents were asked to rate on a scale from 1-5 how important they considered Environmental Impact, Nutritional Value, Price, Taste, and Familiarity when shopping for food, 1 being extremely unimportant and 5 being extremely important. Next, respondents were asked about a hypothetical situation of a new restaurant opening in town, and whether they would either order something they knew they would like, order the server's

recommendation, or order something they'd never tried before. This was to gauge the respondent's willingness to try new food. Respondents were then asked to rate themselves on how adventurous they consider themselves when trying new things in general, from very cautious to very adventurous. This served to gauge how neophobic each respondent was, with responses of "somewhat cautious" and "extremely cautious" correlating to higher scores of neophobia. Next, respondents were asked about their previous knowledge of and previous experience with entomophagy, followed by a question of whether or not they would consider trying it themselves. Respondents were then debriefed, as shown in **Appendix 2**, about the use of cricket flour and its environmental benefits. They were then asked what concerns they would have about cricket flour products, including an option for having no concerns.

3.4 In-Person Survey

The in-person survey was identical to the online survey, with an added question at the end offering the participant a sample of a cricket flour protein bar. The protein bars used were from ExoTM, a company started in 2013 by two Brown University graduates and based in New York. The bars were provided free of charge by ExoTM, in the agreement that the results of this research would be shared with their company. Two boxes of 12 bars were provided, and were cut into three pieces per bar, providing a total of 72 protein bar samples. The flavor was "Peanut Butter and Jelly," which fortunately did not pose any extra risks, as no survey participants had a peanut allergy. In the original complete survey, there was a space to mark, unknown by the participant, whether the person taking the survey was alone (A) or in a group (B), in an attempt to discover whether there was a relationship between a willingness to try the sample and whether other people were around. However only a small number of those surveyed were alone, so the question was removed from the survey for data analysis. The in-person surveys were distributed in two locations in Ann Arbor, Michigan. About half of the

survey responses were obtained in a local co-op grocery store that provided a space and table to distribute samples and surveys; the other half of the survey responses were obtained by approaching University of Michigan students in the Michigan Student Union. The Michigan Union was used for its convenience: it is a large gathering place for University of Michigan students to both socialize and study. The co-op grocery store was used in an attempt to diversify the age, background, and education level of the participants, rather than focusing only on college students. 129 total in-person surveys were distributed, due to the fact that not every survey participant chose to try the protein bar sample, and surveys were distributed until the last food sample was gone.

3.5 Data Analysis

Following the focus group, topics discussed could be sorted into four broad themes. These were: (1) food shopping habits, (2) emotional response to entomophagy before and after learning about cricket flour, (3) concerns and positive perceptions of entomophagy, and (4) recommendations for the promotion of cricket flour. The responses were graded on a scale of how many people agreed or mentioned the response (few, many, or most), and the strength of the emotional response (mild, medium, or strong).

The 475 online surveys and 129 in-person surveys were combined into one data set for analysis, but the in-person surveys were also analyzed separately for the last question regarding whether or not respondents wanted to try the sample. Statistical analysis was done in the program SPSS, and some variables were assigned specific groups or numbers, as in the cases of age and neophobia. The main method of analysis was cross tabulation between variables in SPSS, obtaining a Chi-square value and respective p-value to determine the statistical significance of the relationships between variables.

After the data were collected, the ages of respondents were categorized into 5 groups. Age Group 1 was ages 18-22, in an attempt to create a group mostly consisting of current or recently graduated college students. Age Group 2 was ages 23-35, Group 3 was ages 36-45, Group 4 was ages 46-55, and Group 5 was ages 55 and over. The age groupings were created in an average of 10 year increments after Group 1, with the exception of Group 5, which contained no upper age limit, because there were fewer respondents over the age of 55. The variable of Gender had three options: Male, Female, or Other. For analysis of relationships between gender and respondents' views on entomophagy, responses marked "Other" were omitted, as there were only 7 respondents out of 604 who identified as Other and thus would not be able to provide a reliable representation for analysis. These survey responses were still used in the analysis of other variables.

Questions 6 and 7 on the survey were an attempt to gauge the food neophobia and general neophobia of respondents. For question 6, "Imagine you are eating dinner at a new restaurant in town. Are you more likely to..." the first option, "Order a dish you know you'll like," was assigned a score of 1 for food neophobia, showing that the respondent was hesitant to try new foods. The second option, "Order the server's recommendation," was assigned a score of 0 for food neophobia, showing neither high levels of caution nor high levels of adventurousness regarding food. The third option, "Order something that you've never tried before," was assigned a score of -1 for food neophobia, showing that the respondent was willing to try new foods and thus had a low level of food neophobia. For question 7, "When it comes to trying new things (food or otherwise), how adventurous do you consider yourself?" the first option, "Very cautious" was assigned a score of 2 for general neophobia. "Somewhat cautious" was assigned a 1, "Neither cautious nor adventurous" was assigned 0, "Somewhat adventurous" was assigned a -1, and "Very adventurous" was assigned a -2 for the lowest level of

neophobia. For question 9, “Have you ever eaten an insect/arthropod food item? Even as a dare?” the responses of “Yes, by my own desire to,” and “Yes, as a dare,” were both analyzed as a “Yes.” For question 12, “Would you like to try a sample of a protein bar made with cricket flour?” the answers of “Yes, I would like to,” and “I would like to but I have a shellfish allergy” were both analyzed as a “Yes,” since the purpose of the research was to analyze perceptions rather than physical limitations, and it is unclear whether all people with a shellfish allergy will have an allergic reaction to crickets but avoidance is still recommended as a precautionary measure.

The remaining variables were assigned coded numerical values for no other purpose than to be analyzed in SPSS. The variables of “Environmental Impact” and “Nutritional Value” are referred to in this paper as “Environment” and “Nutrition,” respectively.

4 Results

4.1 Focus Group

4.1.1 Food Shopping Habits

The first four questions were centered on food shopping habits. For question 1, “When food shopping, what considerations are most important to you?” there was a wide array of responses. These included price, nutrition, ease of preparing, quality, taste, availability, and the brand. The considerations stated by most participants were price, taste, and nutrition. Question 2 was more specific, prompting participants with shopping considerations and asking how much they thought about these specific topics while shopping. The categories were Environmental Impact, Nutritional Value, Price, Taste, and Familiarity. Focus group participants informally created their own categories to respond to this question, using the phrases of “not that much,” “a little,” and “a lot.” These are rephrased in the table below as “mild,” “medium,” and “strong,” respectively, based on the most frequent response for each consideration. The consideration for Environmental Impact was mild, the considerations for Nutritional Value and Familiarity were medium, and the considerations for Price and Taste were strong, as shown in **Table 1**.

Category	Environment	Familiarity	Nutrition	Price	Taste
Level of Consideration	Mild	Medium	Medium	Strong	Strong







Table 1. Strength of considerations while shopping for food.

Questions 3 and 4 centered on the main and alternative sources of protein that the participants bought or considered. The majority of participants viewed chicken as their main source of protein. Other sources included beef, fish, beans, eggs, and nuts. There was no consideration of any insects by participants, even when prompted about “alternative” sources of protein.

Responses to this question included cheese, yogurt, buffalo jerky, bread, buckwheat, and quinoa.

4.1.2 Emotional Response Before and After Context of Cricket Flour

Next, the participants were given a debriefing about entomophagy, shown in **Appendix 1**. They were prompted to circle a face on a provided chart that “best [reflected their feelings] about foods made of insects, such as crickets.” After this activity and discussing concerns and positive perceptions, participants were informed about food products made out of cricket flour specifically, rather than whole insects. **Table 2** displays the emotional responses that each participant had before and after learning about the option of cricket flour. It can be seen that while 8 out of the 10 participants initially had a negative emotional reaction, after the debriefing on cricket flour none of the participants expressed a negative emotional response. Reasons given for initial negative reactions included “it’s gross,” “other people might eat bugs, but it’s not part of American culture,” and “I wouldn’t want anything slimy, or be able to see bugs in my food.” The most common reaction (7 out of the 10) to the possibility of cricket flour specifically was a face that looks thoughtful, as if it’s making a decision or pondering an idea.

Participant	Entomophagy in general	Eating foods made from cricket flour
1		
2		
3		















4		
5		
6		
7		
8		
9		
10		

Table 2. Emotional responses before and after learning about cricket flour as a source of entomophagy

4.1.3 Concerns and Positive Perceptions

Following the debriefing on cricket flour, the perceived positives and concerns about its use were discussed. Perceived positives included nutritional benefits, environmental sustainability, and the flour itself disguising the fact that one is eating insects, as well as giving the ability to mix it with other flavors. Concerns included proper inspection and certification of cricket flour companies, the risk of disease, concerns about what kind of food the crickets eat, the shelf life, and “just being grossed out by the idea of it.” Participants were then asked to write down which category best described cricket flour: (a) a healthy food

choice, (b) an environmentally friendly food choice, (c), an exotic or adventurous food choice, or (d) other. 9 out of 10 participants chose (b) an environmentally friendly food choice, and 1 participant chose (c) an exotic or adventurous food choice. When asked whether participants would view crickets as a vegetarian food choice, 4 out of 10 said yes, while 6 out of 10 said no.

4.1.4 Recommendations for Promotion of Entomophagy

The very last question discussed was, “If you were to try to convince a group of your friends to try a protein bar made with cricket flour, what would you do?” Many responses included previously discussed topics, such as “tell them it is environmentally friendly,” “tell them it is healthy or protein-rich,” or “explain that it’s a common practice globally.” Other responses included “have them try it first, and then tell them,” “eat it in front of them and tell them it tastes like regular flour,” “tell them specific examples of other people who have tried it,” and “use celebrities to market it.”

4.2 Combined Survey Scores: Willingness to Consider Entomophagy

Statistical analysis was first done to determine which factors correlated to respondents’ willingness to consider entomophagy before they were given the context of foods made out of cricket flour.

4.2.1 Age, Gender, Education, and Ethnicity

There was not a statistically significant relationship between age group and willingness to consider entomophagy, as shown in **Table 3** below. The Chi-square p-value was .634, far above the .05 ceiling of statistical significance.

Age Group			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.560 ^a	4	.634
Likelihood Ratio	2.499	4	.645
Linear-by-Linear Association	.005	1	.945
N of Valid Cases	599		

Table 3. Chi-square value of age group on willingness to consider entomophagy.

The relationship between gender and willingness to consider entomophagy was not statistically significant, nor was the relationship between education level and willingness to consider entomophagy.

The relationship between ethnicity and willingness to consider entomophagy was statistically significant. **Table 4** shows the respective counts and percentages of respondents from each ethnicity who responded as willing to consider entomophagy.

Ethnicity	Would Consider	Total Responses	% Responding Yes
White	350	468	75
Hispanic/Latino	18	28	64
Black/African American	4	17	24
Native American/ Alaska Native	2	2	100
Asian/Pacific Islander	34	63	54
Other	17	20	85

Table 4. Counts and percentages of respondents from each ethnicity who responded as willing to consider entomophagy.

4.2.2 Considerations While Food Shopping

There were statistically significant relationships between respondents' 1-5 ratings of the importance of Environment, Taste, and Familiarity while food shopping, in regards to their willingness to consider entomophagy before the context of cricket flour. There was no

relationship between respondents' rating of the importance of Price and their willingness to consider entomophagy. Though the relationship between Nutrition and willingness to consider entomophagy was not statistically significant, the Chi-square p-value was 0.051, only 0.001 higher than the required level for statistical significance.

Figure 1 displays the proportions of respondents from each Environment rating who would consider entomophagy. It can be seen that respondents with higher importance ratings for Environment were more likely to report being willing to consider entomophagy, and respondents with lower importance ratings were more likely to report being unwilling to consider entomophagy.

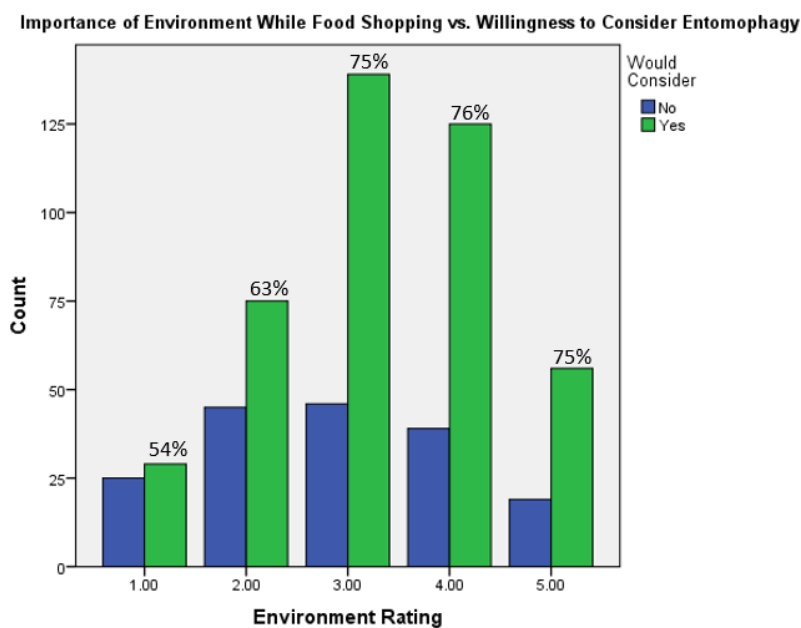


Figure 1. Proportions of respondents from each Environment rating who would consider eating insects without the context of cricket flour

The proportions of respondents from each Nutrition rating who were willing to consider entomophagy is displayed in **Figure 2** below. The general trend shows that respondents with higher importance ratings for Nutrition were more likely to report willingness to consider entomophagy, while respondents with lower importance ratings were less likely to do so. The

biggest outlier in this trend is the importance rating of 1, which may be due to the fact that only 8 respondents marked the importance of Nutrition as a 1.

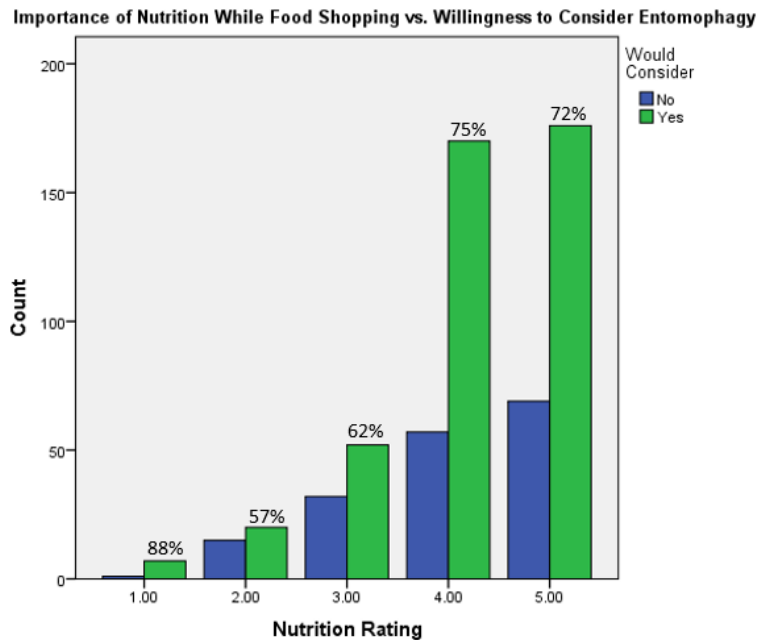


Figure 2. Proportions of respondents from each Nutrition rating who would consider eating insects without the context of cricket flour

The proportions of respondents from each Taste rating who would be willing to consider entomophagy is displayed in **Figure 3** below. It can be seen that respondents with higher importance ratings of Taste were less likely to report being willing to consider entomophagy, and respondents with lower importance ratings of Taste were more likely to report being willing to consider entomophagy. The 71% value for those who rated Taste as a 1 is an outlier in the otherwise inverse relationship between Taste rating and willingness to consider entomophagy; this may be due to the fact that only 7 respondents marked the importance of Taste as a 1.

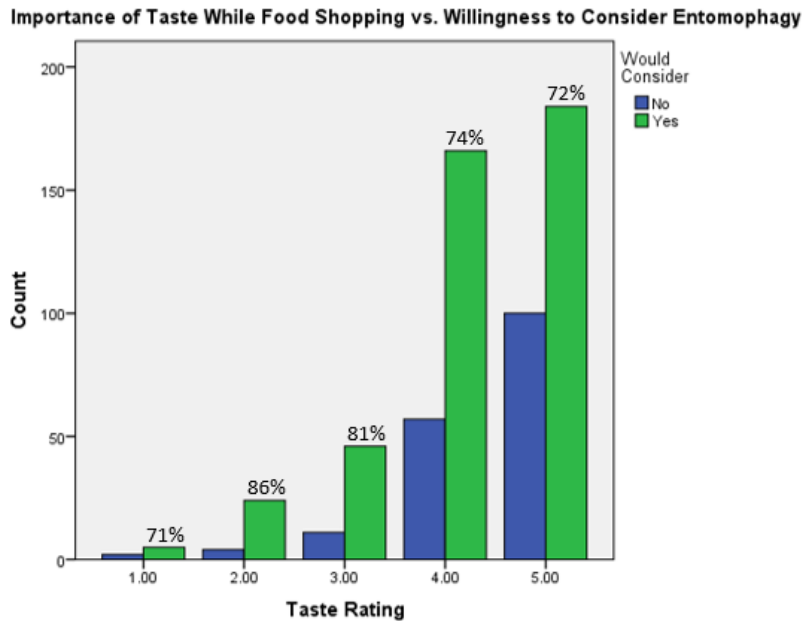


Figure 3. Proportions of respondents from each Taste rating who would consider eating insects without the context of cricket flour

Figure 4 below displays the proportions of respondents from each Familiarity rating who would be willing to consider entomophagy. 89% of respondents who rated the importance of Familiarity as a 1 would consider entomophagy, while 61% of respondents who rated Familiarity as a 5 would consider entomophagy, showcasing the trend in these data: as the Familiarity rating of respondents increased, their willingness to consider entomophagy decreased.

Figure 5 displays the broader picture of respondents' average values of importance ratings for Environmental Impact, Nutritional Value, Price, Taste, and Familiarity. It can again be seen that those with higher Environment and Nutrition ratings were more likely to be willing to consider entomophagy, and those with higher Taste and Familiarity ratings were less likely to be willing to consider entomophagy. The respondents' ranking of these considerations in general, from highest importance to lowest importance, was Taste, Nutrition, Price, Familiarity, and lastly, Environment.

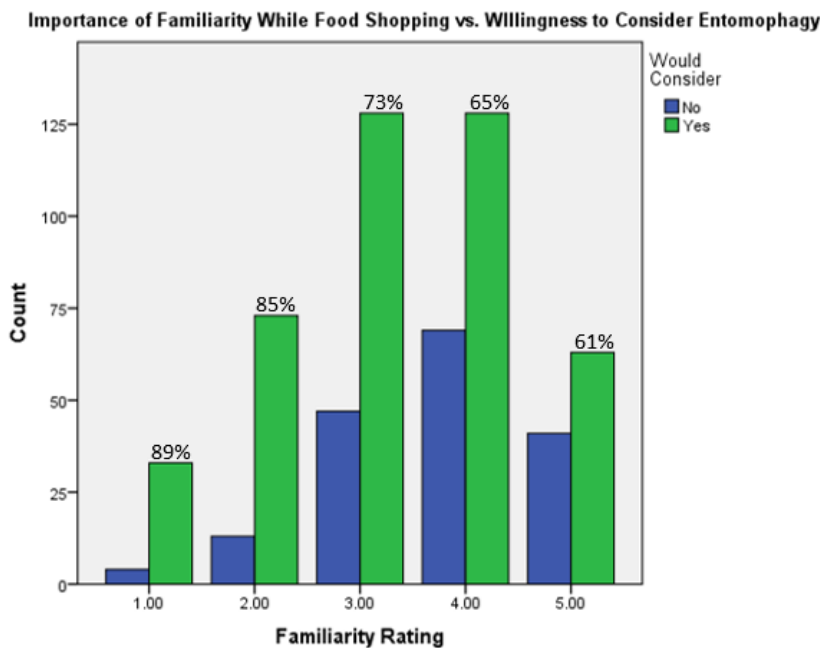


Figure 4. Proportions of respondents from each Familiarity rating who would consider eating insects without the context of cricket flour



Figure 5. Respondents’ average importance ratings for Environment, Nutrition, Price, Taste, and Familiarity.

4.2.3 Food Neophobia and General Neophobia

When cross tabulation was done with Food Neophobia scores and general Neophobia scores, each in relation to whether respondents would consider trying entomophagy, the relationship was statistically significant. **Figure 6** shows the proportions of respondents with each level of

Neophobia who would consider entomophagy. Respondents with the lowest Food Neophobia score of -1 were almost 1.4 times more likely to report being willing to consider entomophagy than respondents with the highest Food Neophobia score of 1. **Figure 7** shows the proportions of respondents with each level of general Neophobia who would consider entomophagy. Respondents with the lowest Neophobia score were almost 3.4 times more likely to report willingness to consider entomophagy than respondents with the highest Neophobia score.

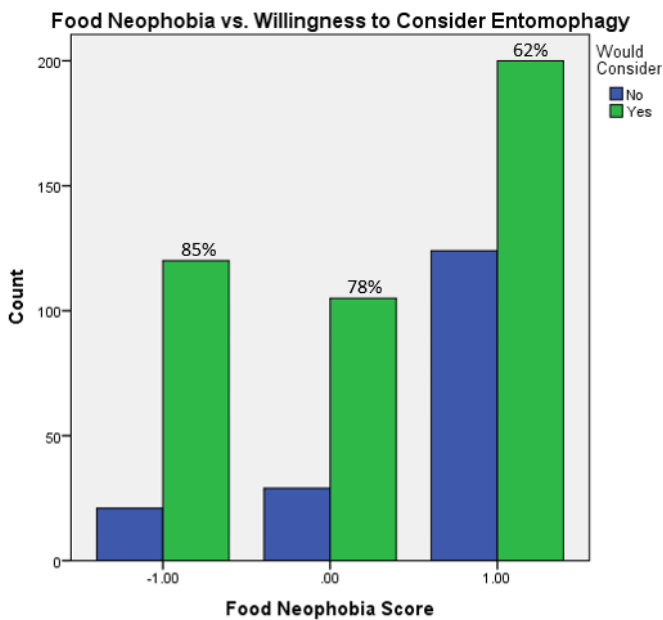


Figure 6. Proportions of respondents from each Food Neophobia score who would consider eating insects without the context of cricket flour.

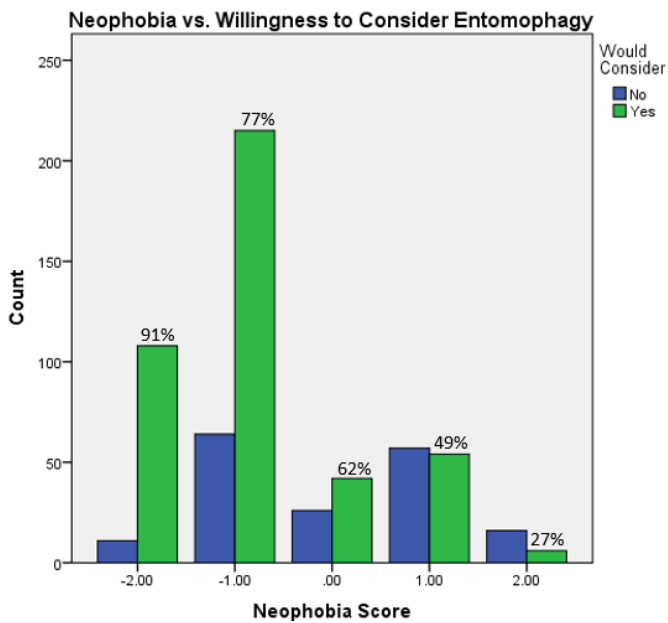


Figure 7. Proportions of respondents from each general neophobia score who would consider eating insects without the context of cricket flour.

4.2.4 Previous Knowledge and Experience

When cross tabulation was done for the Previous Knowledge scores and the Previous Experience scores, each in relation to whether respondents would consider trying entomophagy, the relationship was statistically significant. **Figure 8** shows the proportions of respondents with and without previous knowledge of entomophagy who would consider eating insects. Respondents with previous knowledge of entomophagy were 1.3 times more likely to report being willing to consider entomophagy than respondents without previous knowledge of entomophagy. **Figure 9** shows the proportions of respondents with and without previous experience eating insects who would consider entomophagy. Respondents with previous experience eating insects were 1.6 times more likely to report being willing to consider entomophagy than respondents without previous experience eating insects.

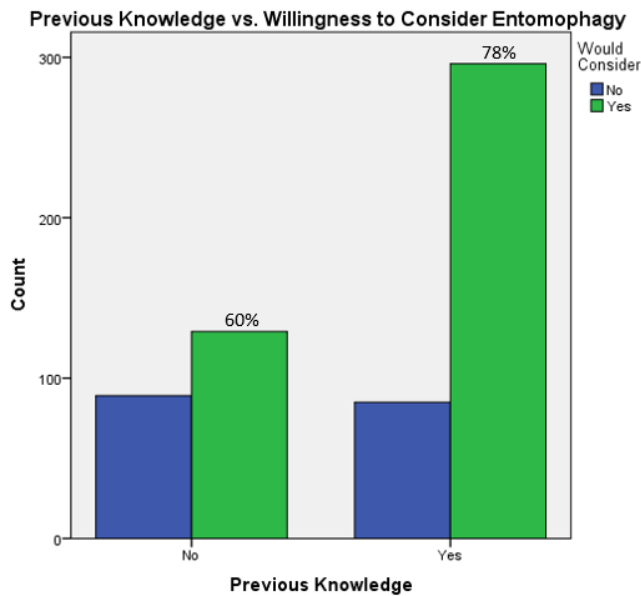


Figure 8. Proportions of respondents with and without previous knowledge who would consider eating insects without the context of cricket flour.

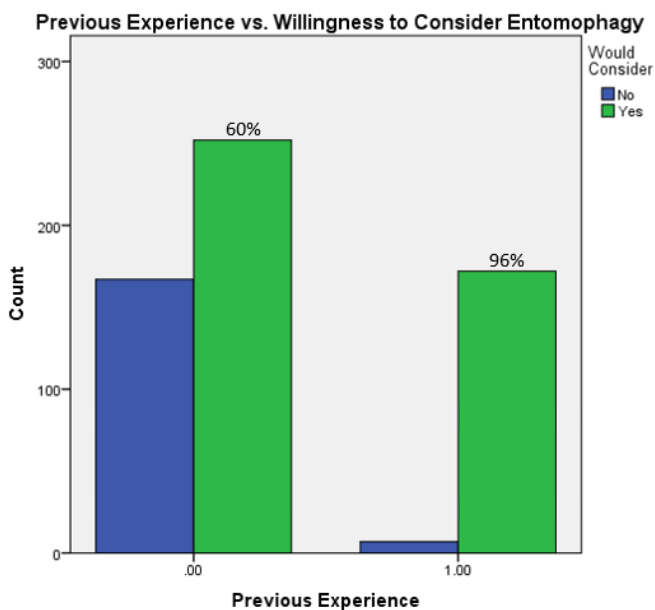


Figure 9. Proportions of respondents with and without previous experience who would consider eating insects without the context of cricket flour.

4.3 Combined Survey Scores: Concerns about Cricket Flour

About 33% of survey respondents, when asked what concerns they would have about cricket flour products, responded that they would not have any concerns if the food product was made from a certified company. **Figure 10** below shows all of the concerns that survey

respondents would have about cricket flour products. After the category of no concerns, the most common categories of concern respondents had about cricket flour were “I would have concerns about the taste,” and “It just grosses me out.” The least common concerns were “Other” and “People might think I’m weird for eating food made with crickets.” While 71% of respondents initially marked that they would be open to entomophagy before the context of cricket flour, 58% of these respondents still had some sort of concern about cricket flour products. **Figure 11** shows the proportions of respondents from each category of concern who had marked previously that they would consider entomophagy before the context of cricket flour. Besides “Other,” the concern category of which respondents were most likely to have previously marked being willing to consider entomophagy was “People might think I’m weird for eating food made with crickets.” This was followed by, in order from most to least likely to consider entomophagy, concerns about taste, concerns about cleanliness, concerns about disease, and concerns about killing crickets, with the concern category of “It’s just gross” correlating to respondents with the lowest likelihood of having previously marked being willing to consider entomophagy. The concern category of “It’s just gross” was the only category in which a larger percentage of respondents marked being unwilling to consider entomophagy than marked being willing to consider entomophagy.

When cross tabulation was done between Previous Experience and Concerns, there was also a significant relationship. **Figure 12** displays the different levels of specific concerns that people with and without previous entomophagy experience had. It can be seen that respondents with previous entomophagy experience had lower levels of concern in all categories; yet both those respondents with and without previous experience viewed “Taste” as one of the highest concerns. Also, while “It’s just gross” was the biggest concern among

respondents without previous experience eating insects, it was one of the lowest concerns among respondents who had previously eaten insects.

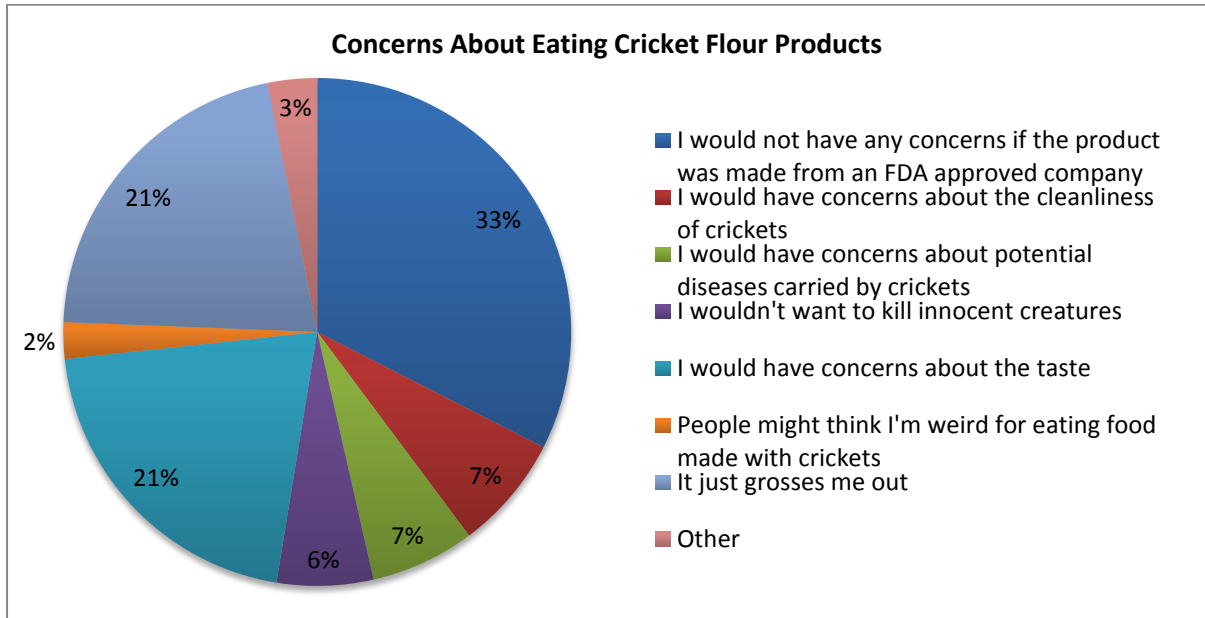


Figure 10. Concerns about eating foods made with cricket flour.

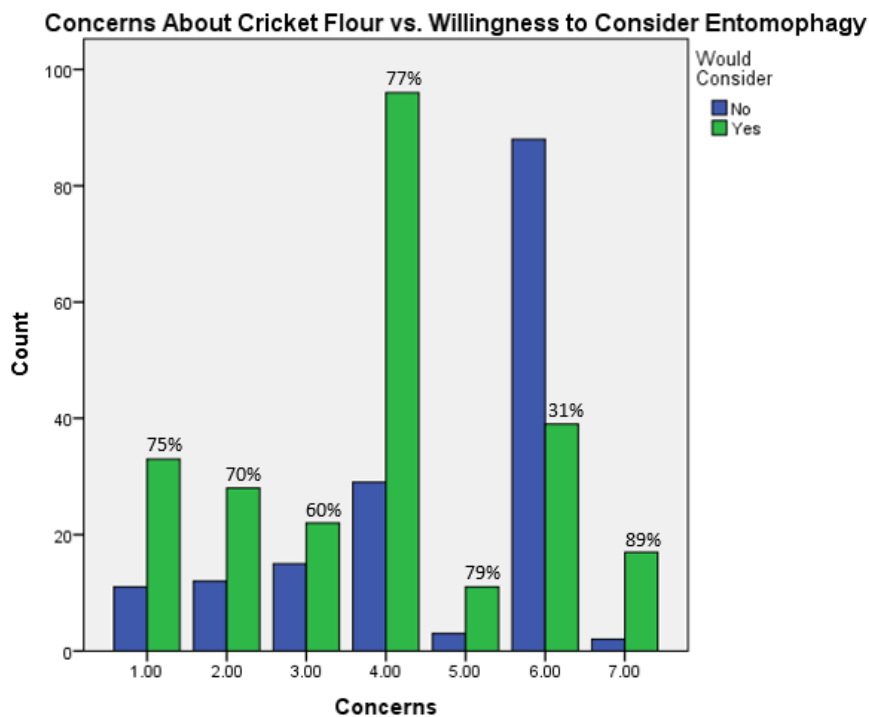


Figure 11. Proportions of respondents from each category of concern who would or wouldn't consider entomophagy without the context of cricket flour. Concerns: (1) Cleanliness, (2) Disease, (3) Killing crickets, (4) Taste, (5) Judgment by others, (6) It's just gross, and (7) Other.

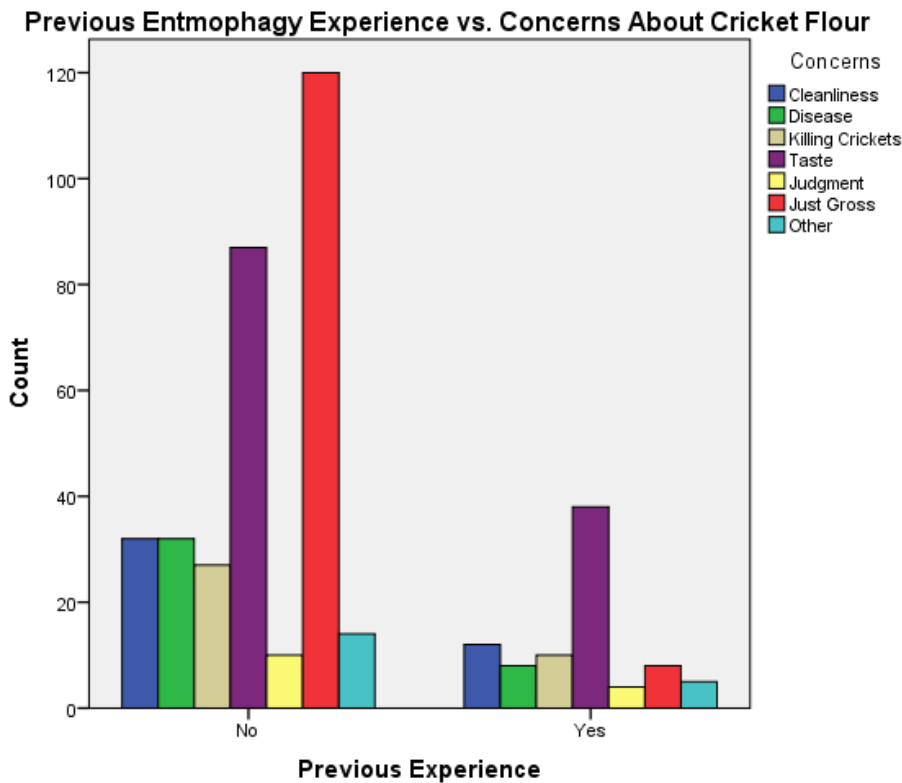


Figure 12. Different levels of concern about cricket flour from people with and without previous entomophagy experience.

There was not a significant relationship between Previous Knowledge of entomophagy and specific categories of concern; however, there was a relationship between Previous Knowledge and Concern in general. **Figure 13** shows the proportions of respondents with previous entomophagy knowledge who would or would not have concerns with cricket flour. Respondents with no previous knowledge of entomophagy were 1.3 times more likely to have concerns about cricket flour than respondents with previous entomophagy knowledge.

Education level, Ethnicity, and Age were found to have no relationship with respondents' concerns about cricket flour. However, there was a significant relationship between Gender and Concern in general. **Figure 14** displays the proportions of Female and Male respondents who had concerns or no concerns about cricket flour. Female respondents were slightly over 1.1 times more likely to have some sort of concern about cricket flour than Male respondents.

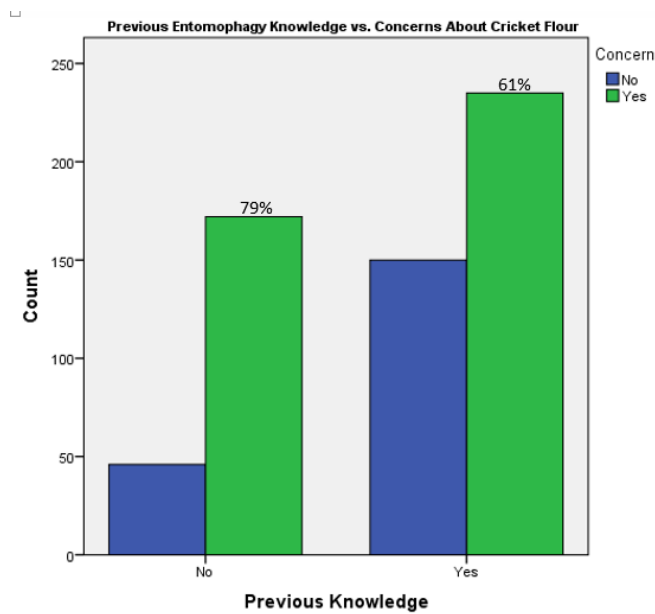


Figure 13. Proportions of respondents with previous entomophagy knowledge who would or would not have concerns with cricket flour

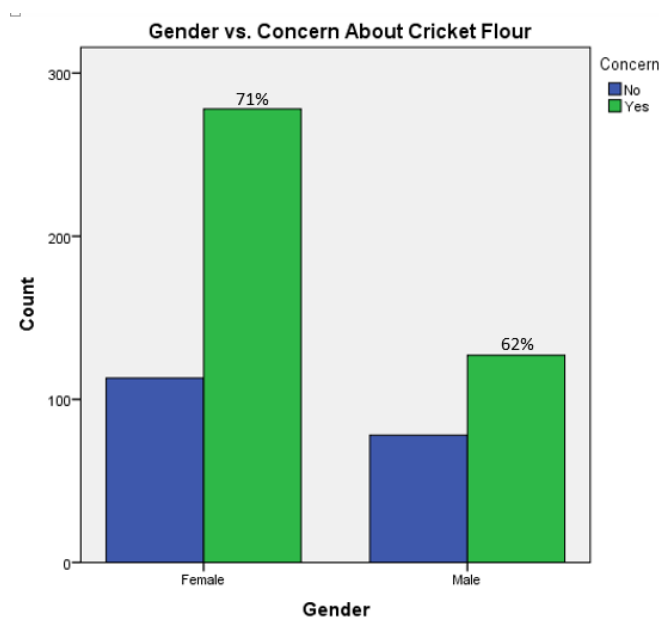


Figure 14. Proportions of female and male respondents with concerns or no concerns about cricket flour

When cross tabulation was done between likeliness of concern about cricket flour and considerations while shopping, some relationships were found. There were no relationships between the considerations of Price or Nutrition and general concern about cricket flour.

Table 5 shows the importance ratings of Familiarity, Taste, and Environment that had the highest level of concern about cricket flour. For Environment, those who rated Environment as a 1 had the highest level of concern for cricket flour. Those who rated Familiarity as a 5

had the highest level of concern for cricket flour, and those who rated Taste as a 5 had the highest level of concern for cricket flour.

Consideration	Rating with Highest Concern	Percentage with Concern at Rating
Environment	1	87%
Familiarity	5	77%
Taste	5	72%

Table 5. Consideration ratings for Environment, Familiarity, and Taste with the highest level of concern for cricket flour products.

4.4 In-Person Surveys: Willingness to Try Sample

When analysis was done on the smaller, in-person survey sample's willingness to try the cricket flour protein bar, there were relationships between their willingness to try the sample and their responses for many previous survey questions. There were not statistically significant relationships between respondents' willingness to try the sample and the variables of Age, Gender, and Education. There was however a relationship between Ethnicity and willingness to try a sample. **Table 6** shows the counts and percentages of respondents from each ethnicity who decided to try the sample. It can be seen that Hispanic/Latino, Asian/Pacific Islander, and White respondents were most likely to try the sample, while Black/African American respondents and those who identified as "Other" were least likely to try the sample. However, half of the ethnicity categories were composed of fewer than 10 respondents, and two were composed of 21 or fewer respondents, while the ethnic category of White was composed of over 80 respondents.

Ethnicity	Tried Sample	Total Responses	% Responding Yes
White	50	81	62
Hispanic/Latino	6	9	67
Black/African American	2	13	15
Native American/ Alaska Native	N/A	0	N/A
Asian/Pacific Islander	13	21	62
Other	1	5	20

Table 6. Counts and percentages of respondents from each ethnicity who decided to try the sample.

There was no relationship between respondents' willingness to try the sample and the importance ratings of Environment, Nutrition, and Price while shopping. The relationship between the importance rating of Taste and the respondent's willingness to try the sample was not statistically significant, with a Chi-square p-value of 0.09; however, a general trend was seen. **Figure 15** shows the proportions of respondents from each Taste rating who tried the sample. There is a general decrease in willingness to try the sample with increasing importance of Taste: excluding the small sample of 5 people who rated Taste as a 1, respondents with the lowest importance rating for Taste were 1.4 times more likely to try the sample than respondents with the highest importance rating for taste.

A statistically significant relationship was found between respondents' importance rating of Familiarity and their willingness to try the sample. **Figure 16** shows the proportions of respondents from each Familiarity rating who tried the sample. Respondents who rated the importance of Familiarity as a 1 were 3.7 times more willing to try the sample than respondents who rated the importance of Familiarity as a 5.

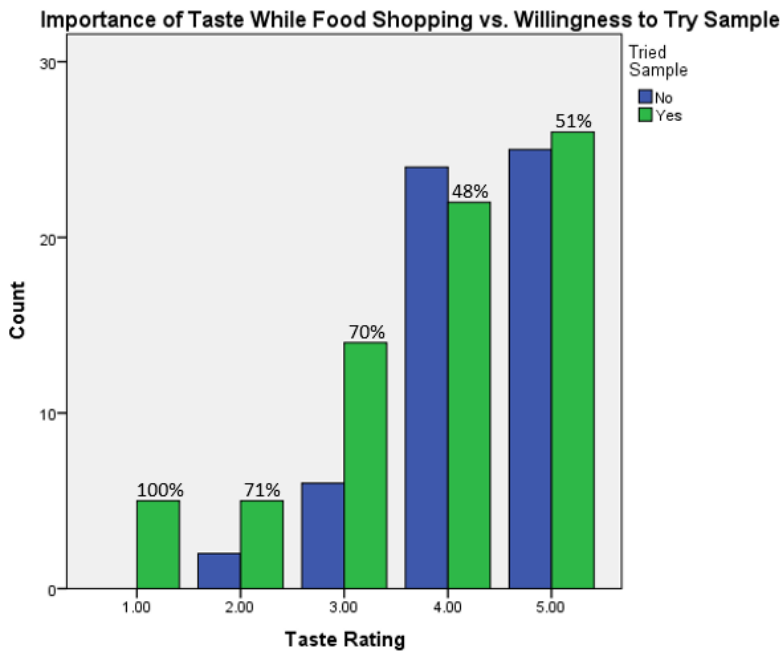


Figure 15. Proportions of respondents from each Taste rating who were willing to try the sample.

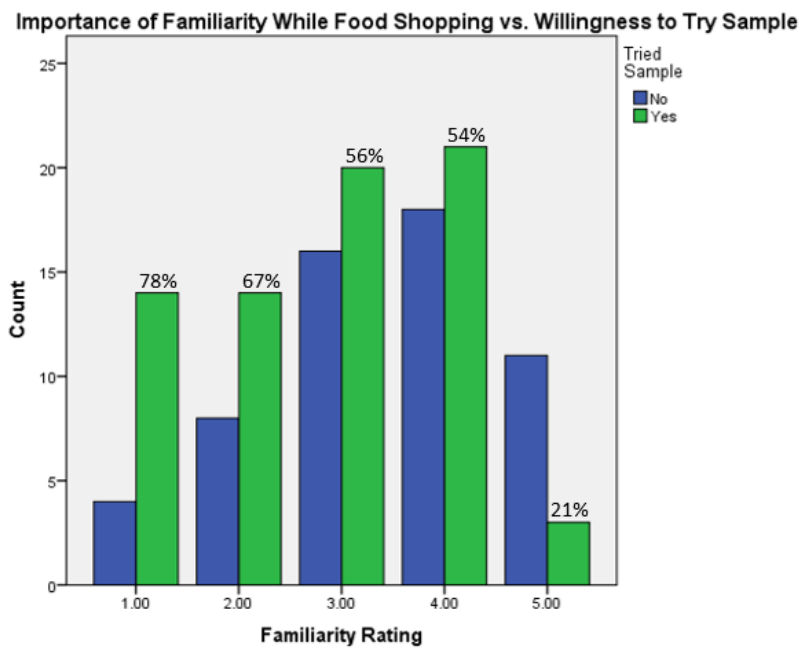


Figure 16. Proportions of respondents from each Familiarity rating who were willing to try the sample

As seen with respondents' willingness to consider entomophagy, there was also a relationship between respondents' willingness to try the sample and their Food Neophobia, Neophobia, Previous Knowledge, and Previous Experience. **Figure 17** and **Figure 18** display the proportions of respondents with each level of Food Neophobia and Neophobia, respectively

that were willing to try the sample. Respondents with the lowest level of Food Neophobia were about 1.9 times more likely to try the sample than respondents with the highest level of Food Neophobia. Regarding general Neophobia, respondents with the lowest Neophobia score were about 2.5 times more likely to try the sample than respondents with the highest Neophobia scores of 1 and 2.

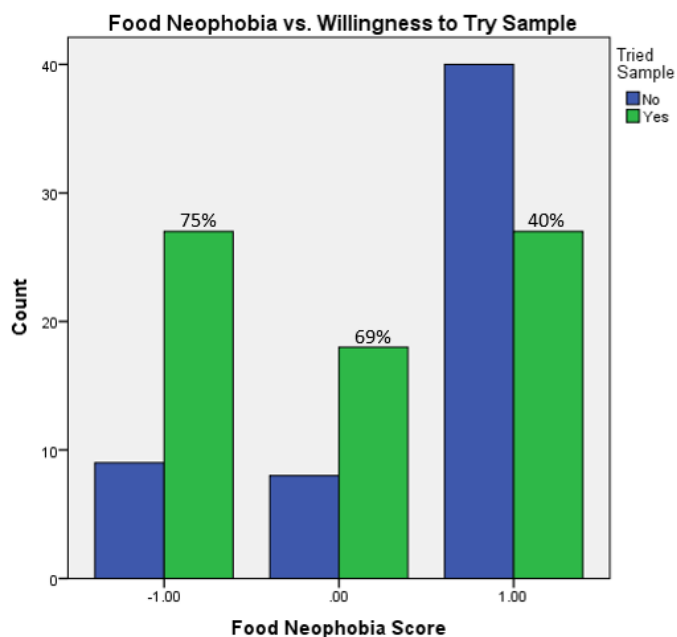


Figure 17. Proportions of respondents from each Food Neophobia score who were willing to try the sample.

The proportions of respondents with Previous Knowledge and Previous Experience who were willing to try the sample can be seen in **Figure 19** and **Figure 20**, respectively. Respondents with Previous Knowledge were 1.4 times more likely to try the sample than respondents without Previous Knowledge, and respondents with Previous Experience were 1.7 times more likely to try the sample than respondents without Previous Experience.

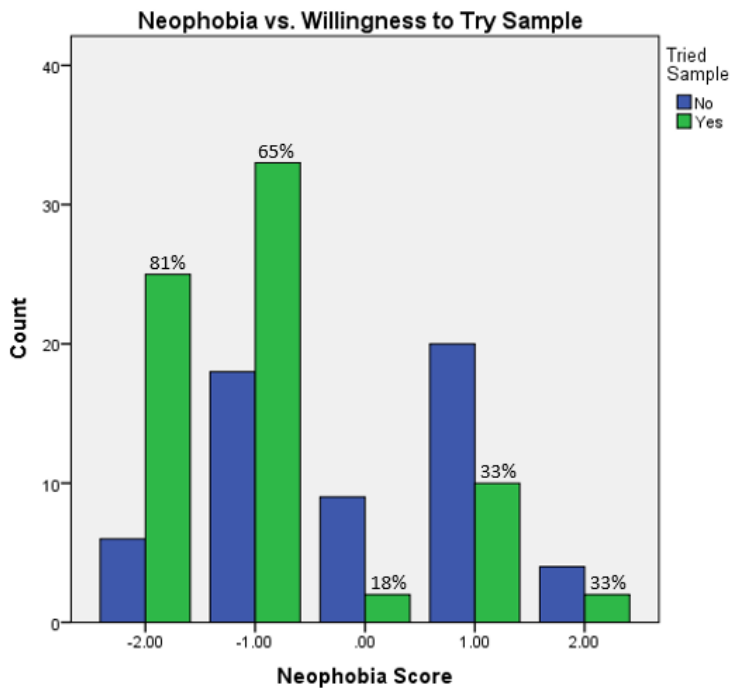


Figure 18. Proportions of respondents from each Neophobia score who were willing to try the sample.

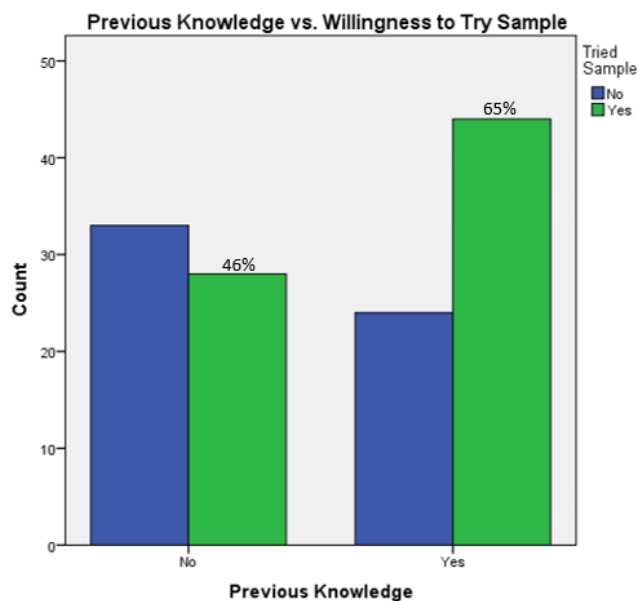


Figure 19. Proportions of respondents with and without previous knowledge of entomophagy who were willing to try the sample.

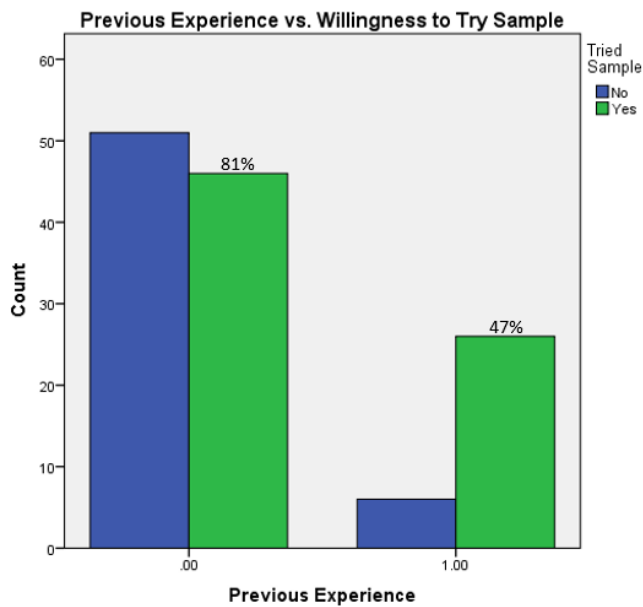


Figure 20. Proportions of respondents with and without previous experience with entomophagy who were willing to try the sample.

A strong relationship was found between respondents' willingness to consider entomophagy and their willingness to try a sample, as shown in **Figure 21**. Those who had previously stated that they would consider entomophagy were 4.3 times more likely to try the sample. Of those who had previously marked being unwilling to consider entomophagy, 19% were later willing to try the sample.

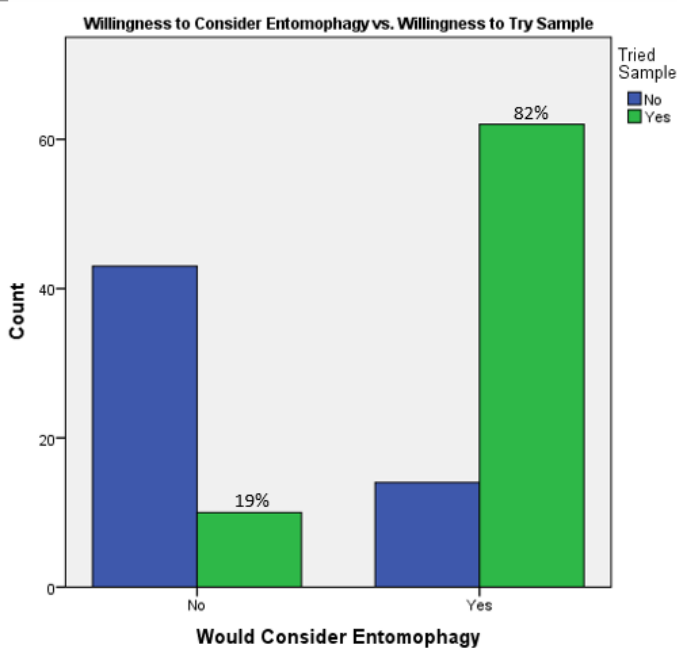


Figure 21. Proportions of respondents willing to consider entomophagy who decided to try the sample

For the respondents who marked that they would consider entomophagy, but then decided not to try the sample, their concerns are shown in **Figure 22** below. The biggest concern categories were no concerns at all, and concern about killing crickets. The least common concerns were concerns about cleanliness, and “It just grosses me out.” There was found to be a relationship between respondents’ presence of Concern in general and their willingness to try a sample. As shown in **Figure 23**, respondents who marked that they would have no concerns with certified cricket flour were 1.9 times more likely to try the sample than respondents who marked that they would have some concern with cricket flour products.

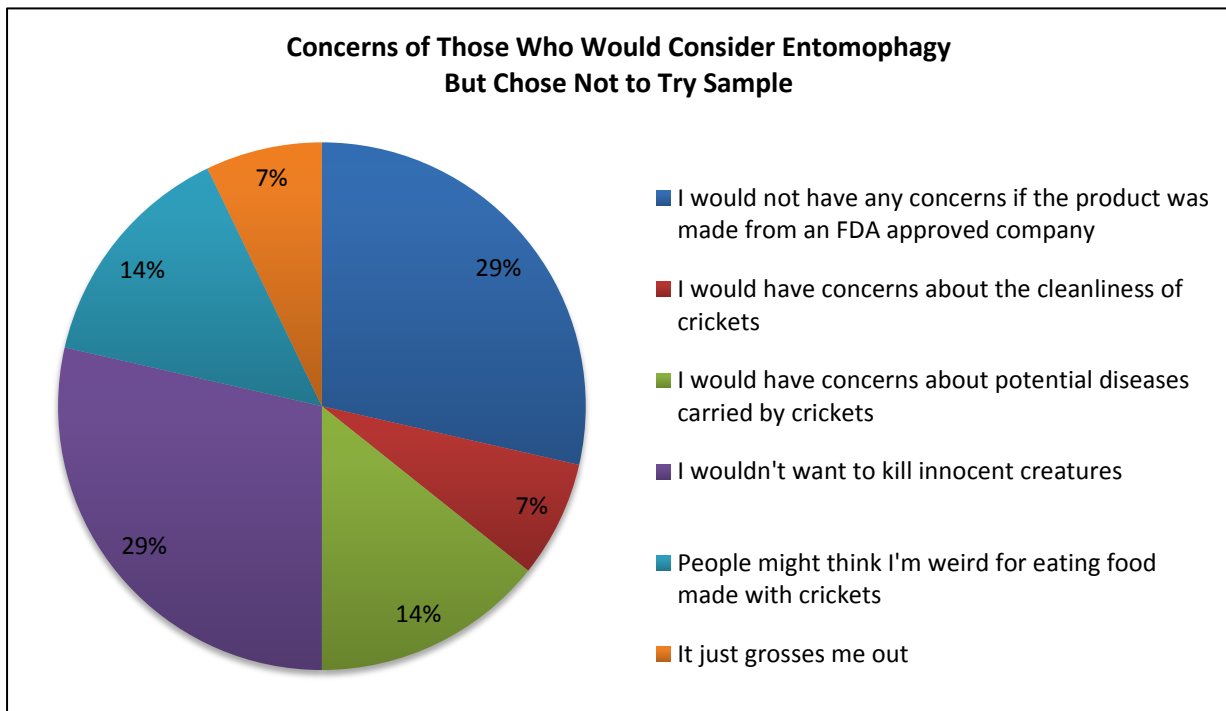


Figure 22. Concerns of those willing to consider entomophagy without the context of cricket flour, but unwilling to try the cricket flour sample.

When analysis was done between respondents’ specific concerns about cricket flour and their willingness to try the sample, there were statistically significant relationships. As seen in **Figure 24**, the two specific concerns that were most strongly related to respondents still being willing to try the sample, besides no concerns at all and the “Other” category, which

only had 3 respondents, were concerns about taste and concerns about the cleanliness of crickets. The specific concerns that related to respondents being least likely to try the sample, besides “People might think I’m weird,” which only had 5 respondents, were “It just grosses me out” and concern about killing crickets.

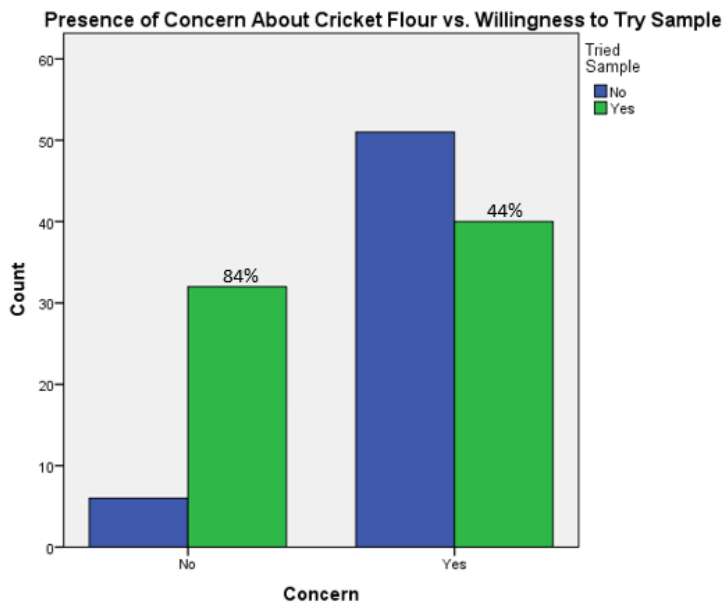


Figure 23. Proportions of respondents with or without concern about cricket flour who were willing to try the sample.

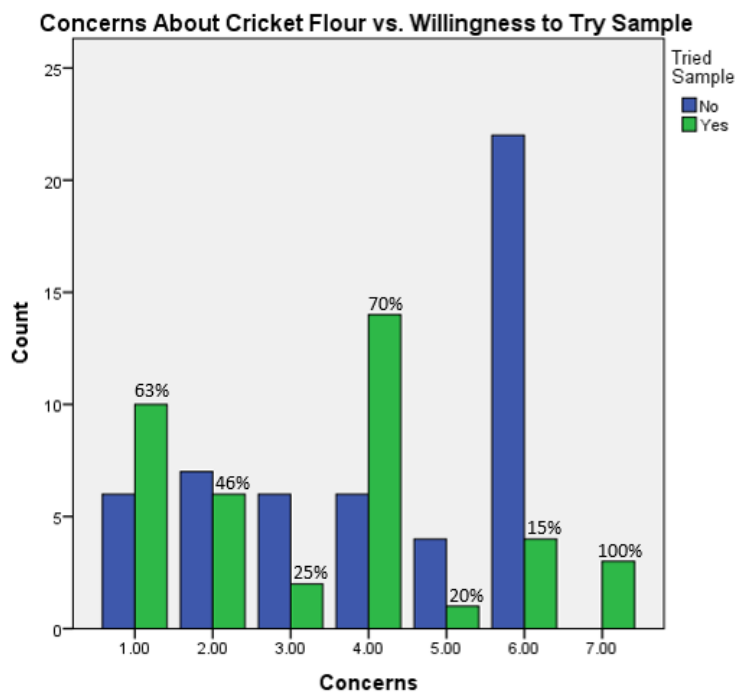


Figure 24. Proportions of respondents from each category of concern who were willing to try the sample. Concerns: (1) Cleanliness, (2) Disease, (3) Killing crickets, (4) Taste, (5) Judgment by others, (6) It’s just gross, and (7) Other.

5 Discussion

The goal of this research was to understand the current perceptions of and barriers to entomophagy in America, as well as what the next steps should be to encourage a greater acceptance and consumption of food products made with cricket flour. Each of these questions involves how people's backgrounds, personal interests, and previous knowledge of entomophagy relate to their view on incorporating cricket products into their diet. The focus group, the online surveys, and the in-person surveys provide different insights into the answers to these questions, and within these data significant relationships, trends and conclusions can be discovered.

The focus group discussion provides insight into common perceptions of entomophagy, as well as steps to encourage greater consumption of cricket flour, while the surveys provide insight into ways that peoples' demographic factors, food-related habits, and previous experiences affect their willingness to consider entomophagy in general, their willingness to try cricket flour products, and their concerns about these products.

5.1 Age, Gender, Education, and Ethnicity

There were no relationships between age group and respondents' willingness to consider entomophagy, or respondents' concerns about cricket flour, or respondents' willingness to try a sample. This could be affected by the fact that almost 60% of the sample was composed of respondents from Age Group 1, ages 18-22. Only about 14% of the sample population was of ages 23-35, about 8% of the population was of ages 36-45, about 8% of the population was of ages 46-55, and about 12% of the sample population was of ages 56 and over, as shown in

Appendix 3. However, it could also be valid that age does not affect one's willingness to consider entomophagy; further research is necessary to establish this.

Varying significance was found in the relationship between gender and responses to entomophagy. While the relationships between gender and respondents' willingness to consider entomophagy or to try the sample were not statistically significant, the relationship between likelihood of concern among respondents was significant. Female respondents had a significantly higher presence of concern about cricket flour (71%) than male respondents (62%), as shown in **Figure 14**. While it is unclear why there were some differences between male and female respondents, it is something to consider while moving forward with the promotion of entomophagy. As it has already been found by Rozin (2002) that overall, females are more concerned with health in relation to food, it may be a good idea to emphasize the nutrition benefits of cricket flour in order to attract more female consumers.

As with age, there were no relationships between respondents' level of education and their willingness to consider entomophagy, or their willingness to try the sample, or their concerns about cricket flour. Like age, this could also be affected by the non-random sample population. Over 50% of respondents were in the category of "Some College," while the highest level of education for about 3% of the sample population was a high school diploma, for about 4% an Associate's degree, for about 26% a Bachelor's degree, and for about 17% a Masters or Doctorate, as seen in **Appendix 3**. Further research is required to determine whether education level plays a role in perceptions of entomophagy.

The relationship between ethnicity and both the willingness to consider entomophagy and the willingness to try a sample was statistically significant, as seen in **Table 4** and in **Table 6**. It was found in both cases that the ethnicity of respondents least likely to consider entomophagy

or the sample was Black/African American. However, because the sample sizes of each ethnicity varied greatly, it is difficult to make generalizations in this regard. About 78% of the respondents identified as white, while only 5% identified as Hispanic or Latino, 3% identified as Black or African American, less than 1% identified as Native American or Alaska native, 11% identified as Asian or Pacific Islander, and 3% identified as Other, as seen in **Appendix 3**. In order to draw valid conclusions regarding ethnicity and response to entomophagy, a more diverse sample population would need to be used. However, within the relatively large sample size of white respondents, a majority of respondents were willing to consider entomophagy and/or the cricket flour sample, showing that white consumers have a promising potential for a positive response to entomophagy.

5.2 Considerations While Food Shopping

From **Table 1**, it can be seen that the considerations while food shopping that were most important to participants in the focus group were Price and Taste, followed by Familiarity and Nutritional Value, and lastly, Environmental Impact. This is slightly different than the findings shown in **Figure 5**, where it can be seen that the considerations while food shopping that were more important to survey respondents were Taste and Nutrition, followed by Price, Familiarity, and lastly, Environment. This discrepancy could potentially be attributable to the differences in demographic compositions between the focus group and survey respondents. Almost all of the focus group participants were college students, which might make them more inclined to be concerned about the price of their food. Also, as previously shown by Rozin (2002), college students are the least likely generation to care about the nutritional content of their food, which could possibly explain why this consideration was ranked lower in the focus group than in the survey population. Although the survey population was composed of more than 50% college students, it still had a smaller percentage of college

students than the focus group, and therefore was potentially less influenced by the concern about price, and more influenced by concerns of nutrition. However, from both of these metrics, it can be seen that Taste is relatively more important to respondents than Familiarity and Environment, and in both cases, Environment is the least important out of the five considerations. It can also be seen in **Figure 10**, **Figure 11** and **Figure 12** that “I would have concerns about the taste” was one of the most common causes for concern about cricket flour. From **Figure 15** it is shown that a statistically significant trend was seen between respondents’ Taste rating and their willingness to try the sample: respondents who gave Taste a higher importance rating were less likely to try the sample. From this it can be concluded that in order for entomophagy and cricket flour to be successful in America, it is essential that the product has a strong focus on taste, and appeals to popular taste preferences. Because cricket flour can be used in the same way as wheat flour, it is possible, and has already been accomplished by companies such as ExoTM and Bitty Foods, to create products such as protein bars or cookies with popular flavors like chocolate and peanut butter.

Although Environment is consistently the lowest-rated consideration, it can still be seen from **Figure 1** and **Table 5** that among those with higher Environment ratings, there is an increased willingness to consider entomophagy before the context of cricket flour, and overall decreased levels of concern about the idea of cricket flour products. Because of this, the strategy of marketing cricket flour products as an environmentally friendly food choice should not be ruled out, as it may draw consumers with environmental interests. This sentiment was also reflected in the focus group, as 9 out of 10 participants marked that they would view cricket flour as an environmentally friendly food choice, in contrast to a nutritional food choice or an adventurous food choice.

The rating of Price was not found to have a significant relationship with respondents' views on entomophagy; however it can be seen in **Table 1** and in **Figure 5** that participants in the focus group and survey respondents both rated Price as a relatively important consideration while food shopping. This shows that in order for entomophagy and cricket flour to be successful, the cricket products must be offered at a reasonable price for consumers.

There were varying levels of significance in the relationship between respondents' rating of Nutrition and their views toward entomophagy. From **Figure 2**, it can be seen that, although the relationship between respondents' rating of Nutrition and their willingness to consider entomophagy was not statistically significant, it was close, with a p-value of 0.051, and with a clear trend. With respondents' increasing importance rating for Nutrition, there was increased willingness to consider entomophagy. There was no significant relationship between respondents' rating of Nutrition and their concerns about cricket flour, or their willingness to try the sample. However, it can be seen in **Table 1** and **Figure 5** that both focus group participants and survey respondents viewed Nutrition as an important consideration while food shopping. Although the relationship between respondents' ratings of Nutrition and their views on entomophagy was not strong, it was still present, and it may be an important factor to consider for the promotion of entomophagy.

Lastly, a strong relationship was found between respondents' ratings of Familiarity and their views on entomophagy. It can be seen in **Table 1** that focus group participants rated the importance of Familiarity while food shopping as moderately high. There was also a statistically significant relationship between survey respondents' Familiarity ratings and their willingness to consider entomophagy, their level of concern about cricket flour, and their willingness to try the sample. It can be seen in **Figure 4** that respondents with higher

Familiarity ratings were less willing to consider entomophagy, and in **Table 5** it can be seen that respondents with the highest Familiarity rating also had the highest level of concern about cricket flour. **Figure 16** shows that respondents with increasingly high Familiarity ratings were also decreasingly willing to try the sample. From this, it can be concluded that people who highly value the familiarity of their food are less likely to consider entomophagy and cricket flour. To help overcome this barrier, it may be important to create products with cricket flour that are similar to food products that are familiar to Americans. For example, the already explored routes of protein bars and cookies are promising, and foods such as candies, chocolate, and other baked goods could also be successful methods of marketing cricket flour. These options tend to be less nutritious than the option of protein or granola bars, which seems to be a favorable combination familiarity, taste, and nutrition—yet sacrificing overall nutritional value in some foods in order to create more desirable tasting products might be necessary in order to accomplish widespread adoption of cricket flour.

5.3 Response Before and After Context of Cricket Flour

It can be seen from **Table 2** that after discussing entomophagy within the context of cricket flour, rather than eating insects in general, focus group participants' emotional responses changed from mostly negative responses to overall positive or more open responses. The most common reaction to cricket flour was the face that looks thoughtful, as if it's making a decision or pondering an idea. It is a less negative emotional response than the faces shown in the first column, and displays more openness to the idea of cricket flour, rather than whole insects, as a form of entomophagy.

With the survey respondents, a strong relationship was seen between willingness to consider entomophagy and willingness to try the sample. Of the in-person survey respondents, 82% of

those willing to consider entomophagy were willing to try the sample, as seen in **Figure 21**. This, however, leaves about 18% of those willing to consider entomophagy who chose not to try the sample. **Figure 22** shows the common concerns among those who would consider entomophagy, but decided not to try the sample. Almost a third of these respondents had concern about killing crickets, and thus were most likely vegetarian or vegan. It is unknown why those who would consider entomophagy and also had no concerns with cricket flour chose not to try the sample. On the other hand, among those who originally marked that they would not consider entomophagy without the context of cricket flour, 19% were later willing to try the sample. This shows that respondents once unwilling to consider entomophagy at all were able to change their minds when presented with entomophagy in the context of cricket flour. It should be noted that among the in-person survey population, a slightly lower percentage of respondents (56%) were willing to try the sample than those who marked being open to the idea of entomophagy before the context of cricket flour (59%). It can only be speculated as to why this is. Perhaps for some respondents it was easier for people to toy with the vague idea of entomophagy, but they changed their minds when actually presented with the opportunity, or they at that moment did not want to try any type of food sample. From the almost 20% of those previously unwilling to consider entomophagy who were then willing to try the sample, it may be speculated that for these respondents, the idea of cricket flour was more appealing than entomophagy in general. With this added to the differences in emotional reactions before and after cricket flour was introduced in the focus group, it can be concluded that cricket flour as a form of entomophagy is more appealing to the respondents than the concept of entomophagy in general. In order for entomophagy to be successful in America, it is a smart idea to convert crickets into a form that makes them unidentifiable as insects, and more like food products that are already widely eaten: flour.

5.4 Food Neophobia and General Neophobia

There were strong relationships between respondents' general and food neophobia and both their willingness to consider entomophagy and their willingness to try the sample. As seen in **Figure 6**, respondents with lower Food Neophobia scores were significantly more willing to consider entomophagy, with 85% of those with the lowest Food Neophobia score of -1 being willing to consider entomophagy, and only 62% of those with the highest Food Neophobia score of 1 being willing to consider entomophagy. While it may not be surprising that those with higher levels of Food Neophobia would be less willing to consider entomophagy, it was also found that with increasing levels of Neophobia in general, respondents had decreasing willingness to consider entomophagy, as seen in **Figure 7**. There was an even bigger difference here, with 91% of those with the lowest Neophobia score of -2 being willing to consider entomophagy, while only 27% of respondents with the highest Neophobia score of 2 were willing to consider entomophagy.

These patterns were repeated in the respondents' willingness to try the sample. As seen in **Figure 17** and **Figure 18**, with increasing levels of Food Neophobia and general Neophobia, respondents were less willing to try the sample. Only 40% of respondents with the highest level of Food Neophobia were willing to try the sample, compared to 75% of those with the lowest level of Food Neophobia, and only 33% of those with the highest general Neophobia score were willing to try the sample, compared to 81% of those with the lowest Neophobia score.

From these data, two separate conclusions can be drawn. One is that because those who lean more toward the "adventurous" side are more willing to consider and try eating insects, this population is a promising market for cricket flour products. Therefore, if cricket flour

products were offered in spaces or gatherings with an emphasis on trying new things or new foods, such as exotic food festivals, restaurants specializing in new or exotic foods, etc., or otherwise marketed as an adventurous food, this could be a successful method of bringing cricket flour products into circulation among those already willing to try them. Exposing any group of people to the existence of cricket flour could then lead to awareness of cricket flour within the social networks of these people, and lead to an overall greater awareness. Because previous knowledge of entomophagy was shown to be an indicator of increased willingness to consider eating cricket flour and insects in general, the ability of those already willing to try cricket flour products to influence others should not be overlooked. The other conclusion, drawn from a different angle, is that because those with higher levels of neophobia and food neophobia are less willing to consider or try entomophagy, it is in contrast important to focus on the familiarity of cricket flour products, i.e., products such as granola bars, cookies, and other foods that, while new and different, have an element of the familiar in them.

5.5 Previous Knowledge and Experience

There were strong relationships between respondents' previous entomophagy knowledge and experience, and both their willingness to consider entomophagy and their willingness to try the sample. As seen in **Figure 8**, respondents with previous knowledge of entomophagy were 1.3 times more willing to consider eating insects. Respondents with previous knowledge were also significantly more willing to try the sample. As seen in **Figure 19**, respondents with previous entomophagy knowledge were 1.4 times more willing to try the sample than respondents without previous knowledge.

These patterns were even stronger with the respondents who had previous experience eating insects. As seen in **Figure 9**, respondents with previous experience were significantly more

willing to consider entomophagy before the context of cricket flour than those without previous experience. A very high percentage (96%) of respondents with previous experience would consider entomophagy, while only 60% of respondents with no previous experience would consider it, showing that those with previous experience were 1.6 times more likely to consider entomophagy than those without previous experience. For the in-person surveys, respondents with previous experience were 1.7 times more willing to try the sample than respondents without previous experience, as seen in **Figure 20**.

From these data, it can be concluded that previous knowledge of and experience with entomophagy play important roles in its widespread acceptance. Two conclusions may be drawn from this. One is that entomophagy has a very promising potential to be widely accepted in America, because once people are aware of its existence, they are much more likely to try it for the first time, and once they have tried it for the first time, they are even more likely to try it again. Another conclusion that can be drawn from this is that spreading awareness of entomophagy and offering people the chance to try insect foods could perhaps be the two most powerful methods of promoting entomophagy and cricket flour in America. This is supported by Rozin's 2006 conclusion that food preferences are influenced by mere exposure (the more someone is exposed to something, the more one likes it), and by social influence (the approval or enjoyment of others can increase liking of a food). Awareness could be spread through the media, as well as local advertising for restaurants or stores that sell insect foods. People could be offered the chance to try insect foods at restaurants, food festivals, museums, zoos, or other public venues.

5.6 Concerns and Recommendations

The concerns about cricket flour that were discussed in the focus group (proper inspection and certification of cricket flour companies, the potential of disease, concerns about what kind of food the crickets eat, the shelf life, and “just being grossed out by the idea of it”) reflect some of the concerns listed on the survey, particularly the concerns of disease and “it just grosses me out.” In order to influence respondents who are simply “grossed out” by the idea of entomophagy, it may be best to reflect on Vernon and Berenbaum’s 2002 study showing that when fear of insects was lowered, disgust responses were also lowered. A potential marketing strategy would be to lower levels of fear by spreading positive information about crickets.

For those who are not just grossed out, it is possible to see reasons they are open or not to the idea of entomophagy. The concerns about cleanliness, diseases carried by crickets, and the proper certification of cricket flour companies show that it is important to assuage any fears about disease or cleanliness of crickets while promoting the use of cricket flour. This could be done by ensuring that producers of cricket flour are somehow certified; this seems to be something that respondents would find comforting and a reason to not be concerned about cricket flour. This could involve creation of legislation about insects as food; however it would be important to ensure that the enactment of cricket/insect food legislation would help promote the use of cricket flour rather than hinder it.

Recommendations for the promotion of entomophagy from focus group participants reflected some of the considerations while food shopping listed on the survey: promoting cricket flour as environmentally friendly or as nutrient-dense reflects the survey options of Environment and Nutrition. Other recommendations for the promotion of entomophagy, such as “explain

that it's a common practice globally," "have them try it first, and then tell them," "eat it in front of them and tell them it tastes like regular flour," "tell them specific examples of other people who have tried it," and "use celebrities to market it," rather than focusing on the health and science behind crickets, relate more to the psychological or cultural norms surrounding entomophagy. From these answers, it can be concluded that the normalization of cricket flour is a very important step to its implementation in America. Again, using examples of other people—particularly widely admired people—who accept or practice entomophagy could be an incredibly valuable tool in the promotion of cricket flour in America.

The surveys provide a deeper look into respondents' concerns about cricket flour. **Figure 10** shows the percentages of respondents within each category of concern. The most common concerns, besides the category of no concern, were "I would have concerns about the taste," and "It just grosses me out," both which made up about 31% of those who had some level of concern. Next, at 11% and 10%, were the concerns of cleanliness of crickets and potential diseases from crickets, respectively. The lowest cause for concern, at only 3%, was the concern about negative judgment from others. From **Figure 11** it can be seen how different concerns related to respondents' willingness to consider entomophagy. For all causes of concern, a higher proportion of respondents had still marked being willing rather than unwilling to consider entomophagy, with one exception: the category of "It just grosses me out." The respondents who were grossed out by cricket flour were substantially more likely not to have marked that they would consider entomophagy. On the other hand, the concern that was most unlikely to negatively relate to respondents' willingness to consider entomophagy was the concern of taste. 77% of respondents who marked that they would have concerns about the taste of cricket flour had previously marked that they would consider

entomophagy before the context of cricket flour. These trends are very similar to those seen in the analysis between respondents' concerns about cricket flour and their willingness to actually try the sample, as seen in **Figure 24**. The concern of taste was least likely to deter respondents from trying the sample, with 70% of respondents concerned with taste still trying the sample (shown in **Appendix 3**). Other categories of concern that were less likely to deter respondents from trying the sample were those of cleanliness and "other," not to mention "no concerns," of which 84% of respondents were willing to try the sample, as shown in **Figure 23**. The concern of grossness was again most likely to negatively relate to respondents' willingness to try the sample. Only about 15% of respondents who were simply "grossed out" were willing to try the sample. Other categories of concern within which respondents were less willing to try the sample included those of disease (although the split in this category was close, with 46% trying the sample and 54% not trying the sample), killing innocent creatures, and judgment by others.

From these data about respondents' concerns, it can be concluded that while it wasn't a large deterrent to trying the cricket bar sample, the concern about taste was the most common concern among respondents about cricket flour besides being grossed out. Therefore, it is important to ensure that cricket flour products have a focus on taste in order to decrease or prevent concern about the food. It can be seen in **Figure 12** that those with previous experience eating insects were substantially less grossed out by the idea of entomophagy; therefore a way to address those who are simply grossed out by entomophagy would be to offer them the opportunity to try a small sample. It is also again important to address the concerns about cleanliness and disease when discussing cricket flour products, to assuage any fears that consumers may have. The concern about judgment from others was very small, making up only about 3% of the respondents with some level of concern, so it may not be

something that requires as much energy and attention to combat in the promotion of cricket flour products. About 9% of the respondents with some level of concern marked that their issue with cricket flour was unwillingness to kill innocent creatures. For people who are vegetarians for moral reasons such as this, the potential for promoting cricket flour might be low. However, with those who are vegetarians for other reasons, such as environmental reasons, dislike of meat, religious reasons, etc., the potential of crickets still holds promise. This sentiment was also reflected in the focus group, as 40% of participants said that they would consider cricket flour a vegetarian food choice.

5.7 Conclusion

From the data collected, it is possible to piece together a picture of the current perceptions of and barriers to entomophagy within the sample population. It was found that entomophagy within the context of cricket flour was more appealing than entomophagy in general, and therefore cricket flour may be a promising way to promote the practice of entomophagy. This is also supported by cricket flour's ability to be added to familiar food products, which addresses the low willingness to consider entomophagy by those who value the familiarity of their food. The variables of age and education level were found to have no significant relationship to respondents' views on entomophagy. Ethnicity was found to play a role in the views of entomophagy and cricket flour, but the homogeneity of the sample makes it difficult to generalize this finding. It was found that males had less concern about cricket flour products than females.

Regarding considerations while food shopping, the importance of Taste was high, and the importance of Environment was low. Yet the importance rating of Environment was related to respondents' willingness to consider entomophagy and their level of concern about cricket

flour products, so it should not be ruled out as a method of promoting cricket flour products. Respondents with high importance ratings of Taste were less willing to try the sample; however the specific concern of cricket flour products' taste did not appear to be a large deterrent to trying the product, showing that while taste is very important to keep in mind, it is not necessarily a current barrier to cricket flour products. The importance rating of Price was not related to respondents' views on entomophagy, but it was regarded as an important consideration while food shopping. This, as well as Ambuehl's (2015) finding that monetary incentives will make people more willing to try insects, shows that price must be considered when promoting entomophagy. There was a weak relationship between the importance rating of Nutrition and respondents' willingness to consider entomophagy, but Nutrition was also regarded as an important consideration while food shopping, and so must also be considered while promoting entomophagy. The importance of Familiarity was strongly related to respondents' views of entomophagy in all categories, and so it is essential that cricket flour products be promoted in the most familiar of contexts as possible to consumers, such as granola bars, baked goods, or other items commonly made with wheat flour.

The biggest determinants of subjects' willingness to consider entomophagy and cricket flour were their levels of neophobia and food neophobia, and their previous knowledge or experience with entomophagy. Respondents with high levels of food neophobia and general neophobia were much less willing to consider entomophagy or to try the sample, while those with previous knowledge of entomophagy, and especially those with previous experience, were much more likely to consider entomophagy and try the sample. While neophobia is a current barrier to entomophagy, if it is possible to convince food-neophobic people to try cricket flour, there is a much higher chance that they will try it again.

The most common concerns about cricket flour products were being grossed out by the idea of it and the taste, followed by the cleanliness and disease of crickets. It is important to spread awareness of entomophagy and its global practice, as well as creating legislation and certification processes to socially establish the safety of insects as food. Other significant possibilities for the promotion of entomophagy and cricket flour are the use of endorsement by widely-admired people, and endorsement by everyday people who can spread knowledge to their personal networks. A tentative description of the most promising demographic for the acceptance of cricket flour is white males with slightly higher value placed on nutrition and the environment while food shopping, who are not opposed to eating animal products, with an openness to trying new things, and with previous knowledge or experience with entomophagy.

5.8 Limitations and Future Research

Due to the nature of the sample populations used for the research, it is difficult to generalize the results to all Americans. The focus group participants were mostly female, and mostly college students, recruited from flyers around the city of Ann Arbor. The online survey participants were gathered by a snowball sample distribution on social media, combined with emails to students in the Program in the Environment at the University of Michigan. The in-person survey participants were partially composed of shoppers at a local Ann Arbor grocery store and partially composed of students at the University of Michigan. The use and combination of three slightly different demographic groups contributes to a slightly more diverse sample, yet it could be improved further. While it is impossible to generalize the results of this research to the entire American population, it still provides a deeper understanding of the hopes and concerns for entomophagy and cricket flour in a small sample of Americans, which had not yet been looked into.

Another limitation of the study is the difference in the surveys. The online survey did not include a question regarding whether or not the respondent would be willing to try a cricket flour product. This question was omitted from the online survey because there was no way to offer the respondents a sample, but if the study were to be done again, it would be very possible to add a question at the end of the online survey simply asking whether or not the respondents would be willing to try a cricket flour sample if offered one. This would vastly increase the sample size for analysis in regards to respondents' willingness to try a cricket flour sample. It is possible to use an algorithm in SPSS called multiple imputation that uses patterns seen in the in-person surveys to estimate whether each online survey respondent, based on their other answers, would have tried a sample if asked. However, the demographics of the survey populations varied so greatly in age and education level, among other variables, and the number of in-person surveys was significantly smaller than the number online surveys, so this method of multiple imputation would not be a very reliable estimate.

In order to acquire a more comprehensive picture that can be generalized to the entire American population, further research with a more random and diverse sample is necessary. Deeper exploration could also be done by further enquiring respondents why or why not they were willing to try the sample.

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Appendix 1: Focus Group Outline

Questions:

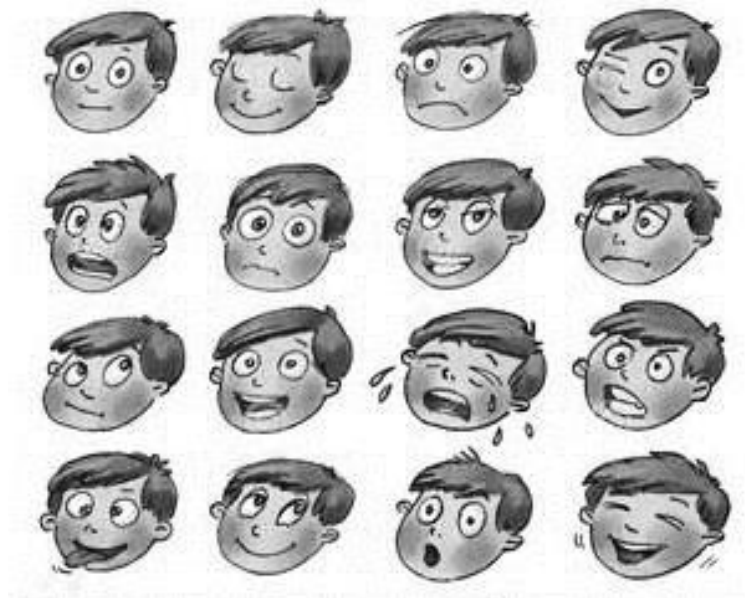
1. When food shopping, what considerations are most important to you?
2. When food shopping, how much do you think about:
 - a. Environmental impact
 - b. Nutritional value
 - c. Price
 - d. Taste
 - e. Familiarity with/ past experience with the food
3. What are your main sources of protein?
4. Have you heard about or thought about trying alternative sources of protein? If yes, please describe.

At this point, the following information was read to the group:

Because meat production has such a large carbon footprint, and because meat consumption is rising in developing areas of the world, the meat industry as a whole plays a large role in climate change. Meat production uses a lot of space, water, animal feed, and energy, and research suggests that alternatives to meat, such as insects, are less demanding of these resources. The farming of crickets produces less greenhouse gasses than does farming cattle, uses less water, less feed per pound, and far less space. Because animal meat in general is considered to be the "best" source of protein, iron, and other nutrients such as vitamin B-12 that are hard to find elsewhere, the capability of crickets to supply these important nutrients has been investigated and has shown to be very promising. Crickets contain vitamin B₁₂, which can only be found naturally in animal products, and have a higher percentage of protein than meat or eggs.

5. Which of the following images best reflect how you feel about foods made of insects, such as crickets?

At this point, individual papers with the following group of images were passed around the table:



6. Please describe the emotion and why it reflects your current attitude
7. Recently, there have been many new companies that grow and sell products made from cricket flour, such as protein bars, cookies, and plain cricket flour.
 - a. What positives, if any, do you associate with eating products made with crickets?
 - b. What, if any, are your concerns about eating cricket products?
8. Does your image selection from earlier exercise change at all? Please put a box around the image that best reflects how you feel about foods made of cricket flour.
9. In your opinion, which of these terms best describe products made from cricket flour?
 - a. A healthy food choice
 - b. An environmentally friendly food choice
 - c. An exotic or adventurous food choice
 - d. Any others?
10. If you are/were a vegetarian, would you consider foods made with crickets a vegetarian food choice? Why or why not?
11. If you were to try to convince a group of your friends to try a protein bar made with cricket flour, what would you do?

Appendix 2: Survey and Informed Consent

PERCEPTION OF FOOD

Thank you for taking this survey. Please mark with an x (no need to fill in entire bubble) which answer(s) you believe most accurate. Answers are anonymous, and you are free to leave the survey at any time. If you do not want to answer any specific question(s), please mark "Prefer not to answer," or leave it blank.

1. What is your age? (Write below):

2. With which gender do you most identify?

- Male
 Female
 Other

3. What is your highest level of education?

- Some high school
 High School graduate
 Some College
 Associate's Degree
 Bachelor's Degree
 Masters or Doctorate

4. What is your ethnicity?

- White
 Hispanic / Latino
 Black / African American
 Native American / Alaska Native
 Asian / Pacific Islander
 Other: _____
 Prefer not to answer

5. Please rate the following considerations, on a scale from 1-5, how important they are to you when shopping for food. (1=Extremely unimportant, 2=Somewhat unimportant, 3=Neutral, 4=Somewhat important, 5=Extremely important)

- ____ Environmental impact
 ____ Nutritional value
 ____ Price
 ____ Taste
 ____ Familiarity with the food

6. Imagine you are eating dinner at a new restaurant. Are you more likely to:

- Order a dish you know you'll like
 Order the server's recommendation
 Order something that you've never tried before

7. When it comes to trying new things (food or otherwise), how adventurous do you consider yourself?

- Very cautious
 Somewhat cautious
 Neither cautious nor adventurous
 Somewhat adventurous
 Very adventurous

8. Have you ever seen food intentionally made with / from insects or other arthropods? (i.e. chocolate covered crickets, scorpion lollipops, etc.)

- Yes
- No

9. Have you ever eaten an insect / arthropod food item? Even as a dare?

- Yes, by my own desire to
- Yes, as a dare
- No

10. Would you ever consider trying something like this?

- Yes
- No

11. Recently, there have been many new companies that grow and sell products made from crickets, such as protein bars, cookies, and plain cricket flour. Raising crickets is far less demanding of space, water and feed than traditional meat sources (i.e. cattle). Furthermore, CO₂ emissions from raising crickets are substantially lower than those from raising beef. What, if any, concerns would you have about food products made from farmed crickets?

- I would not have any concerns if the product was made from an FDA approved company
- I would have concerns about the cleanliness of crickets
- I would have concerns about potential diseases carried by crickets
- I don't want to kill innocent creatures
- I would have concerns about the taste
- People might think I'm weird for eating food made with crickets
- It just grosses me out
- Other

12. Would you like to try a sample of a protein bar made with cricket flour? The bars are from a company called Exo™, which was founded by two Brown University grads and sells protein bars containing cricket flour. (I have no personal or financial connection with Exo™, just an interest in cricket flour products) **ALLERGEN WARNING:** If you are allergic to shellfish, you have an increased chance for a cricket allergy. Please do not take the sample if you have a shellfish allergy.

- Yes, I would like to
- No, I would not like to
- I would like to but I have a shellfish allergy

Informed Consent (used for both versions of survey):

Thank you for participating in this survey! Your feedback is important.

The purpose of this survey is to help measure perceptions of specific foods.

- This survey is anonymous, and no one, including the researcher, will be able to associate your responses with your identity.
- Your participation is voluntary. You may choose not to take the survey, to stop responding at any time, or to skip any questions that you do not want to answer. You must be at least 18 years of age to participate in this study.
- Your completion of the survey serves as your voluntary agreement to participate in this research project and your certification that you are 18 or older.
- Questions regarding the purpose or procedures of the research should be directed to **Rachael Lacey** at **(916) 899-7118** or **rachaelk@umich.edu**.
- This study has been exempted from Institutional Review Board (IRB) review in accordance with Federal regulations. The IRB, a university committee established by Federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at **229-259-5045** or **irb@valdosta.edu**.

Appendix 3: Descriptive Frequencies for Survey Questions

		Frequency	Valid Percent
Age	18-22	358	59.4
	23-35	82	13.6
	36-45	46	7.6
	46-55	46	7.6
	56+	71	11.8
	Total	603	100.0

		Frequency	Valid Percent
Edu Level	High School Graduate	16	2.7
	Some College	306	50.7
	Associate's Degree	22	3.6
	Bachelor's Degree	158	26.2
	Masters or Doctorate	101	16.7
	Total	603	100.0

		Frequency	Valid Percent
Ethnicity	White	472	78.4
	Hispanic/Latino	28	4.7
	Black/African American	17	2.8
	Native American/Alaska Native	2	.3
	Asian/Pacific Islander	63	10.5
	Other	20	3.3
	Total	602	100.0
	Missing System	1	
Total	603		

		Frequency	Valid Percent
Would Consider	No	174	29.0
	Yes	425	71.0
	Total	599	100.0
Missing System		4	
Total		603	

		Frequency	Valid Percent
Concern	None	196	32.5
	Cleanliness	44	7.3
	Disease	40	6.6
	Killing Crickets	37	6.1
	Taste	125	20.7
	Judgment	14	2.3
	Just Gross	128	21.2
	Other	19	3.2
	Total	603	100.0

Concerns*Sample Cross-tabulation

		Sample		Total
		No	Yes	
Concern	Cleanliness	6	10	16
(Count)	Disease	7	6	13
	Killing Crickets	6	2	8
	Taste	6	14	20
	Judgment	4	1	5
	Just Gross	22	4	26
	Other	0	3	3
Total		51	40	91