A global perspective on insect-based foods: willingness to eat, brand equity impact, reasons for not eating and consumer acceptability of an insect-based product

by

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B.S., Saint Mary Catholic University, Peru, 1997
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AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Food, Nutrition, Dietetics and Health
College of Human Ecology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

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Abstract

Insects are becoming more and more popular as a food choice or an ingredient, but the first sensory perception is still triggered by visual cues which influence the overall acceptability of any product. Different studies have suggested to start incorporating insects in familiar food products first and in a powder form to avoid the disgust factor and lower the food neophobia behavior. The first part of this study aims to understand the willingness to eat an insect based products from a global perspective and determine the impact of adding insect powder to specific product of a worldwide brand portfolio. A survey was launched in more than ten countries targeting different regions, backgrounds and cultures. The questionnaire was divided in diverse topics, the reasons for not eating insects segment was the focus of the second part of this research, which explained the main concepts or ideas why consumers would not taste an insect product. Following the outcomes from the unwillingness and reasons to avoid insects, this investigation explored the consumer preferences of a chocolate chip cookie made partially with cricket powder. The results showed that most of the countries were unwilling to try insect products, demonstrating a negative a correlation towards the purchase intention of other products within a brand. The top three barriers that stop consumers to consider eating foods containing insect powder as an ingredient, are led by the appearance factor where no insect fragments should be in the food, then just the concept of consuming insects is disgusting, followed by the statement “Insects are dirty/filthy” were the other two reasons. The sensory properties like taste and texture were not significant limitations to evade insect products. After the consumer acceptability test conducted in USA, Mexico and Spain, the 15% cricket powder chocolate chip cookie was well acceptable and showing higher liking scores than the control cookie in some of

the countries. The results showed that adding insects partially in a baked product formula, does not modified the sensory characteristics and the intensity attributes maintained the same pattern as the control sample. The cookie with higher cricket powder percentages was only preferred in Mexico, the USA and Spain participants showed irrelevance (neither like nor dislike) the sample.

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Chapter 1 - Brief Introductory Literature Review

The population projections are estimating to reach 9.7 billion people by 2050, creating a deficit in the feed resources such animal protein, plant based protein, fish, etc. (United Nations, 2015). Scientists are looking for alternative protein sources that are more efficient and sustainable compared to meat and plants, but the nutritional characteristics should be similar or better than livestock or seeds. Insects could be an effective solution to this challenge and provide different benefits from greenhouse gases to effective mass production costs. (Oonincx and others 2010). Other collateral effects or behaviors play a key role before consumers consciously place insects in their daily diets or partially substitute common ingredients in familiar products. (Martins and Pliner 2005). Food neophobia, entomophagy and consumer acceptability should be considered and studied in different regions and markets to be able to adopt insects as a food source and take advantage of their nutritional composition (Zielinska and others 2015). Moreover, to create awareness of insect based foods and promote their consumption, it is necessary to expose and educated consumers to alternative source of proteins with appealing products and maintain them in the market as a competitive food choice. (Tan H.S.G. and others 2016).

Food Neophobia

Food neophobia in humans has been described as the fear of eating new or unfamiliar foods. Additionally, food neophobia influences people's daily eating behavior, restricting their food choice decisions and shaping their liking food groups (Siegrist and others 2013). Novel foods such as insects are highly correlated to disgust factors which can predict the unwillingness to try new products (Egolf and others 2018). It is not easy to break the disgust feeling barrier

because it involves evolutionary, developmental, and cultural contexts; furthermore, it is a rejection system to protect the body from unpleasant or negative food as Rozin stated. There are two explicit variables that trigger the disgust reaction towards foods; the repulsive textural properties and the association that they were part of a living organism or an animal (Martins and Pliner 2006). A trait of food neophobia in humans can measured using a scale developed by Pliner and Hobden called Food Neophobia scale (FNS) scoring from 1, strongly disagree to 7, strongly agree. The participants respond to the following statements: (1) I am constantly sampling new and different foods, (2) I do not trust new foods, (3) If I do not know what is in a food, I won't try it, (4) I like foods from different countries, (5) Ethnic food looks too weird to eat, (6) At dinner parties, I will try a new food, (7) I am afraid to eat things I have never had before, (8) I am very particular about the foods I will eat, (9) I will eat almost anything, (10) I like to try new ethnic restaurants. But there are more variables that might affect the neophobic behavior like the anxiety level and the antecedents of the trait (Pliner and Hobden 1992). Therefore, it is a complicated behavior which is highly connected to an individual experience, environmental and biological aspects as well as social, contextual and psychological factors (Reilly 2018). All these characteristics play in this model to determine the eating behavior of a person, so to introduce a new product like insects, will require time to break all these conditions and interact with the novel food. Studies have suggested that one of the possible approaches to diminish the food neophobia and reduce these types of rejections, is to expose consumers to the new food and repeat in different product categories to desensitize them (Muhammad and others 2016). These steps will create awareness and in future occasions this initial rejection might decrease so the food could be acceptable and edible. Food neophobia is a constant research topic and the reduction of this behavior in humans needs further investigation.

Entomophagy

Entomophagy is the practice of eating insects by people. The evolution of the human diet goes back to the Paleolithic era where meat was the main food source, but then plants, seeds, fruits and fish started to modify our diets. Following this timeline, it is the turn of the invertebrates to play an important role in our diets and become a new food choice. This emerging movement has increased its popularity not because it is a new fashionable or millennial trend, but because, it is an excellent source of micro and macro nutrients, more nutritious than commonly consumed meats. The sustainable aspects and feed conversion benefits place edible insects as a serious global interest to meet food needs of a growing population (Muller and others 2016). There are more than 2000 edible insects' species consumed around the globe (Jongema 2017) and the number keeps growing as more information is available (McGrew 2014). Based on the United Nations, the most important insect species consumed are caterpillars, larvaes, termites, stink bugs and grasshoppers (crickets-Acheta domesticus are in the same order: Orthopera as the grasshoppers). Approximately, two billion people (30% of the world's population) eat a wide variety of insects regularly, both cooked and raw. Only in Western countries the practice remains a "disgust or ick" factor among the consumers (van Huis and others 2013). If insects are processed and handled under the same sanitary conditions as any other food, there are no known cases of transmission of diseases to human from consumption of insects (Dossey and others 2016). A presumable allergen reaction similar to shrimp or mites might be noticed in insects (Witterman and others 1994).

How will we as human race produce enough protein? Edible insects may become an important solution and will fight malnutrition in several countries around the world (Tao and Li 2018). The incorporation of cricket flour in processed foods has demonstrated that the sensory

characteristics were acceptable and the products maintained the flavor and texture profile similar or better than the conventional product (Castro and Chambers 2019). The extensive research on edible insects is predicting that in a near future bugs or byproducts will be a food choice on our daily diets and available in local markets around the world (Jansson and others 2015). It is time to approach the massive markets and for global companies to introduce core products utilizing insects as a standard ingredient, eradicating or diminishing the disgust factor.

Insect based products acceptance and perception

How willing are the different regions and populations to adopt insects as food and feed? Different qualitative and quantitative investigations around the globe have studied the acceptance and perception of insects in our food products, basically in a powder form (chips made with cricket flour) or the whole insect (worms in a taco) (Hartmann and others 2016). The majority of insect based products or recipes might present a negative visual appealing but the environmental and nutritional benefits have a positive effect on their acceptability (Laureati and others 2016). Hartmann and Siegrist compiled an overview of the diverse studies on perception and acceptance of insects as food, see Table 1-1. But few if any studies have covered more than two or three countries, the lack of a global comparison research is needed to establish regional parameters on how consumers are perceiving insect products. It is necessary to understand the reasons why consumers are not willing to eat insects, what is driving them to take those decisions, are there any psychological or religious barriers (Hartmann and others 2015). Distinguishing all these perceptions, emotions and beliefs will lead R&D and marketing departments to create more appealing insect based products and enlarge the acceptance and thus the consumption (Baker and others 2016).

Table 1-1 Overview of key studies on perception and acceptance of insects as food

Authors, year	Study type (# of test persons)	Insect product
Caparros Megido et al., 2014	tasting in Belgium with visitors at an insectarium (N = 189)	mealworms and crickets combined with different spices and sauces
Caparros Megido et al., 2016	tasting in Belgium with students (N = 79)	hybrid burgers made from mealworms, mealworm/beef and mealworm/lentil combinations
De Boer et al., 2013	online survey in the Netherlands (N = 1,083)	snack made from crickets
Gmuer et al., 2016	online survey in Switzerland (N = 428)	tortilla chips combined with crickets, varying in degree of processing
Hartmann et al., 2015	online survey in Germany (N = 502) and China (N = 443)	products from processed insects (e.g. insect flour cookies) and unprocessed insects (e.g. fried silkworms)
Hartmann & Siegrist, 2016	experiment in Switzerland (N = 104)	insect chips (tortilla crisps with cricket flour); unprocessed insects (fried silkworms and crickets)
Lensvelt & Steenbekkers, 2014	survey and tasting in Australia (N = 75) and the Netherlands (N = 134)	insects (general), roasted crickets, biscuit made from insect flour
Looy & Wood, 2006	experiment with Canadian students (N = 234)	photos and videos on entomophagy and insect tasting
Ruby et al., 2015	online survey in the USA (N = 220) and India (N = 179)	products made from processed and unprocessed insects of different species
Schosler et al., 2012	online survey in the Netherlands, same sample as in De Boer et al., 2013	menus with insects as meat substitutes
Schouteten et al., 2016	tasting experiment in Belgium (N = 97)	burger patty made from mealworms (available to purchase in Belgium)
Tan et al., 2016	tasting in the Netherlands (N = 103)	burger patty made from mealworms
Tan et al., 2016	online survey in the Netherlands (N = 976)	preparations made from mealworms varying in flavor (sweet/savory), seasoning (western, Asian), degree of processing (visible/not visible) and carrier product
Vanhonacker et al., 2013	online survey in Belgium (N = 221)	insects
Verbeke, 2015	online survey in Belgium (N = 368)	insects
Verneau et al., 2016	implicit association test in Denmark and Italy (N = 282)	information videos, chocolate bars made from insect protein

Source: Hartmann and Siegrist (2016) – Science & Research

Taste, above all, is the most important element in order for a product to be successful in any competitive market. The consumer acceptance of insect based product has incremented rapidly due three main factors: (1) the taste is as close as the counterpart, (2) insect tasting sessions and exposure decrease the food neophobia and (3) powdered insects incorporated into ready to eat familiar products (Caparros Megido and others 2016). One of the key components to increase the consumer acceptance is the creation of awareness of insects as food. Again, the fastest path to accomplish this task is providing opportunities for consumers to taste insect based products and support research to educate the general population about all the advantages that insects are bringing to the table (Wilkinson and others 2018).

Research Objectives

The lack of a global understanding about willingness to eat insect based product across multiple backgrounds, cultures and languages was an opportunity to research. The objective of this study was to use qualitative and quantitative sensory techniques to investigate the consumer perception in thirteen different countries around the world about insect based products and determine the impact or potential damage to brand equity of introducing products containing insect powder (cricket flour).

It was necessary to comprehend the principal emotions, feeling and beliefs for not consider eating foods containing insects. This study aimed to obtain the insights of these reasons or behaviors and analysis how the sensory characteristics affect the willingness to try an insect based product. Sensory science plays an extremely important role in novel foods development, the inset category was evaluated during this research conducting a consumer study using a familiar and highly consumed product. Two chocolate chip cookies were developed with

different wheat and cricket flour ratios and one control cookie. The consumer acceptability tests were performed in three countries to find the significant sensory differences between the conventional chocolate chip cookie and the cookies with insect incorporation. Another interest of this study was to learn how the different demographic categories behaved tasting an insect based product.

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Chapter 2 - Willingness to eat an insect based product and impact on brand equity: A global perspective

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Abstract

Rapid population growth is creating the need to find new and sustainable food sources. Insect-based products could satisfy this high priority necessity while incorporating important nutrients in the human diet such as protein, vitamins and minerals. This research provides a global overview of the willingness to try a new product that contains insect powder and determine the impact of adding insect-based products to a brands portfolio. An international survey was conducted in 13 different countries (n=630 consumers per country, total 7,800 consumers) with consumers who represented diverse demographic backgrounds. Eight of the 13 countries could be classified as "disgust" countries where most respondents said they would not be willing to try a familiar product containing insect powder. Nine countries fell into the "impact" category where participants would be more likely to stop buying other products from this company knowing that they have used insect powder in another product from the same brand. The reasons why participants would not consider eating foods containing insect powder were religion, the perception that insects carry diseases and cause allergic reactions. Only the disease-carrying perception was significant in most of the countries.

Practical Applications

The results from this study showed that most consumers from most countries studied are not willing to try insect-based products at this time. However, there was a segment of the population in each country that was willing to try such products. There is a great opportunity for companies to create new products for countries where the disgust factor was not a barrier and to test those new concepts and products. This could help provide information to educate consumers about all the benefits of insect protein and implement the use of insect as an ingredient. It is key to remember that new brands probably are necessary for such products because of the potential damage to brand equity of introducing products containing insect powder.

Introduction

Every primate is, to some degree, insectivorous (McGrew, 2014). Extensive literature has documented that edible insects contain important nutrients such as protein, vitamins and minerals which are essential for human consumption (van Huis, 2013). From the sustainability point, there is no other food source as efficient and effective as insects (van Huis, 2013), the environmental impact is crucial and provides enough benefits to promote this novel food. Müller et al. (2016) challenge the overall concept of insects as a "quick-fix" for food systems, but foresees a potential long-term solution for meat alternatives.

By 2050, the global population of humans is predicted to grow to nine billion, and the demand for animal-derived protein is expected to increase at an even higher rate (Godfray, 2010). Humans already eat insects as part of their diet often without realizing it. For example, according to the US Food and Drug administration (USFDA) an average of 75 or more insect fragments per 50 grams are allowed in wheat flour as a defect (AOAC 972.32).

Currently insects are being studied by academic institutions and companies in different countries to develop edible food products for mass consumption, which comply with the basic sensory standards of a benchmark product, particularly taste and appearance. If insect based products can be marketed and commercialized properly, then insects could become a new source of protein. A challenge is the emotional disgust barrier towards insects and its associations (food neophobia, lack of information, etc.). At the same time consumers want products made from natural ingredients and Chambers, Chambers, and Castro (2018) found that insect powder was considered natural by only 7% of the U.S. population in their survey.

The idea of insects as food is growing because it promises several advantages for health, the environment, and people's livelihoods (van Huis, 2013; Henchion, 2017). Several research studies have shown that insect based product are starting to gain acceptability in different populations across the world. In Belgium during a tasting session experiment conducted with insect based burgers, most (~70%) of the participants were convinced that we will eat insects in the future and were ready to include insects (principally minced or powder) in their diet (Caparros Megido et al., 2014). Moreover, House (2016) states "If insect-based foods are to be commercially successful they will need to be at a comparable price level, tastiness and availability to existing Western foods". Not only the sensory side of an insect based product is crucial but also the cultural factor plays an important role on consumer decision. Additionally, studies in African and Asian countries have reviewed and showed a culture of entomophagy (Kelemu, 2015; Ghosh, 2017).

Familiarity and cultural aspects also plays an important role in acceptance of products (Gama, et al., 2018; Phan and Chambers, 2016, Choe et al., 2018). In addition, disgust particularly for things like insects in food can be an issue. Rozin (1987) "Approaches disgust as a

food-related emotion and define it as revulsion at the prospect of oral incorporation of offensive objects". Disgust about something is a cultural construction, which is socialized to most or all members of a group, and indicates clearly the physical or cultural threat related to some object or action (Herz, 2012). Disgust also can be easily generalized from one entity to others through contamination (Rozin, 1987). In consequence, some insects could easily be clustered in a "decomposition and filthy" group which causes the psychological contamination of all insects, creating a disgust effect in the complete insect category. (Verneau et al., 2016).

Based on Zhang (2015), brand image is the driving force of brand equity, which involves the consumer's general perception and feeling about a brand and influences consumer behavior. "The power of the brand lies in the minds of consumers" (Leone et al, 2006). A brand's equity is comprised of knowledge (brand awareness), relevance (meeting customer needs), esteem (consumer regard), and differentiation (uniqueness) (Keller, 2008). Furthermore, product usage experiences enhance brand awareness; in simple words, the more people buy a product, the higher the brand awareness for this specific product (Huang, 2012). Applying these concepts, it is easy to see that if consumers learn information about when a consumer experiences an insect based product repeatedly and it is positive, brand awareness might increase with little negative effect on brand equity. As suggested and stated by van Doorn *et al*. (2010), "The concept of customer engagement behaviors is defined as customers' behavioral manifestation toward a brand or firm, beyond purchase, resulting from motivational drivers". Companies might be building the bridge between emotions and brand loyalty. According to Lassar *et al*. (1995), brand equity comes from the customers' confidence in a brand. The greater the confidence they place in the brand, the more likely they are willing to pay a high price. It is essential to protect brand image and study if novel products can deteriorate brand equity. This is a key starting point for

new research and development projects among many large multinational companies and essential if future protein sources, such as insects, are to be introduced into their products.

The objectives of this study were to 1) investigate willingness to eat insect-based products and 2) to determine the impact of adding insect-based products on brand equity. The study was conducted in 13 different countries to provide a somewhat global perspective.

Materials and Methods

Participant Profile

Respondents (n=630 per country) were recruited in each country by Qualtrics, an on-line survey company, or their partners in each country, from existing databases. One hundred (100) participants of each gender (male, female) in each of three age groups: 18-34 years old; 35-54 years old; 55+ years old were targeted in each country with additional respondents included in case of incomplete data. The participants did not receive a financial incentive for completing the online survey, but Qualtrics database has a reward system in order to compensate the respondents for their time and collaboration.

The participants represented 13 different countries (United States (USA), Mexico, Peru, Brazil, United Kingdom (UK), Spain, Russia, India, China, Thailand, Japan, South Africa, and Australia) where differences in cultures, languages, traditions and religions make this reasonably broad-based as a multi cross-cultural international survey. One group that is lacking is a primarily Arab country. We attempted to conduct the survey in Egypt, but could not obtain sufficient older adult (55+) participants and that country was dropped from this analysis.

Survey

The questions for this study were included in a larger survey studying multiple aspects of food beliefs. For the overall research, multiple questions covering various topics including socio-, psycho-, and physical demographics and food beliefs about various types of ingredients, incorporation of insects into products, reasons for not eating insects, and impact of products containing insects in a brand, were asked to the consumers. The duration of the entire survey was targeted to be between 15 to 20 minutes to avoid respondent's fatigue.

For this specific research study two main questions related to the willingness to eat new products that contain insect powder and the impact on the company's brand equity, as well as three questions about reasons for not eating insect products are reported. Before the two main questions were asked, a brief statement was presented to the participants. It stated: "If a major worldwide company; e.g., Nestle, Coca-Cola, KFC, Starbucks, etc., introduces a new product similar to one you currently buy that contains insect powder." The two questions presented to the participants were: (1) How willing would you be to try this product? (2) How likely would you be to stop buying other products from this company knowing they have used insect powder in one product? Questions related to reasons were: 1) "Religion does not allow all or certain insects"; 2) "Insects carry diseases" and 3) "I have an actual allergic reaction to some insects". All responses were measured on 7-point Likert-type scales with the appropriate response type.

The survey was translated into nine languages (English, Spanish, Portuguese, Russian, Hindi, Mandarin Chinese, Thai, Japanese, and Afrikaans). Checking of the translations was either by back translation or multiple translation, both with discussion afterward by the translators to resolve any problems.

Data Analysis

Initially, data was simply categorized and described using percentages for each potential answer for each country. For additional analysis of the data, made scores for extremely unlikely, unlikely, and somewhat unlikely were combined into a category of "unlikely" and scores for extremely likely, likely, and somewhat likely were combined into a category of "likely for the questions on willingness to try and impact on brand.

Statistical tests were executed using SAS 9.4 and RStudio version 3.4.1. For every country, the frequency, expected value, total percent values, chi-square and Kendall's correlation coefficient scores (for nonparametric data) were calculated for each gender and age groups, the total percentages bar graphs were plotted using Excel™ software (Microsoft Office™, version 2016). Multinomial logistic regression followed by ANOVA was applied to find significant differences between the gender and age groups for both questions independently. The same procedure was applied to the three additional reasons but ANOVA was not performed for this section.

The correlation was established between the willingness to eat an insect based product and the likeness to stop buying other products from an appointed company. A separately correlation was performed for the religion reason and the willingness question. Note that Kendall's correlation produces a *tau* value that typically is lower than traditional R^2 values, but even those lower values indicate reasonable correlation.

Results

Global Trends and Outcomes

The overall results showed that the majority of the countries are not willing to try insect based products. (See Fig. 2.1). Surprisingly, after clustering the data by gender, a new trend is detected on the male segment. Fig. 2.3 below displayed that the males are highly more willing to try this product than the females. All the countries followed this pattern except for China where women presented a higher percentage than men. Moreover, the two remarkable age segments 18-34 and 35-54 years old are very similar on the willingness to try insect based products. Both categories are receptive and willing to the idea of this new product, but the young age group (18-34) has slightly higher values than the 35-54 age group in most of the countries (See Fig. 2.2). Definitely, the 55+ years old consumers are not responsive to this new concept. For all the graphs, the top three likely scores (somewhat likely, likely, and extremely likely) were merged for a better interpretation.

America is the continent with more countries (Mexico, Peru and Brazil) where the percentage of willingness is greater than the unwillingness, followed by Asia displaying only Thailand and China as disposed countries to the idea of insect as an ingredient for food. Fig. 2.4 provides a global perspective of the willingness to try insect based products.

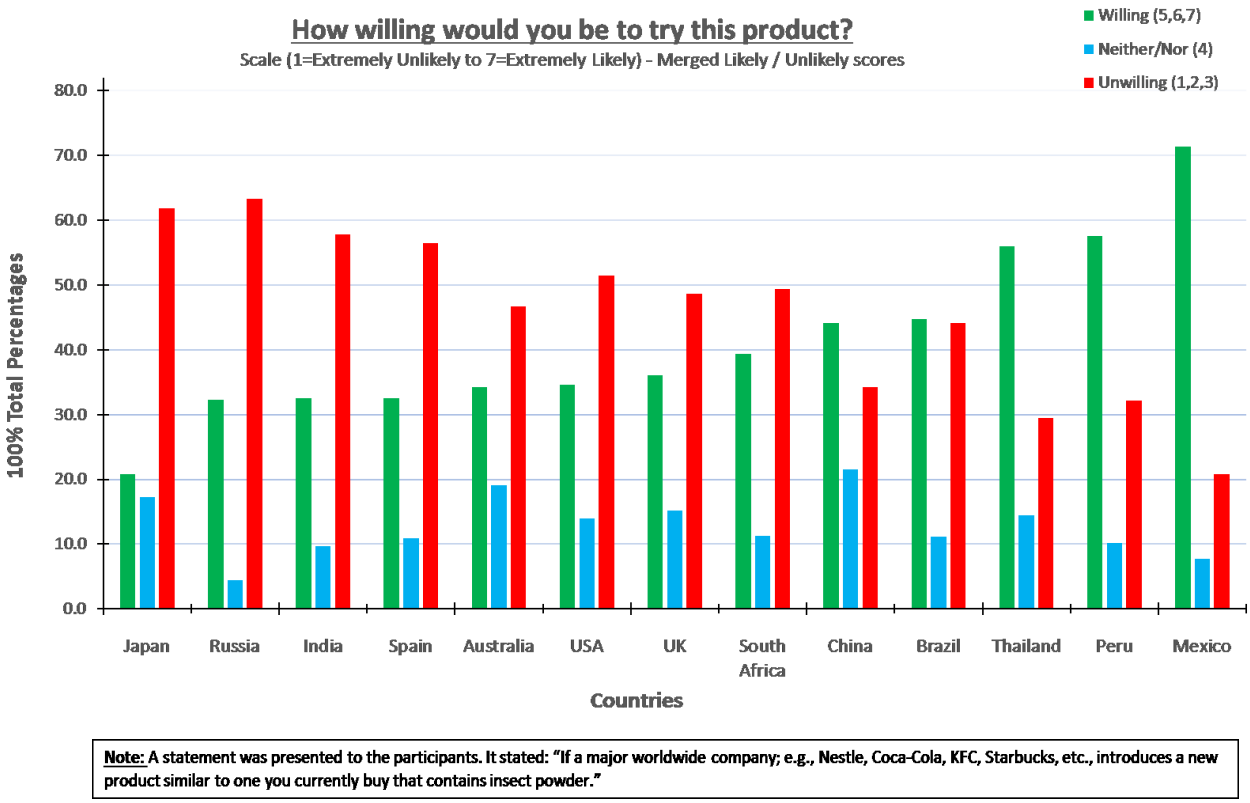
A linear regression line was plotted to understand the relationship between the unwillingness to try insect based products and the impact on the brand equity of a determined company. Basically, as the disgust factor increases, the impact on brand equity decreases, meaning consumers would be more likely to stop buying other products from this specific company, later the correlation analysis confirmed the initial findings; refer to Fig. 2.5 for more details.

Willingness to try a familiar product with insect powder as an ingredient

Fig.2-1 shows that eight of 13 countries (USA, Australia, Spain, India, Russia, South Africa, UK and Japan) could be classed as "disgust" countries where more respondents said they would not be willing to try a familiar product containing insect powder than said they would be willing to try such as product. "Acceptor" countries were Mexico, China, Brazil, Peru, and Thailand, where more respondents indicated they would try familiar products if they had insect powder added than said they would not (Fig. 2-3). Those countries were more receptive to the idea of trying an insect based product.

Respondents in Russia (63.3%), Japan (61.9%), India (57.8%) and Spain (56.5%) were the least willing to try a familiar product that had insects as an ingredient. Consumers in Mexico (71.4%), Peru (57.6%) and Thailand (56.0%) were the most likely to try such products. Respondents in some countries, such Australia and China, showed levels of ambivalence (score=neither unlikely nor likely) nearly equal to any other score given, suggesting that there still is some level of uncertainty concerning insect-based products in some cultures. That could relate to unfamiliarity with such ingredients, which also impacts consumer beliefs for topics such as naturalness (Chambers et al., 2018). However, the "ambivalent" consumers had little impact overall considering the correlation between percentages of willingness and unwillingness to try was high (*tau*=0.94). That shows a clear dichotomy of willingness to try between likely and unlikely in most countries.

Figure 2-1 Total Percentages Bar Graph of the Willingness and Unwillingness to try an Insect Based Product



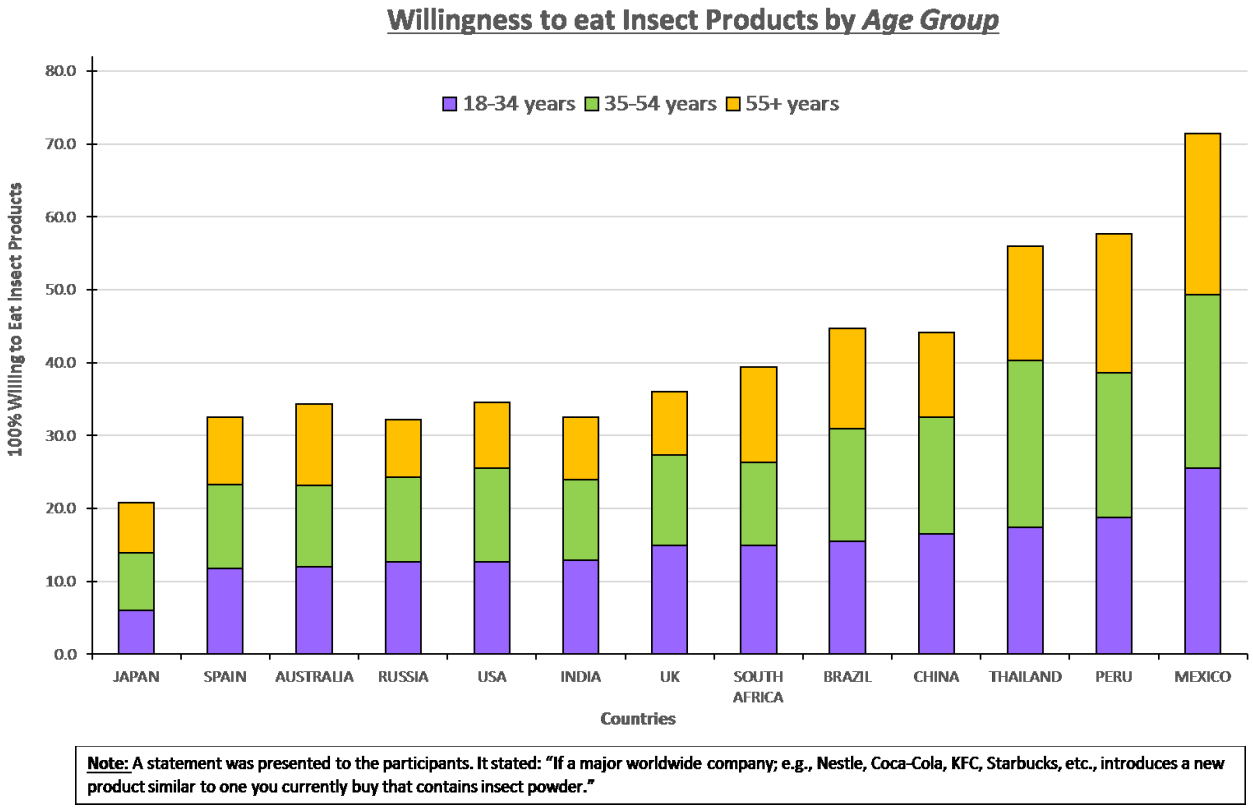
Note: A statement was presented to the participants. It stated: "If a major worldwide company; e.g., Nestle, Coca-Cola, KFC, Starbucks, etc., introduces a new product similar to one you currently buy that contains insect powder."

Effect on Brand Equity

The results from the question "How likely would you be to stop buying other products from this company" were classified into two categories; the "high impact" and "lower impact", and on brand equity. Six of 13 countries (USA, Mexico, Australia, South Africa, UK, and Thailand) could be grouped as "lower impact" on brand equity where more participants mentioned that they would continue buying other products from this specific company. The "high impact on brand equity" countries were China, Spain, Brazil, India, Russia, Japan and Peru. It is important to highlight that the difference between the unlikeness and likeness to stop buying other products was less than 10% for ten out of the thirteen countries which shows an almost even split in tendency for impact or no impact on brand equity. Therefore, most countries have almost equal

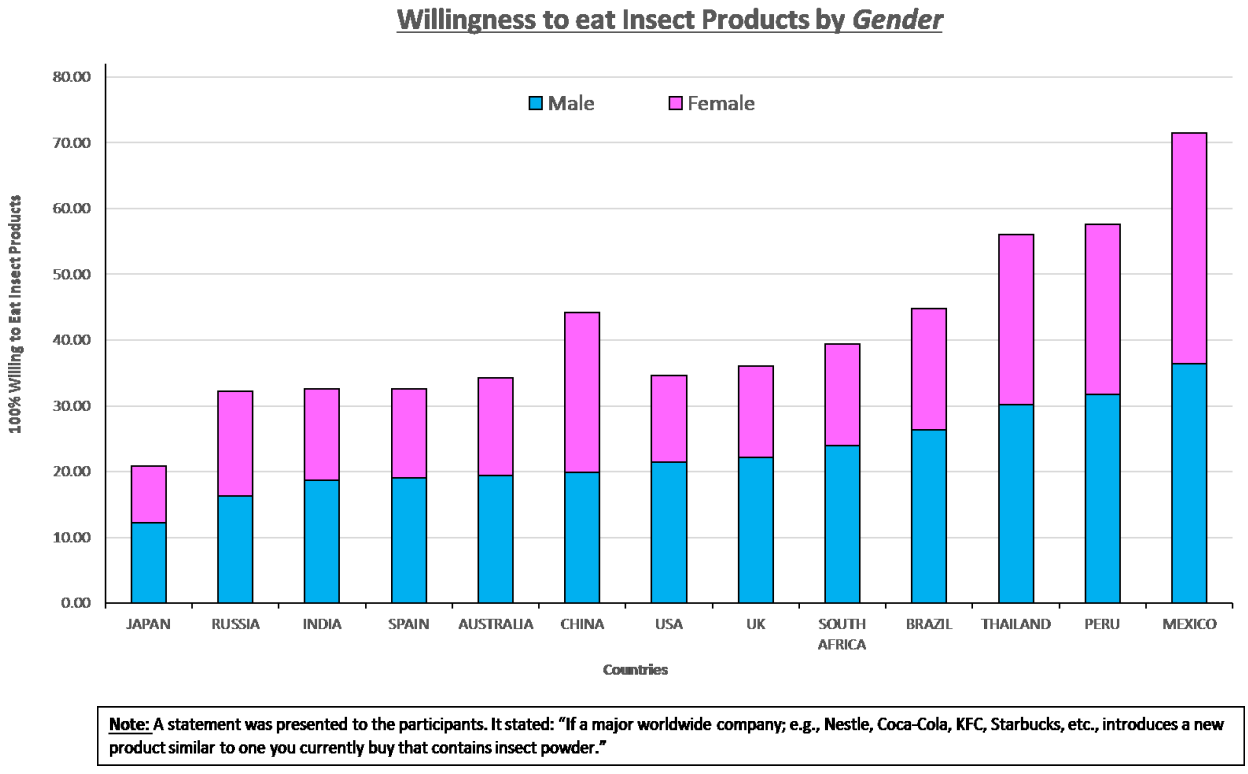
groups of people on whom the inclusion of insects in brands would affect purchases and others on whom it would have no effect. Davcik & Sharma (2015) showed that innovation, such as functional food ingredients, can be a strong driver of brand equity, but also indicate that the innovation must be considered positive by consumers. For those lower impact countries, this data suggests that there is opportunity to introduce and promote an insect based product, but perhaps not using a current brand. A large portion of people in those 10 countries likely may stop buying other products in the brand if insects were used in some products within the brand. This is not surprising given the influence varying criteria on individual consumer and brand differences (Kumar, 2011).

Figure 2-2 Total Percentages Bar Graph of The Willingness to try an Insect Based Product by Age Group.



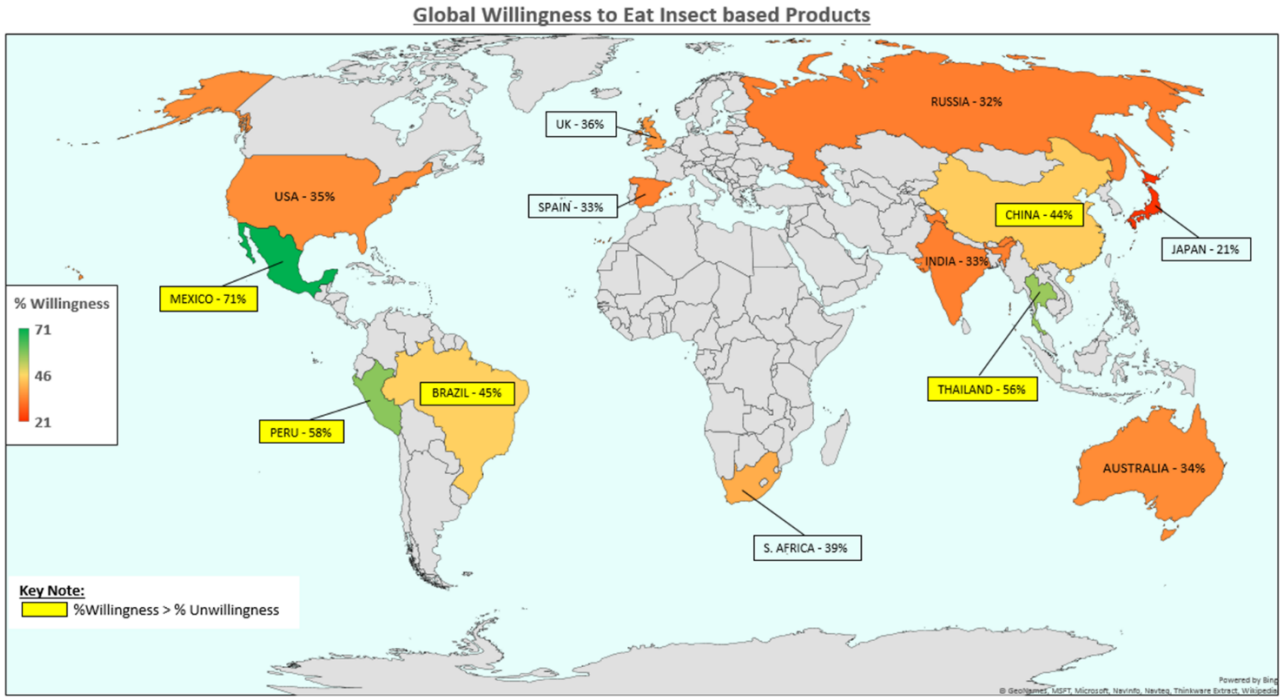
The unlikely ranking on stop buying other products is led by Mexico with the highest percentage (49.8), followed by South Africa (43.3%), USA (42.5%) and UK (40.2%). Consumers in Russia (49.4%), Japan (48.3%), India (47.8%) and Brazil (47.3%) mentioned that they would stop buying other products from this specific company (Fig. 2.6). Mexico, which was most likely to eat insect products also was most unlikely to stop eating other products in a brand if insects were included as an ingredient in other products of that brand. This finding highlights to contrast in consumer input. People may be willing to try or eat something, but may also reject changes in their "branded" products if there is an association with "new" or unusual ingredients that may not be trusted.

Figure 2-3 Total Percentages Bar Graph of the Willingness to try an insect Based Product by Gender.



Based on this information, new brands may be necessary to prevent the dilution of brand equity. Morris, Beresford, and Hirst (2018) suggest that high quality products are one key to brand equity. It would appear from this data that the potential for insect-based products using "new" brands is the best way to introduce such products given the right strategies and the correct product positioning based on the country.

Figure 2-4 Global Map Percentages of the Willingness to try Insects products – by Country/Continent.

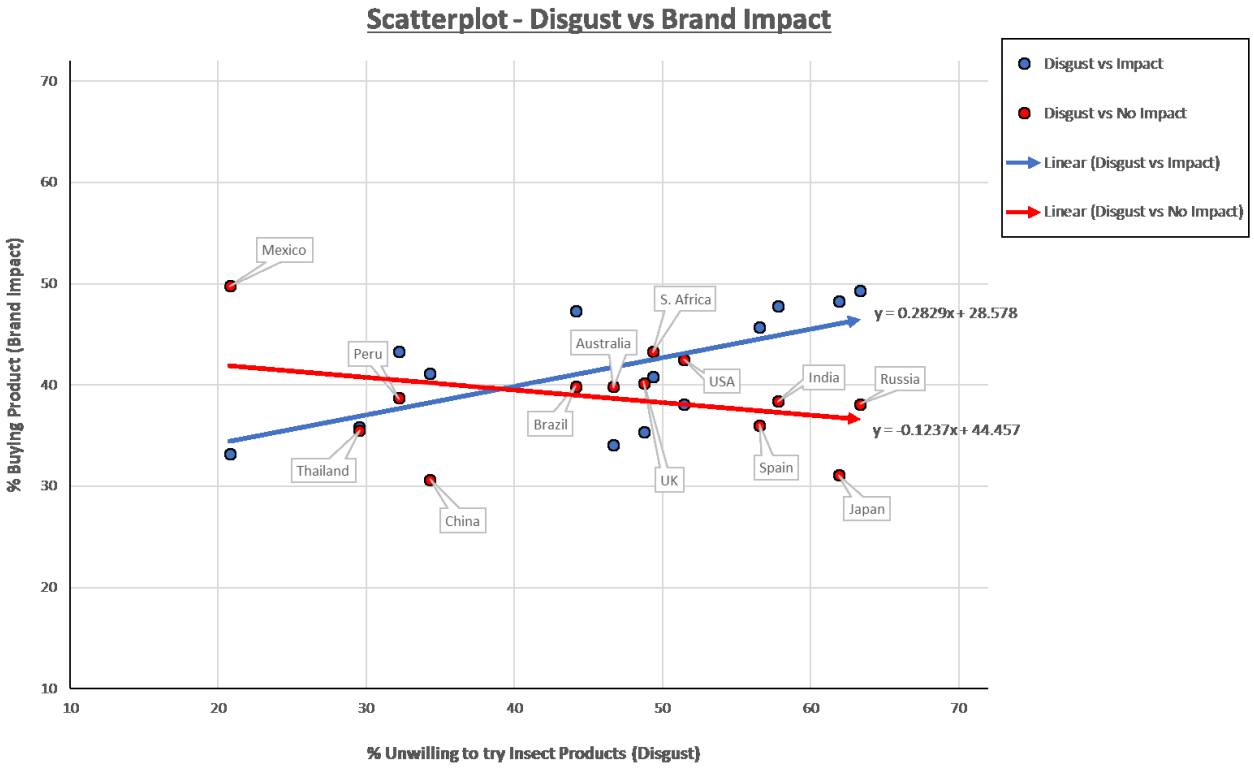


Correlation between Willingness and Brand Equity

For the correlated parameter of willingness to try an insect based product and the likelihood that a consumer would stop buying other products from this company if they introduced an insect based product to their brand, the analysis was performed for each country independently. Four categories were created: 1) Disgust = Lower impact on Brand Equity; 2)

Disgust = Impact on Brand Equity; 3) No Disgust = Lower impact on Brand Equity; 4) No Disgust = Impact on Brand Equity. If the correlation of willingness to try is low or positive with the likelihood of not buying products from that brand, then we can conclude there is lower or no *systematic* impact on brand equity. All correlations are included in the appendixes for gender and age. Only key ones are discussed below.

Figure 2-5 Scatterplot Summary of the Unwillingness to try Insect Based Products and the Impact on the Brand Equity.



United States of America

The disgust factor or the unwillingness to try a product that contains insect powder in the USA is over 50%, but the correlation with the brand equity question is low for gender and most of the age groups. Moreover, males and females between 18-34 years old and males 35-54 years

old indicated quite low correlation for those variables (TAU ~ - 0.11). That shows that the impact of willingness to try insects had little effect on brand equity if companies chose to include insects. The U.S. is categorized as a "Disgust –Impact on brand equity" country, but the impact is lower than some other countries. Consequently, disgust (or unwillingness to try) was not the major factor in brand equity. However, approximately 40% of US consumers, regardless of their willingness to try insect-based products, would be less willing to eat other products from a brand where some products contained insects.

Mexico

The highest score on the willingness to try insect based products displayed the lowest score on the likeness to stop buying other products, demonstrating a moderate to strong negative correlation for males and females in addition to the two oldest age groups (Male/35-54 *tau* = -0.33; Female/35-54 *tau* = -0.24). Thus, Mexico belongs to the No disgust – Impact on brand equity category. Basically, when the willingness to eat decreases, the likelihood that a person would stop buying other products increases.

Australia

There is a negative and moderate correlation between gender and ages (e.g. M/35-54 *tau* = - 0.276; F/35-54 *tau* = - 0.348) except for the youngest females and males group. The p-values for these groups are 0.025 and 0.425 respectively showing little correlation. Thus, in Australia the disgust factor might affect or impact the brand equity, people most likely will stop buying other products. Australia is the second highest score in terms of buying other products from this specific company, belonging to the category of, "Disgust = Impact on Brand Equity".

China

Chinese consumers showed strong ambivalence for the impact on brand equity. All of the age or gender groups showed little correlation between willingness to eat insects and the brand question. Although they generally do not showed disgust towards insect based products, 41% of the participants would stop buying other products from this company. Therefore, China is nominally part of the "No Disgust, No Impact" group. However, it must be understood that there is a relative high percentage of Chinese consumers (~25%) who were scored as uncertain (neither unlikely nor likely) for both questions. This uncertainty would need to be further investigated, but could indicate an opportunity to develop a new product under a different brand within a company's business units.

Spain

Over 50% of Spaniards are disgusted by the idea of trying insect products, they also are likely to stop buying other products from this company. The moderate and negative correlation (*tau* ~ - 0.35) predominates among all the age and gender groups except for the young males and females which are uncorrelated. The lower the disgust the slightly higher the impact on the brand equity. In consequence, Spain is classified in category of "Disgust - Impact on Brand Equity".

Brazil

Brazil is the only country that showed a positive and strong correlation between willingness to eat and the likelihood that they would stop eating other products in a brand (*tau* >0.70) for all demographic categories. This powerful relationship is unexpected because it indicates that as people were more willing to eat insect based products, those same people would reject other products in a brand that used insect based ingredients. This is the opposite of what was expected, but indicates that although insect based products could be accepted, they clearly

need to be branded differently. Brazil along with Russia, Japan and India, is one of the top four countries that would stop buying other products from a brand that used insects in some of their products. Our criteria places them in the category of No Disgust – No Impact, but it does provide a different view of impact than those countries.

India

58% of Indians were not willing to try insect based products and 48% were ready to stop purchasing other products from a brand that included insects in their products. A low correlation between these questions places India in the "Disgust – No Impact" category. It is crucial to understand that in this country, the religion factor, which would not allow many consumers to eat insect based products was high (53% of respondents indicated this as a reason for not eating such products). Moreover, when they were asked to provide other reasons for not eating insects, 75% agree that insects carry diseases. In addition, 53% of the participants mentioned that they have an actual allergic reaction to some insects. Although this last factor is unlikely to be literally true, the fact that consumers believe they are allergic means they would not likely eat such products. Those three factors produce a powerful effect on the outcome of willingness to try an insect based product.

Russia

Consumers from Russia had the highest percentage (63%) who were unlikely to try an insect based product and 49% would stop buying other products from that brand. Negative, moderate correlations were found for all the age groups and genders (e.g. M/18-34 *tau* = - 0.245 and p-value=0.001), showing that as willingness to eat insect-based products decreases, the impact on other products in a brand, and thus, brand equity tends to increase. That relationship places Russia in the category of Disgust - Impact on the brand equity.

South Africa

Consumers in South Africa showed a moderate/strong, negative correlation between willingness to eat and brand equity for all the demographic groups (e.g. M/55+ *tau* = - 0.640; F/55+ *tau* = - 0.465) except for the young males who showed no correlation. South Africans demonstrated that as the willingness to try an insect product reduces, the likelihood that consumers will stop buying other products increases. For older males and females (over 55 years old), the correlation increased significantly. South Africa is categorized as a Disgust - Impact on brand equity country.

United Kingdom

British participants were reluctant to try insect based products (49%) and they were likely to stop buying other products in the brand if insects were used as an ingredient. The moderate, negative correlation coefficients displayed an impact on the brand equity. The highest two values were showed in the two oldest female groups (35 to 54 and 55+) with a correlation of -0.454 and -0.444 respectively. This places the United Kingdom firmly in the category of "Disgust - Impact on brand equity".

Peru

Peruvians generally are willing to try insect based products (58%) placing second behind Mexico in terms of the percentage of the population willing to try insect-based products. However, they also were likely to stop buying other products if insect-based products were introduced by a brand. A negative correlation for willingness to eat and willingness to eating other foods in the brand was found between all the age groups and genders (e.g. M/18-34 *tau* = - 0.237; F/18-34 *tau* = - 0.234), excluding the females over 55 years old. This showed the expected

inverse relationship between the two variables under investigation. Consequently, brand equity is affected, and Peru is placed as a No Disgust - Impact on Brand Equity country.

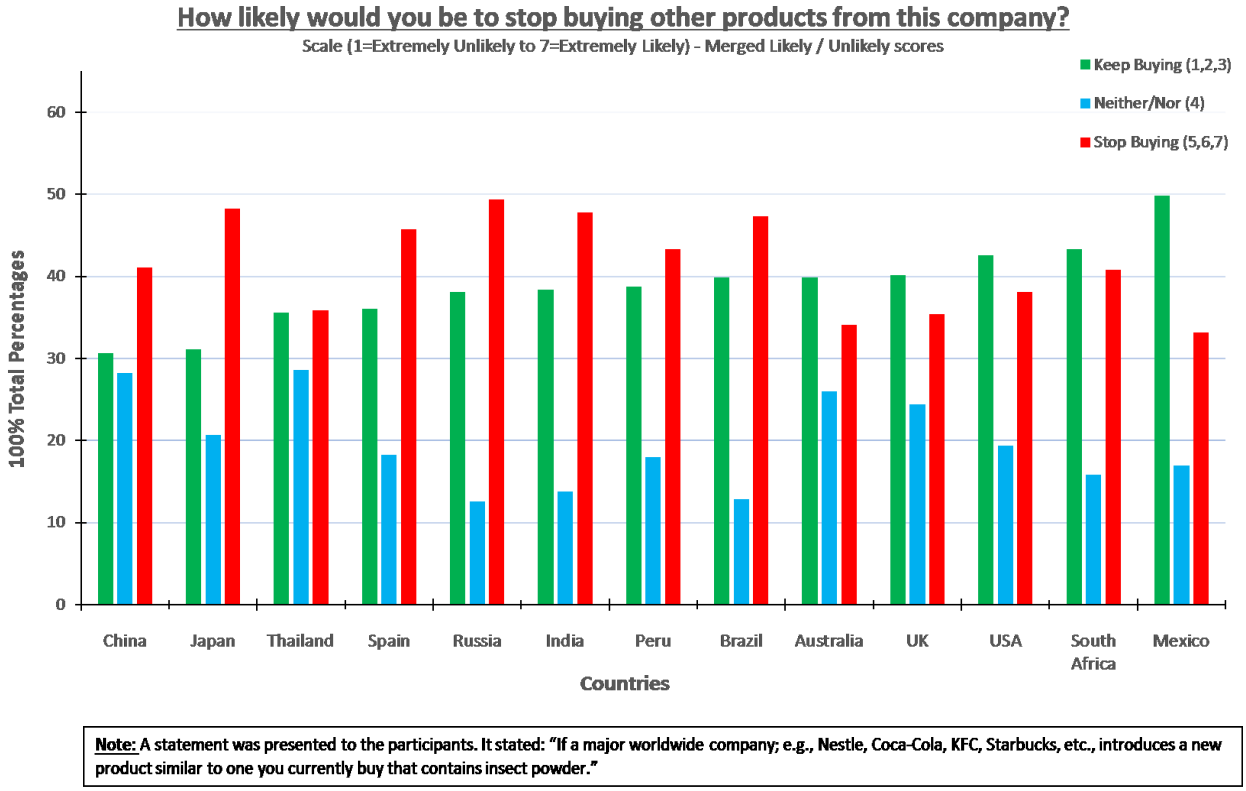
Japan

Japan displays a general unwillingness to trying an insect based product (62%). Following this tendency, 48% of the respondents were likely to stop buying other products from the same company. Moreover, the correlation coefficients were negative across all the demographic groups which reflects the expected inverse relationship observed in several of the countries. Japan, thus is a clear Disgust - Impact on brand equity country.

Thailand

Thailand places third after Mexico and Peru in terms of willingness to try insect based products. Examining the relationship between the two questions shows that with the exception of 35-54 years old males and females and 18-34 years old males who showed little correlation, other demographic groups showed negative correlations as expected. Thailand is part of the category where although some people are willing to try insect products, there still is an inverse relationship suggesting that as willingness to try decreases, the likelihood that other products in the brand would be rejected is higher, placing Thailand in the No disgust - Impact on brand equity category.

Figure 2-6 Total Percentages Bar Graph of the Impact on the Brand Equity.



External Variables

External variables are the reasons that a participant would not consider eating foods containing insect powder as an ingredient. Religion is one reason that does not allow all or certain insects in the participant's diet. A second issue is the concept that insects carry diseases. Lastly is an actual allergic reaction (similar to that for shellfish) to some insects. See Appendix C for the total frequency percentages for all the countries.

India was the only country that showed religion as a major influential factor. All other countries had well less than 50% of their consumers who stated this. Connecting religion with the research questions shows why the elevated scores for the unwillingness to try insect products was prevalent in India, where many people are Hindus and Buddhist (both of which suggest, but do not necessarily require, a vegetarian diet). Although Chakravorty (2014) identified about 255

species of edible insects in India, she pointed out that most insects are eaten by specific ethnic tribes. Religion would primarily be a factor in countries where religious beliefs about foods could interfere with consumption. For example, Mohamed & Daud (2012) showed that religion definitely impacts the choice of fast food restaurants in Malaysia.

India also showed the highest percentage of people (75%) strongly agreeing that insects carry diseases, which affects the results of the two research questions. Most respondents (>50%) agreed with this in each of the countries, except Mexico. This specific factor should be the starting point for extensive research on zoonotic to educate different populations and countries about the impact of eating insects on disease susceptibility and prevention. That is a clear opportunity for further research.

Allergic reactions to insects was again most commonly reported for India (52.7%) where the participants strongly, somewhat or agree to this reaction. Moreover, India was the only country that showed a positive outcome to allergic reactions when clustering and comparing the 7-point scale values. Japan presented a unique result where the respondents were uncertain when it comes to allergic reactions; 42% selected neither agree nor disagree. Except for Mexico, the rest of the countries followed the same trend as Japan, uncertainly in a large percentage of the population. The uncertainty of the majority of the countries probably relates to the fact that many people have not knowingly tried products with insect-based ingredients. This creates another opportunity for future studies based on allergic reactions. Indeed, more studies are necessary to prove that insects are allergens or not. According to Broekman et al. (2017), shrimp allergic patients are most likely at risk of food allergy to mealworm and other insects.

General Discussion

Consumers in many countries exhibit food neophobia towards products with insect-based ingredients. Even in countries classed as acceptor countries (for example, Mexico and China), where more people are willing to try such products, there was a portion of the population that would not. In addition, as the willingness to try an insect based product decreased, the impact on brand equity (not eating other foods by that brand) increased. That finding is key because it suggests that if opportunity exists for companies to create products containing insect powder, they must be careful that the disgust factor does not overflow onto other products in the brand. The development of new brands for insect-based products appears more appropriate than revamping existing products to make them higher in protein from insects.

This trend generally was true for all countries except for China and India, which did not present a correlation with brand equity. Brazil was different from all other countries showing that as willingness to eat insects increased the willingness to stop eating other products by that brand also increased, which is not explained by the data.

In India and China, religion and allergic reactions have the highest percentages as mentions for not eating insects which may be the reason why willingness to eat and impact on brand do not correlate highly in those countries. Instead there is an influence beyond disgust that impacts those questions. These two countries need further investigation on the external factors that influenced the outcome of the desire to eat insect products.

In several countries, the young males and females did not display a correlation between willingness to eat and impact on brand. Therefore, neophobia may be less of an impact on that age group.

The belief that insects carry diseases was high in almost all countries and this provides a clear research topic for further investigation. Clearly consumers need further education on insect proteins to diminish the barrier disgust toward insect products.

Insect based products or using insect powder as an ingredient is becoming more familiar around the world, but this study suggests that willingness to try an insect-based product is still low. In addition, the purchase intention of other products from this specific company often may decline because of the impact to brand equity if insects are added to some products in the brand. As large international companies begin to compete in this marketplace, education and new brands will be needed to overcome neophobic tendencies associated with insects in many countries.

Conclusions

This research aims to provide a global perspective of the willingness to eat an insect based product and the brand impact of a particular company. While there are different studies about edible insects and byproducts investigating two or three countries/regions, very few, if any researches worldwide (13 different countries and in all the continents) perceptions on how likely consumers would be trying a new product that contains insect powder. The major findings of this research are suggesting that consumers around the world are not willing to try an insect based product, but after analyzing the different demographics, millennials are the new trend being more receptive to the idea of insects as food. Additionally, this study is the first to investigate the impact on brand equity correlate to the willingness to try a new insect product, where the results demonstrate that a negative correlation is established. Therefore, as the disgust behavior

increases toward insects, the purchase intention of other products from this specific company decreases. Furthermore, individual analysis by country was conducted to determine the “Disgust - Impact on brand equity” relationship in order to guide future market opportunities and new product development.

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Chapter 3 - Avoidance of Insect Containing Foods: Primary Emotions, Perceptions and Sensory Characteristics Driving Consumers Considerations

Abstract

Why do human beings find "bugs" repulsive? Perceptions, including visual ones leading to disgust, a psychological factor, are believed to be main reasons why consumers would not consider eating foods containing insects. This study aims to understand specific consumers' behaviors towards insect based products. A worldwide survey, translated into nine languages, was launched in 13 different countries. Participants (n=630 from each country) completed the survey that included demographic questions and questions about why they would or would not eat insect-based products. Reasons were analyzed and two were related to sensory attributes of the actual products and others to emotions, feeling and previous perceptions or misconceptions that serve as barriers to consumption. The results show, particularly for some of the Asian countries, that it is necessary to start exposing and familiarize the populations about insects in order to diminish the disgust factor associated with insects. It is strongly recommended that an insect based product should not contain visible insect pieces, which trigger negative associations. The exceptions were consumers in countries such as Mexico and Thailand, evaluated in this study, which did not show significant negative beliefs associated with including insects in their diets. Additional research to promote insect based product consumption with well-known and popular products might be the first strategy to break the disgust barriers and build acquaintance

about insect-based products. The need to educate consumers that not all insects are unhygienic is crucial to eliminating the potentially erroneous concepts from consumer mindsets.

Practical Applications

Marketing strategies should examine the outcomes from this study from the different regions and associated reasons to develop the scope of upcoming projects if insects or insect powder are part of the potential core plan for the government or company. This research should be beneficial for new product development teams to consider before elaborating new product prototypes. Sensory issues as well as in-grained biases need to be addressed to guarantee success before, during, and after product launch. That is particularly true considering that the taste and texture of products were in the top six global reasons why consumer would not eat insect-based products.

Introduction

Why do consumers find insects disgusting? By research and definition, disgust is an emotional response of rejection or revulsion to something potentially contagious or something considered offensive, distasteful, or unpleasant (Curtis, 2012; Rozin and Fallon, 1987). It is not the taste that makes food disgusting, but essentially is the nature and origin of the food that triggers the disgust emotion (Rozin et al., 2015). Different negative perceptions toward insects, such as being disease transmitters, filthy, unhealthy and unhygienic (Van Huis et al., 2013) and the lack of information have built a foundation of disgust. Despite the many excellent reasons to introduce insects to our diets, the current social paradigm likely will have to undergo rather drastic alterations before consumers decide to get a side of crickets with their meal or eat other foods containing insects as an ingredient (Castro and Chambers, 2019).

Food perceptions can change, especially if nutritional factors are involved (Bech-Larsen, 2002). In this age of environmental concerns, people are viewing products in new ways. There are other external variables such as religion and allergic reactions that also can contribute to increase rejection to eating insects (Castro and Chambers, 2019), but disgust has been perceived as the primary motivator. Unfortunately, there is little data showing the actual reasons. Baker et al. (2016) suggested that it is necessary to understand more about all the barriers and the food neophobia challenges to fully understand how to reduce consumer's negative perceptions and attitudes.

In recent years, different studies have covered the consumer acceptance of insect based products (House, 2016), entomophagy (Roberts, 2008) and the willingness to eat food produced using insects as an ingredient (Gmuer et al., 2016) in one or two countries or regions, but only one study has looked more globally at the issue of insect-based food consumption (Castro and Chambers, 2019) and that study only examined the issue in terms of willingness to eat such foods and the impact on brand image if companies chose to use such an ingredient. Research helping to understand the actual barriers to insect-based food is minimal. However, Lorenz et al. (2014) indicated that the simple fact of contemplating the idea of eating insects provokes an immediate disgust response to the general public. What reasons do consumers from various parts of the world and from different cultures, backgrounds and languages give to eating or not eating insect-based food products? Is there a compendium of thoughts, such as those associated with the consumption of wine (feeling smart and sophisticated), another product that must be "learned" and is not immediately accepted by most people (Thompson, 2010). If there is only a feeling of fear or disgust preventing people from eating insect-based products a different challenge is presented than if more extensive concerns must be alleviated.

In consequence, this study aims to understand more thoroughly the psychological and sensory reasons for not eating insects. It does not seek to understand physical or social factors such as allergies or religious restrictions. The study was conducted in 13 countries to provide a somewhat global perspective.

Materials and Methods

This research was conducted in conjunction with a previously published project (Castro and Chambers, 2019). A detailed description of the survey methodology can be found there. See Chapter 2 of this dissertation for a pre-print version of that paper.

Participant profile

Respondents (n=630 per country) were recruited by an on-line survey company from existing databases. Approximately 100 participants of each gender (male, female) age (18-34 years old; 35-54 years old; 55+ years old) combination completed the questionnaire.

The participants were from 13 countries [United States (USA), Mexico, Peru, Brazil, United Kingdom (UK), Spain, Russia, India, China, Thailand, Japan, South Africa, and Australia]. Differences in cultures, languages, traditions and religions make this a broad-based multi cross-cultural international survey.

Survey

The global willingness to eat insect products research study was divided in phases (Castro and Chambers, 2019). This portion of the survey focused only on the phase that covered the psychological and sensory reasons for not eating insect-based products. Participants indicated

their agreement/disagreement on each of the reasons given in Table 3-1 using a 7-point Likert-type scale with 7 as strongly agree to 1 strongly disagree. The English version of the survey was tested for face-validity using four professionals with an understanding of sensory and consumer behavior; was tested for correctness, use, and timing by seven students of various backgrounds; and was pre-tested again using 50 consumers whose data were checked and analyzed to ensure questions were understandable and did not lead to answers that were inappropriate or unreasonable.

Table 3-1 Reasons for not eating foods containing insect powder as an ingredient.

REASONS FOR NOT EATING INSECT-BASED PRODUCTS **S**cale (**7-point Likert type)**
1.- The idea is disgusting
2.- I do not think it would taste good
3.- Insects are not safe to eat
4.- The texture would be bad
5.- Just the thought makes me sick
6.- Insects are dirty/filthy
7.- Color would not be good
8.- I do not want insect pieces in my foods

Scale: 1=Strongly disagree, 2=Disagree, 3=Somewhat disagree, 4=Neither agree nor disagree, 5=Somewhat agree, 6=agree, 7=Strongly agree

For statistical modeling (regression analysis), a question on willingness to eat a food product that included an insect-based ingredient was used from Castro and Chambers (2019).

The survey was translated into nine languages (English, Spanish, Portuguese, Russian, Hindi, Mandarin Chinese, Thai, Japanese, and Afrikaans). Checking of the translations was either by back translation or multiple translation, both with discussion afterward by the

translators to resolve any problems. Single translated versions were offered in some countries (e.g. Russia, UK), but multiple translations appropriate for the country were offered in others (e.g. South Africa, India).

Data Analysis

For each country, the data initially were simply categorized and described using percentages for each potential answer. The next step was to combine the three disagree scores into a category of "disagree" and the same procedure was implemented to the three agree choices obtaining the "agree" category. Score "4", neither agree nor disagree remained a separate category.

Statistical analyses using multiple regression with stepwise elimination were performed using MiniTab-18 (Minitab Inc. State College, PA, USA) and SAS 9.4 (SAS Institute Inc., Cary, NC, USA) to estimate the impact of the reasons for not eating insects over the dependent variable (willingness to eat food obtained from insects). For every country, the following regression equation was executed:

$$Y\ (\textit{Willing to eat insect products}) = \beta_o + \beta_1\ \text{Idea Disgusting} + \beta_2\ \text{Taste Not Good} + \beta_3\ \text{Insects Not Safe to Eat} + \beta_4\ \text{Bad Texture} + \beta_5\ \text{Thought makes me Sick} + \beta_6\ \text{Insects are Dirty/Filthy to} + \beta_7\ \text{Color Not Good} + \beta_8\ \text{No Insect Pieces in my Food} + \varepsilon.$$

For all the countries, the significant coefficients were described in a bar graph for a better interpretation. Additionally, R-squared and P-value summaries were noted to understand the percentage of variation by the models. (See Appendix D).

Results

Psychological/Sensory Reasons for not eating Insects

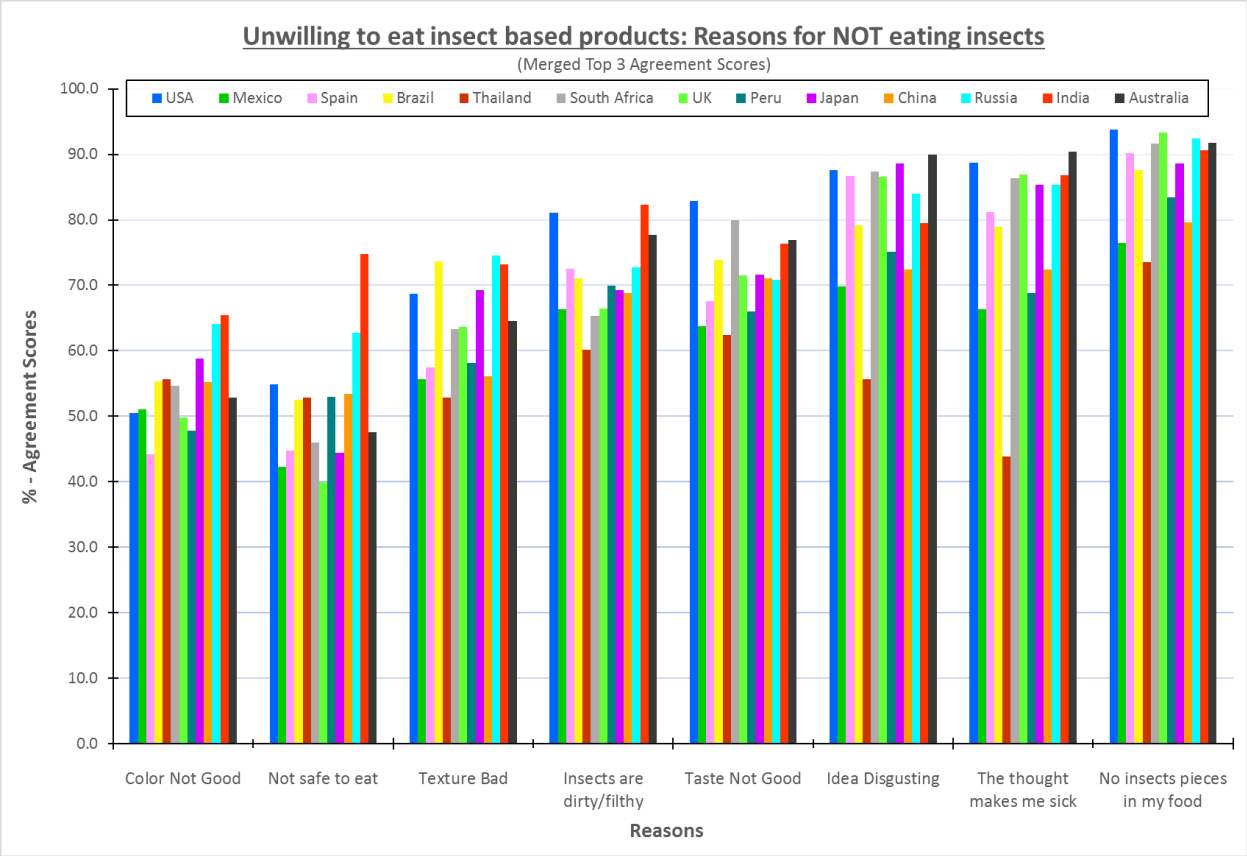
Consumers who are *unwilling* to eat insect based products

Figure 3-1 shows the percentages of the consumers who were *unwilling* to try insect-based-products in each country who selected each psychological or sensory reason for not eating those products. Consumers in all thirteen countries agreed that the most important reason is related to appearance, consumers do not want to see insect pieces in their food, followed by the "Idea is disgusting" or "The thought makes me sick". The two least important reasons were "The color would not be good" and "Insects are not safe to eat", although those reasons still averaged approximately 50% of consumers. More than 70% of the participants from each country agreed that appearance is extremely important; it is not appealing to consumers to see insect pieces in their food or snacks.

The primarily English-speaking countries (i.e., USA, Australia and United Kingdom) and South Africa generally were the top countries whose consumers strongly agreed that the reasons for not eating insects were "I do not want to see insect pieces in my food" and "Just the thought makes me sick"/ "Idea is disgusting". Although the number of people who would not eat an insect-based product was high in India to begin with (>65%), with many saying they would not eat such foods based on religious constraints (Castro and Chambers, 2018), Indian consumers also selected all eight psychological and sensory reasons for not eating insect-based products at high percentages (65-90%). Mexican and Thai consumers were the least likely to reject an insect-based product (Castro and Chambers, 2019), but even those consumers who said they would not try such a product did not agree on reasons for not eating insect-based foods. The

percentage of consumers in Mexico and Thailand who chose particular reasons for not eating insect-based foods were among the lowest of all countries for all reasons except color.

Figure 3-1 Graph of the reasons for not eating insect based products - Consumers Unwilling to try.

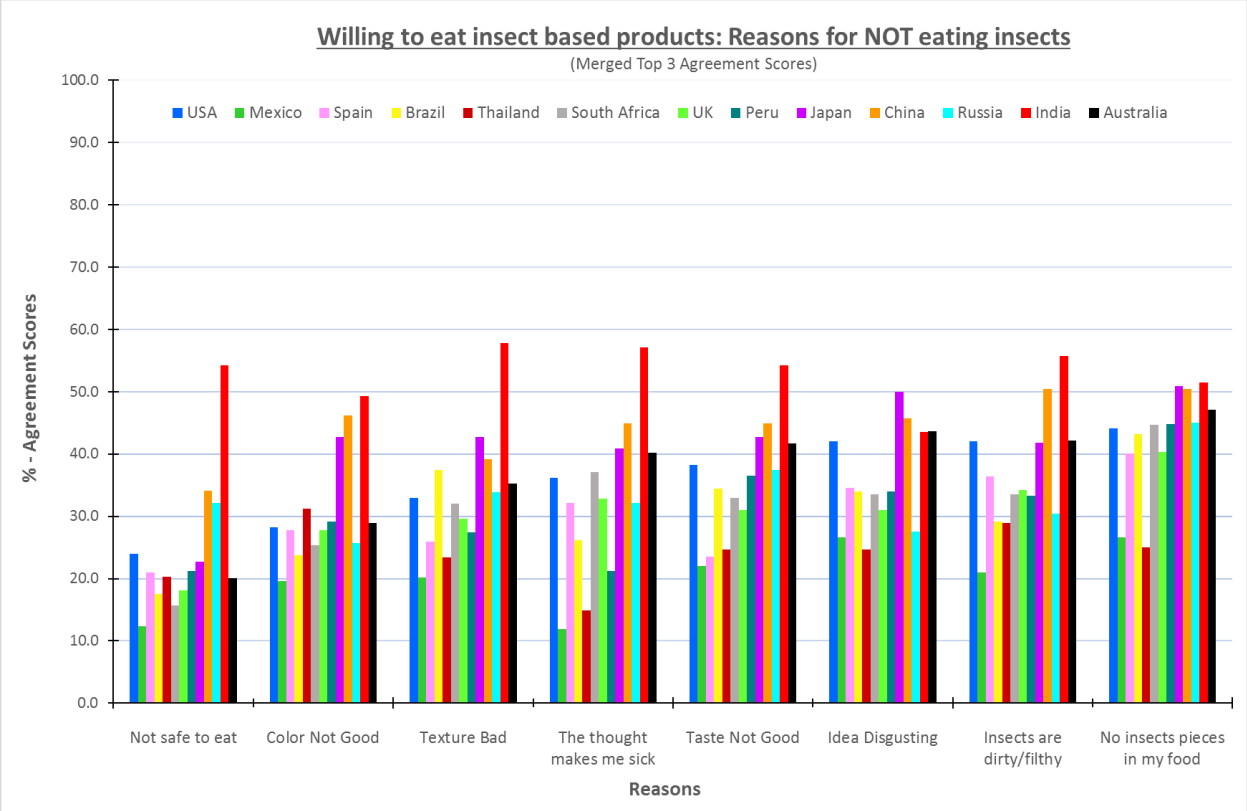


Consumers who are *willing* to eat insect based products

Figure 3-2 shows the percentages of the consumers who were *willing* to try insect products in each country who selected each reason for not eating an insect-based food product. Not surprisingly, the results showed that for most countries except India, consumers who were willing to willing to try insect-based foods generally did not have reasons for not choosing such foods. In most cases, fewer than 40% of consumers in those countries chose a specific reason for

not choosing an insect-based food product. There were two major exceptions. More than 40% of consumers willing to try insect-based product in most countries indicated they still would not choose a food if there were insect pieces in it. Second, even those Indian consumers who were willing to try insect-based products found many reasons not to eat such products. Almost every reason, except disgust, was chosen by 50% or more of willing Indian consumers as a reason not to eat insect-=based products.

Figure 3-2 Graph of the reasons for not eating insect based products - Consumers willing to try.



When considering the reasons for "willing" consumers, the same patterns overall were observed in reasons as from the unwilling consumers. The main reason for not eating such products being appearance of pieces. Mexico and Thailand rated the lowest agreement scores

across all the reasons. Over 40% of Chinese and Japanese consumers agreed to the following reasons: color not good, the thought makes me sick, taste not good, the idea is disgusting, insects are dirty/filthy, and no insect pieces in my food. The results were expected to show low agreement scores because these consumers are willing to eat food obtained from insects, but it is interesting that the pattern of responses is similar to those from unwilling consumers.

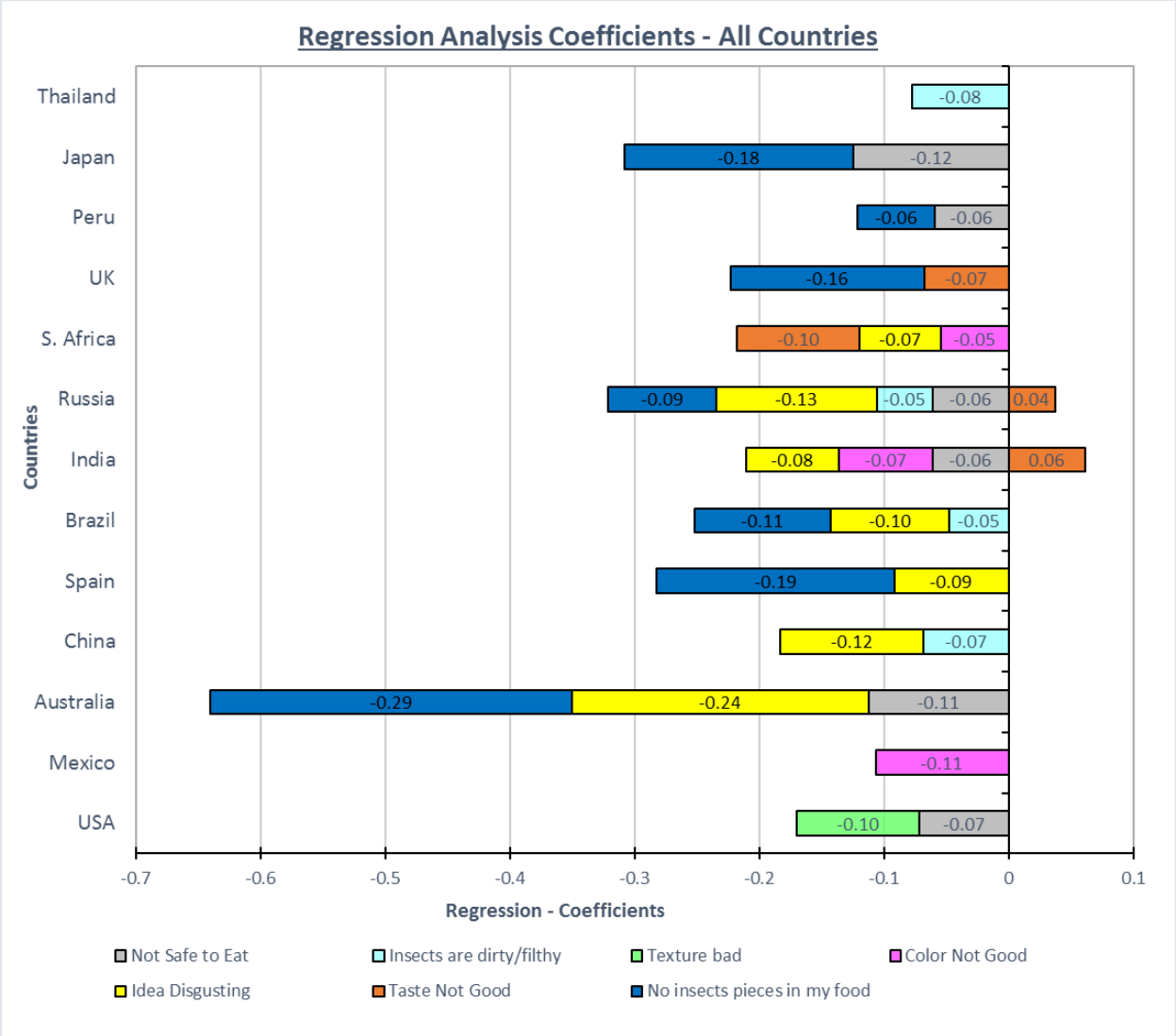
Regression Analysis – Reasons

Participants' responses from all countries showed similarity in which responses were not important to them. Before conducting the multiple linear regression analysis, covariance was detected between two of the reasons. The idea is disgusting and the thought makes me sick were highly correlated and therefore the "thought makes me sick" was dropped from the models because the term "disgust" is commonly used to describe this emotional construct related to insects (Lorenz et al., 2014). Figure 3-3 shows regression coefficients to the seven reasons for not considering eating foods with insect-based components as an ingredient.

"The texture would be bad", was removed for further analysis because during the multilinear regression analysis (stepwise procedure), because this variable was not significant and, ultimately, was eliminated from the equation in all but one country (USA). The remaining six reasons were compared and analyzed with appearance and disgust being the two independent variables that were presented in most of the countries' regression equations. Thus, consumers emphasized a sensory factor – the visual appearance of "insect pieces", an emotional factor – disgust, and a psychological belief/trust factor - "Insects are not safe to eat" as the primary motivations for not eating insect-based products. The rest of the variables; insects are dirty/filthy, taste not good and color not good were small and generally irrelevant reasons that either were co-

dependent on other reasons or did not affect willingness to eat insect-based food products once other considerations were noted.

Figure 3-3 Regression Analysis Coefficients – Stepwise Method

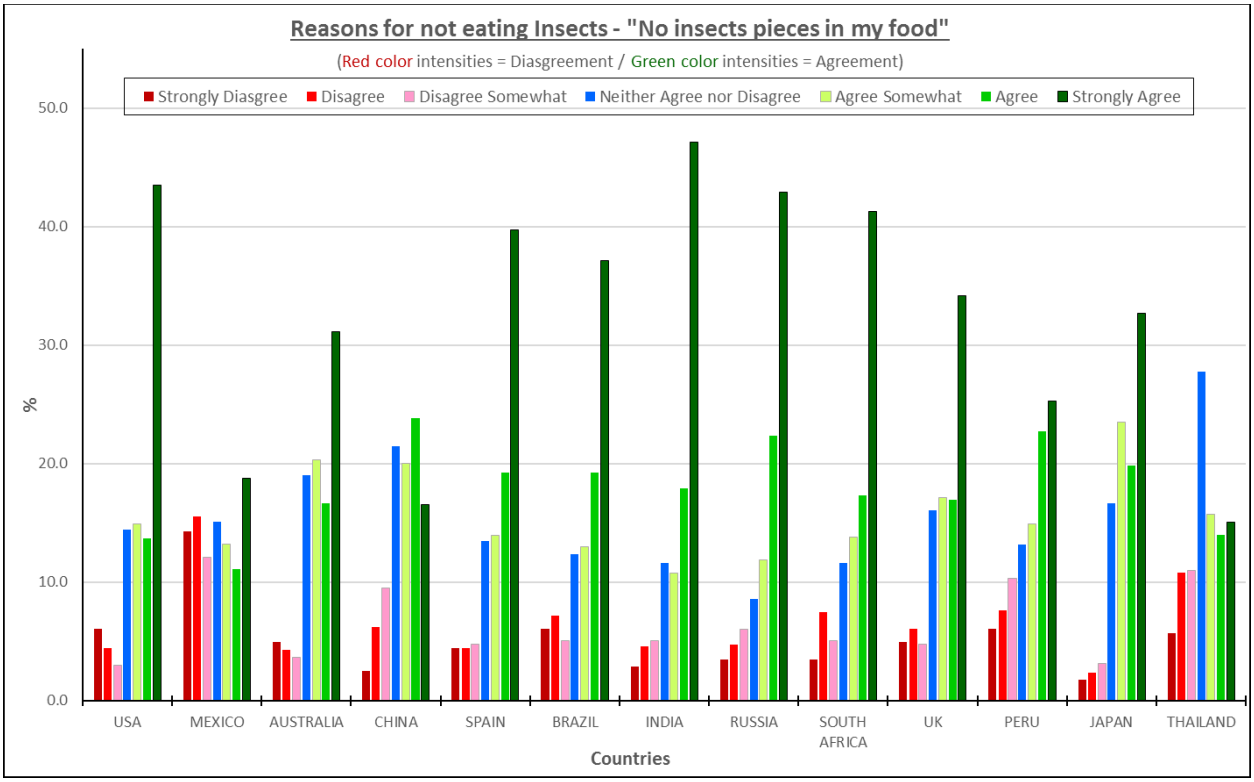


No Insect Pieces in my Food – All consumers considered

When consumers were asked for the reasons that they would not consider eating foods containing insect powder as an ingredient; over 60% of the participants in China, Peru, Australia, UK, Brazil, Russia, South Africa, Spain, India, Japan, and USA strongly agree, agree or somewhat agree that appearance it is extremely important and do not want insect pieces in the

food. In Mexico and Thailand, the percentages were also considered high, over 40% of the respondents agree with the statement “No Insect Pieces in my Food”. (Figure 3-4).

Figure 3-4 Reasons for NOT eating insect products – “Do not want insect pieces in my food”.

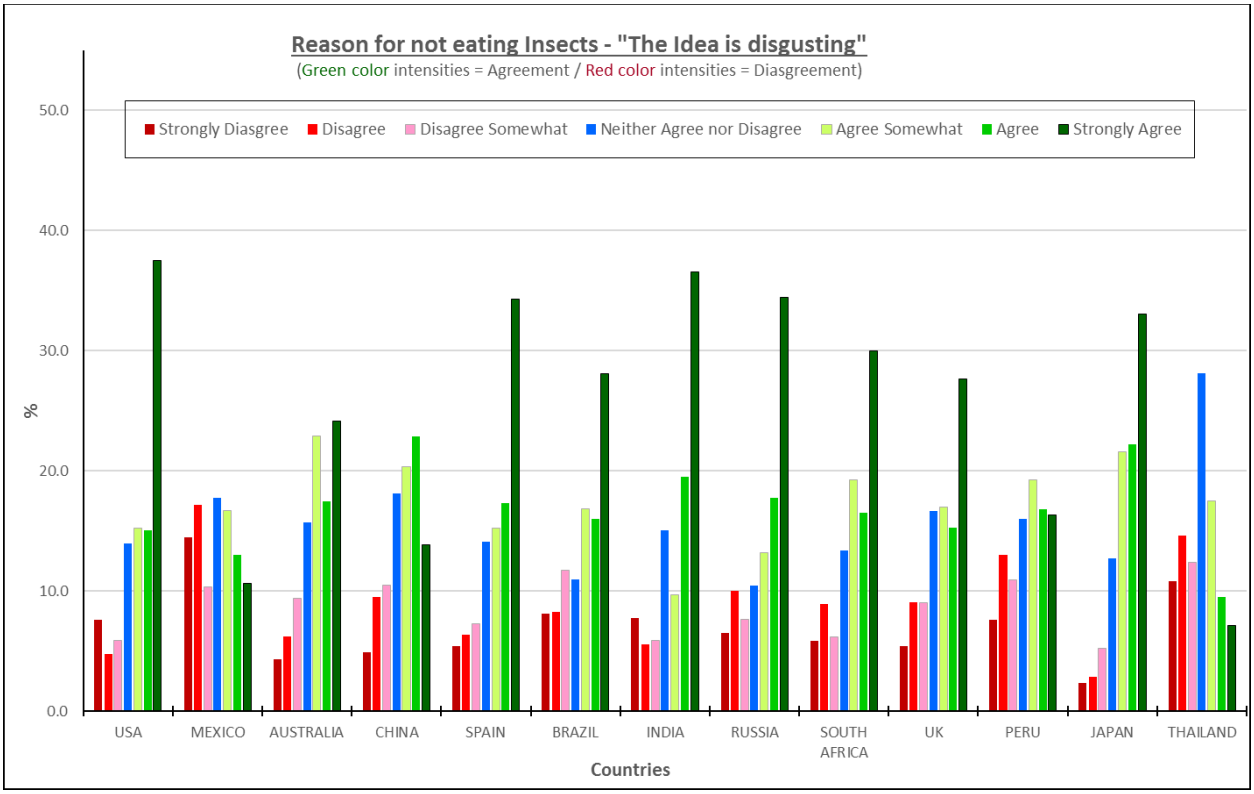


In most of the countries except for South Africa ($\rho = 0.38$) and Thailand ($\rho = 0.35$), the reason “I do not want insect pieces in my food” is highly correlated to “The idea is disgusting” with correlation scores over 0.50. When consumers can see insects or pieces in their food, the food becomes more disgusting. This is a visual sensory cue that should be easy to correct (not seeing insect pieces in my food) by grinding the insects into a powder (flour). Grinding would avoid any visual parts of the insects in the food to be prepared. During the regression analysis, the texture reason was eliminated which confirms that consumers were focusing more into the appearance/visual aspect of the product.

The Idea is Disgusting – All consumers considered

More than 50% of the participants in each of the countries except for Mexico and Thailand shared that the idea of using insects as an ingredient in food is disgusting. Japanese consumers scored this reason the highest out of the six reasons and highest of all the thirteen countries, 77% of the respondents agree that the idea of eating insect-based products is disgusting. The USA (68%) and Spain (67%) completed the top three countries for this concept. (Figure 3-5).

Figure 3-5 Reasons for NOT eating insect products – "The idea is disgusting".



The high percentages for disgust align with the regression coefficients showing that the disgust factor is the second most significant reason for not eating insects after the reason "No insect pieces in my food". Therefore, for such products to be successful, it is essential to begin breaking this emotional barrier by developing insect-based products that are familiar to

consumers to show that insects can simply be another ingredient as opposed to a contaminant. There are many foods whose ingredients alone are not appealing to consumers either because they may not be natural, organic, GMO free, etc, but do not cause the same level of emotional response in an actual food product. The more exposure to these kinds of typical products made with insect ingredients and education about the benefits of insects as food, the more probability there is to decrease the disgust factor.

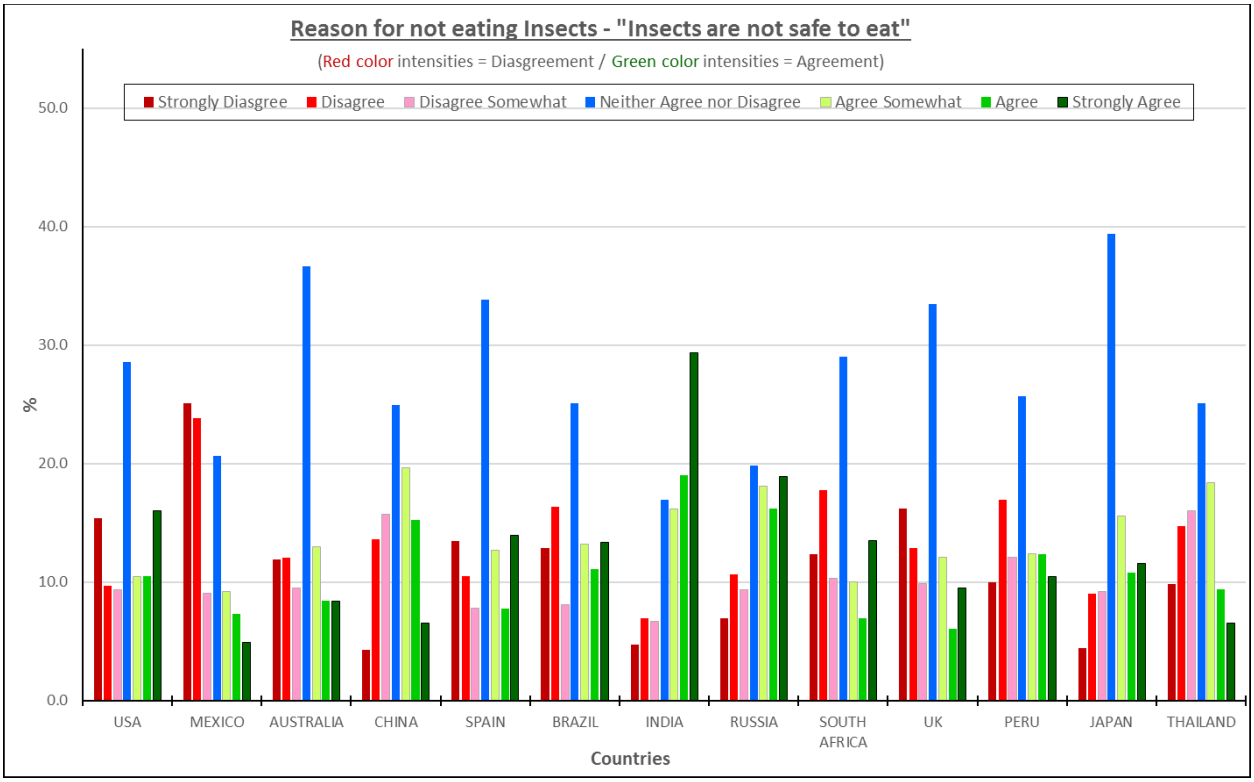
Insects are not safe – All consumers considered

For all the countries, except for Mexico and India, the statement "Insects are not safe to eat" was largely considered to be a neutral statement although it shows up in the regression coefficient as a negative factor (Figure 3-3). Most consumers in those countries scored it neither agree nor disagree. However, 65% of consumers in India agreed to this concept, while in Mexico barely 20% disagreed with that statement. The uncertainty about the safety of insects is a topic that needs further research both from the standpoint of how it impacts the potential use of insect-based foods and the human health perspective. Castro and Chambers (2019) showed that people believe insects carry diseases and some people believe themselves to be allergic to insects. Those are powerful reasons to question the safety of insect-based foods for those consumers. Studies have identified that consumers might experience similar allergic reactions to seafood when insects are consumed. (Witterman et al., 1994).

Furthermore, research in conjunction with clinical studies is necessary from the human standpoint to prove which specific diseases insects might transmit to humans and what chemical components and parts of the insects could provoke allergic reactions. (Dossey, et al., 2016). In

addition, conclusive zoonotic diseases need extensive research to diminish the concept that "Insects are not safe".

Figure 3-6 Reasons for NOT eating insect products – "Insects are not safe to eat".



Insects are Dirty/Filthy – All consumers considered

The percentages of consumers who agreed that insects are dirty-filthy trends lower than for the first three concepts discussed (Figure 3-7). India, USA and Japan, are the top three countries associating insects with filth or dirt. For those three countries, the percentages of consumers ranged from approximately 60-70%. Less than 35% of Mexican consumers agreed with that statement, the lowest of all the countries. Peru and Thailand round out the three countries with the lowest agreement on this statement. This reason might be associated with previous perceptions or misconceptions about intoxicating bacteria, viruses, and parasites or the fact that some insects are connected to waste or decay material (Marshal et al., 2016).

Figure 3-7 Reasons for NOT eating insect products – "Insects are Dirty/Filthy".

Taste Not Good – All consumers considered

Consumers' responses to the agreement "I do not think it would taste good" resemble results from the reason "Insects are dirty/filthy" (Figure 3-8). India, Japan, USA, and Russia are the countries with the highest percentage agreement with this statement, all slightly higher than 60%. Mexico and Thailand showed the lowest percentage agreement. Mexico was the only country that the disagreement response was higher than the agreement rate. It is important to highlight that "Taste not good" is the highest reason related to ingested sensory properties although the visual perception of insects or insect pieces may imply ingested effects. This may suggest that insects are not a barrier from an ingested sensory standpoint, *per se*, but that the

visual perception of insects promotes associations with disgust or textures that would not be desirable. One caution is that the agreement with the concept is quite a bit higher than the disagreement, where the scores were extremely higher compare to the disagreement with a number of consumers choosing neither agree nor disagree, suggesting that consumers are not sure of how insect-based products would tasted and are not confident that an insect based product would taste good. This is a great opportunity to conduct sensory discrimination tests to evaluate if consumers can differentiate between a regular product and an insect product and if they can to conduct descriptive sensory studies to determine the actual sensory differences in those products.

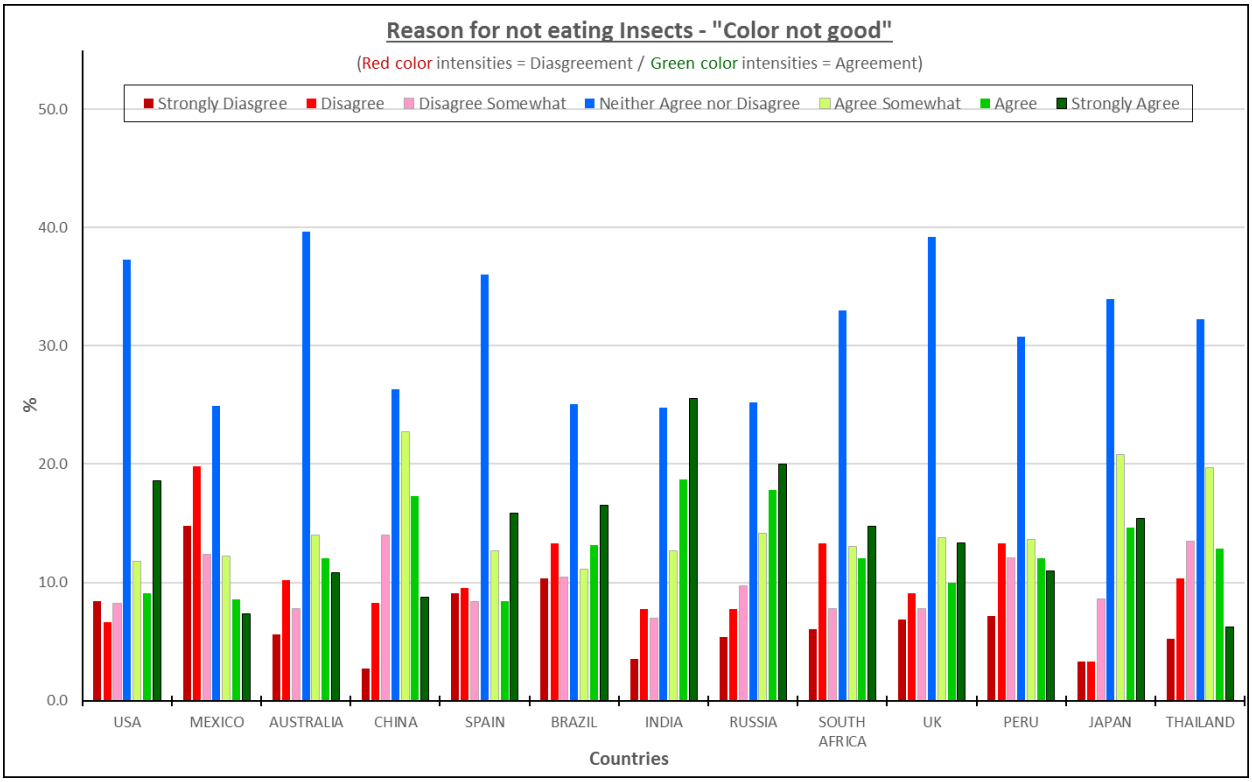
Figure 3-8 Reasons for NOT eating insect products – "I do not think it would taste good".

Several studies focused on the sensory aspect of overall liking to determined consumer's behavior towards insect products (Tan et al., 2017; Hartmann et al., 2016; Caparros Megido et al., 2016). The conclusions from those studies showed that participants' overall liking was influenced by the appearance and taste. In addition, it was noted in some studies that the insect parts needed to be invisible for acceptance, which is similar to the findings related to appearance considerations in this study. In one study (Capparros Megido et al., 2016) of burgers, men rated the insect burger between the beef and lentil burger, with a preference for the mealworm and beef burger. It should be noted in all the prior studies only those consumers who indicated they were willing and interested in eating insect-based products were used.

Color would not be good – All consumers considered

A further sensory consideration is color. Over 50% of the participants in India, Russia and Japan agreed that the color of an insect based product would not be good (Figure 3-9). Interestingly, the Latin American countries (Mexico, Peru, and Brazil) were the only countries where more or almost more consumers disagreed with that statement than agreed. It must be noted that this statement generated uncertainty (high percentages of neither agree nor disagree) like "Insects are not safe to eat", suggesting that consumers simply were not sure what the impact of insect ingredients would be on color. Of course, if insect ingredients do result in a color issue, that color might be altered (fixed?) by adding natural and familiar colors to imitate the original color of a specific product category.

Figure 3-9 Reasons for NOT eating insect products – "Color would not be good".



Conclusions

This study provides a better understanding of reasons that consumers would not consider eating foods containing insect ingredients. Appearance is a critical issue and a high priority for consumers; there is no doubt that fragments or pieces of the insect cannot be present in the final product. The emotional and psychological issues represented by the statements "The idea is disgusting" / "Just the thought makes me sick" and the potential misconception that all "insects are not safe to eat" are as crucial as the visual factor.

Of lesser impact in this study, but potentially related to the key factors are such aspects as the misbelief that all insects are dirty/filthy, which may cause consumers to avoid insect-based products. Two sensory characteristics that concerned some participants were the potential impact

of the insect ingredients on taste and texture, but those should be able to be overcome with the adequate selection and formulation of the food product. Certainly, those two aspects are barriers for any new or revamped products that research and development groups need to carefully consider before the creation of a new product.

This research suggests that the use of insect-based powders/flours to avoid appearance and textural issues and education that overcomes the disgust and safety concerns of consumers are key to the introduction of insect-based food products in many countries. In some countries, such as Mexico and Thailand, the sensory issues may be of more concern than the disgust issues because insect-based products are already known, although not necessarily widely eaten.

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Chapter 4 - Consumer Acceptability of Chocolate Chip Cookies made with Insect Powder in the USA, Mexico and Spain

Abstract

Consumers are noted for reading information about the products they eat including such aspects as the ingredient statement, the nutritional facts panel and packaging claims such as high protein, organic, etc. of food products. But do they really care when an ingredient is partially replaced in a familiar product? Consumers have indicated that they do not necessarily consider insect ingredients a good choice in food products, and part of that concern is based on sensory issues such as appearance, flavor, and texture. This consumer study was conducted in the United States of America, Mexico and Spain to compare acceptability of a familiar product, chocolate chip cookies, in three variations: a control 100% wheat flour chocolate chip cookie, and two versions substituting 15% and 30% cricket flour for an equivalent amount of wheat flour. Two hundred consumers from each country were recruited and scored overall acceptability and acceptability of different sensory attributes for the three cookies. Acceptance was measured using a 9-point hedonic scale and a similar format was used for each attribute. US consumers did not find significant differences in liking between the control and 15% sample. The 30% cricket powder cookie showed a decrease in consumer acceptance. Mexican and Spanish consumers liked the 15% sample significantly more than the control and 30% sample and Spanish consumers also like the control more than the 30% sample. Liking of flavor was positive in all three countries to the 15% cricket flour cookie, with consumers in Mexico and Spain giving significantly higher flavor liking means than the control cookie. The substitution of 15% cricket powder does not negatively impact liking in this product and, in fact, may improve

both liking and protein content. Further research is necessary to determine whether this finding can help to mitigate the impact of insect-containing ingredients on consumer concerns related to sensory and other factors in these and other countries or markets and in other products.

Practical Applications

High protein and sustainability are two key aspects being used to promote products in many markets. The protein content and sustainability of insect-based ingredients could make more competitive baked products if certain negative aspects such as sensory and emotional and psychological barriers can be overcome. This study suggests that good products can be improved using cricket powder. With the right marketing, such a product could become a competitive choice in the product category. The food industry should consider and explore different insect powders/flours as an alternative ingredient.

Introduction

For several years, new food trends have been associated with high protein products, from snacks to shakes across a wide range of food and beverages categories. High protein product intake has substantial benefits related to weight lost, satiety and lean mass preservation (Leidy et al., 2006; Layman et al., 2005; Leidy et al., 2015; Voelker, 2019). The most commonly used marketing statements are: “reduced fat”, “low sodium or sugar” and “good source of protein” which are influencing consumer food purchasing and behavior (Colby et al., 2010; Mintel, 2018). What kind of protein matters to consumers in food products? The concerns about sustainability and environmental impacts of animal based protein consumption have lead consumers to seek alternative source of proteins (Aiking, 2014; de Boer et al., 2017; Baker et al.,

2002; Apostolidis et al., 2016; Aiking et al., 2006). However, there is a skeptical attitude towards many plant based proteins, specifically soy, and consumers may dislike products containing protein from plant sources (Banovic et al., 2018). However, new research from Mintel (2018) indicated that "taste is the top reason why U.S. adults eat plant-based proteins". That reasoning is higher than animal protection, environment and even health.

Are consumers accepting of a switch from traditional animal proteins or plant-based proteins to alternative proteins such as insect-based ingredients? In part the answer will depend on whether those products taste good. Food choice studies in various countries show that liking remains the key reason for food selection (e.g. USA: Phan and Chambers, 2016a,b; Canada: Landry et al., 2018; Chile: Araneda Flores, et al., 2017; Poland: Halagarda. 2017; Turkey: Chambers et al., 2016). However, depending on the country, time of day, and actual food, other reasons such as health, convenience, natural concerns and other issues are important.

Several consumer studies have shown that consumers who were interested in eating insect based products (and often knew they were eating insect-based samples) found the sensory properties of the tested foods similar, or preferred to the product made with conventional ingredients (Caparros Megido et al., 2016; Tan et al., 2016; House, 2016; Hartmann, & Siegrist, 2017).

Hence, sensory studies have an immense role to prove and convince global markets that if a popular and well consumed product (cookies, chips, bread, etc.) using insect flour/powder as one of the ingredients, maintains or exceeds the sensory attributes expectations, most likely consumers would purchase the product. It is especially important to prove that with consumers who are not necessarily acceptors of insect-based ingredients and who may not be aware that the products they are eating contain insect-based ingredients.

This study aims to evaluate the consumer acceptance of a chocolate chip cookies made with cricket flour at different formula ratios in three different countries/regions of the world. The USA, Mexico and Spain were selected based on previous research that indicated their willingness or unwillingness to try insect based products (Castro and Chambers, 2018) and their reasons for being unwilling to try them. There are several questions to answer but the principal target was to assess the overall liking of the three cookies and the significant differences in overall acceptance and liking of various attributes among them.

Materials and Methods

Participants profile

A partnership and a collaboration study was established with the Miguel Hernandez de Elche University from Alicante, Spain, the Sonora University (Unison) from Sonora, Mexico and Kansas State University from Manhattan, Kansas, USA. The countries were chosen because they represent different impacts of insect-based ingredients on willingness to consumer. The USA was categorized by Castro and Chambers (2019) as a Disgust-Impact on Brand Equity country as was Spain, but the two countries represent a North American and European Perspective. In contrast, Mexico was classed as a No Disgust-Impact on Brand Equity country by those authors.

A total of 200 consumers who were either consumers of or positive to the idea of eating chocolate chip cookies were recruited in each country using existing databases. One hundred (100) participants of each gender (male, female) divided equally into each of four age groups: 18-25, 26-45, 46-65, and 66+ years old were targeted in each country with additional respondents included in case of incomplete data. Excluded consumers were those with a degree or major courses in food, nutrition, or marketing; those with jobs in the food or marketing

industries, or those with any food allergies or religious restrictions on food. All consumers were told they would be trying three samples of chocolate chip cookies and were given a list of over 50 possible ingredients that the cookies might contain that they could choose to read or not. Cricket powder was listed as one of the ingredients in approximately the 35th position. The consumers were not explicitly told that the cookies contained an insect-based ingredient and few consumers noted or commented on that ingredient. The participants received an incentive appropriate for the country for completing the consumer acceptability study. The overall project was approved by the Kansas State University Committee on Human Subjects and each university also received appropriate consent from their research approval units.

Chocolate chip cookie ingredients

Most ingredients were purchased in bulk in Manhattan, Kansas, USA. All cookies for the study were produced in the Center for Sensory Analysis and Consumer Behavior at Kansas State University to avoid any variations or errors during the production. See Table 4-1 for the complete list of ingredients and amounts. The control cookie was made according to the recipe for Nestlé® Toll House cookies, one of the most popular chocolate chip cookies in the United States (Hayek et al., 2013). Griopro® cricket powder (All Things Bugs LLC, Gainesville, FL) was used as the alternative insect-based ingredient in this study.

Cookie preparation

The same preparation procedures were used for all cookies using the essential steps to reproduce the key characteristics of a cookie (Cauvain et al., 2006).

1) Preheat oven to 375 °F
2) Combine flour, baking soda, and salt in a small bowl

3) Beat butter, granulated sugar, brown sugar, and vanilla extract in large mixer bowl until creamy.
4) Add eggs, one at a time, beating well after each addition. Gradually add in flour mixture. Stir in morsels and nuts
5) Drop by 1 rounded tablespoon on an ungreased baking sheets.
6) Bake for 10 minutes or until golden brown.
7) Cool on baking sheets for 5 minutes, remove to wire racks to cool completely.

Table 4-1 Ingredients and amounts for the three chocolate chip cookies.

Ingredients	**Control**	**15% Cricket**	**30% Cricket**
	Grams (gr)	Grams (gr)	Grams (gr)
All-purpose flour	288.0	244.8	201.6
Cricket powder	-	43.2	86.4
Baking soda	7.0	7.0	7.0
Salt	5.7	5.7	5.7
Butter	227.0	227.0	227.0
Granulated sugar	148.5	148.5	148.5
Brown sugar	159.0	159.0	159.0
Vanilla extract	5.7	5.7	5.7
Large eggs	100.0	100.0	100.0
Nestlé Semi-Sweet Chocolate Morsels	256.0	256.0	256.0
Chopped Walnuts	128.0	128.0	128.0

After manufacturing, the samples were stored in frozen conditions (-18°C or below) and samples were shipped frozen to Mexico and Spain. Including initial storage in the US, shipping, and holding in country, frozen samples were held for up to 3 months.

Consumer Evaluation

The sensory evaluation of the chocolate chip cookies was conducted targeting consumer preferences and acceptability based on baked products such as a sweet cookie. All cookies were scored on a "blind" basis, meaning that consumers were not told what the differences in cookies were, nor were they told anything about the variations in the cookies. Unless, they read carefully, consumers were unaware that the cookies contained cricket powder.

Consumers scored overall liking and liking of appearance, texture, flavor, color, aftertaste, sweetness, bitterness, crunchiness, hardness, chocolate flavor and flavor strength on a 9-point hedonic scale from 1 to 9, where 1 represents "Dislike Extremely" and 9 represents "Like Extremely" (Lawless & Heymann, 2010). Consumers also rated their perceived intensity of sweetness, bitterness, crunchiness, hardness, chocolate flavor and flavor strength. A 9-point scale scale was used, but ranged from (1) extremely low to (9) extremely high. See appendix E for a full disclosure of the consumer acceptability questionnaire. For Mexico and Spain, the screener and questionnaire was translated to Spanish as appropriate for the country, back translated to English by another native speaker of that or a similar dialect, and verified by the consumer panel leader and at least one consumer native of each country.

The experimental design of the samples was executed using RedJade Software Solutions LLC and the cookies were presented in 4 oz. plastic cups with a randomized three-digit code attached.

Data Analysis

Statistical analyses were performed using MiniTab-18 (Minitab Inc. State College, PA, USA and SAS 9.4 (SAS Institute Inc. Cary, NC, USA). Analysis of variance (ANOVA) was

executed to analyze the differences among the samples for every country followed by Tukey (Pairwise) comparisons to determine the significant differences. Spider plots of the means and liking distribution analysis of every sensory attribute of the chocolate chips cookies were graphed to understand the consumers' perceptions and identify possible differences between the three cookies.

Results

USA

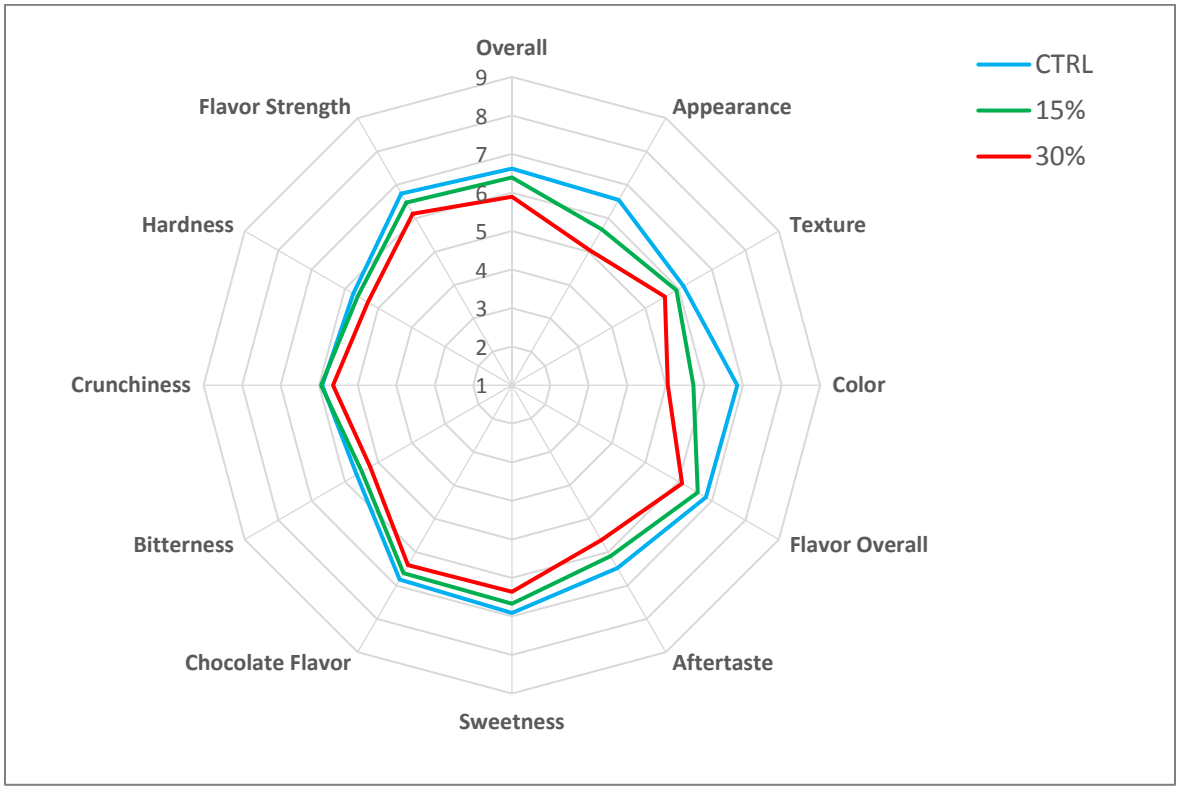
Americans showed few statistical differences in liking or intensity between the chocolate chip cookies made with 85% wheat flour and 15% cricket powder and the control (100% all-purpose wheat flour) (Table 4-2). Overall, consumers liked the flavor, texture and sweetness of the control and 15% cricket powder cookie formulations. However, the 30% cricket powder cookie sample showed significantly lower scores in all the liking attributes and scored significantly higher for bitterness and hardness than the control or 15% sample intensities. Therefore, the addition of cricket powder appears to make the cookie more bitter, which in some cases could affect chocolate flavor as well. The appearance, color and aftertaste liking attributes in the control sample were liked more than in the 15% and 30% samples. The slight dark gray color of the cricket powder might impact the appearance and color characteristics of the cricket powder cookies. A flavor, best described by trained sensory panelists as "barnyard" (Koppel and Koppel, 2018; Cherdchu, Chambers & Suwonsichon, 2013) coming from the cricket powder itself could affect the aftertaste, which was apparent in the 30% cricket cookie aftertaste scores. Figures 4-1 and 4-2 provide a visual display of the means and scores frequencies for the product variations.

Table 4-2 Chocolate Chip Cookie Results - Mean Acceptance Scores – USA.

Sensory Attributes	CTRL (A)	15% Cricket Flour (B)	30% Cricket Flour (C)	p-values	HSD
Overall_Liking	6.62 C'	6.39 C'	5.89	<0.001	0.30
Appearance_Liking	6.55 B'C'	5.67 C'	5.04	<0.001	0.31
Texture_Liking	6.14 C'	5.93 C	5.59	<0.001	0.28
Color_Liking	6.85 B'C'	5.71 C'	5.05	<0.001	0.32
Flavor Overall_Liking	6.81 C'	6.57 C'	6.10	<0.001	0.31
Aftertaste_Liking	6.48 BC'	6.12 C'	5.64	<0.001	0.31
Sweetness_Liking	6.91 C'	6.67 C	6.36	<0.001	0.26
Chocolate Flavor_Liking	6.82 C'	6.63	6.39	0.01	0.30
Bitterness_Liking	5.65 C'	5.49	5.24	<0.01	0.25
Crunchiness_Liking	5.92 c	5.95 C	5.64	0.04	0.26
Hardness_Liking	5.75 C'	5.62 C	5.31	<0.01	0.26
Flavor Strength_Liking	6.74 C'	6.47 c	6.14	<0.001	0.29
Sweetness_Intensity	5.92 bC'	5.63 C	5.28	<0.001	0.26
Chocolate Flavor_Intensity	5.79	5.55	5.59	0.25	0.31
Bitterness_Intensity	3.83	4.00	4.43 A'B	<0.001	0.31
Crunchiness_Intensity	6.93	6.82	6.83	0.53	0.22
Hardness_Intensity	6.12	6.09	6.51 A'B'	<0.001	0.25
Flavor Strength_Intensity	6.17	6.15	6.25	0.72	0.26

Statistical Confidence Levels: **A'<99%**; **A<95%**; **a<90%**. A letter represents the product that is statistically different from the sample. Color and type of letter (lowercase, capital or capital prime) indicate significance level. Only the higher means are tagged.

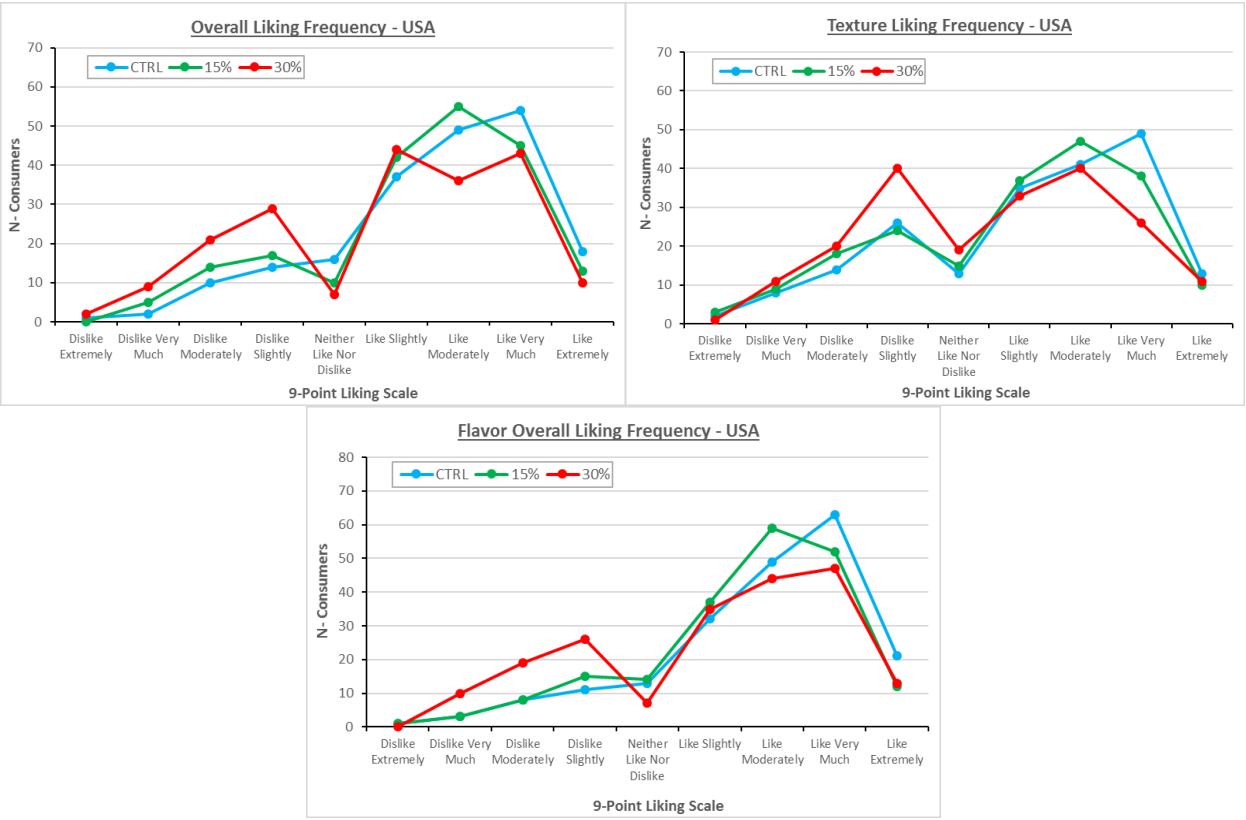
Figure 4-1 Spider Plot Chocolate Chip Cookies – Attributes Liking Means – USA.



Analyzing the demographics sub-groups shows that US males showed higher scores than females in the two cricket chocolate chip cookies; 85% of males liked the 15% cricket cookie compared to 72% females. The same trend was observed for 30% sample but the difference between the gender percentages was smaller. Women liked the control sample (80%) slightly better than the males (76%). Overall, men preferred to consume the cricket cookies over the women. Breaking into the age segments (18-25, 26-45, 46-65, 66+ years old), the young adults, 26 to 45 years old highly liked the cookies over the other age divisions. For example, 71% of the young adults liked the 30% cricket cookie, followed by 65% of the teenagers/early twenties segment (18-25 years old), then the percentages dropped to 60% for the mid-age adults (46-65 years old). Observing the control and the high percentage cricket flour sample, the liking results

displayed the same tendency, being the young adults who highly preferred all three chocolate chip cookies. See Appendix, for age and gender tabulated statistics.

Figure 4-2 Liking Distributions – Chocolate. Chip Cookies – Overall, Texture, Flavor Liking – USA



MEXICO

In Mexico, the participants liked the 15% cricket flour chocolate chip cookie significantly more ($P<.01$) than the other two samples (100% wheat flour or 30% cricket powder samples) with a mean overall liking mean of 7.2 (Table 4-3). This data combined with the fact that Mexican consumer generally are not averse to eating insect-based products shows that these consumers are ready to eat an insect-based cookie such as that tested here. The same statistical

results were observed for liking of flavor overall, aftertaste, bitterness and chocolate flavor overall likings (Table 4-3). There were no significant differences in hardness liking and bitterness intensity among the three samples, but sweetness and chocolate flavor intensity of the 15% cricket powder cookie was perceived higher than the other two samples and the sweetness of this cookie was liked significantly more than other cookies. The appearance and texture liking mean scores were similar in the control and the 15% cricket powder cookie samples and significantly higher than the 30% cookie. The color of the 15% sample was liked significantly more than the 30% sample, which may relate to the natural darker gray color of the insect ingredient at a higher ratio in the final formula. However, no statistical color liking difference was shown between the control (mean = 6.40) and 15% cookie (mean = 6.58, p-value = 0.163).

Clearly the 15% cricket powder cookie is well accepted, which translates to an overall opinion between “Like moderately and “Like very much”. Interestingly for Mexican consumers based on the flavor overall liking, the 30% cricket powder cookie scored the second highest mean (6.6), followed by CTRL with a mean of 6.5, which is not significantly different from each other.

Table 4-3 Chocolate Chip Cookie Results - Mean Acceptance Scores – MEXICO.

Sensory Attributes	CTRL (A)	15% Cricket Flour (B)	30% Cricket Flour (C)	p-values	HSD
Overall_Liking	6.70	7.15 A'C'	6.57	<0.001	0.31
Appearance_Liking	6.29 c	6.31 c	6.03	0.04	0.25
Texture_Liking	6.77 C	6.86 C'	6.47	0.01	0.26
Color_Liking	6.40	6.58 C	6.28	0.04	0.25
Flavor Overall_Liking	6.51	7.10 A'C'	6.61	<0.001	0.30
Aftertaste_Liking	6.13	6.83 A'C'	6.32	<0.001	0.31
Sweetness_Liking	6.54	6.87 A	6.64	0.04	0.27
Chocolate Flavor_Liking	6.74	7.20 A'C'	6.77	<0.001	0.27
Bitterness_Liking	6.05	6.41 AC	6.00	0.01	0.30
Crunchiness_Liking	6.65 C	6.58 c	6.29	0.02	0.28
Hardness_Liking	6.58	6.63	6.35	0.12	0.30
Flavor Strength_Liking	6.53	6.84 ac	6.50	0.04	0.32
Sweetness_Intensity	5.99	6.49 A'C'	6.08	<0.001	0.26
Chocolate Flavor_Intensity	6.22	6.63 AC'	6.14	<0.01	0.33
Bitterness_Intensity	5.26	5.14	5.22	0.73	0.32
Crunchiness_Intensity	6.05 B'C'	5.56	5.50	<0.01	0.33
Hardness_Intensity	5.54 C	5.35	5.09	0.03	0.34
Flavor Strength_Intensity	6.84 c	6.99 C'	6.59	<0.01	0.24

Statistical Confidence Levels: A'<99%; A<95%; a<90%. A letter represents the product that is statistically different from the sample. Color and type of letter (lowercase, capital or capital prime) indicate significance level. Only the higher means are tagged.

Figures 4-3 and 4-4 provide additional details on the comparison of the overall data and the distribution of scores among consumers.

Summarizing, the Mexican participants liked the chocolate chip cookie made with 15% insect flour more than all wheat flour and found the 30% product liked as well as the control. Further research is necessary to investigate higher percentages of cricket flour in the formulas and establish unacceptable liking limits. In addition, this kind of research should be done with other high protein content products for this market.

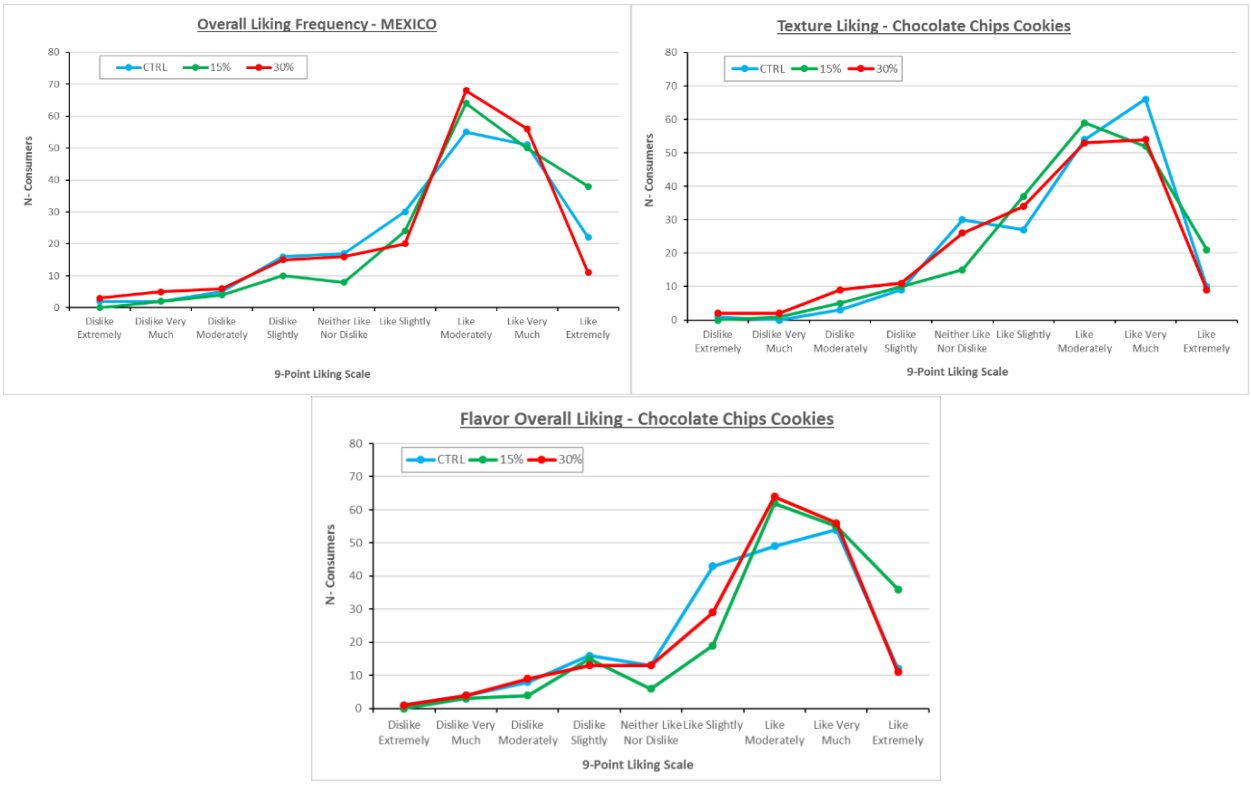
Figure 4-3 Spider Plot Chocolate Chip Cookies – Attributes Liking Means – MEXICO.

The spider plot (Figure 4-3) clearly shows that the 15% cricket cookie generally has numerically higher scores than the control and 30% cricket cookies. Additional studies are needed to investigate the functionality and effects of the cricket powder as an ingredient in final products.

After tasting both cricket samples, the Mexican women (90% for 15% sample and 80% for the 30% sample) displayed higher overall liking scores than men (86% and 74% respectively). The control sample showed higher acceptance by the men than the women. These results are following a completely opposite direction as the USA. In Mexico, females are preferring the insect samples over males. Mid-age adults (46-65 years old) are liking the cricket cookies as well as the control over the rest of the age categories. Observing the 15% cricket

cookie, the difference between the teenagers and the mid-age adults is small, meaning that they are also finding the cricket sample pleasant. See appendix, for age and gender tabulated statistics.

Figure 4-4 Liking Distributions – Chocolate Chip Cookies – Overall Liking, Texture, Flavor – MEXICO



SPAIN

Spaniards clearly liked the 15% cricket flour chocolate chip cookie more than the control and the 30% cricket cookie. Every liking attribute, from overall liking to flavor strength liking, was significantly higher ($P<0.01$) for the 15% cookie (Table 4-4). The flavor overall liking scores on the 15% and control sample were between six and seven on the hedonic scale, meaning the cookies were slightly to moderately liked. The attribute intensities, like chocolate flavor,

crunchiness, hardness and flavor strength also were higher in the 15% cookies versus the other two samples. The second most liked cookie was the control (100% wheat flour), which was significantly higher in liking than the 30% cricket cookie. The bitterness intensity was perceived as slightly low in all the three samples and was not statistically different. Moreover, the 30% cricket flour cookie showed the lowest mean score of all three samples. Therefore, the addition of cricket powder in the formulas might not increase the perceived bitterness level in the final product in this population, providing opportunities for further research tweaking the formulas or in a different product category.

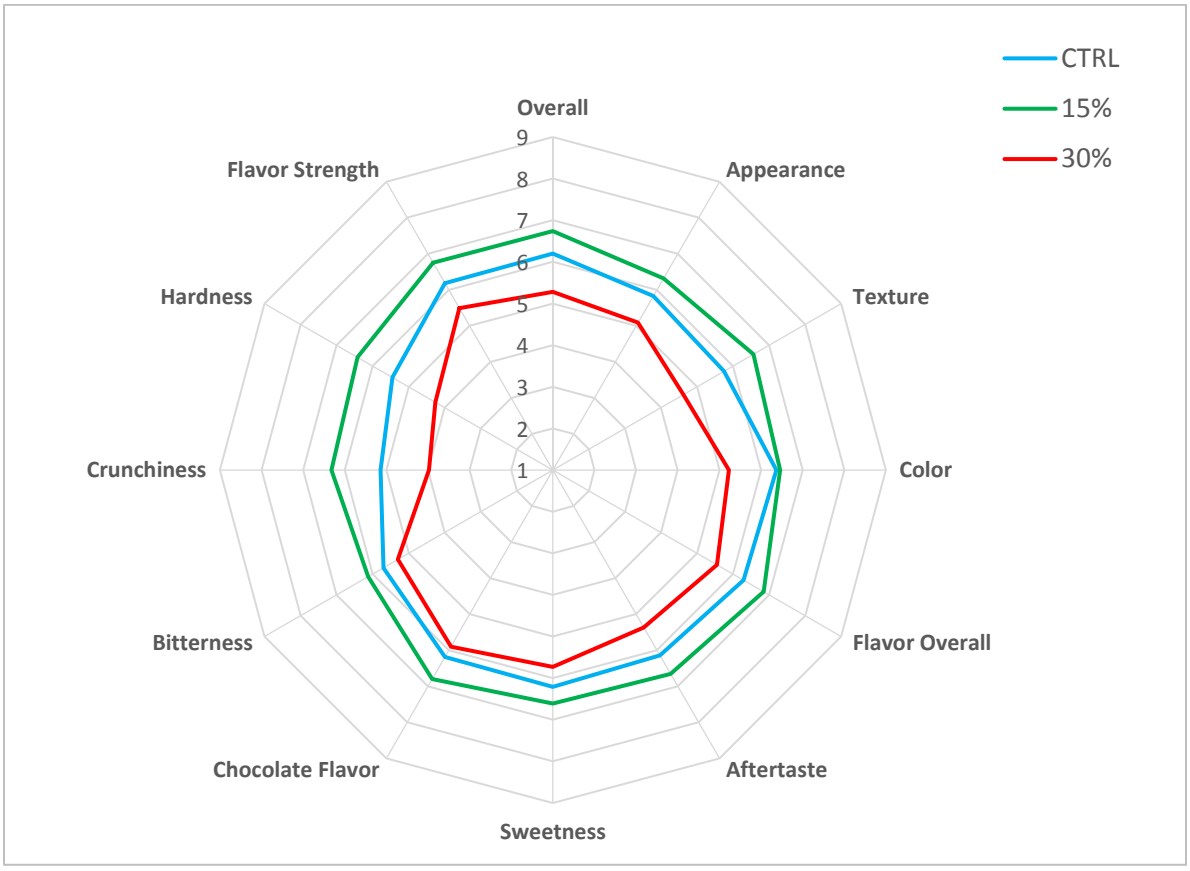
Table 4-4 Chocolate Chip Cookie Results - Mean Acceptance Scores – SPAIN

Sensory Attributes	CTRL (A)	15% Cricket Flour (B)	30% Cricket Flour (C)	p-values	HSD
Overall_Liking	6.20 C'	6.74 A'C'	5.28	<0.001	0.33
Appearance_Liking	5.83 C'	6.32 A'C'	5.09	<0.001	0.29
Texture_Liking	5.75 C'	6.56 A'C'	4.62	<0.001	0.32
Color_Liking	6.37 C'	6.46 C'	5.23	<0.001	0.28
Flavor Overall_Liking	6.29 C'	6.85 A'C'	5.55	<0.001	0.34
Aftertaste_Liking	6.14 C'	6.66 A'C'	5.37	<0.001	0.31
Sweetness_Liking	6.21 C'	6.61 AC'	5.73	<0.001	0.29
Chocolate Flavor_Liking	6.19	6.80 A'C'	5.90	<0.001	0.33
Bitterness_Liking	5.70 C	6.12 A'C'	5.30	<0.001	0.28
Crunchiness_Liking	5.14 C'	6.32 A'C'	3.98	<0.001	0.34
Hardness_Liking	5.45 C'	6.42 A'C'	4.26	<0.001	0.33
Flavor Strength_Liking	6.18 C'	6.75 A'C'	5.49	<0.001	0.31
Sweetness_Intensity	5.41 c	5.66 C'	5.13	<0.001	0.25
Chocolate Flavor_Intensity	5.00	5.43 AC	5.03	0.01	0.31
Bitterness_Intensity	4.60	4.41	4.34	0.15	0.25
Crunchiness_Intensity	3.97 C'	4.87 A'C'	3.21	<0.001	0.31
Hardness_Intensity	4.23 C'	4.77 A'C'	3.60	<0.001	0.33
Flavor Strength_Intensity	5.31	5.72 A'C'	5.18	<0.001	0.28

Statistical Confidence Levels: A'<99%; A<95%; a<90%. A letter represents the product that is statistically different from the sample. Color and type of letter (lowercase, capital or capital prime) indicate significance level. Only the higher means are tagged.

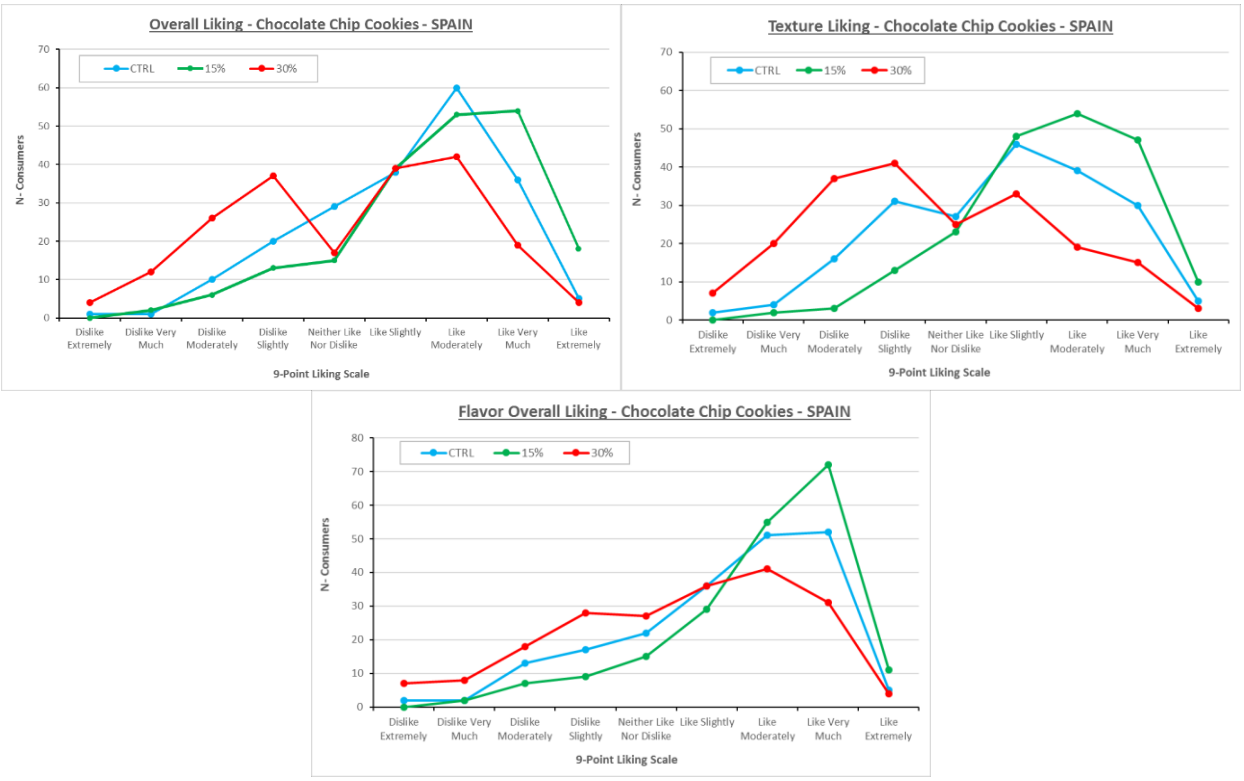
Observing the spider plot (Figure 4-5) and the liking distributions (Figure 4-6) the differences between the three cookies are noticeable, for example the mean liking of crunchiness score on the 15% cookie is slightly higher than that for the control, which is higher than the 30% cookie. A similar pattern was observed for the hardness liking, also showing a significant difference ($P< 0.01$). After, replacing 15 percent of wheat flour with cricket powder, the color of the cookie was not affected, both cookies control and 15% was almost equally liked, not showing statistical differences. However, doubling that amount of cricket powder to 30% drastically impacted the color liking as well as the texture and appearance liking. Based on the flavor overall liking, more than 70 participants liked the 15% cookie very much, and 84% of the consumers liked the sample to some degree meaning that the perceptions found by Castro and Chambers, 2018 where Spain was classified as a disgust country (unwilling to try insect based products), could change after consumers taste an actual insect product and conclude that the sensory attributes are more than acceptable.

Figure 4-5 Spider Plot Chocolate Chip Cookies – Attributes Liking Means – SPAIN



The participants in Spain definitely liked the 15% cricket cookie over the control and the 30% sample. The 15% cricket powder cookie was preferred by the females' consumers (84%) over the males (81%), but the control scores were completely the opposite. In the case of 30% cricket cookie, the Spaniard women (60%) revealed remarkably higher overall liking percentages than the male (45%). The age demographics displayed that the young adults (26-45 years old) preferred the 15% cricket cookies or the control sample over the rest of the age categories. The teenagers group (18-25 years old) showed higher liking percentages (69%) for the 30% cricket cookie than the other age groups. In general, young adults consumers are more receptive to like the insect based cookies than the mid-age group and teenagers.

Figure 4-6 Liking Distributions – Chocolate Chip Cookies – Overall Liking, Texture, Flavor – SPAIN



Conclusions

This study provides information on consumer acceptability from three different countries and different degrees of willingness levels to try insect-based food products. The results demonstrated that in all three countries, USA, Mexico and Spain, the 15% cricket powder chocolate chip cookie was at least as acceptable as the control cookie made with wheat flour and was more acceptable that that cookie in some cases. In Mexico, the 30% cricket powder cookie was found to be as acceptable as the control cookie.

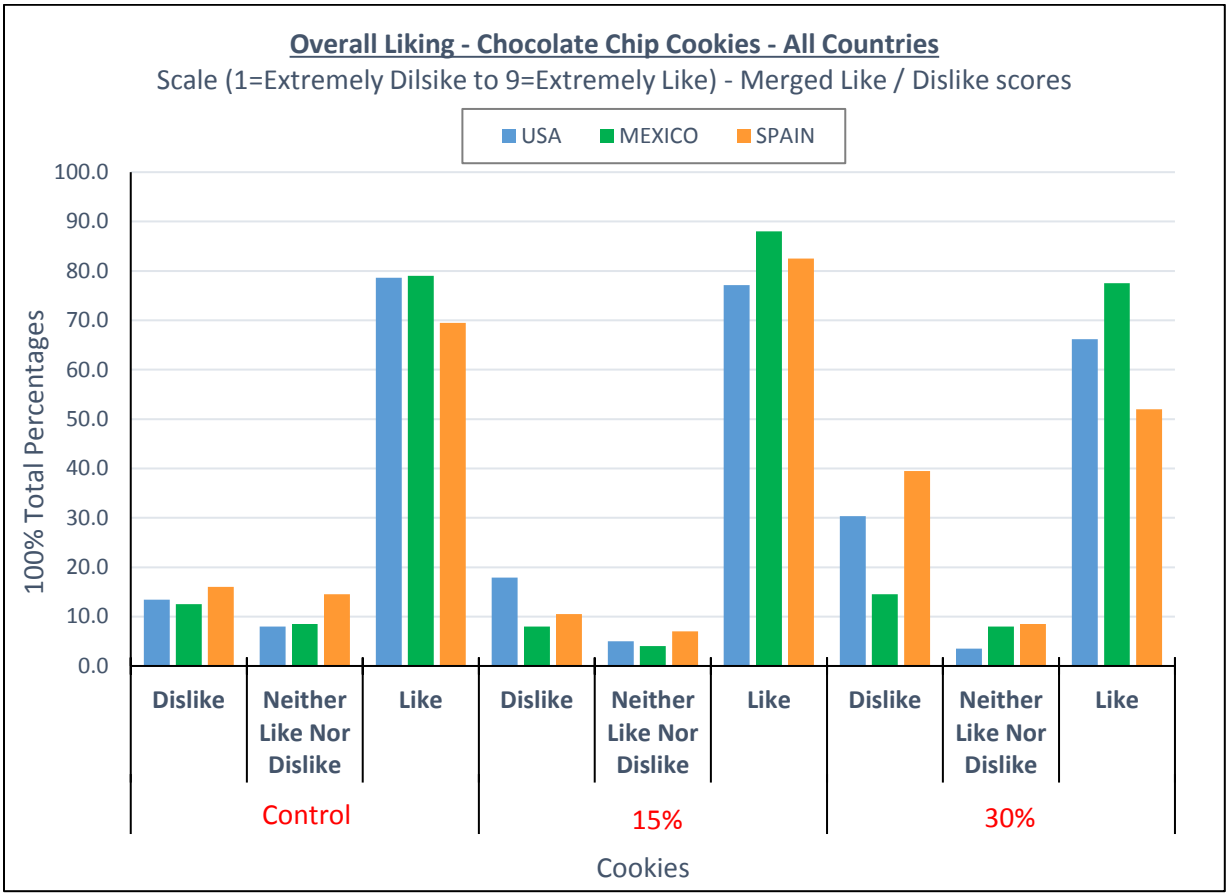
In the Mexican market, where consumers generally were willing to eat insect-based products (Castro and Chambers, 2019) the inclusion of insect powder as an ingredient in baked

products like cookies could start taking advantage of the claims and benefits that insect protein can provide (e.g. protein, sustainability, non-GMO, etc.) to the product without affecting liking. In countries, such as Spain and the USA, where consumers generally were unwilling to eat such products, the inclusion of insect powder in traditional products that show equal or higher liking may help show consumers that insect-based products are acceptable, are not disgusting, and can be made to be similar to their favorite products. In the US 77% of consumers and 83% of Spanish consumers liked the cookies made with cricket powder when they likely did not know that the product contained insect powder. Lower liking scores (66% in the USA and 52% in Spain) were obtained when a higher amount (30%) cricket powder was included in the cookie and resulted in changes to some sensory properties that impacted liking. However, it should be noted that those percentages are still more than half of the consumers who liked that cookie, which contains even more protein. The overall liking summary chart (Figure 4-7.) shows a comparison between the three countries, with Mexico the most receptive country for both cookies containing cricket powder when tested on a blind basis, followed by USA and Spain. It is important to highlight that at least half of all consumers liked all the cookies containing insect flour. Therefore, the insertion of cricket powder does not negatively impact the sensory profile of this product, when used in amounts of 15% or less. Instead it may improve the overall liking for some consumers (Mexico and Spain) and definitely increases the final protein content of the product.

These results show that variation in formulations is possible with little or no change in liking, even when small changes in sensory properties are noted. Thus, different formulations providing various nutritional claims and benefits could be highlighted in insect containing products depending on favorable marketing or sales strategies.

Potential future research includes studies where consumers may test on a blind basis and then learn what the products were after evaluation, a step that was not done in this research to ensure little or no "contamination" of the perception of other participants who had not yet tested. One possible step to break the disgust barrier or unwillingness about insect based products, is to expose consumers to familiar products made with insects and let them experience the sensory characteristics. When consumers realize that their liking expectations have been matched or exceeded, the awareness of insects as alternative ingredient might increase and begin their consumption. Such tastings are similar to those held in many grocery and "warehouse" stores for new products to encourage trial and purchase of products. Further investigation is necessary to implement these findings in other product categories or markets, as well as increasing the cricket powder proportion in the formulas. Currently costs for cricket powder are considerably higher than that for wheat flour and likely would impact consumer costs. However, that is true for many products labeled high protein, organic, non-GMO, etc. Further consumer research in other product categories can help support the use of alternative proteins such as insect-based ingredients, which can lead to production efficiencies, lower costs and facilitate the supply chain and industrialization of these ingredients (Rumpold et al., 2013; Smetana et al., 2016).

Figure 4-7 Summary Overall Liking % - Chocolate Chip Cookies - USA, MEXICO, SPAIN



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Chapter 5 - General Conclusions

Insect-based foods are attempting to become part of a movement to look for successful alternative protein sources as food ingredients. In the last few years, universities, research institutions and entrepreneur companies are studying or manufacturing different product categories based on insects. This study contributes to this important understanding by demonstrating that an insect-based ingredient can be used to create products that are as good as or better than traditional products, even if small changes in the sensory profile are noted. Incorporating these ingredients in a familiar food item could produce positive effects related to concerns over sensory issues that consumers have related to insect-based ingredients in food. The bonus to consumers is that the use of such products could increase the nutritional content of protein, vitamins and fiber content and provide societal benefits of sustainability and minimal impact to land and air.

The unwillingness to try insect-based foods is based on multiple barriers such as sensory issues, disgust, and safety fears that need to be mitigated in consumers' minds. At this time, those barriers do not allow insect-based products to be consumed as a primary food on a daily basis, but the more we learn and expose the population to accurate information about insects and foods containing insect-based ingredients, the higher the potential for awareness and reducing the barriers. If that happens, through introduction of good tasting insect-based products and easing of other consumer concerns about insect-containing foods, consumption might increase creating surprising and unexpected experiences.

After analyzing the data of the first survey, Americans and Spaniards showed unwillingness to try insect based products and provided a number of reasons, including ones

related to the belief that products would not taste good, could make them sick, and were disgusting. However, after consuming products on a blind basis that contained an insect-based ingredient, consumers actually like the 15% replacement product as well or better and no-one reported any issues related to illness or sickness from eating the product. Clearly, associating these results with the number one reason for not eating insect products: "No insect pieces in my food", the last study demonstrates that when consumers eat a familiar product with no visual signs of insect fragments, the product is well accepted. In Mexico, and presumably in other countries that are classed as "no disgust" countries, the potential to introduce new insect-based products under new brands is high. In the rest of the countries further consumer acceptability research is necessary to confirm how consumer can switch from having a disgust feeling to liking insect products.

Companies need to be careful before incorporating insect-based ingredients into their established and popular brands. Our studies suggest a negative brand impact even in some countries where disgust is not an issue. Consumer could stop buying other products in the brand portfolio. Creating a new brand that does not relate to their other product brands and provides a positive information related to insects and health and safety could be one solution to the introduction of such products. Further marketing studies are crucial before implementing the use of insect-based products in widespread global markets.

Appendix A - Survey-Incorporation of Insects

The survey that you are going to take is about food and ingredients.

Please indicate your agreement to the following questions:

Phase I: **Incorporation of Insects**

Insects: Highlights

- By 2050 the world's population will rise to 9 billion which means that in order to satisfy demand for the world's meat consumption we will need to double protein production. We need to seek more sustainable, alternative forms of protein.
- A possible solution is using insects. Insects offer a high level and far more sustainable form of protein.
- Insects already form part of the diets of at least 2 billion people worldwide.
- Insects require only 1-2 gallons of water to produce 1 pound of protein while poultry, pork and beef require 500-2500 gallons of water.

1. I am willing to eat the meat and fish from animals that had been fed with insects.
2. I am willing to eat food obtained from insects, e.g., snacks produced using insect flour/powder.
3. If you were offered a dish based on insects in an ethnic restaurant, would you be willing to taste it.

Scale: 7-point scale. (Strongly disagree - strongly agree)

Phase II: **Reasons for not eating Insect**

4. Please indicate your agreement with each statement on the reasons you would not consider eating foods containing insect powder as an ingredient.

a) The idea is disgusting.
b) I do not think it would taste good.
c) I have an actual allergic reaction to some insects.
d) My religion doesn't allow all or certain insects.
e) Insects are not safe to eat.
f) The texture would be bad.
g) Just the thought makes me sick.
h) Insects are dirty/filthy.
i) Insects carry diseases.
j) Color would not be good.
k) I do not want insect pieces in my food.

Scale: 7-point scale. (Strongly disagree - strongly agree)

Phase VIII: **Insects in a Brand**

Insects: Low Energy and Excellent Source of Protein

- Eating insects has recognized health benefits. Edible insects contain high quality protein and calcium with levels comparable to beef and milk. For example, cricket flour contains 63% protein, more iron than spinach and more calcium than milk.
- We are able to eat between 80 and 100% of insects bred whereas we only eat 40-60% of cows and other livestocks.
- Insects have a high food conversion rate, for instance crickets need 6 times less feed than cattle, four times less than sheep, and two times less than pigs and chickens to produce the same amount of protein.

Answer the following questions based on this idea:

If major worldwide company; e.g., Nestle, Coca-Cola, KFC, Starbucks, etc., introduces a new product similar to one you currently buy that contains insect powder.

5. How willing would you be to try this product?
6. How likely would you be to stop buying other products from this company knowing they have used insect powder in one product?
7. How likely would you be to immediately start looking to replace your favorite products with a different brand knowing that the company is considering insect powder for their products?
8. If an insect based product tastes as good as or better than your current product, would you recommend it to your friends?
9. If the insect based product tastes as good as or better than your current product, would you eat this product regularly and integrate into your daily routine?

Scale: 7-point scale. (Extremely unlikely, unlikely, somewhat unlikely, neither likely or unlikely, somewhat likely, likely, extremely likely)

Appendix B - Correlation between Willingness/Unwillingness to eat insects and Stop buying other products

Correlation Between Willingnes/Unwillingness to eat insects and Stop buying other products									
Countries	Demographics	Chi-squared Test (p-value)	Kendall's Correlation Coefficient		Countries	Demographics	Chi-squared Test (p-value)	Kendall's Correlation Coefficient	
			Tau	P-value, α=0.05				Tau	P-value, α=0.05
USA	Male	<0.001	-0.11	0.01	Mexico	Male	<0.001	-0.39	<0.001
	Female	<0.001	-0.19	<0.001		Female	<0.001	-0.34	<0.001
	18-34	<0.001	0.12	0.03		18-34	<0.001	-0.21	<0.001
	35-54	<0.001	-0.16	<0.01		35-54	<0.001	-0.28	<0.001
	55+	<0.001	-0.41	<0.001		55+	<0.001	-0.61	<0.001
	M/18-34	<0.001	0.16	0.04		M/18-34	<0.001	-0.21	<0.01
	M/35-54	<0.001	-0.11	0.16		M/35-54	<0.001	-0.33	<0.001
	M/55+	<0.001	-0.38	<0.001		M/55+	<0.001	-0.64	<0.001
	F/18-34	<0.001	0.07	0.37		F/18-34	<0.001	-0.19	<0.001
	F/35-54	<0.001	-0.23	<0.01		F/35-54	<0.001	-0.24	<0.01
	F/55+	<0.001	-0.45	<0.001		F/55+	<0.001	-0.59	<0.001
Australia	Male	<0.001	-0.23	<0.001	China	Male	<0.001	-0.05	0.29
	Female	<0.001	-0.32	<0.001		Female	<0.001	-0.06	0.16
	18-34	<0.001	-0.11	0.04		18-34	<0.001	-0.10	0.06
	35-54	<0.001	-0.31	<0.001		35-54	<0.001	-0.01	0.90
	55+	<0.001	-0.41	<0.001		55+	<0.001	-0.07	0.19
	M/18-34	<0.001	-0.06	0.42		M/18-34	<0.001	-0.15	0.05
	M/35-54	<0.001	-0.28	<0.001		M/35-54	<0.001	-0.05	0.49
	M/55+	<0.001	-0.37	<0.001		M/55+	<0.01	0.08	0.28
	F/18-34	<0.001	-0.17	0.02		F/18-34	<0.001	-0.06	0.46
	F/35-54	<0.001	-0.35	<0.001		F/35-54	<0.001	0.03	0.67
	F/55+	<0.001	-0.44	<0.001		F/55+	<0.001	-0.21	<0.01
Spain	Male	<0.001	-0.26	<0.001	Brazil	Male	<0.001	0.75	<0.001
	Female	<0.001	-0.35	<0.001		Female	<0.001	0.75	<0.001
	18-34	<0.001	-0.17	<0.01		18-34	<0.001	0.73	<0.001
	35-54	<0.001	-0.36	<0.001		35-54	<0.001	0.77	<0.001
	55+	<0.001	-0.41	<0.001		55+	<0.001	0.75	<0.001
	M/18-34	<0.001	-0.07	0.34		M/18-34	<0.001	0.67	<0.001
	M/35-54	<0.001	-0.34	<0.001		M/35-54	<0.001	0.78	<0.001
	M/55+	<0.001	-0.34	<0.001		M/55+	<0.001	0.79	<0.001
	F/18-34	<0.001	-0.20	<0.01		F/18-34	<0.001	0.77	<0.001
	F/35-54	<0.001	-0.38	<0.001		F/35-54	<0.001	0.77	<0.001
	F/55+	<0.001	-0.46	<0.001		F/55+	<0.001	0.71	<0.001

India	Male	<0.001	-0.11	0.01	Russia	Male	<0.001	-0.38
	Female	<0.001	0.06	0.18		Female	<0.001	-0.38
	18-34	<0.001	0.09	0.09		18-34	<0.001	-0.32
	35-54	<0.001	-0.04	0.43		35-54	<0.001	-0.37
	55+	<0.001	-0.13	0.01		55+	<0.001	-0.44
	M/18-34	<0.001	0.00	0.99		M/18-34	<0.001	-0.25
	M/35-54	<0.001	-0.07	0.33		M/35-54	<0.001	-0.46
	M/55+	<0.001	-0.28	<0.001		M/55+	<0.001	-0.41
	F/18-34	<0.001	0.17	0.02		F/18-34	<0.001	-0.39
	F/35-54	<0.001	0.00	1.00		F/35-54	<0.001	-0.28
	F/55+	<0.001	-0.01	0.91		F/55+	<0.001	-0.46
South Africa	Male	<0.001	-0.38	<0.001	UK	Male	<0.001	-0.21
	Female	<0.001	-0.40	<0.001		Female	<0.001	-0.37
	18-34	<0.001	-0.32	<0.001		18-34	<0.001	-0.18
	35-54	<0.001	-0.31	<0.001		35-54	<0.001	-0.38
	55+	<0.001	-0.56	<0.001		55+	<0.001	-0.37
	M/18-34	<0.001	-0.21	<0.01		M/18-34	<0.001	-0.16
	M/35-54	<0.001	-0.31	<0.001		M/35-54	<0.001	-0.31
	M/55+	<0.001	-0.64	<0.001		M/55+	<0.001	-0.28
	F/18-34	<0.001	-0.42	<0.001		F/18-34	<0.001	-0.23
	F/35-54	<0.001	-0.30	<0.001		F/35-54	<0.001	-0.45
	F/55+	<0.001	-0.47	<0.001		F/55+	<0.001	-0.44
Japan	Male	<0.001	-0.22	<0.001	Peru	Male	<0.001	-0.34
	Female	<0.001	-0.31	<0.001		Female	<0.001	-0.22
	18-34	<0.001	-0.23	<0.001		18-34	<0.001	-0.23
	35-54	<0.001	-0.28	<0.001		35-54	<0.001	-0.28
	55+	<0.001	-0.31	<0.001		55+	<0.001	-0.32
	M/18-34	<0.001	-0.15	0.06		M/18-34	<0.001	-0.24
	M/35-54	<0.001	-0.24	<0.01		M/35-54	<0.001	-0.32
	M/55+	<0.001	-0.31	<0.001		M/55+	<0.001	-0.45
	F/18-34	<0.001	-0.30	<0.001		F/18-34	<0.001	-0.23
	F/35-54	<0.001	-0.31	<0.001		F/35-54	<0.001	-0.24
	F/55+	<0.001	-0.31	<0.001		F/55+	<0.001	-0.18
Thailand	Male	<0.001	-0.28	<0.001				
	Female	<0.001	-0.29	<0.001				
	18-34	<0.001	-0.19	<0.001				
	35-54	<0.001	-0.18	<0.01				
	55+	<0.001	-0.48	<0.001				
	M/18-34	<0.01	-0.18	0.02				
	M/35-54	<0.001	-0.21	<0.01				
	M/55+	<0.001	-0.47	<0.001				
	F/18-34	0.01	-0.20	0.01				
	F/35-54	0.02	-0.16	0.04				
	F/55+	<0.001	-0.49	<0.001				

Appendix C - Reasons for not Eating Insects: Beliefs and Health

Reasons for not Eating Insects: *My Religion does not allow all or certain insects - %*											
Percentages %	1 = Strongly Disagree	2 = Disagree	3 = Somewhat Disagree	4 = Neither agree nor Disagree	5 = Somewhat Agree	6 = Agree	7 = Strongly Agree	Merged Disagree 1-2-3	Merged Agree 5-6-7	Mean	STD
USA	46.03	14.13	5.40	20.00	3.81	4.13	6.51	65.56	14.45	3.33	2.10
Mexico	55.24	22.70	3.49	10.95	2.06	2.86	2.70	81.43	7.62	4.81	1.77
Australia	43.81	19.84	7.46	18.73	3.33	2.38	4.44	71.11	10.15	3.50	1.91
China	15.08	20.00	14.60	25.40	9.68	10.63	4.60	49.68	24.91	4.06	1.65
Spain	53.97	14.76	3.49	16.98	2.86	2.06	5.87	72.22	10.79	3.18	1.99
Brazil	47.30	22.38	6.19	14.13	2.22	3.81	3.97	75.87	10.00	3.87	2.06
India	11.43	11.75	6.03	18.10	10.00	17.78	24.92	29.21	52.70	3.07	2.08
Russia	31.90	25.40	3.97	23.97	4.13	3.81	6.83	61.27	14.77	2.98	2.05
South Africa	33.97	24.29	5.71	22.38	2.06	3.65	7.94	63.97	13.65	3.48	1.99
UK	55.08	14.44	5.87	14.92	2.86	2.70	4.13	75.39	9.69	3.49	2.01
Peru	42.06	29.05	3.33	17.46	2.38	2.70	3.02	74.44	8.10	4.22	1.78
Japan	33.02	16.03	6.51	32.70	3.81	3.65	4.29	55.56	11.75	2.82	1.72
Thailand	30.00	20.63	11.90	26.98	3.97	3.97	2.54	62.53	10.48	4.35	1.74
Reasons for not Eating Insects: *Allergic reaction to some insects - %*											
Percentages %	1 = Strongly Disagree	2 = Disagree	3 = Somewhat Disagree	4 = Neither agree nor Disagree	5 = Somewhat Agree	6 = Agree	7 = Strongly Agree	Merged Disagree 1-2-3	Merged Agree 5-6-7	Mean	STD
USA	30.63	14.44	7.62	23.65	5.40	8.41	9.84	52.69	23.65	3.87	2.13
Mexico	41.75	25.40	4.29	13.49	4.13	6.67	4.29	71.44	15.09	3.62	1.82
Australia	25.56	21.90	8.73	23.81	7.30	6.83	5.87	56.19	20.00	3.87	1.93
China	6.35	17.14	16.51	24.92	14.29	15.24	5.56	40.00	35.09	4.27	1.52
Spain	34.60	16.19	4.92	22.22	6.51	6.19	9.37	55.71	22.07	4.25	2.07
Brazil	29.37	16.51	6.51	23.97	6.51	8.25	8.89	52.39	23.65	3.99	2.04
India	7.46	12.70	6.51	20.63	14.76	16.19	21.75	26.67	52.70	4.25	2.14
Russia	25.24	23.97	5.87	24.29	5.24	7.14	8.25	55.08	20.63	4.26	2.07
South Africa	21.90	22.06	7.14	25.24	5.24	6.67	11.75	51.10	23.66	3.97	2.01
UK	36.67	17.14	4.92	25.71	6.98	3.97	4.60	58.73	15.55	3.78	1.98
Peru	25.87	23.81	5.24	20.32	7.14	11.11	6.51	54.92	24.76	4.05	1.72
Japan	14.60	14.13	9.37	41.59	6.35	6.83	7.14	38.10	20.32	4.30	1.89
Thailand	14.29	17.14	9.84	26.19	13.17	10.16	9.21	41.27	32.54	3.95	1.66

Reasons for not Eating Insects: *Insects carry diseases - %*											
Percentages %	1 = Strongly Disagree	2 = Disagree	3 = Somewhat Disagree	4 = Neither agree nor Disagree	5 = Somewhat Agree	6 = Agree	7 = Strongly Agree	Merged Disagree 1-2-3	Merged Agree 5-6-7	Mean	STD
USA	5.87	3.49	5.40	16.98	19.21	17.62	31.43	14.76	68.26	3.87	2.13
Mexico	14.29	16.19	12.54	19.21	16.98	10.63	10.16	43.02	37.77	3.62	1.82
Australia	4.44	4.92	5.24	21.75	27.62	16.19	19.84	14.60	63.65	3.87	1.93
China	2.38	6.98	9.21	18.25	24.92	24.13	14.13	18.57	63.18	4.27	1.52
Spain	6.35	5.56	5.08	24.76	19.21	13.81	25.24	16.99	58.26	4.25	2.07
Brazil	6.35	8.41	11.59	22.86	16.19	14.60	20.00	26.35	50.79	3.99	2.04
India	3.33	3.49	5.87	12.86	16.35	21.59	36.51	12.69	74.45	4.25	2.14
Russia	2.86	4.44	6.51	12.38	21.27	24.13	28.41	13.81	73.81	4.26	2.07
South Africa	6.03	8.25	7.78	20.79	20.63	15.87	20.63	22.06	57.13	3.97	2.01
UK	5.24	4.76	6.03	23.97	25.24	14.29	20.48	16.03	60.01	3.78	1.98
Peru	6.03	11.75	13.65	17.14	17.94	18.89	14.60	31.43	51.43	4.05	1.72
Japan	2.06	3.49	6.35	26.83	24.13	15.40	21.75	11.90	61.28	4.30	1.89
Thailand	3.33	9.05	13.97	20.48	23.81	16.35	13.02	26.35	53.18	3.95	1.66

Appendix D - Regression Analysis - Stepwise Procedure

Regression Analysis - Stepwise Procedure

USA

Regression Equation

Q60 = 2.713 - 0.0716 Q63_5 - 0.0985 Q63_6

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.80	9.23%	8.56%	7.07%

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	2.71	0.18	15.23	0.00	
Not Safe to Eat	Q63_5	-0.07	0.03	-2.08	0.04	1.63
Texture Bad	Q63_6	-0.10	0.04	-2.50	0.01	1.63

MEXICO

Regression Equation

Q60 = 2.451 - 0.1067 Q63_10

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.83	5.13%	4.49%	2.54%

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	2.45	0.19	12.95	0.00	
Color Not Good	Q63_10	-0.11	0.04	-2.82	0.01	1.00

AUSTRALIA

Regression Equation

Q60 = 6.889 - 0.2377 Q63_1 - 0.1125 Q63_5 - 0.2902 Q63_11

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)			
1.37	32.74%	32.42%	31.52%			

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	6.89	0.19	36.83	0.00	
Idea Disgusting	Q63_1	-0.24	0.05	-5.07	0.00	2.14
Not Safe to Eat	Q63_5	-0.11	0.04	-2.79	0.01	1.55
No insects pieces in my food	Q63_11	-0.29	0.05	-6.14	0.00	2.15

CHINA

Regression Equation

Q60 = 3.326 - 0.1150 Q63_1 - 0.0683 Q63_8

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.66	13.65%	12.85%	10.21%

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	3.33	0.17	19.21	0.00	
Idea Disgusting	Q63_1	-0.12	0.04	-3.20	0.00	1.7
Insects are dirty/filthy	Q63_8	-0.07	0.04	-1.72	0.09	1.7

SPAIN

Regression Equation

Q60 = 3.476 - 0.0918 Q63_1 - 0.1903 Q63_11

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.73	17.99%	17.51%	15.89%

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	3.48	0.20	17.17	0.00	
Idea Disgusting	Q63_1	-0.09	0.03	-2.94	0.00	1.44
No insects pieces in my food	Q63_11	-0.19	0.04	-5.16	0.00	1.44

BRAZIL

Regression Equation

Q60 = 3.255 - 0.0950 Q63_1 - 0.0478 Q63_8 - 0.1094 Q63_11

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.74	17.07%	16.29%	14.75%

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	3.26	0.19	17.25	0.00	
Idea Disgusting	Q63_1	-0.10	0.03	-3.02	0.00	1.63
Insects are dirty/filthy	Q63_8	-0.05	0.03	-1.57	0.12	1.59
No insects pieces in my food	Q63_11	-0.11	0.04	-3.00	0.00	1.61

INDIA

Regression Equation

Q60 = 2.468 - 0.0750 Q63_1 + 0.0619 Q63_2 - 0.0611 Q63_5 - 0.0747 Q63_10

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.70	9.59%	8.64%	7.10%

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	2.468	0.153	16.09	0	
Idea Disgusting	Q63_1	-0.075	0.0232	-3.24	0.001	1.43
Taste Not Good	Q63_2	0.0619	0.029	2.14	0.033	1.87
Not Safe to Eat	Q63_5	-0.0611	0.0282	-2.16	0.031	1.81
Color Not Good	Q63_10	-0.0747	0.0263	-2.84	0.005	1.53

RUSSIA

Regression Equation

Q60 = 3.471 - 0.1286 Q63_1 + 0.0372 Q63_2 - 0.0606 Q63_5 - 0.0450 Q63_8 - 0.0868 Q63_11

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.64	22.91%	21.89%	20.10%

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	3.47	0.19	18.63	0.00	
Idea Disgusting	Q63_1	-0.13	0.03	-4.76	0.00	1.68
Taste Not Good	Q63_2	0.04	0.02	1.53	0.13	1.51
Not Safe to Eat	Q63_5	-0.06	0.02	-2.52	0.01	1.50
Insects are dirty/filthy	Q63_8	-0.05	0.03	-1.73	0.09	1.66
No insects pieces in my food	Q63_11	-0.09	0.04	-2.34	0.02	1.75

SOUTH AFRICA

Regression Equation

Q60 = 3.049 - 0.0653 Q63_1 - 0.0985 Q63_2 - 0.0541 Q63_10

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.75	11.39%	10.49%	8.83%

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	3.05	0.20	14.98	0.00	
Idea Disgusting	Q63_1	-0.07	0.03	-2.13	0.03	1.27
Taste Not Good	Q63_2	-0.10	0.04	-2.71	0.01	1.55
Color Not Good	Q63_10	-0.05	0.03	-1.82	0.07	1.30

UNITED KINGDOM

Regression Equation

Q60 = 3.265 - 0.0674 Q63_2 - 0.1558 Q63_11

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.80	8.47%	7.73%	5.37%

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	3.27	0.29	11.21	0.00	
Taste Not Good	Q63_2	-0.07	0.04	-1.74	0.08	1.36
No insects pieces in my food	Q63_11	-0.16	0.05	-2.95	0.00	1.36

PERU

Regression Equation

Q60 = 2.599 - 0.0588 Q63_5 - 0.0623 Q63_11

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.71	5.92%	5.16%	3.30%

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	2.60	0.18	14.78	0.00	
Not Safe to Eat	Q63_5	-0.06	0.03	-1.94	0.05	1.46
No insects pieces in my food	Q63_11	-0.06	0.04	-1.77	0.08	1.46

JAPAN

Regression Equation

Q60 = 3.651 - 0.1243 Q63_5 - 0.1840 Q63_11

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.77	15.68%	15.17%	13.86%

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	3.65	0.22	16.51	0.00	
Not Safe to Eat	Q63_5	-0.12	0.03	-4.21	0.00	1.07
No insects pieces in my food	Q63_11	-0.18	0.03	-5.36	0.00	1.07

THAILAND

Regression Equation

Q60 = 2.460 - 0.0774 Q63_8

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.81	2.45%	1.89%	0.16%

Coefficients

	Term	Coef	SE Coef	T-Value	P-Value	VIF
	Constant	2.46	0.19	13.21	0.00	
Insects are dirty/filthy	Q63_8	-0.08	0.04	-2.10	0.04	1.00

Appendix E - Consumer Acceptability Questionnaire of Chocolate Chip Cookies

1. How much do you **like or dislike** this chocolate chip cookie OVERALL?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

2. How much do you **like or dislike** the APPEARANCE of this product?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

3. How much do you **like or dislike** the TEXTURE of this product?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

4. How much do you **like or dislike** the COLOR of this product?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

5. How much do you **like or dislike** the FLAVOR OVERALL of this product?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

6. How much do you **like or dislike** the AFTERTASTE of this chocolate cookie?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

7. How much do you **like or dislike** the SWEETNESS of this product?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

8. How much do you **like or dislike** the CHOCOLATE FLAVOR of this product?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

9. How much do you **like or dislike** the BITTERNESS of this product?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

10. How much do you **like or dislike** the CRUNCHINESS of this product?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

11. How much do you **like or dislike** the HARDNESS of this product?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

12. How much do you **like or dislike** the FLAVOR STRENGTH of this product?

☐	☐	☐	☐	☐	☐	☐	☐	☐
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

13. Please rate the **intensity** of the SWEETNESS of this product?

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Extremely Low — Extremely High

14. Please rate the **intensity** of the CHOCOLATE FLAVOR of this product?

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Extremely Low — Extremely High

15. Please rate the **intensity** of the BITTERNESS of this product?

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Extremely Low — Extremely High

16. Please rate the **intensity** of the CRUNCHINESS of this product?

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Extremely Low — Extremely High

17. Please rate the **intensity** of the HARDNESS of this product?

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Extremely Low — Extremely High

18. Please rate the **intensity** of the FLAVOR STRENGTH of this product?

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Extremely Low — Extremely High

Appendix F - USA - Demographic Results-Chocolate Chip Cookies

USA - Demographic Results										
GENDER										
Product: **Chocolate Chip Cookie - Control**										
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All
Female	1	1	5	10	6	21	30	31	12	117
	0.86	0.86	4.27	8.55	5.13	17.95	25.64	26.50	10.26	100
	100	50	50	71.43	37.5	56.76	61.22	57.41	66.67	58.21
	0.50	0.50	2.49	4.98	2.99	10.45	14.93	15.42	5.97	58.21
Male	0	1	5	4	10	16	19	23	6	84
	0.00	1.19	5.95	4.76	11.91	19.05	22.62	27.38	7.14	100
	0	50	50	28.57	62.5	43.24	38.78	42.59	33.33	41.79
	0	0.50	2.49	1.99	4.98	7.96	9.45	11.44	2.99	41.79
All	1	2	10	14	16	37	49	54	18	201
	0.50	1.00	4.98	6.97	7.96	18.41	24.38	26.87	8.96	100
	100	100	100	100	100	100	100	100	100	100
	0.50	1.00	4.98	6.97	7.96	18.41	24.38	26.87	8.96	100
Product: **Chocolate Chip Cookie - 15% Cricket Powder**										
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All
Female	0	4	11	11	7	21	30	25	8	117
	0	3.42	9.4	9.4	5.98	17.95	25.64	21.37	6.84	100
	0	80	78.57	64.71	70	50	54.55	55.56	61.54	58.21
	0	1.99	5.47	5.47	3.48	10.45	14.93	12.44	3.98	58.21
Male	0	1	3	6	3	21	25	20	5	84
	0	1.19	3.57	7.14	3.57	25	29.76	23.81	5.95	100
	0	20	21.43	35.29	30	50	45.45	44.44	38.46	41.79
	0	0.50	1.49	2.99	1.49	10.45	12.44	9.95	2.49	41.79
All	0	5	14	17	10	42	55	45	13	201
	0	2.49	6.97	8.46	4.98	20.9	27.36	22.39	6.47	100
	0	100	100	100	100	100	100	100	100	100
	0	2.49	6.97	8.46	4.98	20.90	27.36	22.39	6.47	100
Product: **Chocolate Chip Cookie - 30% Cricket Powder**										
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All
Female	2	6	12	18	3	25	20	25	6	117
	1.71	5.13	10.26	15.38	2.56	21.37	17.09	21.37	5.13	100
	100	66.67	57.14	62.07	42.86	56.82	55.56	58.14	60	58.21
	1.00	2.99	5.97	8.96	1.49	12.44	9.95	12.44	2.99	58.21
Male	0	3	9	11	4	19	16	18	4	84
	0	3.57	10.71	13.1	4.76	22.62	19.05	21.43	4.76	100
	0	33.33	42.86	37.93	57.14	43.18	44.44	41.86	40	41.79
	0	1.49	4.48	5.47	1.99	9.45	7.96	8.96	1.99	41.79
All	2	9	21	29	7	44	36	43	10	201
	1	4.48	10.45	14.43	3.48	21.89	17.91	21.39	4.98	100
	100	100	100	100	100	100	100	100	100	100
	1.00	4.48	10.45	14.43	3.48	21.89	17.91	21.39	4.98	100.00

AGE											
Product: **Chocolate Chip Cookie - Control**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
18 - 25 years old	1	2	5	5	2	9	16	13	4	57	*Count*
	1.75	3.51	8.77	8.77	3.51	15.79	28.07	22.81	7.02	100	*% of Row*
	100	100	50	35.71	12.5	24.32	32.65	24.07	22.22	28.36	*% of Column*
	0.50	1.00	2.49	2.49	1.00	4.48	7.96	6.47	1.99	28.36	*% of Total*
26 - 45 years old	0	0	4	7	7	17	15	22	7	79	
	0	0	5.06	8.86	8.86	21.52	18.99	27.85	8.86	100	
	0	0	40	50	43.75	45.95	30.61	40.74	38.89	39.3	
	0	0	2.0	3.48	3.48	8.46	7.46	10.95	3.48	39.30	
46 - 65 years old	0	0	1	1	6	8	13	14	5	48	
	0	0	2.08	2.08	12.5	16.67	27.08	29.17	10.42	100	
	0	0	10	7.14	37.5	21.62	26.53	25.93	27.78	23.88	
	0	0	0.50	0.50	2.99	3.98	6.47	6.97	2.49	23.88	
66+ years old	0	0	0	1	1	3	5	5	2	17	
	0	0	0	5.88	5.88	17.65	29.41	29.41	11.76	100	
	0	0	0	7.14	6.25	8.11	10.2	9.26	11.11	8.46	
	0	0	0	0.50	0.50	1.49	2.49	2.49	1.00	8.46	
All	1	2	10	14	16	37	49	54	18	201	
	0.5	1	4.98	6.97	7.96	18.41	24.38	26.87	8.96	100	
	100	100	100	100	100	100	100	100	100	100	
	0.50	1.00	4.98	6.97	7.96	18.41	24.38	26.87	8.96	100	
Product: **Chocolate Chip Cookie - 15% Cricket Powder**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
18 - 25 years old	0	0	3	7	2	11	14	10	10	57	*Count*
	0	0	5.26	12.28	3.51	19.3	24.56	17.54	17.54	100	*% of Row*
	0	0	21.43	41.18	20	26.19	25.45	22.22	76.92	28.36	*% of Column*
	0	0	1.49	3.48	1.00	5.47	6.97	4.98	4.98	28.36	*% of Total*
26 - 45 years old	0	1	7	6	3	14	26	19	3	79	
	0	1.27	8.86	7.59	3.8	17.72	32.91	24.05	3.8	100	
	0	20	50	35.29	30	33.33	47.27	42.22	23.08	39.3	
	0	0.50	3.48	2.99	1.49	6.97	12.94	9.45	1.49	39.30	
46 - 65 years old	0	3	4	4	2	13	10	12	0	48	
	0	6.25	8.33	8.33	4.17	27.08	20.83	25	0	100	
	0	60	28.57	23.53	20	30.95	18.18	26.67	0	23.88	
	0	1.49	1.99	1.99	1.00	6.47	4.98	5.97	0.00	23.88	
66+ years old	0	1	0	0	3	4	5	4	0	17	
	0	5.88	0	0	17.65	23.53	29.41	23.53	0	100	
	0	20	0	0	30	9.52	9.09	8.89	0	8.46	
	0	0.50	0.00	0.00	1.49	1.99	2.49	1.99	0.00	8.46	
All	0	5	14	17	10	42	55	45	13	201	
	0	2.49	6.97	8.46	4.98	20.9	27.36	22.39	6.47	100	
	0	100	100	100	100	100	100	100	100	100	
	0	2.49	6.97	8.46	4.98	20.90	27.36	22.39	6.47	100	

Product: **Chocolate Chip Cookie - 30% Cricket Powder**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
18 - 25 years old	1	1	9	8	1	12	13	11	1	57	*Count*
	1.75	1.75	15.79	14.04	1.75	21.05	22.81	19.3	1.75	100	*% of Row*
	50	11.11	42.86	27.59	14.29	27.27	36.11	25.58	10	28.36	*% of Column*
	0.50	0.50	4.48	3.98	0.50	5.97	6.47	5.47	0.50	28.36	*% of Total*
26 - 45 years old	1	4	6	9	3	20	13	17	6	79	
	1.27	5.06	7.59	11.39	3.8	25.32	16.46	21.52	7.59	100	
	50	44.44	28.57	31.03	42.86	45.45	36.11	39.53	60	39.3	
	0.50	1.99	2.99	4.48	1.49	9.95	6.47	8.46	2.99	39.30	
46 - 65 years old	0	3	5	9	2	8	9	11	1	48	
	0	6.25	10.42	18.75	4.17	16.67	18.75	22.92	2.08	100	
	0	33.33	23.81	31.03	28.57	18.18	25	25.58	10	23.88	
	0.00	1.49	2.49	4.48	1.00	3.98	4.48	5.47	0.50	23.88	
66+ years old	0	1	1	3	1	4	1	4	2	17	
	0	5.88	5.88	17.65	5.88	23.53	5.88	23.53	11.76	100	
	0	11.11	4.76	10.34	14.29	9.09	2.78	9.3	20	8.46	
	0	0.50	0.50	1.49	0.50	1.99	0.50	1.99	1.00	8.46	
All	2	9	21	29	7	44	36	43	10	201	
	1	4.48	10.45	14.43	3.48	21.89	17.91	21.39	4.98	100	
	100	100	100	100	100	100	100	100	100	100	
	1.00	4.48	10.45	14.43	3.48	21.89	17.91	21.39	4.98	100.00	

Appendix G - MEXICO - Demographic Results-Chocolate Chip Cookies

Supplement 1: USA - Demographic Results										
GENDER										
Product: **Chocolate Chip Cookie - Control**										
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All
Female	1	1	5	10	6	21	30	31	12	117
	0.86	0.86	4.27	8.55	5.13	17.95	25.64	26.50	10.26	100
	100	50	50	71.43	37.5	56.76	61.22	57.41	66.67	58.21
	0.50	0.50	2.49	4.98	2.99	10.45	14.93	15.42	5.97	58.21
Male	0	1	5	4	10	16	19	23	6	84
	0.00	1.19	5.95	4.76	11.91	19.05	22.62	27.38	7.14	100
	0	50	50	28.57	62.5	43.24	38.78	42.59	33.33	41.79
	0	0.50	2.49	1.99	4.98	7.96	9.45	11.44	2.99	41.79
All	1	2	10	14	16	37	49	54	18	201
	0.50	1.00	4.98	6.97	7.96	18.41	24.38	26.87	8.96	100
	100	100	100	100	100	100	100	100	100	100
	0.50	1.00	4.98	6.97	7.96	18.41	24.38	26.87	8.96	100
Product: **Chocolate Chip Cookie - 15% Cricket Powder**										
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All
Female	0	4	11	11	7	21	30	25	8	117
	0	3.42	9.4	9.4	5.98	17.95	25.64	21.37	6.84	100
	0	80	78.57	64.71	70	50	54.55	55.56	61.54	58.21
	0	1.99	5.47	5.47	3.48	10.45	14.93	12.44	3.98	58.21
Male	0	1	3	6	3	21	25	20	5	84
	0	1.19	3.57	7.14	3.57	25	29.76	23.81	5.95	100
	0	20	21.43	35.29	30	50	45.45	44.44	38.46	41.79
	0	0.50	1.49	2.99	1.49	10.45	12.44	9.95	2.49	41.79
All	0	5	14	17	10	42	55	45	13	201
	0	2.49	6.97	8.46	4.98	20.9	27.36	22.39	6.47	100

Supplement 2: MEXICO - Demographic Results											
GENDER											
Product: **Chocolate Chip Cookie - Control**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
Female	2	1	3	10	11	16	25	27	11	106	*Count*
	1.89	0.94	2.83	9.43	10.38	15.09	23.58	25.47	10.38	100	*% of Row*
	100	50	60	62.5	64.71	53.33	45.45	52.94	50	53	*% of Column*
	1	0.5	1.5	5	5.5	8	12.5	13.5	5.5	53	*% of Total*
Male	0	1	2	6	6	14	30	24	11	94	
	0	1.06	2.13	6.38	6.38	14.89	31.91	25.53	11.7	100	
	0	50	40	37.5	35.29	46.67	54.55	47.06	50	47	
	0	0.5	1	3	3	7	15	12	5.5	47	
All	2	2	5	16	17	30	55	51	22	200	
	1	1	2.5	8	8.5	15	27.5	25.5	11	100	
	100	100	100	100	100	100	100	100	100	100	
	1	1	2.5	8	8.5	15	27.5	25.5	11	100	
Product: **Chocolate Chip Cookie - 15% Cricket Powder**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
Female	0	0	2	6	3	17	29	25	24	106	*Count*
	0	0	1.89	5.66	2.83	16.04	27.36	23.58	22.64	100	*% of Row*
	0	0	50	60	37.5	70.83	45.31	50	63.16	53	*% of Column*
	0	0	1	3	1.5	8.5	14.5	12.5	12	53	*% of Total*
Male	0	2	2	4	5	7	35	25	14	94	
	0	2.13	2.13	4.26	5.32	7.45	37.23	26.6	14.89	100	
	0	100	50	40	62.5	29.17	54.69	50	36.84	47	
	0	1	1	2	2.5	3.5	17.5	12.5	7	47	
All	0	2	4	10	8	24	64	50	38	200	
	0	1	2	5	4	12	32	25	19	100	
	0	100	100	100	100	100	100	100	100	100	
	0	1	2	5	4	12	32	25	19	100	
Product: **Chocolate Chip Cookie - 30% Cricket Powder**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
Female	2	4	3	4	8	13	32	34	6	106	*Count*
	1.887	3.774	2.83	3.774	7.547	12.264	30.189	32.075	5.66	100	*% of Row*
	66.67	80	50	26.67	50	65	47.06	60.71	54.55	53	*% of Column*
	1	2	1.5	2	4	6.5	16	17	3	53	*% of Total*
Male	1	1	3	11	8	7	36	22	5	94	
	1.064	1.064	3.191	11.702	8.511	7.447	38.298	23.404	5.319	100	
	33.33	20	50	73.33	50	35	52.94	39.29	45.45	47	
	0.5	0.5	1.5	5.5	4	3.5	18	11	2.5	47	
All	3	5	6	15	16	20	68	56	11	200	
	1.5	2.5	3	7.5	8	10	34	28	5.5	100	
	100	100	100	100	100	100	100	100	100	100	
	1.5	2.5	3	7.5	8	10	34	28	5.5	100	

AGE										
Product: **Chocolate Chip Cookie - Control**										
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All
18 - 25 years old	1	1	2	4	5	3	18	18	10	62
	1.61	1.61	3.23	6.45	8.06	4.84	29.03	29.03	16.13	100
	50	50	40	25	29.41	10	32.73	35.29	45.45	31
	0.5	0.5	1	2	2.5	1.5	9	9	5	31
26 - 45 years old	1	1	1	9	6	18	13	18	8	75
	1.33	1.33	1.33	12	8	24	17.33	24	10.67	100
	50	50	20	56.25	35.29	60	23.64	35.29	36.36	37.5
	0.5	0.5	0.5	4.5	3	9	6.5	9	4	37.5
46 - 65 years old	0	0	1	2	3	8	20	14	4	52
	0	0	1.92	3.85	5.77	15.38	38.46	26.92	7.69	100
	0	0	20	12.5	17.65	26.67	36.36	27.45	18.18	26
	0	0	0.5	1	1.5	4	10	7	2	26
66+ years old	0	0	1	1	3	1	4	1	0	11
	0	0	9.09	9.09	27.27	9.09	36.36	9.09	0	100
	0	0	20	6.25	17.65	3.33	7.27	1.96	0	5.5
	0	0	0.5	0.5	1.5	0.5	2	0.5	0	5.5
All	2	2	5	16	17	30	55	51	22	200
	1	1	2.5	8	8.5	15	27.5	25.5	11	100
	100	100	100	100	100	100	100	100	100	100
	1	1	2.5	8	8.5	15	27.5	25.5	11	100
Product: **Chocolate Chip Cookie - 15% Cricket Powder**										
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All
18 - 25 years old	0	0	1	3	2	8	20	11	17	62
	0	0	1.61	4.84	3.23	12.9	32.26	17.74	27.42	100
	0	0	25	30	25	33.33	31.25	22	44.74	31
	0	0	0.5	1.5	1	4	10	5.5	8.5	31
26 - 45 years old	0	2	3	6	2	8	23	23	8	75
	0	2.67	4	8	2.67	10.67	30.67	30.67	10.67	100
	0	100	75	60	25	33.33	35.94	46	21.05	37.5
	0	1	1.5	3	1	4	11.5	11.5	4	37.5
46 - 65 years old	0	0	0	1	1	7	20	12	11	52
	0	0	0	1.92	1.92	13.46	38.46	23.08	21.15	100
	0	0	0	10	12.5	29.17	31.25	24	28.95	26
	0	0	0	0.5	0.5	3.5	10	6	5.5	26
66+ years old	0	0	0	0	3	1	1	4	2	11
	0	0	0	0	27.27	9.09	9.09	36.36	18.18	100
	0	0	0	0	37.5	4.17	1.56	8	5.26	5.5
	0	0	0	0	1.5	0.5	0.5	2	1	5.5
All	0	2	4	10	8	24	64	50	38	200
	0	1	2	5	4	12	32	25	19	100
	0	100	100	100	100	100	100	100	100	100
	0	1	2	5	4	12	32	25	19	100

Product: **Chocolate Chip Cookie - 30% Cricket Powder**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
18 - 25 years old	0	2	0	4	3	6	24	18	5	62	*Count*
	0	3.23	0	6.45	4.84	9.68	38.71	29.03	8.06	100	*% of Row*
	0	40	0	26.67	18.75	30	35.29	32.14	45.45	31	*% of Column*
	0	1	0	2	1.5	3	12	9	2.5	31	*% of Total*
26 - 45 years old	1	1	6	4	11	7	21	21	3	75	
	1.33	1.33	8	5.33	14.67	9.33	28	28	4	100	
	33.33	20	100	26.67	68.75	35	30.88	37.5	27.27	37.5	
	0.5	0.5	3	2	5.5	3.5	10.5	10.5	1.5	37.5	
46 - 65 years old	0	2	0	7	1	6	20	13	3	52	
	0	3.85	0	13.46	1.92	11.54	38.46	25	5.77	100	
	0	40	0	46.67	6.25	30	29.41	23.21	27.27	26	
	0	1	0	3.5	0.5	3	10	6.5	1.5	26	
66+ years old	2	0	0	0	1	1	3	4	0	11	
	18.18	0	0	0	9.09	9.09	27.27	36.36	0	100	
	66.67	0	0	0	6.25	5	4.41	7.14	0	5.5	
	1	0	0	0	0.5	0.5	1.5	2	0	5.5	
All	3	5	6	15	16	20	68	56	11	200	
	1.5	2.5	3	7.5	8	10	34	28	5.5	100	
	100	100	100	100	100	100	100	100	100	100	
	1.5	2.5	3	7.5	8	10	34	28	5.5	100	

Appendix H - SPAIN - Demographic Results-Chocolate Chip Cookies

SPAIN - Demographic Results											
GENDER											
Product: **Chocolate Chip Cookie - Control**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
Female	1	0	3	11	16	18	31	9	1	90	*Count*
	1.11	0	3.33	12.22	17.78	20	34.44	10	1.11	100	*% of Row*
	100	0	30	55	55.17	47.37	51.67	25	20	45	*% of Column*
	0.5	0	1.5	5.5	8	9	15.5	4.5	0.5	45	*% of Total*
Male	0	1	7	9	13	20	29	27	4	110	
	0	0.91	6.36	8.18	11.82	18.18	26.36	24.55	3.64	100	
	0	100	70	45	44.83	52.63	48.33	75	80	55	
	0	0.5	3.5	4.5	6.5	10	14.5	13.5	2	55	
All	1	1	10	20	29	38	60	36	5	200	
	0.5	0.5	5	10	14.5	19	30	18	2.5	100	
	100	100	100	100	100	100	100	100	100	100	
	0.5	0.5	5	10	14.5	19	30	18	2.5	100	
Product: **Chocolate Chip Cookie - 15% Cricket Powder**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
Female	0	0	4	5	5	24	25	23	4	90	*Count*
	0	0	4.44	5.56	5.56	26.67	27.78	25.56	4.44	100	*% of Row*
	0	0	66.67	38.46	35.71	61.54	46.3	42.59	22.22	45	*% of Column*
	0	0	2	2.5	2.5	12	12.5	11.5	2	45	*% of Total*
Male	0	2	2	8	9	15	29	31	14	110	
	0	1.82	1.82	7.27	8.18	13.64	26.36	28.18	12.73	100	
	0	100	33.33	61.54	64.29	38.46	53.7	57.41	77.78	55	
	0	1	1	4	4.5	7.5	14.5	15.5	7	55	
All	0	2	6	13	14	39	54	54	18	200	
	0	1	3	6.5	7	19.5	27	27	9	100	
	0	100	100	100	100	100	100	100	100	100	
	0	1	3	6.5	7	19.5	27	27	9	100	
Product: **Chocolate Chip Cookie - 30% Cricket Powder**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
Female	1	3	11	16	5	20	23	9	2	90	*Count*
	1.11	3.33	12.22	17.78	5.56	22.22	25.56	10	2.22	100	*% of Row*
	25	25	42.31	43.24	29.41	51.28	54.76	47.37	50	45	*% of Column*
	0.5	1.5	5.5	8	2.5	10	11.5	4.5	1	45	*% of Total*
Male	3	9	15	21	12	19	19	10	2	110	
	2.73	8.18	13.64	19.09	10.91	17.27	17.27	9.09	1.82	100	
	75	75	57.69	56.76	70.59	48.72	45.24	52.63	50	55	
	1.5	4.5	7.5	10.5	6	9.5	9.5	5	1	55	
All	4	12	26	37	17	39	42	19	4	200	
	2	6	13	18.5	8.5	19.5	21	9.5	2	100	
	100	100	100	100	100	100	100	100	100	100	
	2	6	13	18.5	8.5	19.5	21	9.5	2	100	

AGE											
Product: **Chocolate Chip Cookie - Control**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
18 - 25 years old	1	0	6	7	8	11	14	12	0	59	*Count*
	1.69	0	10.17	11.86	13.56	18.64	23.73	20.34	0	100	*% of Row*
	100	0	60	35	27.59	28.95	23.33	33.33	0	29.5	*% of Column*
	0.5	0	3	3.5	4	5.5	7	6	0	29.5	*% of Total*
26 - 45 years old	0	0	1	2	10	13	28	12	3	69	
	0	0	1.45	2.9	14.49	18.84	40.58	17.39	4.35	100	
	0	0	10	10	34.48	34.21	46.67	33.33	60	34.5	
	0	0	0.5	1	5	6.5	14	6	1.5	34.5	
46 - 65 years old	0	1	1	9	7	12	18	12	2	62	
	0	1.61	1.61	14.52	11.29	19.35	29.03	19.35	3.23	100	
	0	100	10	45	24.14	31.58	30	33.33	40	31	
	0	0.5	0.5	4.5	3.5	6	9	6	1	31	
66+ years old	0	0	2	2	4	2	0	0	0	10	
	0	0	20	20	40	20	0	0	0	100	
	0	0	20	10	13.79	5.26	0	0	0	5	
	0	0	1	1	2	1	0	0	0	5	
All	1	1	10	20	29	38	60	36	5	200	
	0.5	0.5	5	10	14.5	19	30	18	2.5	100	
	100	100	100	100	100	100	100	100	100	100	
	0.5	0.5	5	10	14.5	19	30	18	2.5	100	
Product: **Chocolate Chip Cookie - 15% Cricket Powder**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
18 - 25 years old	0	2	1	3	4	14	12	19	4	59	*Count*
	0	3.39	1.69	5.08	6.78	23.73	20.34	32.2	6.78	100	*% of Row*
	0	100	16.67	23.08	28.57	35.9	22.22	35.19	22.22	29.5	*% of Column*
	0	1	0.5	1.5	2	7	6	9.5	2	29.5	*% of Total*
26 - 45 years old	0	0	1	4	6	13	17	21	7	69	
	0	0	1.45	5.8	8.7	18.84	24.64	30.43	10.14	100	
	0	0	16.67	30.77	42.86	33.33	31.48	38.89	38.89	34.5	
	0	0	0.5	2	3	6.5	8.5	10.5	3.5	34.5	
46 - 65 years old	0	0	4	6	4	8	19	14	7	62	
	0	0	6.45	9.68	6.45	12.9	30.65	22.58	11.29	100	
	0	0	66.67	46.15	28.57	20.51	35.19	25.93	38.89	31	
	0	0	2	3	2	4	9.5	7	3.5	31	
66+ years old	0	0	0	0	0	4	6	0	0	10	
	0	0	0	0	0	40	60	0	0	100	
	0	0	0	0	0	10.26	11.11	0	0	5	
	0	0	0	0	0	2	3	0	0	5	
All	0	2	6	13	14	39	54	54	18	200	
	0	1	3	6.5	7	19.5	27	27	9	100	
	0	100	100	100	100	100	100	100	100	100	
	0	1	3	6.5	7	19.5	27	27	9	100	

Product: **Chocolate Chip Cookie - 30% Cricket Powder**											
	Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like Nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely	All	*Cell Contents*
18 - 25 years old	1	4	6	4	3	12	18	9	2	59	*Count*
	1.69	6.78	10.17	6.78	5.08	20.34	30.51	15.25	3.39	100	*% of Row*
	25	33.33	23.08	10.81	17.65	30.77	42.86	47.37	50	29.5	*% of Column*
	0.5	2	3	2	1.5	6	9	4.5	1	29.5	*% of Total*
26 - 45 years old	1	2	10	19	9	15	10	3	0	69	
	1.45	2.9	14.49	27.54	13.04	21.74	14.49	4.35	0	100	
	25	16.67	38.46	51.35	52.94	38.46	23.81	15.79	0	34.5	
	0.5	1	5	9.5	4.5	7.5	5	1.5	0	34.5	
46 - 65 years old	2	4	10	10	5	9	13	7	2	62	
	3.23	6.45	16.13	16.13	8.06	14.52	20.97	11.29	3.23	100	
	50	33.33	38.46	27.03	29.41	23.08	30.95	36.84	50	31	
	1	2	5	5	2.5	4.5	6.5	3.5	1	31	
66+ years old	0	2	0	4	0	3	1	0	0	10	
	0	20	0	40	0	30	10	0	0	100	
	0	16.67	0	10.81	0	7.69	2.38	0	0	5	
	0	1	0	2	0	1.5	0.5	0	0	5	
All	4	12	26	37	17	39	42	19	4	200	
	2	6	13	18.5	8.5	19.5	21	9.5	2	100	
	100	100	100	100	100	100	100	100	100	100	
	2	6	13	18.5	8.5	19.5	21	9.5	2	100	