Chapter 8
Evaluation of Consumers' Acceptance of Bread Supplemented with Insect Protein

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8.1 Introduction

8.1.1 Need for Novel Food Sources

In the next decades, the world population will reach 9 billion, which will result in a significant increase in food production, especially in animal-derived protein (Boland et al. 2013). This increase is also caused by globalization, as developing countries are adopting Western dietary habits, which are richer in the consumption of meat (Msangi and Rosegrant 2011).

This rise in meat production will exacerbate some of the livestock sector impacts on the environment—namely greenhouse gas emissions and atmospheric ammonia emissions (Gerber et al. 2013; Steinfeld et al. 2006)—and also consumer health (Aykan 2015).

With these concerns regarding the current and future sustainability of the production and consumption of meat, there is a growing urgency to change the alimentary habits to follow others that are more environmentally and economically sustainable (Burlingame and Dernini 2012). Strategies that only reduce the meat production or that just lead to slight changes in diets (greater consumption of eggs, vegetables or poultry) will only attenuate the problems and not fix them (Eisler et al. 2014). One of the solutions that have been gaining interest is the possibility of utilizing novel food sources (insects, algae, underutilized pulses) that not only allow

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M. M. Cortez Vieira et al. (eds.), *Sustainable Innovation in Food Product Design*, Food Engineering Series, https://doi.org/10.1007/978-3-030-61817-9_8

economic/environmental sustainability but also fulfill nutritional requirements (van der Spiegel et al. 2013).

8.1.2 Entomophagy in the West

Entomophagy (the practice of eating insects) dates back to the early days of humans (Sponheimer et al. 2005) and is a current practice in over 100 countries (particularly in Latin America, Asia and Africa) with more than 2000 species being consumed (Jongema 2017). Insects can be consumed for a variety of reasons: may act as complementary nutritional sources when traditional ones are not available (Randrianandrasana and Berenbaum 2015) or don't fulfill all the nutritional requirements (Bukkens 1997), or can be consumed as delicacies, due to their sensory properties (Nonaka 2009). There is also a wide variety in the way that insects are consumed: initially, they were eaten alive (van Huis 2011), but they started to be cooked (Yen 2009) and in some countries have reached a gourmet status (Nonaka 2009).

In Europe and North America, the use of insects as food has been historically neglected, mainly due to the abundance of other protein sources that are more easily available and can guarantee a good energy intake (van Huis et al. 2013). Nonetheless, there are spontaneous cases of using insects in the food industry such as the cazu marzu (traditional goat cheese from the Sardinia region) or the food dye carmine. In the last few years, a growing interest within the academic community and the emergence of several hundred companies dedicated to the production of insects for human consumption has gradually changed this scenario. Presently, there are several commercial food products incorporating insects, like protein bars (e.g., Chapul or Exo in the USA, or Jimini's in the UK) or burgers/meatballs (e.g., Damhert in Belgium or Essento in Switzerland), though these are included in a processed and non-visible form. In the West, the most commonly used insect species as human food are mealworms, crickets, grasshoppers and locusts (van Huis 2013). While the uncertainty of their legal status (especially in the European Union) (Belluco et al. 2017) and doubts surrounding food safety—namely high microbiological loads (Vandeweyer et al. 2017) and risk of developing allergic reactions (Ribeiro et al. 2018; Ribeiro et al. 2019a)—have hindered the progress of entomophagy in the West, the greatest barrier seems to be related to the rejection of edible insects by Western consumers (Cunha and Ribeiro 2019).

8.1.3 Nutritional and Environmental Advantages of Insects' Consumption

Edible insects have a high nutritional value, mainly due to their protein content, with cricket species having 60–70% on a dry matter basis, while mealworm species have a protein content ranging from 50 to 60% on a dry matter basis. Furthermore, the protein fraction of edible insects has great quality, having a sum of essential amino acids and good digestibility, very similar to other common protein sources. Fat content is also high (especially in some mealworm species), with insects being generally rich in polyunsaturated fatty acids and having a high ω6/ω3 ratio. In terms of micronutrients, edible insects are excellent sources of minerals (P, Fe, Zn, Cu, Mn and Se) and some vitamins (riboflavin, pantothenic acid, folic acid and biotin) (Ribeiro 2017).

Besides their nutritional value, insect rearing also presents advantages for environmental sustainability: production of insects for human consumption or feed leads to a lower emission of Greenhouse Gases and lower production of ammonia when compared to meat production (Oonincx et al. 2010). Their production also requires small areas of agricultural land per kilogram of protein produced (Oonincx and de Boer 2012) and leads to lower water use (van Huis 2013).

When compared to cattle and poultry, insects also present a more favorable feed conversion ratio, which allows for less feed to be used (van Huis 2013). Insects can also use organic waste as feed, which can also help to diminish food waste (Tabassum et al. 2016).

8.1.4 Sensory and Consumer Perspectives on Edible Insects

8.1.4.1 Entomophagy Rejection

Acceptance of entomophagy in the West is very low, with studies reporting that only 30–40% of Western consumers accept insects as food (Castro and Chambers IV 2018; Cunha et al. 2015). The main factors that control rejection of edible insects are food disgust and food neophobia (Cunha et al. 2015; Hartmann et al. 2015; Verbeke 2015), although food disgust seems to play a greater role than food neophobia (Hartmann and Siegrist 2018; La Barbera et al. 2018).

The disgust sensitivity scale (Haidt et al. 1994), modified by Olatunji et al. (2007), shows that there are three interculturally stable disgust dimensions: basic disgust provoked by the ingestion of non-edible objects or repulsive animals; disgust related to the animal nature of humans (e.g. observing a corpse); disgust based on contamination, induced by objects or situations that can contaminate an individual such as drinking from a glass utilized by someone else. Typically, disgust sensitivity lowers with age and women tend to show a greater disgust sensitivity than men (Hamerman 2016; Olatunji et al. 2007), which can explain why men have a higher acceptance of edible insects than women (Hartmann et al. 2015; Verbeke 2015). Food disgust is a primary emotion that can lead to the rejection of foods that consumers perceive as harmful (Chapman and Anderson 2012; Martins and Pliner 2006). Although there are certain predispositions to the acceptance/rejection of food (humans are born with a predisposition to accept sweet taste and reject bitter taste (Mennella and Bobowski 2015), individual food preferences are mostly dependent on the social and cultural environment (Fischler 1980, 1988). The elicitors of disgust can also be influenced by the cultural and social environment of the individuals (Rozin and Haidt 2013), as seen in the case of insects that are regularly consumed in several regions but provoke disgust in Western consumers. Western consumers do not view insects as food, associating them with vectors of disease, pests, spoiled food, dirtiness and lack of hygiene (Cunha et al. 2014; Looy et al. 2014; Rozin et al. 1986). Furthermore, the observation of whole insects also increases disgust reactions among consumers, because it reminds them of their animal-origin (Hartmann and Siegrist 2018). Disgust towards edible insects may not necessarily reflect a deep fear of contamination/diseases and is instead driven by social and cultural norms (Deroy et al. 2015; Jensen and Lieberoth 2019).

Food neophobia is an established psychological trait that describes a person's tendency to reject or avoid eating unfamiliar foods or foods from other cultures (Pliner and Hobden 1992). It can be greatly influenced by food-disgust sensitivity (Al-Shawaf et al. 2015), although these are two different psychological constructs (Hartmann and Siegrist 2018; La Barbera et al. 2018). This rejection can be a result of unknown origins or expected harmful consequences from consumption (Martins and Pliner 2006) but can also happen due to fear of bad sensory experiences (Pelchat and Pliner 1995). This situation applies to insects because insect-based products have low expectations of liking, sensory-profiling or even emotional-profiling (Cunha and Ribeiro 2019).

8.1.4.2 Strategies to Improve Edible Insects' Acceptance

The negative effect of food neophobia on one's willingness to eat insects can be attenuated through several rational discourses. Increasing consumers' familiarity with insects, especially through tasting sessions, can have a significant positive effect on the acceptance of insects as food (Cunha et al. 2014; Hartmann et al. 2015; Sogari et al. 2019), even for the insect species that are more accepted (Fischer and Steenbekkers 2018). Highlighting the nutritional and/or environmental benefits that are associated with the consumption of insects can be another strategy. However, it will only be truly effective for consumers who are already prone to changes in their dietary habits in accordance with their nutritional and/or environmental choices (Deroy et al. 2015; Hartmann et al. 2015; Verbeke 2015). This is caused by the fact that consumers aren't willing to give up foods conveying positive experiences (sensory properties, price, availability, ability to fit in current diets) for others who only guarantee environmental, nutritional or health-related benefits (House 2016).

Nonetheless, sensory evaluation is one of the key points evaluated by consumers when making food choices (Cunha et al. 2018), and increasing the sensory appeal of edible insects can be a more effective strategy than most communicational strategies (Hamerman 2016; Myers and Pettigrew 2018). Furthermore, developing tasty insect-based products, while associating them with positive gastronomic experiences, can lead to a lower incidence of disgust (La Barbera et al. 2018). The most common strategy to improve the sensory appeal of insect-based products is to associate insects with known flavors and dishes while incorporating them in a processed, non-visible form (Gmuer et al. 2016; Hartmann et al. 2015; Hartmann and Siegrist 2016). This is evident as both in the food industry and scientific articles most products containing insects are incorporated in a processed form such as flour, but the food matrix to be used may affect the most adequate form to incorporate the insects (Cunha and Ribeiro 2019).

Nevertheless, the sensory properties of products incorporating insects are poor and bad taste has been identified as one the major reason why consumers don't repeat the purchase of these kinds of products (House 2016). The inclusion of edible insects into food products can also lead to lower hedonic scores, less willingness to eat and poorer sensory profiles associated with negative attributes (Cunha and Ribeiro 2019; Ribeiro et al. 2019b).

Lastly, for insects to have an established place in the Western food market it is important to find a correct food categorization for them (Deroy et al. 2015) and that consumers deem the incorporation of insects as appropriate (Tan et al. 2016a, 2016b). Insects are usually presented as meat substitutes (Deroy et al. 2015) or incorporated into snack-type foods (Clarkson et al. 2018), but with these categorizations, insects are competing with already-existing food practices and are subjected to wide criteria of selection (e.g. price, sensory properties, availability, convenience) which hinders their incorporation into the regular diet of consumers (House 2016, 2018).

8.2 Goal

Considering that bread is a staple food in many Western societies, it is relevant to evaluate this food as a vector to promote the consumption of alternative protein sources, such as edible insects. In line with this thought, the main goal of this work was to assess the best predictors of acceptance of bread incorporating edible insects or edible insect protein. An online survey among regular consumers of bread was applied that sought to characterize their attitudes towards entomophagy (familiarization, motivation to try insects, willingness to consume insects, recognition of edible insect species), willingness to consume different types of bread incorporating insects and their levels of Food Neophobia and Disgust towards insects. A binary logistic regression model was applied to assess which variables better predicted the intention to consume bread incorporating insects.

8.3 Material and Methods

8.3.1 Questionnaire

An online questionnaire was applied, using Google Forms® technology, to regular bread consumers (adults and residents of mainland Portugal) between April 29th, and June 17th, 2018. A total of 282 valid answers were obtained. The questionnaire was divided into three major groups:

Group 1: Evaluation of bread consumption and purchase habits;

Group 2: Assessment of willingness to try new food products incorporating edible insects;

Group 3: Socio-demographic characterization of the participants.

8.3.1.1 Group 1

The frequency of bread consumption was evaluated based on the daily consumption of bread in the previous week. A multiple-choice increasing scale (ranging from 'none' to '4 times or more per day') was utilized. If the respondent answered "none" or "less than once a day", they would have to answer another question justifying the low consumption of bread. The answer to these two questions determined whether the respondent would be included in the sample study, as it was intended to only work with regular consumers of bread.

Additional behavioral questions included which types of bread were most consumed (white wheat bread, mix Multigrain bread, whole grain bread, etc.). The final question of this group aimed to determine if the respondents had consumed special varieties of bread in the previous year.

8.3.1.2 Group 2

Q1 - Familiarity with entomophagy was assessed through the application of the following questionnaire, adapted from Verbeke (2015), with the participant choosing the option that best describes:

No, I have never heard of the eating of insects.

I've heard that a few insects are edible.

I've heard of the eating of insects in other cultures (i.e. African and Asian).

I've heard of the eating of insects at some restaurants.

I have heard of the eating of insects but don't know what it means.

Yes, I have heard of the eating insects and I know what it means. Q2 - Willingness to try different types of bread supplemented with insects ("None"; "Whole grain bread with insect flour"; "White wheat bread with insect flour"; "Multigrain bread with dehydrated insects"; "Fiber bread with insect protein powder"; "Other") was assessed with a multiple-choice questionnaire.

Q3 - The potential for the inclusion of edible insects in the diet, adapted from Verbeke (2015), was assessed with the choice of one of the following statements: "As a meat protein substitute", "As a new ingredient to add" and "I don't actively eat insects".

Q4 - The motivation to experiment edible insects was evaluated with a multiple-choice tick all that apply questionnaire ("Nothing"; "Taste"; "To experiment new products"; "Curiosity"; "High nutritional value"; "Sustainability"; "Other").

Q5 - The Reduced Food Neophobia Scale (Pliner and Hobden 1992), modified by Ritchey et al. (2003)) was used to assess respondents' neophobia, using a 7-level ordinal scale anchored to the extremes, with the level 1 "strongly disagree" and level 7 "strongly agree" incorporating two items about food neophobia and two items about food neophilia.

In the same question, the level of insect repulsion was evaluated using the Disgust towards insects scale ((Cunha et al. 2015), adapted from Rozin et al. (2014)), evaluated over a 7-point anchored scale, going from 1-" Strongly disagree", to 7-" Strongly agree":

The idea of insects makes me nauseous.

The idea of insects makes me ill.

Eating insects is disgusting.

I am offended by the idea of eating insects.

If an insect crawls on my favorite food I won't eat it.

Q6 - The knowledge of edible insects was also assessed through an open question: "Mention, if you know, up to four insects you consider edible."

8.3.1.3 Socio-Demographic Characteristics

Information was collected about the socio-demographic characteristics of the respondents: gender; age; civil status; education level; professional status; net monthly family income and district of residence.

8.3.2 Sampling

A non-random sampling was structured by age and education level. Respondents were distinguished in three major age groups: 18 to 34 years old; 35 to 54 years old and over 55 years old and according to their level of education (with and without higher education), obtaining a total of six groups, to verify the effect of the age and educational level in the variables under study, thus maximizing the information.

8.3.3 Statistical Analysis

Statistical analysis of the data related to the questionnaires was performed through Statistical Package for the Social Sciences - SPSS® for Windows, version 25.

An exploratory factorial analysis was carried out to determine the applicability of the Disgust towards insects' scale and the Food Neophobia subscales, as variables that predict the acceptance of insect consumption among regular consumers of bread. For each scale, the applicability of the factorial analysis was assessed through the Kaiser-Mayer-Olkin (KMO) coefficient and the internal consistency with the α-Cronbach.

This analysis aimed to predict the acceptance of bread supplemented with insects among regular bread consumers using a binary logistic regression model (Hosmer and Lemeshow 2000). Through this model, we tried to predict the acceptance of the consumption of bread incorporating insects (assessed through the dichotomization of the Q2-Group 2 with 0 corresponding to "never" and 1 corresponding to any other answers). The model expresses the variation in the probability of acceptance of the consumption of bread supplemented with insects according to the following expression:

$$p_i = \left(\frac{e^{(Z_i)}}{1 + e^{(Z_i)}} \right) = \left(\frac{1}{1 + e^{-(\beta_0 + \beta_1 X_{1i} + \ldots + \beta_k X_{kn}}} \right) \tag{8.1}$$

It was intended to determine the relationships between the variables and predict the value of the variable dependent (or response) from a set of independent variables (or predictors). These relationships may be of functional dependence (the magnitude of the dependent variable is a function of the magnitude of the independent variable(s), although the reverse is not applicable) or mere association (none of the variables can be dependent on the other, varying only together) (Marôco 2010). To facilitate the interpretation of the model, variables were dichotomized, such as the education level - higher education (0-no; 1-yes); the intention to consume insects (0- "nothing"; 1-yes), familiarization with insect consumption (0- "I had never heard of eating insects"; 1- "I heard…"), or the consumption of special varieties of bread (0-no; 1-yes).

Starting from a saturated model, with the various variables under analysis, the best model was selected through stepwise backward elimination, based on Ward statistics. The quality of the final model was evaluated, through its correction on the prediction and the pseudo coefficient determination (R^2) of Nagelkerke.

8.4 Results and Discussion

8.4.1 Socio-Demographic Characteristics of the Participants

Initially, 282 questionnaires were obtained. After analysis of the answers to the frequency of consumption of bread, questionnaires from participant whom either "do not consume bread" or consumed bread "less than once per day" were eliminated, given that they did not represent a population of regular consumers of bread. This way, 226 valid questionnaires were obtained for this study.

Concerning the socio-demographic characteristics of the participants (Table 8.1), 61% of the participants were female and 65% had age between 35 and 54 years old. The age of the participants ranged between 22 and 78 years old (average 42.0 ± 11.3). Concerning the education level, most of the participants (74.8%) had high education. Furthermore, most of the participants were married (68.1%). Regarding the

Table 8.1 Socio-demographic characteristics of the participants

Characteristic		*n* (%)
Sex	Male	88 (38.9%)
	Female	138 (61.1%)
Age group (years)	[18;34]	51 (22.6%)
	[35;54]	147 (65.0%)
	≥55	28 (12.4%)
	Average (±SD)	42.0 (± 11.3)
Civil status	Single	53 (23.5%)
	Married	154 (68.1%)
	Divorced/separated	17 (7.5%)
	Widower	2 (0.9%)
Education level	Without higher education	57 (25.2%)
	With higher education	169 (74.8%)
Net monthly family income (€/month)[a]	[485; 900]	23 (10.2%)
	[900; 1500]	50 (22.1%)
	[1500; 2400]	66 (29.2%)
	[2400; 3600]	40 (17.7%)
	≥3600	11 (4.9%)
	Don't know/did not answer	36 (15.9%)
Region of residence	North	97 (42.9%)
	Center and south	129 (57.1%)

[a]National minimum wage of 580 € /month

monthly household income, most of the participants had values between 1500 and 2400 €/month (29.2%).

8.4.2 Characterization of Bread Consumption

Regarding the types of bread that are consumed regularly, there is a predominance of mixture bread (52.0%) and white wheat bread (49.3%), followed by multigrain bread (38.1%), rye bread (28.7%) and whole grain bread (23.3%).

Most participants did not consume any type of specialty bread (65.9%) in the last year (Table 8.2). Of the different types of specialty bread, the ones which were most consumed were low salt bread (14.1%), fiber+ bread (12.3%) and prokorn bread (12.3%).

8.4.3 Familiarization with Insect Consumption

Regarding the level of familiarization with insect consumption (Table 8.3), only 10.2% of the participants did not know this practice. Most of the respondents knew that insects are eaten in African and Asian cultures (38.9%) or that insects are eaten, understanding what that means (35.8%). This high degree of familiarization with the concept of entomophagy among Portuguese consumers has already been reported (Cunha et al. 2015), and has very similar levels to studies with other European (Verbeke 2015) and North American (Tao and Li 2018) consumers. Familiarization with the concept of entomophagy can increase its acceptance (Cunha et al. 2014; Hartmann et al. 2015), but performing tasting sessions can have a greater effect on acceptance since consumers become more familiarized with the sensory properties of insects (Sogari et al. 2017, 2019).

8.4.4 Willingness to Try Edible Insects

Most of the respondents (58%) would not regularly consume insects in their diets, a very similar percentage to the participants who would not try any type of bread incorporating insects. On the other hand, 23.9% of them would use them as new ingredients and 15.5% would use insects as meat substitutes.

The majority of the participants (57.8%) would not consume any of the types of bread supplemented with insects (Table 8.4). Other studies with Western consumers have shown similar levels of unwilling tasters of products incorporating processed insects (Castro and Chambers Iv 2018; Kostecka et al. 2017; Lammers et al. 2019).

Concerning the different types of bread supplemented with insects, "special" types of bread (whole wheat and fiber) incorporating processed insects had the highest acceptance (26.2% and 25.8%, respectively), being higher than the acceptance of white wheat bread with insect flour (16.0%). The type of bread with the lowest acceptance was Multigrain bread with dehydrated insects (13.3%). These results mirror the higher acceptance of products incorporating insects in a processed, non-visible form that is extensively reported in the literature (Gmuer et al. 2016; Hartmann et al. 2015; Hartmann and Siegrist 2016). The higher preference for specialty bread (whole-grain bread and fiber bread) over white wheat bread could have happened because consumers of specialty bread are more predisposed to consume bread incorporating insects (Table 8.6).

Table 8.2 Types of specialty bread consumed within the last year

Type of specialty bread	*n* (%)
Don't consume these types of bread	145 (65.9%)
Low salt bread	31 (14.1%)
Fiber+ bread	27 (12.3%)
Prokorn bread	27 (12.3%)
"São Coração" bread	14 (6.4%)
Gluten-free bread	12 (5.5%)
"Vida" bread	9 (4.1%)
"São Diabéticos" bread	2 (0.9%)

Table 8.3 Level of familiarization with insect consumption

Statement	*n* (%)
I have heard that in some African and Asian cultures insects are eaten	88 (38.9%)
I have heard that insects are eaten, and I know what that means	81 (35.8%)
I have heard that some insects are edible	28 (12.4%)
I have never heard about eating insects	23 (10.2%)
I have heard that in some restaurants, insects are eaten	4 (1.8%)
I have heard that insects are eaten, but I don't know what that means	2 (0.9%)

Table 8.4 Willingness to eat different types of bread incorporating insects

Types of bread	*n* (%)
None	130 (57.8%)
Whole grain bread with insect flour	59 (26.2%)
Fiber bread with powdered insects	58 (25.8%)
White wheat bread with insect flour	36 (16.0%)
Multigrain bread with dehydrated insects	30 (13.3%)
Other	6 (2.7%)

8.4.5 Motivations to Try Insects

Most respondents (40.4%) demonstrated a great reluctance to eat insects, mentioning that nothing would lead them to try them. Curiosity or willingness to try new products (53.8%) is the factor most respondents mentioned that would motivate them to try insects. The sustainability (30.2%) and high nutritional value (20.4%) are also important factors that would motivate participants to try edible insects. Previous works have reported that consumers who are more willing to try edible insects are looking for new food experiences and/or are aware of the nutritional and environmental impacts of their food choices (House 2016; Sogari et al. 2017). Lastly, only 8.0% of the participants mentioned the taste of insects as motivating factors to try edible insects, which further highlights that either consumers have poor knowledge regarding the sensory properties of insects or have expectations of bad sensory experiences caused by consumption of insects (Cunha and Ribeiro 2019).

8.4.6 Edible Insect Species

Regarding the insect species that the respondents considered edible (Table 8.5), the most mentioned species were grasshoppers (30.5%), crickets (18.8%), mealworm (16.7%) and ants (15.6%). The presence of grasshoppers, crickets and mealworms

Table 8.5 Species of insects' participants deemed as edible

Edible insect species	*n* (%)
Grasshoppers	86 (30.5%)
Crickets	53 (18.8%)
Mealworm	47 (16.7%)
Ants	44 (15.6%)
Cockroaches	23 (8.2%)
Scarab	12 (4.3%)
Spiders and scorpions	12 (4.3%)
Worms	10 (3.5%)
Caterpillars	6 (2.1%)
Cicadas	4 (1.4%)
Others	12 (4.3%)

is not surprising since these species are currently the most marketed in the West and the ones which are more accepted by consumers (Fischer and Steenbekkers 2018).

8.4.7 Disgust and Food Neophobia

The "Disgust towards insects" scale has a robust factorial structure (Table 8.6), with all the items of the scale presenting a high factorial loading. The reliability of this scale was also good (α-Cronbach = 0.884).

On the other hand, the Reduced Food Neophobia Scale proved not to be unidimensional, splitting into two subscales: Food Neophilia and Food Neophobia.

Furthermore, the Food Neophilia subscale and the Disgust Scale had a negative correlation (−0.172) as well as the Food Neophilia and Food Neophobia subscales (−0.268) (Table 8.7). On the other hand, the Food Neophobia subscale had a strong correlation with the Disgust Scale (0.553).

8.4.8 Variables Prediction of Acceptance of Insects

Results obtained from the application of the binary logistic regression model (Table 8.8), following a stepwise approach, allowed to observe which variables significantly predict the acceptance of bread supplemented with insects. The main predictor of the acceptance of the bread was the willingness to try insects, given that participants who are willing to eat insects have a probability of 40.6 times higher to accept consuming bread with insects than those who are not willing to try insects.

Gender also plays a significant role, with men being 2.68 times more likely to accept bread with special types of insects. Several studies have shown that males have a higher acceptance of entomophagy (Hartmann et al. 2015; Verbeke 2015;

Table 8.6 Factorial analysis of the Disgust towards insects' scale and of the food neophilia and food neophobia subscales

Scale/Items	Average (±S.D)	Loadings
Disgust towards insects scale (KMO = 0.844; explained variance = 68.5%; α-Cronbach = 0.884)	3.7 ± (0.12)	
Just thinking about insects makes me nauseous	3.6 ± (0.15)	0.892
Just thinking about insects makes me sick	3.3 ± (0.16)	0.874
Eating insects is disgusting	4.1 ± (0.15)	0.867
I get offended by the idea of eating insects	2.5 ± (0.13)	0.789
If an insect crawls over my favorite food I no longer eat it	4.9 ± (0.14)	0.702
Food neophilia (explained variance = 39.4%; α-Cronbach = 0.730)	4.3 ± (0.12)	
I like food from different countries	4.7 ± (0.14)	0.769
I constantly try new and different foods	4.0 ± (0.13)	0.729
Food neophobia (explained variance = 36.0%; α-Cronbach = 0.603)	3.30 ± (0.11)	
If an insect crawls over my favorite food I no longer eat it	2.6 ± (0.12)	0.587
If I do not know the ingredients in a food, I do not try it	3.4 ± (0.13)	0.548

Table 8.7 Correlation between the disgust scale and the Food Neophobia subscales

Scale/Scale	Disgust scale	Food neophilia
Food neophilia	−0.172	
Food neophobia	0.553	−0.268

Woolf et al. 2019). This can be explained by the fact that in general, men are less sensitive to disgust than women and have a lower animal reminder disgust sensitivity (Hamerman 2016).

Consumption of special varieties of bread can also positively influence the acceptance of bread with insects (Exp(β) = 2.54). Consumers of these types of bread have been described as health-conscious in their food choices (Meyerding et al. 2018), which can lead to a higher acceptance of novel ingredients such as insects.

On the other hand, each point increment on the neophilia scale lead to an increase (Exp(β) = 1.56) in the acceptance of bread incorporating insects. This data is consistent with the identification of 'curiosity' and 'willingness to try new products' as the main motivators to try edible insects. Conversely, a point increase in the Disgust Scale halved the probability of accepting bread with insects (Exp(β) = 0.51). Previously, both Food Disgust and Food Neophobia have been identified as mains factors controlling acceptance of insects as food (Cunha et al. 2015; Hartmann et al. 2015; Verbeke 2015), though recent studies (Hartmann and Siegrist 2018; La Barbera et al. 2018), as well as the results of our work, have shown that Food Disgust plays a greater role in predicting willingness to try edible insects, further highlighting that the consumption of insects needs to be associated with positive experiences in order to reverse the induction of dis**gust.**

The R^2-Nagelkerke of 0.676 indicates a high predictability of this model. This model predicts the answer "No availability to consume bread with insect protein" in

Table 8.8 Variables prediction of acceptance of bread incorporating insects

Significant variables	B	Sig	Exp(B)
Willingness to try insects (0 = no; 1 = yes)	3.705	<0.001	40.6
Sex (0 = female; 1 = male	0.984	0.023	2.68
Consumption of specialty breads (0 = no; 1 = yes	0.933	0.032	2.54
Food Neophilia subscale	0447	0.001	1.56
Disgust scale	−0.678	<0.001	0.51
Constant	1.088	0.139	2.97

R^2-Nagelkerke = 0.676

85.4% of the cases and the answer "Some availability of consuming bread with insect protein" in 83.3% of the cases. Globally, this equation/model, predicts 84.5% of the answers. Moreover, the set of variables allows to obtain a model of prediction with a sensitivity value of 80.8% (80/99) and specificity of 87.4% (111/127).

8.5 Conclusion

The results of this work support the current knowledge regarding the Western consumer's attitudes towards entomophagy. The participants of this study showed a high degree of familiarity with the concept of entomophagy, which could have also influenced the insect species they deemed as edible. Concerning the willingness to try different types of bread incorporating insects, a higher acceptance was verified for special-type bread (e.g. wholegrain and fiber bread) incorporating insects in a processed, non-visible form. Consumers of special-type bread were also shown to have higher acceptability of edible insects, most likely because these consumers are more willing to try new ingredients and are more conscious of the health and nutritional effects of their food choices.

Disgust towards insects plays a major role in the rejection of entomophagy, which could have contributed to the gender impact on the acceptance of insects. The role of food disgust was greater than food neophobia, although the subscale of Food Neophilia also predicted the acceptance of edible insects, which is not surprising since the novelty of edible insects is one the main factors that can lead to consumers tasting them.

These results further confirm the necessity of continuing to popularize the concept of entomophagy, so consumers become more familiarized which contributes to higher acceptance. Furthermore, it is also necessary to promote the advantages associated with the consumption of insects to reach the types of consumers who are more predisposed to include insects into their diets. Lastly, positive ideas have to be associated with the consumption of insects to reduce the reactions of disgust triggered by insect consumption.

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