The Role of Emotion in the Acceptance of Insect-Based Foods

Master Thesis

Wenyang Jiao

April 2024

Wageningen University

Page intentionally left blank

Master Thesis

The Role of Emotion in the Acceptance of Insect-Based Foods

Course Number: MCB80436

Student Name: Wenyang Jiao

Student Number: 1069462

Supervisor: dr. Arnout Fischer

Page intentionally left blank

Table of Contents

Abstract

This study reveals the role of emotion in consumer acceptance of insect foods. As global food demand increases, insect protein has emerged as an alternative to meat. The research explores how the visibility of insect ingredients in food and consumers' familiarity with the food trigger emotional responses, and how emotions influence consumer acceptance. The findings showed that the visibility of insect components significantly affected emotions, such as fear and disgust, and that these emotions were inversely related to acceptance. On the other hand, emotions associated with lower visibility, such as trust and joy, have a positive impact on acceptance. This study contributes to understanding the role of emotional factors in food consumption, particularly in the context of emerging foods. It has practical implications for marketing strategy and product development in the food industry, emphasizing the importance of managing consumer sentiment to increase acceptance of sustainable food innovations.

Page intentionally left blank

1 Problem Statement

As the global population surges, so does the demand for food. According to the FAO (2017), the world's population will reach 9.5 billion by 2050 and 11.7 billion by the end of this century. At the same time, 11% of the world's population is currently suffering from hunger and this number is still growing, nutritional shortages have become one of the recognized causes of death (Food & Nations, 2017). The current food system is not sufficient to meet the needs of the global population, and over time, food shortages will be more serious. On the other hand, traditional meat production has been increasingly criticized for being unsustainable due to its large resource footprint, including land, water and energy use (Liu et al., 2020). The environmental consequence includes land degradation through overgrazing, significant impacts of greenhouse gas emissions on air pollution, and large-scale deforestation (Bonnet et al., 2020).

There is a need for alternatives to the current protein sources to shift towards a healthy and sustainable diet. In recent years, there has been a growing interest in exploring alternative protein sources that require fewer resources to produce. As a result, food science and technology research aimed at developing and discovering alternative protein sources that provide humans with adequate nutrition while having less environmental impact (Grossmann & Weiss, 2021). One of the popular research directions with high hopes is insect protein.

Insects are a highly nutritious food source with a high protein content, often over 60% (Belluco et al., 2013). For example, cricket protein has a better amino acid structure than soy protein, making it a good dietary choice (Finke et al., 1989). Furthermore, the digestibility of insect proteins ranges from 77% to 98% (Ramos-Elorduy et al., 1997). Caterpillars and termites are higher in fat and may provide more essential fatty acids than traditional meats (Bukkens & Paoletti, 2005). A balanced fatty acid intake is important for health, so insects can play a beneficial role in the human diet (Belluco et al., 2013).

Another advantage of insects is that their production is relatively environmental friendly (Hartmann & Siegrist, 2018). For example, mealworms require 14 times less land and 5 times less water than beef to produce the same amount of edible protein, highlighting significant less in resource use (Miglietta et al., 2015; Oonincx & de Boer, 2012). Furthermore, cattle emit 6–13 times more CO_2 equivalents than mealworms (Oonincx & de Boer, 2012).

Although some insects can have a higher feed conversion rate and less land use footprint than traditional livestock industries, the sustainability of the insect food industry has not yet been determined, depending on the type of insects raised, the type of feed, waste utilization (Berggren et al., 2019).

2 Literature Review

2.1 Insects as food

In Western countries, people usually find eating insects unappetizing, while protein is largely obtained from animals and crops (Raheem et al., 2019). On the other hand, in areas such as East Asia, Africa, and South America, insect-eating is more common and is not solely a result of hunger or survival, insects are harvested from the wild and are part of the traditional diet (Raheem et al., 2019; Van Huis, 2013). Insects have been used as food by the ancient Chinese for over 3200 years, a well-known example is the cultivation of silkworms (Yi et al., 2010). Silkworms not only provide raw materials for silk products but are also widely consumed as food (Costa-Neto & Dunkel, 2016). Although the diets of Chinese people have evolved with time, the tradition of consuming insects still prevails. Insects like bamboo worms and silkworms are still consumed by various ethnic groups in many regions of China. For instance, the Bai ethnic minority in Yunnan province continues to practice this tradition (Chen et al., 2009).

There is a resistance to eating insects in Western cultures, as they are often perceived as unclean and not for consumption (Looy et al., 2014). Schösler and Boersema (2012) investigated the willingness of Dutch consumers to adopt several meat alternatives, including salad with fried mealworms or locusts and pizzas containing insect proteins. Meat substitutes with visible insects were rated much more negatively in terms of their attractiveness and preparation possibilities than other options. A study of Belgian consumers by Verbeke(2015) found that only 19.3% of the sample showed a willingness or readiness to adopt insects as food.

Although most Western consumers are resistant to insects, the possibility exists to promote insects in the West, especially in Europe. Authorization from the European Food Safety Authority (EFSA) could encourage the use of new ingredients in the European market and thus stimulate innovation in the food industry (de Boer & Bast, 2018). In January 2021, the

European Union (EU) approved the marketplace of 'frozen and freeze-dried lesser mealworm formulations' as a new novel food after receiving a positive opinion from EFSA (Commission, n.d.). This marks the fourth approved novel insect food by the EU, with eight others currently awaiting approval. As more insect foods are introduced to the market, it is important to understand consumer attitudes towards them. This study focuses on insect food but from a consumer attitude perspective.

2.2 Factors that influence the acceptance of insect food

There have been many studies on the acceptance of insect food and the factors influencing it in Western countries, and the number of studies is increasing. Woolf et al. (2019) found in their study that exposure is one of the factors that influence consumer attitudes toward insect food. This was also confirmed in the study of Barton et al. (2020), where consumers' attitudes toward insect food were more positive after increasing their familiarity with it. The extent of processing is an influential factor in consumer acceptance of insect-based foods. For instance, Gmuer et al. (2016) conducted an experiment using chips with varying levels of insect content to gauge consumer emotions. Their findings indicate that chips with less visible insect content received more favorable emotional responses from participants.

Although there are few studies on the sensory properties of insect food, many studies have shown that sensory satisfaction is one of the motivations for consumers to decide whether to use insect products as food (Awobusuyi et al., 2020; Onwezen et al., 2019). In addition to this, factors such as culture and social norms also impact the choice of insect food. For example, insects are not considered as food in some specific cultures, but a food taboo, in some Muslim countries like Indonesia, insect consumption is seen as an unallowed practice, even sinful (Batat & Peter, 2020).

Besides these factors, several studies have documented the emotional reactions of consumers when insects are consumed. Lammers et al. (2019) showed that for German consumers food disgust was the main reason for rejecting insect consumption. The novelty of insect products makes emotional factors have a significant impact on consumer choice. As Onwezen et al. (2019) suggests, that emotional factors are a future research direction because they have been shown to influence food choice, but there is limited research on the current role of emotional factors in the acceptance of insect foods. Therefore, further exploration of the emotional

responses elicited by insects is needed and will serve as a reference for future interventions on insect acceptance.

It is already known that people's eating habits are affected by emotions, and attitudes toward food also deviate under different emotional states (Jiang et al., 2014; Polivy & Herman, 1999). On the other hand, the topic of food's impact on emotion and how emotion influences consumer preferences are also worthy of study. Gutjar et al. (2014) found that relying on liking rates alone cannot accurately predict market success, while consumers' emotional responses to food can provide additional information. Ismael and Ploeger (2020) also concluded that the emotion caused by food will affect the preference for the consumption of organic food, which is the same as the research result of Mojet et al. (2015). These studies all show that assessing the emotions evoked by food has the potential to predict consumer preferences and product development.

2.3 Insects and emotions

Researchers have made efforts around the theme of emotions. However, most research on the association between emotions and insect acceptance has focused on disgust or fear (Kröger et al., 2022). Currently, only a few papers (Gmuer et al., 2016; Onwezen et al., 2019; Schouteten et al., 2016) have extended the range of emotions studied.

For instance, in the experiments of Gmuer et al. (2016), a list with 39 positive and negative emotions was used. Although various emotions were applied to these studies, a lack of diversity in the types of insect food used in the research. For example, Gmuer et al. (2016) showed tortilla chips containing insects with different visibility to respondents, focusing on the effect of the visibility level of insect food. Schouteten et al. (2016) used insect burgers. Onwezen et al. (2019) included a variety of insect foods (like insect burgers, fried insects, and dried insects) based on the level of processing. Furthermore, Onwezen et al. (2019) found that the more novel the products are perceived to be, the more consumers rely on their emotional process to decide whether to buy them or not.

This study aims to bridge the gap in research concerning the emotional responses to insect-based foods. Due to the lack of sufficient research on the emotional responses of consumers towards insect food and the impact it has on their decision-making, this study aims to investigate the connection between insect food and consumer emotions and how acceptance

is affected. This will be done by examining the effect of insect visibility and consumers' familiarity with foods on their emotional response, along with the willingness to consume insect foods. It will investigate these elements both separately and interact with one another to better understand their impact on consumer acceptance. This approach will offer novel insights into the emotional dynamics that shape consumer behavior towards edible insects.

The main research questions can be stated as follows:

- To what extent do the visibility and familiarity of insect material in insect-based food affect the intensity of the emotion?
- What impact do different emotions being triggered have on consumer acceptance?

2.4 Emotions—Basic Emotions Theory

In the dictionary, emotion is defined as, 'a mental feeling or affection (pain, desire, hope, etc.) distinct from cognition or volition' (Dictionary, 1989). The definition of emotion is inconclusive, but many examples can be given when referring to emotion: anger, joy, sadness, and so on. Among so many words to describe emotions, many scholars try to classify or filter many emotions, such as Russel (1980) and Ekman (1992). By now, most emotion theorists agree that a small number of emotions have a special status (Ortony, 2022). These special emotions are often referred to as 'basic emotions'. Basic emotion theory suggests that humans have a limited number of emotions and that these emotions are biologically and psychologically 'basic' (Wilson-Mendenhall et al., 2013). Basic emotion theory was originally proposed by Ekman (1992), who summarized seven basic emotions shared by humans, which are anger, joy, fear, surprise, sadness, contempt, and disgust. These non-verbal signals of emotions (facial expressions and physiological responses) are recognized cross-culturally (Pantic & Rothkrantz, 2003). Following this, scholars have proposed other categorical emotion models, of which Plutchik's emotion wheel is the best known (Plutchik, 1991; Semeraro et al., 2021). In its emotion wheel, there are 8 basic emotions (Anger, Anticipation, Joy, Trust, Fear, Surprise, Sadness, and Disgust), each with 3 intensity levels, as shown in Table1.

Table 1. *Plutchik's basic emotions with 3 degree-intensity (Plutchik, 1991).*

Lower Intensity	Emotion	Higher Intensity
Interest	Anticipation	Vigilance
Serenity	Joy	Ecstasy
Acceptance	Trust	Admiration
Apprehension	Fear	Terror
Distraction	Surprise	Amazement
Pensiveness	Sadness	Grief
Boredom	Disgust	Loathing

This study is based on Plutchik's basic emotion theory, because it has been seriously demonstrated and has a high degree of recognition in the field, and it is one of the most commonly used theories in emotion research. But at the same time, this study screened the expected emotional responses, that is, six emotions, anticipation, joy, trust, fear, surprise, and disgust were retained. A discussion of these six emotions will be made in a later section. Although a review concluded that two emotions, sadness and anger, were found to be triggered by food, even anger was mentioned in four pieces of literature and classified as a high-frequency word (Jiang et al., 2014). However, negative emotions were summarized as anger, sadness, and guilt in Onwezen's (2019) research on the impact of emotional factors on consumers' acceptance of insects as food. The results interestingly showed that these negative emotions did not significantly affect consumers' acceptance of insect food. This emotion research in the field of insects shows the value of anger and sadness more convincingly, so this study focuses on exploring the research value of the remaining six emotions.

3 Conceptual Framework

Previous sections discuss the link between food traits (visibility and familiarity), emotions, and food acceptance, to fully test these links, a conceptual framework is proposed below, and few hypotheses can be made.

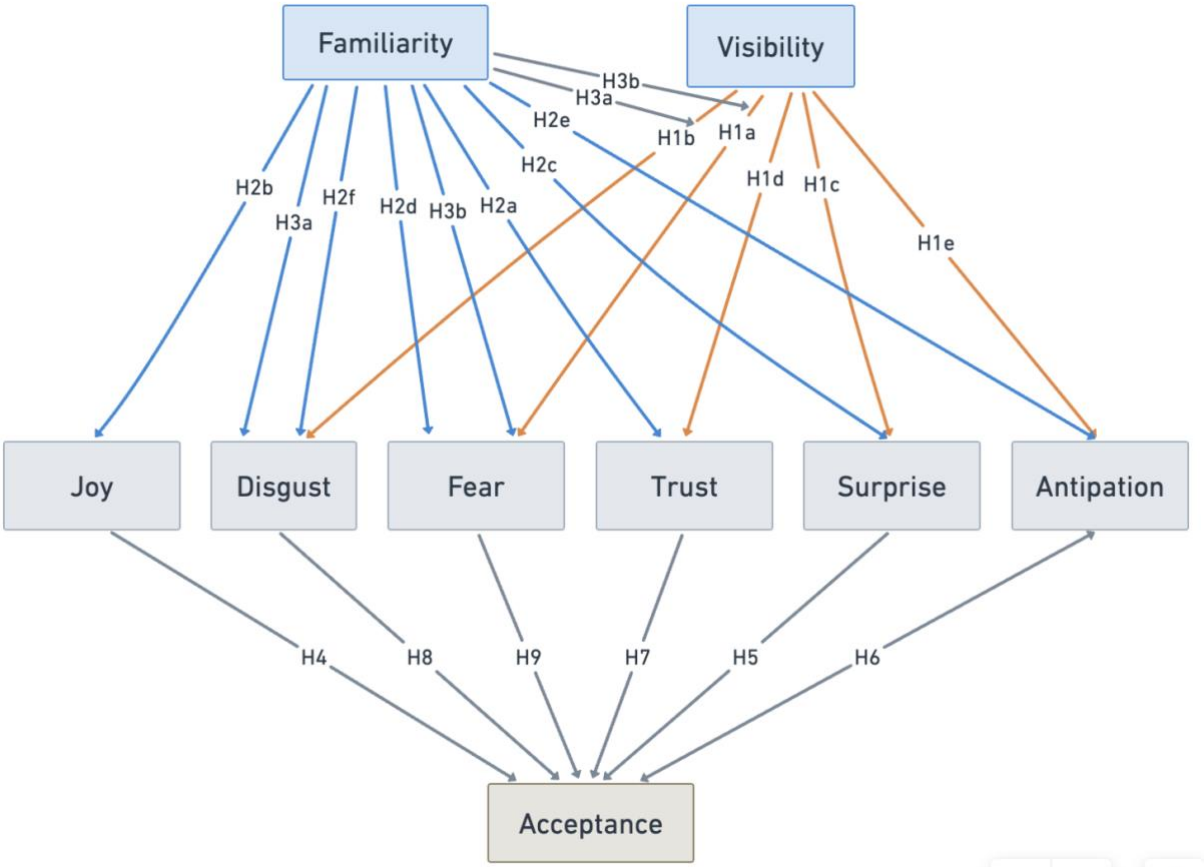

Figure 1. *Conceptual framework*

3.1 Visibility and familiarity

Research on the emotional experience of different types of insect food is necessary to identify potential products and guide development. Although the acceptance of insects by consumers in Western countries is generally low, studies have shown that the visibility of insects in food can greatly affect the evaluation of Westerners. A study on culture and familiarity with insect-eating intentions showed that the visibility of insects in food affects the intention to try, with some Dutch participants suggesting that reduced visibility (eg. insect crackers) would make the food more visually appealing (Tan et al., 2015). In addition to this, Hartmannn et al. (2015) also showed that German consumers are more willing to eat processed foods, such as cricket biscuits, and silkworm drinks, while Chinese are more accepting of low-processed foods such as fried silkworms and crickets (Hartmann et al., 2015). Gmuer et al. (2016) conducted a study on the emotional responses induced by different processing degrees of insect components in food, and the results showed that the

higher the processing degree of insect components, the more positive the consumer's emotions, which had a positive impact on acceptance.

H_{1abc}: Having high-visibility insect food triggers higher levels of fear(H_{1a}) and disgust(H_{1b}) as well as surprise(H_{1c}) emotions compared to low-visibility food compared with low-visibility food.

H_{1de}: Having low-visibility insect food triggers a higher intensity of trust(H_{1d}) and anticipation(H_{1e}) emotions than high-visibility food compared to high-visibility food.

Another reason that processed insect foods are more popular is the greater familiarity of consumers with certain processed foods. Current means of increasing product familiarity include incorporating insect ingredients and retaining familiar flavor profiles in familiar products (Hartmann et al., 2015). For example, black soldier fly larvae fat can replace 25% of butter in bakery products without changing consumer experience and preferences (Delicato et al., 2020). Currently, insect-processed foods that have been developed include energy bars containing insect protein, insect burgers, and pasta (Orsi et al., 2019). So we make the following hypotheses：

H_{2ab}: Compared with low-familiarity foods, high-familiarity insect foods will trigger higher levels of trust(H_{2a}) and joy(H_{2b}).

H_{2cdef}: Compared with high-familiarity foods, low-familiarity insect foods trigger higher intensity surprise(H_{2c}), fear(H_{2d}), anticipation(H_{2e}), and disgust(H_{2f}).

It is also worth noting that two characteristics, visibility and familiarity, can exist simultaneously in insect food. It is assumed that consumers will be influenced by both characteristics and that their emotional responses will be different from those triggered by a single characteristic. From a limited number of studies, it can be found that high consumer familiarity with the product with equally low visibility further increases positive emotional experiences (Gmuer et al., 2016; Schouteten et al., 2016). We hypothesized that high familiarity would reduce the intensity of negative emotions from high visibility, i.e. the intensity of disgust and fear.

H_{3ab}: Compared with low familiarity, the high familiarity feature negatively affects the intensity of high-visibility-triggered disgust(H_{3a}) and fear(H_{3b}).

3.2 Mediators: emotions

In recent years, considerable attention has been paid to food-induced emotions, as emotions are closely related to food acceptance (Piqueras-Fiszman & Jaeger, 2014a, 2014b). Disliking unfamiliar foods is strongly associated with negative emotions, such as fear and disgust (Shim et al., 2019); whereas positive emotions, such as joy, happiness, and satisfaction, are significantly positively associated with food liking (Cardello et al., 2012).

H_4: Joy leads to higher acceptance.

Recent research suggests that to achieve higher customer satisfaction and move beyond satisfaction to delight customers, it is necessary to surprise them (Vanhamme & Snelders, 2001). As an emotion, surprise is neutral and can be influenced by other emotions, either positively or negatively (Vanhamme & Snelders, 2001). Hence, surprise is the key to customer satisfaction and acceptance (Kim & Mattila, 2010).

H_5: Surprise can lead to a higher or lower acceptance

Research has shown that cognitive expectations and affective projections formed during the anticipation process may affect the satisfaction (Vichiengior et al., 2019). For example, satisfaction was found to be negatively affected by negative anticipatory emotions, defined as emotions in anticipation that "some event will be experienced in the future if it happens or does not happen" (Baumgartner et al., 2008).

H_6: Anticipation can lead to a higher or lower acceptance

When consumers are unfamiliar with new food technologies, they rely on others' assessments and trust can reduce the complexity of decision-making (Earle & Cvetkovich, 1995). Also, lack of trust in information sources increases risk perception and thus reduces food acceptance (Richard Eiser et al., 2002). There is relatively little research on whether food can induce feelings of trust, and most research on trust and food acceptance does not link trust with the food itself. Past studies have shown that social trust in the food industry and research

institutions can directly affect public acceptance of nanotechnology foods and genetically modified foods (Siegrist, 2000; Siegrist et al., 2007)

H_7: Trust leads to higher acceptance.

Disgust as a universal basic emotion is thought to protect people from potential sources of disease (Haidt et al., 1994). Davey (1994) defines disgust as a rejection response in which food is disgusted because of their conceptual attributes, such as composition, origin, social history (eg who touched them or ate them), etc. (Martins & Pliner, 2005). Disgust is one of the reasons for refusing insects as food, and food disgust sensitivity can have a significant impact on consumers' eating habits, preferences, and even behavior (Egolf et al., 2019; Hartmann & Siegrist, 2018)

H_8: Disgust leads to decreased acceptance of food.

"The oldest and strongest emotion of man is fear, and the oldest and strongest fear is the fear of the unknown" (Joshi & Schultz, 2001). Fear is an adaptive defense mechanism in animals that is measurable, i.e., the ability to realize that one is in danger (Mobbs et al., 2019; Ornell et al., 2020). The emotion of fear has not received much mention in the sensory and consumer domains (Gómez-Corona et al., 2021). However, we can still find some examples, such as Laros & Steenkamp (2004) found that Dutch consumers have a clear general fear of gene-edited food, this fear stems from distrust of new technology, which will lead to a decline in sales of gene-edited food and smaller market potential. A survey by Wansink & Brumberg (2014) proves that people's concerns about health risks can lead to food fears.

H_9: Fear has a negative impact on acceptance.

4 Methodology

4.1 Participants and design

Researchers who study food have two ways to collect data: either use real product samples or food names with images. With the rise of Internet-based research, using food images and names has become easier than ever before as study participants can be located anywhere. The purpose of this study is to investigate how people respond emotionally to different types of food stimuli, both real and conceptual, through online research. A 2 (visibility: low vs. high)

x 2 (familiarity: low vs. high) between-subjects design was implemented. Participants were randomly assigned, with equal probability, to one of four experimental conditions corresponding to the product variations. Convenience sampling was employed by distributing invitations to a students' WhatsApp group and by placing posters on the bulletin board.

4.2 Stimuli

To effectively measure the impact of visibility and familiarity on emotional response and acceptance, the study developed a set of food stimuli with differing levels of these attributes. Considering the cultural context, certain oriental foods might be less familiar to Western consumers. As such, oriental food was used as a template for low-familiarity foods. For high-familiarity foods, commonly consumed Western items were selected and modified to incorporate insect protein while altering their visibility. Following this basis, 8 food stimuli were created. The stimuli were finalized after a pre-test, which helped ascertain the appropriate level of familiarity and visibility. The outcomes of the pre-test are detailed in Appendix 1. The final stimuli can be seen in Table 2.

Table 2. *Food Stimulus*

	Low visibility	High visibility
Low familiarity	 Pupae mooncake	 Pupae Zhu Cha
High familiarity	 Pupae brownie	 Pupae salad

In the survey, the stimuli are detailed as follows:

a) Pupae mooncake is a bakery product, which consists of a pastry skin enveloping a filling mixed with pupae flour.
b) Pupae Zhu Cha is a drink made by boiling sun-dried pupae in water with mulberry leaves and topping it with cotton candy.
c) Pupae brownie is a type of brownie that contains pupae flour as one of its ingredients.

d) Pupae salad is a dish made with the juvenile stage of pupae and fresh vegetables.

4.3 Measures

The primary variables measured in this experiment were the type and intensity of emotional responses to insect-based food products and the consumers' acceptance of these foods. Emotional responses were quantified based on Plutchik's emotional wheel, each with three levels of intensity. As shown in Figure 2, a seven-point Likert scale was utilized to measure these responses, ranging from 1 (not feeling at all) to 7 (highest intensity of the measured emotion).

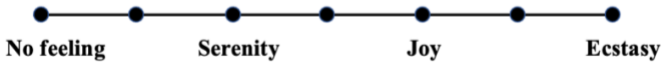

Figure 2: Example scale.

Acceptance was operationalized as the willingness to eat (WTE). Participants were presented with a statement: *If you see such a product/food in a supermarket/restaurant, you will buy/ order it.* This item measured their likelihood to purchase the food if encountered in a supermarket or restaurant, and they indicated their WTE on a seven-point scale (1 = strongly disagree, 4 = neither agree nor disagree, 7 = strongly agree).

4.4 Background

Demographic information from participants was recorded, including gender, education level, and frequency of insect food consumption (categorized as "tasted more than once," "tasted once," "never, but aware of insect food before this survey," or "never tasted nor heard of insect food").

4.5 Procedure

a) Participants accessed the questionnaire via a hyperlink and QR code.
b) Upon entry, they were greeted with a welcome message and an introduction to the survey. Before proceeding with the questions, their informed consents were acquired.
c) After submitting demographic information, they were randomly assigned to one of four experimental food samples. They then assessed which emotions they anticipated

the foods would trigger and the intensity of these emotions, with the six emotions queried in random order.

d) Following this, participants expressed their WTE using the seven-point scale. The survey concluded with an inquiry into the frequency of insect food consumption and ended with a thank-you message.

4.6 Data analysis plan

The survey ultimately gathered responses from 289 individuals. For further analysis, 109 Dutch and 38 Belgian respondents were selected due to their cultural homogeneity. The data analysis was conducted by SPSS (version 29.0.0). Two-way ANOVA was used to examine the effect of the two independent variables (insect visibility and product familiarity) on six emotions. Multiple regression was conducted to compare the effect of six emotions on acceptance. The effect of product features and mediated effects of emotions was examined by using the Process Marco.

5 Results

5.1 Descriptive statistics

As Table 3,4 and 5 show, within the sample, a significant portion of participants reported having a bachelor's degree, illustrating a tendency towards higher education. The age profile was predominantly within the 18-24 years, showing a young participant base. Gender representation was primarily binary, with males slightly outnumbering females, alongside a small representation of non-binary individuals.

Table 3. Age distribution

Age	Frequency
18-24 years old	93
25-34 years old	46
35-44 years old	1
45-54 years old	4
55-64 years old	1

Table 4. *Educational background*

Educational Background	Frequency
Some secondary school	1
Completed secondary school	10
Vocational or Similar	6
Some university but no degree	26

Educational Background	Frequency
University bachelor's degree	87
Graduate or professional degree	15

Table 5. *Gender composition*

Gender	Frequency
Male	65
Female	78
Non-binary	1
Prefer not to say	1

5.2 Hypothesis testing

The dataset includes several key variables, Table 6 shows a general overview of them:

Table 6. *Main variables overview*

	Low Visibility		High Visibility	
	Low Familiarity	High Familiarity	Low Familiarity	High Familiarity
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
n	34	33	41	37
Disgust	3.24 (1.970)	2.64 (1.851)	4.88 (1.053)	4.46 (1.556)
Fear	3.03 (1.678)	2.82 (1.629)	4.37 (1.771)	4.68 (1.492)
Trust	3.35 (1.905)	2.70 (1.489)	1.63 (1.337)	2.00 (1.650)
Joy	3.29 (1.605)	2.70 (1.630)	1.68 (1.540)	2.05 (1.699)
Anticipation	3.50 (1.581)	3.33 (1.021)	3.90 (2.385)	3.65 (2.336)
Surprise	4.47 (1.745)	4.03 (1.845)	3.95 (1.936)	3.65 (1.703)
Acceptance	3.471 (1.562)	3.667 (1.689)	1.537 (1.075)	1.838 (1.280)

Two-way ANOVA was conducted to test the main and interaction effects of visibility and familiarity on the elicited emotions, shown in Table 7.

Table 7. *Two-way ANOVA Results*

	Visibility	Familiarity	Visibility * Familiarity	R Squared
Disgust	F (1,141) =41.265, p<.001	F (1,141) =3.557, p=.061	F (1,141) =0.112, p=.739	.243
Fear	F (1,141) =33.749, p<.001	F (1,141) =0.032, p=.858	F (1,141) =0.898, p=.345	.196
Trust	F (1,141) =20.554, p<.001	F (1,141) =0.296, p=.587	F (1,141) =3.677, p=.057	.150
Joy	F (1,141) =17.480, p<.001	F (1,141) =0.176, p=.676	F (1,141) =3.225, p=.075	.131

	Visibility	**Familiarity**	**Visibility * Familiarity**	**R Squared**
Anticipation	F (1,141) =1.211, p=.273	F (1, 141) =0.415, p=.520	F (1,141) =0.018, p=.894	.012
Surprise	F (1,141) =2.221, p=.138	F (1,141) =1.510, p=.221	F (1,141) =0.052, p=.820	.026

- *$H1_{abc}$: Having high-visibility insect food triggers higher levels of fear and disgust as well as surprise emotions compared to low-visibility food compared with low-visibility food.*

The results support H1a and H1b. High visibility insect food significantly triggered higher levels of fear (F=33.749, p<.001) and disgust (F=41.265, p<.01). However, the emotion of surprise did not significantly differ between high and low-visibility insect-based foods (F=2.221, p=.138), not supporting the second part of H1.

- *$H1_{d}$: Having low-visibility insect food triggers a higher intensity of trust and anticipation emotions than high-visibility food compared to high-visibility food.*

The results support the emotion of trust, with low-visibility insect food eliciting higher levels of trust (F=20.554, p<.001). However, anticipation was not significantly influenced by the visibility of the insect-based food (F=1.211, p=.273).

- *$H2_{ab}$: Compared with low-familiarity foods, high-familiarity insect foods will trigger higher levels of trust and joy.*

The hypothesis is not supported, as familiarity did not have a significant effect on trust (F=0.296, p=.587) or joy (F=0.176, p=.676).

- *$H2_{cdef}$: Compared with high-familiarity foods, low-familiarity insect foods trigger higher intensity surprise, fear, anticipation and disgust.*

This hypothesis is not supported. There were no significant effects of familiarity on the emotions of surprise (F=1.510, p=.221), fear (F=0.032, p=.858), anticipation (F=0.415, p=.520), or disgust (F=3.557, p=.061).

- *H3: Compared with low familiarity, high familiarity features negatively affect the intensity of high-visibility-triggered disgust and fear.*

Since the interaction between visibility and familiarity was not significant for disgust (F=0.112, *p*=.739) and fear (F=0.898, *p*=.345), H5 is not supported.

To test Hypothesis 4 to 9, multiple regression was used.

Table 8. *Regression Analysis*

	Acceptance	**t-value**	**p-value**
Disgust	-.344	-5.660	*p*<.001
Anticipation	.070	1.512	*p*=.133
Joy	.174	2.961	*p*=.004
Trust	.199	3.185	*p*=.002
Fear	-.235	-3.963	*p*<.001
Surprise	.100	1.929	*p*=.056

- *H4: Joy leads to higher acceptance.*

Joy has a positive coefficient of .174, and its relationship with acceptance is statistically significant, as indicated by the t value=2.961 with a p-value of .004. This suggests that as joy increases, acceptance also increases.

- *H5: Surprise can lead to a higher or lower acceptance*

Surprise has a positive coefficient of .100, indicating a positive relationship with acceptance, and this effect is statistically significant (t value of 1.929 with a p-value of .056).

- *H6: Anticipation can lead to a higher or lower acceptance*

Hypothesis H6 does not find strong support. Anticipation has a very small positive coefficient (.070) and is not statistically significant (t value of 1.512 with a p-value of .133). This suggests that anticipation has no clear impact on acceptance.

H7: Trust leads to higher acceptance.

The hypothesis is supported. Trust has a positive coefficient of 0.199, and its relationship with acceptance is statistically significant (t value of 3.185 with a p-value of .002). This indicates that an increase in trust is associated with an increase in acceptance.

- *H8: Disgust leads to decreased acceptance to food.*

Disgust has a negative coefficient of -.344, with a strong statistical significance (t value of -5.660 with a p-value <.001), which means that an increase in disgust is associated with a decrease in acceptance.

- *H9: Fear has a negative impact on acceptance.*

Hypothesis H9 is supported. Fear shows a negative coefficient of -.235, and this relationship is statistically significant (t value of -3.963 with a p-value <.001), indicating that as fear increases, acceptance decreases.

5.3 Mediation analysis

To conduct a sufficient mediation analysis, Process Marco was used.

Table 9 shows the direct effect on Acceptance, using mediation model 8. Since the effects of six emotions have already been discussed in the hypothesis tasting section, here only visibility and familiarity are discussed. Visibility has a significant negative effect on acceptance (b=-.3338, p=.0018), indicating that higher visibility of insect components in food is associated with lower acceptance. On the other hand, familiarity does not significantly affect acceptance (b=.1054, p=.2393). The interaction between visibility and familiarity did not show a significant effect on acceptance either (b=-.0186, p=.8358), which implies that the combination of how visible and familiar the insect-based food is does not have a strong effect on acceptance.

Table 9. *Direct effects on Acceptance*

Direct Effect	b	SE	t value	p-value	LLCL	ULCL
Visibility	-.3338	.1050	-3.1801	.0018	-.5414	-.1262
Familiarity	.1054	.0892	1.1820	.2393	-.0710	.2818
Visibility*Familiarity	-.0186	.0893	-0.2077	.8358	-.1952	.1581
Disgust	-.2840	.0620	-4.5814	.0000	-.4066	-.1614
Anticipation	.0814	.0452	1.7992	.0742	-.0081	.1708
Joy	.1507	.0580	2.5977	.104	.0360	.2654
Trust	.1788	.0618	2.8929	.0045	.0566	.3011
Fear	-.2007	.0595	-3.3717	.0010	-.3184	-.0830
Surprise	.0987	.0505	1.9561	.0525	-.0011	.1985

The mediation model 8 was applied to investigate the indirect conditional effect of visibility on acceptance, with emotions as mediators and familiarity as the moderator, the results are shown in Table 10 below.

Table 10. *Conditional Indirect Effects of Visibility on Acceptance when Familiarity as a Moderator*

Indirect Effect	Level of Familiarity	b	SE	LLCL	ULCL
Disgust	-1	-.2333	.0912	-.4373	-.0840
	1	-.2589	.1041	-.4971	-.0869
Anticipation	-1	.0164	.0227	-.0203	.0698
	1	.0128	.0194	-.0253	.0537
Joy	-1	-.1214	.0699	-.2937	-.0179
	1	-.0484	.0429	-.1538	.0099
Trust	-1	-.1537	.0889	-.3474	-.0043
	1	-.0623	.0554	-.2002	.0052
Fear	-1	-.1341	.0593	-.2662	-.0369
	1	-.1864	.0687	-.3287	-.0632
Surprise	-1	-.0256	.0273	-.0906	.0174
	1	-.0188	.0261	-.0834	.0195

The results showed that disgust has a significant indirect effect on acceptance for both levels of familiarity. For low familiarity, the effect of disgust was b=-.2333 (SE=.0912, LLCL=-.4373, ULCL=-.0840), and for high familiarity, the effect was even stronger b=-.2589 (SE=.1041, LLCL=-.4971, ULCL=-.0869). This indicates that visibility's effect on acceptance is partly driven by disgust, regardless of familiarity, but intensified when the food is highly familiar.

Anticipation has a non-significant indirect effect across both levels of familiarity, with b=.0164 (LLCL=-.0203, ULC =-.0698) for low familiarity and b =.0128 (LLCL=-.0253, ULCL=.0537) for high familiarity. This suggests that anticipation does not significantly mediate the relationship between visibility and acceptance under both of the familiarity levels.

Joy shows a significant indirect effect only at low familiarity levels, b=-.1214 (SE=.0699, LLCL=-.2937, ULCL=-.0179), indicating that lower joy associated with higher visibility negatively impacts acceptance when consumers are less familiar with the product. For high familiarity, the effect was non-significant b=-.0484 (LLCL=-.1538, ULCL=.0099).

Trust as a mediator also shows a significant indirect effect, particularly when familiarity was low, b=-.1537 (SE=.0889, LLCL =-.3474, ULCL=-.0043). When the product was familiar, the indirect effect of trust was not significant b=-.0623 (LLCL =-.2002, ULCL =.0052).

For fear, the indirect effect on acceptance is significant at both levels of familiarity, b=-.1341 (SE=.0593, LLCL=-.2662, ULCL=-.0369) for low familiarity, and b=-.1864 (SE=.0687, LLCL=-.3287, ULCL=-.0632) for high familiarity. This shows that fear serves as a significant mediator in the relationship between visibility and acceptance, with a stronger effect for products with high familiarity.

Surprise demonstrated a non-significant effect on acceptance for low (LLCL=-.0906, ULCL=.0174) and high familiarity (LLCL=-.0834, ULCL=.0195).

Since visibility significantly contributes to the respondents' acceptance, the indirect effects of visibility with emotions as mediators were analyzed using the mediation model 6, results are presented in Table 11.

Table 11. *Indirect Effects of Visibility on Acceptance*

Indirect Effect	b	SE	LLCL	ULCL
Disgust	-.2594	.0846	-.4466	-.1212
Anticipation	.0099	.0153	-.0176	.0446
Joy	-.0578	.0373	-.1479	-.0030
Trust	-.0503	.0492	-.1773	.0063
Fear	-.0741	.0394	-.1632	-.0088
Surprise	-.0075	.0183	-.0514	.0255

As indicated in Table 11, disgust has a significant negative indirect effect on acceptance (b=-.2594, SE=.0846, LLCL=-.4466, ULCL=-.1212). This finding underscores that an increased invisibility of insects in the food, triggering a stronger feeling of disgust, substantially decreases the likelihood of acceptance.

Joy has a significant and negative indirect effect on acceptance (b=-.0578, SE=.0373, LLCL=-.1479, ULCL=-.0030). While these effects are smaller, they reveal a trend where higher visibility of insects, diminishing feelings of joy and trust, leads to lower acceptance levels.

The indirect effect of fear on acceptance was also significant and negative (b=-.0741, SE=0.0394, LLCL=-.1632, ULCL=-.0088), suggesting that visibility-related fear can influence consumer acceptance.

Trust, anticipation and surprise do not have significant indirect effects on acceptance. This result suggests that they are not associated with insect visibility and are not strong determinants of consumers' acceptance of insect-based foods.

6 Discussion

6.1 Conclusion

The study's investigation into the determinants of acceptance of insect-based food products has yielded several key insights.

As hypothesized, the results demonstrate that the visibility of insect components significantly influences consumers' emotional responses and, subsequently, their acceptance of food products. Specifically, the high visibility of insect parts intensifies fear and disgust, which are detrimental to consumer acceptance.

In contrast, surprise did not vary significantly between high and low visibility of insect-based foods, indicating that surprise does not influence acceptance. Higher levels of trust were associated with low-visibility insect foods, indicating that the appropriate incorporation of insect ingredients is a way of making insect food trustworthy.

Food familiarity was examined but did not show significant effects on trust, joy, surprise, fear, anticipation, and disgust. These findings suggest that familiar insect foods do not enhance positive emotions or lessen negative emotions. Furthermore, the interaction between visibility and familiarity did not have a significant effect on the emotions of disgust and fear.

Joy was found to be a positive influence on food acceptance, suggesting that using positive emotional connections can improve acceptance. Trust also had a significant positive impact on acceptance, underscoring the importance of establishing a trustworthy image for insect food.

Conversely, the negative effects of fear and disgust on acceptance were evident, underscoring the importance of overcoming these emotional barriers. Mediation analysis further solidifiy the role of these emotions, with disgust being an important mediator between visibility and acceptance, an effect that exists across all levels of familiarity. Fear also plays a mediating role, with a more pronounced effect on familiar foods, possibly due to higher levels of cognitive engagement with these products.

Trust, anticipation, and surprise did not show significant mediating effects, suggesting that these emotions, while correlated with consumer experience, do not mediate the relationship between visibility and acceptance.

6.2 Theoretical implications

The findings align with the conclusion of Gmuer et al. (2016) and Onwezen et al.(2019), the visibility of insects in insects-based food was proved to be a crucial factor that influences consumers' emotional response and acceptance. Visibility is a cue that influences consumer's perceptions of edible food within their cultural context. When highly visible, food elicits a strong and negative emotional response. Reduced visibility facilitates a more neutral or even

positive emotion with insect-based foods. Understanding these emotional dynamics could be the foundation for promoting sustainable food practices and consumer acceptance of alternative proteins, particularly in Western societies where insect consumption is not mainstream.

The insignificant impact of familiarity on emotional responses adds a new dimension to the theory of food neophobia. It suggests that familiarity alone may not be sufficient to mitigate negative emotions or enhance positive emotions, challenging the finding that familiarity has a positive effect to the acceptance (Barton et al., 2020; Woolf et al., 2019). This insight is a re-evaluation of existing models that set familiarity as a key driver of food acceptance, hinting at a more complex interaction between familiarity and sensory appeal.

It further reinforces previous findings that emotions are critical to the decision-making process for food consumption and extends these theories to the context of entomophagy. These findings will also help further the application of the emotional wheel in the field of food, because Plutchik's emotional theory was proven effective in this study. Further research could adapt Plutchik's model to the evolving landscape of food technology, where consumers are not only driven by taste but also by affective factors. There are a lot of opportunities for examining how trust, joy, and anticipation can be strengthened in the context of edible insects.

6.3 Limitations

This study while providing valuable insights into the emotional responses and acceptance of insect-based foods, still has several limitations.

The demographic profile of the sample cannot represent the broader population. Due to limited channels to access a diverse population, this study uses a convenience sample. The sample is predominantly young and their environmental value remains unknown, which could bias results toward greater acceptance of sustainable food sources like insect-based products. Moreover, the study relied on self-reported measures of emotions and acceptance, which may not always accurately predict actual behavior due to social desirability bias or other reporting biases. The measure of emotion is based on six given emotions. As a result, the emotional responses reported by participants may not fully accurately capture the real reactions in real life.

Another limitation is the measurement of consumer acceptance. The study only used a single scale to measure acceptance and may not capture the multidimensional nature of behavior. Future research should develop multi-item scales that include different aspects, which can help to better understand consumer acceptance of insect foods.

The classification of emotional intensity using the emotional wheel provides a detailed range of emotional responses, but the complexity and abstractness of certain emotions can lead to misunderstanding or confusion among some respondents. To address this, future studies could use more detailed explanations or contexts for each emotion, such as incorporating more detailed interpretations of emotions or visual material to standardize understanding between participants.

In addition to this, the scope of the study was limited to specific cultural contexts, which may affect the generality of the findings. Because food acceptance is culturally based and varies from person to person, the study's reversion may not apply to other cultural Settings.

6.4 Practical implications

The practical implications of this research can be discussed in two areas: marketing communication and food design.

To effectively communicate with consumers, marketing strategies should revolve around sensory appeal. Reduce disgust by avoiding the emphasis on images of insects. Instead, packaging and advertising should focus on a product's appeal, such as pairing it with popular ingredients in familiar dishes. Storytelling can be a powerful tool to chart the journey from traditional use to modern innovation, thereby rationalizing insects as a food source, resonating with consumers on an emotional level, and dispelling consumer fears to turn this into interest. Engaging consumers by inviting them to taste, endorse and collaborate with influencers also helps build positive connections and trust.

Food scientists and product developers are tasked with creating attractive insect foods that minimize the visibility of insect components. Such as the development of products where insects are added in powder form, such as in protein powder or flour, they have a better texture and nutrition, and are not easy to identify.

Developing familiar foods containing insect proteins could also be a strategic approach. By incorporating insect proteins into common foods such as burgers and sausages, consumers can experience these products without prejudice. The design should also consider sensory

attributes such as taste, texture, and aroma, as these are essential to overcome negative tendencies. An effective way to introduce insect proteins in a more palatable way using flavor characteristics that are already popular in the target population.

With the transformative power of marketing and innovation, the food industry can not only overcome the barriers identified in this study but also make insect food mainstream for consumption.

7 Final words

This study shows that the visual characteristics of insect foods have a profound impact on the emotions they elicit, which in turn can significantly influence consumer acceptance. It's not only a rational process for sustainable food choices that influences consumers, but also an emotional journey. Recognizing and subtly navigating the emotions of consumers will be key to a wider acceptance and the successful implementation of insect foods in the future.

Reference:

Awobusuyi, T. D., Pillay, K., & Siwela, M. (2020). Consumer acceptance of biscuits supplemented with a sorghum–insect meal. *Nutrients*, *12*(4). https://doi.org/10.3390/nu12040895

Barton, A., Richardson, C. D., & McSweeney, M. B. (2020). Consumer attitudes toward entomophagy before and after evaluating cricket (Acheta domesticus)-based protein powders. *Journal of Food Science*, *85*(3). https://doi.org/10.1111/1750-3841.15043

Batat, W., & Peter, P. (2020). The healthy and sustainable bugs appetite: factors affecting entomophagy acceptance and adoption in Western food cultures. *Journal of Consumer Marketing*, *37*(3). https://doi.org/10.1108/JCM-10-2018-2906

Baumgartner, T., Heinrichs, M., Vonlanthen, A., Fischbacher, U., & Fehr, E. (2008). Oxytocin Shapes the Neural Circuitry of Trust and Trust Adaptation in Humans [Article]. *Neuron*, *58*(4), 639-650. https://doi.org/10.1016/j.neuron.2008.04.009

Belluco, S., Losasso, C., Maggioletti, M., Alonzi, C. C., Paoletti, M. G., & Ricci, A. (2013). Edible insects in a food safety and nutritional perspective: a critical review. *Comprehensive reviews in food science and food safety*, *12*(3), 296-313.

Berggren, Å., Jansson, A., & Low, M. (2019). Approaching Ecological Sustainability in the Emerging Insects-as-Food Industry. In *Trends in Ecology and Evolution* (Vol. 34).

Bonnet, C., Bouamra-Mechemache, Z., Réquillart, V., & Treich, N. (2020). Viewpoint: Regulating meat consumption to improve health, the environment and animal welfare. *Food Policy*, *97*. https://doi.org/10.1016/j.foodpol.2020.101847

Bukkens, S., & Paoletti, M. (2005). Insects in the human diet: nutritional aspects. Ecological Implications of Minilivestock: Potential of Insects, Rodents, Frogs, and Snails. *Science Publiscers Inc., Enfield*, 545-577.

Cardello, A. V., Meiselman, H. L., Schutz, H. G., Craig, C., Given, Z., Lesher, L. L., & Eicher, S. (2012). Measuring emotional responses to foods and food names using questionnaires. *Food Quality and Preference*, *24*(2). https://doi.org/10.1016/j.foodqual.2011.12.002

Chen, X., Feng, Y., & Chen, Z. (2009). Common edible insects and their utilization in China: INVITED REVIEW. In *Entomological Research* (Vol. 39).

Commission, E. (n.d.). *Approval of insect as a Novel Food. European Commission - Food Safety.* . https://food.ec.europa.eu/safety/novel-food/authorisations/approval-insect-novel-food_en

Costa-Neto, E. M., & Dunkel, F. (2016). Insects as food: history, culture, and modern use around the world. In *Insects as sustainable food ingredients* (pp. 29-60). Elsevier.

Davey, G. C. L. (1994). Self-reported fears to common indigenous animals in an adult UK population: The role of disgust sensitivity. *British Journal of Psychology*, *85*(4). https://doi.org/10.1111/j.2044-8295.1994.tb02540.x

de Boer, A., & Bast, A. (2018). Demanding safe foods – Safety testing under the novel food regulation (2015/2283). In *Trends in Food Science and Technology* (Vol. 72).

Delicato, C., Schouteten, J. J., Dewettinck, K., Gellynck, X., & Tzompa-Sosa, D. A. (2020). Consumers' perception of bakery products with insect fat as partial butter

replacement. *Food Quality and Preference*, *79*. https://doi.org/10.1016/j.foodqual.2019.103755

Dictionary, O. E. (1989). Oxford english dictionary. *Simpson, Ja & Weiner, Esc*, *3*.

Egolf, A., Hartmann, C., & Siegrist, M. (2019). When evolution works against the future: Disgust's contributions to the acceptance of new food technologies [Article]. *Risk Analysis*, *39*(7), 1546-1559. https://doi.org/10.1111/risa.13279

Ekman, P. (1992). Cognition and Emotion An argument for basic emotions An Argument for Basic Emotions. *Cognition and Emotion*, *6*.

Finke, M. D., DeFoliart, G. R., & Benevenga, N. J. (1989). Use of a four-parameter logistic model to evaluate the quality of the protein from three insect species when fed to rats. *The Journal of nutrition*, *119*(6), 864-871.

Food, & Nations, A. O. o. t. U. (2017). *The future of food and agriculture: Trends and challenges*. Fao.

Gmuer, A., Nuessli Guth, J., Hartmann, C., & Siegrist, M. (2016). Effects of the degree of processing of insect ingredients in snacks on expected emotional experiences and willingness to eat. *Food Quality and Preference*, *54*. https://doi.org/10.1016/j.foodqual.2016.07.003

Gómez-Corona, C., Ramaroson Rakotosamimanana, V., Sáenz-Navajas, M. P., Rodrigues, H., Franco-Luesma, E., Saldaña, E., & Valentin, D. (2021). To fear the unknown: Covid-19 confinement, fear, and food choice. *Food Quality and Preference*, *92*. https://doi.org/10.1016/j.foodqual.2021.104251

Grossmann, L., & Weiss, J. (2021). Alternative Protein Sources as Technofunctional Food Ingredients. *Annual Review of Food Science and Technology*, *12*. https://doi.org/10.1146/annurev-food-062520-093642

Gutjar, S., de Graaf, C., Kooijman, V., de Wijk, R. A., Nys, A., Ter Horst, G. J., & Jager, G. (2014). The role of emotions in food choice and liking. *Food Research International*, *76*(P2). https://doi.org/10.1016/j.foodres.2014.12.022

Haidt, J., McCauley, C., & Rozin, P. (1994). Individual differences in sensitivity to disgust: A scale sampling seven domains of disgust elicitors. *Personality and Individual Differences*, *16*(5). https://doi.org/10.1016/0191-8869(94)90212-7

Hartmann, C., Shi, J., Giusto, A., & Siegrist, M. (2015). The psychology of eating insects: A cross-cultural comparison between Germany and China. *Food Quality and Preference*, *44*. https://doi.org/10.1016/j.foodqual.2015.04.013

Hartmann, C., & Siegrist, M. (2018). Development and validation of the Food Disgust Scale. *Food Quality and Preference*, *63*. https://doi.org/10.1016/j.foodqual.2017.07.013

Ismael, D., & Ploeger, A. (2020). Consumers' emotion attitudes towards organic and conventional food: A comparison study of emotional profiling and self-reported method. *Foods*, *9*(1). https://doi.org/10.3390/foods9010079

Jiang, Y., King, J. M., & Prinyawiwatkul, W. (2014). A review of measurement and relationships between food, eating behavior and emotion. In *Trends in Food Science and Technology* (Vol. 36).

Joshi, S. T., & Schultz, D. E. (2001). *An HP Lovecraft Encyclopedia*. Bloomsbury Publishing USA.

Kim, M. G., & Mattila, A. S. (2010). The impact of mood states and surprise cues on satisfaction [Article]. *International Journal of Hospitality Management*, *29*(3), 432-436. https://doi.org/10.1016/j.ijhm.2009.10.022

Kröger, T., Dupont, J., Büsing, L., & Fiebelkorn, F. (2022). Acceptance of Insect-Based Food Products in Western Societies: A Systematic Review. *Frontiers in Nutrition*, *8*. https://doi.org/10.3389/fnut.2021.759885

Lammers, P., Ullmann, L. M., & Fiebelkorn, F. (2019). Acceptance of insects as food in Germany: Is it about sensation seeking, sustainability consciousness, or food disgust? *Food Quality and Preference*, *77*. https://doi.org/10.1016/j.foodqual.2019.05.010

Laros, F. J. M., & Steenkamp, J. B. E. M. (2004). Importance of fear in the case of genetically modified food. *Psychology and Marketing*, *21*(11). https://doi.org/10.1002/mar.20039

Liu, A. J., Li, J., & Gómez, M. I. (2020). Factors influencing consumption of edible insects for Chinese consumers. *Insects*, *11*(1). https://doi.org/10.3390/insects11010010

Looy, H., Dunkel, F. V., & Wood, J. R. (2014). How then shall we eat? Insect-eating attitudes and sustainable foodways. *Agriculture and human values*, *31*, 131-141.

Martins, Y., & Pliner, P. (2005). Human food choices: An examination of the factors underlying acceptance/rejection of novel and familiar animal and nonanimal foods. *Appetite*, *45*(3). https://doi.org/10.1016/j.appet.2005.08.002

Miglietta, P. P., De Leo, F., Ruberti, M., & Massari, S. (2015). Mealworms for Food: A Water Footprint Perspective. *Water*, *7*(11), 6190-6203. https://doi.org/10.3390/w7116190

Mobbs, D., Adolphs, R., Fanselow, M. S., Barrett, L. F., LeDoux, J. E., Ressler, K., & Tye, K. M. (2019). Viewpoints: Approaches to defining and investigating fear. In *Nature Neuroscience* (Vol. 22).

Mojet, J., Dürrschmid, K., Danner, L., Jöchl, M., Heiniö, R. L., Holthuysen, N., & Köster, E. (2015). Are implicit emotion measurements evoked by food unrelated to liking? *Food Research International*, *76*(P2). https://doi.org/10.1016/j.foodres.2015.06.031

Onwezen, M. C., van den Puttelaar, J., Verain, M. C. D., & Veldkamp, T. (2019). Consumer acceptance of insects as food and feed: The relevance of affective factors. *Food Quality and Preference*, *77*, 51-63. https://doi.org/10.1016/j.foodqual.2019.04.011

Oonincx, D., & de Boer, I. J. M. (2012). Environmental Impact of the Production of Mealworms as a Protein Source for Humans - A Life Cycle Assessment. *PLoS ONE*, *7*(12), Article e51145. https://doi.org/10.1371/journal.pone.0051145

Ornell, F., Schuch, J. B., Sordi, A. O., & Kessler, F. H. P. (2020). ‘‘Pandemic fear’’ and COVID-19: Mental health burden and strategies. In *Brazilian Journal of Psychiatry* (Vol. 42).

Orsi, L., Voege, L. L., & Stranieri, S. (2019). Eating edible insects as sustainable food? Exploring the determinants of consumer acceptance in Germany. *Food Research International*, *125*. https://doi.org/10.1016/j.foodres.2019.108573

Ortony, A. (2022). Are All “Basic Emotions” Emotions? A Problem for the (Basic) Emotions Construct. *Perspectives on Psychological Science*, *17*(1). https://doi.org/10.1177/1745691620985415

Pantic, M., & Rothkrantz, L. J. M. (2003). Toward an affect-sensitive multimodal human-computer interaction. Proceedings of the IEEE,

Piqueras-Fiszman, B., & Jaeger, S. R. (2014a). Emotion responses under evoked consumption contexts: A focus on the consumers' frequency of product consumption and the stability of responses. *Food Quality and Preference*, *35*. https://doi.org/10.1016/j.foodqual.2014.01.007

Piqueras-Fiszman, B., & Jaeger, S. R. (2014b). The impact of evoked consumption contexts and appropriateness on emotion responses. *Food Quality and Preference*, *32*(PA). https://doi.org/10.1016/j.foodqual.2013.09.002

Plutchik, R. (1991). *The emotions*. University Press of America.

Polivy, J., & Herman, C. P. (1999). Distress and eating: Why do dieters overeat? *International Journal of Eating Disorders*, *26*(2). https://doi.org/10.1002/(SICI)1098-108X(199909)26:2<153::AID-EAT4>3.0.CO;2-R

Raheem, D., Carrascosa, C., Oluwole, O. B., Nieuwland, M., Saraiva, A., Millán, R., & Raposo, A. (2019). Traditional consumption of and rearing edible insects in Africa, Asia and Europe. In *Critical Reviews in Food Science and Nutrition* (Vol. 59).

Ramos-Elorduy, J., Moreno, J. M. P., Prado, E. E., Perez, M. A., Otero, J. L., & De Guevara, O. L. (1997). Nutritional value of edible insects from the state of Oaxaca, Mexico. *Journal of food composition and analysis*, *10*(2), 142-157.

Richard Eiser, J., Miles, S., & Frewer, L. J. (2002). Trust, perceived risk, and attitudes toward food technologies. *Journal of Applied Social Psychology*, *32*(11). https://doi.org/10.1111/j.1559-1816.2002.tb01871.x

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*(6), 1161-1178. https://doi.org/10.1037/h0077714

Schösler, H., Boer, J. d., & Boersema, J. J. (2012). Can we cut out the meat of the dish? Constructing consumer-oriented pathways towards meat substitution. *Appetite*, *58*(1). https://doi.org/10.1016/j.appet.2011.09.009

Schouteten, J. J., De Steur, H., De Pelsmaeker, S., Lagast, S., Juvinal, J. G., De Bourdeaudhuij, I., Verbeke, W., & Gellynck, X. (2016). Emotional and sensory profiling of insect-, plant- and meat-based burgers under blind, expected and informed conditions. *Food Quality and Preference*, *52*. https://doi.org/10.1016/j.foodqual.2016.03.011

Semeraro, A., Vilella, S., & Ruffo, G. (2021). PyPlutchik: Visualising and comparing emotion-annotated corpora. *PLoS ONE*, *16*(9 September). https://doi.org/10.1371/journal.pone.0256503

Shim, H. K., Lee, C. L., Valentin, D., & Hong, J. H. (2019). How a combination of two contradicting concepts is represented: The representation of premium instant noodles and premium yogurts by different age groups. *Food Research International*, *125*. https://doi.org/10.1016/j.foodres.2019.108506

Siegrist, M. (2000). The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. *Risk Analysis*, *20*(2). https://doi.org/10.1111/0272-4332.202020

Siegrist, M., Cousin, M. E., Kastenholz, H., & Wiek, A. (2007). Public acceptance of nanotechnology foods and food packaging: The influence of affect and trust. *Appetite*, *49*(2). https://doi.org/10.1016/j.appet.2007.03.002

Tan, H. S. G., Fischer, A. R. H., Tinchan, P., Stieger, M., Steenbekkers, L. P. A., & van Trijp, H. C. M. (2015). Insects as food: Exploring cultural exposure and individual experience as determinants of acceptance. *Food Quality and Preference*, *42*. https://doi.org/10.1016/j.foodqual.2015.01.013

Van Huis, A., Van Itterbeeck, J., Klunder, H., Mertens, E., Halloran, A., Muir, G., & Vantomme, P. (2013). *Edible Insects: Future Prospects for Food and Feed Security* (Vol. 97).

Vanhamme, J., & Snelders, D. (2001). The role of surprise in satisfaction judgements. *Journal of Consumer Satisfaction, Dissatisfaction and Complaining Behavior*, *14*, 27-45.

Verbeke, W. (2015). Profiling consumers who are ready to adopt insects as a meat substitute in a Western society. *Food Quality and Preference*, *39*. https://doi.org/10.1016/j.foodqual.2014.07.008

Vichiengior, T., Ackermann, C. L., & Palmer, A. (2019). Consumer anticipation: antecedents, processes and outcomes. *Journal of Marketing Management*, *35*(1-2). https://doi.org/10.1080/0267257X.2019.1574435

Wansink, B., Tal, A., & Brumberg, A. (2014). Ingredient-based food fears and avoidance: Antecedents and antidotes. *Food Quality and Preference*, *38*. https://doi.org/10.1016/j.foodqual.2014.05.015

Wilson-Mendenhall, C. D., Barrett, L. F., & Barsalou, L. W. (2013). Neural Evidence That Human Emotions Share Core Affective Properties. *Psychological Science*, *24*(6). https://doi.org/10.1177/0956797612464242

Woolf, E., Zhu, Y., Emory, K., Zhao, J., & Liu, C. (2019). Willingness to consume insect-containing foods: A survey in the United States. *LWT*, *102*. https://doi.org/10.1016/j.lwt.2018.12.010

Yi, C., He, Q., Wang, L., & Kuang, R. (2010). The utilization of insect-resources in Chinese rural area. *Journal of Agricultural Science*, *2*(3), 146.

Appendices

Appendix 1: Pre-test Results

a) Pupae mooncake

	Re1	Re2	Re3	Re4	Total	Average
Visibility	0	0	0	0	0	0
Familiarity	1	0	0	0	1	0.25
Believability	4	6	4	5	19	4.75

b) Pupa matcha powder

	Re1	Re2	Re3	Re4	Total	Average
Visibility	0	0	0	0	0	0
Familiarity	6	2	1	0	9	2.25
Believability	4	6	5	5	20	5

c) Pupae Zhu Cha

	Re1	Re2	Re3	Re4	Total	Average
Visibility	7	7	7	7	28	7
Familiarity	0	0	0	0	0	0
Believability	3	6	5	5	19	4.75

d) Pupae salad

	Re1	Re2	Re3	Re4	Total	Average
Visibility	7	7	7	7	28	7
Familiarity	6	7	7	7	27	6.75
Believability	4	4	5	4	17	4.25

e) Pupae dumplings

	Re1	Re2	Re3	Re4	Total	Average
Visibility	0	1	0	0	1	0.25
Familiarity	6	2	0	3	11	2.75
Believability	4	6	4	5	19	4.75

f) Pupae bitterballen

	Re1	Re2	Re3	Re4	Total	Average
Visibility	0	0	1	1	2	0.5
Familiarity	7	7	7	7	28	7
Believability	4	3	4	6	17	4.25

g) Pupae protein powder

	Re1	Re2	Re3	Re4	Total	Average
Visibility	0	1	0	0	1	0.25
Familiarity	7	7	7	7	28	7
Believability	6	6	5	5	22	5.5

h) Pupae brownies

	Re1	Re2	Re3	Re4	Total	Average
Visibility	0	1	0	0	1	0.25
Familiarity	7	7	7	7	28	7
Believability	7	6	7	5	25	6.25