


Emoji-based scale to assess emotional response toward edible insects (E-Entomophagy)

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ARTICLE INFO

Keywords:

Acceptance
Consumer perception
Disgust
Emotion
Novel foods
Prediction model

ABSTRACT

Emotional/affective factors (e.g., disgust toward insects) are the primary predictors of consumer acceptance of edible insects; however, most questionnaires assessing emotional responses to edible insects are text-based, which presents several limitations. The primary objective of this study was to develop an emoji-based questionnaire to assess consumers' emotional responses toward edible insects and to evaluate its ability to predict acceptance of different forms of entomophagy. For this, an emoji-based ballot was designed, with participants answering the question: "Thinking about eating edible insects makes me feel", using a Check-All-That-Apply ballot with 11 emojis (E-Entomophagy). Based on the selected emojis, individual scores were computed from their valence and arousal values. A total of 326 participants answered the web-based questionnaire, which also included a short version of the 'Food Disgust Scale', the 'Disgust toward insects' scale, and the evaluation of acceptance of insects as food (either visible or invisible) or feed. The questionnaire also encompassed socio-demographic characteristics and previous experience with edible insects. Cluster analysis was applied based on the degree of acceptance of insects as food/feed, and acceptance of insects was predicted using a binary logistic regression model. The 'E-Entomophagy' scale was the better predictor of visible entomophagy rejection, while it provided similar results to the 'Disgust toward insects' scale for acceptance of invisible and indirect entomophagy. Additionally, participants were divided into four clusters ('Rejecters', 'Feed Acceptors', 'Non-visible acceptors', and 'Acceptors') based on their acceptance of different entomophagy forms. Both disgust scales and the 'E-Entomophagy' scale were able to discriminate between these clusters.

1. Introduction

The topic of entomophagy (intentional consumption of insects) has been increasingly studied in the scientific community, with much of the focus being given to understanding the determinants of acceptance of edible insects as food (Cunha and Ribeiro, 2019, 2025; Kröger et al., 2022; Schomaker and Fiebelkorn, 2026), particularly with Western consumers. Although several socio-demographic characteristics, personality traits, social behaviors, dietary practices, product characteristics, and food choice motives influence the willingness to consume edible insects, emotional/affective factors have the greatest impact (Onwezen et al., 2019, 2022; Palcu et al., 2025). Specifically, disgust (either general disgust sensitivity, food disgust, or disgust toward

insects) has been identified as the main predictor of entomophagy rejection (Cunha et al., 2023; Huang, 2025; La Barbera et al., 2018; Ribeiro et al., 2022, 2021; Sogari et al., 2023; Woolf et al., 2019). Disgust is defined as a primary emotion elicited by an object that provokes a sense of revulsion (Rozin and Fallon, 1987), and in the context of food, it serves as a protective reaction to foods deemed harmful or dangerous (Curtis et al., 2004). Although some disgust elicitors are constant across cultures (e.g., visual cues symbolising food decay or spoilage or unhygienic food preparation), there are foods that cause disgust due to cultural, social, or moral inadequacies (Rozin and Haidt, 2013). Edible insects are one such case, as Western consumers consider them culturally inappropriate (Detilleux et al., 2024; Hartmann et al., 2015; Myers and Pettigrew, 2018; Reed et al., 2021) or a survival food

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<https://doi.org/10.1016/j.fufo.2026.100954>

Received 5 October 2025; Received in revised form 9 February 2026; Accepted 11 February 2026

Available online 13 February 2026

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(Yen, 2009). Furthermore, subjective norms and social stigma negatively influence acceptance (Huang, 2025; Ledesma-Chaves et al., 2024), indicating that social and cultural conformity heavily influence insect acceptance (Shelomi, 2023). As most consumers are unfamiliar with the concept and representations of insects as food (Cunha and Ribeiro, 2019, 2025; Kröger et al., 2022; Schomaker and Fiebelkorn, 2026), it reinforces the association of edible insects with disgusting cues (Koch et al., 2021), such as unhygienic behavior, diseases, spoiled food, pest, or reminders of animal origin (Looy et al., 2014; Molina-Castillo et al., 2025; Qian and Yamada, 2020; Verneau et al., 2016).

Disgust sensitivity refers to a person's predisposition to experience disgust reactions, which is measured using cognitive explicit questionnaires, such as the Disgust Scale (Haidt et al., 1994; Olatunji et al., 2007). However, these questionnaires focus on overall disgust sensitivity and lack specific subscales dedicated to food disgust. The Food Disgust Scale was developed in 2018 by Hartmann and Siegrist (2018), and measures an individual's emotional disposition to react with disgust to certain food-related (offensive) stimuli, and an alternative version of this scale (with food-related pictures instead of sentences), Food Disgust Picture Scale, has also been developed and validated (Ammann et al., 2018).

Regarding the assessment of specific disgust toward insects, a questionnaire was developed by Paul Rozin (Ruby and Rozin, 2019) and has been translated and validated in a cross-cultural study conducted in Portugal and Norway (Ribeiro et al., 2022). This questionnaire consists of five questions that assess the level of disgust participants feel toward insects in various situations. Another specific questionnaire that measures disgust toward insects is the Disgust factor of the Entomophagy Attitude Questionnaire, which consists of five items (La Barbera et al., 2020).

Given the relevance of emotional factors, particularly food disgust and disgust toward insects, in predicting acceptance of edible insects, some of the current trends on measuring emotional responses to food should be incorporated into the topic of consumer acceptance of insects as food and feed. Most methods assessing emotional responses to food products are based on emotional lexicons (Lagast et al., 2017; Low et al., 2022), but these types of questionnaires can present disadvantages such as applicability in cross-cultural studies (e.g., variations in emotional lexicons due to cultural and language differences), difficulty of verbalizing emotions (Jaeger et al., 2013; Köster and Mojet, 2015), and low consumer engagement or ecological validity (Jaeger et al., 2013). One of these recent trends is the successful utilization of emoji to obtain the emotional response of consumers toward food products, since emoji are a more natural and familiar recreation of consumers' emotional response to food products, and can also facilitate the cross-cultural application of the questionnaire due to cross-culturally shared meanings (Jaeger, Lee, and Ares, 2018; Jaeger et al., 2017, 2021; Schouteten and Meiselman, 2021).

The application of emoji-based questionnaires is particularly relevant for unfamiliar and/or emotionally-charged foods, such as wine (Rizo et al., 2023), beer (Viejo et al., 2022), plant-based foods (Appiani et al., 2025), or spicy foods (Chen et al., 2026). In fact, Chen et al. (2026) reported that emoji-rated emotional responses were able to better discriminate between high-frequency and low-frequency consumers and were better predictors for individual spicy food consumption behavior than the lexicon questionnaire. Similar improvements in food choice prediction were also reported by Schouteten et al. (2018). Furthermore, Jaeger et al. (2017) reported that emoji were better suited than emotion words to discriminate between stimuli that elicited negative emotional associations, which suits the case of edible insects.

In this study, consumer acceptance of different edible insect consumption forms (whole edible insects, food products containing insect flour and insects as feed) was assessed, as well as consumers' emotional responses toward edible insects and their sensitivity to food disgust. Furthermore, the ability of emotional responses and food disgust sensitivity to predict acceptance of entomophagy was investigated. To

determine consumers' emotional response toward edible insects, the 'Disgust toward edible insects' questionnaire was applied, and an emoji-based questionnaire ('E-Entomophagy') was developed, in a process that involved emoji selection for a Check-All-That-Apply ballot and conversion of emoji selection into a 7-point standardized scale. This work contributes to the application of emojis in assessing emotional responses to edible insects, which has previously been explored only by Fuentes et al. (2020), and provides an additional, novel tool to predict entomophagy acceptance. It further contributes to the application of rating scales (e.g., polarity scale, RATA) associated with emoji, which have demonstrated improvements in the discriminant ability of emoji and allowed the measure of emotional intensity (Ares and Jaeger, 2017; Sick et al., 2022). In fact, several attempts have been made to develop emoji-based rating scales for assessing the liking or acceptance of food products (Deubler and Swaney-Stueve, 2020; Deubler et al., 2020; Santos et al., 2022; Swaney-Stueve et al., 2018). This study also contributes to the comparison between text-based and emoji-based approaches, which is considered an essential step toward the adoption of emoji-based questionnaires in consumer research (Jaeger, Vidal, et al., 2021; Schouteten and Meiselman, 2021).

2. Materials and methods

2.1. Participants and data collection

Participants were recruited through Sense Test's consumer database, and an online-based questionnaire (Section 2.2) was developed and applied through SenseGest.¹ Sense Test ensures the protection and confidentiality of data through the authorization 2063/2009 of the National Data Protection Commission and follows the EU General Data Protection Regulation (EU 2016/679), as well as a longstanding internal code of conduct. Before starting the questionnaire, participants were informed about the scope of the research and the data treatment procedure. Furthermore, participants gave informed consent via the statement "I declare that I give my informed consent and wish to proceed with the questionnaire", where an affirmative reply was required to enter the survey. Participants' recruitment was controlled to ensure a homogeneous representation across age groups (18–34, 35–49, and 50+ years old), sex (female and male), and education level (with and without higher education – BSc, MSc, or PhD). A total of 326 valid responses were obtained after the application of validation criteria:

- Citizens aged 18 or older and fluent in the language spoken in the country where the survey was conducted;
- Delivery of informed consent;
- Complete the questionnaire (no incomplete answers);
- Survey completed in at least 50 % of the median time to complete the questionnaire (Jaeger and Cardello, 2022);
- Absence of response patterns indicating bias, such as "straight-lining" (selection of the same answer for all items on a scale) (Maniaci and Rogge, 2014; Silva et al., 2024).

The socio-demographic characteristics of the participants are presented in Table S1.

2.2. Questionnaire

The applied questionnaire was composed of six different sections: the

¹ Proprietary software developed by Sense Test - a sensory evaluation and consumer tests company located in Portugal – which operates under a quality management system certified according to ISO 9001:2015 (Quality management systems—Requirements) and is accredited as a Testing Laboratory according to NP EN ISO/IEC 17025:2018 (General requirements for the competence of testing and calibration laboratories).

emoji-based questionnaire to assess emotional response toward edible insects (E-Entomophagy), the short version of the Food Disgust Scale (Hartmann and Siegrist, 2018), a disgust toward insects scale based on the work by Ruby and Rozin (2019), experience with edible insects, perceived acceptance of edible insects in different forms – visible, not-visible and indirect (both developed by (Ribeiro et al., 2022)) – and socio-demographic characteristics, such as age, gender and education level.

The items, composing the text-based scale and the perceived acceptance of visible, not-visible, and indirect entomophagy, were randomized to compensate for possible order effects.

2.2.1. Emoji-based emotional response toward edible insects (E-Entomophagy)

For the emoji-based emotional response toward edible insects (E-Entomophagy), participants were presented with a Check-All-That-












Apply (CATA) ballot composed of 11 emojis (Table 1) and had to answer the question "When I think about eating edible insects, I feel" (please select all the emojis that best represent how you feel). The CATA method was selected based on common practices in studies evaluating emotional responses with emoji (Low et al., 2022), and to allow for more representative responses from the consumer, since emoji can present multiple emotional associations, and consumers often associate entomophagy with multiple emotional terms that can be better represented by multiple emoji. The presentation order of the emoji was balanced between participants.

For emoji selection, the following criteria were applied:

- Emoji with semantic meaning related to the emotional responses toward insect-based food (focusing primarily on studies performed with adults and Portuguese consumers).
- Emoji appropriateness for food consumer research;

Table 1




List of emoji used in the E-Entomophagy ballot, designed to measure emotional response toward edible insects. Valence and arousal scores were adapted from previous research with Portuguese consumers (Rodrigues, Prada, Gaspar, Garrido, and Lopes, 2018). A standardized emoji score is proposed by the authors within this work, by rescaling the Valence x Arousal values into a 7-point scale, where 1 would be the most positive and 7 the most negative (see Section 2.3).


Emoji	Code	Definition	Valence* × Arousal	Standardized emoji score (scale 1 to 7)
	U+1F630	Face with open mouth and cold sweat	-1.80 × 5.24	7.00
	U+1F92E	Face with open mouth vomiting	-1.65 × 4.93	6.69
	U+1F631	Face screaming in fear	-1.18 × 5.75	6.37
	U+1F62C	Grimacing face	-0.96 × 4.59	5.80
	U+1F615	Confused face	-1.17 × 3.59	5.75
	U+1F610	Neutral face	-0.37 × 3.56	5.06
	U+1F60E	Smiling face with sunglasses	1.67 × 3.91	3.19
	U+1F61C	Face with stuck-out tongue and winking eye	1.73 × 5.45	2.50
	U+1F60B	Face savouring delicious food	2.02 × 4.71	2.48
	U+1F600	Grinning face	2.12 × 5.29	2.07
	U+1F60D	Smiling face with heart-shaped eyes	2.56 × 6.14	1.00

*For this purpose, original valence scores were linearly rescaled from a scale ranging from 1 to 7, to a centered bipolar scale ranging from -3 to +3.


- Balanced representation of valence, negative and positive, and inclusion of more neutral emoji. For each valence category, emoji were also selected to reflect the range of valence and arousal levels.


Regarding the emotional responses toward insect-based products, the most common emotional associations are adventurous/daring, disgust, interested, and worried/fear (Giacalone and Jaeger, 2023; Gmuer et al., 2016; Gurdian et al., 2021; Molina-Castillo et al., 2025; Schouteten et al., 2016; Serpico et al., 2021; Tuccillo et al., 2020; Ventanas et al., 2022). The emojis ‘Face with Open Mouth Vomiting’


() and ‘Face with open mouth and cold sweat’ () both have the main semantic meaning of disgust (Jaeger et al., 2019; Rocha et al., 2022). The emojis ‘Face screaming in fear’ () and ‘Grimacing

face’ () were chosen to represent emotional associations with

fear/worry (Jaeger et al., 2019; Rocha et al., 2022). Although the main semantic meanings of these emojis are similar, they belong to different clusters of semantically similar emojis, according to a recent study performed with Portuguese consumers (Rocha et al., 2022). The


‘Confused face’ () was included to represent a less negative emotional association with insects, as it presents semantic meanings of sad/unhappy and confused/unsure (Jaeger et al., 2019; Rocha et al., 2022). To have a representation of a more neutral, indifferent, or even

bored response toward entomophagy, the ‘Neutral face’ emoji ()


was selected. For the adventurous/daring emotion, the ‘Smiling face with sunglasses’ emoji () was included, which conveys the main

semantic meanings of being chill, cool, relaxed, interesting and exhibits a strong antagonistic relationship with the ‘Grimacing face’ emoji

() (Ares et al., 2021; Barbosa et al., 2023; Jaeger et al., 2019;


Rocha et al., 2022). The ‘Face savoring delicious food’ () was

included due to its exceptional appropriateness for food consumer research (Jaeger, Lee, and Ares, 2018), and its antagonistic relationship

with the ‘Face with Open Mouth Vomiting’ emoji () (Barbosa

et al., 2023). The other three emojis with positive valence – ‘Face with

stuck-out tongue and winking eye’ (), ‘Grinning face’ ()

and ‘Smiling face with heart-shaped eyes’ () – belong to different

clusters of semantically similar emojis (Rocha et al., 2022) and represent the semantic meanings of happy, funny and passionate/love (the strongest possible positive emotional reaction) (Jaeger et al., 2019; Rocha et al., 2022).

2.2.2. Food disgust

To evaluate the level of food disgust sensitivity, the short version of the ‘Food Disgust Scale’ (Hartmann and Siegrist, 2018), previously translated following a translation-back-translation procedure (Brislin, 1970) and validated in Portuguese (Sousa, 2018), was used. This questionnaire comprises 8 items, each representing a subscale (animal flesh, poor hygiene, human contamination, mold, decaying fruit, fish, decaying vegetables, and living contaminants). Participants had to answer

how disgusting they perceived each item to be on a 7-point anchored scale (ranging from 1 – “Not disgusting at all” to 7 – “Totally disgusting”).

2.2.3. Disgust toward insects

To evaluate the level of disgust toward insects, a questionnaire based on the work by Ruby and Rozin (2019), and previously translated and validated into Portuguese (Ribeiro et al., 2022), was applied. The questionnaire was composed of 5 items:

- “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”.

For each item, participants had to answer their level of agreement with the sentence using a 7-point anchored scale (ranging from 1 – “Strongly disagree” to 7 – “Strongly agree”).

2.2.4. Experience with edible insects

To measure the participants’ level of experience with edible insects, a single-select multiple-choice questionnaire with six possible responses was designed (Ribeiro et al., 2022):

- “I have never tried and never heard about edible insects”;
- “I have never tried edible insects”;
- “I have tried edible insects on a single occasion”;
- “I have tried edible insects on a few occasions”;
- “I eat edible insects seasonally”;
- “I eat edible insects regularly”.

Participants were asked to choose only the best-suited response among the six options.

Previous experience was recoded into 0 – Without previous experience (“I have never tried and never heard about edible insects”; “I have never tried edible insects”) and 1 – With previous experience (“I have tried edible insects on a single occasion”; “I have tried edible insects on a few occasions”; “I eat edible insects seasonally”; “I eat edible insects regularly”). The binary categorization of the ‘Experience’ variable has been extensively used in studies assessing consumer perception of edible insects (Bengtsson and Wendin, 2023; Detilleux et al., 2024; Ribeiro et al., 2022; Valesi et al., 2024).

2.2.5. Perceived acceptance of insects as food and feed

To evaluate the level of perceived acceptance of insects, a 4-item questionnaire adapted from Ribeiro et al. (2022) was used. Acceptance was evaluated on a 7-point scale (ranging from 1 – “Totally reject” to 7 – “Totally accept”), and was based on the question “If someone offers you a meal or a snack based on”:

- “Snacks with whole edible insects”;
- “Protein bar with flour made out of edible insects”;
- “Fish from animals fed with feed incorporating insects or insect protein”;
- “Meat from animals fed with feed incorporating insects or insect protein”.

The adaption from the work of Ribeiro et al. (2022) consisted on a modification of the items pertaining acceptance of whole edible insects (previously “Edible insects”) and foods incorporating processed insects (previously “Protein bar with flour made out of cricket”) as well as a reduction on the items pertaining to acceptance of insects as feed (previously there were 4 items – Pork, Poultry, Beef and Fish).

2.2.6. Socio-demographic factors

To assess the participants’ socio-demographic information, six

questions were developed, related to age, sex, level of education (with or without higher education), as well as perceived health situation, economic situation, and purchase behavior (price vs quality).

2.3. Data analysis

2.3.1. 'E-Entomophagy' scores

For the analysis of the 'E-Entomophagy' questionnaire, a score (Eq. (1)) was assigned to each emoji based on its Valence (V) and Arousal (A) scores, and then standardized to a 1–7 scale for easier interpretation and comparability. While valence can be defined as the pleasantness of an emotion (negative-positive), arousal is related to the level of activation, and both are fundamental dimensions of emotions that contribute to emoji differentiation (Schouteten, Almlı, et al., 2023; Schouteten et al., 2022).

The mean V and A scores, obtained from a previous study (Rodrigues et al., 2018) with Portuguese participants, were multiplied to obtain an initial $V \times A$ score. For this calculation, valence was rescaled (V_r) into a $-3/+3$ scale (from a 1–7 scale), to properly differentiate between positive and negative valence scores and to segregate $V \times A$ scores according to valence (avoiding that neutral emoji would have a smaller $V \times A$ score than negative valence emoji).

For a final standardization into a 1–7 scale, a simple linear transformation was used, where $V_r \times A$ scores were converted from a scale ranging from $\min\{V_r \times A\}$ to $\max\{V_r \times A\}$, to a scale ranging from 1 to 7 (Eq. (1)). The scores were calculated considering that the emoji with the highest and lowest $V_r \times A$ score would correspond to the extremes of the scale. The step $\frac{[(V_r \times A_i) - \min\{V_r \times A\}]}{[\max\{V_r \times A\} - \min\{V_r \times A\}]}$ normalizes the values to a 0–1 interval, and to convert it into a 1–7 scale, the width of the target scale must be considered ($7 - 1 = 6$). Thus, multiplying by 6 stretches the normalized values to fully occupy the range between 0 and 6. Finally, subtracting the transformed value from 7 reverses the direction of the scale (so more negative or unpleasant emojis receive higher scores), as intended for comparability with the disgust scales.

$$\text{Emoji score}_i = 7 - \left(\frac{[(V_i \times A_i) - \min\{V \times A\}]}{[\max\{V \times A\} - \min\{V \times A\}]} \times 6 \right) \quad (\text{Eq. 1})$$

Individual participants' 'E-Entomophagy' scores were calculated by averaging the scores assigned to the emojis they selected. For instance, a participant who selected emoji with codes $U + 1F92E$, $U + 1F630$ and $U + 1F62C$ (Table 1) would have an E-Entomophagy score of 6.50 ($(6.69 + 7.00 + 5.80)/3$).

2.3.2. Statistical analysis

To describe the sample's basic features, descriptive statistics were used (frequencies, mean, and standard deviation).

The Kolmogorov-Smirnov test was used to assess the normality of the acceptance score distribution; as the data were not normally distributed, acceptance scores were compared using a nonparametric test (Wilcoxon), in line with Ribeiro et al. (2022). Furthermore, a hierarchical cluster analysis using Ward's method (Ward, 1963), followed by a K-means clustering, was conducted. Cluster analysis was applied based on the degree of acceptance of the different forms of insects as food/feed (visible, non-visible, and indirect –corresponding to the consumption of meat or fish feed with insects) to identify different consumer segments.

The selection frequency of each emoji present on the 'E-Entomophagy' CATA ballot was calculated relative to the participants (emoji citations/number of participants) of participants that selected the emoji) and to the total number of emoji citations (emoji citation/total number of citations). A contingency table (Meyners et al., 2013) was also constructed considering the frequency of emoji selection for each identified consumer segment, and a Correspondence Analysis was applied to visualize the associations between emoji in the 'E-Entomophagy' CATA ballot and consumer segments.

To assess the effect of the 'E-Entomophagy' scores and the different

disgust scales on the acceptance of edible insects, scores were transformed into a binary choice where 0 = non-acceptance (scores between one and four) and 1 = acceptance (scores above four). The decision to treat consumers' acceptance of insects as food and as feed as a binary choice is based on the recommendations of Hoek et al. (2011) and Wansink et al. (2004) of dichotomous segmentations for products not frequently purchased and/or when there is a strong attitude toward the product. The decision to use the middle point of the scale as the threshold is based on the work by Verbeke (2015) and Verbeke (2005), in which neutral scores were not considered as acceptance. Acceptance of the different forms of insects as food/feed was predicted using a binary logistic regression model, expressing acceptance as a function of socio-demographic characteristics, experience with edible insects, 'E-Entomophagy', 'Disgust toward insects' and 'Food Disgust'. The model yields coefficients (β) that express the logistic relationship between each predictor variable and the binary acceptance. For binary predictor variables (such as experience with edible insects), the value of $\text{Exp}(\beta)$ expresses the odds-ratio, representing the odds that acceptance will occur given previous experience with eating insects, compared to the odds of acceptance occurring in the absence of such experience.

All statistical tests were applied at a 95 % confidence level, except when stated otherwise. All data was analyzed using the software Statistical Package for Social Sciences (SPSS) - version 27 ® (IBM Corp., Armonk, NY, USA).

3. Results and discussion

3.1. Acceptance of insects as food and feed

There were significant differences in acceptance between the different forms of entomophagy ($p < 0.05$) (Table 2), with results being similar to what has been previously reported in the literature (Cunha and Ribeiro, 2019, 2025; Kröger et al., 2022; Schomaker and Fiebelkorn, 2026), although it is possible to observe an increased acceptance when comparing these results to others previously performed with Portuguese consumers (Ribeiro et al., 2022, 2021). Consumption of products with whole insects (visible entomophagy) had the lowest acceptance, with almost half of the participants (43.9 %) rejecting this form of entomophagy. Consumption of products with invisible (e.g., flour) insects (invisible entomophagy) was found to have higher acceptance, with most consumers (59.2 %) accepting this form of insect consumption. Insects as feed (indirect entomophagy) had the highest acceptance, with over 70 % of participants giving a positive acceptance score for this form of entomophagy. However, it is also important to note that there is a relatively high proportion of consumers (ca. 30 %) who do not give positive acceptance scores to any entomophagy form. This greater acceptance of processed insect-based foods is partly explained by the contrast with the visual appearance of whole insects that remind consumers of their animal origin, increasing disgust reactions (Hartmann

Table 2

Mean (\pm SD) values of acceptance on a 7-point scale, from 1 to 7, and frequency of negative (acceptance < 4), neutral (acceptance = 4) and positive (acceptance > 4) answers for each of the different forms of entomophagy.

Entomophagy form	Mean (\pm SD)	Negative / Neutral / Positive [n (%)]
Snacks with whole edible insects	3.7 (\pm 2.0) ^c	143 (43.9 %) / 57 (17.5 %) / 126 (38.7 %)
Protein bar with flour made out of edible insects	4.7 (\pm 2.0) ^b	85 (26.1 %) / 48 (14.7 %) / 193 (59.2 %)
Meat from animals fed with feed incorporating insects or insect protein	5.2 (\pm 1.9) ^a	58 (17.8 %) / 36 (11.0 %) / 232 (71.2 %)
Fish from animals fed with feed incorporating insects or insect protein	5.3 (\pm 1.9) ^a	55 (16.9 %) / 40 (12.3 %) / 231 (70.9 %)

^{a,b,c} - Homogenous groups according to the Wilcoxon test at 95 % confidence level.

and Siegrist, 2018). The increased disgust reactions with the higher visibility of edible insects is one of the main reasons for the higher entomophagy acceptance of men (Hartmann et al., 2015; Lammers et al., 2019), as they generally present lower disgust and animal reminder disgust sensitivity (Hamerman, 2016; Lammers et al., 2019).

3.2. Consumer segments

Through cluster analysis, it was possible to identify four groups based on their acceptance scores of different forms of entomophagy (Table 3):

- Rejecters (C1) – very low levels of acceptance for all entomophagy forms;
- Feed acceptors (C2) – only presented high acceptance scores for indirect entomophagy;
- Non-visible acceptors (C3) – low acceptance levels for visible entomophagy, but high scores for all other entomophagy forms;
- Acceptors (C4) – high acceptance scores (≥ 6.0) for all entomophagy forms.

(Table 4)

The identified clusters are somewhat different from the ones previously identified in a study with Portuguese consumers (Ribeiro et al., 2022), performed ahead of the introduction of commercial forms of edible insects into the Portuguese market, only authorized by the Portuguese Food Safety Authority (DGAV) by August 2021, which was preceded by a generally very positive outlook given by the national media. Namely, in this study, only one cluster rejects all forms of entomophagy, and a new cluster was identified that shows high acceptance of both processed insects and insects as feed ('Non-visible acceptors', C3). The identification of this cluster contrasts with the results of our previous study, which identified only one cluster with a high acceptance of insects as food. In a study performed with Greek consumers, Gkinali et al. (2024) also observed the formation of clusters that accepted visible and invisible entomophagy ('Innovators') and clusters that only

Table 3

Mean (\pm SD) of acceptance values, on a 7-point scale, from 1 to 7, for each of the different forms of entomophagy as a function of the consumer segmentation.

Entomophagy form	Consumer segments				Kruskal-Wallis test(H (df); p)
	C1-Rejecters	C2-Feed acceptors	C3-Non-visible acceptors	C4-Acceptors	
	n = 60 (18.4 %)	n = 87 (26.7 %)	n = 65 (19.9 %)	n = 114 (35.0 %)	
Snacks with whole edible insects	1.8 (\pm 1.4) ^c	2.9 (\pm 1.1) ^b	2.8 (\pm 1.4) ^b	6.0 (\pm 0.8) ^a	H (3) = 222.418; p < 0.001
Protein bar with flour made out of edible insects	2.0 (\pm 1.4) ^c	3.5 (\pm 1.2) ^b	6.1 (\pm 0.9) ^a	6.3 (\pm 0.7) ^a	H (3) = 235.899; p < 0.001
Meat from animals fed with feed incorporating insects or insect protein	2.0 (\pm 1.0) ^c	5.0 (\pm 1.1) ^b	6.5 (\pm 0.7) ^a	6.5 (\pm 0.8) ^a	H (3) = 209.789; p < 0.001
Fish from animals fed with feed incorporating insects or insect protein	2.0 (\pm 1.1) ^c	5.0 (\pm 1.1) ^b	6.5 (\pm 0.8) ^a	6.5 (\pm 0.7) ^a	H (3) = 216.117; p < 0.001

^{a, b, c} – Homogeneous groups across consumer segments according to Dunn's *post hoc* test at 95 % confidence level. Different letters in the same row indicate statistically significant differences between consumers segments.

accepted the consumption of processed insects ('Early Majority'). As such, the identified clusters complement the acceptance results (Section 3.1) and further demonstrate the increased acceptance of insects as food, especially in processed insect products. (Ribeiro et al., 2022). Van Thielen et al. (2019) also reported that after the introduction of insect-based food products into Belgian markets, awareness and acceptance of entomophagy increased among consumers. In fact, Detilleux et al. (2024) also reported that awareness and familiarity with the concept of entomophagy have reached almost 100 % (from ca. 60 % in 2013) among Belgian consumers, and that this also reflects on increased acceptance. Onwezen et al. (2022) also reported increased acceptance toward alternative proteins (including edible insects) among Dutch consumers between 2015–2019, although actual consumption remained very stable and low.

For the 'E-Entomophagy' scale and both disgust scales, there were significant differences between the 'Rejecters' group (C1) and both the 'Non-visible acceptors' (C3) and the 'Acceptors' (C4) groups for all scales. The 'Disgust toward insects' scale was the only scale that differentiated all the groups, while the 'E-Entomophagy' scale did not differentiate between the 'Rejecters' (C1) and 'Feed acceptors' (C2) groups, and the 'Food Disgust' scale did not differentiate between the 'Non-visible acceptors' (C3) and 'Acceptors' (C4) groups. Furthermore, for the 'E-Entomophagy' scale only the 'Acceptors' (C4) group had a lower average score than the average score for the overall population (5.2 ± 1.6 ; Table S1), while for the 'Disgust toward insects' and 'Food Disgust' scales both the 'Acceptors' (C4) and 'Non-visible acceptors' (C3) groups had lower average scores than the average for the overall population (3.7 ± 1.7 and 4.5 ± 1.2 , respectively; Table S1).

3.3. Emoji selection in the 'E-Entomophagy' questionnaire

On average, each participant selected 1.66 ± 0.97 emojis, with 134 (41.1 %) selecting more than a single emoji. Emoji with negative valence had a higher selection proportion (335/541, 61.9 %) than emoji with positive valence (143/551, 26.4 %), and the emoji 'Face with open mouth vomiting', 'Grimacing face', and 'Face with open mouth and cold sweat' were the most selected by participants (Table 5). On the other hand, emoji with a positive valence had a low proportion of selection, with only the emojis 'Face with stuck-out tongue and winking eye', 'Smiling face with sunglasses' (11.3 %), and 'Grinning face' being selected by more than 10 % of consumers.

Both the cluster 'C1-Rejecters' and 'C2-Feed acceptors' were mainly associated with the emoji 'Face with open mouth vomiting', but the selection rate was much higher for cluster C1 (66.7 %) than for C2 (42.5 %) (Fig. 1). Both clusters were also associated to a lesser degree with the emojis 'Face with open mouth and cold sweat' and 'Face screaming in fear'. Despite the differences in invisible entomophagy acceptance between clusters 'C2-Feed acceptors' and 'C3-Non-visible acceptors', both had similar selection rates for the emoji 'Grimacing face' (19.5 % and 23.1 %, respectively) and 'Confused face' (29.9 % and 29.2 %, respectively), while for the emoji 'Neutral face' the cluster C3 had the highest selection rate (27.7 %). On the other hand, the cluster 'C4-Acceptors' was mostly associated with the emoji 'Grinning face' (26.3 % selection rate) and 'Smiling face with sunglasses' (24.6 % selection rate), and to a lesser extent with the emoji 'Face with stuck-out tongue and winking eye' (21.9 % selection rate) and 'Face savoring delicious food' (18.9 % selection rate).

According to previous studies that have assessed the sentiment and emotional meanings of emoji in food-related context (Ares et al., 2021; Jaeger et al., 2019; Rocha et al., 2022), it is possible to assert that consumers from clusters 'C1-Rejecters' and 'C2-Feed acceptors' were mostly disgusted ('Face with open mouth vomiting') by the concept of entomophagy, but also presented other negative emotional associations due to the emoji 'Face with open mouth and cold sweat', 'Face screaming in fear' and 'Grimacing face' (frightened, worried, fear, anxious, nervous). Previous studies on the emotional associations with entomophagy

Table 4Mean (\pm SD) scores of the E-Entomophagy scale and both disgust scales, on a 7-point scale, from 1 to 7, as a function of consumer segmentation.

Scale	Consumer segments				Kruskal-Wallis test(H (df); p)
	C1-Rejecters n = 60 (18.4 %)	C2-Feed acceptors n = 87 (26.7 %)	C3-Non-visible acceptors n = 65 (19.9 %)	C4- Acceptors n = 114 (35.0 %)	
E-Entomophagy	6.2 (\pm 1.9) ^a	5.9 (\pm 1.0) ^a	5.3 (\pm 1.3) ^b	4.0 (\pm 1.7) ^c	H (3) = 97.407; p < 0.001
Disgust toward insects	5.3 (\pm 1.6) ^a	4.4 (\pm 1.2) ^b	3.2 (\pm 1.2) ^c	2.7 (\pm 1.4) ^d	H (3) = 116.317; p < 0.001
Food disgust	5.4 (\pm 1.1) ^a	4.7 (\pm 1.0) ^b	4.2 (\pm 1.0) ^c	3.9 (\pm 1.2) ^c	H (3) = 63.251; p < 0.001

^{a, b, c} – Homogeneous groups across consumer segments according to Dunn's *post hoc* test at 95 % confidence level. Different letters in the same row indicate statistically significant differences between consumer segments.

have shown that reactions of disgust, followed by fear/worry, are the most common negative reactions toward edible insects (Giacalone and Jaeger, 2023; Gmuer et al., 2016; Gurdian et al., 2021; Molina-Castillo et al., 2025; Schouteten et al., 2016; Serpico et al., 2021; Tuccillo et al., 2020; Ventanas et al., 2022). Consumers from the cluster 'C3-Non-visible acceptors' also presented a negative emotional response (worried, concerned; 'Grimacing face'), but also associated entomophagy with less negative emotional terms such as doubtful, unsure, and indifferent ('Confused face' and 'Neutral face'). On the other hand, consumers from the cluster 'C4-Acceptors' had very positive emotional response with terms such as happy ('Grinning face'), cool, excited, daring, interesting ('Smiling face with sunglasses'), funny, playful ('Face with stuck-out tongue and winking eye'), tasty, pleased or craving ('Face savoring delicious food'). These emotional associations highlight the positive attitudes that acceptors have toward edible insects, but also underscore how sensation-seeking (Valesi et al., 2024; Wang and Park, 2024) and interest/curiosity (Huang, 2025; Francesco La Barbera et al., 2020) can drive acceptance. Beyond the role of the 'E-Entomophagy' scale as a predictor of entomophagy acceptance (Section 3.4), this analysis demonstrates how the application of emoji-based questionnaires allows obtaining consumers' emotional responses toward edible insects, clearly differentiating between consumers with varying acceptance levels. Applying the 'E-Entomophagy' scale in a cross-cultural context and comparing it with lexicon-based emotional questionnaires (e.g., ESense Profile) is essential to determine whether the 'E-Entomophagy' scale leads to more spontaneous and intense emotional reactions and whether it is a more stable tool than lexicon-based questionnaires.

3.4. 'E-Entomophagy' as a predictor of entomophagy acceptance

The regression models for acceptance of visible, invisible, or indirect entomophagy were all significant, explained between 39.7 % (visible entomophagy) and 47.2 % (invisible entomophagy) of the outcome variation, and presented very similar prediction accuracies (76.7 %–78.2 %) (Table 6). For all entomophagy forms, 'Food Disgust' sensitivity did not significantly affect acceptance, and removing this variable from the model did not change any outcome. Regarding variables with a significant effect, for acceptance of visible entomophagy 'E-Entomophagy' ($\beta = -0.624$) had a greater negative effect than 'Disgust toward insects' ($\beta = -0.346$), while for invisible and indirect entomophagy 'Disgust toward insects' had a greater negative effect ($\beta = -0.652$ and $\beta = -0.615$, respectively) than 'E-Entomophagy' ($\beta = -0.581$ and $\beta = -0.554$, respectively) (Table 6).

When comparing with the models that solely incorporated the 'Disgust toward insects' and 'Food Disgust' scales (Table S3), or just the 'Disgust toward insects' scale (Table 7), it is possible to observe that the incorporation of the 'E-Entomophagy' scale into the model (Table 6) improved the R_N^2 and prediction accuracy for all the entomophagy forms. The models with the 'E-Entomophagy' scale (Table S2 and Table 7) provided better parameters (R_N^2 and prediction accuracy) for acceptance of visible entomophagy than the models with the 'Disgust toward insects' scale (Table S3, Table 7), while the opposite occurred for acceptance of indirect entomophagy. For acceptance of invisible

entomophagy, the models with the 'E-Entomophagy' scale provided higher prediction accuracy but lower R_N^2 values. Another contrast between the models concerned the variables that significantly affected acceptance of the different entomophagy forms. For the models that included the 'Disgust toward insects' scale, 'Food Disgust' sensitivity was not a significant variable for acceptance of any of the entomophagy forms (Table S3). On the other hand, in the model that included the 'E-Entomophagy' scale, 'Food Disgust' sensitivity significantly affected the acceptance of invisible and indirect entomophagy, although at a much lower level than the 'E-Entomophagy' scores (Table S2).

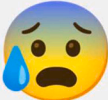

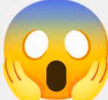








These results demonstrate that emotional responses toward insects can be measured using an emoji-based questionnaire ('E-Entomophagy') and that its scores can accurately predict entomophagy acceptance. In particular, 'E-Entomophagy' scores were better predictors for acceptance of visible entomophagy than 'Disgust toward insects', while 'E-Entomophagy' provides at least similar predictive values for acceptance of invisible and indirect entomophagy, demonstrating that the 'E-Entomophagy' scale can function as an excellent predictor, particularly considering that disgust toward insects has been consistently described as the best predictor of edible insects' acceptance (La Barbera et al., 2018; Ribeiro et al., 2022, 2021; Woolf et al., 2019). Emoji have been increasingly used in sensory analysis and consumer perception studies, and this study further highlights how emoji-based questionnaires can be used as alternatives to text-based questionnaires to measure emotional responses (Jaeger, Vidal, et al., 2021; Schouteten and Meiselman, 2021), and opens up the possibility of applying similar approaches to the acceptance of other protein alternatives, that are also heavily impacted by emotional factors (Onwezen et al., 2022).

Furthermore, comparing the predictive values of the different scales, it is evident that either insect-specific scale provided better results than the 'Food disgust' scale, further demonstrating that the rejection of edible insects is mainly motivated by specific disgust toward edible insects or emotional reaction toward insects, and not general food disgust sensitivity (Cunha and Ribeiro, 2019, 2025; Kröger et al., 2022; Schomaker and Fiebelkorn, 2026). It is possible that participants who are disgusted by the elicitors present on the 'Food Disgust Scale' (e.g., animal cartilage, dirty silverware in a restaurant) are not disgusted by edible insects, and that disgust toward edible insects is motivated by other factors outside the scope of the 'Food Disgust Scale' (e.g., insects as survival food, expectation of bad sensory experiences).

Despite the promising results obtained with the application of the 'E-Entomophagy' questionnaire, it is necessary to address the bias toward higher scores when compared to the 'Disgust toward insects' scale, since it lacks a center point (the 'Neutral Face' emoji has a 5.06 score, Table 1). The 'E-Entomophagy' scale presented an average score of 5.2 ± 1.6 (with ca. 70 % of consumers presenting scores above 5.0 and ca. 25 % of consumers presenting average scores between 2.0 and 4.0), while the average score in the 'Disgust toward insects' was 3.7 ± 1.7 and relative frequency of the average scores was very similar across the scale (highest proportion was observed between 2.0 and 4.0, with 44.5 %). An effect of this bias is that scores from the 'E-Entomophagy' scale are better fitted to predict acceptance of whole edible insects instead of products with processed insects, as discussed in this section. Additionally, while the application of the 'E-Entomophagy' scale can be a

Table 5

List of emoji used in the ‘E-Entomophagy’ ballot, with information regarding frequency of selection (n) and relative frequency in relation to number of participants (% , n = 326) and total number of selected emoji (% . n = 541).

Emoji	Frequency of selection (n)	Relative frequency of selection (% participants)	Relative frequency of selection (% total emoji selected)
	52	16.0%	9.6%
	97	29.8%	17.9%
	56	17.2%	10.4%
	56	17.2%	10.4%
	74	22.7%	13.7%
	63	19.3%	11.6%
	37	11.3%	6.8%
	40	12.3%	7.4%
	24	7.4%	4.4%
	37	11.3%	6.8%
	5	1.5%	0.9%

powerful tool to identify consumer groups with a high rejection or acceptance of the consumption of edible insects, it can present limitations to accurately identify consumers who are not intensely disgusted by the consumption of edible insects (e.g., consumers willing only to consume insect-based food products or insects as feed). Possible corrections to the emoji scores can be applied by also considering the largely neglected dominance dimension, although it has a lower contribution for emoji differentiation than valence and arousal (Jaeger, Jin, et al., 2021; Schouteten, Llobell, et al., 2023).

Socio-demographic characteristics (in particular age and health

status) also significantly affected acceptance of entomophagy . Participants with a higher perceived health status were significantly more likely to accept products containing whole edible insects or animals fed insects. At the same time, younger people were more likely to accept consuming products with processed insects (Table 6). Participants with higher perceived health status may show a more pronounced general interest in food health (e.g., the importance of healthiness and nutrition in their food choices), which positively influences acceptance of edible insects (Orsi et al., 2019; Palmieri et al., 2019; Ribeiro et al., 2021). Furthermore, the effect of age has also been reported with several

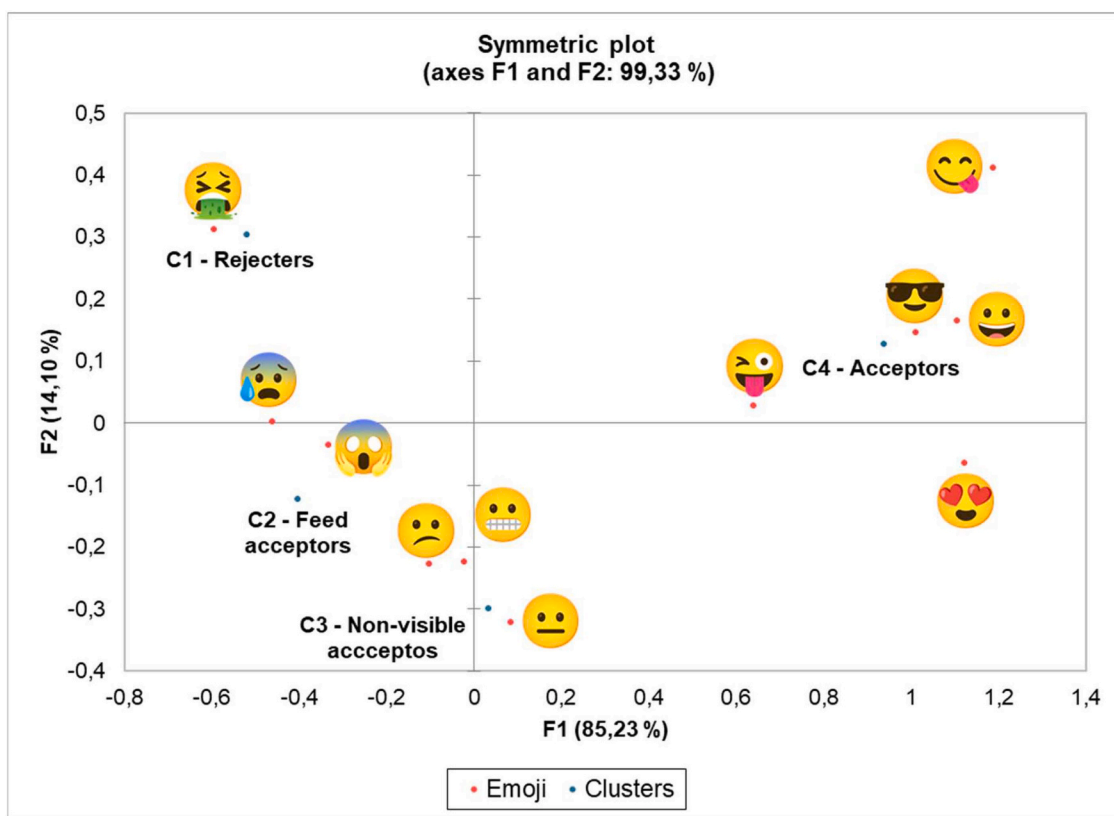


Fig. 1. Correspondence analysis (CA) of CATA frequencies related to emoji selection for each consumer cluster.

Table 6

Coefficient estimates from the binary logistic regression of binary (accept/reject) acceptance of the different forms of entomophagy. Variables with a significant impact ($p \leq 0.050$) are written in italic.

Predictor variable	Visible entomophagy($R^2 = 0.397^*$, 78.2 % accuracy)	
	β	Sig.
<i>Disgust toward insects</i>	-0.346	0.001
<i>E-Entomophagy</i>	-0.624	<0.001
<i>Health situation</i>	0.519	0.004
Predictor variable	Invisible entomophagy($R^2 = 0.472^*$, 77.3 % accuracy)	
	β	Sig.
<i>Age</i>	-0.025	0.032
<i>Disgust toward insects</i>	-0.652	<0.001
<i>E-Entomophagy</i>	-0.581	<0.001
<i>Health situation</i>	0.311	0.094
Predictor variable	Indirect entomophagy($R^2 = 0.459^*$, 76.7 % accuracy)	
	β	Sig.
<i>Disgust toward insects</i>	-0.615	<0.001
<i>E-Entomophagy</i>	-0.554	<0.001
<i>Health situation</i>	0.397	0.026

* Nagelkerke R^2 .

studies demonstrating that younger consumers have a higher entomophagy acceptance (Cunha and Ribeiro, 2019, 2025; Kröger et al., 2022; Schomaker and Fiebelkorn, 2026), since these consumers generally present characteristics (e.g., valorization in environment sustainability, interest in new food experiences) that are associated with higher entomophagy acceptance (Lammers et al., 2019; Videbæk and Grunert, 2020).

Table 7

Nagelkerke R^2 , accuracy prediction and coefficient estimates from the binary logistic regression of binary (accept/reject) acceptance of the different forms of entomophagy. Logistic regression models, for the E-Entomophagy scale and each disgust scale, encompassed experience with edible insects and sociodemographic factors.

Scale	Visible(R_N^2 / Accuracy / β)	Invisible(R_N^2 / Accuracy / β)	Feed(R_N^2 / Accuracy / β)
E-Entomophagy	0.364 / 77.0 % / -0.811	0.358 / 76.4 % / -0.978	0.359 / 73.0 % / -0.895
Disgust toward insects	0.295 / 73.0 % / -0.626	0.424 / 73.9 % / -0.850	0.406 / 73.9 % / -0.825
Food disgust	0.180 / 69.6 % / -0.490	0.246 / 69.3 % / -0.698	0.210 / 65.3 % / -0.599

4. Conclusion

In this study, it was possible to measure Portuguese consumers' acceptance of different forms of entomophagy and to assess the predictive ability of consumers' emotional responses toward edible insects and their sensitivity to food disgust. Acceptance of all entomophagy forms was higher than in a previous study conducted with Portuguese consumers, with fewer than 30 % of consumers giving negative scores for acceptance of products containing processed insects. Furthermore, it was possible to identify two segments (accounting for more than 60 % of consumers) with very high acceptance of products containing processed insects. However, only the cluster with the highest acceptance presents positive emotional associations with entomophagy.

Regarding predictors of entomophagy acceptance, consumers' emotional responses toward edible insects are strong predictors for all entomophagy forms. In particular, the 'E-Entomophagy' scores (a newly developed emoji-based scale based on a CATA ballot with 11 emoji, each with a score standardized to a 7-point scale) yielded the highest

predictive values for acceptance of products with whole insects, while improving model outcomes compared to models that incorporated only disgust scales. For the acceptance of products with processed insects or insects as feed, 'E-Entomophagy' scores had similar predictive strength as the established 'Disgust toward insects' scale. The scale was also able to differentiate between different consumer segments, although, unlike the 'Disgust toward insects' scale, it did not differentiate between 'Rejecters' and 'Feed acceptors'. The 'E-Entomophagy' scale provides an additional and powerful tool to identify consumers with a higher acceptance of edible insects. This newly developed scale can measure consumers' emotional response toward the consumption of edible insects. Using emoji increases the ecological validity of these measures, thereby ensuring a more accurate representation of consumers' real-world behavior.

5. Future work and limitations

It is essential to note that the developed scale yields higher scores than the disgust scales, as it lacks a center point (the 'Neutral Face' emoji has a score of 5.06). Although the rescaling of the valence scores (from a 7-point scale to a $-3/+3$ scale) hindered this issue, this problem is not specific to this study since "neutral" emoji have been described as presenting a negative bias.

Another limitation of the present study concerns the variables included in the models. Due to the objectives of the study, relevant variables with an effect on entomophagy acceptance, such as interest in entomophagy, food neophobia, sensation-seeking, or food choice motives (health, nutrition, or sustainability) were not assessed, which can explain the lower R_N^2 in the models for acceptance of insects as food relative to the previous study performed by the research group in Portugal (Ribeiro et al., 2022). As such, in future studies, the 'E-Entomophagy' scale should be incorporated in studies that apply all the possible relevant variables for entomophagy acceptance.

Further work should also focus on the application of the 'E-Entomophagy' scale in other countries and age-specific segments (e.g., children/adolescents, seniors), because emoji familiarity can be significantly different between cultures and age groups (Boutet et al., 2024; Jaeger, Lee, Kim, et al., 2018). Although the semantic meanings of emoji are relatively stable across countries (Schouteten, Llobell, et al., 2023; Sick et al., 2023) with only small differences mostly observed in the arousal dimension, it should be noted that valence and arousal values must be specific for each country and particular age groups. The necessity of emoji valence and arousal values for specific populations and additional data processing (e.g., emoji individual score calculation) represents logistical constraints that are not applicable to text-based alternatives, such as the disgust scales. Furthermore, the better appropriateness of the emoji-based scale for acceptance of unprocessed insects further demonstrates that emoji-based approaches may be particularly useful for food concepts that elicit strong emotional reactions or when verbalization is limited, while text-based scales may remain adequate and more practical for foods associated with lower emotional involvement.

Furthermore, the 'E-Entomophagy' scale should also be applied with pictures of insects or actual insect-based food products, to assess if its predictive value and application are maintained when consumers are presented with graphical representations of the foods instead of just text-based concepts. Consumers exhibit different behaviors when evaluating abstract food concepts versus when presented with actual products. The disgust scales should also be compared for their predictive value regarding the acceptance of actual products, as well as actual purchase and consumption behavior. Due to the impact of emotions as drivers of intention to consume alternative proteins (Onwezen et al., 2022), similar approaches to the 'E-Entomophagy' scale should also be applied with other alternative proteins.

Ethical statement – studies in humans

The work described in the manuscript entitled *Emoji-based scale to assess emotional response towards edible insects (E-Entomophagy)* has been carried out in accordance with the Declaration of Helsinki for experiments involving humans:

Sense Test's (sensory evaluation and consumer tests company in Vila Nova de Gaia, Portugal) database was used for the recruitment of the consumers (residents of the Oporto metropolitan area, North of Portugal). The company ensures the protection and confidentiality of data through the authorization 2063/2009 of the National Data Protection Commission, and follows the EU General Data Protection Regulation (EU 2016/679), as well as a longstanding internal code of conduct, assuring informed consent. Before starting the questionnaire, participants were informed about the scope of the research as well as data treatment procedure. Furthermore, participants gave informed consent via the statement "I declare that I give my informed consent and wish to proceed with the questionnaire" where an affirmative reply was required to enter the survey.

CRedit authorship contribution statement

José Carlos Ribeiro: Writing – original draft, Methodology, Formal analysis, Conceptualization. **Célia Rocha:** Writing – review & editing, Validation, Investigation. **Manuela Estevez Pintado:** Writing – review & editing, Supervision, Funding acquisition. **Luís Miguel Cunha:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

Authors José Carlos Ribeiro, Célia Rocha, Manuela Estevez Pintado, and Luís Miguel Cunha of the manuscript *Emoji-based scale to assess emotional response towards edible insects (E-Entomophagy)*, submitted to Future Foods, declare there is no conflict of interest related to the work here reported.

Acknowledgments

Author J.C. Ribeiro acknowledges Doctoral Grant No. SFRH/BD/147409/2019, funded by the Portuguese Foundation for Science and Technology (FCT) and PhD Researcher Contract within the "VIAAFOOD" Agenda, approved in the PRR program (Notice No. 02/C05-i01/2022) under No. C644929456-00000040, for the RTD project "HIT-C—High Integration Technology for Consumer Insights". The authors also acknowledge support from GreenUPorto - Centro de Investigação em Produção Agroalimentar Sustentável, through UID/05748/2025 (<https://doi.org/10.54499/UID/05748/2025>) and UID/PRR/05748/2025 (<https://doi.org/10.54499/UID/PRR/05748/2025>), and UID/Multi/50016/2020 (CBQF) funded by FCT.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.fufo.2026.100954](https://doi.org/10.1016/j.fufo.2026.100954).

Data availability

Data will be made available on request.

References

- Ammann, J., Hartmann, C., Siegrist, M., 2018. Development and validation of the food disgust picture scale. *Appetite* 125, 367–379. <https://doi.org/10.1016/j.appet.2018.02.020>.

- Appiani, M., Cattaneo, C., Spinelli, S., Laureati, M., 2025. Understanding sensory and emotional drivers of plant-based fish analogues acceptance in children and adults. *Food Res. Int.* 220, 117024. <https://doi.org/10.1016/j.foodres.2025.117024>.
- Ares, G., Jaeger, S.R., 2017. A comparison of five methodological variants of emoji questionnaires for measuring product elicited emotional associations: an application with seafood among Chinese consumers. *Food Res. Int.* 99, 216–228. <https://doi.org/10.1016/j.foodres.2017.04.028>.
- Ares, G., Vidal, L., Jaeger, S.R., 2021. How do consumers use emoji in a food-related context? Insights for the design and interpretation of emoji questionnaires. *J. Sens. Stud.* 36 (4), e12663. <https://doi.org/10.1111/joss.12663>.
- Barbosa, B., Rocha, C., Pinto, A.C., Lima, R.C., Cunha, L.M., 2023. Development of an emoji polarity scale for food-evoked emotions evaluation. In: 15th Pangborn Sensory Science Symposium. Nantes, France.
- Bengtsson, J., Wendin, K., 2023. Insects as food – The impact of information on consumer attitudes. *Int. J. Gastron. Food Sci.* 32, 100754. <https://doi.org/10.1016/j.ijgfs.2023.100754>.
- Boutet, I., Goulet-Pelletier, J.-C., Sutura, E., Meinhardt-Injac, B., 2024. Are older adults adapting to new forms of communication? A study on emoji adoption across the adult lifespan. *Comput. Hum. Behav. Rep.* 13, 100379. <https://doi.org/10.1016/j.chbr.2024.100379>.
- Brislin, R.W., 1970. Back-translation for cross-cultural research. *J. Cross. Cult. Psychol.* 1, 185–216. <https://doi.org/10.1177/135910457000100301>.
- Chen, D., Jiang, S., Na, R., Ren, L., Han, P., 2026. Comparison of emoji and lexicon questionnaires for measuring spicy flavor-evoked emotions. *Food Qual. Prefer.* 137, 105806. <https://doi.org/10.1016/j.foodqual.2025.105806>.
- Cunha, C.F., Silva, M.B.O., Cheung, T.L., 2023. Understanding the perception of edible insects. *Br. Food J.* 125 (3), 980–993. <https://doi.org/10.1108/BFJ-07-2021-0820>.
- Cunha, L.M., Ribeiro, J.C., 2019. Sensory and Consumer Perspectives on Edible Insects. In: Sogari, G., Mora, C., Menozzi, D. (Eds.), *Edible Insects in the Food Sector: Methods, Current Applications and Perspectives*. Springer International Publishing, pp. 57–71. https://doi.org/10.1007/978-3-030-22522-3_5.
- Cunha, L.M., Ribeiro, J.C., 2025. Consumer Studies of the Use of Insects as Food. In: Meiselman, H.L. (Ed.), *Handbook of Eating and Drinking: Interdisciplinary Perspectives*. Springer, Nature Switzerland, pp. 1–32. https://doi.org/10.1007/978-3-319-75388-1_209-1.
- Curtis, V., Aunger, R., Rabie, T., 2004. Evidence that disgust evolved to protect from risk of disease. *Proc. R. Soc. B: Biol. Sci.* 271 (Suppl 4), S131–S133. <https://doi.org/10.1098/rsbl.2003.0144>.
- Detilleux, L., Bayendi Loudit, S., Le Gall, P., Francis, F., Caparros Megido, R., Dogot, T., 2024. Consumers of insect-based foods: a cross-cultural study between Belgium and Gabon. *J. Insect Sci.* 24 (3). <https://doi.org/10.1093/jisesa/ieae051>.
- Deubler, G., Swaney-Stueve, M., 2020. The K-State emoji scale, a cross-cultural validation with adults. *J. Sens. Stud.* 35 (4), e12573. <https://doi.org/10.1111/joss.12573>.
- Deubler, G., Swaney-Stueve, M., Jepsen, T., Su-Fern, B.P., 2020. The K-State emoji scale. *J. Sens. Stud.* 35 (1), e12545. <https://doi.org/10.1111/joss.12545>.
- Fuentes, S., Wong, Y.Y., Gonzalez Viejo, C., 2020. Non-invasive biometrics and machine learning modeling to obtain sensory and emotional responses from panelists during entomophagy. *Foods* 9 (7), 903. <https://www.mdpi.com/2304-8158/9/7/903>.
- Giacalone, D., Jaeger, S.R., 2023. Consumer acceptance of novel sustainable food technologies: a multi-country survey. *J. Clean. Prod.* 408, 137119. <https://doi.org/10.1016/j.jclepro.2023.137119>.
- Kinali, A.A., Matsakidou, A., Michailidis, A., Paraskevopoulou, A., 2024. How Do Greeks Feel about Eating Insects? A Study of Consumer Perceptions and Preferences. *Foods* 13 (19), 3199. <https://doi.org/10.3390/foods13193199>.
- 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 Qual. Prefer.* 54, 117–127. <https://doi.org/10.1016/j.foodqual.2016.07.003>.
- Gurdian, C.E., Torrico, D.D., Li, B., Tuuri, G., Prinyawiwatkul, W., 2021. Effect of Disclosed Information on Product Liking, Emotional Profile, and Purchase Intent: a Case of Chocolate Brownies Containing Edible-Cricket Protein. *Foods* 10 (8), 1769. <https://www.mdpi.com/2304-8158/10/8/1769>.
- Haidt, J., McCauley, C., Rozin, P., 1994. Individual differences in sensitivity to disgust: a scale sampling seven domains of disgust elicitors. *Pers. Individ. Dif.* 16 (5), 701–713. [https://doi.org/10.1016/0191-8869\(94\)90212-7](https://doi.org/10.1016/0191-8869(94)90212-7).
- Hamerman, E.J., 2016. Cooking and disgust sensitivity influence preference for attending insect-based food events. *Appetite* 96, 319–326. <https://doi.org/10.1016/j.appet.2015.09.029>.
- Hartmann, C., Shi, J., Giusto, A., Siegrist, M., 2015. The psychology of eating insects: a cross-cultural comparison between Germany and China. *Food Qual. Prefer.* 44, 148–156. <https://doi.org/10.1016/j.foodqual.2015.04.013>.
- Hartmann, C., Siegrist, M., 2018. Development and validation of the Food Disgust Scale. *Food Qual. Prefer.* 63, 38–50. <https://doi.org/10.1016/j.foodqual.2017.07.013>.
- Hoek, A.C., Luning, P.A., Weijzen, P., Engels, W., Kok, F.J., de Graaf, C., 2011. Replacement of meat by meat substitutes. A survey on person- and product-related factors in consumer acceptance. *Appetite* 56 (3), 662–673. <https://doi.org/10.1016/j.appet.2011.02.001>.
- Huang, S., 2025. Reviving the entomophagy tradition among the younger generation: an application of the theory of planned behavior. *Food Qual. Prefer.* 124, 105356. <https://doi.org/10.1016/j.foodqual.2024.105356>.
- Jaeger, S.R., Cardello, A.V., 2022. Factors affecting data quality of online questionnaires: issues and metrics for sensory and consumer research. *Food Qual. Prefer.* 102, 104676. <https://doi.org/10.1016/j.foodqual.2022.104676>.
- Jaeger, S.R., Cardello, A.V., Schutz, H.G., 2013. Emotion questionnaires: a consumer-centric perspective. *Food Qual. Prefer.* 30 (2), 229–241. <https://doi.org/10.1016/j.foodqual.2013.05.015>.
- Jaeger, S.R., Jin, D., Ryan, G.S., Schouteten, J.J., 2021a. Emoji for Food and Beverage Research: pleasure, Arousal and Dominance Meanings and Appropriateness for Use. *Foods* 10 (11), 2880. <https://www.mdpi.com/2304-8158/10/11/2880>.
- Jaeger, S.R., Lee, P.-Y., Ares, G., 2018a. Product involvement and consumer food-elicited emotional associations: insights from emoji questionnaires. *Food Res. Int.* 106, 999–1011. <https://doi.org/10.1016/j.foodres.2018.01.024>.
- Jaeger, S.R., Lee, S.M., Kim, K.-O., Chheang, S.L., Jin, D., Ares, G., 2017. Measurement of product emotions using emoji surveys: case studies with tasted foods and beverages. *Food Qual. Prefer.* 62, 46–59. <https://doi.org/10.1016/j.foodqual.2017.05.016>.
- Jaeger, S.R., Lee, S.M., Kim, K.-O., Chheang, S.L., Roigard, C.M., Ares, G., 2018b. CATA and RATA questions for product-focused emotion research: five case studies using emoji questionnaires. *Food Qual. Prefer.* 68, 342–348. <https://doi.org/10.1016/j.foodqual.2018.04.001>.
- Jaeger, S.R., Roigard, C.M., Jin, D., Vidal, L., Ares, G., 2019. Valence, arousal and sentiment meanings of 33 facial emoji: insights for the use of emoji in consumer research. *Food Res. Int.* 119, 895–907. <https://doi.org/10.1016/j.foodres.2018.10.074>.
- Jaeger, S.R., Vidal, L., Ares, G., 2021b. Should emoji replace emotion words in questionnaire-based food-related consumer research? *Food Qual. Prefer.* 92, 104121. <https://doi.org/10.1016/j.foodqual.2020.104121>.
- Koch, J.A., Bolderdijk, J.W., van Ittersum, K., 2021. Disgusting? No, just deviating from internalized norms. Understanding consumer skepticism toward sustainable food alternatives. *J. Env. Psychol.* 76, 101645. <https://doi.org/10.1016/j.jenvp.2021.101645>.
- Köster, E.P., Mojet, J., 2015. From mood to food and from food to mood: a psychological perspective on the measurement of food-related emotions in consumer research. *Food Res. Int.* 76, 180–191. <https://doi.org/10.1016/j.foodres.2015.04.006>.
- Kröger, T., Dupont, J., Büsing, L., Fiebelkorn, F., 2022. Acceptance of insect-based food products in western societies: a systematic review [Systematic Review]. *Front. Nutr.* 8. <https://doi.org/10.3389/fnut.2021.759885>.
- La Barbera, F., Verneau, F., Amato, M., Grunert, K., 2018. Understanding Westerners' disgust for the eating of insects: the role of food neophobia and implicit associations. *Food Qual. Prefer.* 64, 120–125. <https://doi.org/10.1016/j.foodqual.2017.10.002>.
- La Barbera, F., Verneau, F., Videbæk, P.N., Amato, M., Grunert, K.G., 2020. A self-report measure of attitudes toward the eating of insects: construction and validation of the Entomophagy Attitude Questionnaire. *Food Qual. Prefer.* 79, 103757. <https://doi.org/10.1016/j.foodqual.2019.103757>.
- Lagast, S., Gellynck, X., Schouteten, J.J., De Herdt, V., De Steur, H., 2017. Consumers' emotions elicited by food: a systematic review of explicit and implicit methods. *Trends. Food Sci. Technol.* 69, 172–189. <https://doi.org/10.1016/j.tifs.2017.09.006>.
- 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 Qual. Prefer.* 77, 78–88. <https://doi.org/10.1016/j.foodqual.2019.05.010>.
- Ledesma-Chaves, P., Gil-Cordero, E., Maldonado-López, B., 2024. Consumer behavioral factors of the new EU regulatory framework for the feeding of insect-derived products. *Future Foods* 9, 100383. <https://doi.org/10.1016/j.fufo.2024.100383>.
- Looy, H., Dunkel, F.V., Wood, J.R., 2014. How then shall we eat? Insect-eating attitudes and sustainable foodways. *Agric Hum. Values* 31 (1), 131–141. <https://doi.org/10.1007/s10460-013-9450-x>.
- Low, J.Y., Janin, N., Traill, R.M., Hort, J., 2022. The who, what, where, when, why and how of measuring emotional response to food. A systematic review. *Food Qual. Prefer.* 100. <https://doi.org/10.1016/j.foodqual.2022.104607>.
- Maniaci, M.R., Rogge, R.D., 2014. Caring about carelessness: participant inattention and its effects on research. *J. Res. Pers.* 48, 61–83. <https://doi.org/10.1016/j.jrp.2013.09.008>.
- Meyners, M., Castura, J.C., Carr, B.T., 2013. Existing and new approaches for the analysis of CATA data. *Food Qual. Prefer.* 30 (2), 309–319. <https://doi.org/10.1016/j.foodqual.2013.06.010>.
- Molina-Castillo, S., Espinoza-Ortega, A., Sánchez-Vega, L., 2025. Perception of non-conventional food consumption: the case of insects. *Br. Food J.* <https://doi.org/10.1108/BFJ-06-2024-0599>.
- Myers, G., Pettigrew, S., 2018. A qualitative exploration of the factors underlying seniors' receptiveness to entomophagy. *Food Res. Int.* 103, 163–169. <https://doi.org/10.1016/j.foodres.2017.10.032>.
- Olatunji, B.O., Williams, N.L., Tolin, D.F., Abramowitz, J.S., Sawchuk, C.N., Lohr, J.M., Elwood, L.S., 2007. The Disgust Scale: item analysis, factor structure, and suggestions for refinement. *Psychol. Assess.* 19, 281–297. <https://doi.org/10.1037/1040-3590.19.3.281>.
- 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 Qual. Prefer.* 77, 51–63. <https://doi.org/10.1016/j.foodqual.2019.04.011>.
- Onwezen, M.C., Verain, M.C.D., Dagevos, H., 2022. Positive emotions explain increased intention to consume five types of alternative proteins. *Food Qual. Prefer.* 96, 104446. <https://doi.org/10.1016/j.foodqual.2021.104446>.
- Orsi, L., Voegel, L.L., Stranieri, S., 2019. Eating edible insects as sustainable food? Exploring the determinants of consumer acceptance in Germany. *Food Res. Int.* 125, 108573. <https://doi.org/10.1016/j.foodres.2019.108573>.
- Palcu, J., Schreier, M., Janiszewski, C., Kleber, J., Salerno, A., 2025. Fixing the bug in insect consumption. *Food Qual. Prefer.* 128, 105472. <https://doi.org/10.1016/j.foodqual.2025.105472>.

- Palmieri, N., Perito, M.A., Macri, M.C., Lupi, C., 2019. Exploring consumers' willingness to eat insects in Italy. *Br. Food J.* 121 (11), 2937–2950. <https://doi.org/10.1108/BFJ-03-2019-0170>.
- Qian, K., Yamada, Y., 2020. Exploring the Role of the Behavioral Immune System in Acceptability of Entomophagy Using Semantic Associations and Food-Related Attitudes [Original Research]. *Front. Nutr.* 7. <https://doi.org/10.3389/fnut.2020.00066>.
- Reed, M., Norwood, B.F., Hoback, W.W., Riggs, A., 2021. A survey of willingness to consume insects and a measure of college student perceptions of insect consumption using Q methodology. *Future Foods* 4, 100046. <https://doi.org/10.1016/j.fufo.2021.100046>.
- Ribeiro, J.C., Gonçalves, A.T.S., Moura, A.P., Varella, P., Cunha, L.M., 2022. Insects as food and feed in Portugal and Norway – Cross-cultural comparison of determinants of acceptance. *Food Qual. Prefer.* 102, 104650. <https://doi.org/10.1016/j.foodqual.2022.104650>.
- Ribeiro, J.C., Soares, A., de Moura, A.P., & Cunha, L.M. (2021). Evaluation of Consumers' Acceptance of Bread Supplemented with Insect Protein. In M. M. Cortez Vieira, L. Pastrana, & J. Aguilera, *Sustainable Innovation in Food Product Design*. Cham.
- Rizo, A., Bartu, A., Laguna, L., Tarrega, A., 2023. Effect of an opinion app on expectations and emotional responses of young consumers toward white wines. *Food Qual. Prefer.* 103, 104706. <https://doi.org/10.1016/j.foodqual.2022.104706>.
- Rocha, C., Godoy, N., Barbosa, B., Lima, R.C., Cunha, L.M., 2022. Development and Application of an Emoji Ballot to Evaluate Food Evoked Emotions Using Semantic Categorization and Card Sorting. *EuroSense 2022, Turku, Finland*.
- Rodrigues, D., Prada, M., Gaspar, R., Garrido, M.V., Lopes, D., 2018. Lisbon Emoji and Emoticon Database (LEED): norms for emoji and emoticons in seven evaluative dimensions. *Behav. Res. Methods* 50 (1), 392–405. <https://doi.org/10.3758/s13428-017-0878-6>.
- Rozin, P., Fallon, A.E., 1987. A perspective on disgust. *Psychol. Rev.* 94 (1), 23–41. <https://doi.org/10.1037/0033-295X.94.1.23>.
- Rozin, P., Haidt, J., 2013. The domains of disgust and their origins: contrasting biological and cultural evolutionary accounts. *Trends Cogn. Sci. (Regul. Ed.)* 17 (8), 367–368. <https://doi.org/10.1016/j.tics.2013.06.001>.
- Ruby, M.B., Rozin, P., 2019. Disgust, sushi consumption, and other predictors of acceptance of insects as food by Americans and Indians. *Food Qual. Prefer.* 74, 155–162. <https://doi.org/10.1016/j.foodqual.2019.01.013>.
- Santos, L., Alencar, N., Rodrigues, J., Gonçalves, A., Trombete, F., 2022. Proposal of two facial scales using emojis as tools to understand emotions in research with Brazilian consumers. *Acta Sci. - Technol.* 44, e56610. <https://doi.org/10.4025/actascitecnol.v44i1.56610>.
- Schomaker, L., Fiebelkorn, F., 2026. Acceptance of insect-based food products in Western societies: an updated review (2021–2024). *Food Qual. Prefer.* 136, 105738. <https://doi.org/10.1016/j.foodqual.2025.105738>.
- Schouteten, J.J., Almlí, V.L., Rini, L., Berget, I., 2023a. Valence, arousal and projective mapping of facial and non-facial emoji investigated using an incomplete block design approach. *Food Qual. Prefer.* 105, 104762. <https://doi.org/10.1016/j.foodqual.2022.104762>.
- 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 Qual. Prefer.* 52, 27–31. <https://doi.org/10.1016/j.foodqual.2016.03.011>.
- Schouteten, J.J., Llobell, F., Chheang, S.L., Jin, D., Jaeger, S.R., 2023b. Emoji meanings (pleasure–arousal–dominance dimensions) in consumer research: between-country and interpersonal differences. *J. Food Sci* 88 (S1), A106–A121. <https://doi.org/10.1111/1750-3841.16374>.
- Schouteten, J.J., Llobell, F., Roigard, C.M., Jin, D., Jaeger, S.R., 2022. Toward a valence × arousal circumplex-inspired emotion questionnaire (CEQ) based on emoji and comparison with the word-pair variant. *Food Qual. Prefer.* 99, 104541. <https://doi.org/10.1016/j.foodqual.2022.104541>.
- Schouteten, J.J., Meiselman, H.L., 2021. The potential of using emoji instead of words when measuring emotions associated with food. *Food Qual. Prefer.* 92, 104182. <https://doi.org/10.1016/j.foodqual.2021.104182>.
- Schouteten, J.J., Verwaeren, J., Lagast, S., Gellynck, X., De Steur, H., 2018. Emoji as a tool for measuring children's emotions when tasting food. *Food Qual. Prefer.* 68, 322–331. <https://doi.org/10.1016/j.foodqual.2018.03.005>.
- Serpico, M., Rovai, D., Wilke, K., Lesniasukas, R., Garza, J., Lammert, A., 2021. Studying the emotional response to insects food products. *Foods*. 10 (10), 2404. <https://www.mdpi.com/2304-8158/10/10/2404>.
- Shelomi, M., 2023. Factors affecting willingness and future intention to eat insects in students of an edible insect course. *J. Insects Food Feed.* 9 (7), 865–876. <https://doi.org/10.3920/JIFF2022.0084>.
- Sick, J., Almlí, V.L., Dinnella, C., Berget, I., Monteleone, E., Spinelli, S., 2023. Cross-national comparison on the meaning of emoji to describe emotions elicited by foods in preadolescents. *Food Qual. Prefer.* 106, 104791. <https://doi.org/10.1016/j.foodqual.2022.104791>.
- Sick, J., Monteleone, E., Dinnella, C., Pierguidi, L., Spinelli, S., 2022. Development of an emoji-based self-report measurement tool to measure emotions elicited by foods in preadolescents. *Food Qual. Prefer.* 100, 104585. <https://doi.org/10.1016/j.foodqual.2022.104585>.
- Silva, A., Rocha, C., Ribeiro, J.C., Aganovic, K., Lima, R.C., Methven, L., Cunha, L.M., 2024. Consumer perception of risk towards new sustainable non-thermal food processing technologies: a cross-cultural study between Portugal, Germany, and the UK. *Innov. Food Sci. Emerg. Technol.* 96, 103772. <https://doi.org/10.1016/j.ifset.2024.103772>.
- Sogari, G., Riccioli, F., Moruzzo, R., Menozzi, D., Tzompa Sosa, D.A., Li, J., Liu, A., Mancini, S., 2023. Engaging in entomophagy: the role of food neophobia and disgust between insect and non-insect eaters. *Food Qual. Prefer.* 104, 104764. <https://doi.org/10.1016/j.foodqual.2022.104764>.
- Sousa, M.J., 2018. *Perspetivas Do Consumidor Face Ao Consumo De Frutos Do Mar*. Universidade do Porto, Porto, J.
- Swaney-Stueve, M., Jepsen, T., Deubler, G., 2018. The emoji scale: a facial scale for the 21st century. *Food Qual. Prefer.* 68, 183–190. <https://doi.org/10.1016/j.foodqual.2018.03.002>.
- Tuccillo, F., Marino, M.G., Torri, L., 2020. Italian consumers' attitudes towards entomophagy: influence of human factors and properties of insects and insect-based food. *Food Res. Int.* 137, 109619. <https://doi.org/10.1016/j.foodres.2020.109619>.
- Valesi, R., Andreini, D., Pedeliento, G., 2024. Insect-based food consumption: hedonic or utilitarian motives? Moderation and segmentation analyses. *Food Qual. Prefer.* 118, 105193. <https://doi.org/10.1016/j.foodqual.2024.105193>.
- Van Thielen, L., Vermuyten, S., Storms, B., Rumpold, B., Van Campenhout, L., 2019. Consumer acceptance of foods containing edible insects in Belgium two years after their introduction to the market. *J. Insects Food Feed.* 5 (1), 35–44. <https://doi.org/10.3920/JIFF2017.0075>.
- Ventanas, S., González-Mohino, A., Olegario, L.S., Estévez, M., 2022. Newbie consumers try pizzas in which bacon is replaced by *Tenebrio molitor* L. larvae: not as healthy as expected and not as terrible as they thought. *Int. J. Gastron. Food Sci.* 29, 100553. <https://doi.org/10.1016/j.ijgfs.2022.100553>.
- Verbeke, W., 2005. Consumer acceptance of functional foods: socio-demographic, cognitive and attitudinal determinants. *Food Qual. Prefer.* 16 (1), 45–57. <https://doi.org/10.1016/j.foodqual.2004.01.001>.
- Verbeke, W., 2015. Profiling consumers who are ready to adopt insects as a meat substitute in a Western society. *Food Qual. Prefer.* 39, 147–155. <https://doi.org/10.1016/j.foodqual.2014.07.008>.
- Verneau, F., La Barbera, F., Kolle, S., Amato, M., Del Giudice, T., Grunert, K., 2016. The effect of communication and implicit associations on consuming insects: an experiment in Denmark and Italy. *Appetite* 106, 30–36. <https://doi.org/10.1016/j.appet.2016.02.006>.
- Videbæk, P.N., Grunert, K.G., 2020. Disgusting or delicious? Examining attitudinal ambivalence towards entomophagy among Danish consumers. *Food Qual. Prefer.* 83, 103913. <https://doi.org/10.1016/j.foodqual.2020.103913>.
- Viejo, C.G., Fuentes, S., De Anda-Lobo, I.C., Hernandez-Brenes, C., 2022. Remote sensory assessment of beer quality based on visual perception of foamability and biometrics compared to standard emotional responses from affective images. *Food Res. Int.* 156, 111341. <https://doi.org/10.1016/j.foodres.2022.111341>.
- Wang, Z., Park, J., 2024. Does personality make a difference? Exploring the connections between the big five personality traits and entomophagy among Japanese consumers. *Food Qual. Prefer.* 119, 105225. <https://doi.org/10.1016/j.foodqual.2024.105225>.
- Wansink, B., Sonka, S.T., Park, S.-B., 2004. Segmentation approaches that differentiate consumption frequency from sensory preference. *J. Sens Stud* 19 (4), 327–340. <https://doi.org/10.1111/j.1745-459X.2004.tb00151.x>.
- Ward Jr, J.H., 1963. Hierarchical Grouping to Optimize an Objective Function. *J. Am. Stat. Assoc.* 58 (301), 236–244. <https://doi.org/10.1080/01621459.1963.10500845>.
- 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, 100–105. <https://doi.org/10.1016/j.lwt.2018.12.010>.
- Yen, A.L., 2009. Edible insects: traditional knowledge or western phobia? *Entomol. Res.* 39 (5), 289–298. <https://doi.org/10.1111/j.1748-5967.2009.00239.x>.