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Who has an appetite for insects? Identifying segments of early adopters of insect-based food and their product attribute preferences: Insights from a choice experiment study in Germany

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ABSTRACT

Despite well-documented scepticism among Western consumers about eating insects, there are groups of potential early adopters who will form the initial market for insect-based food. Understanding the different preferences of these potential early adopters is key to developing effective targeted marketing actions. This study aimed to identify segments of potential early adopters and their distinct product attribute preferences. Via an online survey in Germany ($N = 922$), we conducted discrete choice experiments using real packaging of insect-based meatballs and crackers. Latent class logit analysis identified four consumer segments for each product, three of which showed a willingness to buy the products. While these potential consumer groups varied in their price sensitivity and insect labelling preferences, they all attached the greatest importance to naturalness claims. Interestingly, sustainability and nutritional information were not top priorities for all consumers; instead we observed the importance of an institutional trust indicator, especially for unconvinced consumers. In conclusion, the results of the present study provide interesting insights for both researchers and practitioners to make informed marketing decisions in the development and labelling of insect-based products.

1. Introduction

In striving to balance the growing demand for protein-rich products and health with environmental sustainability, food scientists and producers have increasingly focused on developing alternative protein sources, including products containing invisibly processed edible insects (Bashi et al., 2019; Onwezen et al., 2021; Sogari, Amato, et al., 2023; van der Weele et al., 2019). Insects are promising as they are nutritionally comparable to conventional meat, and insect-rearing is more environmentally sustainable than traditional livestock farming (Lange & Nakamura, 2023; Nowakowski et al., 2022; Smetana et al., 2023).

Commercialising insect-based food (IBF) in Western markets must overcome considerable consumer resistance to eating insects (Aureli et al., 2023). Despite evidence of widespread disgust and food neophobia about entomophagy (Sogari, Riccioli, et al., 2023; White et al., 2023), research has also identified potential early adopters of IBF in Western countries (House, 2016; Khalil et al., 2024; Rovai et al., 2021). Exploring these consumers' preferences is highly relevant for the marketing of IBF, since they are the ones who will build the initial market for these products (Rovai et al., 2021).

To encourage increased purchase and consumption among potential early adopters it is necessary to target and enhance the appeal of IBF and ensure they stand out from competitive products. Producers could provide consumers with different kinds of labels to create informative and attractive product packaging. However, the presence of too many labels can cause confusion and even loss of confidence in product quality (Grunert & Wills, 2007; Sonntag et al., 2023). It is therefore crucial to identify consumer segments and their preferences in order to determine the most important food labels to target these segments effectively (Naranjo-Guevara et al., 2023). Although prior studies have identified the characteristics of potential early adopters of IBF (e.g. Brunner & Nuttavuthisit, 2019; Rovai et al., 2021; Valesi et al., 2024; Videbæk & Grunert, 2020), no study has yet specifically addressed their preferences for different insect-based product attributes and their preference

Abbreviations: IBF, insect-based food; CE, choice experiment; LCL, latent class conditional logit; WTP, willingness to pay.

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heterogeneity. This is an important knowledge gap because even early adopters can differ in their acceptance and preferences of IBF.

Focusing on Germany, the present study aimed to address the identified research gap by answering the following research questions:

1. What are the specific preferences of different segments of potential early adopters for IBF product attributes?
2. Which product attributes (i.e. sustainability claims, nutritional information, naturalness claims, trust indicator and insect labelling) promote the choice of IBF products?

To answer these questions, a discrete choice experiment (CE) method was conducted with two different products: insect-based meatballs and insect-based crackers. Unlike other stated choice studies (e.g. Broeckhoven et al., 2021; Janssen et al., 2020), the present study employed CE method with real packaging designs, thereby providing participants with a more familiar choice setting that more closely resembles real-life grocery shopping experience. The findings of the present study not only contribute to researchers in the field, but can also facilitate targeted marketing actions and thus have clear implications for practitioners to make evidence-based decisions in the development and marketing of IBFs.

2. State of the art

In this section, we provide a summary of existing knowledge regarding consumer preferences for different attributes of insect-based products and present the product attributes included in the CE.

Consumers make food purchase decisions based on assessing which product possesses attributes that are most likely to deliver the benefits they desire (Lancaster, 1966). While several attributes such as taste and convenience can be directly experienced by consumers, 'credence attributes' such as environmental friendliness and naturalness cannot be perceived even after consumption (Grunert & van Trijp, 2014). Food labelling, including claims and product recommendations on product packaging, plays a crucial role in helping consumers to identify products they want at the point-of-sale. Labelling is especially important for novel foods like IBF since many consumers have little or no sensory experiences of these foods and must base their purchasing decisions on perceived and expected benefits conveyed through labelling and price (Franchi, 2012; Grunert & van Trijp, 2014).

The benefits consumers seek from products can reflect different motives: egoistic motives for desiring attributes that address their own self-interests; and/or altruistic motives for desiring attributes that enhance the well-being of others and/or the environment (Birch et al., 2018). In the case of altruistic motives, prior studies have confirmed that sustainability is a key motive for people consuming IBF (Khalil et al., 2024; Nyberg et al., 2020; Palmieri et al., 2019; Tuccillo et al., 2020). In addition to higher IBF acceptance, Khalil et al. (2024) found that willingness to pay (WTP) for IBF increased when consumers placed a higher value on environmental attribute when purchasing food. Consumers make environmentally conscious food choices by searching for sustainable food labels indicating, for example, organic production, low carbon footprint, and the absence of ingredients whose production is perceived as negative for the environment such as soy and palm oil (Holenweger et al., 2023; Lieke et al., 2023; Siegrist & Hartmann, 2019). Based on these findings, we identified sustainability claims as a potential product attribute influencing consumers' purchase decisions for IBF.

Egoistic motives such as health and food safety, however, often remain consumers' top priorities in purchase decisions (Birch et al., 2018; Sonntag et al., 2023). Previous studies have identified health as one of the main motives for eating insects (Nyberg et al., 2020; Pozharliev et al., 2023; Tuccillo et al., 2020). Pozharliev et al. (2023) found that health consciousness had a positive effect on reducing consumers' perceived disgust toward IBF and increasing their willingness to try it. Consumers seek to make healthy food purchases by selecting products perceived as more natural (Monaco et al., 2024; Román et al., 2017) and/or with nutritional label, which is often provided in two ways: nutrient-specific such as Reference Intakes label or colour-coded scale such as Nutri-Score label (Egnell et al., 2019; Sonntag et al., 2023). While 'naturalness' in food lacks a clear objective definition, consumers seem to have no difficulty perceiving 'natural' products by relying on intuitive judgements (Monaco et al., 2024; Román et al., 2017). Even when buying supposedly 'unnatural' products such as highly-processed foods, consumers tend to search for the presence of natural ingredients or absence of additives (Asioli et al., 2017; Román et al., 2017). Based on the above-mentioned evidence, this study proposed that nutritional information and naturalness claims could influence consumers' choice of IBFs.

Trust in food safety and quality is another egoistic concern that is necessary to be addressed, since people will not consume food they perceive as unsafe. This is particularly important in the case of IBF because many Western consumers still doubt the safety of eating insects (Baker et al., 2016; Ros-Baró et al., 2022), which has intensified since the outbreak of COVID-19 (Khalil et al., 2021). Gómez-Luciano, de Aguiar, et al. (2019) investigated consumers' willingness to buy three alternative protein sources, including IBF, in four different countries. They found that consumers' willingness to purchase IBF was lower in countries where insects were perceived as less safe and less healthy. To address these concerns, producers can highlight the nutritional value or country of origin of the product to support consumers' perceived food quality and safety. However, consumers also tend to seek product assurances from trusted sources, such as third-party institutions and opinion-leaders (Wu et al., 2021). Using validation from credible sources in food labelling may effectively reduce consumers' perceived risk and increase their trust in IBF. Hence, the present study suggested that the presence of trust indicators could influence consumers' choice of IBF products.

Front-of-pack insect labelling is another important attribute for IBF as it can prevent consumers from feeling deceived and help interested consumers to distinguish IBF on the market (Puteri et al., 2023). However, certain types of labelling can backfire, such as realistic images of insects, heightening consumer disgust and risk perception, and reducing taste expectations and willingness to try the product (Baker et al., 2016; Goncikowska et al., 2023; Naranjo-Guevara et al., 2023). Ascertaining the optimal insect labelling is thus essential for effectively communicating the presence of insects in food products. However, there is still limited information on how different types of insect description affect consumers' acceptance. In light of this, the present study proposed that different insect labelling using familiar and easy-to-understand insect terms could influence consumers' preferences for IBF products.

3. Material and methods

3.1. Sampling

For this study a web-based survey was conducted in Germany in November 2023. Participants were recruited randomly from an online consumer panel of a market research agency. To create a pool of potential early adopters, the market research agency distributed a prescreener question to its consumer panel inquiring about their willingness to eat IBF. A total of 18,090 responses were received, and this prescreening process resulted in a pool of 8,076 individuals who indicated a (partial) willingness to eat IBF. Based on the initial assumption of an incidence rate of 15–20 %[1] and with the aim of reaching a target sample of 1,000 participants, 5,149 individuals from the pool of potential early

[1] The anticipated low incidence rate was determined based on the market research agency's previous experience and was driven primarily by the exclusion of mobile devices, which also accounted for over 80% of the screened-out cases in the present study.

Table 1
Product attributes and attribute levels for the choice experiments.

Attributes	Levels (Insect-based meatballs)	Levels (Insect-based crackers)
Price (€)	1.99, 2.99, 3.49, 3.99, 4.49, 5.49	0.99, 1.99, 2.49, 2.99, 3.49, 4.49
Sustainability claims	'CO_2 neutral', 'Soy-free', No label	'CO_2 neutral', 'Palm oil-free', No label
Nutritional information	'Nutri-Score B', 'Reference Intakes', No label	'Nutri-Score A', 'Reference Intakes', No label
Naturalness claims	'No additives', '100 % natural ingredients', No label	'No additives', '100 % natural ingredients', No label
Trust indicator	Institutional product validation ('Stiftung Warentest' logo), Interpersonal product validation (Celebrity endorsement: '"Exactly my protein source!" Ski-star Felix Neureuther'), No label	Institutional product validation ('Stiftung Warentest' logo), Interpersonal product validation (Celebrity endorsement: '"Exactly my snack!" Ski-star Felix Neureuther'), No label
Insect labelling	'With high-quality protein from insects', 'With high-quality protein from mealworms'	'With high-quality protein from insects', 'With high-quality protein from mealworms'

adopters were invited to participate in the survey. In order to ensure the inclusion of potential early adopters from a diverse socio-demographic group, quotas were set for gender, age, and residence at federal state level to resemble the German population.

Participants' willingness to eat IBF was verified again in the screening question within the survey, which also included eligibility criteria to ensure participants were (i) (partially) responsible for household grocery shopping and/or meal preparation, (ii) worked outside the market research industry, and (iii) completed the questionnaire on a desktop PC/laptop to ensure proper display of the CE. Of the 1,800 individuals who opened the survey, 698 were screened out (564 due to the use of a mobile device, 133 due to unwillingness to eat IBF, and one dropout). A total of 1,102 individuals completed the survey, representing a completion rate of 61 %. Data cleaning excluded further 180 responses on the following bases: (i) failure in the attention-check questions[2]; (ii) over-speeding (complete the survey in less than half the median survey duration of 720 s); or (iii) inconsistency in answers. The final sample amounted to 922 individuals.

3.2. Survey design and procedures

The survey consisted of two parts: discrete CEs and a self-administered questionnaire that included socio-demographic questions. (See Supplementary Material for the survey.) Prior to developing the survey, six focus group discussions were conducted with 50 consumers in four German cities, namely Kassel, Dresden, Munich and Hamburg. The focus group participants were 46 % female, 52 % came from big hometowns and the average age was 46 years. The topics discussed covered motives and barriers for consuming IBF and consumers' opinions on insect labelling. We combined insights from these discussions and findings from previous research to inform our choice of the most relevant product attributes for testing in the CE (e.g. Egnell et al., 2019; Holenweger et al., 2023; Román et al., 2017; Wu et al., 2021). We also reviewed the selected product attributes and food labels (see Table 1) in consultation with our collaborating practitioner, the Swiss start-up Essento (https://essento.eu/), to ensure their relevance and feasibility in practice. Finally, the survey was pre-tested with 100 participants.

To compare consumer preferences for different types of IBF, we selected two product categories covering different meal situations, namely meat alternative and savoury snack products, basing this selection on findings from a systematic literature review by Puteri et al. (2023). For each category we selected one product from Essento's portfolio to include foods familiar on the German market: insect-based meatballs and insect-based crackers.

In the present study, we used real packaging designs to reduce the risk of hypothetical bias (Caputo & Scarpa, 2022). Based on Essento's original product packaging, we worked with a professional designer to create new packaging with food labels to be tested in the CEs and general labels commonly found on IBF, namely taste description, a high-protein claim, and a 'made in EU' label. To ensure comprehensibility, all labels on the packaging are written in German. Figs. 1 and 2 show the adapted packaging for insect-based meatballs and insect-based crackers.

3.3. Choice experiments

A CE method was employed to address the research questions. This experimental approach was deemed appropriate for this study, as it allowed us to investigate the importance consumers attach to different food products and product attributes that are not yet commercially available, and it enabled the presentation of food labels in a controlled and easily understandable manner for respondents. Furthermore, CE has a robust theoretical foundation and is a widely used research method in various fields, including environmental and food preference research. When executed appropriately, this method can offer a high level of external validity and predictive power, which can be used to complement revealed preference study (Caputo & Scarpa, 2022).

3.3.1. Design dimensions and food label selection

Two CEs were conducted for the insect-based meatballs and crackers. All participants received both CEs one after the other in randomised order, i.e. some were presented the meatballs CE first, others the crackers CE first. Each participant received six random choice sets for each CE, meaning each participant was tasked with a total of 12 choice sets. As shown in Figs. 1 and 2, participants were asked to choose between three alternatives in each choice set: two product alternatives and a 'no-buy' option, which was always presented on the right-hand side.

Our study focused on six product attributes (see Table 1). Price levels were based on an inventory of retail prices for plant-based meatballs and crackers sold in local German supermarket chains in September 2023. Since our previous focus group discussions indicated consumers demand for the presence of insect ingredients to be indicated clearly on front-of-pack labelling, we compared two levels of labelling for this attribute: more general/abstract insect labelling versus labelling with information about the particular insect species. For the other attributes (i.e. sustainability claims, nutritional information, naturalness claims, trust indicator), three attribute levels were compared, including 'no label' to investigate consumer preferences for the absence and presence of a certain label.

Regarding sustainability claims, we compared the 'CO_2 neutral' label already adopted by Essento on some of its product packaging (Essento, 2024) with a 'soy-free' label for the meatballs and a 'palm oil-free' label for the crackers, as they are the two agricultural commodities most frequently criticised in Germany for driving deforestation (OVID, 2022). Regarding nutritional information, we compared two front-of-pack nutritional labels commonly used in Germany: 'Nutri-Score' and

[2] Participants were excluded if they marked the wrong answer option to any of the following attention-check questions: "In this line, we ask you to mark the answer 'strongly agree' on the answer scale" and "I read this sentence and therefore mark the option 'strongly disagree' on the answer scale".

Fig. 1. A choice set example for insect-based meatballs. (For the English translation of the survey, see Supplementary Materials.)

Fig. 2. A choice set example for insect-based crackers. (For the English translation of the survey, see Supplementary Materials.)

'Reference Intakes' (Egnell et al., 2019). The meatballs were labelled with Nutri-Score B and the crackers with Nutri-Score A, corresponding to the Nutri-Scores for these products at the time the survey was developed. Regarding naturalness claims, we highlighted the absence of negatively perceived ingredients with a 'no additives' label and the presence of positively perceived ingredients with a '100 % natural ingredients' label. Regarding assurances of food quality and safety, we compared consumers' preferences for two trust indicators: (i) institutional product validation using the label of highly trusted independent consumer organisation in Germany involved in product comparisons and evaluations, Stiftung Warentest (2024); and (ii) interpersonal product validation in the form of 'celebrity endorsement'.

3.3.2. Statistical design

The experimental design of the CEs was optimized using NGENE software (ChoiceMetrics, 2018). For the pre-test, we applied a D-efficient design with fixed priors equal to zero and the CE data were estimated using a conditional logit model. Using the parameter estimates

from the pre-test, we determined the range of priors to be used in the main study, in which we implemented the Bayesian efficient design. We generated one design with 24 choice sets for the CE meatballs and used the same design for the CE crackers. (On statistical design, see Supplementary Material.)

3.4. Econometric approach

The CE approach was developed based on random utility theory, which assumes that consumers choose the product that offer maximum utility (McFadden, 1974). The utility that consumers perceive in a product is supposed to derive from two parts: the deterministic and observed (V_{ijt}) component, and the random and unobservable component (ε_{ijt}), also known as the random error term. The utility function for consumer i choosing product alternative j in choice set t can be modelled as follows in Eq. (1):

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} = \beta_i X_{ijt} + \varepsilon_{ijt} \quad (1)$$

The deterministic component V_{ijt} is assumed to have a linear function of the attributes ($\beta_i X_{ijt}$) of product j, where β_i represents the individual coefficient vector (Mariel et al., 2021; Train, 2003). In our study the deterministic component depended on the six product attributes examined. The utility model for the insect-based meatballs is defined as in Eq. (2):

$$\begin{aligned} U_{ijt} = {} & \beta_0 * price_{jt} + \beta_1 * ASC\_product_{jt} + \beta_2 * Nutriscore_{jt} \\ & + \beta_3 * Reference\_Intakes_{jt} + \beta_4 * CO2\_neutral_{jt} + \beta_5 * soy\_free_{jt} \\ & + \beta_6 * no\_additive_{jt} + \beta_7 * natural\_ingredients_{jt} + \beta_8 * institutional\_trust_{jt} \\ & + \beta_9 * interpersonal\_trust_{jt} + \beta_{10} * mealworms_{jt} + \varepsilon_{ijt} \end{aligned} \quad (2)$$

The utility model for insect-based crackers differs in one attribute level, namely 'palm oil-free' instead of 'soy-free'. The vectors β_i are coefficients to be estimated. The $ASC\_product_{jt}$ is an alternative-specific constant to account for the tendency of participants to choose one of the product alternatives, with the 'no-buy' option as a reference. With the exception of price, all attributes were dummy coded. The 'no label' attribute level served as a reference for all attributes except for the attribute insect labelling, for which the general insect label was used as a reference.

For analysing the CE data, we started by estimating the conditional logit model. Like other fixed parameter logit models, however, this model is restrictive in its assumptions, including (i) independence among choices in a sequence of choices, (ii) independence of irrelevant alternatives, which assumes that the probability of choosing between existing alternatives remains unaffected by the introduction of new alternatives, and (iii) preference homogeneity among participants (Boccia & Punzo, 2020; Train, 2003). To account for consumer preference heterogeneity, the main data analysis was conducted using the Latent Class Conditional Logit (LCL) model as a method for consumer segmentation[3] (Greene & Hensher, 2003). The segmentation was determined by consumers' choices in the CEs, and the number of segments was determined based on model fit criteria and interpretability of the parameter coefficients. It is assumed that consumer preferences within each segment are homogenous.

In the present study, the LCL analysis was estimated using the 'lclogit2' command (Yoo, 2020) in Stata software. In LCL modelling, a multinomial logit model is used to determine the membership of each individual consumer in each class. Conditional logit model is then used to estimate a different utility function for each class s, where $U_{ijt|s}$ is the utility that consumers in class s perceived in product alternative j, as shown in Eq. (3) (Roosen et al., 2023):

$$U_{ijt|s} = V_{ijt|s} + \varepsilon_{ijt|s} = \beta_s X_{ijt} + \varepsilon_{ijt|s} \quad (3)$$

The WTP estimates within each class were calculated as the negative ratio of the estimated non-price attribute coefficient $\beta_{j|s}$ divided by the estimated price coefficient $\beta_{cost|s}$, as in Eq. (4) (Broeckhoven et al., 2021; Train, 2003):

$$WTP_{j|s} = -1 * \frac{\beta_{j|s}}{\beta_{cost|s}} \quad (4)$$

The standard errors and the confidence intervals for the WTP were calculated using the delta method (Hole, 2007).

To capture the socio-demographic characteristics and entomophagy experience of the individual classes, the following variables were included as covariates in the model: age (in years), gender (as a dummy variable, 'female'), prior experience of eating IBF (as a dummy variable, 'with entomophagy experience'), hometown (as a dummy variable, 'big hometown': 100,000 or more inhabitants), and income (as two dummy variables, 'income2' (between 2,600 and 3,599€), 'income3' (3,600€ and above), with 'income1' (less than 2,600€) as the reference category). To handle the 88 missing values (9.5 %) for the income variable, we used a multiple linear regression imputation method, with income as the dependent variable and age, gender and education level as the independent variables. (See results in Table A1 in Supplementary Materials.)

To determine the optimal class solution, LCL models were estimated with different numbers of classes (two to six classes) and evaluated using Bayesian information criterion (BIC), where a lower BIC indicates better fit (Yoo, 2020). Fig. 3 presents BIC plot diagrams for (a) insect-based meatballs and (b) insect-based crackers. For the insect-based meatballs, the four-class solution showed the lowest BIC, and increasing the class solution to five led to convergence problem. In the LCL model for insect-based crackers, the five-class solution showed the lowest BIC. However, the inflection point (indicated by the 'elbow' highlighted in Fig. 3b) showed no further significant decrease in the BIC beyond the four-class solution. Since a further increase in class solution did not lead to any more meaningful insights (Sinha et al., 2022), the four-class solution was judged most optimal for interpretation, hence the four-class model with covariates was chosen as the final model for both products, using Class 1 as the reference class.

The LCL analysis results consist of two components: the conditional logit model estimates for the attributes within each class, and the class membership function for the covariates (Tables 3 and 4). A confidence interval of 95 % was used for interpreting the results.

4. Results

4.1. Sample characteristics

Responses to the (pre-)screening question showed that 7,943 (43.9 %) of 18,090 consumers in Germany were (partially) willing to eat IBF. In our final sample of 922 participants, the average age was 46.4 (S.D. = 14.6 years), 52.6 % were female, 38.3 % had spent most of their childhoods in big cities (with populations over 100,000), and 67.9 % had an upper secondary education certificate, showing an over-representation of highly educated people compared to the entire German population (see Table 2). Regarding experience with entomophagy, 38.6 % reported having eaten IBF before. This figure is comparable to the findings of other consumer segmentation studies conducted in Switzerland (Brunner & Nuttavuthisit, 2019) and Denmark (Videbæk & Grunert, 2020), which found an entomophagy experience rate of 34–39 % among potential early adopters.

[3] The data were also analysed using mixed logit models, showing a high and significant standard deviation for almost all coefficient estimates. (See results in Table A2 in Supplementary Materials.) These results indicate the presence of high preference heterogeneity in the sample, demonstrating the need for an LCL analysis to identify segments of potential early adopters.

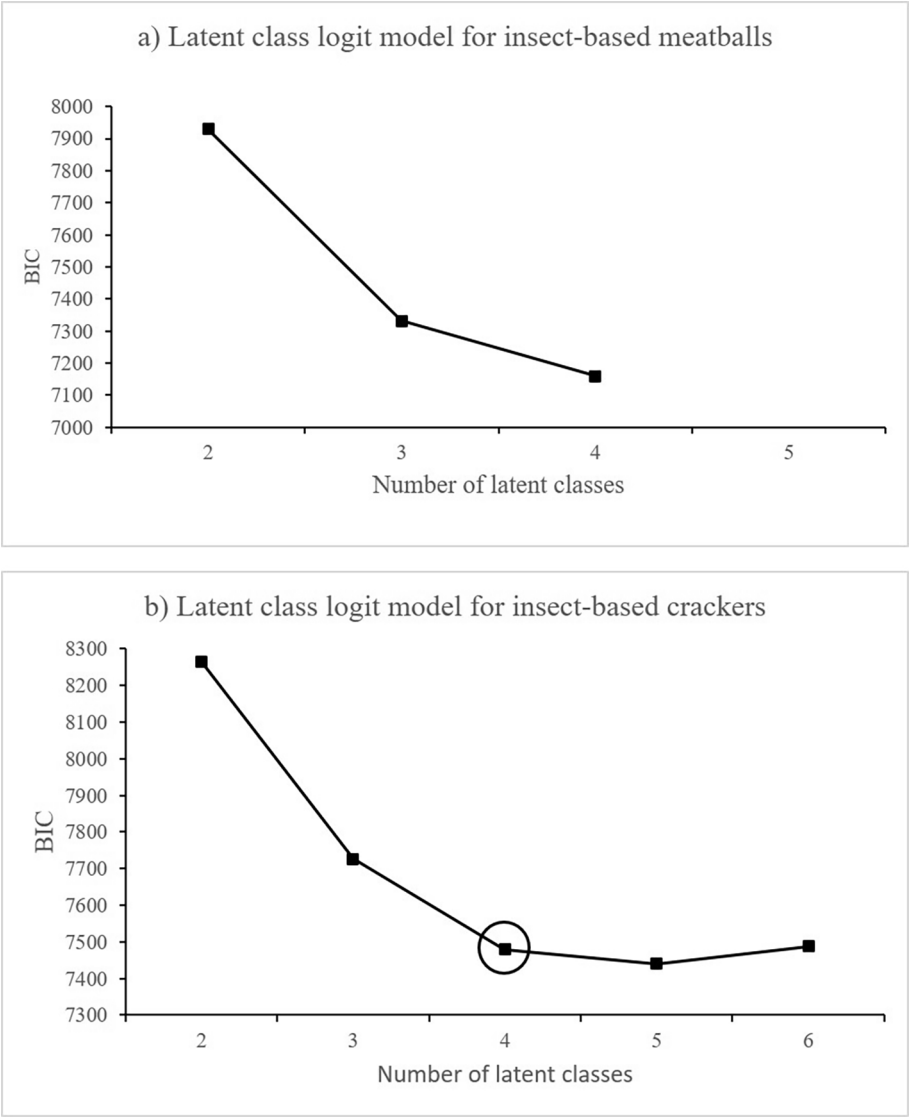

Fig. 3. The 'elbow' plot of model fit criteria BIC for latent class logit models with different numbers of classes for (a) insect-based meatballs and (b) insect-based crackers. (Notes: The circle indicates the 'elbow'. In the LCL model for insect-based meatballs, increasing the class solution to five led to convergence problems.)

4.2. Choice experiment results

The descriptive statistics of the CEs showed that a total of 5,532 purchase decisions were made in each CE. Participants opted not to purchase the insect-based meatballs in 2,048 choice situations and the insect-based crackers in 1,767 choice situations, constituting 37.02 % and 32.30 % of the total choices respectively. A similar pattern emerged when examining serial non-participation, i.e. individuals consistently choosing the 'no-buy' alternative for each product. Here it was found there were more serial non-participation for insect-based meatballs (183) than for insect-based crackers (137), with 97 individuals consistently refraining from buying either product.

4.2.1. Insect-based meatballs: Class characteristics

For insect-based meatballs, the size of the four segments of potential early adopters ranged from 23 % (Class 4) to 28.5 % (Class 3). As shown in Table 3, two segments were found to have a strong preference for the product (classes 2 and 3), while another segment showed potential for buying high-priced meatballs (Class 4). In terms of food labelling, all three segments with a preference for this product (classes 2, 3 and 4) attached the highest importance to labels related to the naturalness of the product. The last segment had a significantly low preference for the insect-based meatballs (Class 1). Regarding trust indicators, all segments, including the reluctant buyer segment (Class 1), showed a strong preference for institutional product validation versus celebrity endorsement.

The mean WTP estimates for classes 2 and 3 are presented in Table 4. Since the price coefficient for classes 1 and 4 was not observed to be significant, we can say these classes are price insensitive, hence no meaningful WTP can be reported for these classes.

4.2.1.1. Class 1: Reluctant buyers. Class 1 consumers (size: 23.4 %) showed the lowest potential to buy insect-based meatballs, including when this product had a low price. This is indicated by their high probability of choosing the 'no-buy' option even though they were not concerned about the price attribute. In contrast to other classes, Class 1 consumers based their purchase decisions mostly on trust indicator attributes, with a higher preference for institutional product validation than celebrity endorsement. This was closely followed by their preference for a 'Reference Intake' label as the source of nutritional information. Regarding socio-demographic characteristics, Class 1 had the highest number of older people, female consumers, and people from smaller cities. As expected, significantly fewer people in Class 1 had entomophagy experience.

Table 2
Characteristics of the sample ($N = 922$).

		Overall (%)	German population (%)	Source
Gender				
	Female	52.6	50.7	Destatis, 2023a
	Male	47.2	49.3	
	Diverse	0.2	–	
Age (Mean: 46.4)			(Mean: 44.6)	Statista, 2024a
	18–39	34.1	33.1	Destatis, 2023b
	40–59	45.6	36.8	
	60–75	20.4	30	
Education				
	Without school-leaving certificate	0.1	4	Destatis, 2020
	Lower secondary education certificate	5.7	28.6	
	Secondary education certificate	25.8	30	
	Upper secondary education certificate	67.9	33.5	
	Others	0.4	–	
Hometown (inhabitants)				
	Rural area (<5,000)	19.1	13.61	Statista, 2024b
	Small city (5,000–19,999)	20.7	26.55	
	Medium city (20,000–99,999)	21.9	27.59	
	Big city (100,000–499,999)	19.2	14.71	
	Metropolitan (≥500,000)	19.1	17.52	
Monthly household net income (Euros)				
	<1300	7.3	13.3	Destatis, 2021
	1300–2599	22.5	29.7	
	2600–3599	23.7	17.8	
	3600–4999	22	16.9	
	≥5000	15.1	22.2	
	Missing values	9.5	–	
Diet				
	Omnivore	46.4	–	
	Flexitarian	47.2	–	–
	Vegetarian	5.1	–	
	Vegan	1.3	–	
Prior experience of eating insects and/or insect-based food				
	Yes (occasional or regular consumers)	5.2		
	Yes	33.4		–
	No	61.4		

4.2.1.2. Class 2: All-claims enthusiasts. Class 2 consumers (size: 25.1 %) exhibited a high preference for the insect-based meatballs. In terms of food label preferences, this group valued all presented claims, with stronger preferences for the 'no additives' label, 'Reference Intakes' information, and the institutional product validation label. Class 2 consumers differed significantly from all other classes in their preference for the 'soy-free' label over the 'CO_2 neutral' label. Regarding the type of insect labelling, Class 2 consumers had a significantly high liking for products labelled 'mealworms'. The price coefficient for this class was negative and significant, indicating this group is price sensitive. However, the WTP estimates revealed this class was willing to pay a higher price for the product than another price-sensitive class (Class 3), which may be explained by their higher income level than Class 3 consumers. Class 2 consumers were also willing to pay an additional price for all food labels except for the 'CO_2 neutral' label, which was not significant. Compared to the reference class (Class 1), Class 2 comprised the largest proportion of younger and male consumers and was also found to have the second-largest number of people with entomophagy experience after Class 4.

4.2.1.3. Class 3: Budget-conscious 'naturals'. Consumers in the largest class (Class 3; size: 28.5 %) are potential buyers of insect-based meatballs, albeit with stricter criteria than Class 2. Consumers in this class placed particularly high value on naturalness claims, closely followed by the institutional product validation label. While Class 3 consumers were price sensitive and only willing to pay a lower price for the product than Class 2 consumers, the WTP estimates revealed that their WTP could be significantly increased by the presence of naturalness claims and a 'CO_2 neutral' label. Compared to the reference class (Class 1), Class 3 consisted of the second-largest proportion of younger consumers and significantly more consumers with entomophagy experience, albeit only above Class 1.

4.2.1.4. Class 4: Value-oriented sceptics. Consumers in the smallest class (Class 4; size: 23 %) tended to choose one of the products instead of selecting the 'no-buy' option, though this tendency was not significant. Class 4 consumers placed the highest importance on naturalness claims, with a slight priority for '100 % natural ingredients' over the 'no additives' label. This class differs from the other two 'potential buyer' classes (2 and 3) in two respects: (i) a higher preference for the 'Nutri-Score' label compared to 'Reference Intakes'; and (ii) a higher preference for products labelled 'insects' than 'mealworms'. Price was relatively unimportant for Class 4, though this difference must be interpreted with caution given the non-significant result, and may be explained by their higher income compared to other classes. Furthermore, this class contained the greatest number of people with entomophagy experience and

Table 3
Latent class logit analysis results on segments of potential early adopters for insect-based MEATBALLS. (Standard errors shown in parentheses.)

		Class 1	Class 2	Class 3	Class 4
Class size ($N = 922$)		23.4 %	25.1 %	28.5 %	23 %
Parameter coefficients					
Product options		−9.76*	8.08**	3.70*	1.51
Reference: No-buy option		(4.31)	(2.59)	(1.71)	(0.94)
Price		−0.16	−1.93***	−2.09***	−0.02
		(0.48)	(0.37)	(0.20)	(0.13)
Sustainability claims	CO_2 neutral	1.76	0.91	1.02*	0.53**
Reference: no label		(0.98)	(0.48)	(0.39)	(0.19)
	Soy-free	1.59	1.17**	0.42	0.48**
		(1.02)	(0.39)	(0.39)	(0.16)
Nutritional information	Nutri-score B	1.42	0.96**	0.56	0.54***
Reference: no label		(0.85)	(0.33)	(0.29)	(0.15)
	Reference Intakes	2.07*	1.22**	0.74*	0.36
		(0.90)	(0.38)	(0.36)	(0.20)
Naturalness claims	No additive	1.22	1.45**	1.43**	0.78***
Reference: no label		(1.21)	(0.43)	(0.45)	(0.18)
	100 % Natural ingredients	1.99	1.16**	1.39**	0.81***
		(1.11)	(0.41)	(0.40)	(0.17)
Trust indicator	Institutional product validation (Stiftung Warentest)	2.96**	1.20**	1.15**	0.51*
Reference: no label		(1.09)	(0.40)	(0.37)	(0.20)
	Interpersonal product validation (Celebrity endorsement)	2.60*	1.08**	0.56	0.25
		(1.07)	(0.39)	(0.35)	(0.19)
Insect labelling	Protein from mealworms	−0.13	1.02***	0.45	−0.53***
Reference: Protein from insects		(0.91)	(0.26)	(0.28)	(0.14)
Class membership model parameters: Class 1 = Reference class					
	Age	0.00	−0.04***	−0.01*	−0.005
			(0.01)	(0.01)	(0.01)
	Female	0.00	−0.53*	−0.27	−0.13
			(0.22)	(0.20)	(0.22)
	With entomophagy experience	0.00	0.79***	0.47*	1.07***
			(0.23)	(0.22)	(0.23)
	Big hometown (≥100,000)	0.00	0.21	0.31	0.49*
			(0.22)	(0.21)	(0.22)
	Income 2 (2600€–3599€)	0.00	−0.04	−0.27	0.03
			(0.26)	(0.24)	(0.26)
	Income 3 (≥3600€)	0.00	0.43	0.20	0.54*
			(0.26)	(0.25)	(0.26)

Notes: ***, **, * denotes $P < 0.001$, $P < 0.01$ and $P < 0.05$.

people coming from big hometowns.

4.2.2. Insect-based crackers: Class characteristics

For insect-based crackers, the size of the four segments of potential early adopters ranged from 22.2 % (Class 1) to 31.8 % (Class 2). All segments showed potential to buy the crackers, though only Class 2 expressed a significantly strong preference for the product (see Table 5). In terms of food labelling, classes 2, 3 and 4 attached the greatest importance to naturalness claims, while Class 1 expressed no particular liking except for the general rather than insect-specific label.

The mean WTP estimates for classes 1, 2 and 3 are presented in Table 6. No meaningful WTP could be reported for Class 4 since their price coefficient was not significant, suggesting this class is price-insensitive.

4.2.2.1. Class 1: Budget-hunters. Consumers in the smallest class (Class 1; size: 22.2 %) based their product choice mainly on the price attribute, indicating they were only inclined to buy insect-based crackers if low-priced. In terms of food labelling, Class 1 consumers expressed a higher preference for products labelled 'insects' than 'mealworms'. Nutritional information, sustainability claims and trust indicators had no significant importance for this class, differing notably from other classes in this respect. The WTP estimates for this class revealed the same pattern as the LCL estimates, suggesting these consumers are only willing to pay a low price for the product. In terms of consumer characteristics, Class 1 included the oldest consumers, the fewest people with entomophagy experience, and the fewest people from the highest income class, which could explain their price sensitivity.

4.2.2.2. Class 2: All-claims enthusiasts. Consumers in the largest class (Class 2; size: 31.8 %) constitute the main target group for insect-based crackers. This consumer segment valued all the food labels presented, with the two naturalness claims considered most important, closely followed by the institutional product validation label and the Nutri-Score. Regarding the type of insect labelling, Class 2 consumers favoured the 'mealworms' over the 'insects' label. Although the price coefficient for this class was significant, indicating price sensitivity, the WTP estimates show Class 2 consumers were more willing to pay higher prices for the product and for almost all food labels than other price-sensitive classes (i.e. classes 1 and 3). Compared to the reference class, Class 2 comprised the youngest age group and the highest number of people with entomophagy experience.

4.2.2.3. Class 3: Budget-conscious claims enthusiasts. Class 3 consumers (size: 22.8 %) can be classified as potential buyers of the insect-based crackers under certain conditions. Similar to Class 1, Class 3 consumers are price sensitive, and the WTP estimates show that they were willing to pay only a low price for the product. However, their WTP can be increased by the presence of their preferred food labels, especially the 'no additives' and 'CO_2 neutral' labels. In terms of nutritional information, these consumers differed from the other classes in their higher preference for 'Reference Intakes' over the Nutri-Score label. Like Class 2, this consumer segment favoured the 'mealworms' label. Class 3 does not differ significantly from Class 1 in terms of socio-demographic

Table 4
Mean WTP estimates for attributes of insect-based MEATBALLS per segment of potential early adopters (€).

		Class 1	Class 2	Class 3	Class 4
Product options		–	4.18***	1.77**	–
Reference: no buy					
Sustainability claims	CO_2 neutral	–	0.47	0.49*	–
Reference: no label					
	Soy-free	–	0.61*	0.20	–
Nutritional information	Nutri-Score B	–	0.50*	0.27	–
Reference: no label					
	Reference Intakes	–	0.63*	0.36	–
Naturalness claims	No additive	–	0.75*	0.68**	–
Reference: no label					
	100 % Natural ingredients	–	0.60*	0.67**	–
Trust indicator	Institutional product validation (Stiftung Warentest)	–	0.62*	0.55*	–
Reference: no label	Interpersonal product validation (Celebrity endorsement)	–	0.56*	0.27	–
Insect labelling	Protein from mealworms	–	0.53**	0.21	–
Reference: Protein from insects					

Notes: ***, **, * denotes $P < 0.001$, $P < 0.01$ and $P < 0.05$. No WTP was reported for classes 1 and 4 due to insignificant price coefficient.

backgrounds and entomophagy experience.

4.2.2.4. Class 4: Value-oriented sceptics. Class 4 (size: 23.2 %) is the least price-sensitive group according to the positive price coefficient of these consumers, though this must be interpreted with caution given the non-significant result. Furthermore, despite their inclination towards buying the insect-based crackers, this tendency did not reach statistical significance. Class 4 consumers appreciated all claims, with the highest appreciation for naturalness claims. Consumers in this class were also distinct in their higher preference for the 'palm oil-free' label over the 'CO_2 neutral' label. This segment showed similarities to Class 1 in their strong preference for the 'insects' label. Compared to the reference class (Class 1), Class 4 had the highest number of female consumers, as well as people from big cities and with high incomes. Consumers in this class also had the second-most experience with entomophagy, only slightly surpassed by Class 2.

5. Discussion

Despite the well-documented scepticism of Western consumers towards eating insects, our study reveals that nearly 44 % of consumers surveyed in Germany are (partially) willing to consume IBF. This is similar to findings of prior studies in Germany (BMEL, 2023; Gassler et al., 2024; Orsi et al., 2019), confirming the existence of potential early adopters and indicating growth potential for the IBF market within Germany's alternative protein market. In comparison to recent studies on consumer acceptance in other European countries, this value demonstrates a lower level of acceptance compared to Spain (Khalil et al., 2024), but higher compared to Italy (Aureli et al., 2023; Valesi et al., 2024) and Poland (Szlachciuk & Żakowska-Biemans, 2024).

Of the two products examined, consumers were notably more open to buying IBF in the form of crackers than meatballs, confirming Tan et al. (2017) finding on the importance of product type for the acceptance of insect ingredients. Other studies have also indicated a preference for insects in convenient snack products (Ardoin & Prinyawiwatkul, 2020; Clarkson et al., 2018). Barriers to consumers experimenting with IBF may be lower for snacks than main dishes because snacks are typically more affordable and readily consumable, requiring less time, effort and involvement (Olsen & Mai, 2013; Wales, 2009). Another reason for this product preference may relate to Nardi et al. (2020) finding that consumers have a higher risk perception of products with animal origins than vegetable origins: for while both our tested products were animal-based, the crackers had a herb-themed packaging design that potentially reduced participants' associations with animal products, in turn reducing their risk perception.

Notwithstanding these findings, our study revealed a relatively high share of non-purchase in overall choices regardless of product type, suggesting the existence of intention-behaviour gaps, where consumers' willingness to eat IBF do not necessarily translate into real purchase intention or behaviour. Such ambivalent attitude has been reported by Videbæk and Grunert (2020), showing that some consumers feel simultaneously interested in and disgusted by eating insects. While these consumers do not exclude the idea of trying IBF, they are hesitant to buy or incorporate them in their regular diet.

The LCL models identified four segments of potential early adopters of IBF with distinct product attribute preferences. Three segments (classes 2, 3 and 4) emerged as target consumers for both, while Class 1 consumers had little willingness to buy the meatballs and were only willing to pay for the crackers a price unrealistically low under normal market conditions. This reluctant segment was characterised by older individuals from less urban backgrounds, lower monthly incomes, and less entomophagy experience, which corresponds with findings from prior studies (Kröger et al., 2022; Marquis et al., 2023; Palmieri et al., 2023). The greatest difference among the three target segments was found in their price sensitivity, with Class 3 preferring low-priced products, Class 2 exhibiting price sensitivity but a willingness to pay more for food labelling, and Class 4 showing price insensitivity. These results indicate the need for competitive pricing to attain broader acceptance. However, we also identified market segments for currently high-priced IBF (House, 2016) if these are combined with benefits desired by these consumers.

5.1. Enhancing consumer acceptance: The importance of naturalness and trust

Marketing efforts to date have focused primarily on the nutritional benefits of IBF and their environmental benefits as a meat alternative (Reverberi, 2021; Shelomi, 2015). Although our study confirms that sustainability claims and nutritional labels are favoured by all target segments, we found these attributes were not the main reasons for purchase in any segment. While nutrition and sustainability have been cited as key motives for consuming IBF (Nyberg et al., 2020; Tuccillo et al., 2020), Naranjo-Guevara et al. (2023) found these attributes to have a low influence on taste expectations and perceived food safety, both of which are critical to consumers' purchasing decisions (BMEL, 2023; Lee & Bae, 2023; Monaco et al., 2024).

In our study, the food labels that perceived to offer the greatest benefits to all target segments were the two naturalness claims. This finding was consistent across both IBF and aligns with prior studies showing consumers' strong preferences for foods perceived as natural, including products with 'clean labels' (Grant et al., 2021; Hsu et al., 2023), as well as with studies finding low preferences for food perceived

Table 5
Latent class logit analysis results on segments of potential early adopters for insect-based CRACKERS. (Standard errors shown in parentheses.)

		Class 1	Class 2	Class 3	Class 4
Class size ($N = 922$)		22.2 %	31.8 %	22.8 %	23.2 %
Parameter coefficients					
Product options		1.05	3.72**	0.71	0.02
Reference: No-buy option		(3.01)	(1.34)	(2.32)	(0.88)
Price		−1.93***	−1.22***	−2.20***	0.12
		(0.43)	(0.21)	(0.35)	(0.14)
Sustainability claims	CO_2 neutral	−0.51	0.95***	1.79**	0.66**
Reference: no label		(0.76)	(0.27)	(0.57)	(0.21)
	Palm oil-free	−0.12	0.88**	1.25*	0.83***
		(0.76)	(0.27)	(0.55)	(0.19)
Nutritional information	Nutri-Score A	0.45	1.00***	0.98*	0.61***
Reference: no label		(0.69)	(0.19)	(0.42)	(0.16)
	Reference Intakes	0.24	0.91***	1.60**	0.45*
		(0.72)	(0.25)	(0.56)	(0.22)
Naturalness claims	No additive	0.36	1.11***	1.89**	0.91***
Reference: no label		(0.77)	(0.27)	(0.70)	(0.20)
	100 % Natural ingredients	−0.25	1.26***	1.50*	0.93***
		(0.81)	(0.24)	(0.65)	(0.19)
Trust indicator	Institutional product validation (Stiftung Warentest)	0.36	1.01***	1.19*	0.72**
Reference: No label		(0.70)	(0.25)	(0.54)	(0.23)
	Interpersonal product validation (Celebrity endorsement)	0.28	0.83***	0.87	0.59**
		(0.73)	(0.24)	(0.53)	(0.22)
Insect labelling	Protein from mealworms	−1.41*	0.73***	1.08*	−0.95***
Reference: Protein from insects		(0.63)	(0.17)	(0.44)	(0.16)
Class membership model parameters: Class 1 = Reference class					
	Age	0.00	−0.04***	−0.01	−0.0009
			(0.01)	(0.01)	(0.008)
	Female	0.00	−0.18	0.21	0.48*
			(0.21)	(0.23)	(0.22)
	With entomophagy experience	0.00	0.92***	0.46	0.83***
			(0.22)	(0.25)	(0.23)
	Big hometown (≥100,000)	0.00	0.02	0.33	0.59**
			(0.22)	(0.23)	(0.22)
	Income 2 (2600€–3599€)	0.00	−0.19	−0.09	0.34
			(0.25)	(0.27)	(0.28)
	Income 3 (≥3600€)	0.00	0.41	0.39	0.78**
			(0.25)	(0.28)	(0.28)

Notes: ***, **, * denotes $P < 0.001$, $P < 0.01$ and $P < 0.05$.

as novel and 'unnatural', including for cultivated meat (Wilks et al., 2021). This preference can be attributed to the general attachment of Western consumers to naturalness (Rozin et al., 2012), which relates to close associations of naturalness with health and taste, meaning natural foods are often perceived as 'healthier' and 'tastier' (Román et al., 2017).

Another product attribute found to be important for consumers in this study was the presence of trust indicators, with all segments favouring institutional validation over interpersonal endorsement. This is consistent with Naranjo-Guevara et al. (2023) finding that institutional certifications positively influence consumer perceptions of the safety of insect-based protein bars. A possible explanation for this is the inclination of consumers to substitute their own evaluations with their trust in the source of information about the product, known as 'trust heuristic' (Monaco et al., 2024; Siegrist & Hartmann, 2020). This tendency is especially pronounced when people lack sufficient knowledge and experience to assess certain attributes themselves, e.g. credence attributes like the safety and quality of novel foods.

Our findings underscore the need to address consumers' safety and quality concerns in order to gain wider acceptance and market share for IBF. Obtaining validation and certifications from reputable third-party institutions is one way to achieve this, although practitioners could also deliberately develop, design and market IBF to improve consumers' perceptions of safety and quality. Our findings indicate that practitioners could leverage consumers' strong attachment to naturalness. This would be especially advantageous in the case of insects since they are already commonly associated with natural foods (Szlachciuk & Żakowska-Biemans, 2024), unlike other novel foods (Wilks et al., 2021). In product development, practitioners could focus on simple and natural ingredients, avoiding the use of perceived 'bad-for-me' ingredients such as additives and preservatives (Román et al., 2017). Information on packaging should also be carefully framed to avoid triggering consumer perceptions of risk and unnaturalness, e.g. by refraining from using E-numbers in ingredient lists (Siegrist & Hartmann, 2020). Notwithstanding the value of sustainability and nutritional information, our findings suggest a shift in marketing focus to emphasise naturalness. This can be communicated through product packaging, e.g. by using front-of-pack 'clean labels' (Hsu et al., 2023) or by incorporating natural elements in the brand logo (Chen et al., 2023).

5.2. Front-of-pack insect labelling

Prior studies have shown that less realistic and more 'abstract' or 'cute' images and descriptions of insects on labelling can reduce consumers' disgust and/or risk perceptions and increase their anticipated liking for IBF (Bruckdorfer & Büttner, 2022; Marquis et al., 2023; Puteri et al., 2023). Our findings contribute to such research and advance this discussion by revealing distinct insect labelling preferences among different segments of potential early adopters depending on their acceptance of IBF. Specifically, those more inclined to buy the products in our study (classes 2 and 3) preferred the label indicating the insect species as 'mealworms', while the more sceptical segments (classes 1

Table 6
Mean WTP estimates for attributes of insect-based CRACKERS per segment of potential early adopters (€).

		Class 1	Class 2	Class 3	Class 4
Product options		0.54	3.06***	0.32	–
Reference: no-buy option					
Sustainability claims	CO_2 neutral	−0.26	0.78*	0.81*	–
Reference: no label					
	Palm oil-free	−0.06	0.73*	0.57	–
Nutritional information	Nutri-Score A	0.23	0.83**	0.45	–
Reference: no label					
	Reference Intakes	0.12	0.75*	0.73**	–
Naturalness claims	No additives	0.19	0.91**	0.86*	–
Reference: no label					
	100 % Natural ingredients	−0.13	1.03**	0.68	–
Trust indicator	Institutional product validation (Stiftung Warentest)	0.19	0.83*	0.54	–
Reference: no label	Interpersonal product validation (Celebrity endorsement)	0.14	0.68*	0.39	–
Insect labelling	Protein from mealworms	−0.73**	0.60**	0.49*	–
Reference: Protein from insects					

Notes: ***, **, * denotes $P < 0.001$, $P < 0.01$ and $P < 0.05$. No WTP was reported for Class 4 due to insignificant price coefficient.

and 4) favoured the general labelling 'insects'.

Strategic compromises on labelling can nevertheless be made to appeal to a larger market. For while classes 2 and 3 preferred the insect-species information, this was one of their least important purchase criteria, suggesting the strong possibility of convincing these consumers with other food labelling. Conversely, those averse to insect-species information placed great importance on more general insect labelling, suggesting they could decide for or against purchase on this basis alone. The most effective strategy to attract wider segments might thus be more general front-of-pack insect labelling, with the insect species indicated in the ingredient list in accordance with the Novel Food Regulation (EU) 2015/2283.

5.3. Limitations and future research

One constraint of our research relates to the online nature of our study, which means our research is based on hypothetical experiment with stated choice data, making our findings susceptible to hypothetical bias (Caputo & Scarpa, 2022). Although we used real product packaging to increase the realism of the choice setting and counter such bias, future research could extend to real in-store testing to explore how consumers' purchasing behaviour is influenced by implementing some of our findings and recommendations in marketing activities.

Furthermore, our study did not delve into consumers' knowledge and perceptions of the used food labelling, which might have afforded us deeper insights into their preferences. For while we included some general labelling commonly found on IBF to increase the realism of the product packaging (e.g. a 'high-protein' claim and a 'made in EU' label), these labels may have influenced consumers' perceptions of the tested labels in ways we did not investigate in this study. Future studies based on qualitative methods could explore the reasons behind consumers' preferences and identify factors influencing repeat purchase intentions.

The aforementioned limitation also means that we could not be certain whether the participants correctly understood the used food labels as intended. For example, it was not determined whether a product carrying 'no additives' label was actually perceived as more natural than products without a natural claim. Differences in food label understanding have been found to have a significant impact on consumers' evaluations and acceptance of food products (Samant & Seo, 2016). However, this does not undermine the validity of our research as it reflects real market situations where consumers make purchase decisions based on their limited knowledge (Mancini et al., 2017; Ufer & Ortega, 2023). Furthermore, we used food labels that are already widely available in the German market, suggesting high familiarity of the participants with these labels.

Finally, the present research focused on consumers in Germany, informing the development of product packaging designs and the selection of food labelling for the experiment. While insights from the present study are also informative for other countries, particularly within the EU, cross-cultural studies have demonstrated differences in consumer acceptance of IBF in different countries (Gómez-Luciano, de Aguiar, et al., 2019; Gómez-Luciano, Vriesekoop, et al., 2019; Tzompa-Sosa et al., 2023). Further research could be conducted in different cultural contexts, considering the product attributes that are important and relevant for the respective country.

6. Conclusions

Insights from the present study contribute to both theoretical and practical knowledge by providing a deeper understanding that extends beyond the 'average' preferences or characteristics of potential early adopters. By exploring the heterogeneity of consumer preferences, the present study identified distinct segments of potential early adopters of insect-based food (IBF) and their product attribute preferences. This study has revealed that while a significant proportion of German consumers expressed a willingness to consume IBF, only a subset of them could be identified as potential buyers. Based on our findings, we propose recommendations for marketers seeking to increase the appeal of IBF to these potential buyers by enhancing product packaging through targeted and attractive food labelling.

While price sensitivity was found to vary across segments, our research suggests that the strategic use of food labelling can appeal to a wider market, particularly through the use of general rather than insect-specific labelling. Practitioners could also enhance the attractiveness of IBF by developing, packaging and marketing them in ways purposefully designed to emphasise the *naturalness* of these products. In addition, providing food quality and safety assurances through product validation labels from trusted institutional sources can increase the appetite of target consumers and help to counter feelings of ambivalence toward IBF among inexperienced and as yet unconvinced consumers.

CRediT authorship contribution statement

Berlianti Puteri: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Malte Oehlmann:** Writing – review & editing, Software, Methodology, Investigation, Formal analysis. **Benedikt Jahnke:** Writing – review & editing, Supervision, Project administration, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that support the findings of this study are openly available in OSF at https://doi.org/10.17605/OSF.IO/FG8DR.

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Ethical statement

The study was ethically approved by the Central Ethics Committee of the University of Kassel on 24 May 2023 (Reference number: zEK-61). The participants provided written informed consent to participate in this study and received financial compensation. The study was explained to the participants in the online survey. They were informed about the strict protection of their anonymity and their freedom to withdraw from the survey at any time.

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Supplementary material

The supplementary material for this study can be found online in OSF at https://doi.org/10.17605/OSF.IO/FG8DR.

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