

# The role of prior information on consumer acceptance of insect-based food and feed in Europe: evidence from a discrete choice experiment

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## ABSTRACT

Insects are a promising alternative source of protein and micronutrients. Their inclusion in human diets and as feed for animals destined for human consumption has been endorsed by the European Commission to promote the achievement of the Sustainable Development Goals (SDGs) of food security (SDG 2) and responsible production and consumption (SDG 12). However, in Germany, Italy and Portugal, their use as food is hampered by low consumer acceptance and unfamiliarity with insects as part of a regular diet. Previous research has demonstrated that modifying the choice architecture, such as providing additional information on positive insect consumption outcomes, affects consumers' choices. In this study, we analyze the effect of information on consumer preferences for insect-based and insect-fed chicken meatball alternatives in three European countries: Germany ( $N = 516$ ), Italy ( $N = 502$ ) and Portugal ( $N = 250$ ). In particular, we inspect whether different information scenarios affect consumer preferences for insect-based food products as a more sustainable alternative to meat products using a discrete choice experiment (DCE) embedded in an experimental design. Results indicate that providing prior information about the sustainability of meat alternatives increases the acceptance of insect-based meat alternatives in Germany and Italy. However, there is no evidence that making the insect-protein content more salient is associated with an increased preference for insect-based meatballs.

## 1. Introduction

Consumption of animal-sourced food products, particularly meat, raises health, environmental, and ethical concerns. Livestock production is responsible for 14.5 % of global greenhouse gas emissions (Gerber et al., 2013) and land-use-related biodiversity loss (Cabernard et al., 2019). Feed production (e.g., soy) for cattle, poultry and fisheries is responsible for 9 % of the total GHG emissions (Xu et al., 2021), urging a sustainable and high-quality feed protein alternative. High levels of meat consumption have also been linked with the prevalence of major chronic diseases (e.g., cardiovascular diseases and cancers) (Giromini and Givens, 2022). As a result, meat alternatives, such as edible insects, as well as alternative protein sources in animal feed, such as insect-based feed, have recently gained interest. In response, the European Union

(EU) Commission authorized the use of insect proteins in pig and poultry feed (Commission Regulation (EU) 2021/1372)<sup>1</sup> and recognized dried *Tenebrio molitor larvae* (Commission Implementing Regulation (EU) 2021/882) and frozen and dried *Locusta migratoria* (Commission Implementing Regulation (EU) 2021/1975) as novel food, subject to the Novel Food Regulation (EU) 2015/2283.

Concomitant market opportunities are expected to increase interest in the large-scale utilization of insects as food and feed. Edible insects present a superior source of protein over plant-based alternatives (Belluco et al., 2013) and a sustainable alternative protein source for food and feed (van Huis, 2013), supporting the realization of the United Nations (UN) sustainable development goals (SDGs) by contributing to food and feed security (SDG 2: zero hunger) and a circular waste-based economy (SDG 12: responsible production and consumption) (Rumpold

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<sup>1</sup> At the time of editing this article, the following four insect species are approved by the EU: yellow mealworm (*Tenebrio molitor*) in whole, dried and powder form, the migratory locust (*Locusta migratoria*), lesser mealworm or buffalo worm (*Alphitobius diaperinus*), and the domestic cricket (*Acheta domestica*) in frozen, dried and powdered form.

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and Schlüter, 2013).

However, although several hundred million people traditionally consume insects worldwide (van Huis et al., 2021), consumer acceptance in Western nations remains low (Hartmann and Siegrist, 2017; Kröger et al., 2022). Low social and cultural acceptance are barriers to insect consumption (Schaufele et al., 2019). Edible insects are limitedly recorded as part of Europeans' traditional diets (Svanberg and Berggren, 2021), with insect species being an important determinant of product acceptance. For example, crickets are more accepted than mealworms in Germany (Schaufele et al., 2019). Nevertheless, the prospect of consuming insects still elicits strong negative emotions in unaccustomed individuals, including fear and disgust (Jensen and Lieberoth, 2019; Looy et al., 2014). Moreover, the consumption of insect as food is perceived as belonging to hunter-gatherer food practices and is therefore, considered culturally or socially unacceptable (Hartmann et al., 2015).

Nonetheless, a growing segment of Westerners consider insects as a potential food source, even regarding them an exotic product to be consumed as part of a gastronomic experience (Chan, 2019). Berger and Wyss's (2020) work on the effects of positive descriptive social norms on the willingness to eat insect-based protein supports this presumption. Furthermore, a high social acceptance of entomophagy correlates with a willingness to eat insects (Hartmann et al., 2015). Nevertheless, the link between acceptance and adoption of insects as part of the regular diet is not straightforward. For example, Modlinska et al. (2021) observed that consumers who reported, in general, positive attitudes towards insects as a meat replacement are not necessarily willing to buy or consume insects as part of their diet. This highlights the need to distinguish general attitudinal acceptance of edible insects from their behavioural acceptance reflected in consumers' preferences, using an appropriate preference elicitation method.

Certain product attributes could potentially facilitate or hinder consumers' adoption of insects as food. The country of origin (COO) not only reinforces the image of the producing country but also acts as a cue to the quality, safety or authenticity of the product (Aichner, 2014; Balcombe et al., 2016), significantly influencing consumer decisions (Al-Sulaiti and Baker, 1998; Aichner, 2014). Also, the presence of the organic logo is associated with a higher consumer willingness to pay (Gerrard et al., 2013), as well as convenience being an important predictor of the type of foods consumed (Glanz et al., 1998). However, the role of COO, organic logo, and convenience in choosing insect-based products have been rarely researched (Ankamah-Yeboah et al., 2018; Kuff et al., 2023)

On the other hand, while mentioning the producer also provides consumers with signals of quality or traceability assurance (Lilavanichakul and Boecker, 2013), in the case of radical food innovations, such as cultured meat, multinational enterprises seem associated with a higher perceived competence than start-ups (Lin-Hi et al., 2022). Low consumer trust and unfamiliarity with start-ups are likely to lead to low adoption rates of innovative products and ultimately to the failure of commercialization attempts (Hauser et al., 2006).

An equally important aspect to explore is consumers' acceptance of insects as feed ingredients, particularly for animals reared for meat production. Insects such as the black soldier fly, the yellow mealworm, and the lesser mealworm can be used as ingredients for farmed animal feed after processing (Baiano, 2020). Some exploratory studies investigated attitudes towards using insects in animal feeding, with results displaying potential (Gasco et al., 2019). Indeed, insects as feed appear more acceptable to consumers than insects as food (Giotis and Dri-choutis, 2021).

To progress towards the SDGs, policies for sustainable food consumption have increasingly sought to trigger changes in food choices and preferences at the consumer level (Reisch, 2021; Vermeir et al., 2020). To this end, it is fundamental to test strategies that might increase the acceptance and use of insect-based food products in Western diets. Information on the benefits of insects is one of them. The objective

of this study is to determine whether providing information on insect-protein content vs sustainability aspects of insect-based food and feed products affects consumers' food preferences. To this end, a hypothetical discrete choice experiment (DCE) embedded in an experimental design manipulating information provision was implemented in Germany, Italy, and Portugal. In light of the recent implementation of a new EU regulation authorizing the use of insect-based feed for poultry, there was a particular need to assess consumer acceptance of insect-fed chicken. To this end, the food products investigated were insect-fed chicken and insect-based meatballs. The contribution of this research is threefold. Previous research has demonstrated that modifying the choice context, such as providing additional environmental or nutritional information (e.g., Colson et al., 2011; Meenakshi et al., 2012; Okello et al., 2018) affects consumer choice (Onwezen et al., 2021). Concerning the effect of information on consumer preferences for insect-based food, the body of literature presents diverging results. While some studies show little evidence supporting the role of environmental benefits in increasing acceptance of insects as food (de-Magistris et al., 2015; Cavallo and Matera, 2018), other studies show that providing information about the environmental, nutritional, and health benefits of insects could elicit preferences for insect-based food (Lombardi et al., 2019; Rumpold and Langen, 2019; Nyberg et al., 2020; Woolf et al., 2021; López et al., 2023; Michel and Begho, 2023; Rabadán et al., 2023). The present study aims to contribute to this line of research by evaluating how information on the insect-protein content and the potential for greenhouse gas emissions reduction of meat alternatives influence consumers' preferences for insects as food. Second, numerous studies have explored consumer attitudes toward insect-based and insect-fed food. Yet, there is a still small, albeit increasing, body of literature that has analyzed consumers' acceptance of insect-based and insect-fed food in Europe using preference elicitation methods (de-Magistris et al., 2015; Kornher et al., 2019; Lombardi et al., 2019; Puteri et al., 2024). The present study makes an original contribution to the existing body of studies on consumers' preferences for insect-fed food products (Bazoche and Poret, 2017; Ankamah-Yeboah et al., 2018; Ferrer Llagostera et al., 2019; Spartano and Grasso, 2021) and insect-based food products. Thirdly, this research contributes with evidence from three European markets, focusing on a product (meatballs made of insect-based ingredients and insect-fed chicken) that previous research has yet to explore.

## 2. Literature review

### 2.1. The role of information on consumers acceptance of new products

Information has been used as a food policy intervention tool to support more sustainable food choices. It strategically influences consumers' attitudes by creating or strengthening beliefs about the benefits of a food product in line with their personal values and long-term goals (Ran et al., 2022; Reisch, 2021). Various theories, such as the Capability-Opportunity-Motivation (COM-B Model) framework (Michie et al., 2011), or the Choice Architecture Theory decision (Thaler and Sunstein, 2008), have exposed the mechanisms through which information on the social and environmental consequences of food affects decision-making and instigates behavioural change, overcoming people's biases, heuristics, informal path, and habits (Reisch, 2021; Ran et al., 2022).

In the case of new product adoption, providing information is capital: first, to create product awareness; second, to increase acceptance and initial demand via education and traditional or digital marketing. This favours the understanding of the mechanisms underlying sustainable food choices at the consumer level, which can, in turn, motivate consumers to consider changing their behaviour (Eng and Quaia, 2009; Rogers, 2003; Skinner and Blake, 2023). The exposure to nutrition and environmental information was found support the increasing acceptance of new food products among innovators/gatekeepers in the food

industry (Hunts et al., 2020).

Specifically to the insect-based food industry, providing information about the advantages of insect-based feed can potentially reduce consumers' reluctance towards these products (Roccatello et al., 2024). Stakeholders might be interested in creating insect-based food product awareness through information to increase the acceptance of the broader circle of consumers. In the insect domain as feed and food, previous research has shown that emphasizing the societal, environmental and nutritional benefits of eating insects helped increase acceptance (Verneau et al., 2016). However, other research has shown contradictory evidence in support of the role of environmental benefits in increasing the acceptance of insects as food (de-Magistris et al., 2015; Cavallo and Matera, 2018; Goncikowska et al., 2023; Gassler et al., 2024). This was also the case for insect-based animal feeding, as Menozzi et al. (2021) found that providing information on the environmental and taste-related aspects of insect-based feed for poultry increased the consumers' acceptance. Nevertheless, Bazoche and Poret (2021) found consumers more reluctant to consume insect-based products even in the context of indirect entomophagy (i.e. food made of insect-fed animals). This matter requires thus further investigation. According to Velasco Vizcano and Pohlmann (2024), future research must identify the most effective interventions in changing consumers' negative reactions towards insect-based food.

Given previous results on the potential of information to motivate more sustainable food choices, we hypothesize that providing information on sustainability claims of meat alternatives positively influences preferences for insect-based food. Although the sustainability of insect-based feed as alternative protein sources for animal feeding is not directly addressed, we also expect that preferences for indirect entomophagy can be, to a certain extent, positively stimulated when providing such information.

**Hypothesis 1a.** *Exposure to information about the potential benefits of edible insect food consumption on sustainability increases consumer preference for insect-based food and feed relatively to no exposure to information.*

Although sustainability aspects are important to consumers and may motivate them to accept insect-based products, it is not their only concern. Health and nutritional content are key when choosing meat alternatives (Rehman et al., 2024). Evidence shows that exposing consumers to information with positive statements framing nutritional benefits could enhance their acceptance of novel foods (Tuorila et al., 1998), such as genetically modified foods (Heiman and Zilberman, 2011; Lee et al., 2018), 3D-printed foods (Califano and Spence, 2024) or alternative protein sources (Onwezen et al., 2021). Similarly, exposure to information that emphasizes the benefits of eating insects can be a strategy to enhance food innovation adoption by raising consumer awareness and interest. However, informing consumers about insects' nutritional and macronutrient content appears to have had contradictory effects in prior research. Namely, one study showed that priming the nutritional content of insects could help increase preferences (Lombardi et al., 2019), whereas others highlighted the rather limited effectiveness of such claims in persuading consumers to include insect-based food in their diets (Hartmann et al., 2015; Berger et al., 2018). Regarding insects as feedings, results are also mixed (Altmann et al., 2022; Bazoche and Poret, 2021; Menozzi et al., 2021).

With the growing interest in fitness and sports performance among European consumers (European Commission, September 2022) and the increasing consumer awareness of the importance of protein intake (Sloan, April 2022), the protein content of food is becoming a key selling point supporting the introduction of new food products. The demand for sports supplements enriched with insect protein, observed in Germany (Essento) and also reported for a large sample of European consumers in the recent EU Consumer Acceptance survey (PIFF Secretariat, March 2024), indicates the potential of mentioning the insect-protein content of the food on the product label. We thus hypothesize that information on insect-protein content can positively influence preferences for

insect-based food products.

**Hypothesis 1b.** *Exposure to information about the possibility of replacing meat with products that contain insect protein increases consumer preference for insect-based food and feed relatively to no exposure to information.*

## 2.2. Indirect entomophagy

Originally reared as pet food, insects, the black soldier fly (*Hermetia illucens*) and the yellow mealworm (*Tenebrio molitor*) are increasingly used as ingredients for farmed animal feed, replacing reliance on soy and fish meals. Evidence shows that indirect entomophagy, i.e., using insects as feed in animal rearing, could be a promising, more sustainable alternative to conventional livestock practices (van Huis et al., 2014) and a more acceptable alternative to direct entomophagy. According to Szlachciuk and Żakowska-Biemans (2024), individuals were more likely to consume food products with added insect protein than when they could visibly identify the insect.

Notably, a shift to insect-based feed would contribute to a reduction of up to 93 % of the environmental impact of conventional feed production in terms of global warming, land use, and fossil-fuel depletion if produced with agricultural waste side-stream and non-fossil-energy sources (Smetana et al., 2023).

Livestock rearing in Europe relies heavily on plant-based feed imported from non-EU countries (PROteINSECT, 2016), which also urges the development of alternative protein feeds of European origin. The use of insects can partially answer this demand. The optimal quantity of insect matter that can be incorporated into feed products remains undetermined (Onwezen et al., 2019). However, the nutritional and growth performances of animals reared on insect-based meals appear comparable and even overcome those of animals fed on conventional feed (Sogari et al., 2023). In addition to the production challenges inherent to insect-feed value chains, it is imperative to carefully consider the potential barriers to consumer acceptance of meat derived from insects. Previous studies have found less resistance from consumers towards the use of insect-based feeding for animals (Menozzi et al., 2021; Roccatello et al., 2024), with Spanish consumers even willing to pay a premium for fish obtained using insect-based feed (Ferrer Llagostera et al., 2019). However, there are also previous DCE studies that have indicated that consumers show relative indifference concerning the use of insect feed in aquaculture (Ankamah-Yeboah et al. 2018; Bazoche and Poret 2017; Ferrer Llagostera et al. 2019), as well as a recent study yielded diverging findings suggesting a lower preference for insect-fed fish compared to grain-fed fish, as well as a degree of price sensitivity for insect-fed fish that does not accommodate the additional costs associated with this feed (Arru et al., 2022).

Only a few studies employing a discrete choice experiment have investigated preferences for insect-fed poultry products (Altmann et al., 2019; Amato et al., 2023). One Best-Worst Scaling study demonstrated the relative reluctance of Italian consumers to consume insect-fed poultry compared to plant-based feed (Amato et al., 2023). Meanwhile, Altmann et al. (2022) found that German consumers had a higher preference for breast meat from insect-fed chicken than for soy- and spirulina-fed chicken, a readiness for protein replacement supported in other studies (Weinrich and Busch, 2021).

Such conflicting findings about incorporating insects into human diets should be complemented with further experimental evidence from studies in Europe, involving diverse food carriers. In view of extant evidence, we expect that consumers prefer indirect to direct entomophagy but that grain-fed chicken is still preferred to insect-fed chicken.

**Hypothesis 2a.** *Consumers prefer meatballs made of grain-fed chicken to those made of insect-fed chicken as the main ingredient.*

**Hypothesis 2b.** *Consumers prefer meatballs made of insect-fed chicken to those made of insects as the main ingredient.*

### 3. Materials and methods

The present study includes a hypothetical DCE embedded in a between-subject experimental design implemented through two information treatments and a control group. It was conducted as part of the Horizon 2020 SUSINCHAIN project ([susinchain.eu](http://susinchain.eu)).

#### 3.1. Discrete choice experiment

DCEs represent a golden standard approach to the elicitation of consumer preferences (Louviere, 1988; Louviere et al., 2000). These methods have been widely employed to investigate consumers' food choices, particularly in hypothetical scenarios or for products whose characteristics fall "outside the range of the current market or environment" (Champ et al., 2017). Such products include novel foods that have yet to be commercialized or recently introduced to limited markets, like insect-based products that are scarcely available in most EU food markets, particularly those originating in animals fed with insects..

##### 3.1.1. Attribute selection

This DCE is an unlabeled choice experiment in which respondents evaluated hypothetical insect-feed and insect-based food products alongside more conventional alternatives. The product in question was a 250-gram preparation package for a meatball recipe. Meatballs are part of local cuisine in all three countries of study (*polpette* in Italy, *Hackbällchen* in Germany, *almôndegas* in Portugal). Meatballs made of minced chicken meat are widespread in the Italian market and culinary repertoire. They are also available in German and Portuguese markets as healthier pork and beef meatballs alternatives. Moreover, chicken meat does not present religious or sanitary restrictions in any investigated countries at the moment of the study.

Product alternatives were displayed in pictures of either packages of chicken-, insect- or pea-based meatballs (all with similar appearance) or a package of edible insect powder. The latter was similar in appearance to mixes offered for the preparation of plant-based meatball analogues (e.g., falafel) present in the market. Product photos were sourced from online images of existing products and adapted with photo edition software (Microsoft Paint) to remove all references to brands. Irrespective of the alternative being evaluated, the main source of protein present was undiscernible from the photos. Extant research concurs that

the discernible presence of edible insects or their fractions as food ingredients can greatly impact end-product preferences (Schaufele et al., 2019).

The DCE attributes were selected based on a review of literature, an expert panel, and a focus group discussion (FGD), all carried out between 2019 and 2020. Table 1 depicts the final six attributes and attribute levels tested.

Convenience in preparation refers to the degree of effort and time needed to acquire, prepare and cook a food product before eating it (Engels et al., 2010). The attribute was represented through pictures of the product packages and the corresponding alternatives descriptions.

Five main ingredients were included, keeping grain-fed chicken as the reference level and pea as the vegetarian alternative, as it is often used as the main ingredient for plant-based meat substitutes available on the market. The insect alternatives included one insect-based feed chicken option and two insect-based alternatives (dried *Tenebrio Molitor* larva - yellow mealworm- and *Acheta Domesticus* -adult house cricket), recently authorized in the EU (IPIFF Secretariat, 2022).




Start-ups represented the reference level of the producers compared to multinational enterprises (MNE), while the presence of the organic label was included as a dummy variable. Regarding the COO, Thailand was selected as the non-EU third country because it is worldwide the biggest producer of insects (Hanboonsong et al., 2013), and it is authorized to export to the EU (Commission Implementing Regulation, November 2019; IPIFF Secretariat, 28.09.2020). Finally, the price levels were chosen to reflect mainstream retailers' prices, ranging from low to high-end offers for chicken and averaging conventional and organic production offers of various supermarkets and discounters in each of the countries investigated at the time.

##### 3.1.2. Discrete choice experiment design

The DCE followed a d-efficient design (D-error = 0.11) generated in Ngene (ChoiceMetrics, 2018). In order to mitigate the risk of dominant alternatives, the design was created using small parameter priors following Bliemer and Collins (2016) and based on the literature and expert judgment. Likewise, unrealistic alternatives were avoided with the inclusion of a design restriction (for example: *main ingredient "chicken" x convenience degree "ready-to-mix"*).

The choice tasks were divided into eight blocks to reduce the respondent burden. The order of the choice tasks was randomized within

**Table 1**  
Product attributes and attribute levels.

Attributes	Level 1 (Reference)	Level 2	Level 3	Level 4	Level 5
Convenience in preparation	Ready-to-mix powder (in packaging) 	Ready-to-cook (raw meatballs in packaging) 	Ready-to-eat (cooked and spiced meatballs in packaging) 	–	–
Main ingredient	Grain-fed chicken	Insect-fed chicken	Pea	Adult cricket	Mealworm larvae
Producer	Start-up	Multinational enterprise	–	–	–
Organic label	No	Yes	–	–	–
Country of origin	Thailand	EU	Local (Germany/Portugal/Italy)	–	–
Price (in EUR)					
<i>Germany</i>	1.49 EUR (5.96 EUR/kg)	2.49 EUR (9.96 EUR/kg)	4.49 EUR (17.96 EUR/kg)	7.49 EUR (29.96 EUR/kg)	–
<i>Italy</i>	0.99 EUR (3.96 EUR/kg)	1.99 EUR (7.96 EUR/kg)	3.99 EUR (15.96 EUR/kg)	6.99 (27.96 EUR/kg)	–
<i>Portugal</i>	0.49 (1.96 EUR/kg)	1.49 (5.96 EUR/kg)	3.49 EUR (13.96 EUR/kg)	6.49 EUR (25.96 EUR/kg)	–

Note: Combinations of ready-to-mix powder x insect-fed chicken and ready-to-mix powder x grain-fed chicken were restricted in the DCE design, and hence not shown to respondents.

blocks. In each choice set, respondents had to choose between two alternatives and a no-choice option (Fig. 1). One block of ten choice sets was randomly presented to each respondent. Ten choice sets per respondent were considered a reasonable trade-off for eliciting information without causing fatigue. A training task was included at the beginning of each block. In total, 80 choice sets were evaluated (10 choice sets x 8 blocks). The choice design was then integrated into Qualtrics (Qualtrics, 2021), using Stata (StataCorp, 2019), which is in line with Weber (2019). A cheap talk script was included to minimize hypothetical bias (Cummings and Taylor, 1999; Tonsor and Shupp, 2011) (See Supplementary materials).

### 3.2. Information treatment

Before being presented with the DCE, respondents were randomly allocated to a control or one of two treatment groups. The three conditions differed in the instruction provided to the respondents before starting the choice tasks. Specifically, while the control group was exposed to a neutral instruction (Table 2), the other two groups were presented with instructions that either highlighted sustainable aspects of meat replacement products (treatment A) or products containing insect proteins as potential meat alternatives (treatment B). This short prior information was expected to influence the respondent’s product choice by providing cues on certain characteristics of the target product (replacement of meat with insect-protein) or the consequences of the choice (reduction of greenhouse gas emissions and more sustainable eating). This design enabled the determination of any effects of prior information on respondents’ preferences for insect-based meat alternatives and meat produced with insect-based feed when compared to conventional alternatives within each country.

### 3.3. Sample

We collected a total of 1268 valid responses from commercial panel respondents between July and September 2021 in Germany (N = 516),

**Table 2**  
Information treatment.

Treatment	Instructions
Control	Imagine you want to prepare a meal based on a meatball recipe for yourself. Which of the following products would you choose to prepare the meal?
(a) Sustainability of meat alternatives	Imagine that you would like to prepare a meal for yourself, based on a meatball recipe that typically contains minced meat. You have heard that minced meat can be replaced with an alternative product, in order to reduce greenhouse gas emissions and eat more sustainably. Which product would you choose?
(a) Insect-protein content	Imagine, that you would like to prepare a meal for yourself, based on a meatball recipe that typically contains minced meat. You have heard that minced meat can be replaced with other products, including products which contain insect proteins. Which product would you choose?

Italy (N = 502) and Portugal (N = 250) using an online questionnaire programmed in the survey software Qualtrics (Qualtrics, 2021). The size of the samples was adjusted to the size of the population in each country investigated. A quota sampling was used based on gender, age and household size characteristics (Eurostat, The Statistical Office of the European Union, 2021a, 2021b). Respondents below 18 and above 64 and those with shrimp and shellfish allergies, were excluded, given the risk of cross-allergy with insects (Leung et al., 1996; Phillips and Burkholder, 1995). Observations that did not meet the quality criteria were excluded. In particular, observations from study participants whose total survey duration was less than half of the median of the total survey duration. Straight-lining and attention checks were also performed.

### 3.4. Data analysis: econometric approach and model estimation

The theoretical model is based on the Random Utility Theory (RUT) extended by McFadden (1973; 1986), and the Lancasterian consumer



"Imagine you want to prepare a meal based on a meatball recipe for yourself. Which of the following products would you choose to prepare the meal?"			
	<b>Option 1</b>	<b>Option 2</b>	
<b>Convenience degree</b>	 Ready-to-cook	 Ready-to-eat	
<b>Main ingredient</b>	Mealworm larvae	Adult cricket	
<b>Producer</b>	Multinational enterprise	Start-up	
<b>Label</b>	Organic	-	
<b>Country of origin</b>	EU	Thailand	
<b>Price</b>	2.99 EUR	4.99 EUR	
	<b>Option 1</b>	<b>Option 2</b>	<b>None of them</b>
Your choice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Fig. 1. Example of a choice task.

theory (Lancaster, 1966). According to these theories, the utilities of different goods can be broken down into the separate utilities of their attributes, so when faced with a set of alternatives, the rational decision-maker will select the alternative that provides the highest utility.

The DCE approach considers that the utility  $U_{nj}$  of alternative  $j$  for the individual  $n$  is a random variable with a deterministic part, say  $V_{nj}$  and a random part  $\varepsilon_{nj}$ , as follows:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \quad (1)$$

Assuming heterogeneous individual preferences across respondents (Train, 2009), the DCE can be specified as a mixed multinomial logit (MMNL) model (McFadden and Train, 2000). The MMNL allows the inclusion of a part of random taste heterogeneity, compared to the MNL model, which fixes the taste coefficient across respondents. In an unlabelled experiment, the respondents' utility for each alternative, including the main effects, can be expressed in linear form as follows:

$$U_n(j) = \beta_{Readytocoook} * Readytocoook + \beta_{Readytoeat} * Readytoeat + \beta_{InsectfedChicken} * InsectfedChicken + \beta_{Pea} * Pea + \beta_{Cricket} * Cricket + \beta_{Mealworm} * Mealworm + \beta_{MNE} * MNE + \beta_{Organic} * Organic + \beta_{EU} * EU + \beta_{Local} * Local + \beta_{Price} * Price + \varepsilon_{nj} \quad (3)$$

$$U_n(One\ of\ them) = ASC + \varepsilon_{nj} \quad (4)$$

where all the random parameters  $\beta_n$ , besides price, are assumed to be normally distributed to allow positive and negative preferences for each attribute. The price parameter, on the other hand, was assumed to follow a negative lognormal distribution to attain a better behavioural fit. The Alternative Specific Constant (ASC) captures the utility of the "none of them" option. The information treatments were included as a direct interaction with the levels of the *main ingredient* attribute.

The data analysis was developed using the Apollo package (Hess and Palma, 2019) in R. The MMNL models were specified for each investigated country separately, using 1000 MLHS draws (Hess et al., 2006) for the random variables and the multinomial logit model (MNL) results as priors. We analyzed preferences by information treatment group and the effect of information by country studied.

## 4. Results

### 4.1. Sample description

Table 3 shows the distribution of respondents along several socio-demographic and diet characteristics across country samples. Quota-based characteristics (sex, age group and household size) were achieved. The samples reflect the distributions of the demographics in all three countries, compared to national statistics (Fundação Francisco Manuel dos Santos, 2024; Statistisches Bundesamt, 2020; Istituto Nazionale di Statistica). Importantly, there were no statistically significant differences in the proportions of the different sociodemographic characteristics between conditions within countries (See Supplementary Material).

### 4.2. Effects of information

Table 4 presents the results of the MMNL models estimated in each country. Results of interaction effects show that the provision of sustainability information positively affected consumer preferences for insect-based food and feed alternatives in Germany and Italy only (Table 4). Specifically, providing prior information on the sustainability of meat alternatives was positively associated with increased preferences for meatballs made of insect-fed chicken and meatball alternatives made of crickets in Germany and mealworm larvae in Italy ( $p < 0.05$ ). Nevertheless, grain-fed chicken remained the preferred alternative

**Table 3**  
Descriptive statistics for respondent country samples.

	Italy	Germany	Portugal
N	502	516	250
Household Size			
Mean (SD)	2.3 (1.5)	2.0 (1.1)	2.4 (1.1)
Median (Q1, Q3)	2.0 (1.0, 3.0)	2.0 (1.0, 2.5)	2.0 (2.0, 3.0)
Presence of children in the household	131 (26.1 %)	88 (17.1 %)	52 (20.8 %)
Sex			
Female	252 (50.2 %)	254 (49.2 %)	120 (48.0 %)
Male	250 (49.8 %)	262 (50.8 %)	130 (52.0 %)
Age group			
18–24	59 (11.8 %)	61 (11.8 %)	31 (12.4 %)
25–34	89 (17.7 %)	105 (20.3 %)	45 (18.0 %)
35–44	108 (21.5 %)	101 (19.6 %)	59 (23.6 %)
45–54	133 (26.5 %)	125 (24.2 %)	60 (24.0 %)
55–64	113 (22.5 %)	124 (24.0 %)	55 (22.0 %)
Education			
High school and below	226 (45.0 %)	150 (29.1 %)	5 (2.0 %)
Vocational education or Bachelor-level	139 (27.7 %)	256 (49.6 %)	70 (28.0 %)
Master-level and above	137 (27.3 %)	110 (21.3 %)	175 (70.0 %)
Income (Net monthly) <sup>1</sup>			
Lower income	225 (48.8 %)	105 (22.3 %)	106 (44.5 %)
Medium income	167 (36.2 %)	223 (47.3 %)	114 (47.9 %)
Upper income	69 (15.0 %)	143 (30.4 %)	18 (7.6 %)
Diet			
Vegetarian	61 (12.2 %)	77 (14.9 %)	16 (6.4 %)
Vegan	8 (1.6 %)	13 (2.5 %)	4 (1.6 %)
Past insect-eating experience			
Never	354 (75.5 %)	319 (73.0 %)	184 (85.2 %)
At least once	115 (24.5 %)	118 (27.0 %)	32 (14.8 %)

<sup>1</sup> Note: Income levels are country-specific, as follows: Germany (1) Below 1800 EUR; (2) Between 1800 and 3600 EUR; (3) 3600 EUR and above; (99) Prefer not to say. Italy: (1) Below 1500 EUR; (2) Between 1500 and 3200 EUR; (3) 3200 EUR and above; (99) Prefer not to say. Portugal: (1) Below 1455 EUR; (2) Between 1456 and 3395 EUR; (3) 3396 and above; (99) Prefer not to say.

regardless of the information provided. Making the insect-protein content more salient was not associated with increased preferences for any insect-based ingredients nor insect-fed chicken in any of the three countries. In Portugal, the provision of information was not significantly associated with increased preferences for insect-based ingredients.

In each of the three countries investigated, alternatives labelled "organic", as well as "EU" and "locally produced" were significantly preferred to conventional products and Thailand as COO, respectively. Respondents were likewise generally indifferent to whether the producer was a start-up company or a MNE. Overall, however, the significant standard deviation estimates imply a high heterogeneity of preferences for the diverse attributes within each country.

### 4.3. Preferences for insect-based food and meat of insect-fed chicken across treatments

Fig. 2 illustrates the trends in preference parameter means estimates for the attribute levels of "main ingredient" by information treatment for each of the three countries studied. As hypothesized in H2a, consumer preferences for meatballs with edible insects as ingredients, namely

**Table 4**  
Mixed multinomial logit model results on effects of prior information treatments.

	Germany		Italy		Portugal	
	Mean estimates					
	Estimate	Rob. s.e.	Estimate	Rob. s.e.	Estimate	Rob. s.e.
Constant "Option A "	0.00	0.09	-0.03	0.06	0.21	0.14
Constant „Option B“	0.00	NA	0.00	NA	0.00	NA
Constant "None "	-1.69	0.25	-1.60***	0.18	-1.32***	0.32
Price	-0.14	0.07	-2.22***	0.17	-0.87***	0.27
Ready-to-cook	-0.01	0.17	0.73***	0.11	1.20***	0.24
Ready-to-eat	0.05	0.17	0.45***	0.11	0.45*	0.24
Pea	-0.12	0.31	-0.26	0.17	-0.28	0.33
Insect-fed chicken	-1.22***	0.27	-1.06***	0.22	-1.73***	0.45
Cricket	-3.68***	0.39	-1.65***	0.24	-5.20***	0.78
Mealworm	-4.53***	0.56	-1.88***	0.22	-7.35***	1.59
MNE	-0.02	0.09	-0.07	0.07	-0.10	0.12
Organic	0.66***	0.10	0.40***	0.07	0.66***	0.16
EU	1.14***	0.14	0.88***	0.09	1.40***	0.22
Local (Germany/Italy/Portugal)	1.22***	0.15	1.38***	0.12	1.56***	0.23
<b>Interactions</b>						
<b>Sustainability information</b>						
Pea*	0.62	0.40	0.29	0.24	0.32	0.47
Sustainability						
Insect-fed chicken * Sustainability	1.19***	0.39	0.42	0.28	0.92	0.64
Cricket * Sustainability	1.19*	0.46	0.45	0.31	0.29	0.92
Mealworm * Sustainability	1.02	0.71	0.60*	0.28	0.59	0.88
<b>Insect-protein information</b>						
Pea * Insect protein	-0.03	0.48	0.09	0.24	0.26	0.58
Insect-fed chicken * Insect protein	0.18	0.37	0.18	0.30	0.50	0.67
Cricket * Insect protein	0.89	0.48	-0.12	0.31	-0.50	0.97
Mealworm * Insect protein	0.78	0.71	0.31	0.28	2.60	2.29
<b>Standard deviations estimates</b>						
	Estimate	Rob. s.e.	Estimate	Rob. s.e.	Estimate	Rob. s.e.
Price	1.05***	0.06	1.63***	0.09	-1.41	0.16
Ready-to-cook	-1.35***	0.18	0.95***	0.11	1.36***	0.20
Ready-to-eat	1.04***	0.15	1.12***	0.14	0.95	0.82
Pea	2.69***	0.24	1.07***	0.15	1.56***	0.36
Insect-fed chicken	1.91***	0.25	1.18***	0.18	2.87***	0.41
Cricket	2.53***	0.26	1.61***	0.15	3.99***	0.64
Mealworm	3.10***	0.33	1.37***	0.15	4.47***	1.56
MNE	0.14	0.41	-0.68***	0.09	0.23	0.28
Organic	0.83***	0.23	-0.63***	0.10	-0.61	0.67
EU	0.37	0.25	0.76***	0.16	-1.00***	0.27
Local (Germany/Italy/Portugal)	-0.58**	0.22	1.28***	0.12	0.51	0.82
N	516		502		250	
Ll	-3469.42		-4178.73		-1718.72	

Note: Reference levels (1) Ready-to-mix (2) Grain-fed chicken (3) Start-up (4) Thailand.

\*  $p < 0.05$ ,  
\*\*  $p < 0.01$ ,  
\*\*\*  $p < 0.001$ .



**Fig. 2.** Preferences means estimates and SD for attributes based on MMNL models by prior information treatment.

mealworm and cricket, were significantly lower than for grain-fed chicken within all three countries and across information treatments. Preference for insect-fed chicken was also low across country markets and information treatment but still higher than for mealworm and cricket ingredients, which were the least preferred alternatives in all three countries.

Overall, preferences for insect-based ingredients and insect-fed chicken appeared lower when no information was provided in all countries. The preferences for the insect-fed chicken, cricket, and mealworm attributes appear higher when the information treatment was presented. In particular, German and Italian consumers in the sustainability information group showed higher preferences for insect-fed chicken, cricket, and mealworm ingredients. In Portugal, the information about insect protein content was associated with increased preferences for mealworms and crickets. Furthermore, the standard deviation estimates indicate heterogeneity of preferences (See Table A1 in the appendix for more details on the means and standard deviation estimates).

Expectedly, only 36.6 % of respondents in Germany, 97.2 % in Italy,

and 41.6 % in Portugal chose a product alternative that was an insect-based meatball preparation (made either of cricket or mealworm) at least once during the ten choice tasks. In Italy and Portugal, the price was statistically significant ( $p < 0.05$ ) and negative, in line with expectations of economic theory (Appendix A1). In Germany, price was found to be significant at the 5 % level on a one-sided test.

## 5. Discussion

In this study, we assessed the effects of providing information on preferences for meatballs made of insect-based ingredients and insect-fed chicken with the help of a DCE embedded in an experimental design presenting an information treatment.

In terms of insects as a main ingredient, our results showed that providing information on the sustainability of meat alternatives affected preferences for the main ingredient in Germany and Italy. The interest of German consumers in sustainability (Grunert et al., 2014; GfK, 2023) might explain their increased preference for crickets when the information on the sustainability of meat alternatives was displayed. At the time of the study, in Germany, the insect-food sector was already developing (Larson, 2021), with cricket-based products of the French start-up *Jimini's* available in supermarkets and online retailers since 2019 (Foodinsects, 2019). In Italy, the first start-up was allowed to produce cricket flour for food in January 2024. As crickets were not present on the market at the time of the study, Italian consumers were not yet familiar with cricket as food. Still, providing information on the sustainability of meat alternatives increased Italian respondents' preferences for mealworms as the main ingredient. Survey results from an IPIFF study showed that an important share of Italian respondents had already tried a mealworm (IPIFF Secretariat, March 2024). Moreover, Italian consumers being aware of the Sardinian cheese *casu marzu* containing larvae could further explain the exposure of Italian consumers to worms as food.

Regarding insect-fed poultry products, our results also support past studies (Menozzi et al., 2021) and contribute with new knowledge on the evolution of consumers' preferences. Interestingly, in Germany, consumers provided with information on the sustainability of meat alternatives were significantly more willing to accept insect-fed chicken. This could suggest that consumers extrapolate the information received on the sustainability of meat alternatives to insect-fed chicken. This cognitive shortcut could explain a more sustainable meat choice, giving the "halo" effect. Providing additional sustainability claims to meat alternatives could increase consumers' preference for insect-fed chicken and, to a certain extent, food with insect-based ingredients. This information could be included, e.g., on the product packaging or through awareness-raising campaigns.

In contrast to the provision of sustainability information, providing information on the insect-protein content of insect-based food products was insufficient to increase consumer preferences for these products, in Italy and Germany. In Portugal, no significant effects of information were observed. However, descriptive data showed that the protein-content information was expected to increase preferences for mealworm- and cricket-based meatballs since Portuguese consumers value nutritional content-related messages. The smaller sample size might be a possible reason for the absence of significant information treatment effects among Portuguese consumers.

In terms of preferences for insect-based ingredients in meatball preparation, these were low in Italy, Germany, and Portugal. Still, in Italy, 97.1 % of the participants chose insect-based food products at least once in the choice tasks. This indicates a relatively high readiness to choose insect-based ingredients. The pre-existing awareness of the use of insects as red colouring additives present in several foods and beverages sold on the Italian market could possibly explain this high share. The

lower adoption rates in Germany and Portugal are expected, given the low acceptance of insect-based food products in Europe, already documented in previous literature (Kröger et al., 2022; Hartmann and Siegrist, 2017; Roma et al., 2020).

While consumers of all three countries still preferred grain-fed chicken as the main ingredient, insect-fed chicken was considered a more acceptable alternative than insect-based meatballs. This evidence supports the notion that indirect entomophagy is much more likely to be adopted by Europeans than direct or stealth entomophagy, particularly regarding poultry meat. Present findings converge with those of other choice experiments conducted with insect-based food products (Kornher et al., 2019; Michel and Begho, 2023; Rabadán et al., 2023); and insect-fed fish and poultry (Altmann et al., 2022; Ankamah-Yeboah et al., 2018; Bazoche and Poret, 2017; Ferrer Llagostera et al., 2019; Menozzi et al., 2021; Roccatello et al., 2024). Nonetheless, according to Altmann et al. (2022), insect-fed chicken breast offers are less preferred by German consumers than corn-fed ones. European consumers' knowledge regarding the typical composition of poultry feed, as being mostly made of grains, is good (Weinrich and Busch, 2021). Despite the common knowledge that the natural diet of broilers and hens may occasionally include insects and earthworms, consumers still seem reluctant to choose insect-fed chicken products over the more conventional offers.

Feed composition is typically not communicated to consumers of meat products in Europe, except when part of certifications or claims related to the form of animal husbandry or banning genetically modified feed ingredients. Hence, the insect-based feed credential presented as attribute level in this DCE was likely rather new and uncommon to consumers. On the one hand, previous research reported that informing consumers about the feed type was associated with higher preferences for insect-fed chicken when the feedstuff was declared (Altmann et al., 2022). On the other hand, our result questions the relevance of indicating to the final consumers the type of feed used to feed poultry as a credence attribute. This apparent contradiction between results could instead support the idea that indicating the meal type alone may not suffice and should be accompanied by actions aimed at raising consumer awareness of feed composition and its implications. This said, insect-based foods are subjected to the same labelling specifications as other foods in compliance with the Food Information to Consumers Regulation (Regulation (EU) No 1169/2011).

The general indifference observed for pea as the main ingredient of meatball analogues is likely explained by the now well-established presence of plant-based meatball alternatives, e.g., falafels, and/or hybrid products made of a mix of meat and pulses, in all three country markets.

Further results about preferences for organic labels, as well as for EU and the local country (Germany, Italy and Portugal, respectively) as the region of origin, provide useful indications to manufacturers in the insect food sector for developing new insect-based food products. This is in line with findings of previous studies that showed that these attributes were overall associated with higher preferences for other food products (e.g., Gerrard et al., 2013; Edenbrandt et al., 2018) and also insect-based food in other cultural contexts (Kuff et al., 2023). Nonetheless, the variability detected among respondents with the standard deviations deserves further investigation, notably via segmentation studies, to shed light on the possible sources of the heterogeneity.

### 5.1. Limitations and future research

Despite promising results regarding the effects of the provision of sustainability information on consumers' preferences for insect-based ingredients and meat of insect-fed chicken, it is important to nuance the role of information strategies in shaping food choices. Indeed, some

scholars appeal to caution about the effectiveness of information and the endurance of resulting behavioural changes, which need further research. The partial perception and processing of available information constitute a challenge. Indeed, information can be complex, and consumers do not always use it, which minimizes behavioural change (Todd and Benbasat, 1992; Guthrie et al., 2015). In a previous study, the role of information found limited effects in long-term insect-based food choices but may be useful to trigger short-term changes (Volpp and Loewenstein, 2020; Wassmann et al., 2021). Along these lines, since our study only considers food choice immediately after seeing information, we can only conclude the short-term effect of information on preferences for insect-based food products. Future research should focus on studying the long-term effects of information. Also, the provision of prior information was studied as part of the instruction to complete the choice tasks, which can be different from the real-world setting, where the presentation of the information may play a role in its perception (Haaland et al., 2023). The modalities to provide this information could lead to additional confounding effects on preferences. Therefore, the place and format to display such information should be studied further with the choice experiment methodology.

Moreover, while information on sustainability and nutritional aspects are important, they might not be the only reasons influencing consumers' choices (Rehman et al., 2024). Complex emotional factors such as familiarity, disgust, and neophobia also have a major influence (Wendin and Nyberg, 2021), along with taste and familiarity. While previous research has demonstrated that consumers with a low degree of neophobia present more positive attitudes towards insect-based foods (Junges et al., 2021; Michel and Begho, 2023), there have also been studies in which neophobia seems to no longer be a barrier to insect-based food consumption (Fischer and Steenbekkers, 2018; Schlup and Brunner, 2018), probably because of the increasing presence of insect-based food in the market and consumer familiarity (Naranjo-Guevara et al., 2021). Moreover, Bazoche and Poret (2021) found that food neophobia in insect-based food was linked to fear of insect taste in the final product. In fact, Valesi et al.'s (2024) findings suggest that promoting hedonic aspects of insect-based foods is more effective in increasing consumer acceptance than emphasizing only ethical aspects. As Miglietta et al. (2025) highlight, consumers must have the right motivations to try new insect-based foods (e.g. curiosity). Future studies should explore the interaction of potential consumer motivations with their acceptance and willingness to pay for insect-based products.

## 6. Conclusion

This study shows the potential of prior information to affect consumers' preferences for sustainable food products associated with low acceptance, like insect-based products. In particular, it reveals that providing prior information on the sustainability of meat alternatives through a short instruction framing the choice task, in general, could increase consumer acceptance for insects in Germany and Italy, but not in Portugal, whereas its effect on the ingredient is country-specific.

In addition, this study consolidates existing literature assessing the low acceptance of insect-based food products in Europe. It also provides novel insights into European consumers' acceptance of insect-fed chicken, as the European Commission recently authorized the use of insect feed for poultry. It shows that, albeit less preferred than grain-fed chicken, insect-fed chicken is still preferable to insect-based ingredients as part of a meatball preparation.

For policymakers and stakeholders of the food processing, retail

industry, and marketing, these findings highlight the relative readiness of the European consumer market to insect-fed poultry and, therefore, the relevance to support the development of the insect-feed sector and ease the commercialization of insect-fed chicken, with an enabling legal framework and a functioning value chain. Practical recommendations include promoting knowledge and education to consumers about the sustainable aspects of consuming insect-fed poultry, as well as the fact that the natural diet of broilers and hens may occasionally include insects and earthworms. Moreover, additional product attributes such as local production and organic certifications may enhance consumers' acceptance of these products.

This study also makes a valuable contribution to the literature as it highlights the potential of providing short prior information on the sustainability of meat alternatives to increase German and Italian consumer acceptance of food products made of insect-fed chicken and insect-based ingredients. This could be developed under the form of the credence attribute of the sustainability of alternative products to meat. Nonetheless, as information on insects' potential as a sustainable alternative protein source might not suffice alone, supply-side development and appropriate promotion will also be needed to further improve the adoption of insects as food.

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## CRediT authorship contribution statement

**Mariam Nikravech:** Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Emilia Cubero Dudinskaya:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis. **Birgit Anika Rumpold:** Writing – review & editing, Funding acquisition, Conceptualization. **Ana Isabel de Almeida Costa:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization. **Raffaele Zanolli:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization. **Nina Langen:** Writing – review & editing, Supervision, Methodology, 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.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.fufo.2025.100667](https://doi.org/10.1016/j.fufo.2025.100667).

## Appendix

### Table A1

**Table A1**  
MMNL preference means and standard deviations estimates by information treatment in Germany, Italy and Portugal.

Preference means estimates																		
	Germany						Italy						Portugal					
	Base		Sustainability		Insect		Base		Sustainability		Insect		Base		Sustainability		Insect	
	Estimate	Rob. std. err.	Estimate	Rob. std. err.	Estimate	Rob. std. err.	Estimate	Rob. std. err.	Estimate	Rob. std. err.	Estimate	Rob. std. err.	Estimate	Rob. std. err.	Estimate	Rob. std. err.	Estimate	Rob. std. err.
Constant alt1	-0.03	0.22	0.11	0.15	-0.01	0.18	-0.05	0.12	0.14	0.09	-0.19	0.12	0.40	0.24	0.16	0.21	0.12	0.33
Constant alt2	0.00	NA	0.00	NA	0.00	NA	0.00	NA	0.00	NA	0.00	NA	0.00	NA	0.00	NA	0.00	NA
Constant none	-1.80***	0.50	-1.66***	0.42	-1.66***	0.42	-1.47***	0.32	-1.66***	0.30	-1.65***	0.31	-1.35*	0.58	-1.81***	0.64	-1.24	0.79
Price	-0.07	0.16	-0.06	0.15	-0.24	0.22	-1.87***	0.22	-2.27***	0.32	-2.36***	0.28	-1.10***	0.31	-0.62**	0.23	-0.71***	0.25
Ready-to-cook	0.05	0.35	0.03	0.26	-0.33	0.32	0.73***	0.21	0.76***	0.20	0.87***	0.20	1.36**	0.49	1.23***	0.35	1.86***	0.47
Ready-to-eat	0.26	0.34	0.00	0.25	-0.03	0.28	0.46*	0.19	0.54***	0.19	0.60**	0.23	0.19	0.34	0.44	0.38	0.73	0.39
Pea	0.10	0.35	0.60	0.34	0.40	0.39	-0.22	0.19	-0.01	0.22	-0.17	0.19	-0.19	0.45	0.14	0.46	0.34	0.49
Insect-fed chicken	-1.26***	0.26	-0.15	0.25	-1.02***	0.35	-1.03***	0.24	-0.67***	0.21	-0.93***	0.23	-2.05***	0.48	-1.02*	0.45	-1.25	0.68
Cricket	-3.95***	0.76	-2.74***	0.40	-3.12***	0.72	-1.64***	0.28	-1.19***	0.24	-1.75***	0.28	-6.78***	1.18	-5.81***	1.51	-5.50***	1.47
Mealworm	-4.68***	0.73	-3.64***	0.57	-3.90***	0.95	-1.98***	0.28	-1.35***	0.25	-1.63***	0.26	-8.74***	1.85	-6.09***	1.41	-4.89***	1.17
MNE	-0.12	0.15	-0.11	0.14	0.29	0.21	-0.14	0.13	0.12	0.10	-0.18	0.12	-0.27	0.26	-0.07	0.27	-0.37	0.29
Organic	0.80***	0.18	0.58***	0.14	0.62***	0.21	0.38***	0.12	0.48***	0.11	0.26*	0.13	0.94***	0.21	0.80***	0.28	0.63*	0.31
EU	0.90***	0.31	1.28***	0.22	1.10***	0.23	0.96***	0.18	0.69***	0.14	1.01***	0.19	1.73***	0.38	1.63***	0.50	1.03**	0.41
Local	1.01	0.27	1.26***	0.22	1.25***	0.32	1.68***	0.24	1.19***	0.19	1.51***	0.21	2.10***	0.39	1.58***	0.43	1.40***	0.43
(Germany/ Italy/ Portugal)																		

Standard deviations estimates																		
	Germany						Italy						Portugal					
	Base		Sustainability		Insect		Base		Sustainability		Insect		Base		Sustainability		Insect	
	Estimate	Rob. std.err.	Estimate	Rob. std.err.	Estimate	Rob. std.err.	Estimate	Rob. std.err.	Estimate	Rob. std.err.	Estimate	Rob. std.err.	Estimate	Rob. std.err.	Estimate	Rob. std.err.	Estimate	Rob. std.err.
Price	0.99	0.17	1.11	0.12	-1.14	0.28	-1.14	0.16	-1.53	0.17	1.84	0.19	1.54	0.25	0.92	0.33	1.81	0.30
Ready-to-cook	-1.51	0.60	0.85	0.27	1.74	0.33	1.05	0.21	-1.27	0.19	-0.53	0.24	2.18	0.50	1.23	0.36	1.80	0.44
Ready-to-eat	1.32	0.68	0.67	0.38	0.64	0.82	1.02	0.22	0.92	0.18	1.32	0.27	-0.70	0.44	1.34	0.65	1.78	0.51
Pea	2.98	0.83	2.09	0.34	3.50	0.69	0.78	0.34	-1.35	0.24	-1.24	0.27	2.43	0.75	2.24	0.71	1.64	0.56
Insect-fed chicken	1.72	0.44	2.11	0.36	1.92	0.40	1.61	0.29	0.75	0.32	1.66	0.31	3.33	0.84	2.56	0.83	3.64	1.11
Cricket	2.89	0.56	2.45	0.30	3.14	0.88	1.82	0.29	1.68	0.26	1.53	0.32	5.97	1.47	3.73	0.84	3.78	1.11
Mealworm	3.34	0.59	2.57	0.51	4.34	1.66	1.31	0.22	1.30	0.20	1.48	0.27	5.37	1.57	3.18	0.64	6.03	1.48
MNE	-0.65	0.26	0.51	0.20	0.72	0.29	0.78	0.19	0.74	0.18	0.76	0.18	0.05	0.33	0.48	0.51	1.06	0.35
Organic	-0.58	0.36	-0.35	0.22	0.80	0.32	0.75	0.21	-0.23	0.41	0.93	0.20	0.32	0.30	0.64	0.45	1.10	0.65
EU	0.51	0.53	-0.15	0.34	-0.37	0.63	0.89	0.22	0.78	0.27	0.92	0.20	0.28	0.74	0.93	0.56	1.47	0.67
Local (Germany/ Italy/Portugal)	-0.24	0.78	-0.74	0.24	-1.14	0.53	1.50	0.26	1.25	0.24	1.20	0.20	1.12	0.28	0.27	0.33	0.79	0.53

**Data availability**

Data will be made available on request.

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