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Puppy power: How neophobia, attitude towards sustainability, and animal empathy affect the demand for insect-based pet food

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ABSTRACT

Despite growing commercial interest in novel foods, there are few studies that analyse consumer willingness to purchase them as pet food. This study aimed to test whether consumers are willing to accept the use of foods with insect-based ingredients, which are found to be poorly accepted for human consumption, to feed their pets. In our case study, we analysed the willingness of 400 Italian dog and/or cat caregivers to pay for pet foods containing insect proteins, as measured by the Multiple Price List methodology. We also explored the role of food neophobia, attention to environmental sustainability, and empathy toward one's pet. The results of the study pointed out that the usual determinants of acceptance in the consumption of novel foods, such as food neophobia and attention to environmental sustainability, play an important role even when the purchase is for the household pet, and that empathy as an expression of the pet caregiver's personal relationship with their pet becomes an additional factor. Insect-based pet foods proved to be attractive for purchase only when consumers are well informed about the product's properties in terms of sustainability and healthiness for their pets.

1. Introduction

Attention to the environment, animal welfare, and climate change are encouraging institutions and individuals to seek alternatives to conventional animal proteins (Feigin et al., 2023; Kumar et al., 2022; Parlasca & Qaim, 2022; Stranieri et al., 2017; Stoll-Kleemann & O'Riordan, 2015). The causes can be attributed to the substantial impact of livestock farming, particularly in the case of intensive practices (Fantechi et al., 2022; Eisen & Brown, 2022; Rust, 2019), characterised by high stocking densities, extensive resource utilization, and densely packed livestock operations. The most notable concerns revolve around significant greenhouse gas emissions, resource consumption (such as land and water), and soil pollution (Banterle et al., 2018; Bellarby et al., 2013; Bernabucci, 2019; Weindl et al., 2017; van de Kamp et al., 2018). Moreover, awareness is increasing with respect to the link between nutrition and health (Gerini et al., 2022; Petrescu et al., 2020; Prada et al., 2022).

These trends create an ideal environment for the development of novel foods, with the goal of either replacing or enhancing existing products. These innovative food items are continually entering the market (Siegrist & Hartmann, 2020) and are particularly focused on providing healthier and more sustainable alternatives compared to conventional options (Tuorila & Hartmann, 2020). As defined by the European Union, novel foods encompass innovative products resulting from new technologies or production processes and can also include items not traditionally consumed in Europe but that are part of the culinary heritage of other continents (Regulation (EU), 2015). This definition includes products such as insect-based products, algae-based foods, lab-grown meat, plant-based sweeteners, edible flowers, and more (Fantechi et al., 2023). However, consumers are generally reluctant to consume novel foods (Frewer et al., 2013; Bearth & Siegrist, 2019) due to concerns mainly related to fear of unpredictable effects, excessive use of technology, and ethics (Frewer et al., 2011). Determinants of the acceptance of novel foods include various aspects linked to the personal sphere, such as attention to health, nutrition, and one's own well-being, and attention to sustainability (Verain et al., 2021; Asioli et al., 2017; Grunert et al., 2014; Aleksandrowicz et al., 2016). Barriers for a more widespread acceptance include lack of

Abbreviations: AES, Animal Empathy Scale; FTNS, Food Technology Neophobia Scale; ISE, Involvement in Sustainable Eating; WTP, Willingness to Pay.

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familiarity, differences in sensory aspects and, most importantly, disgust and neophobia (Tuorila & Hartmann, 2020). These factors mainly affect products that are extremely different from traditional ones, such as cultured meat (Califano et al., 2023) and insect-based foods (Sogari et al., 2022). Research on consumer acceptance of meat alternatives is extensive (Asioli et al., 2022; Anusha Siddiqui et al. 2022; Contini et al., 2020) but the market for some types of novel foods still remains a niche market.

For several years, researchers and society have been focusing their attention on one novel food in particular: foods with insect-based ingredients. The literature indicates that insects could be an excellent substitute for the meat typically consumed in Western cultures (de Koning et al., 2020; Gravel & Doyen, 2020). From an environmental point of view, insect farming could save resources such as water and land. From a health perspective, they could be a good source of protein for human nutrition, given their low levels of saturated fat and high vitamin and mineral content (Dossey et al., 2016; Smetana et al., 2016).

However, the sale of insect-based novel foods in Europe is still reported to be very limited with the exception of a few online stores. This is probably because the acceptance of these products in the Old Continent is still far from allowing a significant spread of insect-based products in the market[2] and many studies report that insect foods are not generally accepted by consumers (Alemu & Olsen, 2019; Onwezen et al., 2021; Poortvliet et al., 2019).

While it seems difficult, at least in the short term, to have them accepted as food for direct consumption, one wonders if their potential could be tapped for other uses. One promising market appears to be pet food. The literature on consumer preferences tends to overlook pet products. Yet in Italy alone, there are more than 64 million pets and the pet food market is worth more than 2.5 billion euros. Moreover, this trend appears to be growing, with about 12.2 million households purchasing these products (ASSALCO, 2022). Meat is the main ingredient especially in dog food and cat food. This implies that the volume of meat used in this market sector is not negligible, and finding an alternative to conventional meat could contribute to the development of more sustainable food systems (Knight, 2023; Van Huis et al., 2021). Furthermore, the literature highlights several beneficial effects of insect-based food on animals for their high digestibility and nutritional value (Valdés et al., 2022; Kierończyk et al., 2022; Bosch et al., 2014). These health benefits can be attributed to the presence of antimicrobial peptides and lauric acid, which enhance the immune system, as well as the high mineral content, including phosphorus, iron, calcium, zinc, copper, selenium, and manganese. Insects not only contain essential amino acids in greater quantities than some traditional meat species but also possess a notable fat content and fatty acid profile, making them a high-quality nutritional source. Moreover, insects are not unfamiliar to pets like dogs and cats; rather, they constitute an integral part of their diet (Kępińska-Pacelik & Biel, 2022).

Therefore, it is fair to ask whether the use of novel foods for pet food is an opportunity for the future. To our knowledge, the literature provides very little evidence on pet caregivers' preferences for insect-based pet food purchases (Higa et al., 2021) although the market has, as indicated above, a considerable volume. Hence, we decided to fill this gap in the literature by investigating pet caregivers' willingness to pay for insect-based pet food, while also determining whether the role of key determinants for human consumption (such as food neophobia and attention to sustainability) also come into play for indirect consumption. Additionally, there is a growing trend of humanizing pets, which may potentially impact the pet food market as many pet caregivers seek food options that resonate with their own preferences. However, ensuring the best choices for their pets can be challenging. Pet caregivers often grapple with distinguishing between what appeals to their own sensory preferences and what suits their pets' distinct sensory world (Spence, 2022). Given these considerations, our study also explored whether animal empathy plays any role, positive or negative, in the acceptance of insect-based pet food.

2. Theoretical background

2.1. Barriers and drivers for the acceptance of insect-based pet foods

Acceptance for novel foods, and insect-based foods in particular, is at the centre of the debate in the literature. There are many barriers, especially in the West, but these are largely attributed to neophobia and disgust (La Barbera et al., 2018; Lammers et al., 2019). Disgust is defined as a natural human reaction designed to avoid disease and potential contact with pathogens (Terrizzi Jr et al., 2013). Specifically, disgust for certain types of food is nothing more than a reaction aimed at avoiding the ingestion of potentially dangerous substances (Chapman & Anderson, 2012). Many consumers consider insects to be disgusting because they are associated with something never consumed before, a "non-food" whose ingestion can pose risks to one's body (Looy et al., 2014; Hartmann & Siegrist, 2018). Food neophobia is defined precisely as the tendency of people to avoid unfamiliar foods (Ritchey et al., 2003; Pliner & Hobden, 1992) and is considered to be the main barrier to insect consumption (Sogari et al., 2019; Rabadán & Bernabéu, 2021; White et al., 2023; Verbeke, 2015; Hartmann et al., 2015; Hartmann & Siegrist, 2016; Sogari et al., 2022).

Among the drivers that determine the acceptance of novel foods, the focus on sustainability seems the most important. As explained in the introduction, reducing conventional meat consumption and resource use are among the benefits of many of the novel foods in the market. Attention to the environment is instrumental in increasing the acceptance of insect-based products among the few population segments interested in the product (Cicatiello et al., 2016; Schäufele et al., 2019; Verbeke, 2015; Wendin & Nyberg, 2021; Kröger et al., 2021).

In order to steer consumers toward new sustainable products, information can play a key role (Krarup et al., 2005; Lombardi et al., 2017). This is also true for insect consumption (Lombardi et al., 2019). For this reason, it is useful to test whether information about the positive aspects that insect-based proteins have for society and animals would affect the willingness to pay of pet caregivers. In addition, associating insect-based products with a healthier and more sustainable product than the conventional product could help increase the acceptance of the novel food considerably.

Along with the factors mentioned above, which may or may not be determinants in pet food purchasing, a factor peculiar to the subject of our study could be empathy for animals. The role of empathy could be a major determinant of indirect acceptance, but it has not been explored yet.

2.2. Just an animal or a family member?

In contemporary society, the role of pets in our daily lives is becoming increasingly important. While it is possible to live with an animal and see it as "just an animal," several studies have shown that it is also possible for people to bond with animals as they would with a family member (e.g., Vandresen & Hötzel, 2021; McConnell et al., 2019): a dog or cat can take on the role of a partner, sibling, or child (Bouma et al., 2021). Many families buy gifts and often celebrate their

[2] To give an example, at the end of October 2022, the leading Italian pasta-maker Barilla posted a comical video on its social channels where it introduced the topic of pasta made with insect flour. The video, which always maintains a joking tone, ends with a sort of survey in which customers are asked what they think about the possible innovation. Reaction to the video was terrible on social media, with many users accusing the company of using insects, and many vowing that they would no longer buy the pasta they produced (de Luna, 2022). The company has since denied everything, but this confirms how far our current culture, especially in Europe, is from accepting such a protein source as a substitute for those considered traditional.

pets' birthdays (Sussman, 2016), while others may see their dog as merely a guardian of their home (Albert & Bulcroft, 1988).

Empathy for animals could play a key role in this difference in treatment (Bouma et al., 2021; Vandresen & Hötzel, 2021). There are several definitions of empathy, but many authors agree that it is a complex construct with at least two components: the cognitive component and the affective component. These components refer to the ability to understand and the ability to share the other's emotional state, respectively (Eisenberg & Strayer, 1987). Human-directed and animal-directed empathy partly overlap but are significantly different (Taylor & Signal, 2005; Paul, 2000), with the latter more related to positive attitudes toward animals (Apostol et al., 2013; Taylor & Signal, 2005). Importantly, this ability to empathise with animals appears to be significantly correlated with the tendency to misattribute human characteristics and feelings to animals (this phenomenon is also known as anthropomorphism bias) (Prato-Previde et al., 2022; Young et al., 2018; Apostol et al., 2013), to the point that some authors suggest the use of "empathic accuracy" to refer to empathy based on actual knowledge of the animal's natural history (Young et al., 2018).

While a limited number of studies in the literature suggest that Western consumers appear to be more accepting of insects for animal consumption than for human consumption (Higa et al., 2021), adopting the perspective of the "pet parent," who is attentive to what they perceive as their pet's needs, one could speculate that when it comes to pet food, empathy for animals might pose an additional barrier to the acceptance of insects as a food source. It is conceivable that the stronger consumers empathize with their pets, the less inclined they may be to purchase insect-based food for their pets, projecting their personal preferences onto their pets' dietary choices.

2.3. Hypotheses and research questions

This study aimed to assess the willingness to pay (WTP) for some insect-based pet foods before and after the association between this product and its beneficial properties (sustainability and healthiness). Then, we evaluated the influence of psychological variables on the price premium (compared with the conventional product) of the insect-based alternative before and after association. Finally, we evaluated the impact of psychological factors on the *change* in WTP for the insect-based product once it was linked to its positive attributes. Specifically, we hypothesised that:

H1 The WTP for the product presented exclusively as insect-based is lower than the WTP for the conventional product (**H1a**), and lower than the WTP for the product presented exclusively as healthy and sustainable (**H1b**);
H2 The WTP for the insect-based product increases significantly after association with its sustainability and health characteristics.

In addition, we posed the following research question:

RQ1 Do empathy for animals, food neophobia, and concern for sustainability influence consumer preferences for insect-based pet food?

The study was conducted in Italy, a country where, according to the 2022 statistics released by the European pet food industry (FEDIAF, 2023), approximately 25 % of households own at least one dog, and another 25 % own at least one cat. Additionally, Italy is known for its notable aversion among people to insect-based products for personal consumption, making it an ideal location to investigate the acceptance of such products in the context of pet food (Lombardi et al., 2019).

3. Methodology

3.1. Questionnaire structure and experimental design

To investigate pet caregivers' preferences for insect-based products, we submitted a questionnaire to a convenience sample of Italian dog and/or cat caregivers. The sample size was set at 400 to satisfy a level of effect size f^2 equal to 0.15, achieving a statistical power of 0.90 and alpha of 0.05, according to the a priori power analysis conducted in G*Power 3.1 (Faul et al., 2009).[3] Responses to the questionnaire were collected between September and November 2022 through the Google Forms platform. A total of 438 Italian pet caregivers were invited to participate in a study on pet food through social media channels. To be eligible to participate, caregivers had to meet the following criteria: (1) be of legal age (age $>$ 18), (2) be a resident of Italy, and (3) be a caregiver for a dog and/or cat. Following the acquisition of informed consent from each participant, 38 individuals were excluded due to non-compliance with our predetermined criteria. Subsequently, each participant proceeded to fill out the questionnaire sections, which will be detailed later. The study protocol is shown in Fig. 1.

The questionnaire submitted to the research group was divided into four sections. The first contained a filter question, which was essential to select only those respondents who are dog and/or cat caregivers. The second allowed us to measure the willingness to pay of dog and cat caregivers for various pet foods. In our study, we employed the Multiple Price List methodology. This approach involves asking each consumer if they are willing to pay a specific amount for a particular product. When a consumer agrees to pay that amount, the inquiry continues with a higher price point. The process concludes when the consumer declines to pay a certain price, and their "true" maximum willingness to pay for the product falls between the last accepted price and the one they declined (Andersen et al., 2006; Jack et al., 2022). For our analysis, we utilized the lower endpoint of this interval, a common practice among many experimenters (Jack et al., 2022).

The experimental design was structured as follows. Consumers were initially asked to express their willingness to pay for three products at the same time: one chicken-based pet food, one insect-based pet food, and one sustainable, healthy, hypoallergenic pet food (without specifying the ingredients) (Fig. 2). Pâté morsels, a standard pet food, was selected as the product form. We chose chicken to represent a traditional pet food because it is one of the most widely used meats in the pet food

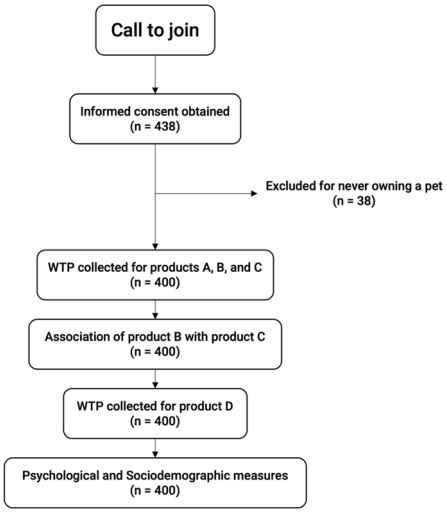

Fig. 1. Participant flowchart.

[3] Given the absence of prior research on this specific topic, we adopted a conservative approach by setting a small effect size with enough power. This decision served to detect even subtle shifts in preferences, thereby providing robustness against Type II errors, while minimizing the risk of Type I errors and consequently reducing the likelihood of false positives.

Fig. 2. Experimental products for dogs (1) and cats (2) submitted for Multiple Price List. Products A (Conventional), B (With Insects), and C (Healthy and Sustainable) were evaluated in the first stage, while product D (With Insects, Healthy and Sustainable) was presented after association.

industry. The attributes associated with the third product—namely, hypoallergenicity, sustainability, and healthiness—are derived from prevalent health and nutrition claims identified in the European market for insect-based pet foods (see Siddiqui et al., 2023). In the context of hypoallergenic properties, it is worth noting that there is no formal legal regulation defining the term "hypoallergenic food."[4] Despite this, the label is commonly used for insect-based pet foods, and several studies, including one by Kępińska-Pacelik and Biel (2022), have demonstrated the validity of these properties in such products.

The prices offered to our consumers ranged from zero (no-buy) to five euros, following the values found in both physical and online markets, with 50-cent intervals.

After this scenario with three products, consumers were given the information consisting in the message "*Did you know? Just like product C, product B (insect-based) is natural, healthy, hypoallergenic and environmentally sustainable. Please feel free to indicate what price you would be willing to pay to purchase this product.*" The purpose of the message was to promote the association between the insect-based product and its sustainability and health attributes by breaking down the product attributes in round one and putting them back together in round two. Following the previous step, respondents were prompted to indicate their willingness to pay for product D, which is presented in Fig. 2, by combining (also graphically) products B and C, using the same method as before.

The third section of the questionnaire contained some questions on respondents' eating behaviours (past consumption/purchase of insects for oneself and animal, type of diet, and role in food purchases), and scales designed to measure the psychological constructs mentioned earlier. Table A1 (Appendix A) shows the items used with the main statistics. Specifically, the Animal Empathy Scale (AES; adapted from Paul, 2000) was used to assess empathy for animals, consisting of 22 items on a Likert scale that ranged from "strongly disagree" (1) to "strongly agree" (5). An example item is "*Seeing animals suffer upsets me*" (Cronbach's $\alpha = 0.80$).

An adaptation of the Involvement in Sustainable Eating (ISE) scale (Van Loo et al., 2017; Pieniak et al., 2010), consisting of 4 items, was used to measure attitudes toward sustainable food purchases. Each participant was asked to express his or her degree of agreement with each statement, using a Likert scale from "strongly disagree" (1) to "strongly agree" (5) (Cronbach's $\alpha = 0.91$).

The Italian version of the Food Technology Neophobia Scale (FTNS; Verneau et al., 2014; Cox & Evans, 2008) was used to measure neophobia with respect to new food technologies. The scale consists of 13 items on a Likert scale that ranged from "strongly disagree" (1) to "strongly agree" (5). Higher values on this scale indicate more negative attitudes toward new food technologies. An example item is "*New foods are not healthier than traditional foods*" (Cronbach's $\alpha = 0.83$).

Finally, the fourth section asked consumers for sociodemographic characteristics, such as gender, age and education level. A copy of the original questionnaire is presented in Appendix B.

3.2. Statistical analyses

To compare the four measured WTPs and test the first two research hypotheses (**H1** and **H2**), a one-way repeated-measures ANOVA was used, followed by a post-hoc test for multiple comparisons. Specifically, the dependent variable of the model was WTP, while the independent

[4] Regulation (EC) No. 767/2009 outlines detailed requirements covering labelling, composition, hygiene, safety, and marketing of pet food within the European Union. These comprehensive prerequisites aim to ensure that pet food products adhere to stringent quality and safety standards, while also providing consumers with accurate and dependable information. The Regulation establishes overarching guidelines and principles for compliance in this context. Notably, it does not provide a specific definition for hypoallergenic, requiring specific claims about product properties, such as hypoallergenicity, to be supported by appropriate and scientifically substantiated evidence.

variable was the categorical variable identifying the type of product (A. Conventional; B. With Insects; C. Healthy and Sustainable; D. With Insects, Healthy and Sustainable). Using ANOVA, it is possible to perform an *omnibus* test to see, in our case, whether at least one of the products differs from the others in terms of mean WTP. The Bonferroni test was then used for multiple product comparisons.

In addition to the various comparisons, it was particularly relevant to compare the following product pairs, assess their differences, and identify the role played by individual characteristics:

i. $\Delta WTP_{B\text{-}A} = WTP_B - WTP_A$

The difference between the willingness to pay for the insect-based product (B) and the conventional product (A) provided us with the impact of insect presence on consumer preferences *(insect effect*).

ii. $\Delta WTP_{C\text{-}A} = WTP_C - WTP_A$

The difference between the willingness to pay for product C versus conventional product (A) provided us with the impact of the sustainability and healthiness attribute on consumer preferences (*benefits effect*).

iii. $\Delta WTP_{D\text{-}A} = WTP_D - WTP_A$

The difference between product D versus the conventional product (A) gave us insight into the preferences expressed by consumers for an insect-based product after associating product B with the benefits previously attributed to product C (*insect with benefits effect*).

iv. $\Delta WTP_{D\text{-}B} = WTP_D - WTP_B$

Comparing the willingness to pay for product D with product B will identify the specific effect on preferences of associating the healthy and sustainable attribute with the insect-based product (*association effect*). This effect represents the *change* in WTP for an insect-based product after it is associated with positive characteristics. In other words, the association effect measures the marginal increase in WTP that results from associating positive claims with an insect-based product.

To answer the research question (**RQ1**) and evaluate the influence of psychological variables on the acceptance of different characteristics of insect-based pet food, a multivariate regression was implemented, in which $\Delta WTP_{B\text{-}A}$, $\Delta WTP_{C\text{-}A}$, $\Delta WTP_{D\text{-}A}$, and $\Delta WTP_{D\text{-}B}$ represent the dependent variables. The system of equations includes the sociodemographic and psychological characteristics of the respondent among the independent variables, and in particular the three scales: FTNS, AES, and ISE. The psychological scales were formed as composite measures from the simple mean of the items, after verifying an appropriate level of reliability for each set of items (Cronbach's $\alpha > 0.70$).

4. Results

4.1. Descriptive statistics

The research group, consisting of 400 dog and/or cat caregivers, consisted mainly of women, young people and highly educated people (Table 1).

In addition, the research group predominantly covered caregivers of at least one dog (only 20 % of respondents owned only cats). With respect to prior purchase of insect-based foods, 7 % said they had tasted them at least once. The research group was well balanced with regard to diet type (51 % predominantly animal) and 74 % said they were responsible or co-responsible for food purchases (Table 2).

Fig. 3 shows the WTPs distribution stated by respondents for each product offered to them in the questionnaire.

4.2. Comparison of WTPs and effectiveness of association

A repeated-measures ANOVA was performed to compare the WTPs of the four products. It showed a substantial difference in WTPs for the different pet foods, $F\,(3, 1197) = 251.57$, $p < .001$, $\eta_p^2 = 0.229$.

Table 3 shows the average WTPs of the products and the results of Bonferroni's test for multiple comparisons. In more detail, the alternative presented as exclusively insect-based was associated with a significantly lower WTP than that for the conventional product ($p < .001$) and for the product presented exclusively as healthy and sustainable ($p < .001$). After association with its sustainability and health properties, the WTP for the insect-based product increased significantly ($p < .001$) by about 47 % (+0.68 €), remaining lower than the WTP for the product presented as healthy and sustainable ($p < .001$), and not significantly differing from the conventional alternative ($p > .10$). So, both hypotheses (**H1** and **H2**) were confirmed.

4.3. Influence of psychological variables on acceptance

A multivariate regression was performed to answer the research question about the effects of the psychological variables examined on the acceptance of insect-based pet food (**RQ1**). The result of the Breusch-Pagan test led to the rejection of the null hypothesis on the independence between the residuals of the equations, $\chi^2_{(6)} = 442.36$, $p < .001$, supporting the choice of the multivariate model.

Table 4 shows the regression results. As for the control covariates, education level, and being vegan or vegetarian reduced the *association effect*, whereas having a dog increased the effect. Having previously tasted or purchased insect-based food or pet food positively influenced

Table 1
Breakdown of the research group (n = 400) by gender, age, area of residence, and education level.

Variable	Frequency (%)
Gender	
Male	26 %
Female	74 %
Age	
18–30	63 %
31–50	25 %
>50	12 %
Area of residence	
Northern Italy	17 %
Central Italy	31 %
Southern Italy and Islands	52 %
Education level	
Junior high school or below	2 %
High school diploma	31 %
Graduate degree	21 %
Post-graduate degree or higher	46 %

Table 2
Characteristics of the research group (n = 400) with respect to the animal owned, their personal experience with insects, type of diet, and role in food purchases within their household.

Variable	Frequency (%)
Pet owned	
Dog	46 %
Cat	20 %
Both	34 %
Previous purchase of insects	
For personal use	1 %
For one's pet	3 %
Only tasted	7 %
Never	89 %
Type of diet	
Predominantly animal	51 %
Predominantly plant-based	43 %
Vegetarian/vegan	6 %
Role in food purchasing	
Buyer/co-buyer	74 %
No involvement	26 %

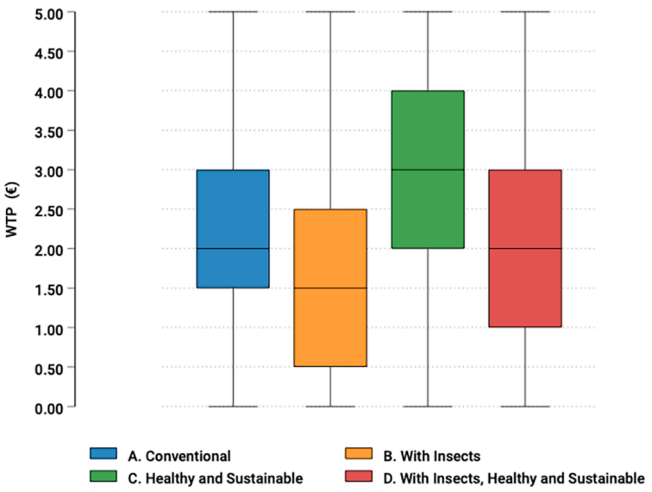

Fig. 3. Boxplot illustrating the willingness to pay for each product. The plot includes the lowest and highest data points (whiskers), the first and third quartiles (box extremities), and the median (line within the box).

Table 3
Results of multiple comparisons.

Product	Willingness to pay	99 % Confidence Intervals
A. Conventional	€ 2.14[a]	[2.04 – 2.25]
B. With Insects	€ 1.48[b]	[1.38 – 1.59]
C. Healthy and Sustainable	€ 3.07[c]	[2.96 – 3.17]
D. With Insects, Healthy and Sustainable	€ 2.16[a]	[2.05 – 2.26]

Notes. Std. Err. = 0.041. Willingness to pay values that are accompanied by identical superscript letters are not significantly different at the 1 % significance level.

Table 4
Standardised coefficients of multivariate regression.

	ΔWTP (i)	ΔWTP (ii)	ΔWTP (iii)	ΔWTP (iv)
FTNS	–0.250***	–0.017	–0.292***	0.042
AES	–0.141**	0.129**	0.030	0.111**
ISE	0.103	0.083*	0.206***	0.103*
Age	0.024	0.017	–0.034	–0.058
Education	0.030	–0.047	–0.072	–0.101**
Female	0.103	0.082*	0.081	–0.022
Prior knowledge	0.100	0.029	0.115*	0.015
Buyer	–0.029	–0.054	–0.088	–0.060
Vegan or vegetarian	0.061	0.033	–0.062	–0.123**
Dog (vs. Cat)	–0.147**	–0.016	–0.047	0.100**
Constant	–0.662***	0.922***	0.014	0.676***
R2	*0.08*	*0.07*	*0.10*	*0.07*

Notes. WTP = Willingness To Pay; i = *insect effect*; ii = *benefits effect*; iii = *insect with benefits effect*; iv = *association effect*; FTNS = Food Technology Neophobia Scale; AES = Animal Empathy Scale; ISE = Involvement in Sustainable Eating. "Prior knowledge" is a dichotomous variable = 1 if the participant has tasted or purchased insect products for themselves or their animal in the past. * p <.10; ** p <.05; *** p <.01.

the price premium for the insect-based product after association (i.e., *insect with benefits effect*). Finally, before association, the price premium referred to the insect product for dogs was lower than the equivalent product for cats.

Turning now to the effects of psychological variables, the FTNS was associated negatively with the deltas of explicitly insect-based products (*insect effect* and *insect with benefits effect*). On the other hand, the AES positively predicted the *benefits effect* and the *association effect*. The AES also negatively predicted the *insect effect*, but this relationship was null following association (i.e., *insect with benefits effect*). Conversely, the ISE was not related with the *insect effect*, whereas after association we found a positive relationship for the *insect with benefits effect*. In addition, the ISE also positively predicted the *benefits* and *association effect*.

The resulting significant relationships led us to affirmatively answer the research question (**RQ1**).

Fig. 4 highlights how the AES and ISE affect the price premium of the insect product before and after association. As regards the AES, we observed that before association (*insect effect*) the slope of the line (estimated for low, medium, and high values of empathy toward animals) is significantly negative, showing that as empathy toward animals increases, willingness to pay for the insect product decreases. After association (*insect with benefits effect*) the negative role of empathy toward animals becomes null, and the straight line flattens out.

In contrast, the ISE acts significantly only after association. The two lines shown in the figure have different slopes (though both positive). After association, the line is steeper, demonstrating the greater influence of the construct on the price premium.

5. Discussion

The results confirm the low acceptance of insects on the market, even in the pet food sector. In detail, **H1** hypothesised that the WTP for the product presented as insect-based only (product B) was lower than the WTP elicited for the conventional product (product A) and the product where only health and environmental benefits were highlighted (product C). The hypothesis was confirmed. The WTP of the insect-based product was €0.66 lower than that for the conventional product (**H1a**) and €1.59 lower than the healthy and sustainable product (**H1b**). In the field of human consumption, the WTP for insect-based products was always lower than conventional products, especially when no additional information on product characteristics was provided (Lombardi et al., 2019). The reasons can be traced back to Western consumers' unwillingness to associate insects with food, as shown in previous research (Vanhonacker et al., 2013; Verbeke, 2015; Hartmann et al., 2015). Our research confirmed the low acceptance of insects in the market, showing how consumers prefer conventional food even when it is not intended for their direct consumption.

The higher WTP for healthy, hypoallergenic and sustainable product compared to the conventional product (as well as the insect-based product) confirmed consumers' predisposition to seek better food for their animals (Koppel, 2014; Banton et al., 2021). Behaviour toward one's pets seems to be consistent with the behaviour of consumers when they had to choose food for themselves. Indeed, the literature shows that the WTP for healthier and more sustainable products was usually higher than that for conventional (Hirogaki, 2013; Valenzuela et al., 2022; de-Magistris & Gracia, 2016; Li & Kallas, 2021; Duckworth et al., 2022).

H2 argued that by associating the characteristics of the healthy and sustainable product with the insect-based, the WTP for the latter would increase significantly. Again, the hypothesis was confirmed by our data. The WTP measured after association, product D, was greater than the WTP for the insect-based product of the first scenario (product B) by €0.68. Thus, the effectiveness of information in studies of this kind was confirmed (Krarup et al., 2005; Lombardi et al., 2017). In addition, it is interesting to note that after association the WTP for the insect-based product reached the same levels as the conventional product. These results are comparable to those obtained by Lombardi et al. (2019) on the role of information in the acceptance of insect-based products for human consumption. Moreover, the increase in WTP following the association with insect-based benefits appears to indicate that consumers may not be aware of these advantages, and health or sustainability claims on these products can exert a significant influence.

Research question **RQ1** aimed to investigate whether the price difference between insect-based pet food and conventional product could depend on empathy for animals, neophobia for food technologies, and attention to sustainable food purchases. We implemented a multivariate

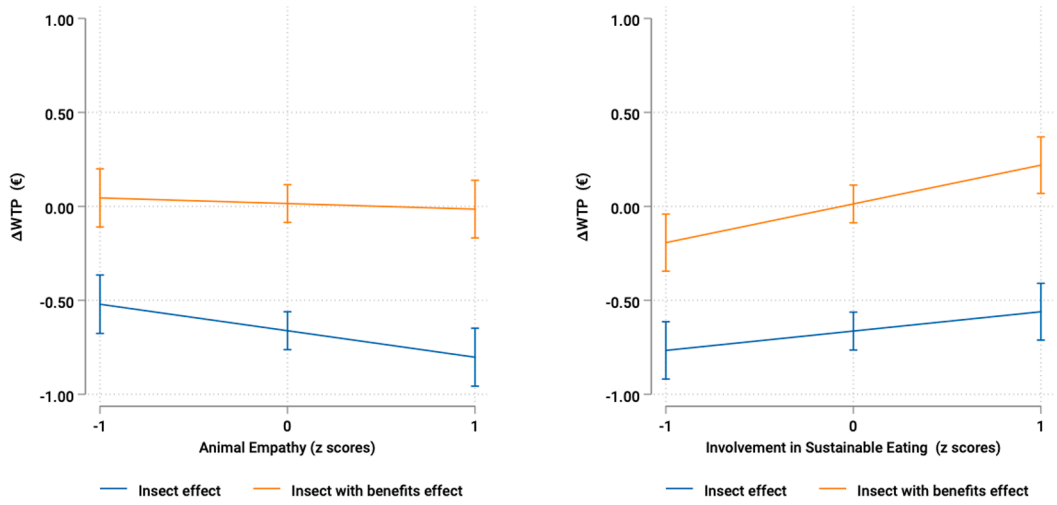

Fig. 4. Price premium of insect-based pet food as the Animal Empathy Scale and Involvement in Sustainable Eating change (+/− 1 *SD*) with 90% *CIs*, before (*insect effect*) and after (*insect with benefits effect*) association.

regression to answer the question. Looking at the results of the model, it can be said that the three constructs explain different aspects of the differences between the observed WTPs. Food technology neophobia is significant with a negative role in explaining the differences in WTP between insect-based products (both before and after information) and the conventional product *(insect effect*). This result is consistent with studies on the human consumption of insects (Sogari et al., 2019; Rabadán et al., 2021; White et al., 2023; Verbeke, 2015; Hartmann et al., 2015; Hartmann et al., 2016; Sogari et al., 2022), showing that neophobia acts similarly when the food product is intended for one's pet. It is equally consistent that neophobia does not explain the difference between the WTP for the healthy and sustainable product and the conventional product *(benefits effect*), nor does it affect the WTP following association *(association effect*). In the former case, the product did not explicitly display characteristics that may be unknown to consumers, while in the latter the difference was between two insect-based products.

Greater empathy for animals had a dual effect on WTP: it reduced WTP for the insect-based product compared to the conventional product (*insect effect*), while simultaneously increasing WTP for the healthy and sustainable product (*benefits effect*) and for the insect-based product when additional information was provided, compared to the conventional product (*insect with benefits effect*). This result highlights the bond between the pet parent and their pet. The negative role of empathy toward animals in the first of the three outcomes mentioned above was the same as one might expect from those who are more empathetic toward a family member, as argued by various authors (Vandresen and Hötzel, 2021; McConnell et al., 2019). Specifically, the empathetic caregiver appears to protect their pet from the "unknown" food, reinforcing the notion that the same limitations affecting what the caregiver themselves would be willing to consume also shape their decision regarding their pets' diet (Spence, 2022). The aspect mentioned above also highlights the positive role that empathy for animals takes in explaining the WTP for the insect-based product and the healthy product, and the association effect. Attention to one's pet and its well-being (Bouma et al., 2021; Vandresen and Hötzel, 2021) increases the WTP for products that can make it feel good. Moreover, the most interesting aspect is that associating beneficial characteristics with the insect-based product leads to a greater increase in the WTP among more empathetic consumers. This demonstrates how caring for one's pet acts opposite to neophobia if pet caregivers are informed of the beneficial aspects of the ingredients. Indeed, previous studies suggest that some consumers are much more serious about buying healthy food for their dogs than they are for themselves (Spence, 2022). This result leads to an important implication: for pet caregivers who deeply cherish their animals, specifying the advantages of using insects as a raw material could serve as a highly influential purchasing incentive. Therefore, focusing on the beneficial effects, such as the presence of antimicrobials and nutritional value (high protein content and high-quality fats), has the potential to substantially increase market share.

Furthermore, attention to sustainability also explains the behaviour of the respondents. It had a positive and significant action in all the differences between WTPs investigated except for the one between insect-based and conventional pet food *(insect effect*). Our results underscore that those who are more concerned about environmental sustainability are willing to pay more for the sustainable product. When this feature is associated with the insect-based product, the insect-based product also gets a premium price. It is consistent that the attention to sustainability also had an effect on the differences in the WTP between the two differently presented insect-based products. Indeed, one of the purposes of the association was to highlight the sustainability of insect-based proteins. As outlined in the section on drivers and barriers, the literature reports that the acceptance of insect-based products increases with attention to sustainability (Cicatiello et al., 2016; Schäufele et al., 2019; Verbeke, 2015; Wendin et al. 2021; Kröger et al., 2021). Our data are in line with the literature highlighting the same correlation when it comes to pet food.

Finally, in terms of determinants to preferences, having already purchased or at least tasted insect-based products increases the WTP of insect-based products compared to the conventional product. The finding is in line with the literature (Megido et al., 2016; Piha et al., 2018) and is also very important. This result confirms that those who have already had experience with insects are more willing to purchase them. Several studies show that trying novel foods is among the most effective ways to reduce neophobia (e.g., Siddiqui et al., 2022). Creating situations in which consumers and their pets become familiar with this type of product could therefore increase the acceptance of insects as a food source. This may begin to reduce the effect of neophobia, which, as mentioned, remains the most important barrier.

Regarding the difference between insect-based products before and after description of their positive characteristics *(association effect*), education level of the caregivers and being vegan or vegetarian played a negative role. In terms of diet, vegans and vegetarians are likely to have shown less willingness to pay for a product that is nonetheless obtained by killing animals. This does not mean that they would not buy it (so much so that the variable is not significant for the other WTPs), but that associating the insect-based product with sustainability and healthiness characteristics does not make it more appealing, but rather devalues it. The findings seem to be in line with the literature that emphasises the

negative attitude of vegans and vegetarians toward insect consumption (Elorinne et al., 2019). In addition, the literature reports that some consumers may not perceive insect-derived proteins as more sustainable (Gamborg et al., 2018). This position may have generated cognitive dissonance in some respondents by negatively influencing willingness to pay.

In contrast, the role of education is peculiar and warrants further investigation. The data seem to indicate a limited confidence of the most educated people in the reported information. This finding could be explained similarly to that for vegans and vegetarians, mainly because more educated people tend to have more polarised beliefs about certain scientific issues (Drummond & Fischhoff, 2017).

The differences in the WTP associated with having a dog (as opposed to having a cat) are also worth consideration. The results show that owning a dog only influenced the WTP for the insect-based product compared to the conventional one, while for all other options this aspect was not relevant. The greater consideration towards dogs compared to cats (Kirk, 2019) could explain the lower WTP elicited among dog caregivers. Coherently, the WTP of dog caregivers increased significantly more than that of cat caregivers after association.

6. Conclusion

Our study investigated the factors affecting pet caregivers' willingness to pay for pet food containing novel ingredients. Results show pet caregivers' buying patterns for pet food mirror their own food purchasing habits, with food neophobia leading to a reluctance to embrace insect-based options. Conversely, those valuing sustainability were willing to pay more for insect-based pet food, perceived as eco-friendlier. Notably, animal empathy also plays a role; without clear communication on the benefits of insect-based products, empathy may deter caregivers from these options. To counteract neophobia, informative campaigns could be crucial for market acceptance. Prior exposure to insect-based foods correlates with higher WTP. The study suggests leveraging the health and eco-benefits of such foods to change consumer habits, though the message's effectiveness could diminish among more educated caregivers. Future research should identify which information can most effectively boost novel food acceptance.

The conclusions drawn from the study should be interpreted with several limitations in mind. The reliance on a convenience sample may introduce bias and limit the extrapolation of results to all pet caregivers. The hypothetical pricing scenarios presented may not accurately reflect actual consumer behaviour, potentially affecting stated willingness to pay. Real-world factors, such as budget constraints and social influences, could lead to discrepancies between reported WTP and genuine purchase decisions. Additionally, while regression analysis clarified the relationship between pet caregiver characteristics and WTP, the potential for carryover or order effects—where the sequence of product presentation influences WTP—cannot be dismissed. This research marks an initial exploration into the acceptance of innovative pet foods, focusing on insect-based products. Future studies could extend this inquiry to other novel food types and geographies, and validate the findings through real-market evaluations, mitigating the biases of a hypothetical market setup.

CRediT authorship contribution statement

Tommaso Fantechi: Methodology, Data curation, Writing – original draft, Formal analysis. **Giovanbattista Califano:** Conceptualization, Methodology, Data curation, Writing – original draft, Formal analysis. **Francesco Caracciolo:** Conceptualization, Formal analysis, Supervision. **Caterina Contini:** Writing – review & editing, Supervision, Formal analysis, 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

Data will be made available on request.

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Appendix A

Table A1
Item descriptions and main statistics.

Item	Description	Mean	SD
AES.13	I get very angry when I see animals being ill-treated.	4.80	0.70
AES.14	It is silly to become too attached to one's pets. *	4.77	0.67
AES.10	It upsets me when I see helpless old animals.	4.66	0.93
AES.18	Seeing animals in pain upsets me.	4.56	0.87
AES.21	I would always try to help if I saw a dog or puppy that seemed to be lost.	4.50	0.91
AES.8	People who cuddle and kiss their pets in public annoy me. *	4.49	0.98
AES.1	So long as they're warm and well fed, I don't think zoo animals mind being kept in cages. *	4.43	0.87
AES.7	It makes me sad to see an animal on its own in a cage.	4.40	1.05
AES.16	Sometimes I am amazed how upset people get when an old pet dies. *	4.40	1.10
AES.5	Sad films about animals often leave me with a lump in my throat.	4.36	1.04
AES.22	I hate to see birds in cages where there is no room for them to fly about.	4.36	1.06
AES.15	Pets have a great influence on my moods.	4.35	0.92
AES.20	I find it irritating when dogs try to greet me by jumping up and licking me. *	4.30	1.13
AES.9	A friendly purring cat almost always cheers me up.	4.24	1.18
AES.19	People often make too much of the feelings and sensitivities of animals. *	4.16	1.21
AES.11	Dogs sometimes whine and whimper for no real reason. *	3.87	1.16
AES.12	Many people are over-affectionate towards their pets. *	3.55	1.40
AES.4	I get annoyed by dogs that howl and bark when they are left alone. *	3.49	1.43
AES.17	I enjoy feeding scraps of food to the birds.	3.24	1.38
AES.2	Often cats will meow and pester for food even when they are not really hungry. *	3.13	1.19
AES.3	It upsets me to see animals being chased and killed by lions in wildlife programs on TV.	2.96	1.41
AES.6	Animals deserve to be told off when they're not behaving properly. *	2.64	1.24

(*continued on next page*)

Table A1 (*continued*)

Item	Description	Mean	SD
FTNS.13	The media usually provides a balanced and unbiased view of new food technologies. *	3.26	1.16
FTNS.7	New food technologies are unlikely to have long term negative health effects. *	3.03	0.96
FTNS.11	It can be risky to switch to new food technologies too quickly.	3.02	1.03
FTNS.12	Society should not depend heavily on technologies to solve its food problems.	2.99	1.14
FTNS.1	There is no sense trying out high-tech food products because the ones I eat are already good enough.	2.94	1.16
FTNS.2	New food technologies are something I am uncertain about.	2.93	1.11
FTNS.3	New foods are not healthier than traditional foods.	2.87	1.10
FTNS.4	The benefits of new food technologies are often grossly overstated.	2.85	1.07
FTNS.10	New food technologies may have long-term negative environmental effects.	2.76	0.98
FTNS.8	New food technologies give people more control over their food choices. *	2.73	1.02
FTNS.6	New food technologies decrease the natural quality of food.	2.61	1.18
FTNS.9	New products using new food technologies can help people have a balanced diet. *	2.54	1.01
FTNS.5	There are plenty of tasty foods around, so we do not need to use new food technologies to produce more.	2.47	1.21
ISE.1	Sustainable eating is very important to me.	3.96	1.01
ISE.3	Sustainable eating means a lot to me.	3.76	1.07
ISE.4	I am very concerned about the consequences of what I eat in terms of sustainability.	3.67	1.12
ISE.2	I care a lot about sustainable eating.	3.65	1.06

Notes. AES = Animal Empathy Scale; FTNS = Food Technology Neophobia Scale; ISE = Involvement in Sustainable Eating; Items ranked from highest to lowest mean within each set; * = reverse scored item; The responses to all items ranged from 1 to 5.

Appendix B. Questionnaire (English translation)

Section B1.

Do you have or have you had pets (dog or cat) in the past?	
☐	Yes, a dog
☐	Yes, a cat
☐	Yes, both
☐	No

In the next section, you will be shown images of three 400 g containers of wet cat food. Please feel free to indicate the price you would be willing to pay for each product.

Section B2

Product A represents chicken-based pâté chunks. Product B represents pâté chunks made from insects. Product C represents natural, healthy, hypoallergenic, and environmentally sustainable pâté chunks.

Please indicate, for each product, all the prices you would be willing to pay by ticking "Yes," and all the prices you would NOT be willing to pay by ticking "No."

Product A (Chicken)			**Product B (Insects)**			**Product C (Healthy and Sustainable)**		
Price	*Yes*	*No*	*Price*	*Yes*	*No*	*Price*	*Yes*	*No*
0.00 €			0.00 €			0.00 €		
0.50 €			0.50 €			0.50 €		
1.00 €			1.00 €			1.00 €		
1.50 €			1.50 €			1.50 €		
2.00 €			2.00 €			2.00 €		
2.50 €			2.50 €			2.50 €		

(*continued on next page*)

(*continued*)

Product A (Chicken)			**Product B (Insects)**			**Product C (Healthy and Sustainable)**		
Price	*Yes*	*No*	*Price*	*Yes*	*No*	*Price*	*Yes*	*No*
3.00 €			3.00 €			3.00 €		
3.50 €			3.50 €			3.50 €		
4.00 €			4.00 €			4.00 €		
4.50 €			4.50 €			4.50 €		
5.00 €			5.00 €			5.00 €		

Section B3

Did you know? Just like product C, product B (with insects) is natural, healthy, hypoallergenic and environmentally sustainable. Please feel free to indicate what price you would be willing to pay to purchase this product.“

Product D (With insects. healthy and sustainable)		
Price	*Yes*	*No*
0.00 €		
0.50 €		
1.00 €		
1.50 €		
2.00 €		
2.50 €		
3.00 €		
3.50 €		
4.00 €		
4.50 €		
5.00 €		

Section B4

Please indicate how much you agree or disagree with each of the following statements using the provided scale:

1 - Strongly disagree

2 - Somewhat disagree

3 - Neither agree nor disagree
4 - Somewhat agree
5 - Strongly agree

	1	2	3	4	5
So long as they're warm and well fed, I don't think zoo animals mind being kept in cages.	☐	☐	☐	☐	☐
I get very angry when I see animals being ill-treated.	☐	☐	☐	☐	☐
It is silly to become too attached to one's pets.	☐	☐	☐	☐	☐
It upsets me when I see helpless old animals.	☐	☐	☐	☐	☐
Seeing animals in pain upsets me.	☐	☐	☐	☐	☐
I would always try to help if I saw a dog or puppy that seemed to be lost.	☐	☐	☐	☐	☐
People who cuddle and kiss their pets in public annoy me.	☐	☐	☐	☐	☐
It makes me sad to see an animal on its own in a cage.	☐	☐	☐	☐	☐
Sometimes I am amazed how upset people get when an old pet dies.	☐	☐	☐	☐	☐
Sad films about animals often leave me with a lump in my throat.	☐	☐	☐	☐	☐
I hate to see birds in cages where there is no room for them to fly about.	☐	☐	☐	☐	☐
Pets have a great influence on my moods.	☐	☐	☐	☐	☐
I find it irritating when dogs try to greet me by jumping up and licking me.	☐	☐	☐	☐	☐
A friendly purring cat almost always cheers me up.	☐	☐	☐	☐	☐
People often make too much of the feelings and sensitivities of animals.	☐	☐	☐	☐	☐
Dogs sometimes whine and whimper for no real reason.	☐	☐	☐	☐	☐
Many people are over-affectionate towards their pets.	☐	☐	☐	☐	☐
I get annoyed by dogs that howl and bark when they are left alone.	☐	☐	☐	☐	☐
I enjoy feeding scraps of food to the birds.	☐	☐	☐	☐	☐
Often cats will meow and pester for food even when they are not really hungry.	☐	☐	☐	☐	☐
It upsets me to see animals being chased and killed by lions in wildlife programs on TV.	☐	☐	☐	☐	☐
Animals deserve to be told off when they're not behaving properly.	☐	☐	☐	☐	☐
The media usually provides a balanced and unbiased view of new food technologies.	☐	☐	☐	☐	☐
New food technologies are unlikely to have long term negative health effects.	☐	☐	☐	☐	☐
It can be risky to switch to new food technologies too quickly.	☐	☐	☐	☐	☐
Society should not depend heavily on technologies to solve its food problems.	☐	☐	☐	☐	☐
There is no sense trying out high-tech food products because the ones I eat are already good enough.	☐	☐	☐	☐	☐
New food technologies are something I am uncertain about.	☐	☐	☐	☐	☐
New foods are not healthier than traditional foods.	☐	☐	☐	☐	☐
The benefits of new food technologies are often grossly overstated.	☐	☐	☐	☐	☐
New food technologies may have long-term negative environmental effects.	☐	☐	☐	☐	☐
New food technologies give people more control over their food choices.	☐	☐	☐	☐	☐
New food technologies decrease the natural quality of food.	☐	☐	☐	☐	☐
New products using new food technologies can help people have a balanced diet.	☐	☐	☐	☐	☐
There are plenty of tasty foods around, so we do not need to use new food technologies to produce more.	☐	☐	☐	☐	☐
Sustainable eating is very important to me.	☐	☐	☐	☐	☐
Sustainable eating means a lot to me.	☐	☐	☐	☐	☐
I am very concerned about the consequences of what I eat in terms of sustainability.	☐	☐	☐	☐	☐
I care a lot about sustainable eating.	☐	☐	☐	☐	☐

Section B5

Have you ever purchased products made from insects?	
☐	Yes, for me
☐	Yes, for my pet
☐	No, but I have tried them
☐	No

How would you define your diet?	
☐	Vegan
☐	Vegetarian
☐	Mostly vegetarian
☐	Mostly animal-based

Which of these descriptions represents you best?	
☐	I am responsible for food purchases.
☐	I am jointly responsible for food purchases.
☐	I occasionally handle food purchases.
☐	I do not handle food purchases.

Gender	
☐	Man
☐	Woman
☐	Other:

Age: ___

Region of residence	
☐	North East
☐	North West
☐	Centre
☐	South or islands

Employment	
☐	Worker
☐	Student
☐	Unemployed
☐	Retired
☐	Other:

Education	
☐	Middle school education or lower
☐	High school diploma
☐	Bachelor's degree
☐	Master's degree or higher

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