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An Insight into the Level of Information about Sustainability of Edible Insects in a Traditionally Non-Insect-Eating Country: Exploratory Study

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Abstract: Insects have been reported as a possible alternative solution to help feed the growing world population with less stress on the planet, thus contributing to the preservation of the environment and natural ecosystems. However, the consumption of edible insects (EIs), although culturally accepted for some communities, is not readily accepted for others. Hence this work explores the level of information that people in a traditionally non-insect-eating country have about the sustainability issues related with EIs, and also some possible reasons that could motivate their consumption. The study was based on a questionnaire survey and the results were explored by descriptive statistic tools, tree classification analysis, factor analysis and cluster analysis. The results showed that the level of information is still low in general, with most people not manifesting an opinion. However, some aspects are relatively familiar to the participants (88.9% know that the ecological footprint of insects is smaller than other meats and 86.9% know that they efficiently convert organic matter into protein). Factor and cluster analysis showed three classes: cluster 1—people not informed about the facts disclosed through the true statements and also not able to distinguish the false information; cluster 2—people not informed about the facts disclosed through the true statements but who were able to distinguish the false information; and cluster 3—people well informed about the facts disclosed through the true statements but who were marginally unable to distinguish the false information. It was also found that education, sex and professional area are the most relevant sociodemographic factors associated with the level of information, and the highest motivations to consume EIs are their contribution to preserve the environment and natural resources followed by being a more sustainable option (for 64.7% and 53.4% of participants, respectively). Hence it was concluded that, although some work still needs to be done to better inform people about EIs, there is already some conscientiousness that they constitute a good and more sustainable alternative to other types of meat.

Keywords: edible insects; sustainability; information; questionnaire survey

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1. Introduction

The planet faces in the modern times a most prominent challenge associated with the need to feed the increasing world population, while producing food in sustainable ways, so as to preserve the environment and the biosystems [1]. The sustainability aspects must be sought throughout the entire food chain, from primary production to industrial pro-

cessing, transport and storage, consumption and final disposal of leftovers and packaging materials [2,3].

Intensive food production is leading to unsustainable practices around the planet with consequences, such as global warming due to increasing greenhouse gas (GHG) emissions, loss of natural habitats and deforestation or animal overexploitation, with these stresses being caused by both vegetable and animal food production [4–7]. It has been reported that nearly 80% of the GHG emissions resulting from the food sector derives from livestock, including the emissions generated from forage growing, cattle rearing, transportation of meat to the processing companies and to the sales points [8].

Insects have emerged as one of the possible solutions to help feed the world population with a lower impact on the environment. One of the reasons for this is associated with the high feed conversion ratio, which allows to obtain animal protein with a considerably lower need for land, feed or water, while at the same time generating less GHG. All these result in a much lower ecological footprint [9–14].

EIs are a good source of nutrients, besides protein and their essential amino acids, they also contain fiber, fat (including polyunsaturated fatty acids), vitamins (particularly those of group B) and dietary minerals (for example calcium, iron and magnesium) [15–17]. However, they may also contain anti-nutrients, such as oxalates and phytic acid [18]. On the other hand, there is some debate about the food safety aspects that may affect not only producers but also consumers of EIs [19]. Some risks are associated with a possible microbial contamination or with chemical hazards, such as toxins or heavy metals. Additionally, while for some people eating insects is safe, for others it may be problematic because sensitive people may suffer from allergic reactions [20].

Although billions of people consume insects in many countries worldwide [21], in other cultures eating insects, especially among individuals from Western societies, is still a taboo and people experience a high degree of neophobia with this practice. This is particularly intense if the insects are presented whole, making the consumers more prone to not start eating foods that contain insects [22–24].

Portugal is a country situated in Europe, more precisely on the Iberian Peninsula, and therefore the dietary habits are Western and traditional diets are typically Mediterranean. The Mediterranean diet was recognized by UNESCO (United Nations Educational, Scientific and Cultural Organization) as an Intangible Cultural Heritage of Humanity in 2010, initially applying to four Mediterranean countries (Greece, Italy, Morocco and Spain), but in 2013 the list of countries was expanded to include Cyprus, Croatia and Portugal [25]. Therefore, this study aimed to explore how people perceive EIs in a country where eating insects is a strange habit because it is not part of the traditional dietary patterns. Additionally, and having in mind the need to have in the near future more sustainable diets in order to feed the world population, this study also intends to investigate whether people are informed about the role of EIs as a possible more sustainable food in the future. In particular, our research questions were as follows: (1) Are people informed about the sustainability aspects that relate to EIs, either associated with their production or consumption? (2) What sociodemographic factors may influence people's level of information? (3) What reasons could influence people to consume EIs?

2. Literature Review

In this section are presented some insights into the scientific literature related to each of the three research questions addressed in this study.

2.1. Information about the Sustainability of EIs

The potential of EIs to constitute a more environmentally friendly alternative to other protein sources, for example beef, has been pointed out as a significant advantage that could potentially influence people towards a better acceptance of entomophagy [1].

Verbeke [2] studied the consumer acceptance of EIs in a sample of 368 consumers in Belgium, by means of an online survey, and one of their explanatory variables was

the attention paid to the environmental impact of food choice. They observed significant effects of food choice motivation from the importance people attribute to the environmental impact of the food they consume. They quantified this influence as so: "an increase of one unit in the importance attached to the environmental impact of food choice increased the likelihood of being ready to adopt insects by 71%" [2].

Kostecka et al. [3] have investigated insect-based food acceptance among a sample of Polish consumers under a view of less resource-consuming food systems. They concluded that although Polish consumers are not prone to incorporating insect-based food into their diet, they recognized the importance of the food sector to the preservation of natural resources. In this way, they believe that consumers must be informed about the advantages of production or use of insect biomass originating from natural ecosystems. As a result, increasing the acceptance of alternative sources of protein may contribute to an effective reduction in the pressure generated by the food systems on the environment [3]. Although Kostecka et al. [3] did not evaluate the knowledge of consumers about facts related with sustainability of EIs, it gives some insight into the role of knowledge and information in the food choice process.

The study by Lensvelt and Steenbekkers [4] investigated consumer acceptance of edible insects through an online survey conducted with 134 participants from the Netherlands and 75 from Australia. They concluded that information is one of the key factors to positively influence the participant's willingness towards entomophagy, and therefore, "education is a pivotal key to be addressed". However, this research focused on information about social norms and trust and on information about physiological factors, and therefore the sustainability was not directly studied.

2.2. Sociodemographic Factors That Influence People's Knowledge

It has been widely known that sociodemographic characteristics influence people's food behavior, including food choices. The work by Guiné et al. [5] investigated the influence of environmental issues on consumer's food choice, by an online questionnaire survey using a non-probabilistic sample of 10,067 participants from 13 countries. Their results showed that people attributed importance to the sustainability of their food choices. They also reported significant differences in the motivations for food choice across sociodemographic groups (age, sex, marital status, education, professional area, living environment and country), with country being the more influential variable, followed by age and sex.

In related research, Guiné et al. [6] reported that most consumers admitted to basing their food choices on some environmental issues. Additionally, they conducted a factor analysis that showed two factors: purely environmental concerns and sustainability related to quality concerns. They also conducted a cluster analysis which allowed them to conclude that more than half of participants paid attention to both types of concerns when making their food choices, which is indicative that consumers are becoming more aware of their role in the sustainability of the food chain.

Sarić et al. [7] reported for a sample of 1534 participants from Croatia that sociodemographic factors influenced the food choices for more sustainable options. In their research they reported that older and female participants with higher education level (university degree) and married were more concerned about environmental friendly food choices.

There are other works that address the effect of sociodemographic factors on the way people act and how they attribute importance to sustainability. However, although there is some environmental awareness about EIs, no specific studies were found that focused on the evaluation of the level of knowledge about sustainability of EIs and the way that knowledge varies across sociodemographic groups.

2.3. Motivations to Consume EI

Although insects are a highly appreciated food source in numerous parts of the world, it is also a known fact that for most Western cultures EIs are not considered as an appropriate food source, and therefore negative attitudes continue to be dominant [8].

Some studies carried out in different countries highlight that individuals who pay attention to the environmental impact of the foods they consume, and who are informed about the ecological benefits of EIs, are more open to entomophagy [9].

The study by Tan et al. [10] conducted a cross-cultural qualitative study investigating how cultural exposure and individual experience can shape the perceptions of people who usually consume EIs and those who do not. They used eight focus groups, four in the Netherlands and four in Thailand, being a total of 54 participants. One of the factors that was pointed out by some participants as motivation for consumption was sustainability.

Niva and Vainio [11] investigated consumers' willingness to replace the consumption of beef by alternative sources, including insect-based protein products, in a sample of 1000 Finish consumers. They observed that a quarter of participants intended to increase the consumption of insect-based products, and this was driven by a wish to comply with more sustainable systems.

The work by Orsi et al. [9] addressed the determinants of consumer acceptance of EIs in Germany through an online survey on a sample constituted by 393 participants. Their study revealed a low willingness of Germans to try insects as food. They also were able to identify some obstacles to the consumption related with the prevalence of psychological and personality barriers, including a sense of disgust and food neophobia. Nevertheless, they also found that processed insect products might be a better solution to introduce EIs into the diets of Germans than whole insects. However, this study did not consider the effect of EIs as a possible more sustainable source of protein.

In a study conducted through an online survey with 820 Australian consumers, Wilkinson et al. [12] reported that factors, such as taste, appearance, safety and quality could motivate the willingness to try eating insects. Nevertheless, the consumer's attitudes towards EIs were relying to a great extent on food neophobia. Again, the authors found that the incorporation of insects into familiar products (e.g., biscuits, snacks) or cooked meals could improve the motivation to consume them, but no attempt was made to investigate if sustainability could influence the willingness to consume EIs.

3. Materials and Methods

This research was based on a questionnaire survey undertaken through internet invitation. The instrument used to collect the data was developed under the objectives of project "FZ—Drone Flour", which is under development and aims to investigate the technological possibility to produce innovative drone flour to commercialize in the Portuguese food market. This flour was obtained from the beehives held by the Portuguese beekeepers, as a way to mitigate the harmful effects of the Varroa mite in the beehives, while at the same time having a socioeconomic impact, providing extra income to the farmers.

3.1. Instrument and Data Collection

The questionnaire was developed purposely for this work, and submitted to the ethics committee at the Polytechnic Institute of Viseu, who approved it under ref. no. 06/SUB/2020, dated 11 September 2020. The full questionnaire is shown in Appendix B. Only after approval the questionnaire was deployed into the Google Forms platform, ensuring the anonymity of all answers received. The participation was voluntary and data collection occurred between September and October 2020. All ethical issues were respected when designing the research and collecting the data, and the participants only answered the questionnaire after giving informed consent or declaring that they were 18 years of age or older.

Taking into count the nature of the data collection strategy, the questionnaire was applied to a convenience sample, defined in terms of facility of recruitment and disposition to take part in the research. It is an unquestionable fact that convenience samples have some limitations, namely in what concerns the extrapolation of the conclusions to the whole population. However, they have also been reported as having some advantages, namely being easy to recruit and providing a good tool to undertake exploratory research [26,27].

Although being a convenience sample, some hint of the possible minimum sample size was calculated, as indicated. For this, some assumptions were considered:

- confidence interval = 90%;
- Z score = 1.645;
- power of the test = 5% (minimum acceptable probability of preventing type II error = 0.05) [28,29];
- Portuguese population in 2019 (the latest year available when the data collection started) = 10,283,822 people [30]: assumed that ~7.5 million were adults and the target population was 25% = 1875 thousand.

We targeted only 25% of the population in this research because it was assumed that in a Western country (situated in Europe under influence of Mediterranean diet) where eating insects it not natural or traditional in any way, it might not be expected that more than a quarter of the population might be interested in the near future to shift to this kind of food product. Considering all aforementioned conditions, calculation of the minimum sample size resulted in 203 adults [31,32].

3.2. Data Analysis

The data were analyzed using SPSS software V26 (IBM, Inc., Armonk, NY, USA) and Excel 2016 (Microsoft Corporation, Redmond, WA, USA).

The crosstabs with the chi-square test and Fisher's test were used to investigate the relations between some research variables and the sociodemographic categorical variables. Furthermore, the Cramer's V coefficient was used to quantify the intensity of the significant associations found between variables (considering a level of significance of 5%). The value of V varies between a minimum of zero (corresponding to no association) and a maximum of one (when the association is perfect). Indicative values were considered as the following [15,33]: $V \approx 0.1$—weak association; $V \approx 0.3$—moderate association; and $V \approx 0.5$ or higher—strong association.

The different items used to assess the level of information about sustainability issues related with EIs were submitted to a Factor Analysis (FA) for possible reduction of constructs. FA was completed using extraction by Principal Component Analysis (PCA) method, with quartimax rotation and using the scree plot to determine the number of factors. The percentage of variance explained by the factors extracted was based on the communalities [34]. Factor loadings with absolute below 0.5 were excluded, meaning that variables which had at least 25% of variance explained were only considered in the analysis. Internal consistency of the factors was evaluated through the Cronbach's alpha (α) [34,35].

Cluster Analysis (CA) started by applying five hierarchical methods based on the variables that resulted from the FA (scores saved as variables): (1) average linkage—between groups, (2) average linkage—within groups, (3) complete linkage—furthest neighbor, (4) centroid and (5) Ward. In all cases, it considered the measure for interval by the squared Euclidean distance. Based on the agglomeration schedule, it was possible to identify the most adequate number of clusters. Then, those five solutions were compared for similarity using contingency tables, which allows inferring about possible stability.

After establishing the number of clusters as three, the partitive method K-means was used, as it is commonly recommended for cluster analysis, due to its robustness [36]. The five initial solutions all converged to the same final solution, confirming the stability of the solution [36] and consequent confidence in the results.

Figure 1 presents a schematic representation of the procedures followed in the FA and CA.

Additionally, the items used to assess the level of information about sustainability of EIs were used to calculate an average score accounting for the general level of information, and this variable was submitted to a tree classification analysis against all the sociodemographic variables in the study, to investigate their relative importance to the level of information. For this, the CRT (classification and regression trees) algorithm was used with cross-validation [37], considering a minimum change in improvement equal to 0.001 and establishing the minimum number of cases equal to 10 for parent nodes and 5 for child nodes.

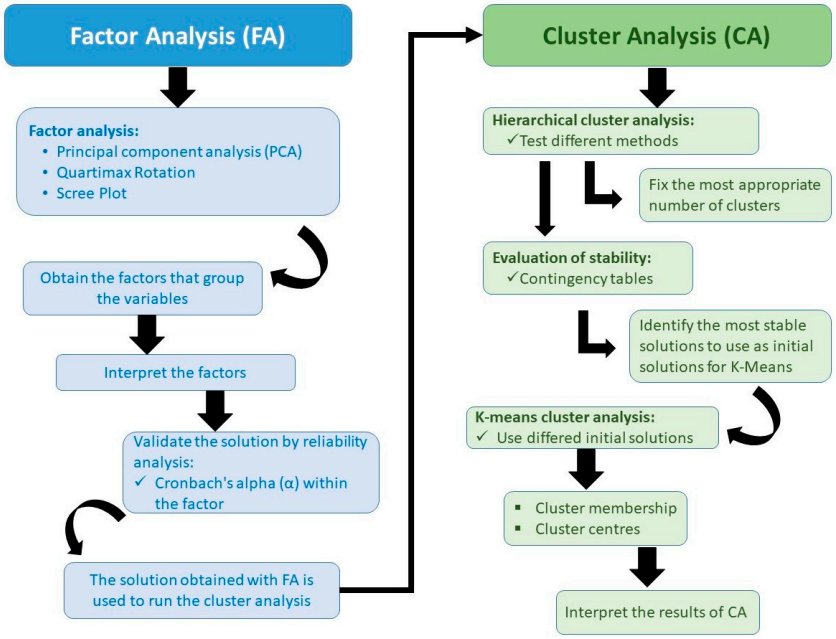

Figure 1. Methodology used to perform FA and CA.

4. Results

4.1. Sample Characterization

The sample consisted of 213 respondents, of whom most were female (79%), and a lower percentage were men (21%) (Table 1). The minimum age of the participants was 18 and the maximum was 80 years old. The participants were classified into groups according to the age, as follows: young adults (18–30 years), representing 24.4%, intermediate adults (31–55 years) accounting for 57.7% and senior adults (56 years or over) representing the remaining 17.8%. The majority of the participants, 78.4%, had a high education level (university graduate or post-graduate). Concerning the area of residence, most lived in urban environments (62.9%). Regarding marital status, most respondents (59.6%) had a life partner, i.e., were married or living together as a couple. Finally, the professional area of the participants was also investigated for its possible association with some variables of interest in the research. For this, it was specifically addressed if the participants were from areas related with food or nutrition (25.4%), agriculture, environment or biology (16.0%) or with other areas (58.7%).

Table 1. Sociodemographic characteristics of the sample used in the research.

Variable	Groups	N (%)
Sex	Women	168 (78.9)
	Men	45 (21.1)
Age group	Young adults (18–30 years)	52 (24.4)
	Intermediate adults (31–55 years)	123 (57.7)
	Senior adults (≥56 years)	38 (17.8)
Education level	Under university level	46 (21.6)
	University level (graduate or post-graduate)	167 (78.4)
Living environment	Urban	134 (62.9)
	Suburban/Rural	79 (37.1)
Marital status	No life partner (Single/Divorced/Widowed)	86 (40.4)
	With life partner (Living together/Married)	127 (59.6)
Professional area	Food/Nutrition	54 (25.4)
	Agriculture/Environment/Biology	34 (16.0)
	Other areas	125 (58.7)
	Total	**213 (100.0)**

4.2. Information about Sustainability Aspects That Relate to EIs

To answer research question (1) "Are people informed about the sustainability aspects that relate with EI, either associated with their production or consumption?", the results of the answers to a set of questions formulated to measure the participants knowledge/degree of information about sustainability facts related with EIs were used. Table 2 presents such results, highlighting the number of answers given to each question and the fraction corresponding to informed or not informed participants. From the 213 participants, a high number had not manifested an opinion about questions 1 to 7 in Table 2. The question that received most answers was Q1 with 160 responses. Among these, a great majority (82.5%) was correct in their perception, which indicates that the respondents were relatively well informed about the possibility of EIs providing protein to fight hunger in the world. On the other extreme end stands Q4, Q5 and Q6 with around 100 responses, all related with the comparison of the use of resources to produce protein. Nevertheless, most participants were well informed about these statements, except for Q5, which was formulated in the reverse mode, and that might have confused the respondents when answering it.

Table 2. Responses for the questions regarding sustainability issues related to EIs.

Facts about Sustainability of EIs (N [1])	Not Informed N (%)	Informed N (%)
Q1. Insects are a possibility to respond to the growing world demand for protein (N = 160).	28 (17.5)	132 (82.5)
Q2. The production of insects for human consumption emits about 10 times less greenhouse gases (GHG) than the production of steak (N = 115).	16 (13.9)	99 (86.1)
Q3. Insects efficiently convert organic matter into protein (N = 122).	16 (13.1)	106 (86.9)
Q4. To produce 1 kg of insect protein, 5 times less food is spent than to produce 1 kg of cow protein (N = 97).	14 (14.4)	83 (85.6)
Q5. To produce 1 kg of chicken protein, 5 times less water is used than to produce 1 kg of insect protein (N = 92) [2].	45 (48.9)	47 (51.1)
Q6. To produce 1 kg of insect protein requires an area 3 times smaller than to produce 1 kg of pig protein (N = 102).	18 (17.6)	84 (82.4)
Q7. The ecological footprint of insects is comparatively smaller when compared to other sources of protein for human consumption (N = 137).	14 (10.2)	123 (89.8)

[1] N = Number of respondents who expressed their opinion on each of the questions. [2] This is a false statement.

The seven questions accounting for sustainability issues related with EIs were submitted to FA with PCA extraction and quartimax rotation, resulting in two components or factors. The total variance explained by the factors was: F1—80.3% and F2—12.3%, with a high cumulative variance of 92.6% explained. The communalities showed that all variables had high variance explained by the solution, with the lowest being for Q3 which was still high (0.820, corresponding to 82% of variance explained). The rotation algorithm converged in three iterations and the results of FA are shown in Table 3.

Table 3. Results of the FA with extraction by PCA and quartimax rotation (factor loadings under 0.5 were excluded).

Items	Loadings	
	Factor F1	Factor F2
Q1. (True)	0.969	
Q2. (True)	0.986	
Q3. (True)	0.905	
Q4. (True)	0.986	
Q5. (False)		0.913
Q6. (True)	0.943	
Q7. (True)	0.932	
Cronbach's alpha	**0.980**	**(*)**

(*) Not calculated because there was only one variable in the factor.

The structure of the factors in Table 3 allows identifying factor F1 as linked with all the true statements, while factor F2 was associated with the false information. All variables presented very high loadings in the factors, being the lowest for Q3 in F1 (0.905), but still corresponding to a very high correlation. Because all the seven variables had loadings with an absolute value higher than 0.5, the solution was satisfactory by including all the

variables [38]. Additionally, this solution resulted in a grouping configuration that can be easily interpreted.

Validation through Cronbach's alpha (α) [34] was only possible for factor F1, since F2 included only one variable. The results showed that the internal consistency within factors was 0.980, which is considered very good [39–41]. Furthermore, the value of alpha did not increase by elimination of any of the items, thus meaning that F1 presented a very strong internal uniformity.

The scores obtained with FA were used for the Cluster Analysis (CA). In a first step, CA was applied by five different hierarchical methods in order to define the number of clusters, which in the present case was found to be three according to Figure A1 in Appendix A.

The compatibility between the solutions obtained with the five hierarchical methods, when the number of clusters was fixed as three, was checked though contingency tables, and these results are presented in Appendix A (Table A1). The values of the percentages indicated that the solutions obtained by all the methods converge to a single solution, i.e., the percentage of the cases allocated to the same clusters is the maximum. These results confirm that the ideal number of clusters is three, and that any of the five solutions tested previously were potentially stable, and therefore can be used as an initial solution to the next step, that is to apply the K-means clustering analysis. Furthermore, the application of the K-means to the five initial solutions confirmed that they all converge to a single solution, thus proving stability. The values of the F statistic in ANOVA are high for both factors ($F_{statistic}$ = 901.6 for F1 and $F_{statistic}$ = 2109.6 for F2, with $p < 0.0005$ in both cases), thus confirming the similarity between the cases within the groups and the differences between groups. Additionally, because both values of $F_{statistic}$ are of similar order of magnitude, they both equally contribute to the discrimination of the groups. Figure 2 shows the final cluster canters that were confirmed by the results of the K-means CA.

The interpretation of the clusters is as follows:

- Cluster 1: people not informed about the facts disclosed through the true statements, and are also not able to distinguish the false information;
- Cluster 2: people not informed about the facts disclosed through the true statements, but who were able to distinguish the false information;
- Cluster 3: people well informed about the facts disclosed through the true statements, but who were marginally unable to distinguish the false information.

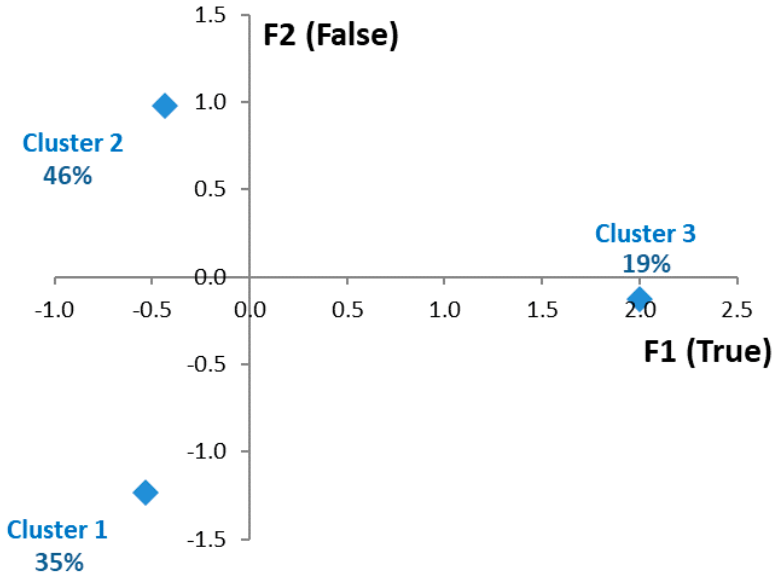

Figure 2. Cluster centers in relation to the factors.

4.3. Influence of Sociodemographic Factors on People's Level of Information

To answer research question (2) "What sociodemographic factors may influence people's level of information?", the responses to the questions Q1 to Q7 were tested against the sociodemographic variables using contingency tables and the chi-square test, being the results presented in Table 4. The results are resented as % in row for each variable and each question because this allows to eliminate the effect of uneven group distribution within each sociodemographic variable. For example, for variable sex, it is % of informed and % of not informed within each group: women or men.

The results showed that for most topics (Q1 to Q7), the sociodemographic variables tested are not associated with the level of information, just with two exceptions:

(1) The information for Q5 (to produce 1 kg of chicken protein, five times less water is used than to produce 1 kg of insect protein), given as a false statement, varies significantly with age ($p = 0.011$) and the association is moderate (V = 0.312);
(2) The information for Q5 varies significantly with marital status ($p = 0.030$) and the association is moderate (V = 0.219).

Table 4. Association between the sociodemographic variables and the responses to questions about EIs and sustainability.

Sociodemographic Variables/Groups	Q1		Q2		Q3		Q4		Q5		Q6		Q7	
	I [1] (%)	NI [2] (%)	I [1] (%)	NI [2] (%)	I [1] (%)	NI [2] (%)	I [1] (%)	NI [2] (%)	I [1] (%)	NI [2] (%)	I [1] (%)	NI [2] (%)	I [1] (%)	NI [2] (%)
Sex														
Women	80.0	20.0	84.4	15.6	85.1	14.9	82.4	17.6	51.4	48.6	80.3	19.7	87.7	12.3
Men	90.0	10.0	92.0	8.0	92.9	7.1	95.7	4.3	50.0	50.0	88.5	11.5	96.8	3.2
p-value [3]	0.112		0.272		0.234		0.102		0.556		0.265		0.127	
V [4]	0.114		0.090		0.097		0.160		0.011		0.094		0.125	
Age														
Young adults	81.6	18.4	84.0	16.0	84.6	15.4	87.5	12.5	29.2	70.8	82.1	17.9	94.4	5.6
Intermediate adults	80.4	19.6	84.7	15.3	86.7	13.3	82.1	17.9	64.2	35.8	80.0	20.0	86.3	13.8
Senior adults	92.0	8.0	94.4	5.6	90.5	9.5	94.1	5.9	40.0	60.0	89.5	10.5	95.2	4.8
p-value [5]	0.391		0.535		0.836		0.447		0.011		0.646		0.270	
V [4]	0.108		0.104		0.054		0.129		0.312		0.093		0.138	
Education														
Under university	78.1	21.9	83.3	16.7	81.8	18.2	81.8	18.2	47.8	52.2	76.9	23.1	86.2	13.8
University	83.6	16.4	86.6	13.4	88.0	12.0	86.7	13.3	52.2	47.8	84.2	15.8	90.7	9.3
p-value [3]	0.311		0.475		0.318		0.395		0.425		0.286		0.339	
V [4]	0.058		0.034		0.070		0.058		0.038		0.083		0.061	
Living Environment														
Urban	80.7	19.3	84.1	15.9	87.5	12.5	86.1	13.9	53.1	46.9	77.8	22.2	92.0	8.0
Suburban/Rural	83.5	16.5	87.3	12.7	86.5	13.5	85.2	14.8	50.0	50.0	84.8	15.2	88.5	11.5
p-value [3]	0.405		0.411		0.550		0.579		0.474		0.263		0.368	
V [4]	0.035		0.045		0.015		0.012		0.030		0.089		0.056	
Marital status														
No life partner	78.8	21.2	84.4	15.6	81.8	18.2	86.1	13.9	37.1	62.9	82.5	17.5	94.4	5.6
With life partner	85.1	14.9	87.1	12.9	89.7	10.3	85.2	14.8	59.6	40.4	82.3	17.7	86.7	13.3
p-value [3]	0.204		0.442		0.167		0.579		0.030		0.597		0.120	
V [4]	0.082		0.038		0.113		0.012		0.219		0.003		0.124	
Professional area														
Food/Nutrition	87.2	12.8	87.9	12.1	90.3	9.7	87.5	12.5	44.0	56.0	82.6	17.4	91.7	8.3
Agric./Env./Biol.	93.3	6.7	90.5	9.5	91.3	8.7	87.5	12.5	50.0	50.0	88.2	11.8	95.5	4.5
Other areas	76.9	23.1	83.6	16.4	83.8	16.2	84.2	15.8	54.9	45.1	80.6	19.4	87.3	12.7
p-value [5]	0.082		0.691		0.529		0.902		0.668		0.767		0.491	
V [4]	0.177		0.080		0.102		0.046		0.094		0.072		0.102	
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

[1] I = informed. [2] NI = not informed. [3] Significance of the Fisher's test (level of significance of 5%). [4] V = Cramer's V coefficient. [5] Significance of the chi-square test (level of significance of 5%).

As a complement to the study, a new variable was considered as the average score of all the seven questions, to account for a global level of information for each participant. This new variable was submitted to a tree classification analysis to investigate the relative importance of the sociodemographic variables in the level of information. Figure 3 reveals that the first discriminating sociodemographic variable is education, with the participants with a university level of education being more informed. In level 2 for the people without

university education, the next discriminating variable is sex, and then for women the next discriminating variable is professional area. On the other hand, for the ones who had a university degree, the discriminant for level 3 is professional area, in this case the professionals from other areas being less informed than people from Food/Nutrition or Agriculture/Environment/Biology. In level 4, the participants from other areas were separated according to marital status, with the highest information for people with a life partner as compared with those without. Nevertheless, in both these two groups, the last discriminant was living environment.

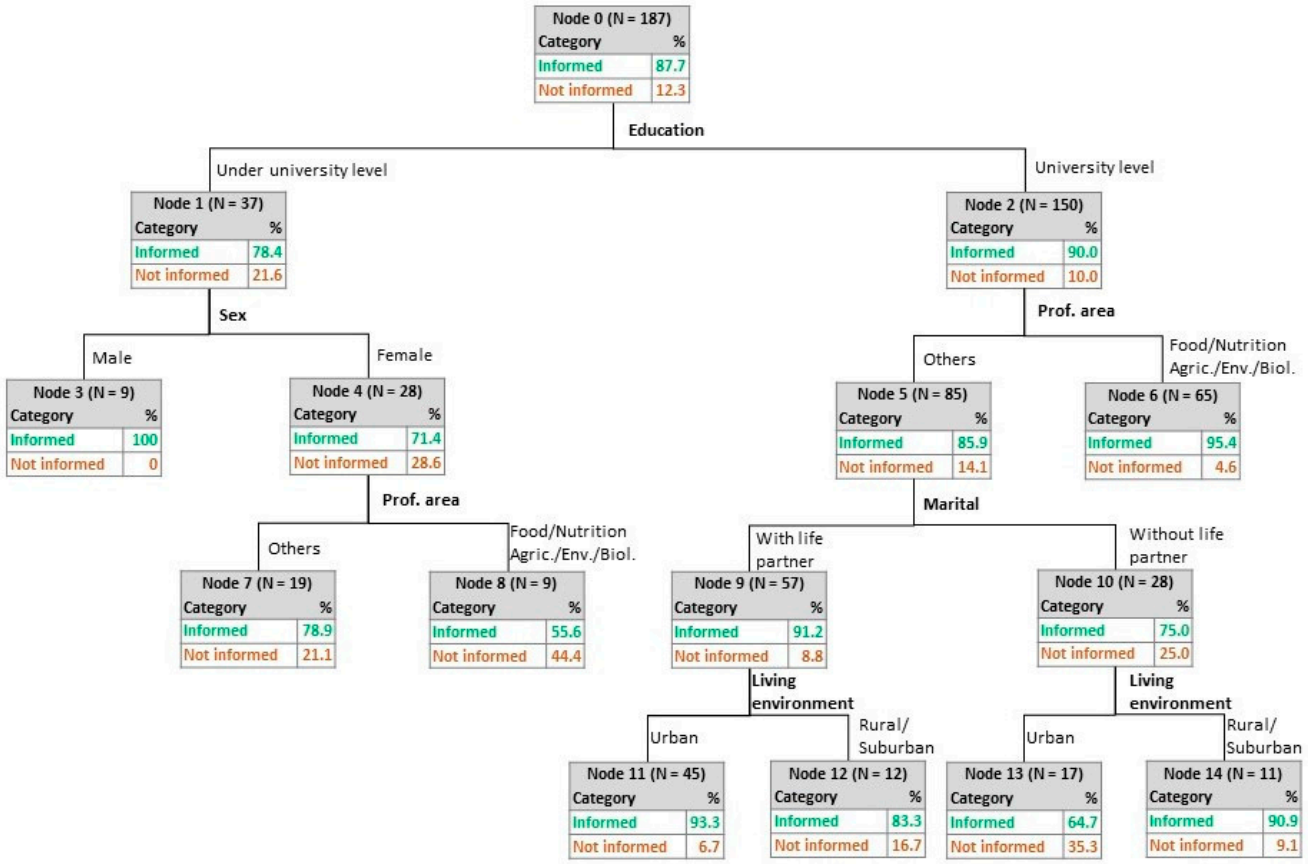

Figure 3. Classification tree for influence of sociodemographic variables on the general level of information.

4.4. Motivations to Consume EIs

To answer the last research question (3) "What reasons could influence people to consume EIs?", a number of possible factors that could motivate people were investigated and the results are presented in Table 5. The reasons that could be more motivating for people to consume EIs included contributing to the preservation of the environment and natural resources (64.7% motivated by this aspect), being a more sustainable option (53.4% motivated by this) or serving to increase the income of the producers' families (50.9% motivated by this). The willingness to follow innovative trends or mimic personalities/influencers is a very weak motivation for the participants (only 8.9% admit this possibility).

Table 5. Responses for the questions regarding motivations to consume EIs.

Possible Motivations to Consume EIs (N [1])	Not Motivated N (%)	Motivated N (%)
Q8. Insects are a more sustainable option (N = 176).	82 (46.6)	94 (53.4)
Q9. Desire to try exotic foods (N = 174).	126 (72.4)	48 (27.6)
Q10. Insects contribute to the preservation of the environment and natural resources (N = 167).	59 (35.3)	108 (64.7)
Q11. Insects contribute to the diversification of food production (N = 169).	90 (53.3)	79 (46.7)
Q12. Insects are a way to increase the income of families that produce them (N = 159).	78 (49.1)	81 (50.9)
Q13. Willing to follow innovative trends or mimic personalities/influencers (N = 192).	175 (91.1)	17 (8.9)
Q14. EIs provide protein foods at cheap prices (N = 164).	92 (56.1)	72 (43.9)

[1] Number of respondents who expressed their opinion.

5. Discussion

Regarding the research question (1) "Are people informed about the sustainability aspects that relate to EIs, either associated with their production or consumption?", the first finding of this study clearly shows that most participants are quite well informed about the facts related to sustainability. These results are in line with the works by Verbeke [2] and Kostecka et al. [3], which concluded that environmental issues are on the rise as factors shaping food choices. Nevertheless, in those studies, the level of knowledge was not assessed as it was in the present study, and therefore, it constitutes a novel approach to quantify the level of knowledge by means of people's accordance with true and false statements provided. To this matter, it was found that half of the participants still accepted false information as true. One explanation for this can be related to the difficulty that people in general experience on a daily basis due to the saturation of information that comes from advertising and online social networks. Fake news, fake videos or biased comments also contribute to this ascertainment. The cluster analysis also confirms this core result, because only one small cluster aggregates the participants that are well informed about the facts which were presented to them in true statements, but who still could not discern the false statements. This result also exposes a lack of skills to distinguish real and fake information [42–45].

The sector of EIs as food or food ingredients is an emerging agricultural sector, with higher potential to grow and a lower associated environmental impact [46]. However, there are some issues that must be identified related to attitudes and knowledge of the consumers towards these products. Additionally, an increase in EI consumption globally could only be possible through insect farming, due to the unfeasibility collecting them in high quantities from natural habitats.

Production of meat foods is responsible for high emissions of GHG, and the results obtained in this work confirm that there is knowledge about this fact, as well as about its association to climate change effects that require urgent dietary changes. In general, a higher percentage of the inquired are well informed about the importance of insects in the food supply chains as a substitute for meat, which is in accordance with an increase in the market for insects or insect protein that may further develop in non-insect-eating countries. However, the cluster analysis evidenced that the possible future consumers need more information to adhere to EIs consumption. Our results showed that practically all of the participants know very well that the footprint of insects is comparatively smaller when compared to other sources of protein for human consumption. Is well known that insects' production emits a considerable lower percentage of methane than cattle, and provide more protein than chicken and beef [9]. This study indicated a good knowledge about these facts. Nevertheless, even though the nutritional value and the positive effects of EIs on the environment are well understood and could be a positive incentive for eating insects, some studies reveal that the sensory aspects and overall experience of eating insects could be an impediment, given the disgust or unfamiliarity issues that can prevent consumers

from accepting EIs as food [47]. Additionally, according to Hartmann and Siegrist [48], consumers' disposition to eat EIs is weak.

Regarding the research question (2) "What sociodemographic factors may influence people's level of information?", in a first approach, and considering that women were more participative in this study than men, we could deduce that they would possibly be more interested in this topic. However, it is a fact that the willingness of women to participate in surveys is in general higher than men, regardless of the topic. Therefore, the disposition to participate is not a direct indicator of better acceptability of EIs as foods. To this matter, we must analyze the effect of food neophobia on the participants. Food neophobia could affect the variety of foods in the diet, because some people tend to avoid the consumption of unfamiliar foods [49]. On the other hand, food neophobia could protect the individuals from ingesting possibly toxic or nutritionally inadequate foods, if the consumers are not well informed [50]. Some studies identified men as less food neophobic and less disgusted by insects than women [51,52]. In concordance with this, for the Portuguese sample, the cluster results showed that men are more likely to accept insects as food than woman. This result is also in line with Verbeke [51], which suggests that attitudes towards the use of insects in feed and food in general were significantly more favorable among males than females [51].

The acceptance of EIs as food can be variable according to cultural, geographical, personal and emotional factors [51]. Eating insects is very common in some countries, but can be very disturbing for many people in other countries [53]. In this study, there were not a lot of participants that would be motivated to eat EIs because they desire to try exotic foods. This antipathy could be related to the historical and cross-cultural belief that EIs are disgusting and not edible by humans, except in cases of hunger or malnourishment. In some European countries, such as Belgium [24], Netherlands [54] or Finland [55], a moderate acceptance for EIs has also been shown. The use of EIs as food ingredients might also help increase the adoption of insect-based foods [56–58].

Globally, because responses related to the queries about sustainability of EIs reveal a good knowledge of the positive effects of using EIs as food or food ingredients, we could infer that this could possibly be a good indication that neophobia might not affect the introduction of EIs into the Portuguese consumer's diet. This would be in line with the trend to look for more sustainable foods, so as to preserve the planet resources and defend the natural ecosystems [59]. Portuguese consumers are aware that EIs can help solve some environmental problems by promoting sustainable food choices, in line with other studies that showed consumers have the perception that diets have to adapt to a more sustainable processing and to more environmental friendly food chains [10,60,61].

In regard to research question (3) "What reasons could influence people to consume EI?", among the motivations evaluated, the participants highlighted that aspects, such as being a more sustainable option or contributing to the preservation of the environment and natural resources were stronger motivations. However, the results also show that participants claim that they are not motivated enough to follow innovative trends or mimic personalities or influencers, so these are not aspects valued by possible future consumers of EIs in a non-insect-eating country, such as Portugal. Nevertheless, these results could exhibit cognitive biases when observing the current trends and the time spent by humans on social media. FAO considers insects a sustainable alternative source of animal protein that can respond to population growth. As shown in previous research, the lack of familiarity with EIs can contribute as a barrier in addition to cultural differences, in terms of acceptance of new food [42–45]. For instance, the price dimension combined with the more sustainable option and the fact that it contributes to the diversification of food production should be spotlight by ad campaigns in non-insect-eating countries.

From the point of view of the nutritional value of EIs, the participants also had a good perception that they are rich in protein, if we take into account that Portugal is non-insect-eating country. Due to the presence of proteins, unsaturated fats and fiber, richness in lysine, threonine and tryptophan amino acids [62], as well as in micronutrients, such as iron, zinc, calcium and vitamins [15–19], it is possible to classify EIs as a very good source

of nutrients. Some of EIs are also particularly rich in chitin, an insoluble fiber derived from their exoskeleton, which has been found to improve immune responses in humans and decrease allergies [63]. However, EIs can also contain residues of pesticides and heavy metals from the ecosystem and cause human allergic reactions [64], and this point must be well studied in future.

Factors, such as (1) contributing to environmental care; (2) being a sustainable option; (3) economic benefits (increased income); (4) happiness; (5) food security; and (6) long life, can be used to promote consumption of foods from edible insects as a sustainable source of protein [54,65,66]. Some consumer studies disclosed that food choice is primarily motivated by price and health consequences [54,65], which is in line with some of the motivations observed in this study. Furthermore, the economic benefits (higher income) were a motivation highlighted in this work.

6. Conclusions

This study assessed the knowledge regarding information about the sustainability of EIs, either when the questions were related to true or with false information, in a traditionally non-insect-eating country. Additionally, it evaluated the motivations to consume EIs. The results showed that there is a good level of knowledge about sustainability aspects related to EI production and consumption, but also exposed the lack of ability to identify false information as fake. The levels of knowledge seem globally high, but when analyzed in detail, this study finds that the absence of factual knowledge leads to the fact that false information becomes relevant for many participants.

Some limitations can be pointed out, such as the inequality of sociodemographic groups, with more female participants than men, more people with a university degree or more people residing in urban areas as compared to rural environments, which can somewhat bias the study. This heterogeneity results from the fact that we had to use a convenience sample, and woman are more prone to answering questionnaire surveys than men. Furthermore, the contacts used to send the survey included more people with a university degree living in urban areas. Another limitation was related to the method of delivering the survey, through internet, but this limitation was caused by the pandemic situation that the world was facing at the time of the research.

This work brought added value to the identification of the national situation about perceptions of the Portuguese about EIs, and sustainability issues and their implications. It demonstrated that the general public's level of information in traditionally non-insect-eating countries, such as Portugal, needs to be improved and therefore it is imperative to adapt effective strategies to pass the message of sustainability to the wider public. Future educational strategies need to focus on the characteristics of the citizens in non-traditional insect eating countries, and look for ways to shift people's perceptions. As such, producers and brands must educate and inform possible future consumers on this topic. Additional actions could encompass free tastings in shops/supermarkets/restaurants, which in a more direct approach could help overcome some of the barriers for eating IEs. Nevertheless, industries and other actors in the food chain must take into account that some consumers would continue to feel fear, aversion or disgust towards EIs, and therefore not adopt these foods, even knowing about their environmental advantages.

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Institutional Review Board Statement: This research was implemented taking care to ensure all ethical standards and followed the guidelines of the Declaration of Helsinki. The development of the study by questionnaire survey was approved on 11 September 2020 by the ethics committee of Polytechnic Institute of Viseu (Reference No. 06/SUB/2020).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are available from the corresponding author upon reasonable request.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Figure A1 shows the last 20 values of the coefficients of the agglomeration schedule for each hierarchical method tested to evaluate the number of clusters.

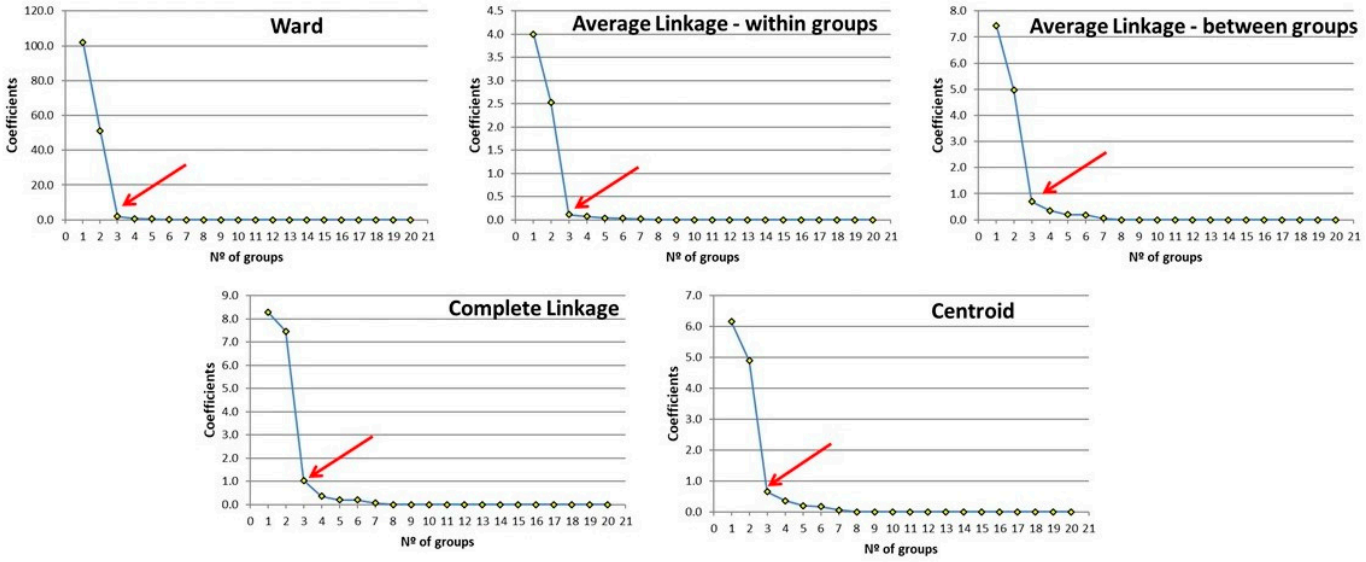

Figure A1. Determination of the number of groups by five hierarchical methods.

Table A1 presents the comparison of the solutions obtained with the five hierarchical methods tested.

Table A1. Comparison of the solutions obtained with the hierarchical methods.

Method [1]	AL-BG	AL-WG	CL-FN	CENT	WARD
AL-BG	—	—	—	—	—
AL-WG	100%	—	—	—	—
CL-FN	100%	100%	—	—	—
CENT	100%	100%	100%	—	—
WARD	100%	100%	100%	100%	—

[1] AL-BG: average linkage—between groups; AL-WG: average linkage—within groups; CL-FN: complete linkage—furthest neighbor; CENT: centroid.

Appendix B

In this appendix the full questionnaire is presented.

I. DEMOGRAPHICS

Age: _____ years

Sex: Female ☐ 1 Male ☐ 2

Highest level of education concluded:

Basic school (9 school years) ☐ 1
Secondary school (12 school years) ☐ 2
University degree ☐ 3
Post-graduate studies (master or PhD) ☐ 4

Living environment:

Rural ☐ 1 Urban ☐ 2 Suburban ☐ 3

Marital status:

Single ☐ 1 Married ☐ 2 Divorced ☐ 3 Widowed ☐ 4

Professional activity/studies related to any of the following areas:

Nutrition ☐ 1 Food ☐ 2 Agriculture ☐ 3 Environment ☐ 4
Biology ☐ 5 Health related activities ☐ 6 None of the previous ☐ 7

II. CHARACTERIZATION OF PARTICIPANT'S HABITS

How often do you eat in restaurants?

Rarely (less than once/month) ☐ 1
Sporadically (between once/week and once/month) ☐ 2
Occasionally (about once/week) ☐ 3
Moderately (2–3 times/week) ☐ 4
Frequently (4 or plus times/week) ☐ 5

When going to restaurants, what kind of establishments do you prefer? (you can choose more than one option)

Portuguese traditional food ☐ 1
Ethnic food (Chinese, Italian, Mexican, Indian, etc . . .) ☐ 2
Gourmet ☐ 3
Convenience food (fast-food) ☐ 4
No preference ☐ 5
Other ☐6 Which: _____6.a

How often do you travel abroad?

Never ☐ 1
Rarely (about once/year) ☐ 2
Occasionally (about 2–3 times/years) ☐ 3
Frequently (more than 3 times/year) ☐ 4

When traveling abroad, you prefer the type of food you consume?

Typical food from the country visited ☐ 1
Food as similar as possible to Portuguese cuisine ☐ 2
International food (types of food commonly spread around the world) ☐ 3

III. PERCEPTIONS ABOUT EDIBLE INSECTS AND DERIVATIVES

Please indicate, on the scale between Strongly Disagree and Strongly Agree, your opinion on the following information

	Totally Disagree	←		→	**Totally Agree**	**No Opinion**
There are more than 2000 species of insects that are consumed by humans in the world	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Entomophagy is a dietary practice that consists of the consumption of insects by humans	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Some insects can be used to produce animal feed	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
There are flours for human food produced from insects	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
There is no consumption of insects in developed countries (INV)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
In some European gourmet restaurants it is practice to use edible insects	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Insects are part of the gastronomic culture of most countries in the world	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Insect consumption is characteristic of less developed countries	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Not all insects are edible	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
In Portugal there are regulations to ensure food safety in the case of edible insects (INV)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Insects are used by some people in traditional medicine	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0

IV. KNOWLEDGE ABOUT EDIBLE INSECTS AND SUSTAINABILITY

Please indicate, on the scale between Strongly Disagree and Strongly Agree, your opinion on the following information

	Totally Disagree	←		→	**Totally Agree**	**No Opinion**
Insects are a possibility to respond to the growing world demand for protein	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
The production of insects for human consumption emits about 10 times less greenhouse gases than the production of beef	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Insects efficiently convert organic matter into protein	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
To produce 1 kg of insect protein, it takes 5 times less food than to produce 1 kg of cow protein	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
To produce 1 kg of chicken protein, 5 times less water is used than to produce 1 kg of insect protein (INV)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
To produce 1 kg of insect protein requires an area 3 times smaller than to produce 1 kg of pig protein	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
The ecological footprint of insects is comparatively smaller when compared to other sources of protein for human consumption	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0

V. KNOWLEDGE ABOUT NUTRITIVE PROPERTIES OF EDIBLE INSECTS

Please indicate, on the scale between Strongly Disagree and Strongly Agree, your opinion on the following information

	Totally Disagree				**Totally Agree**	**No Opinion**
Edible insects are a good source of energy	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Edible insects are poor in macro and micronutrients (INV)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Edible insects contain group B vitamins	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Edible insects are very rich in animal protein	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Insect proteins are of poorer quality compared to other animal species (INV)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Edible insects contain minerals of nutritional interest, such as calcium, iron and magnesium	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Edible insects contain fat, including polyunsaturated fatty acids.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Edible insects contain bioactive compounds beneficial to human health	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Edible insects contain anti-nutrients, such as oxalates and phytic acid	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Some edible insects have a proven antioxidant effect	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0
Some edible insects may have anti-inflammatory activity	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 0

VI. ATTITUDES REGARDING EDIBLE INSECTS AND DERIVATIVES

Have you ever consumed insects or derived products?

Yes ☐ 1 No ☐ 2 I don't know/don't remember ☐ 3

Under what circumstances did you consume insects or derived products?

a. In Portugal ☐ 1 Abroad ☐ 2

b. In a restaurant☐ 1 In a hotel ☐ 2 On the street ☐ 3

At home ☐ 4 In the house of friends/family ☐ 5 In parties ☐ 6

c. By my own initiative ☐ 1 Encouraged by friends ☐ 2

Advised by restaurant professionals ☐ 3

Other ☐ 4 Which:_____4.a

Have you ever bought food containing insects?

Yes ☐ 1 No ☐ 2 I don't know/don't remember ☐ 3

If you have already bought food containing insects, where did you get them?

Supermarket ☐ 1 Internet ☐ 2 Specialized shop ☐ 3

Street market ☐ 4 Other ☐ 5 Which:_____ _____5.a

What is your acceptability to consume products that contain insect derivatives in their ingredients (e.g., snacks with insect meal)?

Definitely Would Not Eat				**Definitely Would Eat**
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

What is your acceptability to consume dishes made with whole insects?

Definitely Would Not Eat ⟷				Definitely Would Eat
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

What are the motivations that may encourage you to consume foods based on edible insects?

	Very Week Motivation ⟷			Very Strong Motivation
Being a more sustainable alternative	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Wanting to try exotic foods	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Contribute to the preservation of the environment and natural resources	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Contribute to the diversification of food production	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Contribute to increasing the income of families that can produce them	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Follow trends/innovative fashions of personalities/influencers	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Possibility of having protein foods at cheap prices	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

References

1. Ordoñez-Araque, R.; Egas-Montenegro, E. Edible Insects: A Food Alternative for the Sustainable Development of the Planet. *Int. J. Gastron. Food Sci.* **2021**, *23*, 100304. [CrossRef]
2. Krishnan, R.; Yen, P.; Agarwal, R.; Arshinder, K.; Bajada, C. Collaborative Innovation and Sustainability in the Food Supply Chain- Evidence from Farmer Producer Organisations. *Resour. Conserv. Recycl.* **2021**, *168*, 105253. [CrossRef]
3. Thapa Karki, S.; Bennett, A.C.T.; Mishra, J.L. Reducing Food Waste and Food Insecurity in the UK: The Architecture of Surplus Food Distribution Supply Chain in Addressing the Sustainable Development Goals (Goal 2 and Goal 12.3) at a City Level. *Ind. Mark. Manag.* **2021**, *93*, 563–577. [CrossRef]
4. Runyan, C.W.; Stehm, J. Land Use Change, Deforestation and Competition for Land Due to Food Production. In *Encyclopedia of Food Security and Sustainability*; Ferranti, P., Berry, E.M., Anderson, J.R., Eds.; Elsevier: Oxford, UK, 2019; pp. 21–26. ISBN 978-0-12-812688-2.
5. Theurl, M.C.; Lauk, C.; Kalt, G.; Mayer, A.; Kaltenegger, K.; Morais, T.G.; Teixeira, R.F.M.; Domingos, T.; Winiwarter, W.; Erb, K.-H.; et al. Food Systems in a Zero-Deforestation World: Dietary Change Is More Important than Intensification for Climate Targets in 2050. *Sci. Total Environ.* **2020**, *735*, 139353. [CrossRef] [PubMed]
6. Haque, M.M.; Biswas, J.C. Emission Factors and Global Warming Potential as Influenced by Fertilizer Management for the Cultivation of Rice under Varied Growing Seasons. *Environ. Res.* **2021**, *197*, 111156. [CrossRef] [PubMed]
7. Zhuang, M.; Shan, N.; Wang, Y.; Caro, D.; Fleming, R.M.; Wang, L. Different Characteristics of Greenhouse Gases and Ammonia Emissions from Conventional Stored Dairy Cattle and Swine Manure in China. *Sci. Total Environ.* **2020**, *722*, 137693. [CrossRef] [PubMed]
8. McMichael, A.J.; Powles, J.W.; Butler, C.D.; Uauy, R. Food, Livestock Production, Energy, Climate Change, and Health. *Lancet* **2007**, *370*, 1253–1263. [CrossRef]
9. Halloran, A.; Roos, N.; Eilenberg, J.; Cerutti, A.; Bruun, S. Life Cycle Assessment of Edible Insects for Food Protein: A Review. *Agron. Sustain. Dev.* **2016**, *36*, 57. [CrossRef] [PubMed]
10. Huis, A. Potential of Insects as Food and Feed in Assuring Food Security. *Annu. Rev. Entomol.* **2013**, *58*, 563–583. [CrossRef]
11. Huis, A.; Itterbeeck, J.V.; Klunder, H.; Mertens, E.; Halloran, A.; Muir, G.; Vantomme, P. *Edible Insects: Future Prospects for Food and Feed Security*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2013.
12. Nelson, G.C.; Rosegrant, M.W.; Koo, J.; Robertson, R.; Sulser, T.; Zhu, T.; Ringler, C.; Msangi, S.; Palazzo, A.; Batka, M.; et al. *Climate Change: Impact on Agriculture and Costs of Adaptation*; International Food Policy Research Institute: Washington, DC, USA, 2009.
13. Ramos-Elorduy, J. Energy Supplied by Edible Insects from Mexico and Their Nutritional and Ecological Importance. *Ecol. Food Nutr.* **2008**, *47*, 280–297. [CrossRef]
14. Smil, V. Eating Meat: Evolution, Patterns, and Consequences. *Popul. Dev. Rev.* **2002**, *28*, 599–639. [CrossRef]

15. Florença, S.G.; Correia, P.M.R.; Costa, C.A.; Guiné, R.P.F. Edible Insects: Preliminary Study about Perceptions, Attitudes, and Knowledge on a Sample of Portuguese Citizens. *Foods* **2021**, *10*, 709. [CrossRef] [PubMed]
16. Dupont, J.; Fiebelkorn, F. Attitudes and Acceptance of Young People toward the Consumption of Insects and Cultured Meat in Germany. *Food Qual. Prefer.* **2020**, *85*, 103983. [CrossRef]
17. Gahukar, R.T. Edible Insects Collected from Forests for Family Livelihood and Wellness of Rural Communities: A Review. *Glob. Food Secur.* **2020**, *25*, 100348. [CrossRef]
18. Kunatsa, Y.; Chidewe, C.; Zvidzai, C.J. Phytochemical and Anti-Nutrient Composite from Selected Marginalized Zimbabwean Edible Insects and Vegetables. *J. Agric. Food Res.* **2020**, *2*, 100027. [CrossRef]
19. Cappelli, A.; Cini, E.; Lorini, C.; Oliva, N.; Bonaccorsi, G. Insects as Food: A Review on Risks Assessments of Tenebrionidae and Gryllidae in Relation to a First Machines and Plants Development. *Food Control* **2020**, *108*, 106877. [CrossRef]
20. Guiné, R.P.F.; Correia, P.; Coelho, C.; Costa, C.A. The Role of Edible Insects to Mitigate Challenges for Sustainability. *Open Agric.* **2021**, *6*, 24–36. [CrossRef]
21. Baiano, A. Edible Insects: An Overview on Nutritional Characteristics, Safety, Farming, Production Technologies, Regulatory Framework, and Socio-Economic and Ethical Implications. *Trends Food Sci. Technol.* **2020**, *100*, 35–50. [CrossRef]
22. Sidali, K.L.; Pizzo, S.; Garrido-Pérez, E.I.; Schamel, G. Between Food Delicacies and Food Taboos: A Structural Equation Model to Assess Western Students' Acceptance of Amazonian Insect Food. *Food Res. Int.* **2019**, *115*, 83–89. [CrossRef]
23. Orsi, L.; Voege, L.L.; Stranieri, S. Eating Edible Insects as Sustainable Food? Exploring the Determinants of Consumer Acceptance in Germany. *Food Res. Int.* **2019**, *125*, 108573. [CrossRef] [PubMed]
24. Megido, R.C.; Gierts, C.; Blecker, C.; Brostaux, Y.; Haubruge, É.; Alabi, T.; Francis, F. Consumer Acceptance of Insect-Based Alternative Meat Products in Western Countries. *Food Qual. Prefer.* **2016**, *52*, 237–243. [CrossRef]
25. Trichopoulou, A. Mediterranean Diet as Intangible Heritage of Humanity: 10 Years On. *Nutr. Metab. Cardiovasc. Dis.* **2021**. [CrossRef]
26. Guiné, R.P.F.; Florença, S.G.; Villalobos Moya, K.; Anjos, O. Edible Flowers, Old Tradition or New Gastronomic Trend: A First Look at Consumption in Portugal versus Costa Rica. *Foods* **2020**, *9*, 977. [CrossRef] [PubMed]
27. Guiné, R.P.F.; Florença, S.G.; Barroca, M.J.; Anjos, O. The Link between the Consumer and the Innovations in Food Product Development. *Foods* **2020**, *9*, 1317. [CrossRef] [PubMed]
28. Triola, M.F.; Flores, V.R.L.F. *Instrodução ÀEstatística*, 12th ed.; LTC: Rio de Janeiro, Brasil, 2017.
29. Levin, J.; Fox, J.A. *Estatística Para Ciências Humanas*, 9th ed.; Pearson: Rio de Janeiro, Brasil, 2004.
30. Fundação Francisco Manuel dos Santos: PORDATA—Base de Dados Portugal Contemporâneo. Available online: https://www.pordata.pt/Home (accessed on 10 December 2020).
31. Cochran, W.G. *Sampling Techniques*, 3rd ed.; John Wiley & Sons: New York, NY, USA, 1977.
32. Levine, D.M.; Stephan, D.F.; Krehbiel, T.C.; Berenson, M.L. *Estatistica Teoria e Aplicacoes Usando o Microsoft Excel em Portugues*, 5th ed.; LTC: Rio de Janeiro, Brasil, 2008; ISBN 978-85-216-1634-4.
33. Witten, R.; Witte, J. *Statistics*, 9th ed.; Wiley: New Jersey, NJ, USA, 2009.
34. Broen, M.P.G.; Moonen, A.J.H.; Kuijf, M.L.; Dujardin, K.; Marsh, L.; Richard, I.H.; Starkstein, S.E.; Martinez-Martin, P.; Leentjens, A.F.G. Factor Analysis of the Hamilton Depression Rating Scale in Parkinson's Disease. *Parkinsonism Relat. Disord.* **2015**, *21*, 142–146. [CrossRef] [PubMed]
35. Tanaka, K.; Akechi, T.; Okuyama, T.; Nishiwaki, Y.; Uchitomi, Y. Development and Validation of the Cancer Dyspnoea Scale: A Multidimensional, Brief, Self-Rating Scale. *Br. J. Cancer* **2000**, *82*, 800–805. [CrossRef] [PubMed]
36. Dolnicar, S. A Review of Data-Driven Market Segmentation in Tourism. *Fac. Commer.-Pap.* **2002**, *12*, 1–22. [CrossRef]
37. Guiné, R.P.F.; Florença, S.G.; Ferrão, A.C.; Bizjak, M.Č.; Vombergar, B.; Simoni, N.; Vieira, V. Factors Affecting Eating Habits and Knowledge of Edible Flowers in Different Countries. *Open Agric.* **2021**, *6*, 67–81. [CrossRef]
38. Stevens, J.P. *Applied Multivariate Statistics for the Social Sciences*, 5th ed.; Routledge: New York, NY, USA, 2009; ISBN 978-0-8058-5903-4.
39. Hair, J.F.H.; Black, W.C.; Babin, B.J.; Anderson, R.E. *Multivariate Data Analysis*, 7th ed.; Prentice Hall: Hoboken, NJ, USA, 2009; ISBN 978-0-13-813263-7.
40. Maroco, J.; Garcia-Marques, T. Qual a fiabilidade do alfa de Cronbach? Questões antigas e soluções modernas? *Lab. Psicol.* **2006**, *4*, 65–90. [CrossRef]
41. Davis, F.B. *Educational Measurements Their Interpretation*; Wadsworth Pub. Co.: Belmont, CA, USA, 1964.
42. Cicatiello, C.; De Rosa, B.; Franco, S.; Lacetera, N. Consumer Approach to Insects as Food: Barriers and Potential for Consumption in Italy. *Br. Food J.* **2016**, *118*, 2271–2286. [CrossRef]
43. Schösler, H.; de Boer, J.; Boersema, J.J. Can We Cut out the Meat of the Dish? Constructing Consumer-Oriented Pathways towards Meat Substitution. *Appetite* **2012**, *58*, 39–47. [CrossRef]
44. House, J. Consumer Acceptance of Insect-Based Foods in the Netherlands: Academic and Commercial Implications. *Appetite* **2016**, *107*, 47–58. [CrossRef]
45. Gallen, C.; Pantin-Sohier, G.; Peyrat-Guillard, D. Familiarisation et diffusion de l'entomophagie en France. *Innovations* **2021**, *64*, 153–182. [CrossRef]
46. Huis, A. Insects as Food and Feed, a New Emerging Agricultural Sector: A Review. *J. Insects Food Feed* **2020**, *6*, 27–44. [CrossRef]

47. La Barbera, F.; Verneau, F.; Amato, M.; Grunert, K. Understanding Westerners' Disgust for the Eating of Insects: The Role of Food Neophobia and Implicit Associations. *Food Qual. Prefer.* **2018**, *64*, 120–125. [CrossRef]
48. Hartmann, C.; Siegrist, M. Consumer Perception and Behaviour Regarding Sustainable Protein Consumption: A Systematic Review. *Trends Food Sci. Technol.* **2017**, *61*, 11–25. [CrossRef]
49. Ritchey, P.N.; Frank, R.A.; Hursti, U.-K.; Tuorila, H. Validation and Cross-National Comparison of the Food Neophobia Scale (FNS) Using Confirmatory Factor Analysis. *Appetite* **2003**, *40*, 163–173. [CrossRef]
50. Martins, Y.; Pliner, P. Human Food Choices: An Examination of the Factors Underlying Acceptance/Rejection of Novel and Familiar Animal and Nonanimal Foods. *Appetite* **2005**, *45*, 214–224. [CrossRef]
51. Verbeke, W. Profiling Consumers Who Are Ready to Adopt Insects as a Meat Substitute in a Western Society. *Food Qual. Prefer.* **2015**, *39*, 147–155. [CrossRef]
52. Gere, A.; Székely, G.; Kovács, S.; Kókai, Z.; Sipos, L. Readiness to Adopt Insects in Hungary: A Case Study. *Food Qual. Prefer.* **2017**, *59*, 81–86. [CrossRef]
53. Srivastava, S.; Babu, N.; Pandey, H. Traditional Insect Bioprospecting—As Human Food and Medicine. *Indian J. Tradit. Knowl.* **2009**, *8*, 485–494.
54. Lensvelt, E.J.S.; Steenbekkers, L.P.A. Exploring Consumer Acceptance of Entomophagy: A Survey and Experiment in Australia and the Netherlands. *Ecol. Food Nutr.* **2014**, *53*, 543–561. [CrossRef] [PubMed]
55. Elorinne, A.-L.; Niva, M.; Vartiainen, O.; Väisänen, P. Insect Consumption Attitudes among Vegans, Non-Vegan Vegetarians, and Omnivores. *Nutrients* **2019**, *11*, 292. [CrossRef]
56. Cunha, L.M.; Ribeiro, J.C. Sensory and Consumer Perspectives on Edible Insects. In *Edible Insects in the Food Sector: Methods, Current Applications and Perspectives*; Sogari, G., Mora, C., Menozzi, D., Eds.; Springer International Publishing: Verlag, Germany, 2019; pp. 57–71. ISBN 978-3-030-22522-3.
57. Cunha, L.M.; Moura, A.P.; Costa-Lima, R. Consumers' associations with insects in the context of food consumption: Comparisons from acceptors to disgusted. In *Book of Abstracts of the 1st International Conference: Insects to Feed the World (14–17 May 2014)*; Wageningen University: Wageningen, The Netherlands, 2014; p. 108.
58. Cunha, L.M.; Gonçalves, A.T.S.; Varela, P.; Hersleth, M.; Neto, E.M.; Grabowski, N.T.; House, J.; Santos, P.; Moura, A.P. Adoption of insects as a source for food and feed production: A cross-cultural study on determinants of acceptance. In *Book of Abstracts of the 11th Pangborn Sensory Science Symposium (23–27 August 2015)*; European Sensory Science Society: Gothenburg, Sweden, 2015; p. [O.10.06]: 1-1.
59. Guiné, R.P.F.; Bartkiene, E.; Florença, S.G.; Djekić, I.; Bizjak, M.Č.; Tarcea, M.; Leal, M.; Ferreira, V.; Rumbak, I.; Orfanos, P.; et al. Environmental Issues as Drivers for Food Choice: Study from a Multinational Framework. *Sustainability* **2021**, *13*, 2869. [CrossRef]
60. Rodriguez-Oliveros, M.G.; Bisogni, C.A.; Frongillo, E.A. Knowledge about Food Classification Systems and Value Attributes Provides Insight for Understanding Complementary Food Choices in Mexican Working Mothers. *Appetite* **2014**, *83*, 144–152. [CrossRef]
61. Machovina, B.; Feeley, K.J. Livestock: Limit Red Meat Consumption. *Nature* **2014**, *508*, 186. [CrossRef] [PubMed]
62. Bukkens, S.G.F. Insects in the human diet: Nutritional aspects. In *Ecological Implications of Minilivestock; Role of Rodents, Frogs, Snails, and Insects for Sustainable Development*; Science Publishers—CRC Press Group: Boca Raton, FL, USA, 2005; pp. 545–577.
63. Lee, K.P.; Simpson, S.J.; Wilson, K. Dietary Protein-Quality Influences Melanization and Immune Function in an Insect. *Funct. Ecol.* **2008**, *22*, 1052–1061. [CrossRef]
64. Kouřimská, L.; Adámková, A. Nutritional and Sensory Quality of Edible Insects. *NFS J.* **2016**, *4*, 22–26. [CrossRef]
65. Roininen, H.; Ohgushi, T.; Zinovjev, A.; Virtanen, R.; Vikberg, V.; Matsushita, K.; Nakamura, M.; Price, P.; Veteli, T. Latitudinal and Altitudinal Patterns in Species Richness and Mortality Factors of the Galling Sawflies on Salix Species in Japan. In *Galling Arthropods and Their Associates: Ecology and Evolution*; Springer: Tokyo, Japan, 2006; pp. 3–19.
66. Arsil, P.; Li, E.; Bruwer, J.; Lyons, G. Exploring Consumer Motivations towards Buying Local Fresh Food Products: A Means-End Chain Approach. *Br. Food J.* **2014**, *116*, 1533–1549. [CrossRef]