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Are Consumers Aware of Sustainability Aspects Related to Edible Insects? Results from a Study Involving 14 Countries

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Abstract: In recent years, edible insects have been suggested as an alternative food that is more sustainable compared with other sources of animal protein. However, knowledge about the sustainability aspects associated with this source of food may play a role in convincing consumers to adopt insects as part of their diet. In this context, the present study investigated the level of knowledge about the sustainability of edible insects in a group of people originating from 14 countries, with some naturally entomophagous and others not. To measure the knowledge, 11 items were selected and the scores obtained were tested with statistical tools (*t*-test for independent samples, analysis of variance—ANOVA) to search for differences according to sociodemographic and socioeconomic characteristics, geographical origin, and consumption habits of edible insects. The obtained results showed that, in general, knowledge is moderate, with the values of the average scores for the 11 items investigated ranging from 0.23 ± 0.99 to 0.66 ± 1.02, on a scale ranging from -2 (=very low knowledge) to 2 (=very high knowledge). The highest scores were found for items relating to the lower use of animal feed and lower emission of greenhouse gases required for the production of insects compared with beef. When investigating the differences between groups of participants, significant differences were generally found, revealing a trend for higher knowledge among males and young adults, for participants residing in urban areas and in countries such as Spain, Mexico, and Poland, and for participants with higher education levels and higher incomes. When testing the influence of consumption variables on the level of knowledge, the results showed a higher knowledge for participants who had already consumed insects or are willing to consume them. Finally, it was observed that higher knowledge was found for participants whose motivation to consume insects

Citation: Guiné, R.P.F.; Florença, S.G.; Anjos, O.; Boustani, N.M.; Chuck-Hernández, C.; Sarić, M.M.; Ferreira, M.; Costa, C.A.; Bartkiene, E.; Cardoso, A.P.; et al. Are Consumers Aware of Sustainability Aspects Related to Edible Insects? Results from a Study Involving 14 Countries. *Sustainability* **2022**, *14*, 14125. https://doi.org/10.3390/su142114125

Academic Editor: Marian Rizov

Received: 29 September 2022
Accepted: 26 October 2022
Published: 29 October 2022

related to curiosity, a wish to preserve the planet, the gastronomic characteristics of insects, and their nutritional value. In conclusion, these results clearly indicate a very marked influence of a number of variables on the knowledge about the sustainability of edible insects, and this may be helpful to delineate strategies to effectively raise knowledge and eventually increase the willingness to consider insects as a more sustainable alternative to partially replace other protein foods, even in countries where this is a not a traditional practice.

Keywords: edible insects; minimize waste; sustainability; sociodemographic characteristics; socioeconomic variables; country differences; motivation

1. Introduction

The rate of increase in the world's population and the consequent higher demand for food has led to a high degree of unsustainable agricultural practices across the planet [1–3]. These practices include the production of foods of both vegetable and animal origin. The consequences of these practices are reflected by the degradation of natural habitats, loss of biodiversity, extensive use of natural resources including water, impoverishment of soils, deforestation, and emission of gases with a greenhouse effect [4–6]. These factors have a direct and pronounced impact on climate change and the quality of life on Earth, and need to be rethought [7].

It is more or less consensual that one of the factors that greatly contributes to this problem resides in the intensive meat production aimed at satisfying the needs and desires of a great number of consumers worldwide, although there is debate regarding the fact that vegetable production, when too intensive, can also have a similar impact on ecosystems [8]. Either way, there is an urgent need to find more sustainable ways to produce, transform, and transport foods, diminishing their ecological impact across the whole food chain from production to the discarding of waste and packaging [9–11].

Regarding the need to supply protein-based foods to satisfy the world demand, it has been suggested that insects can have a role in partially replacing other more conventional sources of protein, especially those with the highest impact, which are bovines [8,12–14]. In this way, insects and insect-based foods arise as meat alternatives that have a considerable lower environmental impact [15,16]. The production of insects generates fewer greenhouse gas emissions and ammonia, and requires significantly less feed, land, and water than conventional livestock. Additionally, the consumption of insects could importantly increase world food security, mitigating hunger in lower socioeconomic communities [17–19].

A wide range of edible insect species, more than 2000, are available for human consumption. They are consumed by more than 2 billion people in 130 countries, predominantly in sub-Saharan Africa, Central and South America, Southeast Asia, and the Pacific. Figure 1 shows, as an example, some of the common insects consumed around the world [8,20]. Edible insects are classified as: (a) Butterflies and moths (Order Lepidoptera); (b) True bugs (Order Hemiptera); (c) Cicadas (Order Homoptera); (d) Termites (Order Isoptera); (e) Bees, ants and wasps (Order Hymenoptera); (f) Beetles (Order Coleoptera); (g) Grasshoppers, crickets, etc. (Order Orthoptera); (h) Spiders and scorpions (Class Arachnida); (i) Walking stick and leaf insects (Order Phasmatodea) [21].

Since 2033, the FAO (Food and Agriculture Organization of the United Nations), recognizing the challenges of supplying food to an increasing number of people, while diminishing the pressure on ecosystems and natural resources, has been actively promoting actions to incentivize the production and consumption of insects worldwide, while providing knowledge that helps consumers to make more informed food decisions. In the European Union Market, the Novel Food Regulation establishes the legal framework for the introduction of innovative foods into the EU while guaranteeing food safety to protect consumers. Under this legal framework, some insects have been approved as Novel Foods, with the most recent being the cricket [22,23].

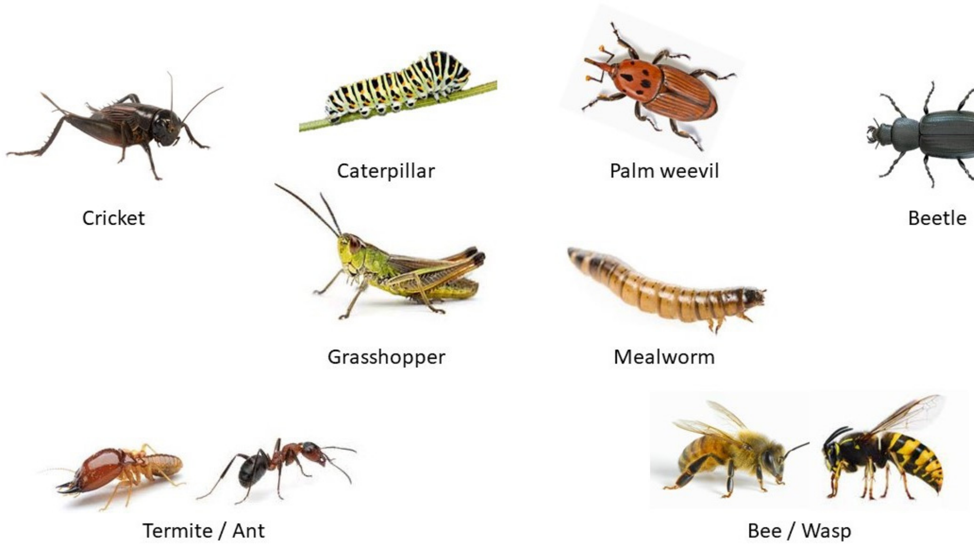


Figure 1. Some of the world's common edible insects.

Insects possess an interesting range of nutritive and bioactive properties. The nutritional quality of edible insects is reported as being equivalent, and sometimes superior, to foods derived from more conventional sources of protein such as birds and mammals [24]. Insects have high content in macronutrients such as protein, fat and fiber, and micronutrients including vitamins and dietary minerals [18,25,26]. Lucas et al. [18] reported that edible insects possess interesting nutritional value. As an example, a single dose of 100 g of caterpillars accounts for more than three quarters of the recommended daily intake of protein and practically the full amount of the recommended daily intake of vitamins. Additionally, caterpillars provide dietary minerals, including, for example, three times the daily recommended dosage of iron [18]. Anaduaka et al. [27] reported on the nutritional value of two edible insects, the palm beetle and the grasshopper. The results indicated that protein contents ranging between 31–35%, lipids between 10–20%, fiber between 9–22%, carbohydrates between 5–10%, and ash approximately 10%. They found these insects to be rich in calcium, magnesium, phosphorus, potassium, sodium, iron, zinc, and selenium [27].

Although consumers are becoming more alert to the environmental impact of their diets and tend to adapt their food choices according to more sustainable diets [27–30], it is also an unquestionable fact that there are a great number of consumers, especially in western societies, to whom the practice of entomophagy is not readily accepted. Behind these barriers can be cultural factors as well personal traits and preferences. While insects are frequently eaten in many regions across the globe, their consumption is associated with feelings of disgust, with a precarious lifestyle, and primitive behavior in many Western countries [24,31,32].

Considering the role of the consumer in the adoption of more sustainable diets with protein foods based on insects, the present study explored the degree of knowledge about the sustainability of edible insects in a group of people originating from 14 countries, some of them without a tradition of insect consumption and others where entomophagy is an accepted practice. The knowledge was then investigated in relation to the participants' sociodemographic and socioeconomic characteristics, geographical origin, and consumption habits of edible insects.

2. Materials and Methods

2.1. Instrument and Data Collection

This research was based on a questionnaire survey, using an instrument that was constructed in the ambit of the EISuFood Project which aimed to study various domains related to insect consumption, namely: characterization of habits, culture and tradition, gastronomic innovation and gourmet kitchen, nutritional aspects, health effects, environment and sustainability, social and economic aspects, and commercialization and marketing. This paper addresses one of the domains investigated in the project—environmental and sustainability issues—in relation to insect consumption in the group of countries participating in the project. The 11 items included in the questionnaire to investigate this problem were:

It1. Insects are a more sustainable alternative compared with other sources of animal protein.
It2. Insect production for human consumption emits fewer greenhouse gases than beef production.
It3. Insects efficiently convert organic matter into protein.
It4. The production of insect protein uses considerably less feed than beef protein.
It5. Insects are a possibility for responding to the growing world demand for protein.
It6. The production of poultry protein requires much less water than insect protein.
It7. The ecological footprint (impact) of insects is smaller compared with other animal proteins.
It8. The production of insect protein requires much more area than pork protein.
It9. Insects are collected as a means of pest control for some cultivated crops.
It10. The loss of biodiversity is lower with insect production compared with other animal food production.
It11. The energy input needed for the production of insect protein is lower than for the production of other proteins from animal origin.

The participants had to express their agreement on a central five-point Likert scale as follows: 1 = strongly disagree, 2 = disagree, 3 = no opinion, 4 = agree, 5 = strongly agree [33]. While most of the items were given as true statements, some were false (items 6 and 8) to evaluate the capability of the respondents to identify false information.

2.2. Data Collection

This is a descriptive cross-sectional study undertaken on a non-probabilistic sample of 7221 participants from 14 countries, as follows: Brazil (n = 322), Croatia (n = 686), Greece (n = 636), Latvia (n = 300), Lebanon (n = 357), Lithuania (n = 510), Mexico (n = 1139), Poland (n = 520), Portugal (n = 527), Romania (n = 492), Serbia (n = 344), Slovenia (n = 517), Spain (n = 575), and Turkey (n = 296). All ethical principles were strictly followed when designing the questionnaire and collecting data, especially those of the Declaration of Helsinki. The Ethics Committee of the Polytechnic Institute of Viseu approved this questionnaire survey with reference 45/SUB/2021.

Data were collected between July and November 2021, using a computer/web-based methodology. The questionnaire was delivered through the electronic platform Google Forms, under the restrictions caused by the COVID-19 pandemic. A link to participate in the survey was sent to all participants, who had access to the questionnaire in their own native language after translation following a back-translation process from the English version delivered to all research teams in each of the participating countries. Recruitment was achieved using email and social media, and followed a snowball methodology in each of the participating countries, given that this is a particularly effective methodology for data collection, under special research constraints [34]. Only adult citizens (aged 18 years old or over) who had expressed their informed consent were allowed access to the questionnaire to participate in the survey.

2.3. Statistical Analysis

The software used for the statistical analysis was SPSS Version 28 from IBM, Inc. (Armonk, NY, USA). Basic descriptive statistics were used and statistical tests were used to test differences between groups of variables. Parametric tests were used because they are stronger and more powerful than their non-parametric counterparts. In the present case, the high number of cases allowed obtaining data that presented a normal distribution (according to the Kolmogorov–Smirnov test), thus making it possible to use parametric tests. The tests used were the *t*-test for independent samples and Analysis of Variance—ANOVA, with a post hoc test of Tukey to identify the differences. In all tests, a significance level of 5% was considered ($p < 0.05$).

3. Results

3.1. Sample Characterization

The participants' ages varied from a minimum of 18 to a maximum of 88 years, being on average 34.7 ± 13.7 years and similar for both sexes (34.5 ± 13.4 and 35.2 ± 14.1 years for women and men, respectively). The participants were classified into age groups as follows: young adults (aged between 18 and 30 years) representing 47.4%, adults (aged between 31 and 50 years) representing 37.0%, and senior adults (aged 51 or over) accounting for 15.6% of participants.

The majority of participants were female (63.5%), with the number of male participants much smaller (35.9%), while there were 0.7% of participants who did not want to answer. Another variable investigated related to living environment, with 65.6% of the participants living in urban areas and a smaller percentage living in suburban (15.3%) or rural areas (19.1%). Income was also a variable in the study, with a question that related income to the average salary in each of the countries. For the participants in the study, when compared to the average income, 5.9% had a much lower income, 15.9% had a lower income, 38.1% had an equal income, 32.5% had a higher income, and 7.6% had a much higher income, in each of the countries.

Because the level of education is also relevant in this type of study, this question was also formulated, in a general way, to be representative across the different countries. The data showed that approximately one third of the participants were undergraduates, completed secondary or elementary school (35.8%), approximately a third (32.3%) had completed a university degree, and another third (31.9%) had completed post-graduate studies (Master or Doctoral degree).

3.2. Indices for Knowledge about Edible Insects

For each item in the questionnaire, an index was calculated of the mean value of the answers given by those participants who expressed an opinion (Table 1). This means that the participants who did not answer or chose the option "neither agree nor disagree" were not considered. For the calculation of the indices, variables that corresponded to false statements were previously reversed so that all variables were expressed on the same scale, as follows: −2 = very low knowledge, −1 = low knowledge, 1 = high knowledge, 2 = very high knowledge. The highest indices were observed for items It4, It2, and It5, and related to feed conversion ratios, emission of greenhouse gases, and insects as responding to the worldwide problem of hunger, respectively. The lowest indices were observed for items It8 and It6, with both corresponding to items that were reversed because they were presented to participants as false statements.

Table 1. Indices of the items for assessment of knowledge about edible insects' sustainability (Global number of participants, N = 7221).

Item Description	**n [1]**	**Indices [2] (Mean ± SD)**
It4. The production of insect protein uses considerably less feed than beef protein.	4769	0.66 ± 1.02
It2. Insect production for human consumption emits fewer greenhouse gases than beef production.	4820	0.66 ± 1.05
It5. Insects are a possibility for responding to the growing world demand for protein.	5117	0.62 ± 1.08
It11. The energy input needed for the production of insect protein is lower than for the production of other proteins from animal origin.	4407	0.55 ± 0.98
It3. Insects efficiently convert organic matter into protein.	4224	0.54 ± 0.97
It7. The ecological footprint (impact) of insects is smaller compared with other animal proteins.	4579	0.53 ± 1.03

Table 1. *Cont.*

Item Description	n [1]	Indices [2] (Mean ± SD)
It9. Insects are collected as a means of pest control for some cultivated crops.	4326	0.46 ± 0.99
It1. Insects are a more sustainable alternative compared with other sources of animal protein.	5108	0.44 ± 1.16
It10. The loss of biodiversity is lower with insect production compared with other animal food production.	3890	0.37 ± 0.96
It8. The production of insect protein requires much more area than pork protein. (Reversed)	4074	0.36 ± 1.07
It6. The production of poultry protein requires much less water than insect protein. (Reversed)	3552	0.23 ± 0.99

[1] Number of responses considered as expressing an opinion, obtained for each item. [2] Mean value ± standard deviation; Scale −2 = very low knowledge, −1 = low knowledge, 1 = high knowledge, 2 = very high knowledge.

3.3. Influence of Sociodemographic Variables on the Knowledge about Edible Insects

To calculate the mean values for all answers, the same assumptions that were indicated for the calculation of the indices were followed: the variables for items 6 and 8 were reversed and the measurement scale was adjusted so that the no answer corresponded to zero: −2 = very low knowledge, −1 = low knowledge, 1 = high knowledge, 2 = very high knowledge.

The results in Table 2 indicate that significant gender differences ($p < 0.05$) were encountered for items 1It1, It2, It3, It4, It10, and It11. In all cases, the mean value of the score was higher for women than for men, revealing a higher knowledge among women with respect to the sustainability of edible insects. In relation to age groups, significant differences were found for most items, with the exception of It6, It8, It9, and It10. The results indicate generally higher mean values for scores in younger adults and lower mean values for senior adults, which is consistent with a trend of decreasing knowledge as age increases.

Table 2. Knowledge about sustainability of edible insects according to sex and age.

	Mean Values and Significance of the Test [1]										
Variable/Group	**It1**	**It2**	**It3**	**It4**	**It5**	**It6**	**It7**	**It8**	**It9**	**It10**	**It11**
Sex											
Female	0.38 (1.14)	0.63 (1.03)	0.51 (0.94)	0.66 (0.98)	0.59 (1.04)	0.22 (0.96)	0.53 (0.99)	0.35 (1.04)	0.47 (0.96)	0.33 (0.93)	0.52 (0.94)
Male	0.52 (1.19)	0.70 (1.09)	0.59 (1.02)	0.66 (1.08)	0.67 (1.14)	0.24 (1.05)	0.54 (1.08)	0.37 (1.11)	0.43 (1.04)	0.43 (1.02)	0.61 (1.05)
p-value [2]	*<0.001*	*0.006*	*<0.001*	*0.912*	*0.002*	*0.422*	*0.811*	*0.419*	*0.068*	*<0.001*	*<0.001*
Age [3]											
Young adults	0.46 [b] (1.18)	0.70 [b] (1.07)	0.53 [ab] (0.99)	0.68 [b] (1.04)	0.63 [b] (1.10)	0.22 [a] (1.01)	0.56 [b] (1.04)	0.37 [a] (1.08)	0.46 [a] (0.99)	0.37 [a] (0.97)	0.58 [b] (0.99)
Adults	0.46 [b] (1.13)	0.64 [b] (1.03)	0.57 [b] (0.95)	0.66 [ab] (1.01)	0.64 [b] (1.04)	0.23 [a] (0.99)	0.52 [ab] (1.03)	0.35 [a] (1.07)	0.46 [a] (0.99)	0.36 [a] (0.96)	0.53 [a] (0.98)
Senior adults	0.28 [a] (1.18)	0.55 [a] (1.04)	0.49 [a] (0.95)	0.59 [a] (0.98)	0.54 [a] (1.08)	0.28 [a] (0.96)	0.47 [a] (0.99)	0.34 [a] (1.03)	0.43 [a] (1.01)	0.35 [a] (0.94)	0.52 [a] (0.96)
p-value [4]	*<0.001*	*<0.001*	*0.047*	*0.025*	*0.017*	*0.188*	*0.043*	*0.472*	*0.600*	*0.706*	*0.028*

[1] Mean value (standard deviation); Scale −2 = very low knowledge, −1 = low knowledge, 1 = high knowledge, 2 = very high knowledge; Significance of the test: $p < 0.05$. [2] *t*-test for independent samples. [3] Young adults: 18–30 years, Adults: 31–50 years, Senior adults: ≥51 years. [4] ANOVA with post hoc test of Tukey. Different letters in the same column correspond to statistically different mean values.

3.4. Influence of Geographic Variables on the Knowledge about Edible Insects

Table 3 show the results for the comparison of knowledge about sustainability of edible insects according to country and living environment. In Table 3, significant differences can be observed in the knowledge of participants from different countries for all 11 items in the study. Countries with the highest values for the knowledge score in a high number of items include Spain, Poland, Mexico, and Slovenia. On the other hand, countries with the lowest scores, and consequently lower knowledge, for a high number of items include Serbia, Croatia, Turkey, Greece, Latvia, and Lebanon. Considering a global score as the sum of the scores for all 11 items, Figure 2 reveals that the countries with a higher knowledge are, in decreasing order, Spain, Mexico, Poland, Slovenia, and Lithuania. On the other hand, countries with a lower score, in increasing order, include Serbia, Croatia, and Greece.

Table 3. Knowledge about sustainability of edible insects according to country and living environment.

	Mean Values and Significance of the Test [1]										
Variable/Group	**It1**	**It2**	**It3**	**It4**	**It5**	**It6**	**It7**	**It8**	**It9**	**It10**	**It11**
Country											
Brazil	0.45 [d] (1.16)	0.69 [efg] (0.97)	0.52 [cd] (0.90)	0.55 [bcd] (0.98)	0.58 [def] (1.02)	0.31 [bcde] (1.04)	0.59 [cd] (0.99)	0.45 [def] (1.14)	0.52 [efg] (0.94)	0.46 [de] (0.95)	0.64 [def] (0.96)
Croatia	−0.02 [ab] (1.14)	0.27 [ab] (1.07)	0.28 [ab] (0.94)	0.34 [ab] (1.01)	0.03 [a] (1.00)	0.20 [abcd] (0.92)	0.23 [ab] (0.97)	0.39 [cde] (1.02)	0.36 [bcde] (0.99)	0.20 [abc] (0.85)	0.26 [ab] (0.97)
Greece	−0.13 [a] (1.10)	0.45 [bcd] (0.93)	0.35 [abc] (0.86)	0.51 [bcd] (0.94)	0.32 [bc] (1.01)	0.13 [ab] (0.82)	0.39 [bc] (0.94)	0.21 [abc] (0.93)	0.20 [abc] (0.88)	0.19 [abc] (0.80)	0.36 [abc] (0.85)
Latvia	0.34 [cd] (1.03)	0.45 [bcd] (0.97)	0.45 [abcd] (0.77)	0.57 [cd] (0.81)	0.54 [cde] (0.87)	0.00 [a] (0.70)	0.37 [abc] (0.84)	0.28 [bcde] (0.76)	0.15 [ab] (0.78)	0.15 [ab] (0.76)	0.38 [abc] (0.79)
Lebanon	0.94 [f] (0.98)	0.88 [g] (0.96)	0.29 [ab] (0.86)	0.39 [abc] (0.89)	0.78 [fgh] (0.96)	0.06 [a] (0.77)	0.39 [bc] (0.87)	−0.01 [a] (0.81)	0.13 [a] (0.79)	0.80 [e] (0.88)	0.50 [cde] (0.98)
Lithuania	0.53 [d] (1.08)	0.80 [fg] (1.01)	0.43 [abcd] (1.11)	0.79 [ef] (1.00)	0.92 [hi] (0.95)	−0.01 [a] (1.03)	0.44 [bcd] (1.14)	0.46 [def] (1.05)	0.62 [g] (1.06)	0.57 [e] (1.04)	0.76 [f] (0.97)
Mexico	0.90 [f] (1.15)	0.88 [fg] (1.12)	0.89 [f] (1.02)	0.86 [efg] (1.14)	1.01 [i] (1.11)	0.17 [abc] (1.17)	0.86 [f] (1.10)	0.24 [bcd] (1.21)	0.59 [fg] (1.08)	0.59 [e] (1.10)	0.81 [f] (1.09)
Poland	0.56 [de] (1.01)	0.88 [g] (0.96)	0.78 [ef] (0.87)	1.03 [g] (0.90)	1.01 [hi] (0.90)	0.48 [ef] (0.97)	0.53 [cd] (0.98)	0.49 [efg] (1.13)	0.44 [defg] (0.91)	0.39 [cde] (0.88)	0.69 [ef] (0.86)
Portugal	0.46 [d] (1.10)	0.65 [def] (1.03)	0.48 [bcd] (0.95)	0.52 [bcd] (0.97)	0.57 [def] (1.01)	0.39 [cde] (0.96)	0.58 [cd] (0.99)	0.39 [cde] (1.05)	0.38 [cdef] (0.99)	0.18 [ab] (0.95)	0.52 [cde] (0.96)
Romania	0.13 [bc] (1.09)	0.51 [cde] (1.04)	0.43 [abcd] (0.91)	0.68 [de] (0.99)	0.39 [bcd] (1.06)	0.08 [a] (0.99)	0.51 [cd] (1.01)	0.19 [abc] (1.06)	0.53 [efg] (1.00)	0.27 [bcd] (0.97)	0.48 [cde] (0.98)
Serbia	0.05 [ab] (1.09)	0.19 [a] (1.03)	0.27 [a] (0.96)	0.23 [a] (0.99)	0.20 [ab] (1.07)	0.09 [a] (0.89)	0.15 [a] (1.07)	0.27 [bcde] (0.92)	0.29 [abcd] (0.96)	0.05 [a] (0.88)	0.18 [a] (0.92)
Slovenia	0.58 [de] (1.10)	0.84 [fg] (1.04)	0.62 [de] (0.95)	0.93 [fg] (0.95)	0.66 [efg] (1.07)	0.40 [de] (1.00)	0.62 [de] (1.00)	0.68 [fg] (1.07)	0.33 [abcde] (0.89)	0.31 [bcd] (0.89)	0.62 [def] (0.99)
Spain	0.78 [ef] (1.14)	0.90 [g] (1.08)	0.76 [ef] (1.01)	0.91 [efg] (1.04)	0.84 [ghi] (1.13)	0.64 [f] (1.06)	0.82 [ef] (1.01)	0.70 [g] (1.16)	1.03 [h] (1.03)	0.45 [de] (1.05)	0.69 [ef] (1.02)
Turkey	−0.01 [ab] (1.17)	0.37 [abc] (0.90)	0.41 [abc] (0.85)	0.44 [abc] (0.88)	0.26 [ab] (1.00)	0.08 [a] (0.82)	0.42 [bcd] (0.86)	0.13 [ab] (0.82)	0.40 [cdef] (0.85)	0.25 [abcd] (0.85)	0.46 [bcd] (0.87)
p-value [2]	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*
Living Environment											
Rural	0.36 [a] (1.15)	0.61 [a] (1.06)	0.44 [a] (0.97)	0.57 [a] (1.01)	0.52 [a] (1.06)	0.25 [a] (0.97)	0.46 [a] (1.00)	0.35 [a] (1.07)	0.42 [a] (0.98)	0.34 [a] (0.94)	0.50 [a] (0.97)
Urban	0.46 [b] (1.16)	0.67 [a] (1.05)	0.58 [b] (0.97)	0.69 [b] (1.02)	0.65 [b] (1.08)	0.22 [a] (1.00)	0.56 [b] (1.03)	0.36 [a] (1.06)	0.47 [a] (1.00)	0.37 [a] (0.97)	0.57 [a] (0.99)
Suburban	0.42 [ab] (1.16)	0.67 [a] (1.05)	0.50 [a] (0.97)	0.66 [b] (1.01)	0.60 [ab] (1.06)	0.23 [a] (1.01)	0.51 [ab] (1.04)	0.34 [a] (1.08)	0.44 [a] (0.99)	0.36 [a] (0.97)	0.56 [a] (0.98)
p-value [2]	*0.010*	*0.169*	*<0.001*	*<0.001*	*<0.001*	*0.643*	*0.006*	*0.789*	*0.147*	*0.547*	*0.100*

[1] Mean value (standard deviation); Scale −2 = very low knowledge, −1 = low knowledge, 1 = high knowledge, 2 = very high knowledge; Significance of the test: $p < 0.05$. [2] ANOVA with post hoc test of Tukey. Different letters in the same column correspond to statistically different mean values.

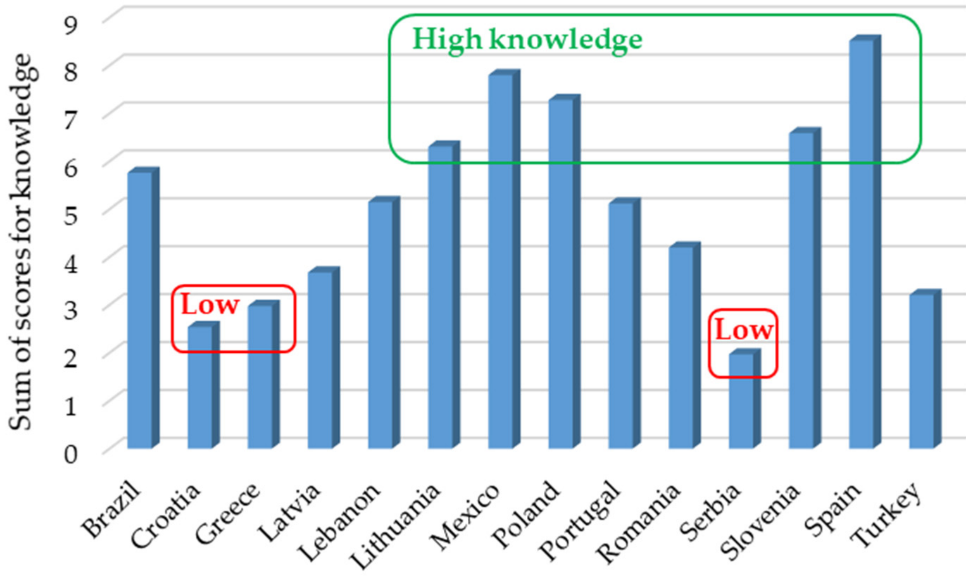


Figure 2. Global scores for knowledge about sustainability of edible insects, according to country.

With respect to living environment, the results in Table 3 show that the scores for knowledge were lowest for practically all items among participants who live in rural areas and highest for participants residing in urban areas.

3.5. Influence of Socioeconomic Variables on the Knowledge about Edible Insects

Table 4 presents the statistics of the tests in relation to knowledge about edible insects' sustainability according to education level and income. The results show that for groups of participants with different education levels, significant differences were found for all items except item It9 which related to the collection of insects as a means of pest control for some cultivated crops. Furthermore, the results indicate that the level of knowledge was significantly higher as the level of education increased. With respect to income, statistically significant differences were also found for all items except the same item It9. Moreover, in this case, a general trend was observed according to which the level of knowledge about sustainability issues related to edible insects increased as the income rose.

Table 4. Knowledge about sustainability of edible insects according to education level and income.

	Mean Values and Significance of the Test [1]										
Variable/Group	**It1**	**It2**	**It3**	**It4**	**It5**	**It6**	**It7**	**It8**	**It9**	**It10**	**It11**
Education level											
Post-graduate	0.50 [b] (1.10)	0.72 [b] (1.00)	0.63 [b] (0.91)	0.74 [c] (0.96)	0.74 [c] (1.09)	0.28 [b] (0.99)	0.60 [b] (0.98)	0.42 [b] (1.05)	0.48 [a] (0.96)	0.37 [ab] (0.93)	0.60 [b] (0.94)
University degree	0.48 [b] (1.17)	0.68 [b] (1.05)	0.52 [a] (0.98)	0.66 [b] (1.03)	0.64 [b] (1.07)	0.22 [ab] (1.00)	0.54 [b] (1.03)	0.31 [a] (1.07)	0.45 [a] (0.99)	0.41 [b] (0.97)	0.56 [ab] (1.00)
No university degree	0.33 [a] (1.20)	0.58 [a] (1.10)	0.48 [a] (1.01)	0.59 [a] (1.06)	0.48 [a] (1.11)	0.20 [a] (0.99)	0.47 [a] (1.06)	0.34 [a] (1.07)	0.44 [a] (1.02)	0.32 [a] (0.98)	0.51 [a] (1.01)
p-value [2]	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.024*	*<0.001*	*0.002*	*0.231*	*0.008*	*0.004*

Table 4. *Cont.*

	Mean Values and Significance of the Test [1]										
Variable/Group	**It1**	**It2**	**It3**	**It4**	**It5**	**It6**	**It7**	**It8**	**It9**	**It10**	**It11**
Income [3]											
Much lower	0.34 [a] (1.27)	0.59 [a] (1.15)	0.51 [a] (1.04)	0.57 [a] (1.12)	0.64 [ab] (1.13)	0.15 [a] (1.04)	0.50 [ab] (1.12)	0.25 [a] (1.08)	0.39 [a] (1.03)	0.33 [a] (1.00)	0.55 [a] (1.02)
Lower	0.43 [ab] (1.19)	0.62 [a] (1.07)	0.53 [a] (1.01)	0.62 [ab] (1.06)	0.59 [a] (1.12)	0.19 [ab] (0.99)	0.53 [ab] (1.05)	0.30 [ab] (1.09)	0.44 [a] (1.02)	0.36 [ab] (1.00)	0.55 [a] (1.01)
Equal	0.39 [a] (1.15)	0.62 [a] (1.05)	0.49 [a] (0.95)	0.62 [ab] (1.01)	0.56 [a] (1.06)	0.24 [ab] (0.95)	0.47 [a] (0.99)	0.39 [bc] (1.03)	0.45 [a] (0.99)	0.33 [a] (0.93)	0.52 [a] (0.97)
Higher	0.48 [ab] (1.13)	0.71 [ab] (1.02)	0.61 [b] (0.93)	0.74 [b] (0.96)	0.69 [ab] (1.03)	0.21 [ab] (1.01)	0.59 [ab] (1.02)	0.34 [ab] (1.07)	0.48 [a] (0.97)	0.40 [ab] (0.95)	0.57 [a] (0.96)
Much higher	0.56 [b] (1.21)	0.76 [b] (1.09)	0.60 [b] (1.05)	0.72 [b] (1.08)	0.73 [b] (1.16)	0.33 [b] (1.12)	0.62 [b] (1.13)	0.49 [c] (1.17)	0.48 [a] (1.00)	0.48 [b] (1.06)	0.71 [b] (1.07)
p-value [2]	*0.002*	*0.002*	*<0.001*	*<0.001*	*<0.001*	*0.026*	*<0.001*	*<0.001*	*0.483*	*0.007*	*<0.001*

[1] Mean value (standard deviation); Scale −2 = very low knowledge, −1 = low knowledge, 1 = high knowledge, 2 = very high knowledge; Significance of the test: $p < 0.05$. [2] ANOVA with post hoc test of Tukey. Different letters in the same column correspond to statistically different mean values. [3] In comparison with the average salary, considered as a reference in each of the participating countries.

3.6. Influence of Consumption Variables on the Knowledge about Edible Insects

Table 5 shows the results of the statistical tests in relation to knowledge according to some consumption variables. Considering the first question, asking if participants had already consumed edible insects, significant differences were found for practically all items, with the exception of items It6 and It8 (both given as false statements). These differences clearly indicate that participants who had previously consumed insects have much higher average scores for the items of knowledge compared with participants who have never consumed insects. Regarding the other question, answered only by those who do not eat insects on a regular basis, and which relates to the possibility of consuming insects in the future, the results show clear significant differences for all items of knowledge. Additionally, there is a trend showing that higher scores for knowledge are associated with a higher willingness to consume insects in the future.

Table 5. Knowledge about sustainability of edible insects according to consumption variables.

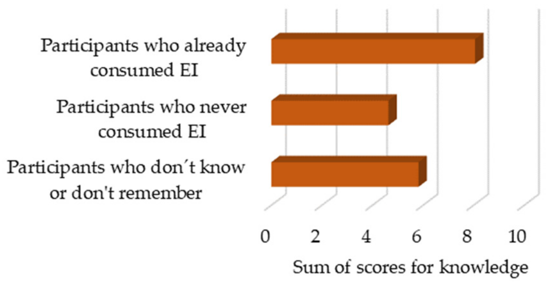
	Mean Values and Significance of the Test [1]										
Variable/Group	**It1**	**It2**	**It3**	**It4**	**It5**	**It6**	**It7**	**It8**	**It9**	**It10**	**It11**
Has already consumed edible insects											
Yes	0.87 [c] (1.11)	0.94 [c] (1.06)	0.87 [b] (0.99)	0.93 [b] (1.05)	1.00 [c] (1.04)	0.26 [a] (1.15)	0.82 [c] (1.07)	0.39 [a] (1.23)	0.60 [b] (1.06)	0.57 [c] (1.04)	0.81 [b] (1.03)
No	0.30 [a] (1.15)	0.57 [a] (1.04)	0.45 [a] (0.95)	0.59 [a] (1.00)	0.50 [a] (1.07)	0.22 [a] (0.95)	0.45 [a] (1.00)	0.35 [a] (1.02)	0.42 [a] (0.97)	0.30 [a] (0.93)	0.48 [a] (0.96)
Don't know/Don't remember	0.59 [b] (1.09)	0.75 [b] (1.10)	0.52 [a] (0.83)	0.67 [a] (0.94)	0.73 [b] (0.98)	0.25 [a] (0.92)	0.60 [a] (0.91)	0.28 [a] (0.99)	0.38 [a] (0.91)	0.44 [b] (0.93)	0.58 [a] (0.95)
p-value [2]	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.309*	*<0.001*	*0.148*	*<0.001*	*<0.001*	*<0.001*

Table 5. *Cont.*

	Mean Values and Significance of the Test [1]										
Variable/Group	**It1**	**It2**	**It3**	**It4**	**It5**	**It6**	**It7**	**It8**	**It9**	**It10**	**It11**
If you never consumed them, would you consider eating?											
Definitively not	−0.02 [a] (1.18)	0.33 [a] (1.15)	0.26 [a] (0.98)	0.38 [a] (1.03)	0.23 [a] (1.09)	0.18 [a] (0.93)	0.29 [a] (1.01)	0.31 [a] (0.99)	0.33 [a] (0.99)	0.18 [a] (0.96)	0.31 [a] (0.99)
Maybe	0.54 [b] (0.97)	0.70 [a] (0.93)	0.54 [b] (0.84)	0.72 [b] (0.89)	0.67 [b] (0.92)	0.22 [ab] (0.91)	0.51 [b] (0.92)	0.32 [a] (1.00)	0.46 [b] (0.91)	0.39 [b] (0.86)	0.58 [b] (0.87)
Yes, only foods containing insects	0.92 [c] (1.01)	1.09 [c] (0.93)	0.86 [c] (0.93)	0.97 [c] (0.95)	1.10 [c] (0.92)	0.24 [ab] (1.07)	0.84 [c] (1.01)	0.47 [b] (1.13)	0.54 [b] (1.00)	0.61 [c] (0.95)	0.84 [c] (0.92)
Yes, food with insects and whole insects	0.95 [c] (1.08)	1.03 [c] (1.03)	0.95 [c] (0.96)	1.00 [c] (1.04)	1.10 [c] (0.99)	0.31 [b] (1.17)	0.89 [c] (1.06)	0.40 [ab] (1.25)	0.68 [c] (1.04)	0.61 [c] (1.04)	0.87 [c] (1.02)
p-value [2]	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.005*	*<0.001*	*0.001*	*<0.001*	*<0.001*	*<0.001*

[1] Mean value (standard deviation); Scale −2 = very low knowledge, −1 = low knowledge, 1 = high knowledge, 2 = very high knowledge; Significance of the test: $p < 0.05$. [2] ANOVA with post hoc test of Tukey. Different letters in the same column correspond to statistically different mean values.

Figure 3 reveals that, considering the global knowledge, i.e., summing the scores for all 11 items, higher global knowledge was obtained for participants who have already consumed edible insects and the lowest was for those who have never eaten them. Moreover, higher global knowledge was obtained for participants who are willing to consume insects as food, regardless of the form of consumption, i.e., with the whole insect or foods that contain insects as ingredients, such as insect flour.



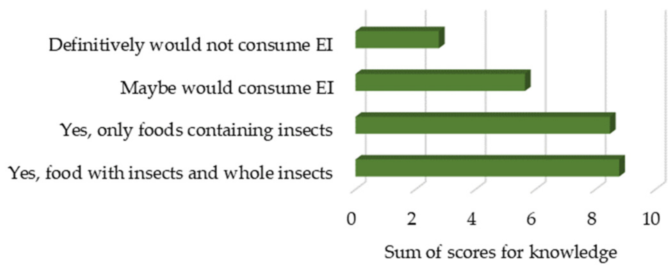


Figure 3. Global scores for knowledge about the sustainability of edible insects, according to consumption habits (**left**) and willingness to consume insects (**right**).

One other aspect investigated the association between the level of knowledge about sustainability of edible insects and the motivations of the participants to consume them, with the results shown in Table 6. Results of the *t*-test for independent samples revealed that there were significant differences in the level of knowledge for the motivation of curiosity for all items except item It8. Additionally, the values of the scores of knowledge were systematically higher for the participants who admit that they might consume insects moved by curiosity. In relation to the following aspect investigated, i.e., motivation related with food scarcity, no significant differences were found in general in the level of knowledge for those who would consume insects if there was a shortage of food and those who would still not eat them. There are two exceptions to this trend, for items It6 and It7, respectively, about the consumption of water and the ecological footprint of insects in comparison with other sources of animal protein. The third motivation to consume insects investigated was the will to help preserve the planet, with the results showing significant differences for all items, indicating that people with higher scores for knowledge about the sustainability of edible insects are those who would consider eating them as a way to help preserve the planet. Also investigated were the associations between the knowledge and the motivation to consume insects due to their gastronomic characteristics, with the results revealing that significant differences were found for all items of knowledge except item It6. Furthermore, the higher scores of sustainability were obtained for participants who are motivated to consume insects due to their culinary potential and properties. With respect to the last motivation investigated, the nutritional value of edible insects, statistically significant differences were found for all items of knowledge, with higher scores for participants who would consider eating insects based on their nutritional composition.

Table 6. Knowledge about sustainability of edible insects according to different types of consumption motivations.

		Mean Values and Significance of the Test [1]										
Motivations		**It1**	**It2**	**It3**	**It4**	**It5**	**It6**	**It7**	**It8**	**It9**	**It10**	**It11**
For curiosity												
	No	0.19 (1.20)	0.34 (1.09)	0.32 (0.99)	0.47 (1.01)	0.35 (1.09)	0.17 (0.93)	0.31 (1.01)	0.36 (0.98)	0.39 (0.97)	0.30 (0.94)	0.37 (0.99)
	Yes	0.62 (1.07)	0.77 (1.02)	0.64 (0.94)	0.76 (1.00)	0.77 (1.02)	0.27 (1.00)	0.63 (1.02)	0.40 (1.09)	0.51 (0.99)	0.42 (0.96)	0.65 (0.96)
p-value [2]		*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.147*	*<0.001*	*<0.001*	*<0.001*
If food is scarce												
	No	0.47 (1.12)	0.63 (1.07)	0.49 (0.97)	0.65 (0.99)	0.59 (1.06)	0.18 (0.97)	0.48 (1.03)	0.41 (1.03)	0.44 (0.99)	0.38 (0.94)	0.54 (0.98)
	Yes	0.45 (1.17)	0.68 (1.04)	0.53 (0.97)	0.65 (1.01)	0.63 (1.06)	0.27 (0.98)	0.54 (1.00)	0.39 (1.05)	0.49 (0.98)	0.37 (0.95)	0.55 (0.99)
p-value [2]		*0.529*	*0.152*	*0.190*	*0.837*	*0.223*	*0.003*	*0.049*	*0.461*	*0.118*	*0.786*	*0.773*
To help preserve the planet												
	No	0.29 (1.14)	0.50 (1.06)	0.38 (0.96)	0.52 (0.99)	0.43 (1.07)	0.19 (0.92)	0.38 (0.99)	0.38 (0.99)	0.42 (0.98)	0.30 (0.93)	0.42 (0.97)
	Yes	0.93 (0.98)	1.10 (0.91)	0.84 (0.90)	1.03 (0.91)	1.05 (0.92)	0.43 (1.08)	0.86 (0.99)	0.59 (1.15)	0.58 (0.98)	0.62 (0.94)	0.85 (0.93)
p-value [2]		*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*
Due to their gastronomic characteristics												
	No	0.33 (1.16)	0.54 (1.07)	0.41 (0.96)	0.55 (1.00)	0.45 (1.07)	0.21 (0.94)	0.40 (1.01)	0.40 (1.01)	0.42 (0.99)	0.30 (0.93)	0.44 (0.98)
	Yes	0.84 (1.08)	0.94 (1.03)	0.82 (0.98)	0.90 (1.02)	1.01 (1.01)	0.25 (1.11)	0.78 (1.03)	0.36 (1.20)	0.63 (1.00)	0.60 (1.02)	0.79 (1.00)
p-value [2]		*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.288*	*<0.001*	*0.250*	*<0.001*	*<0.001*	*<0.001*
Due to their nutritional properties												
	No	0.26 (1.15)	0.50 (1.06)	0.35 (0.95)	0.51 (0.99)	0.41 (1.06)	0.20 (0.91)	0.37 (0.99)	0.37 (0.98)	0.42 (0.97)	0.28 (0.93)	0.41 (0.97)
	Yes	0.98 (1.03)	1.03 (0.99)	0.92 (0.94)	1.00 (1.00)	1.07 (0.98)	0.29 (1.14)	0.83 (1.05)	0.43 (1.19)	0.60 (1.02)	0.62 (1.00)	0.86 (0.98)
p-value [2]		*<0.001*	*<0.001*	*<0.001*	*<0.001*	*<0.001*	*0.002*	*<0.001*	*0.048*	*<0.001*	*<0.001*	*<0.001*

[1] Mean value (standard deviation); Scale −2 = very low knowledge, −1 = low knowledge, 1 = high knowledge, 2 = very high knowledge; Significance of the test: $p < 0.05$. [2] *t*-test for independent samples.

4. Discussion

The data provided by the United Nations Department of Economic and Social Affairs predict that by 2100 the number of people living on planet Earth will reach approximately 11 billion. With a rising number of people needing to be fed, the challenge of how to respond to this necessity is of the utmost importance. However, there is another factor to consider, which is the improvement of the economic situation that leads also to an increase in the per capita food demand. It is even postulated that this is likely to be a more important driver of food demand than population growth. Economic projections increase world food demand by about a third until 2050. However, food insecurity will have an uneven distribution around the world, resulting from economic and societal differences. It is estimated that until 2100, Africa's population will increase from 1.3 billion to 4.3 billion, with most of these people arising in sub-Saharan African countries, corresponding also to one of the least developed regions in the world [35,36].

Food is a basic need for every human being, and providing food for all people on Earth is essential to pursue the possibility of a "good life", as proposed in the UN Sustainable Development Goals (SDG). However, this is intimately linked with achieving other SDG such as eliminating poverty, responsible consumption and production, life on land and below water, and climate change, among others. These goals depend to a large extent on the success in implementing more sustainable food systems, with effective measures to mitigate the impact of production, transformation, transportation, and the discarding of foods along the supply chain, also indulging their packaging materials [1,37–40].

Edible insects can become part of a global strategy to achieve food security, as suggested by the FAO—Food and Agriculture Organization of the United Nations. In fact, they have gained high significance in recent years, and have been investigated as a more sustainable alternative food source compared with other protein-rich foods. This interest derives from several factors which include, apart from their high nutritional value, lower environmental impact, and possible contribution to the sustainability of rural communities and of poor families, in line with the SDG, the elimination of poverty accompanied by responsible food production, from a reduced use of natural resources [40–43].

While possessing valuable nutrients and bioactive compounds with benefits for human health [18,25,26], edible insects may also represent a risk for humans if proper safety is not guaranteed, since they can be a vehicle for zoonoses, pathogenic microorganisms causing diseases, or harmful compounds leading to food poisoning [44–46].

Novel nutrient-rich foods which have been produced based on sustainable methods are a viable solution to increase food security. However, their unfamiliar aspect, the tastiness, and the lack of knowledge by most people could pose serious obstacles to their broader adoption [47]. Edible insects have been intensively studied as foods, and the role of the consumer is of most importance to allow acceptability. Studies have been conducted in many countries aiming to better understand this relationship between consumers and insects as food. In Hungary, it was reported that food neophobia constitutes a barrier for the consumption of insects, and a person's sex influences consumption, with women less willing to consume them [48]. In Finland, a study by Tuorila et al. [49] confirmed that women were more neophobic compared to men, and also older people were less willing to eat insect foods. A study by Hartman et al. [50] focusing on a cross-cultural comparison between Germany and China revealed that Chinese participants valued insect-based food more favorably on a range of aspects (flavor, nutrition, familiarity, and acceptance) than the Germans. In another study with German consumers, Orsi et al. [51] confirmed the barriers that impede them from accepting insects in their diet were linked with disgust and neophobia. In Italy, a study by Laureati et al. [52] reported that Italian consumers are not ready to accept insects as food but are willing to consider them as animal feed. On the other hand, Sogari et al. [53,54] concluded that young Italians are willing to eat insects, mainly due to curiosity. A study revealed that in Poland [55], consumers are more willing to consume foods with processed insects. A cross-regional study in Northern and Central Europe [56] revealed that consumers in Northern European countries tend to have a more positive attitude towards insect food compared to consumers in Central Europe. A study by Bednarova et al. [57] investigated the nutritional value of edible insects and the suitability of the species among consumers from the Czech Republic. A study by Schlup and Brunner [58] showed that in Switzerland, food neophobia is not a key factor in influencing the willingness to consume insects. In Belgium, studies [59,60] confirmed the possible acceptance of foods based on insects, if they are associated with known flavors and crispy textures, and that 11.2% of Belgians have already consumed foods with processed insects.

The role of consumers has been identified as pivotal to produce positive changes towards more sustainable diets, and it has been documented that environmental concerns are a strong motivation to more sustainable food choices. However, for these modifications in the habits of people to be effective, information and knowledge are foundational [27–29,48].

In line with this, the present research identified some fragilities in the knowledge about sustainability issues related to the impact of edible insects on the environment, resulting in relatively low indices for knowledge, revealing that participants not familiar or aware of the issues addressed in this study are in the great majority. These include the lower use of resources for the production of edible insects compared with other animals, the lowest footprint, their role for maintaining biodiversity, their lower emissions of greenhouse gases, or their possible usage as sustainable pest control tools, among others. Documented research has established that the production of edible insects uses considerably less natural resources [49]. For example, to produce 1 kg of beef, 24,202 L of water, 25 kg of feed, and extensive land are required, while to produce the same weigh of crickets, only 8.3 L of water, 2 kg of feed, and small cubicles are necessary. Moreover, the production of 1 kg of insects (live weight) requires only 2 kg of feed, while for chicken, pork, and cows, 3 kg, 5 kg, and 10 kg, respectively, are needed. Regarding water, the needs for the production of protein from insects are half that of poultry, a third of that for pork, and a fifth of that for beef [8,49]. A study by Vauterin et al. [50] investigated the way that insect protein could help reduce the impact on global warming arising from food consumption in Europe. They came up with two key insights. On the one hand, insect protein shows an incredible potential to reduce the carbon footprint of European consumers, when they are consumed directly as food, and particularly when processing is minimized. On the other hand, the use of insects as animal feed can substantially contribute to the sustainability of other animals' production systems [50].

The knowledge about management practices assumes a pivotal rule in the redefinition of strategies and achieving more sustainable food supply chains [51]. When investigating the influence of sociodemographic characteristics of the participants on the level of knowledge about sustainability of edible insects, significant differences were found, revealing a trend for higher knowledge among males and young adults. This confirms previous studies according to which variables such as age and sex have been identified as factors influencing knowledge in several domains [52,53], and drivers to the adoption of environmental behaviors [54]. A study by Laureati et al. [55] reported that the principal factors affecting Italian consumers' willingness to consume edible insects included age and gender, besides their cultural background.

The socioeconomic variables education and income were identified as influencing the level of knowledge about the sustainability of edible insects. People with higher education levels and higher incomes show better knowledge. Education assumes a central role for improving knowledge in all sectors. Seehawer and Breidlid [56] discuss the contribution of quality education for the effective learning and improvement of knowledge regarding sustainable development goals. Estrada-Vidal and Tójar-Hurtado [58] identified knowledge and the attitudes of university students regarding environmental health education and sustainability education as a way to define future interventions for better sustainability. Although better knowledge can be a driver for more sustainable behaviors, sometimes that may not be a direct relation, as observed by Redman and Redman [59], according to whom declarative knowledge is not a predictor for sustainable behavior while social knowledge is.

One other aspect investigated in this research was to look for possible differences in knowledge according to geographic variables, namely, country and living environment. The results revealed higher scores for knowledge were generally obtained by people residing in urban areas and in countries such as Spain, Mexico, and Poland, while scores were lower in countries including Serbia, Croatia, Turkey, and Greece. The 14 countries involved in this research have variable sociocultural backgrounds. While most countries are in Europe, there is also an involvement of Latin American countries such as Brazil or Mexico, and Asia, in the case of Turkey. It is a fact that in some of these countries, the act of consuming insects is an accepted practice, while in most European countries, entomophagy is not a traditional habit. Therefore, it is expected that the information about edible insects may change widely according to cultural background. Additionally, these countries also have highly variable educational systems, and the means of dissemination of information can also change in nature, reach, and effectiveness. For example, although some traditional groups consume insects in Latin America, it is reported that in urban areas of Brazil, people tend to adopt the same resistance to consumed insects as verified in most Western countries. However, consumption can be encouraged by selecting some insect species that would be more accepted by Brazilian consumers [60]. A study by Castro and Chambers [57] focusing on 13 countries (United States, Mexico, Peru, Brazil, United Kingdom, Spain, Russia, India, China, Thailand, Japan, South Africa, and Australia) found differences in the willingness to consume insects or insect-based foods according to the cultural background. In another study by Gómez-Luciano et al. [61], based on a survey conducted in Spain and the Dominican Republic, it was reported that Spanish people reveal an openness to eat almost anything, which is a positive driver for accepting insects as food, which is in line with our findings, while in the Dominican Republic, a higher food neophobia and consequently lower acceptance of insects as food was observed. Analyzing the factors that influence consumer acceptance of entomophagy among Dutch and Australian participants, it was concluded that providing information, and therefore creating knowledge about entomophagy, seems to be vital issue [62]. In China, the most relevant factors influencing the decision to purchase edible insect foods include sociodemographic variables such as age, household size, household income, and region of the country [63].

Finally, testing the influence of consumption variables on the level of knowledge, the results indicated that higher knowledge was observed for participants who had already consumed insects and for those who, although yet to do so were willing to consume insects. Additionally, it was concluded that higher knowledge was found for participants whose motivation to consume insects related to curiosity, a wish to preserve the planet, the gastronomic characteristics of insects, and their nutritional value. A high number of studies have confirmed some of these motivations that positively influence the consumption of insects, namely, curiosity [64], their nutritional value [61,64–68], and sustainability [64,65,67–70]. In a study by Bisconsin-Júnior et al. [60], participants from Brazil were described as potential consumers of insects, mainly for survival or due to curiosity. Additionally, understanding the perceptions of innovative chefs about the use of insect-based ingredients can help promote their use in gastronomy and ultimately improve their acceptability by consumers [71].

5. Conclusions

This work investigated the level of knowledge about the sustainability of edible insects in different countries, and showed that in general the knowledge is moderate, with the values of average scores for all 11 items investigated being below the score set for high knowledge. The results further showed that the highest knowledge was obtained for items relating to the lower use of feed and lower emission of gases in terms of greenhouse effect for the production of insects compared with bovines. When investigating the influence of sociodemographic characteristics on the level of knowledge, significant differences were found for most items, revealing a trend for higher knowledge among males and young adults. This research further showed significant differences in knowledge according to geographic variables, namely, country and living environment, with higher scores for knowledge obtained generally for people residing in urban areas and in countries such as Spain, Mexico, and Poland. The socioeconomic variables education and income were also investigated and significant differences were found, revealing that higher knowledge occurred for participants with higher education levels (graduate or post-graduate) and higher incomes (higher or much higher than the average salary in each of the participating countries). Finally, testing the influence of consumption variables on the level of knowledge, the results indicated that higher knowledge was observed for participants who had already consumed insects and for those who, although yet to do so, were willing to consume insects. Additionally, it was concluded that higher knowledge was found for participants whose motivation to consume insects related to curiosity, a wish to preserve the planet, the gastronomic characteristics of insects, and their nutritional value.

These results reveal the role of a number of demographic, social, economic, and geographic variables on the knowledge of the sustainability of edible insects, which can be a starting point to delineate strategies that allow a better dissemination of information among populations, thus leading to an increase in the willingness to consider insects as a more sustainable alternative to partially replace other protein foods, even in countries where this is a not a traditional practice. It is also suggested that, following the relevant results encountered, this research could be replicated in other countries in the future, either with a cultural background of entomophagy or countries where eating insects is not a traditional practice.

Author Contributions: Conceptualization, R.P.F.G., O.A. and I.D.; methodology, R.P.F.G., S.G.F., O.A., M.F., C.A.C., A.P.C., P.M.R.C. and S.C.; software, R.P.F.G.; validation, R.P.F.G. and M.F.; formal analysis, R.P.F.G.; investigation, R.P.F.G., S.G.F., O.A., N.M.B., C.C.-H., M.M.S., M.F., C.A.C., E.B., A.P.C., M.T., P.M.R.C., S.C., M.P., D.A.C., M.K., M.Č.-B., Z.K., E.D., V.F. and I.D.; resources, R.P.F.G., S.G.F., O.A., M.F., C.A.C., A.P.C., P.M.R.C., S.C. and I.D.; data curation, R.P.F.G.; writing—original draft preparation, R.P.F.G., S.G.F., O.A., M.F., C.A.C., A.P.C., P.M.R.C. and S.C.; writing—review and editing, I.D.; visualization, R.P.F.G.; supervision, R.P.F.G.; project administration, R.P.F.G.; funding acquisition, R.P.F.G. and I.D. All authors have read and agreed to the published version of the manuscript.

Funding: This work was funded by the CERNAS Research Centre (Polytechnic Institute of Viseu, Portugal) in the ambit of the project EISuFood (Ref. CERNAS-IPV/2020/003). We also received funding from the FCT—Foundation for Science and Technology (Portugal) through projects Ref. UIDB/00681/2020, UIDB/05507/2020, and UIDB/007421/2020. The APC was funded by FCT through projects Ref. UIDB/00681/2020, UIDB/05507/2020, and UIDB/007421/2020.

Institutional Review Board Statement: This research was implemented taking care to adhere to all ethical standards and followed the guidelines of the Declaration of Helsinki. The development of the study by questionnaire survey was approved on 25 May 2020 by the Ethics Committee of the Polytechnic Institute of Viseu (Reference No. 45/SUB/2021).

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 request.

Acknowledgments: This work was supported by the FCT—Foundation for Science and Technology, I.P. Furthermore, we would like to thank the CERNAS, CIDEI, and UCISA:E Research Centers and the Polytechnic Institute of Viseu for their support. This research was developed in the ambit of project “EISuFood—Edible Insects as Sustainable Food”, with Reference CERNAS-IPV/2020/003.

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

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