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Insect-Based Food: A (Free) Choice

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Abstract: The literature highlights the importance of insect consumption for nutritional health habits. The increasingly clear legislation, the developed studies demonstrating their nutritional value, and the prospect of overcoming some barriers that have prevented consumers from consuming insects are among the reasons supporting the advantages of consuming insects. The leading determinants of consumption are culture and individual and social beliefs, accessibility to a particular nutritional resource, and individual behavior. The barriers to neophobia were analyzed by evaluating factors of influence and their respective relationship and meaning through quantitative research to measure the significance of the results. To develop a conceptual model that aims to change eating behavior and recognize structural aspects that can be barriers in the process of changing eating behavior, a methodological framework was developed. The methodological framework aimed to identify the characteristics that can be associated with the profile of opinion leaders, and it included a questionnaire which was applied to 213 young people. Moreover, the structural equation model was the statistical technique used. Given the projected population growth and increasing life expectancy, nutrition is a challenge in terms of health, but also in economic, social, and environmental respects. Aiming for sustainability, it is crucial to identify nutritional alternatives within the circular economy.

Keywords: consumer behavior; insect-based food; sensory perception; intention; neophobia

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1. Introduction

Recognizing the importance of food for human survival in providing immunity [1] and considering that current protein feed production alternatives influence the environment [2], Rzymski defended three sources of protein: plant-based diets, insect-based foods, and cultured meat [3]. However, estimating that by 2050 there will be more than nine billion people [4], and with life expectations increasing [2], the resulting combination may create many nutrition problems. Therefore, it is crucial to reflect on the future of humanity due to the expected growth of the world's population [5].

Proteins can be of animal or vegetable origin. Despite their nutritional value, animal proteins have a strong negative impact on the environment [6]. Therefore, it is crucial to identify new alternatives for dietary protein quality. Among some of the alternatives which are being studied is insect-based feeding [5,7]. This alternative is rich in protein [3], low in cost [4], and highly sustainable [8,9]. In general, insects are animals with a chitinous exoskeleton, head, thorax, abdomen, legs, eyes, and two antennae; entomophagy is the practice of eating insects [9].

In the European Union, edible insects, in whole or in part, fall within the definition of novel foods provided by the European Commission—a type of food that does not have a significant history of consumption or is produced by a method that has not been used before for nutrition.

According to the regulations published by the EFSA on 13 January 2021, the yellow flour worm (Tenebrio molitor) is considered a safe food for human consumption; on 2 July 2021, the EFSA published the scientific opinion that frozen, dried, or ground migratory grasshoppers (Locusta migratoria) are safe for human consumption; on 17 August 2021, the EFSA published another assessment on house crickets (Acheta domesticus), which, in frozen and dried forms, are safe for consumption.

The growth of the population and the perverse effects of animal production on the environment can drive us to assume that the supply of the animal-based protein will be insufficient to meet demand, favoring an increased price of meat. Therefore, other sources should be found to replace or complement the current animal protein sources and thus provide a different means for human survival. It will be crucial to identify more sustainable and accessible alternatives for food. How simple or complicated can it be to accept a new food? Is the reason to feed ourselves, or are our physiological resources dictating what food can we consume? The taste of phagostimulants (*phagein gr.—to eat*) from food—especially carbohydrates, proteins, and fats—is essential for nutrition and influences our choice to consume them. Can the consumption of insects be valid, for all of us, given that ancient peoples appreciated certain species of insects [10] and also that, today, in the culinary culture of many peoples, insects are common ingredients in recipes? Some studies have investigated the acceptance of insects in food by certain people to whom these foods were not expected [11]. An attitude toward food consumption must be correlated with several factors that underline the acceptance/rejection of novel foods. Neophobia has been mentioned in most studies as the main barrier to insect consumption, and disgust is the leading cause of rejection [12,13]. Food neophobia or food cainotophobia is an abnormal fear of new foods or new culinary experiences.

This study aims to identify factors of influence to trying new foods, in three countries, with two culinary cultures, Balkan and Mediterranean. Furthermore, the difference in culinary culture between the participating countries was not considered, and insect consumption is not considered common in the cultural diet of each country studied. At the same time, we must point out that we are talking about "cultures" of controlled insects and not of naturally growing insect populations in this study.

The claim that this food source can be a solution to a food crisis is not supported unless the barriers to insect consumption are removed. Variables and agents were studied to identify early adopters. Therefore, the main objective was divided into the following specific objectives: (i) to identify the characteristics that can be associated with the profile of early adopters [7]; (ii) to identify variables that have an influence on the new food experimentation; (iii) to identify agents that can influence the behavior of testing new food products; (iv) to identify relationships between the variables to develop a model aiming to change food behavior; and (v) to identify structural aspects that can represent barriers to changes in behavior.

Since the aim was to explore the influence factors and measure the respective relation and significance, quantitative research was considered adequate. The research reviewed the relationship between the various published articles to develop and validate the questionnaire applied. Furthermore, the quantitative research measured the significance of the results. The theoretical framework is presented below.

Following this introduction, the paper presents a theoretical framework that includes the intention, defined as a function of individual and social beliefs, as well as the influence of sensory perception. With the help of VOSviewer, version 1.6.18, this research identified a few articles related to insect-based foods. Then, the methodology employed was defined, and the results were presented and discussed. Finally, the main conclusions were highlighted.

2. Theoretical Framework

Insect-based food is an alternative source of protein, which is characterized by a high nutritional profile and a lower ecological footprint. Therefore, it is ethically more acceptable than others despite the risk of viral transmission yet to be assessed [3]. Insect-based food is also influenced by cultural aspects [14]. It is sometimes looked upon as strange or with disgust [15].

Intention precedes behavior and is based on individual and social beliefs [16]. On the one hand, individual beliefs can result from reasonable [17] and emotional aspects, which can influence intention [18]. Moreover, social beliefs can be influenced by people around the individual (other references) and by social norms and/or social pressure [19], such as cultural aspects [14]. Table 1 presents all variables of the theory of reasoned action (TRA) and respective relationships.

Table 1. TRA variables and respective relationships.

Variables			Suggestions
Intention related to experimentation with new products [16,20] such as insect-based food [8].	Attitude involves individual beliefs [16]. Attitudes toward eating insect-based foods [8,21] may or may not favour this behaviour [22].	Reasonable (beliefs based on empirical reality [23].	Overcome negative emotions [24] and communicate the ecological benefits [25] and positive effects on health of insect-based foods [4,17,24,26,27].
		Emotional beliefs: initial perceptions were strangeness and disgust [15].	
	Social beliefs are socialreferents [8].	Reference to others is the opinion of people who mean something to the individual [19].	
		Acceptability (social communication and social acceptability) depends on the nature of the food [14].	

Positive intentions to consume insect-based foods were considered higher for rural households because the individuals that constitute them were more open and comfortable with them [8]. On the other hand, tactile, olfactory, visual, and gustative senses affect perception. Following these assumptions, the research considered that experiencing influencing factors such as the state of the matter (liquid, solid) [24,28], temperature (ambient temperature, hot, cold, etc.) [29], vision (quantity, distribution, color, appearance, etc.) [21], smell (mild/intense, pleasant/unfriendly, etc.) [30,31], and touch (thick/low consistent, solid/liquid, etc.) [32,33] influence the sensory perception of new foods [7]. However, this depends on the nature of the new food [14]. Table 2 presents the sensory perception variable and respective indicators used to evaluate sensory perception.

Table 2. The sensory perception variable and respective indicators.

Variables	
Sensory perception [32] is exponentiated perception through the senses.	Influence of the product features [6,33,34]. Influence of preparation [28,35,36]. Influence of flavor and related [31,37]. Influence of smell and related aspects [30,31]. Influence of product temperature [29,35]. Influence of the presentation of the shape [28,35]. Influence of visual aspects: seeing part of the insect is a trigger for disgust [18,21,33,34].

Several authors recommended avoiding seeing part of the insect [18,21,33] because it can be a trigger of disgust [34]. In a study carried out with yellow mealworm chips (YMC), the perceived characteristics have a strong influence on the probability of consumption, and the most appreciated characteristic was the lower environmental impact [34]. Another study compared pizza made with spirulina algae flour and 'cricket' flour and argued that consumers show increasing attention to their physical well-being [14]. Thus, while aiming to remove obstacles [36], the food system can focus on taste [37]. This means exploiting phagostimulants in insects once there are no other barriers. Carcea suggested hiding insects in traditional foods such as cereal-based foods (e.g., bread, pasta, bakery products, etc.) to remove stigmas [38]. This can increase people's willingness to eat insect-based foods.

Behavior is based on habits, mostly unconscious, and changing food behavior requires time and effort [37], which involves personal [15] and social beliefs [14] as well as other cognitive aspects of decision making. In addition, consciousness is another relevant factor which has a positive influence [39]. Therefore, it is also important to identify the main agents and variables, called influence factors, for changing food behavior [40] and to develop a model of the interaction between these factors. The following model results from these variables. Figure 1 presents these main variables of the model and the respective relationships.

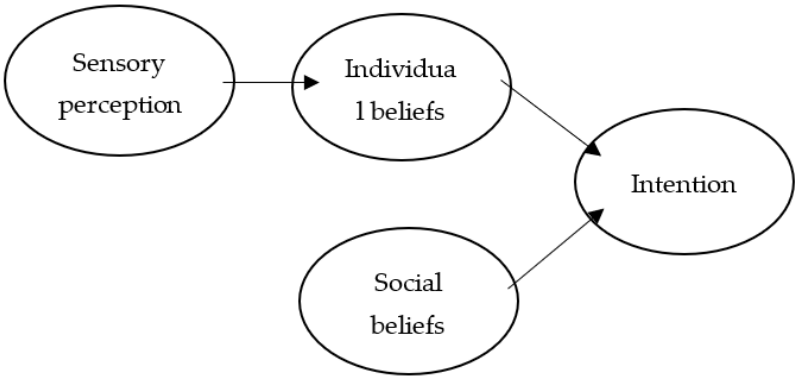

Figure 1. Sensory perception model adapted from TRA [16].

The senses and memory are connected; they facilitate the ability to provide a means by which memories are encoded in food [32]. The sensory perception of new foods can influence individual beliefs, which can influence the intention and social beliefs, which can in turn influence the intention [25]. Furthermore, the experimentation with insect-based foods in some Western countries can be influenced by many factors [41], depending on the culture. Therefore, it is necessary to change habits in order to increase their consumption, and to differentiate the most significant factors from the others. In addition, an individual with positive arousing emotions (such as fun and excitement) would be more willing to eat insect-based foods rather than one actuated by calming emotions (such as romance and tranquility), and pairings play different roles in the acceptance of eating insect-based foods [4]. In addition, it is also important to identify structural barriers in the environment before changing individual behavior.

To communicate promptly and assertively, it was considered relevant to identify the main profiles of the opinion makers. According to the innovation curve, the early adopters were crucial in creating public opinion. Usually, this initial group of consumers influences others through public opinion [42–44]. In other words, resources should be focused on small groups of individuals and organizations that greatly influence their followers [45].

The literature review considered that intention precedes behavior and aimed to develop and apply a model that would support the desired behavior. In this sense, aspects related to attitude, social norms, and sensory perception were identified. However, to better understand what was being studied in the field of insects, with the help of the artificial

intelligence algorithm, a second search was developed with the main articles indexed on the Web of Science regarding insect-based foods.

3. Review Research of Web of Science Articles from 2018–2020

The following topics defined the research design: insect-based food (topic), 2018–2020 (year published), food behavior (all fields), edible insects (all fields) or early adopters (all fields), and articles or review articles (document types) and articles (document types) and management or business or environmental studies or green sustainable science technology or communication or food science technology or entomology or veterinary sciences or psychology or psychology multidisciplinary (Web of Science categories) (https://www.webofscience.com/wos/history (accessed on 19 April 2022)) [46]. As a result, only 300 papers were selected. Figure 2 shows seven clusters and the respective links between the themes.

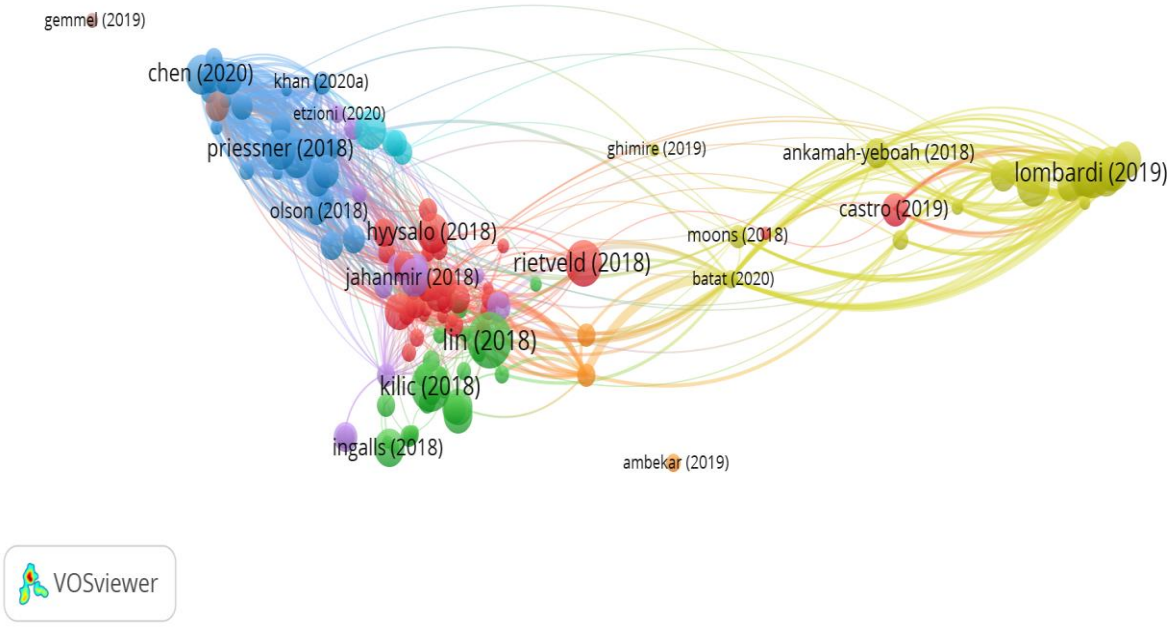

Figure 2. Clusters of papers published from 2018 to 2020 (source: free version of VOSviwer, version 1.6.18 (January 2022)) [47].

According to the reprinted from a free version of VOSviewer software, it is possible when visualizing scientific landscapes to observe seven main clusters. Aiming to group papers according to year, a second image was created. The second image helps to understand the main topics and their connection. Figure 3 shows the link between the themes per year.

Considering all the themes, only one cluster was identified as very important to the theme after the first analysis. The golden cluster of papers presented in Figure 3 was selected because it approaches topics related to insect-based food. Then, a few papers were added to the list. A total of 13 papers were added. Table 3 presents the summary of these papers.

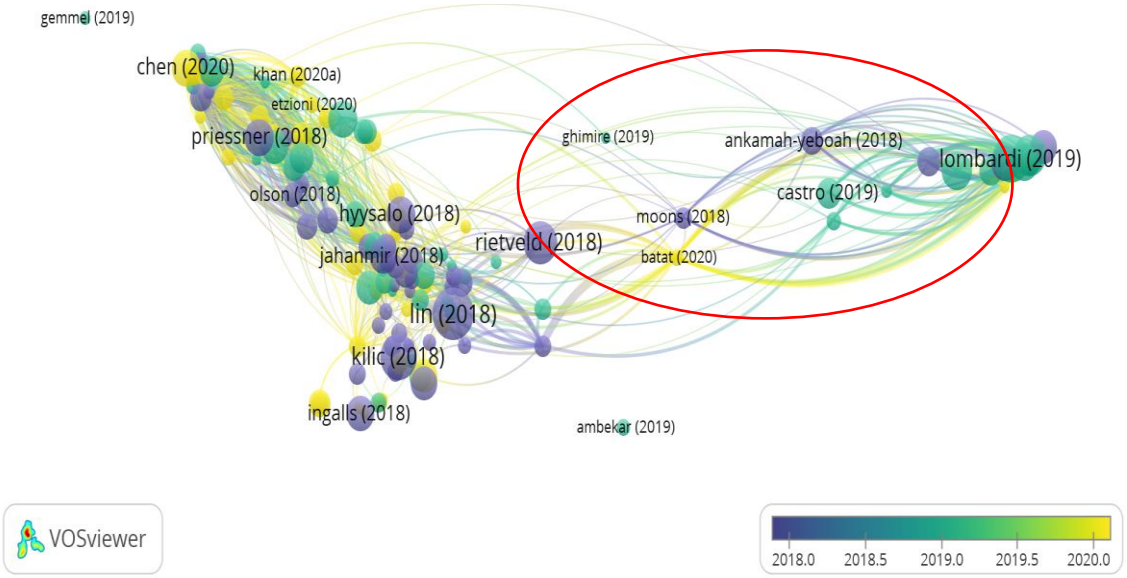

Figure 3. Clusters of papers per year, published from 2018 to 2020 (source: reprinted from a free version of VOSviewer, version 1.6.18 (January 2022)) [47].

Table 3. Literature review of Web of Science (2018–2020) regarding insect-based food.

Insect-Based Food Description
Entomophagy was considered a disgusting practice. Instead, the authors suggested developing early adopters' practical skills in insect preparation (qualitative methodology) [48].
Insect-based products should communicate all benefits [26].
The market impact of insects on the animal protein value chain should be communicated [49].
Snacking behavior increases the likelihood of consumption of seaweed products [50].
Acceptance increases when insects are transformed into ingredients [22].
A health-conscious, eco-friendly, brave, and insect-based meat alternative was evaluated as a healthy vegetarian alternative [51].
Social factors are a mediating variable between neophobia and personal factors. In addition, communication should stress the health aspects, and sensory perception should be concerned [25].
Health consciousness is a motivator for adopting food such as spirulina-enhanced food [52].
Trying to eat insects increases consumers' sensory property expectations [53].
In the adoption of insect-based foods, one should consider idiocentric and allocentric factors [54].
Countries with an entomophagy tradition behave differently from those without such a tradition [55].
The impact of post-harvest processing routes of mealworm larvae is important [56].
Beef burgers received higher footprint ratings than vegetarian and insect burgers [57].

Once the articles were reviewed, most of the works developed a quantitative study to understand the behavior. The aim of the authors was to increase acceptance, and their main contributions are related to transforming insects into ingredients for food and communicating the benefits. However, social, and personal factors were considered to overcome the barriers. Nevertheless, the perceived lower environmental impact was considered to be an appreciated characteristic [34,58].

4. Methodology

This study was centered on factors that can influence people to experiment with new foods. Therefore, the main objective of this study is to identify factors of influence in trying new foods, which was divided into five specific objectives: (i) to identify the characteristics that can be associated with the profile of opinion leaders; (ii) to identify variables that have an influence on new food experimentation; (iii) to identify agents that can influence the behavior of testing new food products; (iv) to identify relationships between the variables to develop a model aiming to change food behavior; and (v) to identify structural aspects

that can represent barriers to changing the behavior. Figure 4 presents a methodological diagram of the research.

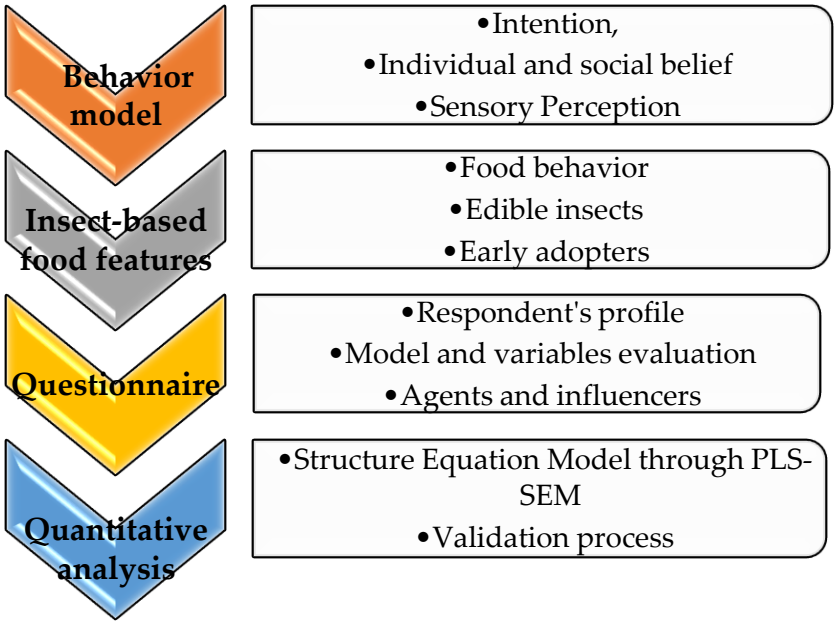

Figure 4. A methodological diagram.

Intention precedes behavior and is based on individual and social beliefs [16]. On the one hand, individual beliefs can result from reasonable [17] and emotional aspects, which can influence intention [18]. Moreover, social beliefs can be influenced by people around the individual (other references) and by social norms and or social pressure [19], such as cultural aspects [14]. Table 1 presents all variables of the theory of reasoned action (TRA) and their respective relationships.

The universe of this quantitative research is inserted in a project developed in a network between Romania, Serbia, and Portugal. The central theme of this research is to understand consumer behavior when experimenting with new foods. The sample was focused on higher education students. The questionnaire was made available by e-mail to the academic community and social networks, similarly done in [59]. A pre-test of the questionnaire was performed before implementing it. In addition, the instrument (questionnaire) was divided into three parts, which were in accordance with the following objectives: (i) to know the profile of the sample; (ii) to assess the significance of the influencing factors; and (iii) to assess the percentage and profile of the influencers (opinion leaders) of innovation. Moreover, the validation process of the translation was carried out so that the questionnaire could be available in each country's language.

The first part of the questionnaire sought to know the respondent's profile by acquiring personal, demographic, social, and economic data. Age, education, the average monthly income level per person in the household, and working conditions were considered influencing factors and the type of protein (animal, vegetable, both, or none) included in the meals. The second part of the questionnaire sought to assess intention according to sensory perception (e.g., physical conditions, the preparation and temperature of the product, characteristics associated with the preparation, and perception by the senses, namely, sight, taste, and smell), as well as individual beliefs (reasonable or emotional), and the social beliefs (such as the opinion of people from reference groups relevant to the individual, from society in general, or as disseminated through social networks and social communication). This section of the questionnaire was intended to determine the importance of first-hand experience for those who can be opinion formers. The personalities and emotions of these risk takers were studied. This phase also assessed risk control or aversion—the tool allowed for other contributing factors to be suggested. The third part of

the questionnaire sought to identify the significance of the first to experience, who, many times, can be influencers or opinion makers. The profile and emotions of these adventurous individuals in experimentation were analyzed. Finally, the control or aversion to risk was also evaluated in this phase. The instrument provided a space for suggestions of other influencing factors to be added.

To determine the questionnaire's validity, we examined the items (questions) that constitute the questionnaire. A questionnaire is safe and reliable when all its items add up to the same result (overall score). The estimated time for answering the questionnaire was around 10 to 12 min. Furthermore, the information was treated anonymously.

5. Results of Quantitative Research

Considering that there are numerous factors which influence the decision to try an unknown food, the main objective was defined to understand the characteristics and attributes or factors which influence the intention of individuals regarding trying new food products.

This research highlights three main variables: intention, attitude (individual beliefs), and social norms (social beliefs), as well as the influence of sensory perception on trying new foods [32]. Thus, this research developed and applied a questionnaire to identify socio-demographic aspects of the respondents, as well as their beliefs and perceptions. Among the most crucial demographic data, it can be highlighted that:

- 51.4% of the respondents were male;
- 26.64% were from 18 to 25 years old and 28.5% from 46 to 55 years old;
- 40.65% completed high school and 39.72% have a higher education degree;
- 43.93% earned from EUR 500 to EUR 1000 per person per month;
- 63.55% were currently being paid and were employed;
- 43.93% did not eat protein at breakfast;
- 63.08% ate both kinds of protein (animal and vegetable) at lunch and 57.01% at dinner;
- 44% did not eat protein for dinner.

In the descriptive statistics (Table 4 and Figure 5), our data series overall presents a normal distribution, with minimal standard errors. There are some exceptions: the standard deviation (1.33) and variance (1.76) are too high for age because we had few answers (16.7%) from older people (over 55 years old). The standard deviation is slightly higher for work (1.21) and breakfast (1.15). The kurtosis and skewness values are contained in the (−1,1) interval, meaning that our data series has a normal distribution. We can observe some smaller values for kurtosis for age (−1.31), gender (−2.02), lunch (−1.20), and dinner (−1.11), but the differences are minimal [60], and we can assume that our sample is representative and can continue the interpretation.

Table 4. Descriptive statistics.

Variable	Age	Gender	Schooling	Income	Work	Breakfast	Lunch	Dinner
Mean	2.73	1.51	2.82	2.11	1.81	2.95	2.39	2.43
Standard error	0.09	0.03	0.06	0.06	0.08	0.08	0.06	0.07
Median	3	2	3	2	1	3	3	3
Mode	4	2	2	2	1	4	3	3
Standard deviation	1.33	0.50	0.88	0.89	1.21	1.15	0.93	0.96
Sample variance	1.76	0.25	0.77	0.79	1.46	1.33	0.86	0.92
Kurtosis	−1.31	−2.02	0.12	−0.47	−0.63	−0.99	−1.20	−1.11
Skewness	0.01	−0.06	0.79	0.47	1.06	−0.70	−0.68	−0.50
Minimum	1	1	1	1	1	1	1	1
Maximum	5	2	5	4	4	4	4	4
Count	214	214	214	214	214	214	214	214
Confidence level (95.0%)	0.18	0.07	0.12	0.12	0.16	0.16	0.12	0.13

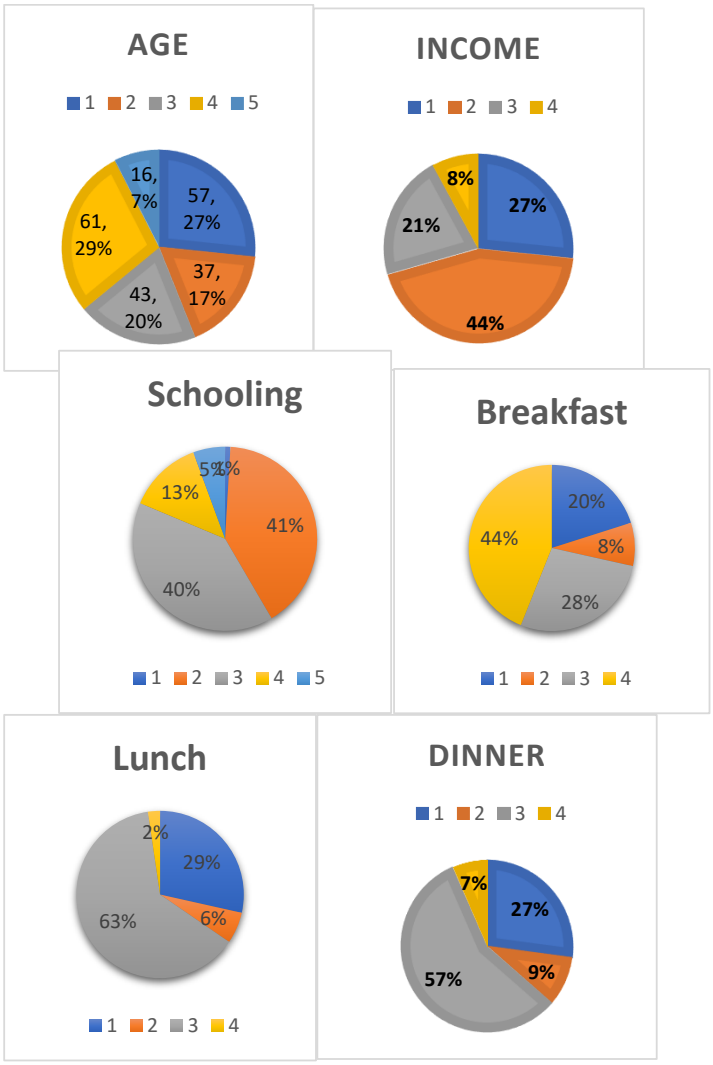

Figure 5. Descriptive statistics.

To ensure the validity of the questionnaire, we checked whether the items from which it was constituted (the questions) contributed to the significance of a statement/hypothesis assumed. A questionnaire is safe and consistent whit the items that are composed of correlations of each of them with the additive result of all items (overall score).

PLS-SEM is a nonparametric method without minimum distributional assumptions [61]. Typically, the value of the *Cronbach alpha* index [62] tends to increase as the number of items (questions) increases. However, it is useless to keep items whose contribution to the overall score is null, or small, or even contrary to the general direction. Therefore, identifying and eliminating these items or modifying them in the spirit of the measured attribute was one of the objectives of the item analysis. In this regard, we deleted the O44 variables to obtain a representative model.

This model has a recursive character, with successive evaluations of the relationships between the items and between the items and the overall score, and the operation of the selection of the items according to their relationship with it. The essential criterion for this operation is the value of the *Cronbach alpha* index, which has a range of variation between 0 and 1 [63]. To be considered consistent, a scale must be of a value above 0.70 [63], this being accepted as a threshold limit by most researchers. However, the value of *Cronbach's alpha* cannot be less than 0.60.

A confirmatory tetrad analysis in PLS-SEM (CTA-PLS) [64] allows for distinguishing between formative and reflective measurement models. The analysis follows Bollen and

Ting's [65] confirmatory approach of testing model-implied vanishing tetrads in the PLS-SEM context, with the difference lying in a bootstrapping procedure applied to test the significance of the model-implied tetrads [64].

In our analysis, we used two types of variables (Tables 1 and 2, and Figure 1):

- Four formative variables: emotional beliefs (with four subfactors: EmoB36–EmoB39), reasonable beliefs (with four subfactors: RatB35–RatB37), reference to others (with four subfactors: RefO42–RefO45), and social acceptability (with five subfactors: AceitSoc46–AceitSoc50).
- Four reflective variables: sensory perception (with three subfactors: PSSensPerc28, PSSensPerc29, and PSSensPerc30), individual belief (with four subfactors: IndB38, IndB39, IndB40, and IndB41), social belief (with four subfactors: SocB51, SocB52, SocB53, and SocB54) and intention (with four subfactors: I1 to I4).

Table 5 presents all these variables.

Table 5. Analyzed Variables.

Variable	Definition	Code	Indicator Explanation
1. Emotional beliefs	Emotional beliefs: initial perceptions were strangeness and disgust [15].	EmoB36	The belief that tasting new foods is a gratifying sensation
		EmoB37	The belief that tasting new foods is a sensation of pleasure
		EmoB38	The belief that testing new foods involves a sense of fear
		EmoB39	The belief that tasting new foods is a sensation to be avoided
2. Reasonable beliefs	Reasonable (or rational) beliefs are based on empirical reality [23].	RatB35	The belief that new foods should be tried
		RatB36	The belief that tasting new foods is an opportunity that cannot be missed
		RatB37	The belief that new foods should be tested to discover new flavors
3. Reference to others	Reference to others is the opinion of people who mean something to the individual [19].	RefO42	The influence of family's opinion
		RefO43	The influence of the husband's/wife's opinion
		RefO44	The influence of friends' opinion
		RefO45	The influence of colleagues' opinions
4. Social acceptability	Acceptability (social communication and social acceptability) depends on the nature of the food [14].	AceitSoc46	The influence of videos published on YouTube
		AceitSoc47	The influence of posts on social media
		AceitSoc48	The influence of news published by journalists
		AceitSoc49	The influence of the chef's opinion
		AceitSoc50	The influence of seeing other people tasting it

Table 5. *Cont.*

Variable	Definition	Code	Indicator Explanation
Sensory perception	The senses and memory are connected [32]. Moreover, the state of the matter (liquid, solid) [24,28], temperature (ambient temperature, hot, cold, etc.) [29], appearance (quantity, distribution, color, appearance, etc.) [21], smell (mild/intense, pleasant/unfriendly, etc.) [30,31], and touch (thick/low consistent, solid/liquid, etc.) [33] influence the sensory perception of new foods [7]. Nevertheless, this depends on the nature of the new food [14]. Considering that the tactile, olfactory, visual, and gustative senses affect perception, sensory perception is based on the senses.	PSSensPerc28	The perception of seeing the product before tasting it
		PSSensPerc29	The perception of touching the product before tasting it
		PSSensPerc30	The perception of smelling the product before tasting it
Individual belief	Individual beliefs result from reasonable [17] and emotional aspects that influence intention [18]. The individual opinion analyzed the individual beliefs variable.	IndB38	The belief in trying new foods
		IndB39	The belief that trying new foods provides positive sensations
		IndB40	The fear of trying new foods
		IndB41	Avoiding unknown foods
Socialbelief	Social beliefs can be influenced by people around the individual (other references) and by social norms and/or social pressure [19], such as cultural aspects [14]. Therefore, the social beliefs variable was analyzed according to the influence of recommendations from people whom he/she cares about.	SocB51	Trying new foods that are accepted by the culture
		SocB52	Trying new foods that are accepted by the religion
		SocB53	Trying new foods that are accepted by the society
		SocB54	Trying new foods that are common in my region
Intention	The intention is based on individual beliefs and social beliefs and precedes behavior [16]. Therefore, the intention was analyzed according to the individual opinion and the recommendations from people whom he/she cares about.	I1	Intention to taste new foods
		I2	Intention to taste foods that other people have already tried
		I3	Intention to taste new foods that other people recommend
		I4	Intention to taste new foods that the people who are closest to them recommend

Individual beliefs result from reasonable [17] and emotional aspects that influence intention [18]. Therefore, the individual beliefs variable was analyzed through the individual opinion.

Social beliefs can be influenced by people around the individual (other references) and by social norms and/or social pressure [19], such as cultural aspects [14]. Therefore, the social beliefs variable was analyzed through the influence of recommendations from people whom the respondent cared about.

The intention is based on individual beliefs and social beliefs and precedes behavior [16]. Therefore, the intention was analyzed according to the individual opinion and the recommendations from people whom the respondent cared about.

Senses and memory are connected [32]. Furthermore, the state of the matter (liquid, solid) [24,28], temperature (ambient temperature, hot, cold, etc.) [29], appearance (quantity, distribution, color, appearance, etc.) [21], smell (mild/intense, pleasant/unfriendly, etc.) [30,31], and touch (thick/low consistent, solid/liquid, etc.) [33] influence the sensory perception of new foods [7]. Nevertheless, this depends on the nature of the new food [14]. Considering that the tactile, olfactory, visual, and gustative senses affect perception, sensory perception is based on the senses.

The loading factors for all these sub items are more significant than 0.7 (Cronbach Alpha), demonstrating that the analyzed items correlate with the additive result of all items (overall score); thus, they lead to the conclusion that the questionnaire is safe and consistent.

There is only one exception for IndB40 and IndB41, which have a negative influence on individual beliefs. Figure 6 shows the PLS Analysis.

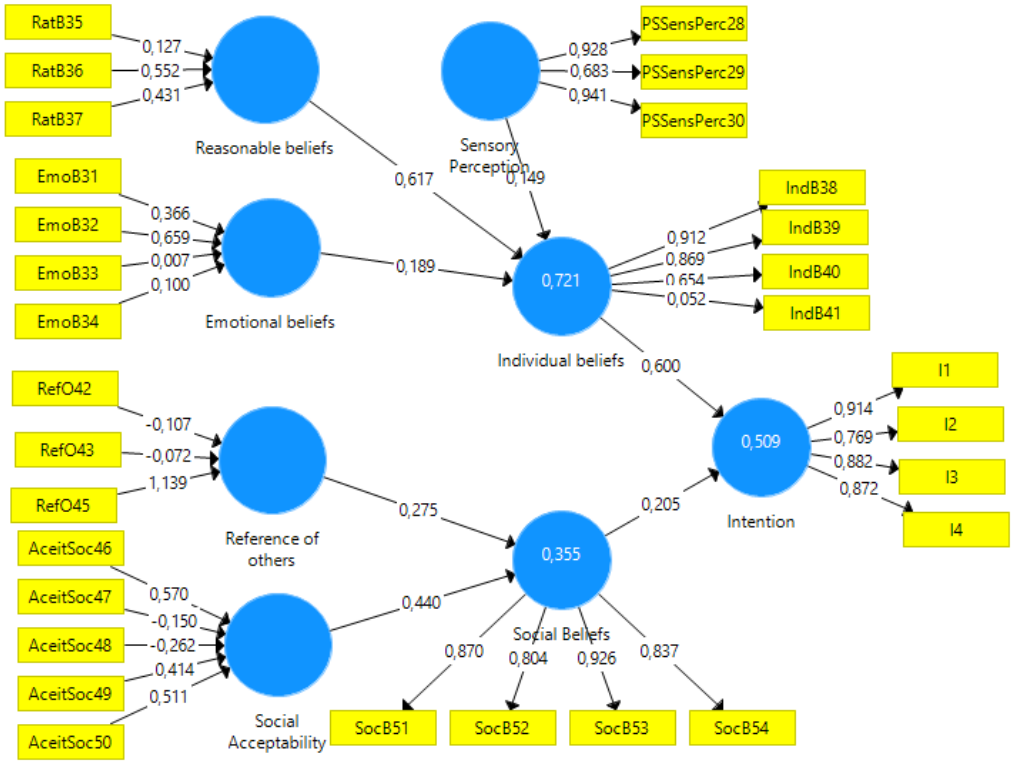

Figure 6. PLS analysis (source: reprinted from a free version of SmartPLS software, version 3.3.9, created on 2 April 2022) [66].

The partial least squares (PLS) algorithm should be developed [67] in three stages: (i) the estimation of latent variable scores; (ii) the estimation of outer weights/loading and path coefficients; and (iii) the location of parameters [68] as a sequence of regressions in terms of weight [69]. A path coefficient PLS analysis can be implemented using the SmartPLS 3.0 software [61,70,71].

In this analysis, individual beliefs were found to strongly impact the intention to consume insect products (0.600). However, social beliefs had a negligible influence on the intention to consume insect products (0.205). On the one hand, individual beliefs were significantly influenced by reasonable beliefs (0.617) and minimally influenced by emotional beliefs (0.189) or sensory perception (0.149). On the other hand, social beliefs were highly influenced by social acceptability (0.444) and reference to others (0.275). Composite reliability, Rho_A, R-square Cronbach's alpha, and AVE were evaluated regarding the reflexive constructs' validation process, as shown below (Table 6). We observed that all four variables met all the validation criteria at a high percent. There was an exception regarding the Cronbach's alpha value for individual beliefs (0.674), which was smaller than 0.7. However, some statisticians considered that all values higher than 0.6 for Cronbach's alpha showed a consistent model (a good decision in choosing variables).

The path coefficients (Figure 4) show a strong influence of reasonable beliefs -> individual beliefs (0.617), individual beliefs -> intention (0.600), social acceptability -> social beliefs (0.440), and smaller influences of reference to others -> social belief (0.275), social beliefs -> intention (0.205), emotional beliefs -> individual beliefs (0.189), and sensory perception -> individual beliefs (0.149). The indirect effects were also evaluated, as presented in Table 7. We observed that the logical information collected about this type of food influenced the individual beliefs that have a rather high impact on consumption intention (0.370). Another remarkable influence is related to emotional beliefs that affect the consumption intention (0.113).

Table 6. Model validation criteria.

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
VIF Minimum Limit	**>0.7**	**>0.7**	**>0.7**	**>0.5**
Emotional beliefs		1.000		
Individual beliefs	0.674	0.877	0.757	0.504
Intention	0.920	0.923	0.920	0.742
Reasonable beliefs		1.000		
Reference to others		1.000		
Sensory perception	0.887	0.913	0.892	0.738
Social acceptability		1.000		
Social beliefs	0.919	0.922	0.919	0.740

Table 7. Indirect effects.

Specific Indirect Effects	
Reasonable beliefs -> individual beliefs -> intention	0.370
Social acceptability -> social beliefs_ -> intention	0.090
Emotional beliefs -> individual beliefs -> intention	0.113
Sensory perception_ -> individual beliefs -> intention	0.089
Reference to others -> social beliefs_ -> intention	0.056

Individual beliefs correlated positively and firmly with reasonable beliefs (0.824), and reasonable beliefs with intention (0.697) and emotional beliefs (0.690). Emotional and individual beliefs correlated positively and at a medium level with intention (0.688 and 0.551). Sensory perception correlated positively and at a medium level with individual and reasonable beliefs (0.556 and 0.510), as shown in Table 7. Social acceptability and social beliefs correlated positively but only slightly with emotional beliefs, individual beliefs, intention, reasonable beliefs, reference to others, and sensory perception, obtaining values between 3 and 5 (Table 8). All these effects and correlations show that the intention of consuming insect products is influenced significantly by individual beliefs, secondarily by sensory perception, and to a lesser degree by social beliefs.

Table 8. Latent correlation between variables.

	Emotional Beliefs	Individual Beliefs	Intention	Reasonable Beliefs	Reference to Others	Sensory Perception	Social Acceptability	Social Beliefs
Emotional beliefs	1.000	0.688	0.551	0.690	0.242	0.487	0.449	0.421
Individual beliefs	0.688	1.000	0.689	0.824	0.166	0.556	0.469	0.433
Intention	0.551	0.689	1.000	0.697	0.256	0.481	0.488	0.465
Reasonable beliefs	0.690	0.824	0.697	1.000	0.197	0.510	0.466	0.426
Reference to others	0.242	0.166	0.256	0.197	1.000	0.200	0.357	0.432
Sensory perception	0.487	0.556	0.481	0.510	0.200	1.000	0.431	0.365
Social acceptability	0.449	0.469	0.488	0.466	0.357	0.431	1.000	0.538
Social beliefs	0.421	0.433	0.465	0.426	0.432	0.365	0.538	1.000

Following the discriminant validity of the Fornell–Larcker criterion [72], the model is also statistically robust because all values obtained were less than 0.70, meaning that the discriminant validity likely presents between scales taken two by two (Table 9).

The discriminant validity found that the chosen variables we are conceptually unrelated. Sensory perception -> individual belief (0.556), sensory perception -> intention (0.481), individual belief -> intention (0.689), social belief -> intention (0.465), social beliefs -> individual belief (0.433). The standardized root means square residual (SRMR) had a value less than 0.1, demonstrating a good fit [73]. d_ULS represents the squared Euclidean distance, and d_G represents the geodesic distance used to compute the discrepancy which

is based on eigenvalues. The Normed Fit Index (NFI), or the Bentler and Bonett Index [74], is defined as one minus the Chi^2. The greater the number of parameters in the model, the larger (i.e., better) the NFI result [75]. The SRMR, d_ULS, d_G, and chi-square values for the estimation were greater than the values for the saturated models. Thus, we can affirm that our model is consistent and it confirms our hypotheses (Table 10). All the R-square and F-square values confirm the validity of our model (Table 11).

Table 9. Discriminant validity: the Fornell–Larcker criterion.

	Emotional Beliefs	Individual Beliefs	Intention	Reasonable Beliefs	Reference to Others	Sensory Perception	Social Acceptability	Social Beliefs
Emotional beliefs								
Individual beliefs	0.688	0.710						
Intention	0.551	0.689	0.861					
Reasonable beliefs	0.690	0.824	0.697					
Reference to others	0.242	0.166	0.256	0.197				
Sensory perception	0.487	0.556	0.481	0.510	0.200	0.859		
Social acceptability	0.449	0.469	0.488	0.466	0.357	0.431		
Social beliefs	0.421	0.433	0.465	0.426	0.432	0.365	0.538	0.860

Table 10. Model fit.

Latent Construct	Saturated Model	Estimated Model
SRMR	0.062	0.081
d_ULS	1.804	3.073
d_G	0.702	0.745
Chi-square	737.294	761.010
NFI	0.859	0.854

Table 11. R-square and F-square.

Variables	R-Square	R-Square Adjusted	F-Square		
			Individual Beliefs	Intention	Social Beliefs
Emotional beliefs			0.064		
Individual beliefs	0.721	0.717		0.595	
Reasonable beliefs			0.661		
Reference to others					0.102
Intention	0.509	0.504			
Social beliefs	0.355	0.349		0.70	
Social acceptability					0.262
Sensory perception			0.056		

The variance inflation factor (VIF) of each construct (collinearity statistics VIF) was used to check the significance of the variables. The VIF was lower than the maximum limit accepted (5), meaning that no collinearity was manifested between the variables. The variance inflation factor (VIF) of each construct was performed with 1000 samples to evaluate the significance of the variables. A reliability of 95% through the bootstrapping procedure was achieved with the help of the SmartPLS software [66]. The results are summarized in Tables 12 and 13.

Table 12. VIF values.

Variable	VIF	Variable	VIF	Variable	VIF	Variable	VIF
I1	2.454	PSSensPerc28	3.138	AceitSoc46	2.709	RatB35	1.866
I2	2.824	PSSensPerc29	2.049	AceitSoc47	3.733	RatB36	2.805
I3	4.874	PSSensPerc30	3.723	AceitSoc48	2.443	RatB37	2.062
I4	3.784	SocB51	3.419	AceitSoc49	2.159	RefO42	3.889
IndB38	3.433	SocB52	3.000	AceitSoc50	2.294	RefO43	3.858
IndB39	3.375	SocB53	3.345	EmoB31	3.571	RefO45	3.350
IndB40	1.519	SocB54	2.654	EmoB32	3.576		
IndB41	1.010			EmoB33	1.753		

Table 13. Path coefficient analysis of bootstrapping analysis (1000 samples) (source: SmartPLS software, version 3.3.9, created on 2 April 2022) [66].

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	*p*-Values
Emotional beliefs -> individual beliefs	0.181	0.194	0.070	2.602	0.009
Individual beliefs -> intention	0.533	0.534	0.059	8.999	0.000
Reasonable beliefs -> individual beliefs	0.584	0.579	0.063	9.316	0.000
Reference to others -> social beliefs	0.264	0.268	0.060	4.374	0.000
Sensory perception -> individual beliefs	0.129	0.126	0.055	2.332	0.020
Social acceptability -> social beliefs	0.422	0.442	0.056	7.498	0.000
Social beliefs -> intention	0.221	0.221	0.064	3.455	0.001

PLS-SEM is a nonparametric approach that requires no distributional assumptions. However, the parametric significance tests (e.g., as used in regression analyses) cannot be applied to evaluate if outer weights, outer loadings, and path coefficients are significant. Instead, PLS-SEM relies on a nonparametric bootstrap procedure to test the significance of various results such as path coefficients, Cronbach's alpha, HTMT, and R^2 values.

In bootstrapping, subsamples are randomly drawn observations from the original data set (with replacement). A subsample is then used to estimate the PLS path model. This process is repeated until many random subsamples have been created (e.g., 5.000). The estimations from the bootstrapping subsamples are used to derive standard errors for the PLS-SEM results. To assess the significance of PLS-SEM data, the SmartPLS software calculates standard errors, t-values, and confidence intervals [66]. With this information, t-values, p-values, and confidence intervals are calculated to assess the significance of PLS-SEM results [76]. *p*-values less than 0.05 indicate the model's coherence [76]. Our theories will be corroborated if they meet the criteria mentioned earlier.

In the bootstrapping analysis, subsamples were randomly drawn observations to estimate the PLS path model. The estimations aimed to derive standard errors and t-values, p-values, as well as confidence intervals, to assess the significance of PLS-SEM results with the SmartPLS software [66]. The *p*-values lower than 0.05 confirm that the model is coherent and consistent. The hypotheses were accepted based on the above criteria.

6. Discussion

The literature highlights the importance of insect consumption for nutritional health habits [5,7] and their lesser impact on the environment. However, the beliefs, intention,

and behavior research has paid little attention to the factors that influence consumers to experiment with new foods.

The main goal of the present study was to identify factors that influence consumers to try new foods, which was divided into five specific objectives: (i) identify characteristics associated with opinion leaders; (ii) identify variables that influence new food experimentation; (iii) identify agents that influence new food product testing behavior; (iv) identify relationships between variables to develop a model aimed at changing food consumption, and (v) to identify structural aspects that can represent barriers to changes in behavior.

This study provides evidence about demographic and socioeconomic factors, as well as some protein eating behaviors, in contributing to a better understanding of the factors that influence people to try new foods. Several studies such as [6,7,11,14,28] demonstrated that demographic factors are related to people trying new foods, specifically gender and age. Our sample was constituted with almost the same male as female participation in the study. Two different age groups were represented: one group aged from 18 to 25 years old and the other group from 46 to 55 years old, such as [7,11,14].

Regarding socioeconomic status, our sample consisted mostly of active persons who are still employed (63.5%). In addition, it is evident that our sample was strongly represented by respondents with lower and middle income (almost 44% earned from 500 EUR to 1000 EUR per person per month). It is important to mention that the countries considered in the study, Portugal, Romania, and Serbia, have differences in purchasing power that were not considered here.

Regarding protein eating behaviors, almost 44% of respondents did not eat protein at breakfast at all, but they had the consumer habit of introducing animal and vegetable protein, either at lunch or at dinner. However, 44% of the sample answered that they did not eat protein at dinner.

In accordance with the theory of Fishbein and Ajzen (i.e., TRA) [16], the assumptions of this research were that: (i) many variables impact the choice to try a new meal; (ii) intention precedes behavior; and (iii) factors related to the sensory perception to try new meals are relevant [32]. Thus, the primary goal was to understand the qualities and properties of food, as well as the main elements influencing individuals' intention to try new foods. Each concept's variance inflation factor (VIF) was used to assess variable importance.

Our study corroborates results from previous studies identifying variables that influence new food experimentation [14,28,36,39]. We used four formative constructs in our study: emotional beliefs, reasonable beliefs, reference to others, and social acceptability. We also used three reflexive constructs: individual beliefs, social beliefs, and intention.

There is no consensus regarding the relation of influence between these variables. For this reason, in the present study, the influence of the variables' relations was characterized as either strong, moderate, or weak. In our study, individual beliefs had a strong impact on the intention to consume new food, such as insect products. Moreover, not all variables identified in this research generated a strong impact on the intention to consume insect products. For example, social beliefs had a negligible influence on the intention to consume this kind of food. On the one hand, individual beliefs were significantly influenced by reasonable beliefs and very slightly influenced by emotional beliefs and sensory perception. On the other hand, social beliefs were significantly influenced by social acceptability and less by reference to others.

Regarding to the path coefficients, Figure 6 shows a strong influence of some relations between variables. For example, our results show that reasonable beliefs had a strong influence on individual beliefs. There was further evidence of a strong influence of individual beliefs on intention.

The relation between social acceptability and social beliefs showed a moderate influence. Moreover, there were a few relations between variables which evidenced a weak influence. For example, the relation between social beliefs and intention was a weak influence. Another example is the relation between emotional beliefs related and individual

beliefs. In addition, the relation between sensory perception and individual beliefs also evidenced a weak relation of influence.

The indirect effects were also evaluated, as presented in Table 7. We observed that the logical information collected about this type of food influenced the individual beliefs that have a rather high impact on consumption intention. Another influence was related to emotional beliefs that affect the consumption intention.

This study provides insights helping to identify relationships between variables and to develop a model with the aim of changing food consumption. All the effects and correlations in this study provide remarkable evidence of, for instance, the influence of reasonable beliefs on individual beliefs, or of individual beliefs on the intention of consuming insect products. Moreover, social beliefs, as well as emotional beliefs and sensory perception, had a smaller weight of influence on the intention of consuming insect products.

More specifically, reasonable beliefs correlated positively and strongly with individual beliefs. Individual beliefs correlated positively with intention. Moreover, emotional beliefs and sensory perception correlated positively and moderately with individual beliefs. In addition, social acceptability and social beliefs correlated positively with intention, but reference to others had a weak correlation with intention. Our study did not identify relevant agents. Finally, insect-based food constitutes a new food for Europeans. Therefore, structural barriers should be removed.

Entomophagy is a food of good quality that can be an effective alternative to meat, especially if one considers the increasing price of meat and that its detrimental influence on the environment [6] means that it cannot ensure human survival [5,7]. Further reasons to nudge the public toward insect-based food are: (i) its higher nutritional profile, (ii) its lower ecological footprint, and (iii) its strong social acceptability compared to other protein sources [3]. Insect based-food consumption is influenced by culture [14], individual and societal ideas [16] (which might be rational [17] or emotional [18]), and the tactile, olfactory, visual, and gustatory senses.

Insect based-food consumption is also influenced by the state of the matter (liquid, solid) [24,28], temperature (ambient temperature, hot, cold, etc.) [29], perception (amount, distribution, color, etc.) [21], smell (mild/strong, pleasant/unfriendly, etc.) [30], and touch (thick/thin, solid/liquid) [33] of unfamiliar foods [7]. However, the acceptability depends on the way the new meal is presented [14].

Changing dietary habits takes time and effort [37], involving personal [15] and societal views [14]. Consciousness is also a beneficial element [39]. Critical agents and variables that impact food choices should also be identified [40] and a model should be constructed of their interactions. According to the innovation curve, early adopters are vital to shaping public opinion [43,44]. Dearing and Cox argued that resources should be concentrated on a small group of influential persons and organizations [45].

In accordance with the theory of Fishbein and Ajzen (i.e., TRA) [16], the assumptions of this research were that: (i) many variables impact the choice to try a new meal; (ii) intention precedes behavior; (iii) factors related to the sensory perception to try new meals are relevant [32].

PLS-SEM allowed us attain different insights on the variables chosen [61,76]. The Cronbach's alpha index tended to rise with the number of elements (questions). However, keeping items that add nothing to the total score or move it in a different direction is pointless. Therefore, we identified, removed, or adjusted these items according to the spirit of the measured characteristic [64,65]. Thus, our four formative constructs were emotional beliefs, reasonable beliefs, reference to others, and social acceptability, with several subitems. As reflective constructs, we chose individual beliefs, social beliefs, and intention (with several sub-indices).

Our results show that the intention of consuming insect-based food is influenced by individual and social beliefs. However, in turn, individual beliefs were found to be influenced by sensory perception. To put it briefly, the perspectives and recommendations

of people that the respondent cared about were analyzed. Reasonable and emotional components impact individual beliefs. An individual opinion was examined as individual beliefs. The senses impact perception. Social beliefs can be affected by others (references), social standards, social pressure, or cultural factors. The PLS-SEM analysis and a number of tests (CR, CA, AVE, R-square, and F-square) empower us to accept our hypothesis. The estimated SRMR, d ULS, d G, and chi-square values were larger than the in saturated models. Thus, our model is coherent, and we may assume that protein-based alimentation might be included in everyone's life, especially in athletes' diets [77].

7. Conclusions

Plant-based diets and insect-based proteins have significant health and environmental benefits, but they require overcoming obstacles and issues related to acceptance [3]. Food processing, such as food bars, can be a good solution. For example, an insect-based bar can be an excellent alternative to a cereal bar [78]. Some food compounds that are phagostimulants in fermented foods provide functional sensory properties [79]. Even though these food compounds are characterized by a high nutritional value due to the nutrients they contain, the consumption of insects is faced with many barriers. This study aims to find out what makes people try new ways of consuming food.

Although the reference constructs of others need to be improved, early adopters would be important for changing behavior. The study identified variables and agents that influence the behavior of testing new food products, the relationships between these variables, and structuration, and developed a model to change food behavior. The quantitative study was deemed competent for investigating the influencing factors and their relevance. The questionnaire was developed and validated by reviewing the published studies. Quantitative research was used to assess the results' significance. To help overcome some barriers, this research aimed to identify variables that influence the new food experimentation and relationships between variables to develop a model aiming to change food behavior.

On the one hand, we found that individual beliefs are significantly influenced by reasonable beliefs and very slightly influenced by emotional beliefs and sensory perception. On the other hand, social beliefs are significantly influenced by social acceptability and reference to others. In this analysis, reasonable beliefs were found to significantly influence individual beliefs, and individual beliefs to significantly impact the intention of consuming insect products. Social beliefs had a negligible influence on the intention to consume insect products, but social acceptability also had many results. In terms of individuals, the behavior depended on personal and social beliefs, but also on individual perception (namely, sensory perception of food products). Based on the review of the literature, we can conclude that experimentation is influenced by vision, as well as by texture, smell, and taste. People generally seem to consider it difficult to taste food when the insect is seen, although it becomes a little bit easier to try as flour (or another food product). The suggestion is to offer insect-based products which should be as flour, or cooked, or as another industrialized product such as protein bars.

In social terms, because insect-based foods are new for Europeans, the innovation curve tells us that it is necessary to influence those with the "courage to try" (called early adopters). New adopters represent between 16 and 18% of the group. The new adopters will be the ones who influence the group, and their attitude influences the whole group. After that, 34% will be the first followers, and 34% the second followers. The remaining 16% are difficult to change. They will change if there is no other alternative. Thus, the early adopters would be those who have their individual and social beliefs grounded (e.g., those who are concerned about the environment or the future of humanity).

Processing technologies or protein extraction can transform the original food. Through dehydration, drying, crushing, etc., it is possible to alter the physical aspects of insect-based foods, preventing them from being perceived—for example, by the eyes—and masking their taste.

Why are these influencing variables so important? For the theory, the consequences were related to the relevance of the individual and social beliefs for tasting new food products, as well as the sensory perception. The main practical implications were related to the structural aspects that can represent barriers to changing the behavior and, consequently, sustainability. The academic environment in which the questionnaire was applied is a good framework for holding scientific information sessions to provide arguments for individual beliefs—the nutritional value of these foods, food security, etc. Nevertheless, policymakers and leaders can take advantage of the opportunity and obtain benefits from good practices, which can drive us to sustainable development and which are suitable for the environment.

In terms of limitations to our study, considering that insect-based products are food, it would be suggested to develop specific research on sensory perception. The taste, the state of the matter (liquid, solid), the temperature (ambient temperature, hot, cold, etc.), the appearance (quantity, distribution, color, appearance, etc.), the smell (mild/intense, pleasant/unfriendly, etc.), and the texture (thick/low consistent, solid/liquid, etc.) should be further investigated. In addition, insect welfare might be relevant to consumers' perceptions [80]. In a circular economy, from the perspective of resource utilization, insect food and the supply chains for these raw materials are some of the aspects to be considered in insect production [81].

Although this study presents important contributions to theory and practice, there are some limitations. In the present study, the influencers and opinion leaders were considered important. Future work should seek a deeper understanding of the behavioral characteristics that contribute to influencing consumers regarding new food, such as insect-based food. Another important suggestion is that this study should be replicated in other Western as well as non-Western countries in order to understand how different countries and different cultures adopt insect-based food in their dietary habits.

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