

INNOVATIVE FOOD PRODUCTS BASED ON EDIBLE INSECTS

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Purpose: The aim of this article is to investigate attitudes and intentions towards consuming food products based on edible insects.

Design/methodology/approach: In order to directly compare which statements (A. to F.) are more acceptable, a weighted average of the selected answers was calculated for each of them. The χ^2 statistic was used to examine whether there is a dependence between two nominal qualitative variables, and the Spearman's R rank correlation coefficients, which can be used for ordinal qualitative scales.

Findings: The study revealed a low readiness to frequently consume food based on edible insects in the daily diet. Among respondents, curiosity turned out to be an important variable related to the decision to try a product based on edible insects. Interest in food containing an insect component due to additional health benefits was not a factor convincing the respondents to be more interested in this type of food. Taking into account the diversity of responses among respondents, the study revealed that women, people with secondary education, rural residents and people aged 18–24 mostly had a negative attitude towards the intention to consume edible insect-based food. People belonging to the groups: men, people with higher education, city residents and people over 24 years of age seem relatively open to the idea of trying and consuming food products containing edible insects.

Research limitations/implications: There are some limitations to this study. The first is the use of a sample that is not representative and the results of the study cannot be generalized to the population. Another limitation is the fact that data was collected via the Internet, therefore, only users with access to the Internet and basic computer skills participated in the study.

Practical implications: This study provides new insight into the acceptance and intention to consume novel foods based on edible insects before an unknown food product is introduced to the market. The results of this study contribute to the existing literature on the intention to consume innovative foods.

Originality/value: The results of this study highlight the challenges associated with developing the edible insect market as well as the opportunity for education to help promote innovative edible insect-based products.

Keywords: edible insects, entomophagy, insects as food, insect-based products, insect consumption, novel foods.

Category of the paper: Research paper.

1. Introduction

The growth of the world population is causing an increasing demand for food. It is believed that edible insects can be a valuable source of protein in this regard (van Huis et al., 2015; Sun-Waterhouse et al., 2016). It is predicted that the production of insect-based protein powder will be more environmentally beneficial than conventional protein-rich food products (Smetana et al., 2016). Edible insects can thus provide ecological and economic benefits. Edible insects can be a cheaper substitute for expensive animal proteins. Breeding edible insects can reduce the climatic pressure exerted by agriculture and livestock farming, requiring less land, water or feed resources (Premalatha et al., 2011). Optimization of breeding is crucial for sustainable production of edible insects (Costa-Neto, Dunkel, 2016).

In recent years, a much larger variety of products based on edible insects has been offered in Western countries. There is also growing business interest in this new food ingredient, especially in processed insects, cricket or mealworm powder as a food ingredient for other products (e.g. French fries, energy bars and bakery products). Many small and medium-sized enterprises have been established in different European countries with the intention to enter and develop with an innovative food product in this new emerging market (La Barbera et al., 2018).

Previous studies have shown that curiosity is one of the main factors driving intentions and motivating consumers to take the first step towards trying an insect product (Detilleux et al., 2021; Sogari et al., 2017). The results of the study by Menozzi et al., (2017a) confirm that intention is the most important predictor of behavior related to the consumption of a new edible insect product. Consumers are also showing greater openness to consuming insect foods in “invisible” forms (Ruby et al., 2015; Tan et al., 2016a), such as flour or protein powder (Barton et al., 2020). The biggest challenge for the insect-food industry will be to introduce insects to the Western market as a food product that until recently was not considered food at all. The aim of this paper is to investigate attitudes and intentions to consume innovative edible insect-based foods.

2. Methods

2.1. Information about the study

Data were collected in an online interview (n = 477). The research instrument was a survey questionnaire divided into sections. The first one concerned the perception and intention to consume food based on edible insects. All items were measured using the 5 point Likert scale (from “definitely no” to “definitely yes”). The second one included the characteristics of the sociodemographic characteristics of the respondents.

The final sample ($n = 477$) consisted of 307 women and 170 men. Slightly more respondents had secondary education (50.7%) than higher education (49.3%). Of the respondents, 81.1% were under 24 years of age, and a smaller age group was 25 years and older (18.9%). A detailed description of the sample and the socio-demographic profile are presented in Table 1.

Table 1.
Characteristics of respondents

Feature		Number (N)	Structure (in %)
Gender	Female	307	64,4
	Male	170	35,6
Age	18-24 years	387	81,1
	25 years and more	90	18,9
Education	Secondary	242	50,7
	Higher	235	49,3
Place of residence	City	233	48,8
	Village	244	51,2
TOTAL		477	100,0

Source: Own research.

2.2. Statistical analysis of data

The results of the responses obtained were presented in analytical tables in the form of structures, presented as percentages.

In order to directly compare which statements (A. to F.) are more acceptable, a weighted average of the selected answers was calculated for each of them and based on this, a ranking was established from the most to the least acceptable. The following ranks were used to determine the average:

- "definitely not" – rank 1,
- "no" – rank 2,
- "neither yes/nor no" – rank 3,
- "yes" – rank 4,
- "definitely yes" – rank 5.

In order to examine the possible relationship between variables, two measures were calculated:

- 1) The χ^2 statistic, which examines whether there is a relationship between two qualitative nominal variables. The significance level of 0.05 was assumed and if the probability of the χ^2 distribution does not exceed this threshold (i.e. we reject the hypothesis H_0 about independence and accept the alternative hypothesis H_1 about the existence of a relationship between variables), then the strength of this relationship was calculated by determining the Pearson contingency coefficient C (and only then the value of C is determined in the tables). The following interpretation of this coefficient was used:

- $0 \leq C < 0,1$ – faint strength of the relationship,
- $0,1 \leq C < 0,3$ – weak strength of the relationship,

$0,3 \leq C < 0,5$ – average (mean) strength of the relationship,

$0,5 \leq C < 0,7$ – high strength of the relationship,

$C \geq 0,7$ – very high strength of the relationship.

where C takes a value in the range 0-1.

- 2) Spearman's R rank correlation coefficients, which can be used for qualitative ordinal scales. The following interpretation of this coefficient was used:

$0,2 \leq |R| < 0,4$ – weak dependency,

$0,4 \leq |R| < 0,7$ – moderate dependency,

$0,7 \leq |R| < 0,9$ – strong dependency,

$|R| \geq 0,9$ – very strong dependency,

where $|R|$ is the absolute value of R, since the correlation can be positive and negative, so the coefficient can take values from -1 to +1.

3. Results

It was checked (through ranking) which statements among the respondents were more and which were less acceptable. Tables 3, 4, 5, 6 present the results in the form of response rates (in %) and coefficients defining whether and to what extent for each of the statements (A. to E.) the responses vary depending on the four explanatory variables: "Gender", "Education", "Place of residence" and "Age".

Table 2.

Attitude and intention to consume food based on edible insects – opinion ranking

Analyzed statement	definitely not	no	neither yes/nor no	yes	definitely yes	weighted average	ranking
A. I would be willing to eat food based on edible insects in my daily diet	41,5%	26,8%	20,7%	7,6%	3,4%	0,41%	5
B. I would be happy to buy food made from edible insects if it were available on the market	45,1%	25,2%	11,7%	11,3%	6,7%	0,42%	4
C. I will recommend my friends to buy food based on edible insects if it is available on the market	44,2%	29,1%	20,3%	5,2%	1,1%	0,38%	6
D. I would be interested in trying a new dish/product made from edible insects	37,7%	20,1%	13,8%	17,2%	11,1%	0,49%	2
E. In special circumstances, I could eat a dish based on edible insects	31,9%	15,5%	14,3%	25,6%	12,8%	0,54%	1
F. I will be interested in food based on edible insects if it provides additional health benefits (e.g. improves physical condition, strengthens the immune system)	37,7%	16,8%	23,5%	17,8%	4,2%	0,47%	3

Source: Own research.

It should be noted that the differences in averages are not large (from 0.01% to 0.05%), but the first place in the ranking (with the greatest favorability) was taken by the opinion "E. In special circumstances I could eat a dish based on edible insects", and the last place (the least favorable) was taken by "C. I will recommend my friends to purchase food based on edible insects if it were available on the market" (Table 2).

Table 3.

Attitude and intention to consume edible insect-based foods by gender

Analyzed statement	Gender (in %)										C (contingency coefficient)	R (rank correlation coefficient)
	Female					Male						
	definitely not	no	neither yes/nor no	yes	definitely yes	definitely not	no	neither yes/nor no	yes	definitely yes		
A. I would be willing to eat food based on edible insects in my daily diet	47,9	27,7	15,6	5,5	3,3	30,0	25,3	30,0	11,2	3,5	0,27	0,82
B. I would be happy to buy food made from edible insects if it were available on the market	52,1	29,3	10,1	6,5	2,0	32,4	17,7	14,7	20,0	15,3	0,43	0,50
C. I will recommend my friends to buy food based on edible insects if it is available on the market	49,8	29,6	15,0	4,6	1,0	34,1	28,2	30,0	6,5	1,2	0,25	0,90
D. I would be interested in trying a new dish/product made from edible insects	44,6	24,8	13,7	13,4	3,6	25,3	11,8	14,1	24,1	24,7	0,45	0,00
E. In special circumstances, I could eat a dish based on edible insects	37,1	18,9	17,3	23,1	3,6	22,4	9,4	8,8	30,0	29,4	0,47	0,20
F. I will be interested in food based on edible insects if it provides additional health benefits (e.g. improves physical condition, strengthens the immune system)	41,7	19,9	19,5	14,3	4,6	30,6	11,2	30,6	24,1	3,5	0,25	0,62

Source: Own research.

For the individual statements examined, the following relationships were observed.

3.1. Statement A. *I would be willing to eat food based on edible insects in my daily diet*

The Spearman's R rank correlation coefficient indicates a strong positive correlation with gender ($R = 0.82$), so it can be stated that both women and men gave similar answers. However, looking at the percentages, it can be seen that women are more negative, as many as 75.6% (47.9% "definitely not" and 27.7% "no"), while men had a negative attitude of 55.3% (30% "definitely not" and 25.3% "no") (Table 3).

In both age groups (Table 4), negative opinions predominate, with 73.1% (46.5%+26.6%) among people aged 18-24 and 47.8% (20%+27.8%) among people over 24. The similarity of opinions is indicated by the Pearson rank correlation coefficient R, although the strength of the relationship is moderate ($R = 0.6$).

Neither education nor place of residence differentiates the answers among the respondents, which in both cases is indicated by very strong positive correlations of 0.90. However, there are more negative opinions among respondents with secondary education, 74% (45.9%+28.1%), than those with higher education, 62.5% (37%+25.5%) (Table 5). The situation is similar when we analyze subgroups distinguished by place of residence. Negative opinions were expressed by 74.6% of rural respondents, while among urban respondents the percentage was 61.9% (Table 6).

Table 4.

Attitude and intention to consume edible insect-based foods by age

Analyzed statement	Age (in %)										C (contingency coefficient)	R (rank correlation coefficient)
	18-24 years					25 years and more						
	definitely not	no	neither yes/nor no	yes	definitely yes	definitely not	no	neither yes/nor no	yes	definitely yes		
A. I would be willing to eat food based on edible insects in my daily diet	46,5	26,6	15,0	8,0	3,9	20,0	27,8	45,6	5,5	1,1	0,38	0,60
B. I would be happy to buy food made from edible insects if it were available on the market	49,6	29,5	12,1	6,7	2,8	25,6	6,7	10,0	31,1	26,7	0,58	-0,60
C. I will recommend my friends to buy food based on edible insects if it is available on the market	48,3	30,0	15,5	5,2	1,0	26,7	25,6	41,1	5,6	1,1	0,31	0,70
D. I would be interested in trying a new dish/product made from edible insects	43,4	23,0	13,7	16,3	3,6	13,3	7,8	14,4	21,1	43,3	0,59	-0,80
E. In special circumstances, I could eat a dish based on edible insects	36,4	17,6	15,8	26,6	3,6	12,2	6,7	7,8	21,1	52,2	0,62	-0,20
F. I will be interested in food based on edible insects if it provides additional health benefits (e.g. improves physical condition, strengthens the immune system)	42,4	18,	18,6	16,3	4,7	17,8	11,1	44,4	24,4	2,2	0,34	0,50

Source: Own research.

3.2. Statement B. *I would be happy to buy food made from edible insects if it were available on the market*

Greater skepticism towards purchasing products based on edible insects is observed among women: 81.4% (52.1%+29.3%), while among men the same percentage is 50% (32.4%+17.7%). The difference can be seen here when analyzing the ranking of the number of individual answers, where women have the most negative opinions and these numbers gradually decrease, moving on the ordinal scale towards increasingly positive opinions. Among men, the most negative opinion is also the most numerous, but the second place is taken by the positive opinion "yes" (Table 3).

The situation is completely different when we ask people aged 19–24 and over 24 for their opinions (Table 4). Among younger people, the percentage of “definitely not” ratings is the highest - 49.6%, and decreases almost linearly to 2.8% for "definitely yes". On the other hand, the most frequently chosen answers among older people are positive opinions "yes" 32.1% and "definitely yes" 26.7%. Only in third place is the negative opinion "definitely not" 5.6%. It is clearly visible that the opposite of the previous group, positive opinions dominate (positive correlation), however, this relationship is moderate and the R coefficient is -0.6.

People with secondary education expressed a negative opinion in 76.9% (49.2%+27.7%), and those with higher education slightly less, i.e. 63.4% (40.9%+22.6%), however, it should be noted that there is a strong positive correlation (R = 0.7), so education does not differentiate preferences in this respect (Table 5).

The rank correlation coefficient for opinions among rural and urban residents (R = 0.7) also indicates similarity of opinions, but it should be noted that there are almost five times more positive opinions among urban residents (30%) than among rural residents (6.6%) (Table 6).

3.3. Statement C. *I will recommend my friends to purchase food made from edible insects if it is available on the market*

In the case of this statement, none of the explanatory variables significantly differentiate the answers provided. Regardless of the variable, the most common opinions were "definitely not" and this percentage decreases as we move on to increasingly positive opinions. This is confirmed by a very strong positive correlation, which for individual variables is: $R_{(Gender)} = 0,9$; $R_{(Education)} = 1,0$; $R_{(Place\ of\ residence)} = 0,9$ and a slightly smaller, moderate correlation for $R_{(Age)} = 0,7$ (Tables 3, 4, 5, 6).

Table 5.
Attitude and intention to consume food based on edible insects according to beducation

Analyzed statement	Education (in %)										C (contingency coefficient)	R (rank correlation coefficient)
	Secondary					Higher						
	definitely not	no	neither yes/ nor no	yes	definitely yes	definitely not	no	neither yes/ nor no	yes	definitely yes		
A. I would be willing to eat food based on edible insects in my daily diet	45,9	28,1	14,5	8,3	3,3	37,0	25,5	27,2	6,8	3,4	0,20	0,90
B. I would be happy to buy food made from edible insects if it were available on the market	49,2	27,7	14,9	6,2	2,1	40,9	22,6	8,5	16,6	11,5	0,32	0,70
C. I will recommend my friends to buy food based on edible insects if it is available on the market	49,2	30,2	14,5	5,0	1,2	39,2	28,1	26,4	5,5	0,9	0,19	1,00
D. I would be interested in trying a new dish/product made from edible insects	42,6	24,8	14,9	14,5	3,3	32,8	15,3	12,8	20,0	19,2	0,34	0,20

Cont. table 5.

E. In special circumstances, I could eat a dish based on edible insects	36,8	17,4	16,5	25,6	3,7	26,8	13,6	11,9	25,5	22,1	0,34	0,70
F. I will be interested in food based on edible insects if it provides additional health benefits (e.g. improves physical condition, strengthens the immune system)	43,0	18,6	19,4	14,5	4,6	32,3	14,9	27,7	21,3	3,8	0,19	0,90

Source: Own research.

3.4. Statement D. *I would be interested in trying a new dish/product made from edible insects*

The respondents' answers for both genders differ, with 69.4% of women having a negative attitude towards trying this type of products (44.6% "definitely not", 24.8% "no") and 16.9% having a positive attitude (13.4% "yes" and 3.6% "definitely yes"). There are almost half as many men with a negative attitude than women, i.e. 37.1% (25.3% "definitely not" and 11.8% "no"), and almost three times as many men with a positive attitude than women, i.e. 48.8% (24.1% "yes" and 24.7% "definitely yes"). However, the Pearson rank correlation coefficient R indicates a complete lack of relationship between this variable and gender ($R = 0$). This does not mean that there is no relationship between the two gender groups. The probability of the χ^2 distribution is 0.00, so the hypothesis of independence of variables should be rejected and it should be assumed that such a relationship exists. The strength of this relationship, measured by the Pearson C coefficient of 0.45, should be assessed as average (Table 3).

People aged 18-24 are much more skeptical than older people. Younger people most often chose the rating "definitely not" (43.4%), followed by "no" (23%), and this percentage further decreases when we move on to positive ratings "yes" (16.3%) and "definitely yes" (3.6%). The numbers of ratings are reversed for people aged 25 and over, where the majority of opinions are definitely positive (43.3%) and decreases when moving on to opinions that are definitely negative (21.1%; 14.4%; 7.8%; 13.3%). This is confirmed by the Pearson R rank correlation coefficient value of -0.8, so this relationship should be described as strong. The strong negative correlation indicates that it is possible to statistically justify the claim that older people (over 24 years old) have a different opinion than younger people (18-24 years old) (Table 4).

The relationship between the level of education and the analyzed variable is weak ($R = 0.2$), but the existence of this relationship is confirmed by the χ^2 test and the strength of the relationship is average ($C = 0.34$). There are more people with secondary education who have a negative attitude, 67.4% (42.6% "definitely not" and 24.8% "no"), and 17.8% have a positive attitude (14.5% and 3.3%, respectively). Among people with higher education, negative opinions also predominate, 48.1% (32.8% "definitely not" and 15.3% "no"), but there are fewer of them, less than half and not 2/3 as among people with secondary education. The percentage of people with a positive attitude is also correspondingly higher: 39.2% (20.0%+19.2%) (Table 5).

The percentages of positive/negative ratings are also different among rural and urban residents. 68.9% of rural residents rate this idea negatively (41.4%+27.5%), while the number of urban residents with a negative rating is 1/3 lower, at 46.4% (33.9%+12.5%). Similarly, there are more people with a positive attitude among urban residents - 40.3% (20.2%+20.2%), compared to 16.8% (14.3%+2.5%) of rural residents. The Pearson rank correlation coefficient R indicates no relationship between this variable and place of residence (R = 0.13), but as above, the probability that these variables are independent (measured with the χ^2 test) is too small (0.00) to accept this hypothesis. Therefore, there is an average (C = 0.31) relationship between urban and rural residents, although it is difficult to talk about the direction of this relationship (Table 6).

Table 6.
Attitude and intention to consume food based on edible insects by place of residence

Analyzed statement	Place of residence (w %)										C (contingency coefficient)	R (rank correlation coefficient)
	Village					City						
	definitely not	no	neither yes/nor no	yes	definitely yes	definitely not	no	neither yes/nor no	yes	definitely yes		
A. I would be willing to eat food based on edible insects in my daily diet	46,7	27,9	15,2	6,2	4,1	36,1	25,8	26,6	9,0	2,6	0,20	0,90
B. I would be happy to buy food made from edible insects if it were available on the market	50,0	31,2	12,3	4,9	1,6	39,9	18,9	11,2	18,0	12,0	0,37	0,70
C. I will recommend my friends to buy food based on edible insects if it is available on the market	48,8	31,2	13,5	5,7	0,8	39,5	27,0	27,5	4,7	1,3	0,22	0,90
D. I would be interested in trying a new dish/product made from edible insects	41,4	27,5	14,3	14,3	2,5	33,9	12,5	13,3	20,2	20,2	0,39	0,13
E. In special circumstances, I could eat a dish based on edible insects	34,0	18,4	18,4	25,4	3,7	29,6	12,5	9,9	25,8	22,3	0,36	0,67
F. I will be interested in food based on edible insects if it provides additional health benefits (e.g. improves physical condition, strengthens the immune system)	42,2	18,9	20,1	15,2	3,7	33,1	14,6	27,0	20,6	4,7	-	0,90

Source: Own research.

3.5. Statement E. *In special circumstances, I could eat a dish based on edible insects*

Opinions on the thesis differ between the genders. Women reject this idea in 56% (37.1%+18.9%) of cases, while 26.7% of women (23.1%+3.6%) accept it. More than twice as many men (59.4%) as women (26.7%) would consider eating such a dish. Although the hypothesis of the existence of a relationship between variables should be accepted, it should be assessed as weak (Table 3).

The answers given by both age groups differ significantly. Negative responses among people aged 18–24 amount to 54% (36.4%+17.6%) and positive responses to 30.2% (26.6%+3.6), while among people older than 24, negative responses are only 18.9% (12.2%+6.7%) and positive ones as many as 73.3% (21.1%+52.2%). The value of the coefficient $R = 0.2$ indicates that there is a negative correlation of ranks, although it is weak, while $C = 0.62$ indicates that the choices of both groups differ significantly (Table 4).

Among people with secondary education, negative attitudes dominate in 51.4% and positive attitudes in 29.3%. The situation is reversed among people with higher education, where 47.7% of attitudes are positive, compared to 40.4% of those who are reluctant (Table 5).

The place of residence differentiates the responses in a similar way, with rural residents reporting more negative opinions (52.5%) than positive ones (29.1%). Among urban residents, there were fewer negative responses (42.1%) than positive responses (48.1%). However, these are not large differences and the opinions of both groups are similar (the rank correlation coefficient $R=0.67$ shows that we can speak of a moderate positive relationship here) (Table 6).

3.6. Statement E. *I will be interested in food based on edible insects if it provides additional health values/benefits (e.g. improves physical condition, strengthens the immune system)*

The opinions of both gender groups do not differ much and are mostly negative, 61.6% among women and 41.8% among men (Table 3). Similarly, the level of education and place of residence do not differentiate opinions on the analyzed issue. It should be noted, however, that there are more negative opinions among people with secondary education (61.6%) than with higher education (47.2%) and among rural residents (61.1%) than urban residents (47.6%). The strength of the relationship measured by the Spearman's rank correlation coefficient R for gender is moderate (0.62) and for education and place of residence very strong (0.9) (Tables 3, 5, 6).

The analysis of both age groups confirms that they have similar opinions, which is confirmed by the calculated coefficient $R = 0.5$, although this relationship should be described as moderate. Among 18-24-year-old respondents negative opinions were expressed by 60.5% (42.4%+18.1%) and among those over 24 years of age by 28.9% (17.8%+11.1%). The main difference is the percentage of people expressing neutral opinions "neither yes/nor no", which is almost two and a half times higher among the older respondents (44.4%) compared to the younger respondents (18.6%) (Table 4).

4. Discussion

Comparison of our results with studies from other countries highlights differences in regional attitudes towards entomophagy. In our study, only 11% of respondents declared willingness to frequently consume food based on edible insects in their daily diet. On the other hand, 18% of respondents declared willingness to purchase food based on edible insects. The situation looks slightly better regarding the consumption of food based on edible insects in special circumstances - 38.4% of respondents declared such willingness. Studies conducted among Belgian consumers showed that less than half of respondents were willing to try insect products (Van Thielen et al., 2019), while in another study involving Belgian consumers, 77.7% reported willingness to consume products based on edible insects (Caparros et al., 2014). The results of studies on willingness to try have shown that US consumers seem relatively open to the idea of trying food products containing insects, with 72% of respondents in the study by Ruby et al., (2015) and 60% in the study conducted by Ardoin, Prinyawiwatkul (2020). In contrast, when similar questions were asked of Italian respondents, intention to try ranged from only 17% to 31% in three separate studies (Cicatiello et al., 2016; Laureati et al., 2016; Palmieri et al., 2019). In turn, Castro and Chambers (2019), collecting data from multiple countries, found similarly low willingness to eat insect-based foods among consumers in the UK, Spain, and Australia (all between 33% and 36%). Consumers in the USA seemed less willing to regularly eat insect-based foods (Woolf et al., 2019) than to try them (Ruby et al., 2015). In a Polish study, 41% of consumers would purchase insect-based products if they were available on the market (Zielińska et al., 2020).

Two important variables related to the decision to try edible insects among respondents are curiosity and interest (Berger et al., 2018). In the case of unfamiliar food such as insects, the first attempt to consume may consist of a level of interest and curiosity that exceeds fear and disgust (Tan et al., 2015; Balzan et al., 2016). In our study, 28.3% of respondents declared that they would try an insect-based product out of curiosity. Results from a study conducted among Belgian respondents who agreed to participate in an insect tasting experiment, curiosity (69%) was more common than fear (14%) and disgust (13%) at the thought of eating insect-based food (Caparros et al., 2016). Similarly to the study by Tuccillo et al. (2020), they noted that the main motivation for including insects in the Italian diet is curiosity. The intention to try is a strong predictor of the behavior of eating this type of food.

From the perspective of additional benefits, information about health values is important for consumers' perception of food based on edible insects. As found by de-Magistris et al. (2015), Dutch consumers were willing to pay a higher price for an insect-based product with a health claim related to the content of "omega 3". Interest in food due to additional health benefits, e.g. strengthening the immune system, was declared by 22% of respondents in our study.

The results of the studies show that men are more open to trying edible insect-based foods than women. Looking at the results of our study, it can be seen that women have a more negative attitude towards foods based on edible insects than men. The effect of gender on the likelihood of trying insect-based foods indicates that men were consistently more likely to eat insects than women (Sogari et al., 2019). These findings are consistent with other reports in which men are more likely to try entomophagy than women (Caparros et al., 2016; Menozzi et al., 2017). The influence of gender is also well demonstrated by other studies on edible insects (Hartmann et al., 2015; Michel, Begho, 2023; Sogari et al., 2017; Tan et al., 2016). These results confirm, as expected, that gender as a very important explanatory variable for consumer evaluation of food based on edible insects.

Young adults with higher education have been shown to be more open to food based on edible insects (Cicatiello et al., 2016; Roma et al., 2020). This is confirmed by our research results - there were more negative opinions among people with secondary education than among those with higher education. In both age groups, negative opinions prevail, but there were more of them among people aged 18-24 than among people over 24. Many studies have shown that age and education are predictors of willingness to eat insects, with younger and better educated participants more likely to have positive perception of edible insect-based foods (Cicatiello et al., 2016; Collins et al., 2019; Roma et al., 2020). It can be clearly stated that younger, male, and better educated consumers had a more favorable attitude towards foods based on edible insects.

5. Summary

In general, it should be stated that there is a negative attitude towards food based on edible insects. Out of 48 analyzed subgroups (6 issues studied divided into 4 sociodemographic features and each of them divided into 2 subgroups), only 7 of them had a predominance of positive opinions. Women, people with secondary education, rural residents and people aged 18-24 mostly chose the answer "definitely no" or "no" and in the minority these were positive opinions "yes" or "definitely yes". Among people belonging to the groups: men, people with higher education, city residents and people aged over 24, there were cases where the positive answers "yes" or "definitely yes" prevailed over the negative ones.

It should be emphasized that the production and availability of innovative food products based on edible insects should be regulated by guidelines regarding their safety. With increased exposure to edible insects will also come familiarity, which is necessary to overcome neophobia, where novelty is at the root of aversion. Even the most negative associations of edible insects with disgust may fade with time and well-directed product development (Simpson et al., 2006). Progress towards large-scale adoption of entomophagy will require

a gradual shift in the positioning of insects in the marketplace, as well as consumer acceptance. Finding a niche for insects in modern food systems, beyond novelty products, will require sustained effort by food companies and will be a very gradual process. Educational campaigns can prepare people to adopt entomophagy and help them overcome their reluctance (Costa-Neto, Dunkel, 2016; Hamerman, 2016). In the current environment, consumers do not seem prepared for a rapid shift towards insect consumption.

Changing the mindset and, more importantly, the behaviors of large segments of consumers is a difficult task, especially given that food choices are partly irrational and claims about environmental and social benefits are too distant in time and culture to seem relevant to consumers.

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