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Insects as food - Changes in consumers' acceptance of entomophagy in Hungary between 2016 and 2021

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ABSTRACT

Public interest in entomophagy (consumption of insects) has developed significantly over the past several years. Possible nutritional benefits are perceived by consumers according to several recent studies, as well as sustainability and food security. However, most European communities, including the Hungarian, do not embrace entomophagy, despite the widespread practice elsewhere globally. This study aims to evaluate the changes in the perception of entomophagy among the Hungarian population between 2016 and 2021, together with the factors differentiating between acceptive and dismissive consumers. The results of the two representative quantitative surveys indicate that more than 70% of Hungarian consumers are not willing to try entomophagy, which had not changed significantly in the observed period, despite the high media coverage of this topic in recent years. Some groups open to insect consumption can still be identified. According to the socioeconomic segmentation of the data collected in 2021, consumers who accept insect-based foods can be found in high numbers among men between 18 and 39 years old (49.3%). Positive attitudes are less likely to be observed among females; however, 27.6% of highly educated women between 18 and 59 years demonstrated a certain level of interest. Those consumers willing to consume insects are driven mainly by curiosity, and also value high protein content and sustainability, and perceive insect-based food as nutritious. Consumers who prefer local and national food tend to refuse to eat insects in a higher ratio.

1. Introduction

Protein is one of the most vital human nutrients, and everyone needs around 0.8–1.0 g of protein/kg of body weight daily (Richter et al., 2019). Animal products, like meat, are regarded as excellent sources of protein for humans: protein sources such as pork, beef, poultry and fish contain approximately 19–21% protein (Ariño et al., 2013; Montalvo-Puente et al., 2018). Demands have increased for meat products, resulting in the fast expansion of the livestock sector, particularly in European countries (Food and Agriculture Organization, 2002; Landgeist, 2021). This has been further amplified by the population growth, which is anticipated to reach 9.7 billion by 2050 (United Nations, 2019). Yet, the livestock industry's growth also significantly influences the environment, as meat production is accompanied by a high level of land and water usage and greenhouse gas emission (Singh et al., 2021). As a result, food industry gradually turns toward more sustainable meat substitutes to replace traditional protein sources.

In recent years many have believed that insect protein is a promising option, and different insect-based products can also be used as a source of macronutrients, micronutrients, and bioactive food components (Lange & Nakamura, 2021). Insects have a protein level ranging from 9.96 to 35.2 g per 100 g, which shows a great potential to substitute traditional animal proteins (Payne et al., 2016). In addition, ten essential and semi-essential amino acids are found in insects that are crucial for the human body (Payne et al., 2016). Also, the edible portion (%) of cricket is 80%, significantly higher than that of poultry (55%), pork (55%), and beef (40%) (Van Huis, 2013). In parallel, the feed conversion ratio (FCR) of insects is also significantly better than other conventional animal protein sources (Fig. 1), and they are not particularly selective in regard to feed quality than traditional food animal species (Kemenczei

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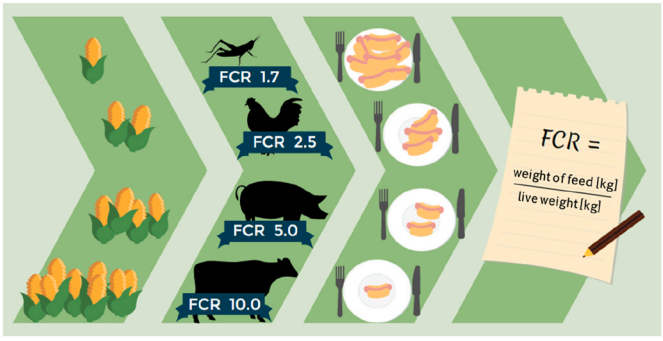

Fig. 1. Feed conversion ratio (FCR) values of different protein sources based on Kemenczei et al., (2016a).

et al., 2016a).

FAO has released a report titled "Edible Insects: Future Prospects for Food and Feed Security" that emphasizes the potential for insect consumption in terms of sustainability and human health, and encourages innovation in this new food category (Van Huis et al., 2013). According to the report, the benefits of ingesting insect protein over animal protein include better feed conversion efficiency, the responsibility for lower greenhouse gas and ammonia emissions and water consumption, ensuring animal welfare more easily, smaller production cost, a short life cycle, and a lower space demand (Van Huis, 2013). Additionally, diversifying diets and enhancing food security by reducing the incidence of starvation in nations with limited economic resources can be mentioned (daSilva Lucas et al., 2020). Therefore, it may be concluded that insects constitute a valuable edible alternative food source for humans.

Besides all the advantages, it must be kept in mind, as with the consumption of all kinds of foods, there are also risks associated with insects used for food purposes. In terms of microbiological hazards, the presence of pathogens and their toxins is strongly related to the substrates used as feed. Still, un-processed insects generally pose a similar risk to meats or other animal protein sources. A circumstance specific to insects is that they might be fed manure, sewage or other human and animal wastes. In these cases, particular attention must be paid to appropriate pretreatment due to microbiological contaminants (for example, spore-forming bacteria can survive even at high temperatures) (European Food Safety Authority (EFSA), 2015). Given these circumstances, extraordinary attention should be placed on traceability and consumer information. In the case of insects collected from the wild and which were not farmed in a controlled environment (mostly imported from outside the EU), the analysis of the concentration of chemical contaminants such as pesticides and heavy metals might be important (Kemenczei et al., 2016b). Allergies and the primary sensitization of those working in processing insects can also be problematic (EFSA, 2015).

More than two billion people globally routinely consume insects (Van Huis et al., 2013). In 130 countries, 3071 ethnic groups consume over 2086 insect species, with the African, Australian, Asian and South-American continents traditionally being the most entomophagous regions (Lange & Nakamura, 2021; Ramos-Elorduy, 2009). However, insect-based foods are still not common in Europe. Only products made from four insect species have been assessed as safe for human consumption by EFSA (European Food Safety Authority) so far: the yellow mealworm (*Tenebrio molitor larvae*), the migratory locust (*Locusta migratoria*), the house cricket (*Acheta domesticus*) and the lesser mealworm (*Alphitobius diaperinus larvae*) (European Union Law, 2021; 2022a; 2022b, 2023). In the evaluation of the authorized products, EFSA notes that for people who have allergies to crustaceans, mites and molluscs, there is a risk of allergic reactions caused by the insect proteins; moreover, allergens from the feed (e.g. gluten) also can be present in the final form of the processed products (EFSA, 2021a; 2021b; 2022a; 2022b). Despite the level of rejection by consumers, numerous products are currently awaiting the completion of the mandatory risk assessment and authorization process (European Commission, 2023). Due to the asymmetry between the number of insect species consumed around the world and the number of authorized within the EU, the possibility of producing counterfeit food may be tempting, especially in the case of processed foods in which the origin of insect-based ingredients cannot be defined easily (such as insect-flours or protein-extracts); however, there have been promising results on the identification and differentiation recently (Benes et al., 2022).

The majority of people do not perceive insects as possible food material and often associate them with negative connotations (Balogh, 2016; Looy et al., 2014; Mancini et al., 2019; Szczepanski et al., 2022; Szendrő, Tóth, & Nagy, 2020). Several consumers define insects as sources of health risks and unfit for consumption (Van Huis, 2013), especially certain insect species considered poisonous due to the accumulation or synthesis of toxic chemicals (Mézes, 2018) and transferring pathogens (Smith et al., 2022). Other reasons why consumers do not want to eat insects are related to numerous factors, such as food neophobia, eating insects previously and having negative experiences, also disgust (Balogh, 2016; Gere et al., 2017; Hartmann & Siegrist, 2016; Lammers et al., 2019; Mancini, Sogari, et al., 2019; Szenrdő et al., 2020a; Toti et al., 2020).

Several studies found that less than 20% of the consumers in Western societies were ready to adopt insects as food (Naranjo-Guevara et al., 2021; Ribeiro et al., 2022; Verbeke, 2015). Northern European populations seem to be more accepting than Central Europe (Piha et al., 2018), including Hungary (Gere et al., 2017; Szendrő, Tóth, & Nagy, 2020), where only 11% of a relatively small and young sample was willing to try edible insects in previous research (Balogh, 2016). In terms of Italian consumers, age, gender, cultural background, and food neophobia influenced the willingness to consume insects as food and animal feed (Laureati et al., 2016). As recent studies highlighted, Greek, Dutch, and German consumers prefer insects as feed instead of food (Giotis & Drichoutis, 2021; Naranjo-Guevara et al., 2021) since disgust is reduced in this case. Based on Mancini et al.'s (2019b) review, disgust has an even more substantial discouraging effect than neophobia in European consumer groups (Mancini, Moruzzo, et al., 2019).

In the Hungarian context, there is insufficient information accessible concerning entomophagy and the acceptance of insects in food products, as no representative surveys have been done with satisfactorily large sample sizes among consumers so far (Gere et al., 2017; Szendrő, Tóth, & Nagy, 2020). Since the issue was first investigated in Hungary in 2016, foods containing insects have not only become more and more known due to the growing media attention (Smith, 2022), but in 2021, the first insect food product was also authorized as a novel food in the EU (European Commission, 2021). Considering all the above, our hypotheses included: firstly, most of the Hungarian population rejects insect consumption, but secondly, acceptance has significantly increased from 2016 to 2021; and lastly, a demographic group open to insect consumption can be distinguished, in which young men are overrepresented. Hence, this study aims to explore the attitude of the Hungarian population towards edible insects and the changes in consumers' openness from 2016 to 2021, investigate the background of willingness-to-try, the influencing aspects of food choice and identify the groups potentially interested in entomophagy.

2. Methods

2.1. The surveys and the participants

Two quantitative consumer surveys were conducted in the framework of the study in accordance with the protocol approved by the Scientific Research Committee of the University of Veterinary Medicine Budapest and in compliance with the General Data Protection Regulation (GDPR). The first survey was implemented in April 2016, counting

1024 participants, and the second in 2021, between April–July with 1001 respondents. All respondents gave informed consent to participate in the survey.

The first research completed in 2016 was undertaken in nine Hungarian cities: Budapest, Debrecen, Szolnok, Győr, Miskolc, Nyíregyháza, Pécs, Székesfehérvár and Szeged. Meanwhile, the second research, performed in 2021, was implemented in Dombóvár, Füzesabony, Győr, Kecskemét, Sárbogárd, Siófok, Székesfehérvár, Szolnok and Veszprém.

The participants were randomly selected in both cases; however, quotas were set up based on the latest censuses (Hungarian Central Statistical Office (HCSO), 2013, 2016) to ensure the representativeness of the sample according to the total Hungarian adult population regarding gender, age, and geographical distribution (NUTS-2 regions) (Table 1). The respondents received information about the purpose and topic of the research, the anonymous data handling and storage procedure, and the analysis before the interview. If respondents consented to participate, the quota factors (age, gender, and geographic area) were recorded based on self-reporting; hence the interviewers could follow the quota ratios.

The paper-based questionnaire was designed following the research objectives to obtain data on particular situations related to food consumption (Verbeke, 2005). Even though the questionnaire was intended to be self-administered, interviewers assisted the respondents in completing it when needed. The length of the interview was approximately 15–18 min per respondent. The respondents were asked about their perspectives on insect consumption via closed- and open-ended questions. 5-point Likert-scales (1 = not important at all, 5 = extremely important) and single-choice questions were used to quantify the consumption and preference-related variables. Demographic information such as level of income and education, as well as the type of education, were integrated into the last section of the questionnaire (Table 2).

2.2. Statistical analysis

The statistical data analysis was carried out using the IBM SPSS Statistics 26.0 software package. Besides descriptive analysis, correlations and differences between the 2016's and 2021's samples were determined using cross-tabulations combined with Pearson's χ^2-test supplemented by z-test (at a 95% significance level). The dataset collected in 2021 was further analysed. Regarding the important aspects of food choice, Kruskal-Wallis H-test followed by Dunn's post hoc test with Bonferroni correction ($p < 0.05$ was regarded as significant) was applied. Based on the willingness to try insect consumption considering the socio-demographic variables, the CHAID (Chi-squared Automatic Interaction Detection) technique was used in order to identify the potentially open group(s). CHAID is a suitable statistical method for population segmentation considering demographic data (Chung et al., 2004; Legohérel et al., 2015). The socio-demographic variables examined by CHAID included age, sex, education, and income level (Adasme-Berríos et al., 2015). The Bonferroni-controlled χ^2-statistic with a p-value of 0.05 was applied to determine the most significant multinomial splits (Biggs et al., 1991).

Table 2
Further socio-demographic characteristics of the sample (valid % of respondents).

Socio-demographic categories		2016	2021
Type of residence	Village	16.41	16.27
	City	62.79	59.79
	Capital	20.80	23.94
Education	Primary education	13.31	11.16
	Secondary education	42.80	36.03
	Higher education	43.89	52.81
"Natural science" specialization among those with higher education	Yes	27.23	20.00
	No	72.77	80.00
Connection to work to food production and food trade	Yes	11.91	21.28
	No	88.09	78.72
Level of income	Very low	4.76	1.04
	Low	22.39	14.66
	Average	56.03	66.32
	Above average	15.20	16.01
	Outstanding	1.62	1.97

3. Results and discussions

3.1. Acceptance of entomophagy among Hungarian consumers between 2016 and 2021

The percentage of the Hungarian population ready to consume insect products is increased slightly from 4.47% in 2016 to 4.91% in 2021, even though the number is still low (Table 3). However, consumers who

Table 3
Hungarian consumers' acceptance of entomophagy in 2016 and 2021.

Would you like to eat food made from insects?	2016	2021
Yes (%)	4.47	4.91
Maybe, I would try it (%)	25.34	22.52
No (%)	70.19	72.57
Total (%)	100.00	100.00

Table 1
Representative socio-demographic characteristics of the sample (% of respondents, $N_{2016} = 1024$, $N_{2021} = 1001$).

Socio-demographic Categories		2016		2021	
		Sample	Population[a]	Sample	Population[a]
Gender	Woman	52.64	53.00	52.65	53.07
	Man	47.36	47.00	47.35	46.93
Age group (years old)	18–29	15.53	16.00	17.48	17.59
	30–39	21.19	20.00	16.88	17.04
	40–59	33.79	35.00	33.87	33.83
	60-	29.49	29.00	31.77	31.54
Region of residence	Central Hungary	30.53	30.00	30.97	30.75
	Central Transdanubia	11.69	11.00	10.29	10.80
	Western Transdanubia	9.12	10.00	10.49	10.03
	Southern Transdanubia	8.92	9.00	9.19	9.13
	Northern Hungary	11.79	12.00	11.79	11.62
	Northern Great Plain	16.25	15.00	14.38	14.90
	Southern Great Plain	11.69	13.00	12.89	12.78

[a] Note: Ratio in the population according to the latest census at the time of each survey (HCSO, 2013, 2016).

reject insect-based products also grew: from 70.19% to 72.5%. The percentage of customers who responded, "Maybe I would try it", decreased from 25.45% to 22.52%. The differences between 2016 and 2021 were not significant ($\chi^2 = 2.2585$; df = 2; p = 0.3233). A more substantial increase in acceptance was expected since, over the years, food and feed products containing proteins from insects became more widely available, especially in the online markets; and the topic received intense media attention. In addition, several business investments, research projects, innovation activities and conferences promoting the consumption of insects have been organised in Hungary since the time of the first survey (Harsányi et al., 2020; Pintér et al., 2021).

3.2. Differences in the importance of food purchasing factor, as well as the relationship between entomophagy willingness and attitudes about consuming Hungarian products

Hungarian consumers are much more dismissive of insect consumption than the European average despite the majority (60%) have already heard of insect consumption as a phenomenon and been also aware of its benefits (namely nutritional value and environmentally friendly production method) according to previous studies (Gere et al., 2017; Szendrő, Tóth, & Nagy, 2020). One of the most influential barriers to the consumption of edible insects is food neophobia (Balzan et al., 2016; Gere et al., 2017; Hartmann & Siegrist, 2016; Szendrő, Tóth, & Nagy, 2020). Food neophobia is a psychological attitude that refers to a person's unwillingness to try new foods and propensity to avoid them (Siddiqui et al., 2022). In countries where long-standing national traditions are related to gastronomy and food consumption (e.g. Italy), it is typical that they are less open to new food products than residents of countries with a food culture that alters continually (e.g. the Netherlands or Denmark) (Verneau et al., 2016). The results of the present research are also in line with this (Table 4) since those respondents for whom it is essential to buy Hungarian products - which attribute is perceived as firmly attached to traditional products according to Fricz et al. (2020) - were significantly more dismissive to insect consumption ($\chi^2 = 21.0404$; df = 4; $p < 0.001$).

The attitude to choose traditional and local foods was also found to be influential to the willingness to entomophagy (Table 5). According to Dunn's post hoc test, trustworthiness (reliable origin, trusted manufacturer/brand, trademark), domestic source (made in Hungary, small-scale/local product), and food feature-related attributes (safety, quality, GMO-free (GMO: Genetically modified organism)) had significantly higher importance for participants who keep aloof themselves from entomophagy. Purchasing an environment-friendly product is slightly more important for consumers willing to try edible insects; however, this connection was not significant (Table 5). The nutritional aspect (the food product should fit into a healthy diet) could have also reached higher scores on the Likert-scale among the open respondents considering the results of other similar studies (Gere et al., 2017); however, in our case, no significant difference was observed here.

Table 4
Relationship between willingness to try entomophagy and attitudes toward consuming Hungarian products (superscripts refer to the results of the z-test, different characters represent significantly different groups, results from 2021).

Would you like to eat food made from insects?	Are you paying attention to buying Hungarian food?		
	Yes, I always pay attention	I only pay attention in case of certain products	No, it doesn't matter to me
Yes (%)	2.91[a]	6.85[b]	6.31[b]
Maybe, I would try it (%)	17.43[a]	25.59[b]	28.16[b]
No (%)	79.66[a]	67.56[b]	65.53[b]
Total (%)	100.00	100.00	100.00

3.3. Game changers for the acceptance of entomophagy

In addition to food neophobia, disgust has also a substantial, detrimental impact on customers' propensity to consume insect-based foods (Barbu et al., 2022; Szendrő, Tóth, & Nagy, 2020). The aversion can be reduced effectively, if the insects are introduced in a processed form, for example, as flour or additional protein to foods such as dry pasta, biscuits, and baked goods (Orkusz et al., 2020). Another solution for integrating insects to achieve a more sustainable food chain could be using them as feed (Kopnina, 2022), although Hungarian consumers are reluctant regarding this possibility. In previous research by Szendrő, Nagy, and Tóth (2020), such an ambivalent attitude was observed since outdoor keeping was considered the best option for livestock farming in connection with animal welfare while insects as feed were rejected. This suggests a lack of knowledge and understanding because it is natural for animals like poultry to eat insects.

Nevertheless, each Hungarian consumer who accepts entomophagy at least partially has their own reason for welcoming insects into their diet. According to Table 6, the three most influential triggers for consumers to eat insect products in Hungary are curiosity, high protein content, and sustainability aspects. This result is in accordance with numerous studies (Sogari, 2015; Stone et al., 2022), in which curiosity, nutritional and environmental benefits were the most important factors in motivating the consumption of insects. However, the fact that the nutrition-, health- and sustainability-related features were not significantly more valuable for the accepting respondents in terms of general food purchases suggests that when it comes to insect-based foods, these aspects would be ranked ahead of the others.

3.4. Which Hungarian consumers would like to consume insect-based foods?

Socio-demographic characteristics of consumers, such as age and gender, are additional attributes that influence consumers' willingness to accept insects as food (Laureati et al., 2016), which correlates with the findings of this study. Results of the CHAID analysis showed significant differences between consumers based on gender, age group and level of education. However, income did not influence the forming of the nodes at a 95% significance level (Fig. 2). In terms of gender, men have a higher acceptance than women: 7.2% of men would like to eat foods made with insects indeed, while this ratio was only 2.9% among women (Fig. 2). This finding is consistent with other research indicating that men are more accepting of insect products than women, as they tend to be less neophobic, more interested in innovations and have a more adventurous taste (Gere et al., 2017; Megido et al., 2016; Menozzi et al., 2017; Modlinska et al., 2021; Schlup & Brunner, 2018; Szendrő, Tóth, & Nagy, 2020; Verbeke, 2015). The results also indicated that men between the ages of 18 and 39 were the most open. 97 participants answered "yes" or "maybe", which is a non-negligible number of elements considering all the respondents (9.93% of those who answered). According to the CHAID analysis, education did not significantly affect the entomophagy acceptance of any group of men.

In contrast, most rejecting participants were women over 60 years old; 90.00% of them answered "no" to the entomophagy-related question in this segment. However, there is a small group of women (N = 12), which accept edible insects: in age groups younger than 60, consumption of insect-based products proved to be significantly more favoured among those with a university or college education (Fig. 2). Other research found ambivalent results regarding the influence of age and education (Kröger et al., 2022). Still, in most cases, age increment has a negative effect (the lower the age, the people are more open) (Bartkowicz, 2018; Gere et al., 2017; Kane & Dermiki, 2021; Kouřimská et al., 2020), while education level positively affects the acceptance of entomophagy (Clara et al., 2016; Szendrő, Tóth, & Nagy, 2020; Vartiainen et al., 2020). A possible explanation of the connection between age and the openness to insects as food might be that with increasing age, disgust

Table 5
Differences in the willingness to try insect consumption based on the importance of the food shopping aspects (Aspects were evaluated on 5-point Likert-scales, sample collected in 2021).

The aspects of food choice when shopping	Would you like to eat food made from insects?												Results of Kruskal-Wallis's test	
	Yes				Maybe, I would try it				No					
	Mean	St. dev.	Median	MAD	Mean	St. dev.	Median	MAD	Mean	St. dev.	Median	MAD	H	p
Low price	3.17	1.217	3	1	3.09	1.131	3	1	3.27	1.204	3	1	3.548	0.170
Value for money	4.32	0.810	4	1	4.51	0.747	5	0	4.46	0.797	5	0	3.554	0.169
Discount price	3.47	1.231	4	1	3.43	1.177	3	1	3.61	1.149	4	1	4.105	0.128
Safety	4.08	1.007	4	1	4.29	0.898	5	0	4.42	0.842	5	0	9.446	0.009
Reliable producer or brand	4.00	0.989	4	1	4.26	0.896	4	1	4.38	0.877	5	0	13.782	0.001
Originated from Hungary	3.52	1.185	4	1	3.62	1.213	4	1	4.07	1.096	4	1	34.446	<0.001
Reliable source	4.31	0.854	4	1	4.33	0.883	5	0	4.49	0.784	5	0	7.430	0.024
Quality	4.50	0.772	5	0	4.52	0.725	5	0	4.65	0.637	5	0	6.834	0.033
Trademarks	2.67	1.034	3	1	3.02	1.173	3	1	3.37	1.171	3	1	24.153	<0.001
Attractive advertising/packaging	2.34	1.238	2	1	2.47	1.088	3	1	2.55	1.148	3	1	1.924	0.382
Fitting into a healthy diet	4.06	0.987	4	1	4.01	1.072	4	1	4.12	1.035	4	1	2.159	0.340
Small-scale produced or local product	3.68	1.163	4	1	3.51	1.211	4	1	3.85	1.149	4	1	14.694	0.001
Organic	2.85	1.351	3	1	2.75	1.259	3	1	2.97	1.333	3	1	4.305	0.116
GMO-free	3.06	1.538	3	2	3.42	1.412	4	1	3.72	1.387	4	1	15.667	<0.001
Environment-friendly	4.04	1.197	4	1	3.80	1.161	4	1	4.01	1.041	4	1	5.520	0.063

Note: St.dev. represents the standard deviation; MAD is the median absolute deviate; H denotes the Kruskal-Wallis test statistic; p represents p-value.

Table 6
Consumers' reasons regarding entomophagy acceptance (Sample from 2021. Respondents: 115; the number of total mentions: 142).

Number of mentions	Total	Percentage (%)
Out of curiosity	49	34.51
Because of its protein content	24	16.90
Due to the sustainability aspect	23	16.20
Nutritious, healthy	15	10.56
Positive previous experience	9	6.34
Taste	8	5.63
There is no reason not to consume it ("Why not?")	5	3.52
They eat in other countries too	4	2.82
Animal welfare	3	2.11
Variety	2	1.41

towards specific foodstuffs is more common (Egolf et al., 2018), and neophobia can also be more robust in advanced ages (van den Heuvel et al., 2019). The influence of education seems to be more complex, mainly due to the latent effect of higher income. Higher educational levels can be linked to broader knowledge and awareness of food, nutrition, and sustainability. Moreover, groups with higher education backgrounds tend to eat healthily more often, and are usually more open to other cultures (Orkusz et al., 2020).

4. Conclusions and limitations

4.1. Conclusions

The number of studies on consumer acceptance of entomophagy has been increased substantially in recent years (Onwezen et al., 2021). Insects are perceived by many as a viable alternative to meat consumption, promising sustainability, food security and dietary benefits, while specific risks can also be observed. Although insect-based foods have gained some popularity over the years, European consumers continue to maintain an aversion to include insects in their regular diets, since these foods are often perceived to be repulsive, risky, and pointless to eat (Balogh, 2016; Fernando et al., 2023; Kreczmańska-Gigol & Gigol, 2022; Looy et al., 2014; Mancini et al., 2019).

The findings of the present study indicate that the level of consumers' willingness to try edible insects did not increased significantly in Hungary between 2016 and 2021. Most of the Hungarian population (more than 70%) is not ready for insect-based foods, which corresponds to our hypothesis. Other research pointed out that European consumers prefer different options to achieve a more sustainable diet than eating insects (Onwezen et al., 2021). Surely, there are various possibilities even in the framework of the traditional European dietary patterns, with slight but conscious modifications in the composition of our regular menus (Tompa et al., 2020). According to a recent quantitative survey, plant-based alternative proteins (such as soy and pulses) are two times more accepted than edible insects. Moreover, by many consumers, insects were considered less safe even when they access the food chain only in the form of feed (Food Standards Agency (FSA), 2021).

Based on the findings, the 18–39 years old men are the less reluctant to give insect-based foods a try (almost half of them would do so), which supports one of the hypotheses of this study. Men are less neophobic and more curious; they tend to be sensation seekers, moreover, trendsetters and early adopters of innovations usually emerge from them (Lammers et al., 2019; Sogari et al., 2017). However, previous research highlighted that men are less willing to reduce their meat consumption, suggesting the problematic formulation of long-term consumption habits. At the same time, women proved to be more tolerant in this matter (Dagevos, 2021). Unexpectedly, another less hesitant group was explored in the study: about 28% of 18–59 years old women with higher education would at least try tasting edible insects. The positive effect of education about entomophagy is unquestionable in childhood (Kröger et al., 2022); however, in the case of adults, it is not completely clear how a higher education background affects the willingness to try, but probably having more knowledge about nutrition and sustainability contributes to it (Orkusz et al., 2020). Those who defined themselves as open-minded to entomophagy also mentioned dietary and environmental aspects as an explanation besides curiosity for tasting edible insects in general. According to international studies, these product attributes also play a prominent role in affecting purchase intentions in terms of insect-based foods (Cavallo & Materia, 2018; Gere et al., 2017; Verneau et al., 2016).

In the case of the Hungarian population, dismissive consumers are strongly attached to traditional, Hungarian, and local food, and trustworthiness is one of the top priorities for them, when they choose products. Food safety, quality and value for money are also important aspects.

Hungarian consumer attitudes might change over time as an effect of several factors. The approach of public organisations and the

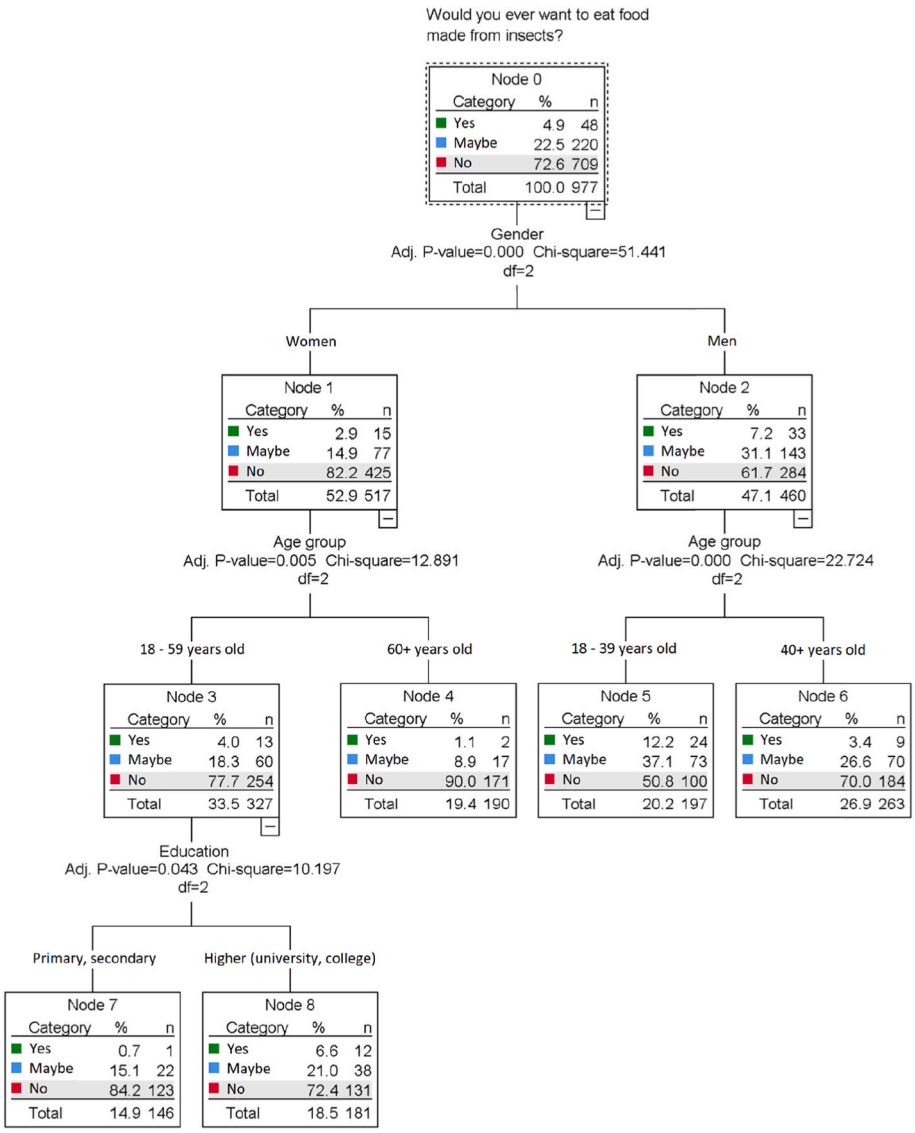

Fig. 2. Result of CHAID analysis based on socio-demographic variables.

government can strongly influence the population's attitude to such novel foods (Balzan et al., 2016), via, for example, regulations on differentiating the products containing insect proteins by their packaging and product placement (Hungarian Ministry of Agriculture, 2023). Labelling, education, organising tastings or "bug banquets", and marketing campaigns have also been demonstrated to affect consumer attitudes in this field (Cavallo & Materia, 2018; Gere et al., 2017; Hopkins et al., 2022; Looy & Wood, 2006; Sogari et al., 2017; Verneau et al., 2016). Food industry innovations can also result in higher acceptance, especially through developing foods that fit into the regular and well-known product range of consumers, in which the ingredients originating from insects are not recognisable (Balzan et al., 2016; Barton et al., 2020; Cavallo & Materia, 2018; Schäufele et al., 2019).

4.2. *Limitations and recommendations for further research*

Our study delivered findings of a quantitative analysis representing the Hungarian population; however, it only concentrates on general perceptions about willingness to try, which should not be concluded as a willingness for regular consumption (Tan et al., 2015). Further examination of the knowledge, general mindset, motivations, opportunities and barriers should be carried out as new insects gain permission for distribution as food in Europe. In the future, focus group discussions can be useful for a better understanding of consumer attitudes, as Hungarian research is currently more focused on product development's economic, technical and sensory aspects (Biró et al., 2019, 2020; Gere et al., 2017; Pintér et al., 2021; Szendrő et al., 2020a, 2020b).

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Author contributions

G.K., D.S. and M.S. were responsible for the design of the study. W.S.N. and M.H.T. contributed to the handling of raw data. Data analysis was carried out by T.I. and D.S., supervised by G.K. G.K., T.I., W.S.N., and M.H.T wrote the first draft of the manuscript, review and editing were done by M.S. and D.S. All authors provided relevant contributions to the manuscript. All authors read and approved the final version of the manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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