Ann Ig. 2025 Nov-Dec; 37(6): 786-796. doi: 10.7416/ai.2025.2700. Epub 2025 Apr 10

Insect-based novel food: is Italy ready for the food of the future? A survey on entomophagy among Italian people.

Roberta Buongiovanni[1], Maria Teresa Pisano[1], Federico Rossi[1], Federica Maria Agata Spagnolo[1], Denny Locorriere[1], Chiara Lorini[2], Marco Del Riccio[2], Guglielmo Bonaccorsi[2]

Keywords: Novel food; insect-based food; survey; Italy; entomophagy; cultural barriers; consumer behavior; insects
Parole chiave: Novel food; alimenti a base di insetti; indagine; Italia; entomofagia; barriere culturali; comportamento dei consumatori; insetti

Abstract

Introduction. *According to the European Food Safety Authority (EFSA), novel food is defined as food that had not been consumed to a significant degree by humans in the EU before May 15th 1997, when the first regulation of novel food came into force. This study investigates the consumption of insect-based novel food in Italy, where cultural aversions and particular disgust are major barriers to acceptance.*

Methods. *A cross-sectional study was conducted using a three-sections questionnaire shared through social media platforms (Facebook, Instagram, WhatsApp). The questionnaire explored socio-demographic characteristics, prior knowledge of novel food, willingness to consume insect-based food, and the impact of packaging on consumer choices. Frequencies for different items were calculated and reported in tables and charts.*

Results. *The sample showed that the majority of respondents were female (56.3%) and aged 26-35 years (24.8%). Most participants were from Southern Italy (61.8%) and had a high school diploma (45.6%). However, the majority of novel food consumers appears to be male, less than 35 years-old and born in Northern Italy. Disgust is the main obstacle towards the consumption of insects (n=261, 78.4%) while, conversely, curiosity was also significant (72.9%). Packaging had a considerable influence on consumer choices: 74.1% were willing to try chips made from cricket flour, while only 15.0% were willing to try whole insects.*

Conclusion. *Despite strong cultural barriers, strategies such as improved information and appealing packaging could increase acceptance of insect-based foods in Italy, particularly among younger, educated consumers.*

[1] *Master's student, Food Science Master's Degree Course, University of Florence, Italy*
[2] *Department of Health Sciences, University of Florence, Italy*

Roberta Buongiovanni, Maria Teresa Pisano, Federico Rossi equally contributed to the present research work
Marco Del Riccio, Guglielmo Bonaccorsi equally contributed to the present research work

Annali di Igiene : Medicina Preventiva e di Comunità (Ann Ig)
ISSN (print) 1120-9135 ISSN (online) 3035-5559

https://www.annali-igiene.it

Introduction

As global populations continue to rise and environmental sustainability becomes increasingly critical, finding alternative nutrient sources is essential for addressing both human health and ecological challenge (1). Edible insects have long been part of the diet in various regions of the world, particularly in Asia, Africa, and Latin America, due to their large availability and their high nutritional values. Insects are indeed rich in proteins, lipids, vitamins, minerals and fibers source (present in the form of chitin in their exoskeleton) (2,3). Also, they have a much lower environmental footprint compared to conventional livestock, offering a promising alternative for the future of food production.

In the European Union (EU) the production and marketing of edible insects as food has been more recent: since 2021, the European Food Safety Authority (EFSA) accepts insect species for human consumption, including *Tenebrio Molitor* (January 13th, 2021), *Acheta domesticus* (August 17th, 2021), *Locusta migratoria* (November 12th, 2021) (4). Each one of them can be considered an excellent protein source, in particular *Acheta domesticus* (the cricket) which contained 60.3 g of crude protein/100 g of sample powder (dry basis) (5). In addition, most edible insects contain more heme iron, which is the most bioavailable form of iron, than their meat counterparts, and are rich in Vitamin B12. Edible insects could compensate for the increased demand for animal protein and can help to avoid deforestation for pasture use; additionally, they present a high feed conversion efficiency compared to conventional livestock and are responsible for a relatively low emission of greenhouse gases and ammonia (6,7). They don't need big farm spaces and their harvest cycle is generally 45 days, which is far shorter than 4–36 months for traditional farm animals (8).

Despite the nutritional and environmental benefits, Western consumers, particularly in Italy, have shown significant resistance to adopt insects as a part of their diet. Disgust and neophobia—fear of the unfamiliar—are widely recognized as major psychological barriers to entomophagy in these cultures (9,10). While research on the acceptance of novel foods is growing, little is known about the specific attitudes of Italian consumers toward insect-based products. Previous studies (11,12) have shown that packaging, consumer education, and curiosity can influence the willingness to try such foods, but data on these factors within the Italian context remain limited. The goal of this study is to investigate insects-based novel food consumption, perception and attitudes in Italy, where entomophagy is rejected due to the widely spread disgust and neophobia, through a questionnaire addressed to Italian consumers.

Materials and Methods

1. Study Design, Data Collection and Inclusion Criteria

This study employed a non-probabilistic convenience sampling method. This anonymous survey, designed on the Google forms platform and shared online in Italian language, was active for a limited period (January 9th to January 13th, 2024), resulting in a final sample size of 540 respondents. Due to the exploratory nature of the study and the lack of comparable prior research in Italy, no formal power analysis was conducted, as there were no reliable baseline data available for prevalence estimates or other reference parameters. The survey was disseminated in the main social platforms (Facebook, Instagram, WhatsApp). Participation was voluntary and all subjects accepted to participate providing online informed consent.

Participants were required to meet the following criteria: (i) be 18 years or older, (ii) be a resident in Italy, and (iii) have the ability to complete an online questionnaire in Italian. The questionnaire was distributed broadly via social media, and no specific target number of recipients was predetermined.

2. Ethical Approval

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was waived as the study did not involve sensitive personal data, medical interventions, or vulnerable populations. Participation was entirely voluntary; data collection was fully anonymous, with no personally identifiable information recorded at any stage. All responses were analyzed at the group level to ensure confidentiality. Given these conditions, formal ethical approval was not required.

3. Questionnaire

The questionnaire was designed by a group of five students of the University of Florence attending a master's degree program in food science; it was aimed at exploring the intention to taste insect-based food, the reasons brought by the participants to refuse or accept such food and exploring strategies in order to improve the willingness towards entomophagy in Italy. The questionnaire had three sections. The

Figure 1 - Spheric chips made from cricket flour. Two commercial packages (blurred to avoid brand identification) are shown along with product samples served in glass bowls.

first collected data on the participants' age, gender, region of birth, educational level, and employment status. In the second section, by means of multiple choice or dichotomous answers, participants were asked whether they were familiar with the concept of novel food, whether they had ever tried insect-based products, and their reasons for either accepting or rejecting such food. The section also inquired about their sources of information regarding novel foods (e.g., internet, television, friends). The final section evaluated participants' perceptions of insect-based foods by presenting two images: one of chips made from cricket flour (Figure 1) and another of whole edible insects (Figure 2).

Participants were asked whether they would be willing to consume the products shown and how much the packaging influenced their decisions, using a four-point Likert scale (1 = none, 4 = a lot).

4. Statistical analysis

Data collected from the completed questionnaires were entered into a dedicated Excel spreadsheet for analysis. Non-complete questionnaires were excluded from the analysis. Descriptive statistics were used to summarize the socio-demographic characteristics and responses to the survey questions. Frequencies and

Figure 2 - Whole edible insects in commercial packaging. Brand names and logos have been intentionally blurred to avoid displaying commercial trademarks.

percentages were calculated for categorical variables. Inferential analyses were conducted using the Chi-square test to assess associations between categorical variables, or Fisher's exact test whenever cell counts were below 5. Responses related to packaging influence and willingness to try insect-based foods were cross-tabulated to explore patterns of behavior. Charts and tables were used to represent the data.

Results

The final sample consisted of 540 participants who completed the questionnaire. All the participants completed the questionnaire and met the included criteria, therefore none of them was excluded from the analysis. No participants were born in a country where entomophagy is a traditional habit. Table 1 shows the summary statistics of the variables that were collected.

Most respondents were female (n=304, 56.3%), and the largest age group was 26-35 years old (n=134, 24.8%). The majority of participants were born in Southern Italy (n=334, 61.8%), with fewer from Central (n=140, 26.0%) and Northern Italy (n=66, 12.2%). In terms of education, 45.6% of respondents held a high school diploma (n=246, 45.6 %).

Table 2 reports some general information about the opinions towards entomophagy in our sample.

Nearly half of the participants (n=278, 51.5%) reported not being familiar with novel foods, while the rest (n=262, 48.5%) already knew them, mainly through internet (n=162, 61.8%) and television (n=105; 40.1%) as main informational sources. Only a small fraction (n=23, 4.3%) had previously tried insect-based foods. Among those who had never tried insect-based foods, the most frequently cited reasons for refusal were disgust (n=261, 78.4%) and lack of information (n= 75, 22.5%). When asked if they would be willing to try novel foods, 207 (38.3%) responded affirmatively, indicating "genuine curiosity" (n=151, 72.9%) and "sustainability" (n=73, 35.3%) as the main reasons. In our sample, previous consumption of novel food was significantly associated with age, region of birth, and education level (Table 3).

Younger individuals (under 35) and those from Northern and Central Italy appear more likely to have tried novel food compared to older individuals and those from Southern Italy. Additionally, individuals with higher educational level exhibited a greater likelihood of having consumed novel food. However, gender does not appear to play a significant role in past consumption, as both males and females show similar rates.

Table 1 - Sociodemographic characteristics of the participants' sample (N = 540).

Characteristics	Classes	N	%
Age	18-25	104	19.3
	26-35	134	24.8
	36-45	60	11.1
	46-55	103	19.1
	56-65	124	23.0
	Over 70	15	2.8
Gender	Male	228	42.2
	Female	304	56.3
	Other	8	1.5
Region of birth	Northern Italy	66	12.2
	Centre	140	26.0
	Southern Italy	334	61.8
Job	Housekeeper	20	3.7
	Retired	40	7.4
	Student	107	19.8
	Worker	13	2.4
	Farmer	0	0
	Craftsperson	35	6.5
	Employee	118	21.9
	Trader	10	1.9
	Entrepreneur	30	5.6
	Manager	7	1.3
	Religious	0	0
	Healthcare professional	33	6.1
	Unemployed	13	2.4
	Teacher	54	10
	Other	60	11.1
Study title	Elementary school	2	0.4
	Middle school	29	5.4
	High school diploma	246	45.6
	Master's degree	201	37.2
	PhD/postgraduate	62	11.5

When examining the willingness to try insect-based novel foods, significant differences emerged again across multiple demographic factors. Males, younger individuals, and those with higher education levels were more likely to express willingness to try these foods, and regional disparities persisted.

After viewing Figure 1 (chips made from cricket flour), three out of four participants (n=400, 74.1%) answered that they would eat the product, while only 81 (15.0%) responded positively to Figure 2, which showed whole insects. Conversely, 140 (25.9%) refused the cricket-flour chips, compared to 459 participants (85.0%) who declined the whole insects.

The influence of packaging was evident in participants' answers, as the majority of them reported feeling at least somewhat influenced by the packaging.

Table 2 - Collections of the questions and participants' answers related to the second and third section of the questionnaire

Questions	Answers	n	%
1. "Did you already know about novel food?"	Yes	262	48.5
	No	278	51.5
1.1.* "If 'Yes', How?"	Internet	162	61.8
	Magazines/ books	58	22.1
	Friends	28	10.7
	Tv	105	40.1
2."Have you ever eaten novel food before?"	Yes	23	4.3
	No	517	95.7
3."Would you ever eat insect-based novel food?"	Yes	207	38.3
	No	333	61.7
3.1.* "If 'Yes', Why?"	"Because they represent a sustainable choice"	73	35.3
	"Because they represent an excellent source of nutrients"	67	32.4
	"I think they are healthy"	11	5.3
	"I think they are good for recipes"	3	1.4
	"Genuine curiosity"	151	72.9
3.2.* "If 'No', Why?"	"I think they are unhealthy"	16	4.8
	"I think they could disgust me"	261	78.4
	"I think they're not safe"	22	6.6
	"I don't know how to cook them"	22	6.6
	"I'm uninformed about them"	75	22.5
	"I'm vegetarian, vegan etc."	17	5.1
4.1 Figure 1** "Would you eat it?"	Yes	400	74.1
	No	140	25.9
4.2. Figure 2*** "Would you eat it?"	Yes	81	15
	No	459	85
5. "How much packaging influenced your final answer?"	Not at all	126	23.3
	A bit	94	17.4
	Sufficiently	160	29.6
	A lot	160	29.6

*Respondents could provide more than one answers
** Figure 1: chips made of cricket flour
***Figure 2: whole edible insects

Figures 3 and 4 illustrate the extent of packaging influence, divided by participants' willingness to try insect-based novel foods.

Most (61.7%) of those who reported they would not try novel food answered "I would eat it" after looking at Figure 1, while 99.4% still refused after viewing Figure 2. In contrast, among those willing to try insect-based food, 93.2% responded positively to Figure 1, while the willingness dropped to 38.2% for Figure *2*. Figure 5 further explores the participants' self-awareness regarding how much packaging influenced their decisions.

Table 4 shows how responses to the question "Would you eat it?" (for Figure 1 and Figure *2*) were cross-tabulated with responses to the question "How much did packaging influence your final answer?" (Table 3).

As expected, Figure 2 led to more "significantly influenced" responses, particularly negative ones (n=286, 53.0%), likely due to the less appealing packaging design. Conversely, Figure 1 generated a more positive influence in participants' responses (N=282, 52.2%), underscoring the importance of an effective packaging strategy. Additionally, the study found a relationship between the level of information and the willingness to try novel food, as suggested in Table 5.

Also in this case, the final products' design played a crucial role, to such an extent that it surpassed the consumers' level of information about novel food, probably due to the high sense of disgust. For participants without prior knowledge of novel food, willingness expectedly decreased from 37.0% of Figure 1 to 5.0% of Figure 2. Even those with prior knowledge showed

Table 3 - Association between socio-demographic variables and willingness or previous experience in consuming insect-based novel food.

		Have you ever eaten novel food before?			Would you ever eat insect-based novel food ?		
		Yes	No	p value	Yes	No	p value
Gender*	M	9 (3.9%))	219 (96.1%)	0.84	108 (47.4%)	120 (52.6%)	<0.001
	F	11 (3.6%)	293 (96.4%)		94 (30.9%)	210 (69.1%)	
Age	Under 35	15 (6.3%)	223 (93.7%)	0.04	128 (53.8%)	110 (46.2%)	<0.001
	Over 35	8 (2.6%)	294 (97.4%)		79 (26.2%)	223 (73.8%)	
Region of birth	Northern Italy	6 (9.1%)	60 (90.9%)		36 (54.5%)	30 (45.5%)	0.006
	Central Italy	10 (7.1%)	130 (92.9%)	0.005	57 (40.7%)	83 (59.3%)	
	Southern Italy	7 (2.1%)	327 (97.9%)		114 (34.1%)	220 (65.9%)	
Study title	Elementary school	1 (50.0%)	1 (50.0%)		1 (50.0%)	1 (50.0%)	<0.001**
	Middle school	0	29 (100.0%)		6 (20.7%)	23 (79.3%)	
	High school diploma	5 (2.0%)	241 (98.0%)	0.01**	77 (31.3%)	169 (68.7%)	
	Master's degree	12 (6.0%)	189 (94.0%))		92 (45.8%)	109 (54.2%)	
	PhD/postgraduate	5 (8.1%)	57 (91.9%)		31 (50.0%)	31 (50.0%)	
Would you ever eat insect-based novel food	Yes	21 (10.1)	186 (89.9%)				
	No	0	331 (100%)	<0.001**			

* 8 NA were removed; ** Fisher's exact test was used due to cell counts below 5.

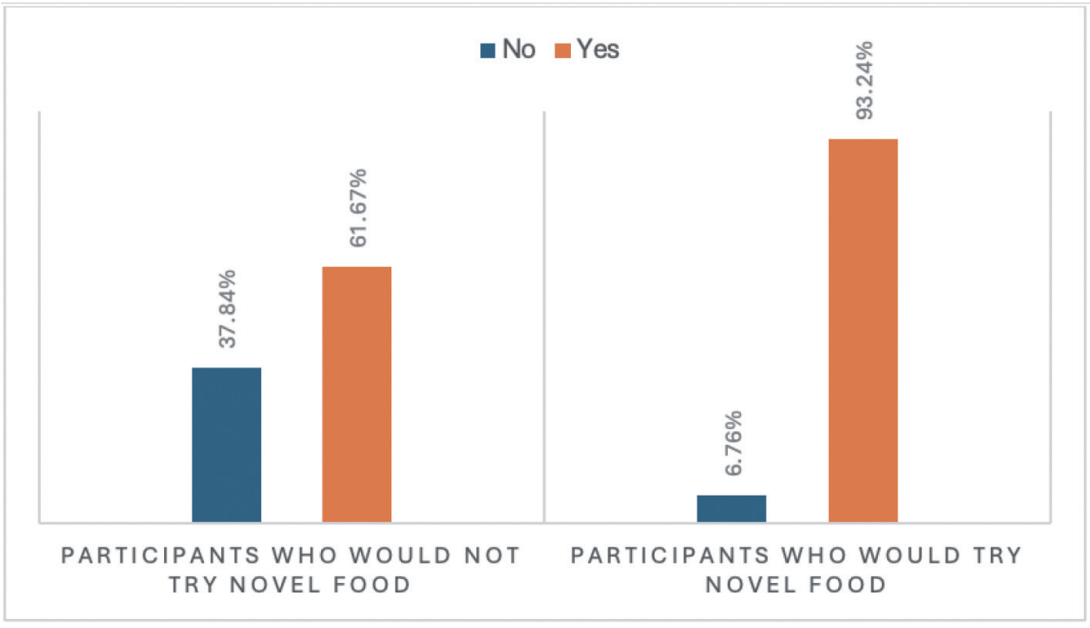

Figure 3 - Ratio of participants that would eat or not what shown in Figure 1, among those who would try novel food and those who would not.

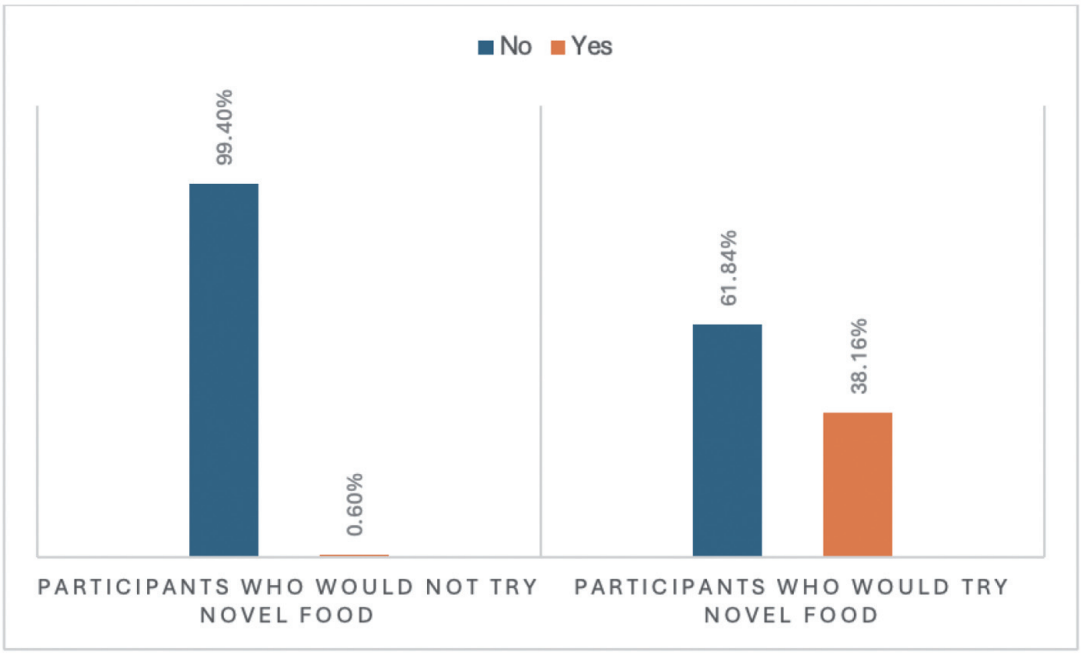

Figure 4 - Percentage of participants that would eat or not what shown in Figure 2, among those who would try novel food and those who would not.

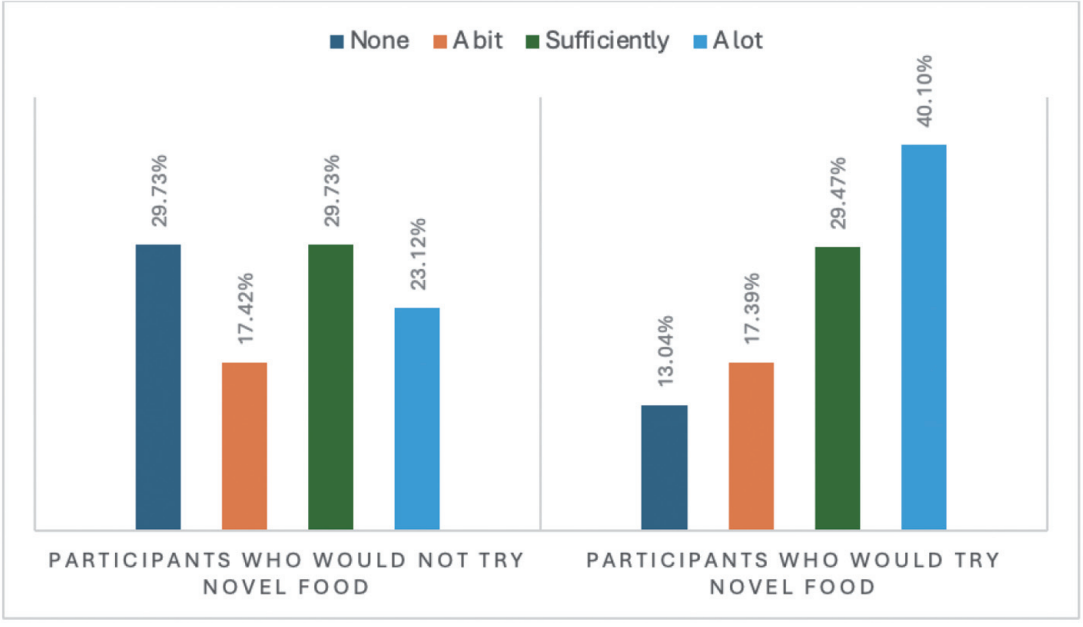

Figure 5 - Percentage of participants feeling influenced or not influenced by the packaging and presentation of Figure 1 and Figure 2, among those who would try novel food and those who would not.

Table 4 - Cross-tabulation of Participants' Responses to Figure 1 and Figiure 2 with Self-reported Packaging Influence

	Figure 1		Figure 2	
	I would eat it	I would not eat it	I would eat it	I would not eat it
Not at all influenced/a bit influenced by packaging in response	n=118 21.9%	n=102 18.9%	n=47 8.7%	n=173 32.0%
Significantly influenced by packaging in response	n=282 52.2%	n=38 7.0%	n=34 6.3%	n=286 53.0%

a declining willingness to try insect-based food from 37.0% of Figure 1 to 10.0% of Figure 2. This result obtained confirm that effective packaging is crucial in influencing consumer behavior.

Discussion

Insects and insect-based products may be a potential, nutritionally valid food source, as well as a sustainable choice (13,14). However, in Italy, entomophagy is not a well-established tradition, largely due to widespread disgust and neophobia (10,15). Our study explored Italian consumers' perceptions of insect-based novel foods, focusing on the influence of disgust, curiosity, and packaging on willingness to try these products. Our analysis highlighted how age, gender, education level, and region of birth may play a significant role in shaping consumer attitudes, with younger individuals, especially males, and those with higher education levels, exhibited greater willingness to try insect-based foods. Additionally, respondents from Northern and Central Italy showed higher acceptance rates compared to those from Southern Italy, which may be attributed to regional variations in culinary traditions and openness to new consumption patterns. Importantly, individuals who had previously consumed novel foods were significantly more willing to try insect-based alternatives, reinforcing the idea that familiarity might reduce food neophobia. Consistent with previous research, our findings confirm that disgust remains the primary barrier to the acceptance of insect-based foods among Western consumers; however, curiosity and packaging appear to significantly mitigate these negative perceptions, particularly when the insect component is less visible, as in cricket flour-based products. Among the 540 participants, 38.3% expressed their willingness to taste insect-based food, driven by "genuine curiosity" (72.9%) and the perception that this might be a "sustainable choice" (35.3%). On the other hand, the vast majority (61.7 %) was reluctant towards eating them, primarily due to disgust (78.4%) and lack of information (22.5%). Disgust has often emerged as the main obstacle against the development of entomophagy in Western countries such as Italy (16,17), despite the also-well-known nutritional and environmental advantages brought by insects themselves (18). Increasing awareness and knowledge about insect-based foods could play a crucial role in reducing these negative perceptions (17): e.g, those who regularly consume insects have reported their positive taste and culinary versatility (19,20), highlighting their potential to address global hunger.

However, as for any food source, there are potential risks associated with insect consumption, such as allergies, chemical contaminants (e.g., heavy metals), and microbiological contamination (18,21). According to the EFSA (5), the risk of contamination from bacteria like Salmonella spp and E. coli in insects is comparable to that of other animal-origin foods; despite these concerns, the overall safety profile of insects remains positive, reinforcing their potential as a sustainable alternative in global diets.

In addition to health and safety concerns, consumer acceptance can also be strongly influenced by the way insect-based foods are presented, particularly in Western cultures, where disgust often stems from the visual appearance of whole insects. This study examined whether consumer behavior could be altered by

Table 5 - Cross-tabulation of Participants' Responses to Figure 1 and Figure 2 with Prior Knowledge of Novel Food

	Figure 1		Figure 2	
	I would eat it	I would not eat it	I would eat it	I would not eat it
I knew about novel food	N=200 37.0%	N=62 11.5%	N=54 10.0%	N=208 38.5%
I didn't know about novel food	N=200 37.0%	N=78 14.4%	N=27 5.0%	N=251 46.5%

changing the form and presentation of insect-based foods. We explored the role of packaging by presenting two different images of insect-based food. The first image showed chips made with cricket flour, while the second showed whole edible insects. We found that 61.7% of participants who were initially unwilling to try novel foods responded positively to Figure 1, and, as expected, 99.4% of the same participants responded negatively to Figure 2. Conversely, among those willing to try insect-based novel food, 93.2% responded positively to Figure 1, while 61.9% responded negatively to Figure 2. It has been demonstrated that an influence brought by packaging exists, even with insects. In fact, Logue and colleagues (22) asserted that visual appearance and food texture are closely related to food acceptance, and it is not possible to assume that the perception of eating an insect-based food is the same as the perception of eating a visible insect. Similarly, other researchers explained how the "invisible" insect inside processed food is more positively received than visible whole insects (23,24). By altering the visual presentation through appealing, colorful packaging, producers may reduce the consumer's initial aversion and increase willingness to try insect-based products (25,26).

Despite the promise of packaging, marketing and communication strategies for insect-based products remain underdeveloped (12).

While these findings provide important insights into consumer behavior, several limitations must be acknowledged. One of the weaknesses of the present study could derive from the survey sample which was limited and mainly based on convenience and not on a structured sampling: while convenience sampling allowed rapid data collection, it may have led to the underrepresentation of older individuals and those less active on social media. The survey sample was relatively small and may not be fully representative of the entire Italian population. In fact, the majority of responses came from specific regions (e.g., Campania, Sicily, and Tuscany), which could introduce regional biases. Also, the study did not perform a formal power analysis, and the sample size reflects the maximum number of responses collected during the survey's active period, which may affect the robustness of the conclusions; future studies should certainly consider conducting a power analysis to ensure optimal sample size for statistical robustness. Moreover, participants were self-selected and primarily recruited through social media, which may not reach a diverse demographic. As a matter of fact, the survey was conducted online, which may exclude individuals who do not have internet access or are not comfortable using digital platforms. Furthermore, there is a possibility of response bias, where participants may provide socially desirable answers or may not accurately reflect their true behaviors and attitudes towards insect-based foods.

Finally, the questionnaire was not formally validated or pilot-tested before distribution: although efforts were made to ensure clarity through expert review, future research should consider conducting pilot testing and assessing reliability metrics to improve questionnaire robustness. Despite these limitations, the study contributes valuable insights to the emerging field of entomophagy. The high response rate of 540 participants, achieved over a short data collection period, indicates strong interest and engagement with the topic. The findings suggest that, with the right marketing strategies, there is significant curiosity and potential acceptance of insect-based foods in Italy. The growing interest in sustainable food alternatives, such as insect-based products, could play a key role in addressing global food security challenges.

Conclusions

The present paper shows that entomophagy in Italy is far from accepted despite potential nutritional and environmental benefits, since cultural norms and disgust still represent major barriers. However, this aversion can be reduced through better information and effective packaging. Educational campaigns on the benefits and safety of insect-based foods, as well as attractive packaging, like cricket flour chips, might be key in increasing acceptance. Targeted marketing to receptive groups, such as younger and educated consumers, combined with government support through research, regulations, and public awareness campaigns, can help build a market and pave the way for the adoption of entomophagy in Italy by addressing key barriers.

Riassunto

Novel food a base di insetti: l'Italia è pronta per il cibo del futuro? Un'indagine sull'entomofagia tra gli italiani

Introduzione. Secondo l'Autorità Europea per la Sicurezza Alimentare (EFSA), un "novel food" è definito come un alimento che non è stato consumato in modo significativo dagli esseri umani nell'UE prima del 15 maggio 1997, data in cui è entrata in vigore la prima regolamentazione sui novel food. Questo studio indaga il

consumo di novel food a base di insetti in Italia, dove le avversioni culturali, in particolare il disgusto, rappresentano i principali ostacoli all'accettazione.

Metodi. È stato condotto uno studio trasversale utilizzando un questionario strutturato in tre sezioni, condiviso tramite piattaforme di social media (Facebook, Instagram, WhatsApp). Il questionario ha esplorato le caratteristiche socio-demografiche, la conoscenza pregressa dei novel food, la disponibilità a consumare alimenti a base di insetti e l'impatto del packaging sulle scelte dei consumatori. Le frequenze delle diverse risposte sono state calcolate e presentate in tabelle e grafici.

Risultati. Il campione ha mostrato che la maggioranza dei rispondenti era costituita da donne (56,3%) di età compresa tra 26 e 35 anni (24,8%). La maggior parte dei partecipanti proveniva dall'Italia meridionale (61,8%) e possedeva un diploma di scuola superiore (45,6%). Tuttavia, la maggioranza dei consumatori di novel food risulta essere composta da uomini, di età inferiore ai 35 anni e nati nell'Italia settentrionale. Il disgusto è emerso come il principale ostacolo al consumo di insetti (n=261, 78,4%), mentre, al contrario, la curiosità è risultata altrettanto significativa (72,9%). Il packaging ha avuto un'influenza considerevole sulle scelte dei consumatori: il 74,1% era disposto a provare patatine a base di farina di grillo, mentre solo il 15,0% era disposto a provare insetti interi.

Conclusioni. Nonostante le forti barriere culturali, strategie come una migliore informazione e un packaging accattivante potrebbero aumentare l'accettazione degli alimenti a base di insetti in Italia, in particolare tra i consumatori più giovani e istruiti.

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Corresponding author: Marco Del Riccio, MD, Department of Health Sciences, University of Florence, Viale GB Morgagni 48, 50134 Firenze, Italy
e-mail: marco.delriccio@unifi.it