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Determinants of Receptivity Towards Entomophagy among Young Adults

Determinantes de la Receptividad hacia la Entomofagia entre Jóvenes Adultos

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ABSTRACT

This research focuses on understanding the factors influencing the acceptance of entomophagy in Morelia, Michoacán. The study involves a survey aimed at two distinct groups of young adults aged 18 to 29 (control and experimental), a demographic known for being open to evolving food preferences. The results revealed interesting differences in preferences between individuals who have and have not tried insect-based foods. Surprisingly, the price did not emerge as a dominant influencing factor. The study suggests entomophagy can be a viable and accepted dietary option when relevant information is easily accessible, potentially reducing neophobia levels.

Keywords: Entomophagy, sustainable consumption, alternative foods.

JEL code: L66, Q13, Q18, Q56

RESUMEN

El objetivo de este estudio es comprender los determinantes que influyen en la receptividad a la entomofagia en Morelia, Michoacán. La investigación emplea una encuesta dirigida a dos cohortes distintas de adultos jóvenes, de 18 a 29 años, un grupo demográfico conocido por ser receptivo a la evolución de las preferencias alimentarias. Los hallazgos revelaron disparidades notables en las preferencias entre las personas que han probado y no han probado alimentos a base de insectos. Sorprendentemente, el precio no surgió como un factor de influencia dominante. El estudio concluye que la entomofagia puede representar una opción dietética factible y aceptada cuando se dispone de información relevante, lo que podría mitigar los niveles de neofobia.

Palabras clave: Entomofagia, consumo sostenible, alimentos alternativos.

Código JEL: L66, Q13, Q18, Q56.

INTRODUCTION

The global population's growth is intensifying the demand for food, with over 8.1 billion people (WM, 2024; Gahukar, 2011); exploring alternative food production methods is crucial. This is due to increased demand and the ecological harm caused by traditional agriculture, which relies heavily on resources and agrochemicals (Tsoraeva, 2020; Ueasangkomsate et al., 2018; Devi et al., 2024). In addition, challenges such as climate change, energy access, input supply, and food distribution further emphasize the need for urgent action (Badgley et al., 2007; Cronin et al., 2018). Given these circumstances, alternative food production methods are being considered, with entomophagy, the practice of consuming insects, emerging as a sustainable option with low ecological impact and high nutritional value (Carvalho, 2006; Naseem et al., 2021; Derler et al., 2021; Doğan & Çekal, 2022).

Entomophagy refers to consuming insects as a sustainable food source, with over 1,900 insect species suitable for human consumption. Insects play various environmental roles and are a part of human diets. 'entomophagy' comes from 'entomos' (insect) and 'phăgein' (to eat). In India, it is connected to health as' entomotherapy.' Throughout history, edible insects have held significance in many cultures, and the current emphasis on circularity ties this food choice to sustainability rather than traditional farming.

Throughout history, entomophagy, the practice of consuming insects as a food source, has been observed across diverse cultures. China has documented 324 species of insects from 11 orders that are either edible or associated with entomophagy. These include common edible species, less commonly consumed species, and medicinal insects, as identified by Feng et al. (2018). In ancient Greece and Rome, the larva cossus was revered as a delicacy. In South Asia, aquatic bugs, beetles, crickets, grasshoppers, termites, and cicadas, among others, formed part of the local diet as sustenance for the lower social strata in these communities, as highlighted by Fuentes.

Globally, the most consumed insects include locusts, grasshoppers, crickets, ants, termites, butterflies, and beetles. In modern-day Mexico, there are two main types of markets: an informal market with high demand that primarily sells insects as ingredients or snacks and a less developed formal market that mainly sells insects as flour (Ronquillo-de Jesús et al., 2024). Recently, insects have gained popularity as a sustainable protein source, complementing conventional options such as beef and pork due to ease of collection and production. However, the demand for insects remains low, partly due to the historical absence of insects in Western diets. Nevertheless, this trend appears to be shifting, as between 50% and 80% of the population are open to trying and incorporating insects into their diet,

especially once they become aware of the nutritional benefits (Ross et al., 2022a; Freund, 2019).

The practice of insect farming can provide a sustainable method of food production. Edible insects are calorie-dense and highly nutritious, and their consumption could help alleviate famine on a global scale. The protein and micronutrients in insects offer potential environmental and economic benefits (Lange & Nakamura, 2021). Among the benefits of producing and consuming insects, in comparison with agriculture, we could highlight six aspects: 1) lower water consumption; 2) change in land use is not necessary; 3) less pollution (do not require pesticides or agrochemicals); 5) provide more protein per kilogram than meat and vegetables; and, 6) require relatively short spaces for production (Ross et al., 2022a; 2022b).

In recent years, the per capita water availability in the Cuitzeo basin has experienced a reduction of 10%, leading to an increase in water scarcity in urban and agricultural centers (Alfaro, 2023; Camacho, 2022). Simultaneously, the population has consistently risen over the last two decades. Furthermore, there is a recurring concern regarding grasshopper infestations affecting rural crops in Morelia, triggering discussions on the potential collection and utilization of these insects as a food source. This initiative presents a sustainable and economically feasible solution with minimal water consumption (Cerritos, 2019), introducing the concept of entomophagy as a viable approach to generating nutritious sustenance. The ongoing research is structured around a demand-oriented perspective to investigate the acceptance of entomophagy as a substitute food supply. What factors influence Morelia's consumption of edible insects?

EDIBLE INSECTS' PRODUCTION AND ENTOMOPHAGY TO SUSTAINABILITY. THEORETICAL ASPECTS

The insects can be cultivated using a variety of organic substrates, ranging from livestock manure to food and crop residues. This practice adds value to agricultural waste, decreases pollution caused by waste disposal, and minimizes soil, air, and water contamination risks. Additionally, insects produce lower levels of greenhouse gases, exhibit efficient feed conversion rates, and have lower water requirements than conventional farm animals. Moreover, they present minimal risk of zoonotic disease transmission (Borsari, 2022). The increasing demand for food requires rapid, sustainable production (Acosta, 2024). Introduce novel food alternatives, enhance efficiency, and adopt eco-friendly methods. Entomophagy transforms feed efficiently, contrasting with cattle, improving food security (Naseem et al., 2020; Varela, 2019).

Insects are a sustainable food source globally. Challenges, determinants, and benefits: Because of their cold-blooded nature, insects require less water than cattle, making them highly efficient at converting food to protein. Using insect-based food reduces water usage, preserving water for agricultural needs. Agriculture faces challenges like public undervaluation of water, changes in river flow, and overuse of aquifers; instead, insect production requires less water and emits less ammonia (Borsari, 2022; Morán, 2021).

In soil conservation, cultivating edible insects has a beneficial influence on soil restoration. The expansion of agriculture and cattle breeding has notably contributed to widespread deforestation, with cattle breeding necessitating more extensive tracts of land for grazing. Conversely, insect cultivation exhibits a reduced reliance on land resources in contrast to livestock rearing. Through a juxtaposition of entomophagy and livestock husbandry in terms of land utilization, it becomes apparent that entomophagy serves as an eco-friendly method of food production (Lange & Nakamura, 2021; Cruz & Peniche, 2018).

While insects may not be readily available in all climates or seasons, they can be substituted with alternative protein sources based on seasonal availability. For example, the consumption of seasonal fruits tends to increase during periods of abundant production, paralleling the trend of insect consumption. In some countries like Holland and the Netherlands, supermarkets have introduced burgers and nuggets made from worm meal, and insects are being cultivated for pet and fish feed purposes. Insects can serve as a protein substitute alongside lentils and algae. Furthermore, consuming insects provides a dietary option with minimal greenhouse gas emissions (Cruz & Peniche, 2018).

Entomophagy, the practice of eating insects, is uncommon in the Western world, primarily due to the challenges of collecting insects in temperate climates compared to tropical regions. Western societies generally dislike insects (Van Huis, 2015). Nevertheless, owing to their ecological and nutritional benefits, there has been a growing interest in cultivating and consuming insects. Consequently, this dietary choice is anticipated to gain a larger market share, as evidenced by the increasing demand in recent years (Dagevos, 2021; Sogari, 2019). Although there is a lack of awareness regarding the nutritional value of insects and insufficient training in rearing practices, large-scale insect rearing as an alternative in rural areas has yet to be widely implemented. There is potential for insects to serve as a significant protein source based on available information (Talom et al., 2024).

Insects are growing in food production, producing products like cookies, flour, and protein bars. Banu and Kudesia (2023) discuss a market analysis of edible insect foods. Global meat consumption in 1970 was 26 kilograms per person, projected to reach 41 kilograms. Meat consumption may triple by 2050, raising environmental concerns. Transitioning to insect-

based diets could alleviate resource strains. Edible insects are resource-efficient and offer a beef-equivalent protein profile with essential minerals (Van Huis, 2020).

Insect farming would also prioritize the conservation of overexploited species that possess economic value and are in high demand. Nonetheless, several studies have indicated that the primary factors influencing the acceptance of edible insects include knowledge, aversion, cultural influences, and culinary choices. Numerous individuals consume edible insects as a sustainable dietary choice to mitigate environmental imbalances and address the challenges of global warming.

METHODOLOGY

The methodological design to achieve the objective comprises seven main steps. First, studies are reviewed to identify the techniques and variables used. Second, experts were interviewed to identify relevant variables, and the Saaty algorithm was used. Third, variables and their indicators are selected for quantification. Fourth, the interview was designed and applied in a pilot test. Fifth, the sample is delimited, and 387 questionnaires were used. Sixth, interviews are conducted. Lastly, an experimental design is developed.

Figure 1. Relative frequency of occurrence of variables in entomophagy studies

Source: Own elaboration (Aung et al., 2023; Cicatiello et al., 2020; Francis et al., 2019; Marinova & Bogueva, 2022; Megido et al., 2016; Caparros et al., 2014; Chantawannakul, 2020; Bialkoba et al., 2016; La Barbera et al., 2020; Mancini et al., 2019; Marinova et al., 2019; Nyberg et al., 2021; Ros et al., 2022a; Hartmann & Siegrist, 2017; Sogari et al., 2019; Lensvelt & Steenbekkers, 2014; Van Huis et al., 2015; Verneau et al., 2016, 2021.

The review of previous studies analyzed 50 scientific articles on entomophagy published between 2017 and 2023. The objective was to identify the variables most relevant to insects' demand, purchase, and consumption. These variables were constructed inside a circle, and indicators can be seen outside the circle (Figure 1).

The variables were categorized based on their attributes, as illustrated in Table 1. Different nomenclatures in diverse research publications may pertain to these variables, though they signify identical factors. This categorization elucidates five key variables: CA denoting Quality, CU representing Culture, NU indicating Nutrition, Pre for Price, and NE for Neophobia (commonly termed Disgust in alternative investigations) (Figure 2).

Figure 2. Grouping of variables and indicators.

Source: Own elaboration.

A comparative analysis of different groups and identifying factors influencing the decision to consume insects to ascertain the impact of Neophobia, Nutrition, Culture, Price, and

Quality on adopting entomophagy delineated two distinct cohorts: individuals who have experienced insect consumption and those who have not. The latter cohort was assessed regarding their inclination to engage in entomophagy, gauged by the variables mentioned. The research encompassed interviews with college students aged between 18 and 30, conducted from January to March 2023.

The interview comprised 31 iítems. The Likert scale uses a 1 to 5 range per indicator, and integrating these indicators quantifies the variable. A trial examination was conducted with 10 participants to evaluate its effectiveness, yielding a Cronbach's alpha of 0.72. This prompted the refinement of inquiries to enhance precision. After integrating the revised questionnaire, Cronbach's alpha consistently surpassed 0.90. The survey encompassed 387 young adults aged between 18 and 30. Among them, 202 had no prior exposure to the consumption of insects, while 185 did. The survey was disseminated to undergraduate students spanning diverse fields such as Architecture, Biology, Accounting, Economics, Philosophy, and Civil Engineering.

The study conducted on young adults aged between 18 and 30 is well-justified. This is because young adults have established eating habits that can be modified during this period. University students assume responsibility for their diet for the first time, making it an ideal time to introduce dietary changes. During this period, social, psychological, and cultural factors combine to form a new eating pattern that may last for the rest of their lives (Cervera et al., 2013).

EXPLORING THE ACCEPTANCE OF ENTOMOPHAGY: RESULTS AND DISCUSSION

Initially, a statistical F-test analysis was conducted for the ratio interval of variances between individuals inclined to consume insects or their by-products and those opposed to consumption. The findings indicate that the variance ratio is 1. The data exhibits satisfactory variance behavior, allowing for a comparison of means, as demonstrated in Table 1. This suggests that a normality test analysis should be pursued.

Table 1
Results of Fisher's F-Test for Variance Ratio at a 95% Confidence Level

Ratio	1.271
F (Observed Value)	**1.271**
F (Critical Value)	**1.329**
GL1	**201**
GL2	**184**
valor-p (bilateral)	**0.098**

alfa	**0.05**

Source: Own elaboration with the information of the sample.

Following this, normality assessments were carried out to examine the data distribution. The data presented in Table 2 indicates the probability that all variables follow a normal distribution. Once this fundamental requirement is established, we can analyze the variables within both groups: the group that favors insect consumption and the group that does not, in addition to the experimental group, to identify any significant differences.

Table 2. Shapiro-Wilk Normality Test

	Quality	**Price**	**Culture**	**Nutrición**	**Neophobia**	**Total**
W	0.985	0.969	0.981	0.962	0.984	0.978
p-value (bilateral)	**0.042**	0.000	0.012	0.000	0.029	**0.005**
alfa	0.05	0.05	0.05	0.05	0.05	0.05

Source: Own elaboration with the information of the sample.

Table 3. Analysis of Means for Acceptance of Entomophagy Between Groups

	Quality	**Price**	**Culture**	**Nutrición**	**Neophobia**	**Total***
Difference	-0.376	-0.050	-0.816	-0.646	-0.580	2.459
z (Observed value)	-6.659	-0.752	-15.460	-10.862	-9.357	10.229
|z| (Critical value)	1.960	1.960	1.960	1.960	1.960	1.960
p-value (bilateral)	**<0.0001**	**0.452**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
alfa	0.05	0.050	0.050	0.050	0.050	0.05
*** = integration of all variables; the integration of the entomophagy acceptance rate**						

Source: Own elaboration.

The research has indicated a conspicuous disparity between the experimental group (Table 3), subjected to testing, and the control group, which did not undergo testing, regarding the embrace of entomophagy. Specifically, a substantial contrast is observable across four of the five variables: quality, cultural aspects, nutritional value, and neophobia. These variables notably influence the acceptance of entomophagy among the study participants. Further studies (Sogari, 2019; Verneau, 2016) suggest that factors such as neophobia, encompassing aspects of unfamiliarity, aversion, appearance, and societal norms, exert a more significant impact on individuals' readiness to explore insect consumption than financial considerations.

In addition to the acquired findings, a principal component analysis revealed that 80% of the variance is concentrated in two factors. Factor 1 (F1) demonstrates the lowest factor load in the price variable. In contrast, the second factor (F2) shows the highest factor load in this variable, implying that F2 is mainly influenced by price, accounting for 15.4% of the variance. This confirms that the price variable does not act like the other variables and does not hold significant importance in consumers' decision-making regarding insects.

Consequently, all variables, excluding price, exhibit noteworthy influence concerning eigenvalue, owner vectors, and factors loading for F1, as indicated by their correlation with F1 (Table 4).

Table 4. Principal Component Analysis to Entomophagy Variables

	F1	F2	F3	F4	F5
Eigenvalue	3.214	0.767	0.430	0.319	0.270
Variability (%)	64.276	15.339	8.604	6.372	5.408
Cumulative %	64.276	79.615	88.219	94.592	100.000
Own vectors:	F1	F2	F3	F4	F5
Neophobia	0.491	-0.168	-0.090	-0.297	-0.796
Nutrición	0.441	-0.350	0.755	0.302	0.148
Culture	0.481	-0.206	-0.265	-0.564	0.581
Precio	0.330	0.894	0.269	-0.135	0.035
Quality	0.473	0.087	-0.529	0.696	0.074
Factor loads:	F1	F2	F3	F4	F5
Neophobia	0.881	-0.147	-0.059	-0.168	-0.414
Nutrición	0.791	-0.307	0.495	0.170	0.077
Culture	0.863	-0.180	-0.174	-0.318	0.302
Precio	0.591	0.783	0.177	-0.076	0.018
Quality	0.847	0.076	-0.347	0.393	0.038
Correlations between variables and factors:					
	F1	F2	F3	F4	F5
Neophobia	0.881	-0.147	-0.059	-0.168	-0.414
Nutrición	0.791	-0.307	0.495	0.170	0.077
Culture	0.863	-0.180	-0.174	-0.318	0.302
Precio	0.591	0.783	0.177	-0.076	0.018
Quality	0.847	0.076	-0.347	0.393	0.038

Source: Own elaboration.

In a study conducted in Myanmar, it was discovered that 67% of the population exhibited a preference for consuming insects. This preference was influenced by ethnicity, religion, attitude toward eating insects, aversion to insects, nutritional value, societal factors, and disgust. The practice of entomophagy is prevalent among all ethnic groups, including both urban and rural residents, and there is a moderate level of acceptance of edible insects as a food source. However, despite this prevalence, edible insects are not commonly consumed, and there are persistent challenges in leveraging them to address food insecurity and malnutrition (Aung et al., 2023).

In a recent research study, 88 participants sampled edible insects while researchers investigated various factors such as neophobia, gustatory expectations, and past consumption

history of the food. The results indicated more openness among male participants towards exploring edible insects than their female counterparts (Sogari, 2019).

Additionally, the study found a negative correlation between food neophobia and the willingness to consume insects. Individuals exposed to insects for the first time showed an improved perception of their sensory qualities. The study suggests that awareness campaigns could help increase understanding of the benefits of consuming insects, mainly due to their novelty and limited familiarity. These findings are consistent with our research results, although our analysis did not include sensory parameters.

Numerous research studies have indicated no direct correlation between the perceived importance of sustainable consumption and the willingness to buy insect-based products among survey participants. However, a decrease in aversion to consuming insects among participants is positively correlated with a greater desire to purchase insect-based items. Additionally, a reduced aversion to insect consumption among participants is linked to a stronger intention to buy such products, with cultural factors playing a significant role in this association (Dagevos & Taufik, 2022).

In traditional societies, introducing a new food item is often resisted due to social and psychological factors. A neophobia scale, ranging from one to ten, has been developed to quantify this resistance. Neophobia significantly impacts the decision-making process regarding the consumption of edible insects. A 2016 study at the University of Parma in Italy focused on individuals aged 18 to 40. The findings revealed that cultures that include insects in their diets perceive them as a valuable source of nutrients. However, in Western societies, edible insects are frequently considered repugnant due to psychological factors. Nonetheless, there is a promising outlook for the practice of entomophagy (the consumption of insects) as consumer interest and curiosity propel the experimentation with edible insect products, as suggested by studies conducted by Sogari (2019).

The recent study underscores that there are still numerous unknown factors related to nutrients, marketing, promotion, and information concerning the production and consumption of insects at the local level. *Valle y Pampa*, a Peruvian company, experimented with introducing an entomophagous product to reduce the carbon footprint of animal production. Nevertheless, the findings indicate that producing a product made from edible insects necessitates further research and expertise to comprehend the properties and benefits of edible insects in Peru. In contrast to Peru, optimal conditions for producing edible insects were discovered in San Lorenzo. This discovery can contribute to a more sustainable pest management system by considering insect-mediated ecosystem services, such as biological control (Cruces et al., 2020).

The available research highlights the potential advantages of introducing insect-based food products. However, further in-depth research and practical demonstrations are essential to grasp their potential fully. This study is a source of inspiration for future research to address the current limitations in insect-based product production. Promoting the consumption and acceptance of entomophagy requires ongoing effort and attention. It is worth noting that significant work is still needed to encourage the consumption and acceptance of insect-based foods (Hartmann, 2017).

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Researchers in Myanmar conducted a recent study that revealed the various factors influencing edible insect consumption. These factors include ethnicity, religion, attitudes toward eating insects, insect phobia, nutritional properties, social concerns, discomfort, income, family size, taste, smell, and safety concerns. The study emphasizes the importance of cultural context as a significant variable with diverse expressions and points of reference (Aung et al., 2023).

CONCLUSIONS

The consumption of insects, known as entomophagy, is not widely embraced in Western societies. Consequently, the tradition of cultivating insects as a food source has yet to become integrated into Western eating habits. In contrast, pre-Columbian cultures and rural societies favor consuming insects more.

Various factors influence insect consumption, including quality, price, neophobia, nutrition, and culture. Numerous research studies have analyzed and categorized these factors using different indicators. This study focuses on the Universidad Michoacana de San Nicolás de Hidalgo student community, specifically individuals aged 18 and 30. This age group is crucial in developing eating habits and forming critical nutrition and food preference decisions.

In certain studies on entomophagy, the price factor is omitted or regarded as a secondary factor with less impact on the decision to consume insects. In this study, we aimed to verify this information, and the outcome indicated that price was not a significant variable between

the control and experimental groups. Results showed acceptance of entomophagy, indicating the feasibility of adopting edible insects in the diet.

There appears to be a significant difference between the groups regarding their willingness to consume insects. The results suggest that those who had the chance to taste the insects, regardless of whether they accepted or declined, and those who did not have the opportunity to taste did not consider price to be a deciding factor in their decision to consume insects. However, factors such as neophobia, culture, quality, and nutrition did play a significant role in their decision-making process. The results suggest that it is feasible to consider entomophagy as an alternative food source; simultaneously, its production has minimal environmental impacts.

Implementing information campaigns promoting the nutritional benefits of consuming insects could influence the consumption decisions of individuals between the ages of 18 and 30. This is because the lack of knowledge and fear of trying new foods are significant factors in the decision to engage in entomophagy. Therefore, producing insects for human consumption could be a viable solution to reduce water, ecological, and carbon footprints. However, it is crucial to study the associated costs.

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