Proteins of the future: a bibliometric study of alternative food acceptance

Proteínas del futuro: un estudio bibliométrico sobre la aceptación de alimentos alternativos

Review Article

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Abstract

The present study aimed to evaluate the state of research linking alternative proteins with consumer attitude and behavior, through a bibliometric analysis of 265 documents indexed in Scopus. The methodology involved the identification of descriptive indicators such as temporal evolution of publications, journals, authors and most cited documents. A qualitative content analysis was also carried out to determine research designs, data sources and predominant analysis techniques. The results show an exponential growth of publications since 2018, with majority contributions from Europe and North America. In terms of methodological aspects, quantitative and empirical survey-based studies predominate. The literature linkage evidenced three streams: overcoming cultural barriers towards edible insects, factors predicting general acceptance of alternative proteins, and acceptance drivers specifically for plant-based meat substitutes. Future research opportunities include the need for more comparative studies across countries and population segments, experimentation with communication and packaging strategies, forms of gradual insertion into the diet, and analysis of microbial and fungal protein sources.

Keywords: alternative proteins, innovative foods, entomophagy, consumer behavior.

Resumen

El presente estudio evaluó el estado de la investigación que vincula las proteínas alternativas con la actitud y comportamiento del consumidor, mediante un análisis bibliométrico de 265 documentos indexados en Scopus. La metodología identificó indicadores como: evolución temporal de publicaciones, revistas, autores y documentos más citados. También se realizó un análisis cualitativo de contenido para determinar diseños de investigación, fuentes de datos y técnicas de análisis predominantes. Los resultados muestran un crecimiento exponencial de publicaciones desde 2018, con aportes mayoritarios de Europa y Norteamérica. El acoplamiento bibliográfico evidenció tres corrientes: la superación de barreras culturales hacia los insectos comestibles, los factores que predicen la aceptación general de proteínas alternativas, y los impulsores de aceptación para los sustitutos vegetales de la carne. Las oportunidades de investigación futura destacan la necesidad de más estudios comparativos entre países y segmentos poblacionales, la experimentación con estrategias de comunicación y empaque, formas de inserción paulatina en la dieta, y el análisis de fuentes proteicas microbianas y fúngicas.

Palabras clave: proteínas alternativas, alimentos innovadores, entomofagia, comportamiento del consumidor.

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1.   Introduction

Alternative proteins, derived from sources such as insects, algae, cultured meat, vegetables, and other non-animal substitutes, have garnered significant attention and interest from the global community, particularly in response to current challenges related to sustainability and food security (Tang & Chung, 2023). These novel protein sources have been extensively studied in the scientific literature, with a focus on their nutritional profiles and environmental sustainability, positioning them as promising alternatives to conventional animal-based proteins (Ketelings et al., 2023). However, despite these advantages, the integration of alternative proteins into daily diets has been hindered by consumer reluctance and preconceived notions, representing a significant barrier to their widespread adoption (Heijnk & Schuenemann, 2023).

An analysis of the scientific literature reveals that various factors influencing consumer acceptance or rejection of alternative proteins have been extensively explored (Marquis et al., 2023). These factors include perceptions of healthiness and nutrition, environmental sustainability, novelty and unfamiliarity, neophobia, price, and emotional reactions such as disgust and aversion (Jiang & Farag, 2023). Additionally, studies have investigated the effectiveness of strategies to enhance acceptance, such as packaging design, information dissemination, and repeated exposure (Tang et al., 2023).

Nevertheless, despite these studies, comprehensive reviews summarizing and condensing the state of research in this field are still lacking. Bibliometrics, recognized as a robust and systematic methodology, provides the necessary tools to conduct an exhaustive and detailed analysis of the scientific literature, enabling the identification of trends and publication patterns, as well as the assessment of the influence and reach of research in this field (Molina-Collado et al., 2021). Through this technique, it is possible to quantify and analyze the impact of scientific works, revealing collaboration networks, the most prolific sources, and the documents that have set a milestone in research (Yu et al., 2020).

Addressing this research gap, the primary objective of this article is to evaluate the state of research linking alternative proteins with consumer attitudes, acceptance, and overall behavior. The research questions guiding this study are: (i) How has the field related to consumer acceptance of these types of foods developed?; (ii) Which sources, countries, and authors are the most productive in this area?; (iii) Which documents are the most cited?; (iv) What are the prevailing research trends?; (v) What methodological approaches (methods and research techniques) are used to study this field?; and (vi) What should be the future research directions?

To address these questions, the Scopus academic database was used to analyze 265 scientific documents related to the topic of interest. Descriptive indicators were obtained using the analysis tools provided by this database. Additionally, VOSviewer software was used to create bibliographic coupling maps, which allowed the identification of the most significant research trends in this area. Finally, a content analysis of the documents included in the sample was conducted to determine the most commonly used research techniques in this field and to identify research gaps.

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In light of the above, the contribution of this study initially lies in identifying how the acceptance of these types of products has been analyzed in consumer behavior, as well as in recognizing the main scientific trends. Therefore, the results provide a foundation for areas such as food development, marketing of these products, organizational structuring for companies deciding to market and produce them, and even fields related to nutrition.

2. Methodology

2.1 Alternative proteins

In recent times, alternative proteins have emerged as a promising avenue to address sustainability and health concerns associated with the consumption of animal proteins. Conventional livestock farming, which has been a cornerstone of the human diet for millennia, is now under scrutiny for its detrimental environmental impacts (Realini et al., 2023). According to Ford et al. (2023), the meat production chain is significantly responsible for greenhouse gas emissions, deforestation to create space for livestock and forage crops, and the disproportionate use of water and agricultural land. These factors have accelerated the search for viable alternatives.

Plant-based proteins are at the forefront of emerging substitutes, with advances in food engineering enabling the replication of the texture and flavor of animal meat. Meanwhile, lab-cultivated protein offers a futuristic promise of "real" meat without the need to raise and slaughter animals (White, 2022). Edible insects, considered a delicacy in some cultures and a taboo in others, present an opportunity due to their high protein content and low resource requirements for production. Similarly, algae and fungi, with their ability to grow in adverse conditions and their unique nutritional profiles, are promising candidates in this food paradigm shift, as noted by Chen (2022).

Moura et al. (2022), argue that these food innovations not only mimic the nutritional value of their animal counterparts but also offer ecological benefits by reducing the carbon footprint and natural resource consumption. Despite these advances, Mancini and Antonoli (2022), emphasize that considerable obstacles remain for the widespread adoption of alternative proteins, including technical challenges in large-scale production, regulations that need to be adapted to new products, and consumer reluctance to change deeply ingrained dietary habits.

### 2.2 Consumer attitudes towards alternative proteins and foods

Contemporary research has highlighted the importance of understanding consumer attitudes towards alternative proteins, employing theoretical frameworks such as the Theory of Planned Behavior (TPB). These studies suggest that the willingness to purchase alternative proteins is influenced by the consumer's attitude towards the product, perceived benefits, and the social norms governing its consumption (Bogueva & Marinova, 2022). Despite the growing interest and curiosity among consumers, significant barriers limit the acceptance of alternative proteins. These barriers include adverse emotional reactions such as rejection and disgust, as well as concerns about potential risks associated with their consumption (Chen, 2022). Therefore, sensory acceptance of these proteins is crucial and is directly affected by their organoleptic attributes, such as taste, texture, and appearance (Hirunyophat et al., 2023).

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In this context, systematic literature reviews become essential for analyzing progress and gaps in research related to the acceptance of alternative proteins. These reviews can provide a solid foundation for future research, helping to bridge the gap between product innovation and consumer acceptance, and potentially fostering a smoother transition towards more sustainable diets that are acceptable at both sensory and emotional levels.

2.3   Method

For this study, bibliometric methods were applied to systematically analyze the scientific literature on alternative proteins. Bibliometrics, as a methodological tool, allowed us to employ statistical and mathematical techniques to retrieve, organize, and analyze relevant scientific publications (Keramatfar & Amirkhani, 2019). This methodological approach was chosen for its ability to overcome common limitations in traditional literature reviews, such as biases in study selection and the lack of quantitative indicators (Rowe et al., 2023). Our methodological process is outlined in the following section of the study, detailing the steps and tools used in data collection and analysis, ensuring a rigorous and objective approach to understanding the current state of research in this field (see Figure 1).
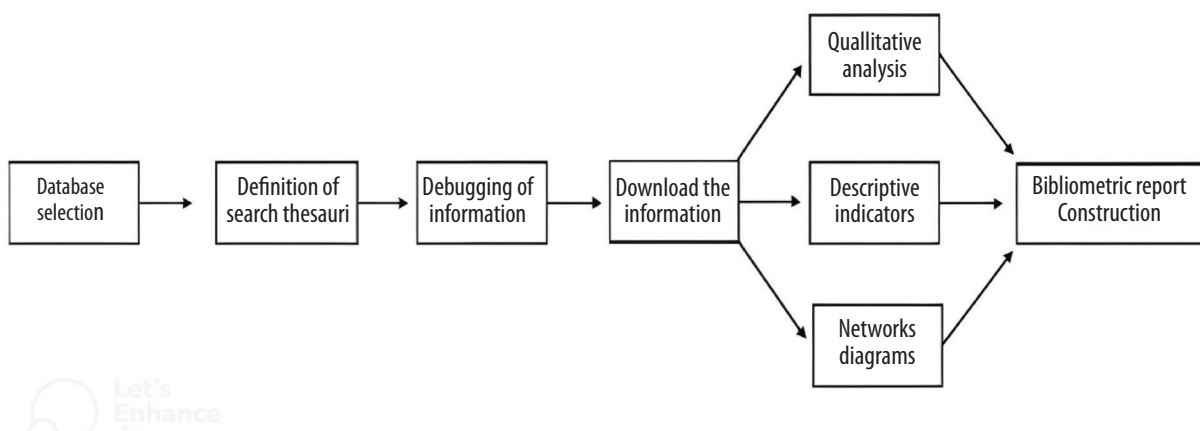
Figure 1. Methodological process (Adapted from Osorio et al., 2023).

Database Selection: For the bibliometric analysis, Scopus was selected due to its multidisciplinary nature and its recognition within the scientific community (Livia et al., 2022). Its extensive database of academic documents ensures comprehensive coverage of the field of study.

Definition of Search Thesauri: Careful selection of keywords was essential to ensure the relevance and comprehensiveness of the research. A comprehensive search strategy was developed using two sets of terms: the first related to alternative proteins, including "Alternative protein sources," "insect-based foods," "plant-based proteins," "entomophagy," "algae-based foods," "meat alternatives," and "meat substitutes"; the second set focused on consumer attitudes, with terms like "consumer attitudes," "Willingness to buy," "Willingness to try," "purchase intention," and "consumer acceptance." This strategy was applied in Scopus, conducting searches in the title, abstract, and keyword fields of the

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articles. Additionally, Boolean operators were used to combine these terms, ensuring that each retrieved document included at least one term from each set.

Data Refinement: To refine our selection and ensure the quality and relevance of the documents, several inclusion and exclusion criteria were implemented. Regarding inclusion, we focused on peer-reviewed scientific articles published in all languages and fields of science that directly addressed the intersection between alternative proteins and consumer attitudes. Conferences, book reviews, and publications in languages other than English were excluded. Additionally, a time frame covering the last ten years (2011-2023) was established to capture the most recent trends in the field. During the refinement process, titles and abstracts were manually reviewed to verify thematic relevance, eliminating those that did not closely align with our research objectives. This selection and refinement process resulted in a final sample of 265 documents, all of which are scientific articles representing original research with data and methods validated by peer review. It is important to note that the final extraction of documents was carried out on November 1, 2023, thus establishing a clear temporal limit for our analysis.

Data Download: Bibliometric data were downloaded in CSV format from the Scopus database. This dataset included detailed information on each publication, specifically: document title, author names, year of publication, DOI, abstract, keywords, journal name, and list of cited references. The choice of CSV format was due to its versatility and compatibility with various software specialized in bibliometric analysis.

Descriptive Indicators: Indicators such as the temporal evolution of publications, the most productive journals, the most productive countries, and the most cited documents were identified. These indicators provide an overview of the impact and distribution of research in the field.

Qualitative Document Analysis: To delve deeper into the analysis of the selected articles, a qualitative analysis was conducted. This process involved a detailed and systematic review of each article, specifically focusing on their abstracts and methodologies. Two researchers carried out this review, carefully reading each mentioned section to extract relevant information about the research designs employed, the types of studies conducted, the sources of information used, and the data analysis tools applied. To ensure the rigor of the analysis, a protocol based on the guidelines proposed by Gupta et al. (2006) and Donthu et al. (2021) was followed. Similarly, content analysis was applied to the theoretical sections of the articles to identify the main variables explored in the field, the most recurring research hypotheses, and the most commonly used theories or theoretical models in this field. This operationalization approach was applied following Lopes & Carvalho (2018). Finally, a manual review of the future research sections was conducted to identify future trends in this field.

Network Mapping: VOSviewer software was employed for the creation of bibliographic coupling maps, allowing the identification of the main research streams.

Bibliometric Report Construction: After the analysis, the bibliometric report was constructed, which synthesizes the findings and provides a detailed structure of the state of research in the field of alternative proteins and consumer behavior

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3. Results and discussion

3.1 Evolution of scientific production

To begin with the descriptive results, Figure 2 presents the evolution of scientific production and citation in the field of alternative proteins over time. The production and citation count in the field of alternative proteins demonstrates a dynamic and fluctuating trajectory over the years. Beginning in 2011 with three publications, the field garnered a significant 732 citations, indicating early recognition and impact. The following year, 2012, saw no publications or citations, representing a brief lull in activity. However, the years that followed showed varied levels of academic engagement, with 2013 and 2014 accumulating 445 and 343 citations respectively, despite a minimal number of publications.
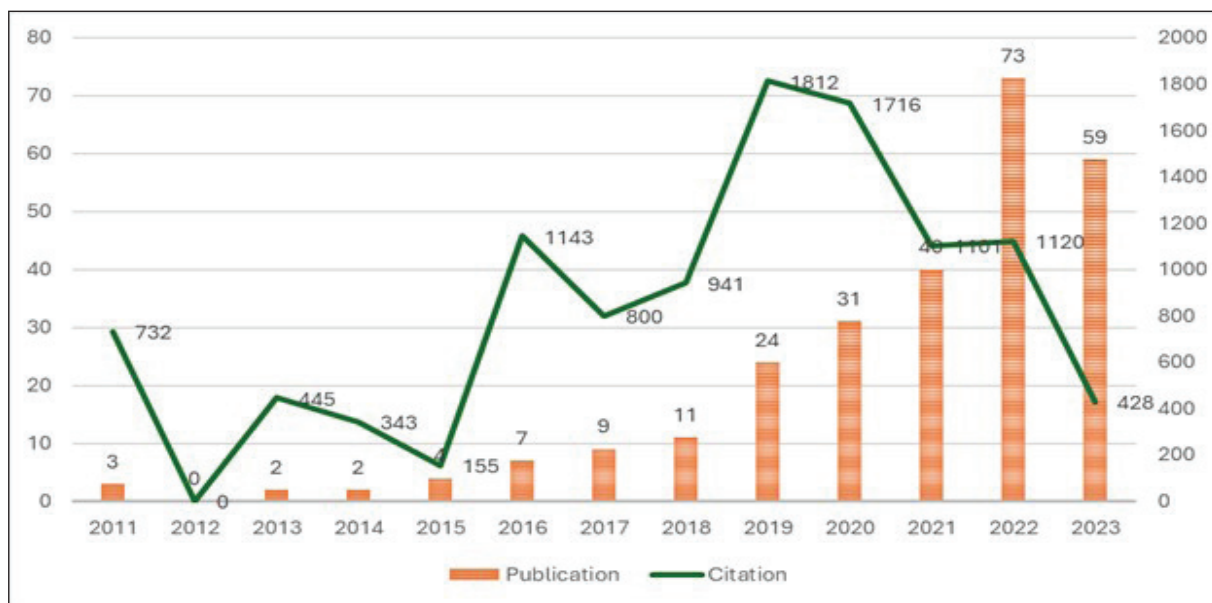

Figure 2. Evolution of scientific publications over time.

A more pronounced growth phase commenced in 2016 with a marked increase to 1,143 citations, corresponding to seven publications, suggesting heightened academic interest and relevance. The upward trend continued into 2017 and 2018, with citations reaching 800 and 941, respectively. The year 2019 stands out significantly with 24 publications attracting 1,812 citations, reflecting a surge in both research output and academic attention.

This momentum continued into 2020 with 31 publications and 1,716 citations, solidifying the field's relevance. However, despite a substantial rise in publications, 2021 and 2022 saw slightly lower but still impressive citation counts of 1,101 and 1,120, respectively. In 2023, while the number of publications remained high at 59, the citation count dropped to 428. This overall pattern underscores the evolving impact and recognition of research within the domain of alternative proteins over the years.

3.2 Most productive countries in the field

Table 1 reveals a diverse and concentrated academic geography in the production of documents on the subject. The United King-

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dom leads with 37 publications, followed by the Netherlands (33) and the United States (30), together representing 24.6% of the total analyzed. Germany and Italy share the fourth position with 28 contributions each. The participation of countries outside Europe and North America, such as Australia (18) and China (12), is noteworthy, highlighting the growing interest in the Asia-Pacific region. However, the presence of Latin America is modest, with Brazil leading the region with only 10 documents. This distribution reflects global research and publication patterns, where regions like Latin America generally produce less than the United States and Europe due to factors such as research investment and academic structures. Regarding impact, it is notable that countries like the Netherlands and Belgium, despite having fewer publications, accumulate a high number of citations (2,032 and 1,226 respectively), suggesting a significant influence of their contributions in the field.

Table 1. Countries with the highest scientific production.

No.	Country	Document	Citation
1	United Kingdom	37	1,388
2	Netherlands	33	2,032
3	United States	30	616
4	Germany	28	977
5	Italy	28	1,434
6	Australia	18	1,259
7	France	18	438
8	Canada	15	1,047
9	Belgium	14	1,226
10	Denmark	14	434

3.3 Journals of major publication

Continuing with the descriptive analysis, Table 2 presents the most productive journals in the field of consumer attitudes and behaviors toward alternative foods and proteins. "Appetite" (United States) leads with 37 publications, a 1.27 impact factor, and an H-index of 178, ranking in the Q1 quartile of the Scimago Journal Rank (SJR). This journal focuses on the psychological, social, and cultural aspects of food consumption. "Food Quality and Preference" (United Kingdom) follows with 32 publications, a 1.13 impact factor, and an H-index of 152, also in Q1, concentrating on sensory perception and consumer behavior. "Foods" and "Nutrients," both Swiss and in Q1, contribute 18 and 14 publications, respectively. "Foods" (impact factor 0.87, H-index 97) covers food science and technology, while "Nutrients" (impact factor 1.3, H-index 209) specializes in human nutrition. The "Journal of Insects as Food and Feed" (Netherlands) matches "Foods" in publications but ranks in Q2 with an impact factor of 0.88 and an H-index of 42, reflecting its specialized focus on entomophagy. This distribution underscores the diversity and specificity of research in the field, with journals covering everything from psychological aspects to innovative technological applications in alternative food.

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Table 2. Journals with the highest scientific production.

Journal	Country	Number of documents	Quartile (Scimago)	Impact Factor	H-Index
Appetite	United States	37	Q1	1.27	178
Food Quality And Preference	United Kingdom	32	Q1	1.13	152
Foods	Switzerland	18	Q1	0.87	97
Journal of Insects as Food and Feed	Netherlands	18	Q2	0.88	42
Nutrients	Switzerland	14	Q1	1.3	209

3.4   Authors with the highest production

This section analyzes the contributions of the five most prolific researchers in the study of alternative proteins and their influence on consumer attitudes and behavior (see Table 3). It is important to note that the h-index mentioned for each author reflects their overall academic impact, based on all their publications, not just those related to this specific field. Leading the group is Pieternel Arianne Luning from Wageningen University & Research in the Netherlands, with seven documents and an h-index of 44, indicating significant influence in areas such as child nutrition and food safety, which can be crucial when studying preferences in the consumption of alternative proteins. In second place is Beatriz Urbano from the University of Valladolid, Spain, with six publications and an h-index of 11. Her work focuses on cellular agriculture and entomophagy. Frank Vriesekoop from Harper Adams University, United Kingdom, also has six documents and a more robust h-index of 24. His research spans from cellular agriculture to meat consumption. Johanna E. Elzerman from Van Hall-Larenstein University of Applied Sciences, United Kingdom, presents five documents and an h-index of 5, focusing on consumer behavior and meat consumption. Finally, Giovanni Sogari from the University of Parma, Italy, has five documents and an h-index of 21. His research on consumer behavior and entomophagy may provide valuable insights into consumers' willingness to adopt innovative diets that include alternative proteins.

Table 3. Authors with the most publications.

Author	Documents	h-index	Afiliation	Research areas
Luning, Pieternel Arianne	7	44	Wageningen University & Research, The Netherlands	Child nutrition, food safety, gastronomic tourism
Urbano, Beatriz	6	11	University of Valladolid, Spain	Cellular agriculture, local food systems, entomophagy
Vriesekoop, Frank	6	24	Harper Adams University, United Kingdom	Cellular agriculture, meat consumption, entomophagy, infant nutrition
Elzerman, Johanna E.	5	5	Van Hall-Larenstein University, Applied Sciences, United Kingdom	Meat Consumption, Consumer Behavior
Sogari, Giovanni	5	21	University of Parma, Italy	Meat consumption, entomophagy, consumer behavior, sea food

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3.5   Most cited documents

After discussing the most prolific authors, Table 4 presents the five most cited papers in the field of alternative proteins and consumer behavior. Hoek et al. (2011) lead with 404 citations (31.07 citations/year), examining attitudes toward meat substitutes in the United Kingdom and the Netherlands. Their study reveals that improving sensory quality

and similarity to meat could be more effective than emphasizing ethical arguments to attract consumers. Kumar et al. (2017) follow with 333 citations (55.5 citations/year), highlighting the urgency for protein alternatives due to population growth and resource scarcity. They suggest that products mimicking meat in taste, texture, and nutritional value could meet various dietary needs.

Table 4. Most cited papers.

No.	Document Title	Author and Year of Publication	Citations	% Citations/ Year
1	Replacement of meat by meat substitutes. A survey on person- and product-related factors in consumer acceptance	Hoek et al. (2011)	404	31.07
2	Protein alternatives: Trends in meat substitutes	Kumar et al. (2017)	333	55.5
3	Consumer acceptance of insect-based alternative meat products in Western countries.	Megido et al. (2016)	311	44.4
4	Flemish consumer attitudes towards more sustainable food choices	Vanhonacker et al. (2013)	289	28.9
5	Consumer acceptance of insect-based foods in the Netherlands: Academic and commercial implications	House (2016)	240	34.2

Megido et al. (2016) contribute with 311 citations (44.4 citations/year), exploring the perception of entomophagy and the sensory factors influencing the acceptance of insect-based foods. They recommend a gradual integration in non-visible forms within prepared foods. Vanhonacker et al. (2013), with 289 citations (28.9 citations/year), analyze Flemish consumer attitudes towards sustainable food options, identifying five consumer segments based on personal relevance and perceived ecological footprint.

Finally, House (2016), with 240 citations (34.2 citations/year), offers a critical view on the acceptance of insect-based foods in the Netherlands, distinguishing between factors that motivate initial trials and repeated consump-

tion. This research suggests evaluating these foods using the same criteria as conventional ones, focusing on early adopters.

3.6   Most common research methods in the field

Upon reviewing the previously mentioned descriptive data, the fifth table summarizes the predominant methods, main data sources, and methodological strategies used in research that links alternative foods and proteins with consumer behavior. The framework for classifying the research works is based on the models proposed by Gupta et al. (2006) and Donthu et al. (2021). In this case, content analysis was applied to the abstracts of the 265 documents included in

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the study. Interpreting Table 5 reveals that most studies are quantitative (70%), indicating a preference in the research community for methods that allow for the collection and analysis of numerical data and the ability to generalize findings to a broader population. The use of quantitative techniques is particularly relevant in this field for identifying consumption trends, determinants of product acceptance, and the effectiveness of various marketing strategies. Qualitative studies account for 18% of the sample and offer deep insights into individual attitudes and perceptions, allowing for a richer and more detailed understanding of consumer motivations and barriers to the acceptance of alternative proteins. Mixed-method studies, at 12%, reflect a comprehensive approach that combines the strengths of both methods to provide a more holistic and corroborated view of the studied phenomena.

Table 5. Research methods.

Research design	
Quantitative	70%
Qualitative	18%
Mixed studies	12%
Type of study	
Empirical studies	80%
Theoretical-conceptual studies	5%
Literature reviews	15%
Data collection techniques	
Surveys	57%
Documentary review	15%
Interviews	13%
Case studies	2%
Experiments	15%
Focus groups	8%
Sensory evaluations	3%
Other techniques	11%
Data analysis techniques	
Qualitative analysis	14%
Descriptive analysis	54%
Content analysis	11%
Regression or correlation models	28%
Cluster analysis	11%
Other techniques	13%
Proteins Research	
Insects	23%
Plant-based proteins	20%
Cultivated meat	4%
Other alternative proteins	5%

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Regarding the type of study, empirical research represents 80% of the analyzed sample, highlighting a strong orientation toward research based on direct observation and experimentation. This aligns with the applied nature of consumer behavior research, where empirical analysis can provide substantial evidence for decision-making in the food industry. Theoretical-conceptual studies and literature reviews are less prevalent, suggesting a significant opportunity for contributions that synthesize and build theoretical frameworks in this domain.

In terms of data collection methods, surveys are the predominant technique (57%), reflecting their utility in assessing attitudes and behaviors in large population samples. Document reviews and experiments, each accounting for 15%, are also relevant, indicating a value placed on existing evidence and controlled environments to test specific hypotheses. Interviews and focus groups, which together comprise 21%, are important techniques for obtaining a more qualitative and in-depth understanding of consumer attitudes and behaviors. Sensory evaluations and other techniques demonstrate the diversity of methods employed to address the multitude of aspects related to alternative proteins.

Regarding data analysis techniques, descriptive analysis is the most used (54%), consistent with the need to describe and summarize large datasets to identify patterns and trends. Regressions and correlation models are also significant (28%), highlighting the importance of understanding relationships and predicting factors that influence consumer acceptance and behavior. Cluster analyses and other identified techniques reflect the application of advanced and mixed statistical methods to segment the market and understand group dynamics within the study domain.

Finally, concerning the type of protein studied, there is a varied distribution that reflects the wide spectrum of alternative proteins in the market and research. Forty-six percent of the documents address multiple alternative proteins, suggesting a holistic approach in many studies that compare and contrast various options. Insects, at 23%, represent a significant area of interest, possibly due to their potential as a sustainable protein source and the cultural challenges associated with their acceptance in many societies. Plant-based proteins are the second most studied type (20%), reflecting the growing popularity of plant-based diets and innovation in this sector. Cultivated meat, although representing only 4% of the studies, indicates an emerging field with growth potential. Other alternative proteins, such as fungi, algae, and dairy, make up the remaining 5%, demonstrating the diversity of options explored in the quest for sustainable and acceptable protein sources for consumers.

3.7 Analysis of key variables and theories in the field of research

After analyzing the most commonly used research methods in the field of interest, content analysis was applied to the theoretical sections of the 265 documents included in the study, aiming to identify the main variables and theories established in the field of study.

Various studies have analyzed the variables influencing consumer attitudes and responses toward meat substitute products. Among the main predictors is food neophobia, which

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is negatively associated with purchase intention and acceptance of these products (Ford et al., 2023; López, 2023). People with higher neophobia show a lower willingness to try them. Sociodemographic aspects such as age, gender, and educational level are also related to differences in acceptance, with younger consumers exhibiting a more positive attitude (López et al., 2023; Clark et al., 2021). Another relevant factor is the perception of risks associated with the consumption of meat substitutes, which negatively affects their attitude and acceptance (Legendre et al., 2022; Begho & Zhu, 2023). On the contrary, greater knowledge about the characteristics and benefits of these products is linked to a higher willingness to try them and a more positive evaluation (Begho & Zhu, 2023; Wang, 2022). Similarly, previous experience with plant-based substitutes predicts greater preference and subsequent acceptance (Cornelissen & Piqueras-Fizman, 2023; van Dijk et al., 2023). Other variables such as environmental concern, attachment to meat, type of diet, and personal values also influence the response to meat substitutes (van Dijk et al., 2023; Sogari et al., 2022; Jang & Cho, 2022).

3.8 Most commonly used theories in the field

The content analysis of the theoretical sections of the 265 documents also identified the main theories employed to understand consumer attitudes towards meat substitutes. One of the prominent theoretical approaches in the literature is the Theory of Planned Behavior (TPB), which has been used to understand how consumers' beliefs about the consequences of their choices, along with the influence of social pressure and their perceived control, shape their intention to purchase and consume alternative proteins.

The repeated appearance of this theory in the documents underscores its relevance in predicting conscious and sustainable consumption behavior (Jang & Cho, 2022). The Technology Acceptance Model (TAM), provides a framework for analyzing how consumers perceive the usefulness and ease of use of alternative proteins, which is crucial for their widespread adoption. This model helps companies and policymakers design strategies that enhance the perception of food innovations and encourage their integration into everyday life (Begho & Zhu, 2023).

The Diffusion of Innovations Theory has also been used in this field, offering insights into how new ideas and products, such as alternative proteins, spread across different social groups, identifying key factors that accelerate or inhibit their adoption. This theory is particularly valuable for developing market tactics that increase the adoption speed of these products (Zhou et al., 2022). Similarly, the Theory of Perceived Value is crucial for understanding how consumers balance the perceived cost and benefit of meat substitutes, which directly affects their willingness to purchase and recommend these products to others (Shin et al., 2023).

Both the Cognitive Dissonance Theory and the Protection Motivation Theory are closely related to psychological reactions to information about the impacts of conventional meat and available alternatives. These theories explain how consumers justify their purchase decisions and how concerns about health and the environment can motivate consumers to switch to more sustainable options (Jang & Cho, 2022).

Lastly, among the theoretical approaches used in this field is the Competing Values

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Theory, which suggests that the conflict between different values (such as personal pleasure vs. environmental well-being) can influence consumer decisions, providing a framework for understanding the complex deliberations individuals face when choosing foods (de Koning et al., 2020).

3.9   Research streams

After presenting the descriptive indicators, methodologies, data sources, and research approaches used in the field that studies consumer behaviors towards novel foods and proteins, this section introduces the bibliographic coupling map that identifies the main research streams. According to Boeris (2010), the relationship between two or more scientific articles can be determined by the number of bibliographic references they share. Bibliographic coupling is a method that facilitates tracking the interconnections between articles within a specific discipline. This method is useful for uncovering clusters of closely linked articles that represent predominant lines of research.

A bibliographic coupling map (Figure 3), was generated using the bibliometric software VOSviewer to highlight the most referenced articles. For the creation of this map, all articles in our sample were considered, establishing a minimum citation threshold to include an article in the analysis. The association strength normalization method was used to calculate the similarity between articles, and the VOSviewer clustering algorithm was applied to identify clusters, adjusting the resolution parameter to optimize the detection of coherent groups. The resulting analysis revealed a cluster structure suggesting the presence of three main research trends. These trends were identified based on the density of connections within each cluster, the centrality of certain articles within each group, and the thematic coherence of the grouped articles. This last criterion was determined through a qualitative analysis of the titles, abstracts, and keywords of the articles in each cluster.
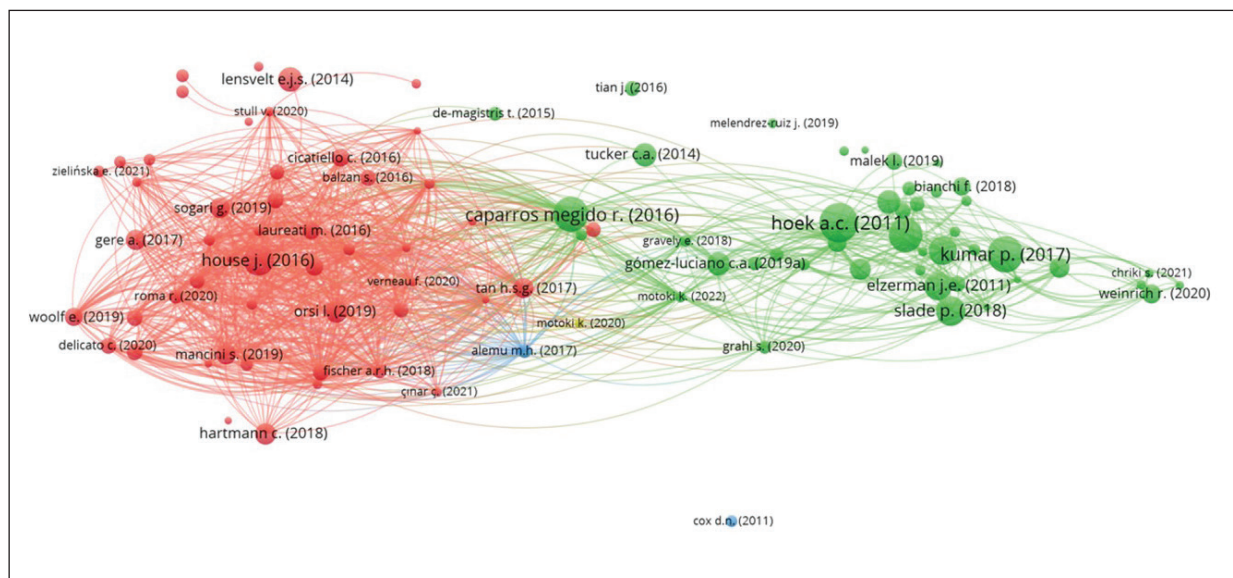

Figure 3. Research areas.

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3.10   Detailed clusters from bibliographic coupling

Cluster 1: edible insects overcoming psychological and cultural barriers

This cluster focuses on investigating the psychological and cultural barriers that hinder the adoption of insects as food in Western societies. House (2016), for example, explores factors like food neophobia, disgust, and negative sensory expectations that cause consumers to reject insects. Megido et al. (2016) and Sogari et al. (2022), argue that strategies are needed to overcome these barriers, such as hiding insects in processed foods, highlighting nutritional and environmental benefits, and conducting informative campaigns. It is concluded that Western consumers prefer processed products with invisible insects over whole insects (Tucker, 2014).

Cluster 2: Preferences and acceptance of alternative proteins

This cluster examines consumer attitudes towards alternative protein sources, including insects, cultured meat, and plant-based proteins (Goméz-Luciano et al., 2019). The articles in this stream use methodologies like choice surveys and conjoint analysis to understand drivers of acceptance. Hartman et al. (2018), identify the need to shift to less meat-intensive diets for health and environmental reasons. Findings indicate that consumers prefer plant-based proteins (Gomez-Luciano et al., 2019) but are also open to cultured meat and insects if the nutritional and sustainability benefits are emphasized (Cox et al., 2011). Sensory characteristics and price also influence acceptance (Alemu et al., 2019).

Cluster 3: Determinants of acceptance for meat substitutes

This research stream focuses on the factors influencing the acceptance of meat substitutes, such as soy and gluten products. Hoek et al. (2011) and Kumar et al. (2017), compare regular consumers of these products with occasional and non-consumers. It is identified that food neophobia and negative sensory expectations are significant barriers. Non-consumers, in particular, expect substitutes to be similar to meat (Kumar et al., 2017). Therefore, it is concluded that to increase acceptance, companies should improve sensory qualities and resemblance to meat rather than emphasizing ethical arguments (Hoek et al., 2011).

Research opportunities

To identify research gaps in the area exploring acceptance and behaviors towards alternative proteins, a qualitative analysis was conducted by examining the conclusions, limitations, and recommendations for future research sections of the last 59 documents published during 2023. This examination revealed several emerging trends and fields expected to be of vital importance in the near future.

Opportunity 1: Antecedents and Consequences of Acceptance of Alternative Proteins

There is a need for more studies exploring the factors that motivate or discourage the consumption of these proteins in different population segments. Several studies highlight differences according to countries, cultures, gender, and age groups. For instance, in Western countries, barriers related to

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rejection and aversion predominate, while in China, health is the primary motivator. Understanding these variations is crucial for developing effective marketing strategies by region and demographic group (Ford et al., 2023).

Opportunity 2: Communication Strategies to Reduce Resistance to Alternative Proteins

Another promising line is experimenting with different communication approaches and informational content to reduce perceptual barriers and increase acceptance. Several studies found positive effects when presenting environmental, health, or animal welfare benefits, but more research is needed to determine the optimal messages by audience and product type (Stone et al., 2023).

Opportunity 3: Impact of the Presentation of Alternative Proteins

It is also necessary to delve into how packaging, labeling, and product design influence purchase decisions. Some studies indicate that familiar images, transparent windows, and anthropomorphic designs can improve acceptance, but more tests are needed in real consumption conditions (Wang & Park, 2023).

Opportunity 4: Integration of Alternative Proteins into Diets

Further research is needed on effective ways to introduce these proteins into diets, as several studies indicate that consumers do not see them as direct substitutes for traditional meats. Strategies such as gradual incorporation into mixed products and developing preparations that highlight positive sensory attributes could be explored (Jiang & Farag, 2023).

Opportunity 5: Viability of Microbial Proteins

Most studies focus on plant-based, insect, and cultured proteins. More research is needed on the viability of alternative sources such as microbial and fungal proteins, as well as comparative analyses to determine the strengths and weaknesses of each option in terms of consumer acceptance (Tzompa-Sosa et al., 2023).

4. Conclusions

This bibliometric study reveals the rapid growth of research on the acceptance of alternative proteins and consumer behavior. Since 2018, there has been an exponential increase in publications, primarily driven by developed countries in Europe and North America, with the United Kingdom, the Netherlands, and the United States leading the way. However, this geographical distribution highlights a significant gap. Despite the tradition of insect consumption in Africa and some South and Central American countries, scientific production in these regions is sparse, with nations like Uganda, Mexico, Ecuador, and Nigeria barely represented in the academic literature.

Methodologically, empirical quantitative studies predominate, mainly using surveys. It is recommended to complement these with qualitative approaches to delve deeper into consumer motivations. Content analysis identified key factors influencing the acceptance of alternative proteins, including food neophobia, sociodemographic factors, perception of risks and benefits, and previous experience. Seven theories stand out in the analysis of consumer behavior, among them the Theory of Planned Behavior and the Technology Acceptance Model.

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The main research streams focus on overcoming barriers to edible insects, understanding the general acceptance of alternative proteins, and analyzing the drivers of plant-based meat substitute consumption. For future research, more comparative studies between populations and countries are suggested, as well as experimentation with communication strategies, analysis of the impact of packaging, and exploration of microbial protein sources.

Authors' contribution

Carlos Fernando Osorio-Andrade: Conceptualization, Investigation, Supervision.

Carlos Alberto Arango-Pastrana: Formal análisis, Writing - original draft.

Juan Manuel Candelo-Viáfara: Writing - original draft, Writing - review editing, Validation.

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5. References

Alemu, M. H., Olsen, S. B., Vedel, S. E., Pambo, K. O., & Owino, V. O. (2017). Combining product attributes with recommendation and shopping location attributes to assess consumer preferences for insect-based food products. *Food Quality and Preference,* 55, 45-57. https://doi.org/10.1016/j.foodqual.2016.08.009

Boeris, C. (2010). Aplicación de métodos bibliométricos a la evaluación de colecciones: el caso de la Biblioteca del Instituto Argentino de Radioastronomía. https://bit.ly/3RpTKjU

Bogueva, D., & Marinova, D. (2022). Australian Generation Z and the Nexus between Climate Change and Alternative Proteins. *Animals, 12* (19), 2512. https://doi.org/10.3390/ani12192512

Chen, H. S. (2022). Towards environmentally sustainable diets: consumer attitudes and purchase intentions for plant-based meat alternatives in taiwan. *Nutrients, 14* (18), 3853. https://doi.org/10.3390/nu14183853

Cox, D. N., Evans, G., & Lease, H. J. (2011). The influence of product attributes, consumer attitudes and characteristics on the acceptance of:(1) Novel bread and milk, and dietary supplements and (2) fish and novel meats as dietary vehicles of long chain omega 3 fatty acids. *Food Quality and Preference, 22* (2), 205-212. https://doi.org/10.1016/j.foodqual.2010.10.003

Donthu, N., Kumar, S., Pandey, N., Pandey, N. y Mishra, A. (2021). Mapping the electronic word-of-mouth (eWOM) research: A systematic review and bibliometric analysis. *Journal of Business Research,* 135, 758-773. https://doi.org/10.1016/j.jbusres.2021.07.015

Ford, H., Gould, J., Danner, L., Bastian, S. E., & Yang, Q. (2023). "I guess it's quite trendy": A qualitative insight into young meat-eaters' sustainable food consumption habits and perceptions towards current and future protein alternatives. *Appetite,* 190, 107025. https://doi.org/10.1016/j.appet.2023.107025

Rev.Investig.Desarro.Innov. Vol. 14(2), julio-diciembre de 2024, 195-214. ISSN: 2027-8306 ISSN-E: 2389-9417

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Gómez-Luciano, C. A., de Aguiar, L. K., Vriese-koop, F., & Urbano, B. (2019). Consumers' willingness to purchase three alternatives to meat proteins in the United Kingdom, Spain, Brazil and the Dominican Republic. *Food Quality and Preference,* 78, 103732. https://doi.org/10.1016/j.foodqual.2019.103732

Gupta, P. y Harris, J. (2010). How e-WOM recommendations influence product consideration and quality of choice: A motivation to process information perspective. *Journal of Business Research, 63* (9-10), 1041-1049. https://doi.org/10.1016/j.jbusres.2009.01.015

Hartmann, C., & Siegrist, M. (2018). Development and validation of the Food Disgust Scale. *Food Quality and Preference,* 63, 38-50. https://doi.org/10.1016/j.foodqual.2017.07.013

Heijnk, V., Espey, A., & Schuenemann, F. (2023). A comparison of influencing factors on attitudes towards plant-based, insect-based and cultured meat alternatives in Germany. *Food Quality and Preference*, 110, 104966. https://doi.org/10.1016/j.foodqual.2023.104966

Hirunyophat, P., NAKPATCHIMSAKUN, P., & FUENGKAJORNFUNG, N. (2023). The effect of the addition of pineapple residue (Ananas comosus L.) on texture, physicochemical properties, and sensory acceptability of the plant-based minced meatball. *Future of Food: Journal on Food, Agriculture and Society, 11* (2).

Hoek, A. C., Luning, P. A., Weijzen, P., Engels, W., Kok, F. J., & De Graaf, C. (2011). Replacement of meat by meat substitutes. A survey on person- and product-related factors in consumer acceptance. *Appetite, 56* (3), 662-673. https://doi.org/10.1016/j.appet.2011.02.001

House, J. (2016). Consumer acceptance of insect-based foods in the Netherlands: Academic and commercial implications. *Appetite,* 107, 47-58. https://doi.org/10.1016/j.appet.2016.07.023

Janik, A., Ryszko, A. y Szafraniec, M. (2020). Scientific landscape of smart and sustainable cities literature: A bibliometric analysis. *Sustainability, 12* (3), 1-39. https://doi.org/10.3390/su12030779

Jiang, M., & Farag, K. W. (2023). Is China ready for change? Consumer behaviour towards buying plant-based meat alternatives: applying the COM-B model. *British Food Journal*. https://doi.org/10.1108/BFJ-07-2022-0596

Keramatfar, A., & Amirkhani, H. (2019). Bibliometrics of sentiment analysis literature. *Journal of Information Science, 45* (1), 3-15. https://doi.org/10.1177/0165551518761013

Ketelings, L., Benerink, E., Havermans, R. C., Kremers, S. P., & de Boer, A. (2023). Fake meat or meat with benefits? How Dutch consumers perceive health and nutritional value of plant-based meat alternatives. *Appetite,* 106616. https://doi.org/10.1016/j.appet.2023.106616

Kumar, P., Chatli, M. K., Mehta, N., Singh, P., Malav, O. P., & Verma, A. K. (2017). Meat analogues: Health promising sustainable meat substitutes. *Critical Reviews in Food Science and Nutrition, 57* (5), 923-932. https://doi.org/10.1080/10408398.2014.939739

Livia, J., Merino-Soto, C., & Livia-Ortiz, R. (2022). Producción científica en la base de datos Scopus de una Universidad privada del Perú. *Revista Digital de Investigación en Docencia Universitaria, 16* (1). http://dx.doi.org/10.19083/ridu.2022.1500

Mancini, M. C., & Antonioli, F. (2022). Italian consumers standing at the crossroads of alternative protein sources: Cultivated meat, insect-based and novel plant-based foods. *Meat Science,* 193, 108942. https://doi.org/10.1016/j.meatsci.2022.108942

Marquis, D., Oliveira, D., Pantin-Sohier, G., Reinoso-Carvalho, F., Deliza, R., & Gallen, C. (2023). The taste of cuteness: How claims and cute visuals affect consumers' perception of insect-based foods. *International Journal of Gastronomy and Food Science, 32,* 100722. https://doi.org/10.1016/j.ijgfs.2023.100722

Rev.Investig.Desarro.Innov. Vol. 14(2), julio-diciembre de 2024, 195-214. ISSN: 2027-8306 ISSN-E: 2389-9417

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Megido, R. C., Gierts, C., Blecker, C., Brostaux, Y., Haubruge, É., Alabi, T., & Francis, F. (2016). Consumer acceptance of insect-based alternative meat products in Western countries. *Food Quality and Preference,* 52, 237-243. https://doi.org/10.1016/j.foodqual.2016.05.004

Molina-Collado, A., Salgado-Sequeiros, J., Gómez-Rico, M., Aranda-García, E., & De Maeyer, P. (2021). Key themes in consumer financial services research from 2000 to 2020: a bibliometric and science mapping analysis. *International Journal of Bank Marketing, 39* (7), 1446-1478. https://doi.org/10.1108/IJBM-01-2021-0043

Moura, M. A. F. E., Martins, B. D. A., Oliveira, G. P. D., & Takahashi, J. A. (2022). Alternative protein sources of plant, algal, fungal and insect origins for dietary diversification in search of nutrition and health. *Critical Reviews in Food Science and Nutrition,* 1-18. https://doi.org/10.1080/10408398.2022.2085657

Realini, C. E., Driver, T., Zhang, R., Guenther, M., Duff, S., Craigie, C. R., & Farouk, M. M. (2023). Survey of New Zealand consumer attitudes to consumption of meat and meat alternatives. *Meat Science*, 109232. https://doi.org/10.1016/j.meatsci.2023.109232

Rowe, F., Kanita, N., & Walsh, I. (2023). The importance of theoretical positioning and the relevance of using bibliometrics for literature reviews. *Journal of Decision Systems,* 1-16. https://doi.org/10.1080/12460125.2023.2217646

Sogari, G., Menozzi, D., Mora, C., Gariglio, M., Gasco, L., & Schiavone, A. (2022). How information affects consumers' purchase intention and willingness to pay for poultry farmed with insect-based meal and live insects. *Journal of Insects as Food and Feed, 8* (2), 197-206. https://doi.org/10.3920/JIFF2021.0034

Stone, H., FitzGibbon, L., Millan, E., & Murayama, K. (2023). Encouraging willingness to try insect foods with a utility-value intervention. *Appe-*

tite, 190, 107002. https://doi.org/10.1016/j.appet.2023.107002

Tang, Q., & Chung, S. J. (2023). Effect of explicit frames on the sensitivity and acceptance of mealworm in protein shake. *Food Quality and Preference,* 104924. https://doi.org/10.1016/j.foodqual.2023.104924

Tucker, C. A. (2014). The significance of sensory appeal for reduced meat consumption. *Appetite,* 81, 168-179. https://doi.org/10.1016/j.appet.2014.06.022

Tzompa-Sosa, D. A., Sogari, G., Copelotti, E., Andreani, G., Schouteten, J. J., Moruzzo, R., ... & Mancini, S. (2023). What motivates consumers to accept whole and processed mealworms in their diets? A five-country study. *Future Foods,* 7, 100225. https://doi.org/10.1016/j.fufo.2023.100225

Vanhonacker, F., Van Loo, E. J., Gellynck, X., & Verbeke, W. (2013). Flemish consumer attitudes towards more sustainable food choices. *Appetite, 62,* 7-16. https://doi.org/10.1016/j.appet.2012.11.003

Wang, Z., & Park, J. (2023). "Human-like" is powerful: The effect of anthropomorphism on psychological closeness and purchase intention in insect food marketing. *Food Quality and Preference*, 109, 104901. https://doi.org/10.1016/j.foodqual.2023.104901

White, S. K., Ballantine, P. W., & Ozanne, L. K. (2022). Consumer adoption of plant-based meat substitutes: A network of social practices. *Appetite,* 175, 106037. https://doi.org/10.1016/j.appet.2022.106037

Yu, F., Van, A. A., Patel, T., Mani, N., Carnegie, A., Corbie-Smith, G. M., ... & Dave, G. (2020). Bibliometrics approach to evaluating the research impact of CTSAs: a pilot study. *Journal of Clinical and translational Science, 4* (4), 336-344. https://doi.org/10.1017/cts.2020.29

Rev.Investig.Desarro.Innov. Vol. 14(2), julio-diciembre de 2024, 195-214. ISSN: 2027-8306 ISSN-E: 2389-9417

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