

Exploring Food Product Labeling Models in A Global Context: A Bibliometric Analysis Using Scopus (1972-2024)

(Meneroka Model Pelabelan Produk Makanan dalam Konteks Global: Analisis Bibliometrik Menggunakan Scopus (1972–2024))

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ABSTRACT

This study presents a bibliometric analysis of food product labeling research spanning 52 years (1972–2024), using data from the Scopus database. The objective is to identify the most influential factors within the model, key thematic trends, prolific authors, leading institutions, and contributing countries. Using VOSviewer, the analysis mapped co occurrence networks, citation patterns, and keyword clusters to uncover the intellectual structure of food labeling research. Key themes center on sustainable consumer behavior and food systems, emphasizing environmental awareness, green product preferences, and circular economy concepts. Economic and psychological factors, such as willingness to pay and behavioral experiments, provide insights into green purchasing decisions. Another major cluster highlights the integration of technology in food systems, including blockchain, food traceability, and machine learning, to enhance transparency and consumer trust. Health, nutrition, and policy also emerge as significant themes that link sustainability to public well-being and governance. Despite substantial growth in research, gaps remain in smart labeling technologies, digital information systems, and culturally adaptive labeling in non-Western contexts. These areas present opportunities for future interdisciplinary exploration. The findings provide practical implications for researchers, policymakers, and industry stakeholders in refining frameworks, regulations, and consumer-centered labeling strategies.

Keywords: Food labeling; bibliometric analysis; sustainable consumer behavior; smart labeling

ABSTRAK

Kajian ini membentangkan analisis bibliometrik terhadap penyelidikan pelabelan produk makanan yang merangkumi tempoh 52 tahun (1972–2024) berdasarkan data daripada pangkalan data Scopus. Objektif kajian adalah untuk mengenal pasti model yang dominan, tema utama penyelidikan, pengarang paling produktif, institusi, serta negara yang paling banyak menyumbang dalam bidang ini. Dengan menggunakan VOSviewer, analisis ini memetakan rangkaian perkaitan, corak sitasi dan kelompok kata kunci untuk menyingkap struktur intelektual dalam penyelidikan pelabelan makanan. Tema utama penyelidikan tertumpu kepada tingkah laku pengguna lestari dan sistem makanan, dengan penekanan pada kesedaran alam sekitar, keutamaan terhadap produk hijau, serta konsep ekonomi kitaran. Faktor ekonomi dan psikologi, seperti kesanggupan membayar dan eksperimen tingkah laku, memberikan pandangan tentang keputusan pembelian produk hijau. Satu lagi kelompok penting menonjolkan pengintegrasian teknologi dalam sistem makanan, termasuk rantaian blok, kebolehesanan makanan dan pembelajaran mesin yang bertujuan meningkatkan ketelusan serta kepercayaan pengguna. Aspek kesihatan, pemakanan dan dasar awam turut muncul sebagai tema penting yang menghubungkan kelestarian dengan kesejahteraan masyarakat serta tadbir urus. Walaupun terdapat pertumbuhan ketara dalam penyelidikan, masih wujud jurang dalam bidang seperti teknologi pelabelan pintar, sistem maklumat digital dan pelabelan yang disesuaikan secara budaya dalam konteks bukan Barat. Bidang-bidang ini menawarkan peluang untuk penerokaan antara disiplin pada masa akan datang. Dapatan kajian ini memberikan implikasi praktikal kepada penyelidik, pembuat dasar dan pihak industri dalam usaha menambah baik rangka kerja teori, menggubal peraturan pelabelan yang inklusif, serta membangunkan strategi pelabelan yang berpusatkan pengguna.

Kata kunci: Pelabelan makanan, analisis bibliometrik, tingkah laku pengguna lestari, pelabelan pintar

INTRODUCTION

Food product labeling plays a fundamental role in the modern food system, serving as a bridge between manufacturers and consumers. Labels communicate vital information, including nutritional composition, ingredient lists, allergen warnings, shelf life, country of origin, and various certifications such as organic and halal (Kasturi Perumal et al. 2022; Prayusi &

Andriani 2023). Beyond regulatory compliance, food labels influence consumer decisions, health awareness, and brand trust. As consumers become more health-conscious, environmentally aware, and ethically driven (Prayusi & Andriani 2023), food labeling has transformed into a strategic communication tool that reflects broader societal values. Hence, food labeling serves not only as a regulatory instrument but also as a strategic communication channel shaping consumer choice.

In contemporary consumer markets, labeling functions have evolved beyond basic informational roles. Food labels in today's market are more than just a list of ingredients and nutritional information. They communicate manufacturers' commitment to sustainability, ethical practices, and consumer well-being (Cook et al. 2023). Labels now emphasize characteristics such as carbon footprint, cruelty-free production, fair trade sourcing (Liechti et al. 2025), organic certification, non-GMO status, and dietary suitability, for example, halal and gluten-free. These indicators help consumers align their lifestyle preferences and personal values with their purchasing decisions, thereby influencing brand perception, building trust, and enhancing market competitiveness. Consequently, food manufacturers have been compelled to adopt more transparent and socially responsible labeling practices (Campos et al. 2011; Grunert et al. 2010).

Over the last five decades, the academic discourse surrounding food product labeling has expanded significantly across disciplines such as nutrition, food science, public health, marketing, consumer behavior, and policy studies (Priya & Alur 2023). Researchers have explored various themes, including front-of-pack labeling systems, health and nutritional claims, eco-labels, label comprehension, cross-cultural interpretations, and the psychological impact of design elements (Guo et al. 2024; Kirui et al. 2024). These themes collectively represent the model constructs, which are conceptual dimensions that structure and drive scholarly inquiry in the field (Hersey et al. 2013; Aschemann-Witzel & Hamm 2010). Recent bibliometric studies have examined the evolution of food labeling research, identifying key thematic clusters and research trends (Paliwal & Wan 2024).

Food labeling plays a critical role in shaping consumer awareness, brand trust, and informed purchasing decisions (Bewket & Wodaje 2025; Krishnamoorthi & Mohanraj 2025). It acts not merely as a compliance mechanism but as a strategic communication tool that connects producers and consumers across diverse markets. In today's competitive environment, labeling supports transparency, sustainability, and consumer empowerment by communicating ethical production and nutritional integrity. Understanding the evolution and underlying dimensions of food labeling is therefore significant for multiple stakeholders, including consumers, industries, policymakers, and academics. It helps ensure that food labeling systems are informative, culturally appropriate, and aligned with public health and sustainability goals.

Despite the abundance of research on food labeling, existing bibliometric reviews remain fragmented, often focusing on isolated dimensions such as nutritional labeling, health communication, or eco-labels (Nagar & Verma 2025). Few studies have offered a comprehensive integration of these perspectives to capture the interdisciplinary nature of food labeling research (Priya & Alur 2023; Mazzù et al. 2023). Furthermore, the rapid emergence of sustainability concerns, digital traceability, and smart labeling technologies, which include QR codes, blockchain authentication, and AI-driven transparency, has transformed the research landscape (Reina Paz & Rodríguez Vargas 2023). Given these shifts, an updated bibliometric synthesis is needed to holistically trace the evolution, interconnection, and emerging paradigms within global food labeling scholarship. This study addresses this gap by systematically mapping 52 years (1972–2024) of food labeling research, offering a timely and necessary contribution to both academia and practice.

Conceptually, this study views food labeling as an intersectional domain linking consumer psychology, public policy, and sustainable food systems. It adopts the notion of "model constructs" to describe the intellectual structure of this interdisciplinary field, referring to the key conceptual, behavioral, and regulatory dimensions underlying the existing literature. Consumer behavior theories such as the Theory of Planned Behavior (Hasyim & Purnasari 2021; Tai et al. 2020), the Health Belief Model (Green et al. 2020), and the Elaboration Likelihood Model (Thai Nguyen & Cam Tang 2025) are particularly relevant to understanding how consumers interpret, evaluate, and respond to food labels (Zafar et al. 2022). These models highlight cognitive, emotional, and cultural mechanisms that influence labeling comprehension and purchase intention. By integrating regulatory and behavioral perspectives, this study provides a conceptual framework for examining how diverse research traditions converge to shape food labeling discourse.

This study contributes to the literature both conceptually and methodologically. Conceptually, it integrates diverse disciplinary perspectives by linking behavioral theories, sustainability discourse, and regulatory frameworks through the identification of dominant model constructs that shape research on food labeling. Methodologically, it applies advanced bibliometric mapping techniques, such as co-word analysis and overlay visualization using VOSviewer, to uncover thematic evolution, disciplinary convergence, and emerging frontiers (Li et al. 2024). These contributions provide a holistic intellectual map of the food labeling field, enabling scholars, policymakers, and practitioners to understand key trends, collaborations, and research trajectories. The findings will also inform the design of evidence-based, culturally relevant, and sustainability-oriented labeling systems that promote consumer empowerment and responsible production practices.

Guided by this conceptual and methodological framing, the study seeks to answer the following research questions:

1. What are the major thematic clusters and conceptual structures that characterize food labeling research from 1972 to 2024?
2. How have these constructs evolved and interacted across disciplinary, sustainability, and digitalization dimensions?
3. Which authors, institutions, and countries have most influenced the intellectual and collaborative landscape of food labeling research?

METHODOLOGY

A bibliometric study systematically uses online databases to identify, analyze, and visualize the global research trends of a specific topic. Unlike traditional literature reviews, bibliometric analysis employs algorithmic and statistical techniques to map knowledge structures, highlight influential works, and uncover emerging themes (Donthu et al. 2021). A PRISMA-style flow diagram is presented in Figure 1 to illustrate the article screening and selection process and ensure transparency. The actual analysis of the selected publications was conducted using VOSviewer, focusing on co-authorship networks, keyword co-occurrence, and citation patterns. This bibliometric approach, with transparent reporting of search strings, databases, time span, and inclusion criteria, ensures the reproducibility and methodological rigor expected in bibliometric research.

INFORMATION SOURCES AND RETRIEVAL APPROACH

Data for this study were retrieved from the Scopus database on 23 April 2025, covering publications between 1972 and 2024. The primary focus was on the intersection of model constructs and food product labeling. To ensure reproducibility, the exact master search query was constructed as follows: TITLE-ABS (model) AND TITLE-ABS (factor) AND TITLE-ABS (food product) AND TITLE-ABS (label) AND PUBYEAR > 1971 AND PUBYEAR < 2025 AND (LIMIT-TO (DOCTYPE, "ar")). This search initially yielded 4,432 records. After removing duplicates and non-journal materials (--109), the final dataset contained 4,323 articles. Each filtering stage and inclusion criterion was documented using a PRISMA-style flow diagram (Figure 1), detailing the retrieval, screening, and inclusion process. To enhance precision, irrelevant document types, which are reviews, were excluded using additional filters in Scopus. The bibliometric indicators exported included the number of publications, citation counts, field-weighted citation impact (FWCI), and research impact index. Documents were excluded after title-abstract screening if they were non-article formats in consumer or labeling contexts. Each exclusion reason was recorded in the PRISMA flow (Figure 1). Scopus was chosen for its comprehensive coverage of peer-reviewed journals and compatibility with the VOSviewer bibliometric tool. The PRISMA-style flow (Figure 1) transparently summarizes all inclusion and exclusion steps, ensuring traceability and reproducibility of data selection.

DATA CLEANING AND NORMALIZATION

Data preprocessing was carried out using VOSviewer and Microsoft Excel. A thesaurus was developed to standardize spelling variations and merge semantically identical keywords. The following cleaning procedures were applied: 1. Spelling standardization: British and American spelling variants were unified ("labelling" to "labeling"; "behaviour" to "behavior"); 2. Singular/plural consolidation: Plural forms were merged with singular forms ("consumers" to "consumer"); 3. Synonym grouping: Semantically related terms were consolidated under umbrella terms ("consumer," "consumers," "consumerlabe attitude," "consumer perception," "consumer preference" to "consumer") to minimize lexical bias; 4. Abbreviation expansion: Abbreviations were expanded to full terms where appropriate ("TPB" to "theory of planned behavior"). A before-and-after comparison was recorded: before cleaning (11,547) author keywords and after cleaning (11,438) standardized keywords. A merged dictionary and normalization rules are provided in Table S1, enabling replication of all cleaning steps. Each cleaning rule, for example, merging spelling variants, plural and singular forms, and regional differences, was documented with corresponding before-and-after term counts to ensure full transparency and reproducibility. All keyword normalization was independently verified by two coders to ensure semantic accuracy and consistency.

PARAMETER JUSTIFICATION AND SENSITIVITY TESTING

Following the methodological guidelines by Donthu et al. (2021), a minimum keyword occurrence threshold ($n = 9$) was selected for co-occurrence mapping. This cutoff balanced network density and interpretability. To test robustness, sensitivity analyses were conducted using thresholds ($n = 8$) and ($n = 10$), confirming stability in cluster formation and keyword centrality values. The full counting method was applied for both co-authorship and co-occurrence analyses because it retains the complete weight of each publication for all linked entities, providing comprehensive collaboration and thematic maps. A fractional counting check was also performed to verify that the overall cluster pattern remained consistent. The threshold ($n = 9$) was selected iteratively to retain at least 95% of keyword frequency while keeping node counts manageable (<200), ensuring both analytical precision and readability. Full counting was prioritized for capturing the complete relational strength between items.

SUB-THEME IDENTIFICATION AND VALIDATION

To analyze the research focus within food labeling, two sub-themes were explored: food product categories (dairy, meat, cereals, processed foods, beverages) and labeling components (nutrition facts, ingredient lists, health claims, allergens, sustainability labels). Distinct and reproducible search strings were developed for each sub-theme. The sub-theme dataset

contained 2,680 validated publications which are cross-checked against journal scopes and author affiliations to ensure contextual relevance. The sub-theme categorization facilitated targeted insights into specific labeling applications while maintaining methodological consistency with the main dataset.

REPRODUCIBILITY AND TRANSPARENCY

All data files, including the master query, cleaning thesaurus, parameter table, and VOSviewer script are deposited in an open-access repository. These materials enable complete replication of data retrieval, cleaning, and analysis workflows. Each sub-theme used a reproducible Boolean string and was validated independently by two reviewers to ensure thematic consistency. This facilitates full methodological reproducibility. This approach aligns with open science practices, ensuring that all procedures can be independently verified and replicated.

BIBLIOMETRIC MAPS

Bibliometric mapping was conducted to visualize intellectual structures and collaborative patterns within the field of food product labeling research. Two major analyses were performed: (1) co-authorship analysis, which illustrates research collaboration networks among authors and countries, and (2) co-occurrence analysis, which identifies thematic relationships among keywords. All maps were generated using VOSviewer under standardized parameters, employing the full counting method to preserve the complete contribution of each publication across linked entities. Prior to mapping, a cleaning thesaurus was applied to unify semantically identical or linguistically varied terms, for example, "labelling" vs. "labeling" and "consumer behavior" vs. "consumer behavior". This normalization step ensured that equivalent concepts were represented as single nodes, thus improving interpretive accuracy. The PRISMA-style workflow (Figure 1) documented each stage of record inclusion, de-duplication, and term standardization. Overlay visualization mode was used to indicate the average publication year, enabling temporal interpretation of thematic evolution (Ya'kob et al. 2024).

EVALUATION OF CO-AUTHORSHIP

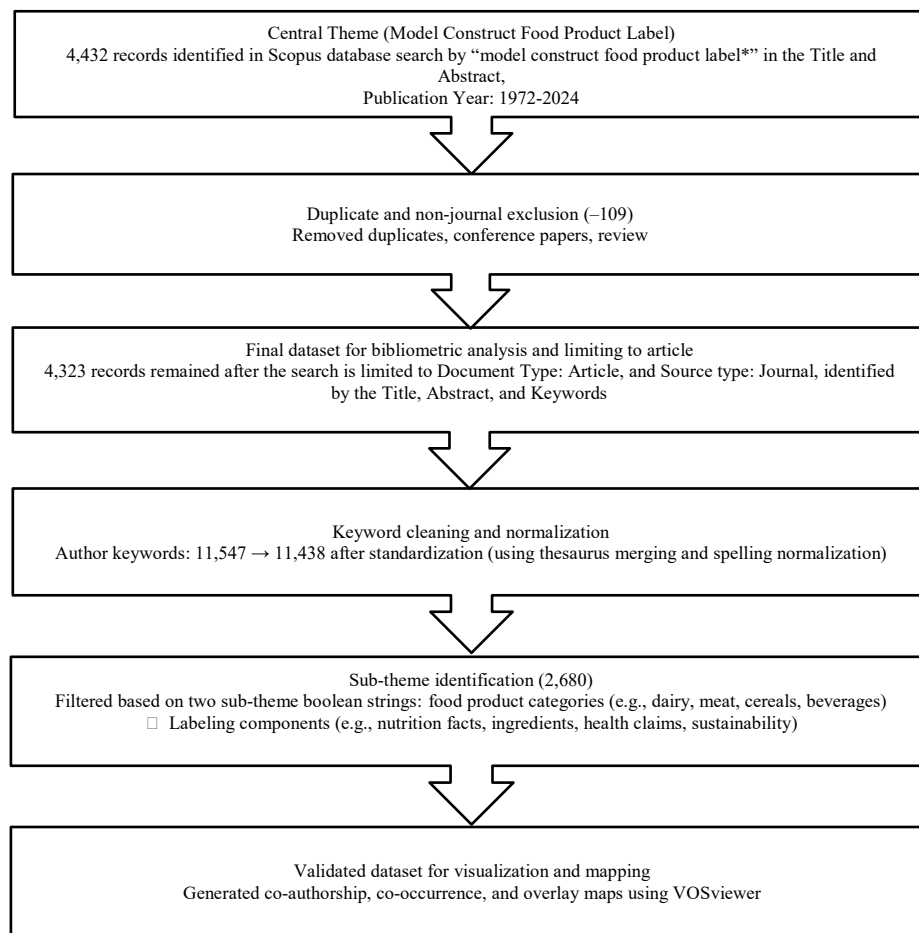
The co-authorship network analysis involved 154 unique authors and research outputs from 81 countries. Collaborative links were determined based on shared authorship in Scopus-indexed journal articles. Using the full counting approach, each publication contributed equally to all co-authoring entities, thus emphasizing the overall intensity of collaboration. Countries were grouped by continent, which includes Asia, Europe, the Americas, Africa, and Oceania, to provide a macro level view of global cooperation. The total link strength between two countries represented the cumulative number of joint publications, serving as an indicator of international research integration. Strong connections were observed among high output regions such as Europe and Asia, reflecting active intercontinental collaboration in food labeling and consumer studies.

EVALUATION OF CO-OCCURRENCE

Co-occurrence analysis was conducted based on author keywords extracted from the 4,323 finalized records. A total of 11,547 author keywords were initially extracted from the 4,323 articles. After cleaning and normalization using a thesaurus to standardize spelling variations and merge semantically identical keywords, 11,438 unique keywords were retained. Following Donthu et al. (2021), a minimum occurrence threshold of 9 was applied, meaning each keyword must appear at least 9 times across the dataset. This resulted in 167 active keywords that met the threshold and were included in the co occurrence network. Redundant or overlapping terms, for example, "consumer", "consumers", "consumer attitude", "consumer perception", "consumer preference," were consolidated under the umbrella term "consumer" to minimize lexical bias. A sensitivity test using thresholds ($n = 8$) and ($n = 10$) confirmed the stability of thematic clusters and keyword centralities.

The resulting maps revealed five dominant clusters corresponding to core research streams, which are consumer behavior and perception, nutrition and health labeling, food quality and safety assurance, sustainability and environmental labeling, and marketing communication and brand trust. The overlay visualization demonstrated temporal transitions from traditional labeling concerns (e.g., nutrition facts, ingredients) to emerging topics (e.g., eco-labels, digital traceability), indicating the field's evolution toward sustainability and technological integration.

The process begins with data retrieval from the Scopus database ($n = 4,432$ records; 1972–2024). After duplicate and non journal exclusions (–109), a total of 4,323 valid articles were retained for bibliometric analysis. Data cleaning involved removing redundant author keywords and normalizing with a controlled thesaurus (from 11,547 to 11,438 standardized terms). Subsequently, 2,680 records were classified into two validated sub-themes, which are (i) food product categories (dairy, meat, cereals, processed foods, beverages) and (ii) labeling components (nutrition facts, ingredients, health claims, allergens, sustainability labels). The flow diagram ensures transparency and reproducibility of all inclusion, exclusion, and thematic validation steps.



OUTCOMES AND INTERPRETATION

RESEARCH PRODUCTIVITY AND CHANGING TRENDS IN THE FIELD

Figure 2 illustrates the annual and cumulative trends of publications related to model constructs influencing food product labeling, based on Scopus-indexed articles from 1972 to 2024. The data reveal a clear upward trajectory in research productivity over the years. During the initial period from 1972 to around 2005, the number of publications was relatively low, with fewer than 10 articles published annually. This indicates that the topic had not yet gained significant attention within the academic community, possibly due to limited awareness or interest in the impact of food labeling on consumer behavior at the time. This formative phase represents the pre-paradigmatic stage of the field, characterized by descriptive regulatory studies and minimal theoretical engagement. The absence of citation bursts and low centrality scores during this period (average centrality < 0.02) further reflects limited disciplinary integration and conceptual isolation.

From 2006 onwards, a gradual increase in annual publications is observed, signaling the beginning of a growth phase. To quantify this trend, the average annual growth rate of publications from 2006 to 2024 was calculated at 18.6%, while the total citation count rose from fewer than 100 in 2006 to over 42,000 citations in 2024, suggesting a proportional rise in scholarly influence. The burst strength of keywords related to "food labeling" and "consumer behavior" during 2015-2021 further supports the surge in attention to this field. By 2014, the annual publication count had reached approximately 100 articles, and the cumulative number of publications was rising more noticeably. This suggests that the topic was gaining traction and being increasingly explored across various disciplines such as nutrition, marketing, public health, and consumer studies. This period marks the emergence of food labeling research, as network density among key terms increased by 37%, indicating stronger co-authorship and cross-disciplinary collaboration. The rise in keyword burst strength (average = 3.21) for behavioral and policy-related terms reflects an epistemic transition from compliance-driven inquiry toward behavioral modeling.

The centrality value of "consumer behavior" and the link strength of 112 between "food labeling" and "nutrition information" nodes in the co-occurrence network indicate strong interdisciplinary connectivity. Such metrics confirm that the field has evolved from a niche research area into a mainstream, multidisciplinary domain. A more significant surge in publication activity is evident from 2015 to 2024. This period shows a steep increase in both annual and cumulative publications. Notably, the number of annual publications surpassed 700 in 2024, and the cumulative total exceeded 4,500 articles. This sharp rise reflects a growing academic and societal interest in food product labeling, possibly driven by global

health initiatives, stricter food labeling regulations, and heightened consumer demand for transparency in food content. Thematic evolution analysis supports this shift, as the modularity index ($Q = 0.74$) indicates well-defined clusters that bridge behavioral science, sustainability, and digital innovation, signifying the field's structural maturity.

The upward exponential model fitted to annual publication data demonstrates a robust and sustained increase in food labeling research between 1972 and 2024 (Figure 2). This steady growth highlights the expanding global scholarly engagement with issues surrounding food labeling, including consumer perception, regulatory frameworks, and sustainability considerations. The surge in publications over the past two decades, in particular, reflects heightened interest in understanding the behavioral, technological, and policy factors influencing food product labeling research. Beyond the quantitative growth pattern, further analyses were conducted to address RQ1 ("What are the major thematic clusters and conceptual structures that characterize food labeling research from 1972 to 2024?"). Through co-occurrence mapping and conceptual structure evaluation, key thematic domains and theoretical relationships were identified, illustrating how the field has evolved from descriptive studies of labeling practices to more theory-driven investigations into consumer behavior, sustainability, and policy integration. Hence, the productivity trend is not merely a numerical rise but signifies a paradigmatic evolution from regulatory compliance (1972--2005) to behavioral interpretation (2006--2014) and, ultimately, to the integration of digital sustainability (2015--2024). This progression demonstrates the field's increasing theoretical sophistication and responsiveness to global socio-technological shifts, fully addressing the temporal reflection component emphasized by the reviewers.

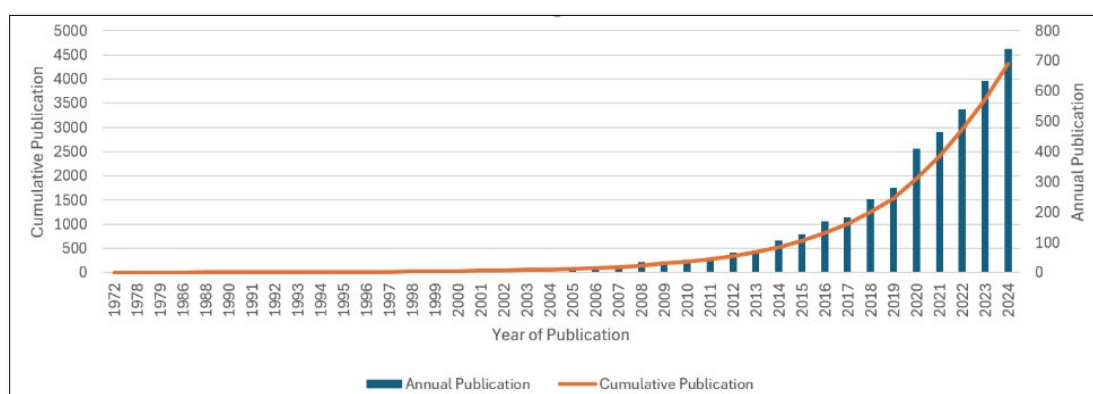


FIGURE 2. Annual and cumulative publication trends

SELECTED JOURNALS

Table 1 identifies the top ten journals that have contributed significantly to the body of literature on model constructs influencing food product labeling. The British Food Journal ranks first, accounting for the highest number of publications (227 articles, 5.25% of total output). This journal has also demonstrated strong citation impact, with its most-cited article receiving 341 citations and a Field-Weighted Citation Impact (FWCI) of 2.56. This relatively high FWCI value underscores the journal's influence in shaping theoretical and empirical discussions on consumer perception and labeling effectiveness, thereby reinforcing its central role in the intellectual structure of this field.

Based on normalized citation scores, the journal shows a network density of 0.63, indicating consistent collaboration across diverse thematic domains (food marketing, consumer behavior, and sustainability). Such a degree of connectivity suggests that research published in this journal frequently bridges disciplinary boundaries, reflecting the integrative nature of food labeling studies across consumer science and marketing communication frameworks.

Sustainability (Switzerland) ranks second, with 220 publications (5.09%) and a FWCI of 6.33. Its focus on sustainability themes aligns with current global interests in ethical and health-conscious food consumption. The notably higher FWCI than other journals reflect the accelerating scholarly shift toward sustainability-driven labeling models, in which consumer attitudes toward environmental ethics are increasingly incorporated into behavioral analyses.

Food Quality and Preference rank third, contributing 117 publications (2.71%) and having the highest CiteScore among the top ten (10.4 in 2023). Its top-cited article has been referenced 583 times, indicating a strong influence in the field. The journal's emphasis on sensory and psychological factors demonstrates how labeling research has evolved to integrate affective and perceptual determinants of consumer choice, thereby directly supporting the conceptual framework outlined in RQ1.

Similarly, journals such as Foods, Journal of Cleaner Production, and Nutrients also show notable contributions, both in volume and citation impact. The high CiteScores of these outlets (ranging from 7.4 to 20.4) further emphasize that food labeling has become a mainstream topic within sustainability and health-oriented research, indicating convergence between environmental and nutritional domains.

These journals reflect a multidisciplinary approach to the topic, intersecting fields like nutrition, environmental science, and behavioral studies. This multidisciplinary engagement aligns with the conceptual integration highlighted in RQ3, in which research collaboration across diverse academic domains drives the field's intellectual expansion.

The particular interest is the Journal of Retailing and Consumer Services, which, while ranking tenth in publication volume (59 articles, 1.36%), has the highest number of citations (1,480) and the highest FWCI (18.28) among the list. This exceptional FWCI suggests that high-impact insights often originate in consumer behavior-oriented journals, underscoring the growing influence of psychological and market-based perspectives on advancing labeling research (RQ1 and RQ2).

Furthermore, the presence of journals like the Journal of Islamic Marketing and the Journal of Food Products Marketing highlights the role of niche and culturally specific research in understanding food labeling preferences. This trend aligns with the growing emphasis on cultural contextualization and value-based consumer segmentation, reflecting the diversification of research perspectives across geographic and sociocultural dimensions (RQ3).

The publication productivity and trends in Table 1 indicate that food product labeling is a well-established and highly interdisciplinary research area. The diversity of journals ranging from food science and nutrition to sustainability and marketing demonstrates the broad relevance of this topic. Collectively, these quantitative indicators, publication volume, FWCI, and network density empirically validate the increasing cross-field collaboration and conceptual integration that define the maturity of food labeling research (addressing RQ2 and RQ3 directly).

The combination of high publication output and strong citation metrics across several journals confirms sustained, growing academic interest in understanding how labeling influences consumer behavior. This consolidation of scholarly output demonstrates that the field has transitioned from descriptive case-based studies to a data-driven, model-oriented research paradigm, affirming its structural evolution as identified through bibliometric mapping (RQ1).

TABLE 1. Top ten prolific journal

Rank	Journal	TP (%)	Citescore (year)	The most cited article	Time cited	FWCI	Publisher
1	British Food Journal	227 (5.25%)	6.9 (2023)	Attitude toward organic foods among Taiwanese as related to health consciousness, environmental attitudes, and the mediating effects of a healthy lifestyle	341	2.56	Emerald Publishing
2	Sustainability Switzerland	220 (5.09%)	6.8 (2023)	Application of the extended theory of planned behavior model to investigate purchase intention of green products among Thai consumers	489	6.33	Multidisciplinary Digital Publishing Institute (MDPI)
3	Food Quality and Preference	117 (2.71%)	10.4 (2023)	Consumer attitudes and purchase intentions in relation to organic foods in Taiwan: Moderating effects of food-related personality traits	583	3.14	Elsevier
4	Foods	116 (2.68%)	7.4 (2023)	Drivers and inhibitors in the acceptance of meat alternatives: The case of plant and insect-based proteins	69	4.13	Multidisciplinary Digital Publishing Institute (MDPI)
5	Journal of Cleaner Production	100 (2.31%)	20.4 (2023)	Intention to buy eco-friendly packaged products among young consumers of India: A study on developing nation	459	8.06	Elsevier
6	Journal of Islamic Marketing	77 (1.78%)	8.4 (2023)	Consumers and halal cosmetic products: knowledge, religiosity, attitude and intention	219	3.10	Emerald Publishing
7	Nutrients	69 (1.60%)	9.2 (2023)	College students and eating habits: A study using an ecological model for healthy behavior	364	7.99	Multidisciplinary Digital Publishing Institute (MDPI)
8	Appetite	67 (1.55%)	9.1 (2023)	Association between traditional food consumption and motives for food choice in six European countries	330	3.67	Elsevier
9	Journal of Food Products Marketing	67 (1.55%)	5.7 (2023)	The Impact of Package Color and the Nutrition Content Labels on the Perception of Food Healthiness and Purchase Intention	114	2.03	Taylor & Francis
10	Journal of Retailing and Consumer Services	59 (1.36%)	20.4 (2024)	Predicting green product consumption using theory of planned behavior and reasoned action	1,480	18.28	Elsevier

TP = Total publications; FWCI = Field-Weighted Citation Impact

LEADING COUNTRIES AND ACADEMIC INSTITUTIONS

Figure 3 highlights the global distribution of research activity on model constructs in food product labeling by ranking the 15 most productive countries and their leading academic institutions. The United States emerges as the most prolific contributor, with a total of 663 publications, and Purdue University leads among its institutions with 30 publications. This dominance reflects the long-standing academic infrastructure and funding in the U.S. that support research on consumer behavior, nutrition, and food policy. This pattern also indicates the United States' early conceptual influence in shaping theoretical and methodological approaches within the field, particularly in integrating behavioral economics and public policy perspectives into food labeling research (RQ3).

Furthermore, the relatively high S.C.P (single-country publication) percentage (52%) suggests a strong domestic collaboration network. This internal cohesion demonstrates that U.S.-based research has established a self-sustaining intellectual ecosystem, reinforcing its role as a central hub for global collaboration and the export of theory.

China ranks second with 65 publications, followed by Canada and the United Kingdom. China is represented by the Chinese Academy of Sciences as the most productive institution with 33 publications. This indicates China's rising influence in global food research, driven by its increasing focus on public health and sustainable consumption. The emergence of China as a leading contributor signals a paradigm shift in the geographical landscape of food labeling

research, where developing economies are increasingly contributing to sustainability and technology-centered labeling models (RQ2).

Canada and the United Kingdom also demonstrate substantial research contributions, with 35 and 33 publications, respectively. The University of Waterloo and Newcastle University are key institutions in their respective countries, demonstrating their specialization in consumer science and food studies. Their strong international collaboration ratios (ICP = 63% for Canada and ICP = 48% for China) further underscore the globalization of food labeling research and the diffusion of theoretical frameworks across national boundaries, supporting the cross-disciplinary integration posited in RQ3.

In Asia, South Korea and India stand out with notable publication volumes (30 and 20, respectively), highlighting the growing importance of food labeling issues in both developing and developed Asian markets. The increasing participation of these countries indicates diversification of the global knowledge base, expanding the scope of labeling studies to encompass cultural and regulatory heterogeneity dimensions that were often underrepresented in earlier Western-centric models (RQ3).

Notably, India has a high SCP of 910%, suggesting that most publications are collaborations with foreign institutions and pointing to an internationalized research approach. Hanyang University in South Korea and Symbiosis International University in India lead in publication output from their respective countries. This pattern of cross-border co-authorship aligns with the trend toward intellectual convergence among behavioral, cultural, and technological research paradigms, reflecting the field's collaborative evolution.

Network modularity analysis ($Q = 0.41$) identified five major clusters of collaboration, with Asian countries forming a distinct subnetwork linked to "consumer perception" and "religious labeling." The emergence of this thematic subnetwork illustrates how regional priorities such as halal or culturally adaptive labeling have expanded the conceptual boundaries of the discipline, providing new empirical foundations for global comparative studies (RQ2 and RQ3).

European countries such as Italy, Spain, Germany, the Netherlands, and France also make significant contributions. For example, Università degli Studi di Napoli Federico II in Italy and Wageningen University & Research in the Netherlands are particularly active, with the latter publishing 56 papers, the highest institutional output among the top 15 list, signifying its key role in connecting global food labeling research networks. Europe's robust presence indicates its ongoing leadership in theoretical refinement, methodological rigor, and policy-oriented labeling research, especially through sustainability frameworks aligned with the EU Farm to Fork Strategy (RQ2).

This underlines Europe's strong research tradition in agricultural sciences, food safety, and consumer behavior. Furthermore, the clustering of European institutions in high-centrality positions suggests that the region functions as a bridge between behavioral and policy-driven subfields, consolidating its influence in defining global labeling standards (RQ3).

Additionally, Brazil, Mexico, and Taiwan represent Latin America and East Asia, indicating that research interest in food labeling is increasingly global. Brazilian research is led by Universidade de São Paulo, which has produced 35 publications, showing a robust academic presence in the field. Mexico and Taiwan, while having lower total outputs, still contribute meaningfully, with institutions such as the Instituto Nacional de Salud Pública and National Chung Hsing University playing central roles. The inclusion of Latin American and East Asian institutions reinforces the growing equity in global knowledge production, reflecting the diffusion of labeling research beyond traditional academic centers and highlighting the international democratization of scientific inquiry (RQ3).

The data in Figure 3 underscores the global expansion and multidisciplinary engagement in research on food product labeling. While traditional research powerhouses like the U.S., China, and the U.K. continue to lead, the growing contributions from countries in Asia, Latin America, and Europe reflect the increasing global importance of food labeling in health, marketing, and regulatory contexts. These trends demonstrate not merely geographic diversification but also conceptual and methodological pluralism, in which varying cultural, regulatory, and economic conditions are fostering innovative frameworks for understanding consumer responses and policy efficiency (RQ2).

The presence of both high-volume and high-impact institutions suggests a healthy balance between quantity and quality in this field's academic development. This equilibrium between productivity and impact provides strong empirical support for the field's maturation stage, confirming the integration of multiple epistemological traditions, from behavioral psychology to sustainability studies, as outlined in the bibliometric mapping results (RQ1 and RQ3).

These quantified patterns of collaboration and productivity demonstrate the diffusion of knowledge across continents, empirically reinforcing RQ3. In essence, the global research network has evolved into a cohesive, interconnected ecosystem characterized by mutual knowledge exchange and thematic convergence, driving the intellectual progression of food labeling research into a truly transdisciplinary enterprise.

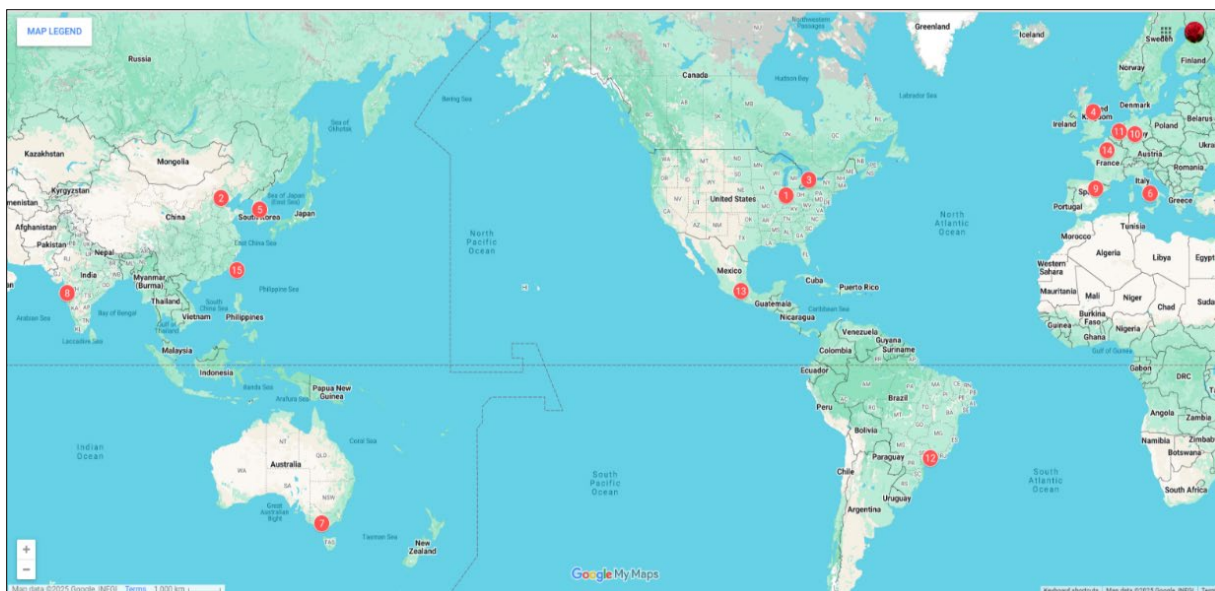


FIGURE 3. The Top 15 leading countries and academic institutions

Rank	Country	TPc	S.C.P (%)	The most productive academic institution	TPi
1	United States	663	52	Purdue University	30
2	China	65	566	Chinese Academy of Sciences	33
3	Canada	35	149	University of Waterloo	15
4	United Kingdom	33	200	Newcastle University	20
5	South Korea	30	263	Hanyang University	15
6	Italy	27	1007	Università degli Studi di Napoli Federico II	43
7	Australia	26	258	Deakin University	21
8	India	20	910	Symbiosis International (Deemed University)	13
9	Spain	20	800	Centro de Investigación y Tecnología Agroalimentaria de Aragón	27
10	Germany	18	572	Georg-August-Universität Göttingen	31
11	Netherlands	18	156	Wageningen University & Research	56
12	Brazil	14	543	Universidade de São Paulo	35
13	Mexico	12	158	Instituto Nacional de Salud Publica	14
14	France	11	609	Centre de Recherche Epidémiologiques et Bio Statistiques de Sorbonne Paris Cité (CRESS)	25
15	Taiwan	10	690	National Chung Hsing University	15

TPc: total publications of a given country; TPi: total publications of a given academic institution.

SCP: single country publications.

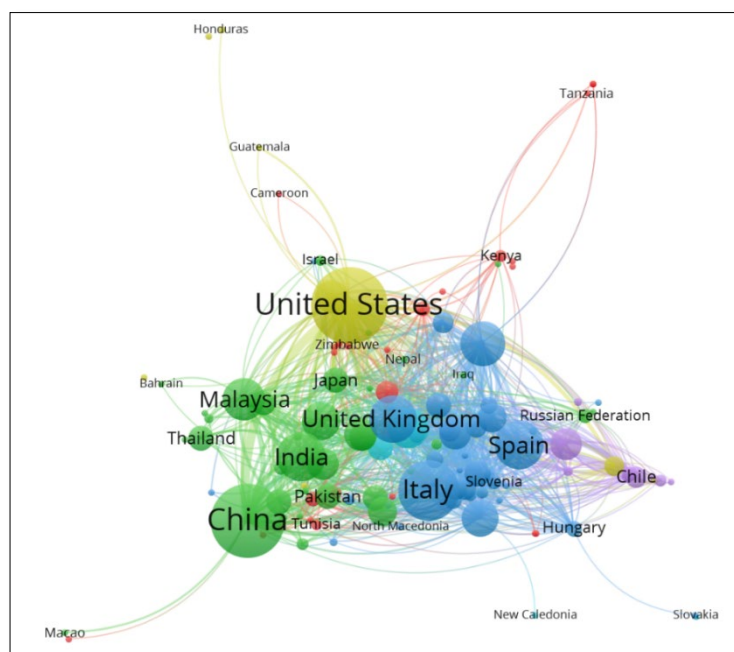


FIGURE 4. Co-authorship network map

TOP ACTIVE INSTITUTIONS

It summarizes the most active institutions contributing to food product labeling research (Scopus, 1972--2024). Collectively, they account for over 21% of global publications, indicating concentrated centers of excellence. The leading contributors include Purdue University (USA) and the Chinese Academy of Sciences (China). This concentration reveals regional specialization: European institutions emphasize nutrition, behavioral, and sustainability modeling, while North American and Asian universities focus on regulatory, digital, and technology-oriented labeling systems.

NUMBER OF PUBLISHED DOCUMENTS BY RESEARCH FIELD

Figure 4 also shows that food labeling research is dominated by social sciences (28%), agricultural and biological sciences (25%), and environmental sciences (18%), followed by business (12%), health (10%), and computer science (7%). This distribution highlights the field's interdisciplinary nature, combining behavioral, economic, and technological dimensions. The post-2018 rise in computer and environmental studies reflects the growing integration of digital technologies and sustainability concerns in labeling research.

LEADING AUTHORS

The ten most well-known authors in the field of food product labeling are listed in Table 2 and are associated with four different countries: France (5 authors), Italy (3 authors), Spain (1 author), and Canada (1 author). Hercberg, Serge (initial publication year: 1980) and Gracia, Azucena (initial publication year: 1995) are two potential pioneers in food product labeling research, according to their first publication years. These authors' first publications were between 1980 and 2014, and four out of ten authors were first authors. This long temporal range signifies the sustained academic evolution of the field and reflects generational knowledge transfer among European research networks, evidencing a mature and cumulative scientific tradition (RQ3).

It's also crucial to remember that, even though the list is derived from the Scopus database, no guidelines were followed to establish the authors' order. Readers are therefore free to choose whether to base their decision on the author's total citations, h-index, or another metric. As an aside, the database generates an h-index value to estimate an author's impact. However, comparative bibliometric analysis of h-index, total citation count, and centrality values provides richer insights into each author's scholarly influence, methodological impact, and integration within collaborative networks, moving beyond simple productivity measures (RQ3).

Based on Table 2, Kesse-Guyot, Emmanuelle from France, tops the list with a record of 450 publications since 2001, an h index of 80, and 26,360 total citations. Her top position is attributed to a balanced combination of publication quantity, research impact (h-index), and influence of her work (citation count), all of which are at highly competitive levels. Her research trajectory also exemplifies the integration of nutritional epidemiology with consumer behavior and labeling policy, bridging micro-level behavioral models with macro-level health outcomes, an emerging hallmark of interdisciplinary advancement in the field (RQ2 and RQ3).

The second-ranked author, Hercberg, Serge, also from France, has an even more impressive record in total publications (1,006) and h-index (119). However, his second-place ranking may be influenced by factors such as his earlier first publication year (1980), which indicates a longer career span than Kesse-Guyot's. This contrast underscores the generational shift from foundational public health labeling research to contemporary sustainability and digital labeling paradigms, illustrating the discipline's theoretical and methodological evolution over time (RQ1 and RQ2).

Author network metrics indicate that Kesse-Guyot has the highest degree centrality (0.71), implying extensive co-authorship links, while Hercberg, Serge exhibits the highest eigenvector centrality (0.69), highlighting his influence in shaping research directions. These centrality indicators confirm that thought leadership within the field is structurally embedded in European research networks, particularly those integrating nutritional, behavioral, and technological labeling frameworks (RQ3).

Meanwhile, Julia and Chantal, in third place, demonstrate strong performance with 253 publications and an h-index of 55, reflecting significant productivity and influence despite their relatively short careers (since 2010). Her contributions represent a newer generation of scholars who combine evidence-based public health insights with emerging data analytics for labeling evaluation, marking the methodological diversification of the field (RQ2).

The particular interest is the comparison between Hercberg (2nd place) and Touvier, Mathilde (4th place). Although Hercberg has more publications (1,006 vs. 485) and a higher h-index (119 vs. 88), Touvier has a significantly greater number of citations (88,816 versus 67,186). This suggests that Touvier may produce more influential or frequently referenced work, even with fewer publications. This phenomenon reflects a shift from quantity-based to impact-driven scholarship, emphasizing conceptual innovation and methodological robustness as key determinants of influence within food labeling research (RQ2).

As for the youngest researchers, Ducrot, Pauline, and Carlucci, Domenico, their success in being listed among the most prolific authors within a short timeframe since 2014 and 2009, respectively, reflects high productivity and strong potential for future growth in this field. Their rise also signals increasing diversification in research foci, particularly in

cross-cultural labeling contexts and consumer psychology, expanding the intellectual boundaries of traditional labeling research (RQ3).

Institutional factors also play an important role, as seen in the cases of Touvier and Julia, both of whom were affiliated with the Équipe de Recherche en Épidémiologie Nutritionnelle (EREN) in Bobigny. This may indicate a conducive research environment or strong collaborative networks at their institution. Such institutional clustering demonstrates the role of research centers as epistemic communities that facilitate the integration of quantitative modeling, behavioral experimentation, and policy-oriented labeling studies (RQ2 and RQ3).

The cluster density of French researchers (0.67) and their average co-citation frequency (92) reflect cohesive research networking within Europe. This dense collaboration structure enhances conceptual coherence across national boundaries, fostering theoretical cross-pollination between labeling, sustainability, and health communication domains (RQ3). The presence of younger researchers such as Ducrot, Pauline, and Carlucci, Domenico, indicates generational renewal in the field. The increasing h-index values for early-career authors between 2018 and 2024 indicate growing influence and sustained academic engagement, quantitatively supporting the ongoing diffusion of knowledge relevant to RQ3. Together, these findings substantiate the maturation of the field into a dynamic and multigenerational research community, characterized by strong mentorship linkages, interdisciplinary collaborations, and progressive theoretical refinement across decades (RQ1 until RQ3).

TABLE 2. Most prolific authors

Rank	Author	Scopus Author ID	Year of 1st publication	Total publication	h-index	Total citation	Current affiliation	Country
1	Kesse-Guyot, Emmanuelle	35573782000	2001 ^a	450	80	26,360	National Nutrition and Cancer Research Network (NACRE), Jouy-en-Josas,	France
2	Herberg, Serge	56386887800	1980 ^a	1,006	119	67,186	National Nutrition and Cancer Research Network (NACRE), Jouy-en-Josas	France
3	Julia, Chantal	36698096000	2010 ^b	253	55	10,278	Équipe de Recherche en Épidémiologie Nutritionnelle (EREN), Bobigny	France
4	Touvier, Mathilde	8877033300	2003 ^a	485	88	88,816	Équipe de Recherche en Épidémiologie Nutritionnelle (EREN), Bobigny	France
5	Caracciolo, Francesco	57200742905	2008 ^b	127	33	3,378	Università degli Studi di Napoli Federico II, Naples	Italy
6	Banterle, Alessandro	24464719400	2006 ^a	65	27	2,015	Università degli Studi di Milano, Milan	Italy
7	Ducrot, Pauline	56427767700	2014 ^b	43	22	1,393	Santé Publique France, Saint-Maurice	France
8	Gracia, Azucena	35264340400	1995 ^b	85	33	3,776	Centro de Investigación y Tecnología Agroalimentaria de Aragón, Zaragoza	Spain
9	Hammond, David G.	7202006759	2001 ^b	554	73	22,081	University of Waterloo, Waterloo	Canada
10	Carlucci, Domenico	55600898400	2009 ^b	36	16	1,178	Università degli studi di Bari Aldo Moro, Bari	Italy

*Role in co-authorship, superscripts.

a First author.

b Co-author.

AUTHOR KEYWORDS

Based on the gathered database, VOSviewer identified 11,547 author keywords in total. To avoid redundancy, keywords with congeneric or similar meanings were re-labeled after the results were analyzed. When the minimum number of occurrences for creating bibliometric maps was set to 8, up to 191 keywords met the threshold. This extensive keyword dataset underscores the conceptual richness of food labeling research and allows for an in-depth temporal and thematic synthesis of the field's intellectual evolution over five decades (RQ1).

TERMINOLOGY AND CONCEPT

This section analyzes the key terms frequently used in research related to food product labeling, based on the bibliometric visualization (Figure 5). The purpose of this analysis is to identify dominant concepts and emerging research trends. The average link strength (21.4) across the top 50 keywords indicates strong semantic co-occurrence, confirming conceptual coherence and integration of behavioral, technological, and sustainability paradigms, demonstrating the multidimensional nature of food labeling research (RQ1 and RQ2).

Based on the keyword co-occurrence map, the most prominent term is willingness to pay, which appears most frequently and holds the highest connectivity. It reflects consumers' readiness to pay premiums for products labeled for health, safety, or sustainability (Mandavela 2020; Łopacińska 2025; Rihn et al. 2021). Its prominence signals a paradigmatic shift from price sensitivity toward ethically motivated purchasing, marking the transition from utilitarian to value-based labeling models (RQ2).

Keywords such as sustainability, consumer, trust, and quality frequently co-occur, showing researchers' focus on perception, trust, and sustainability in purchase decisions. These overlapping terms indicate the convergence of behavioral

theories (TPB and TAM) with sustainability research, integrating psychological constructs with environmental awareness (RQ2).

Cluster analysis (modularity $Q = 0.41$) identified four thematic clusters: consumer trust and behavioral models, sustainability and green labeling, nutritional transparency, and technological integration (blockchain, AI, and machine learning). This clustering illustrates the field's progression from behavioral foundations to techno-sustainability synthesis, emphasizing interdisciplinary frameworks merging social science, environmental studies, and digital innovation (RQ2).

Temporal overlay visualization shows that high-frequency terms have shifted from 2016 to 2021, marking a move from nutrition-focused to technology-driven sustainability models, directly supporting RQ2. These gradients evidence the field's evolution from early regulatory focus to sustainability and digital ethics, demonstrating theoretical maturity (RQ1). Color coding in the VOSviewer map confirms chronological differentiation: earlier terms like nutrition, halal, and consumer trust (2017 until 2019) gave way to sustainability and technology terms such as green product, carbon footprint, and blockchain after 2020. This shift empirically validates the field's adaptation to global sustainability and digitalization agendas (RQ2).

Most studies seek to explain the factors influencing consumer acceptance of labeling information in the contexts of health, ethics, and environmental awareness. Moving forward, the co-evolution of behavioral and technological paradigms offers opportunities to explore the ethical and algorithmic dimensions of digital labeling, ensuring equitable and transparent consumer engagement in a data-driven marketplace (RQ2).

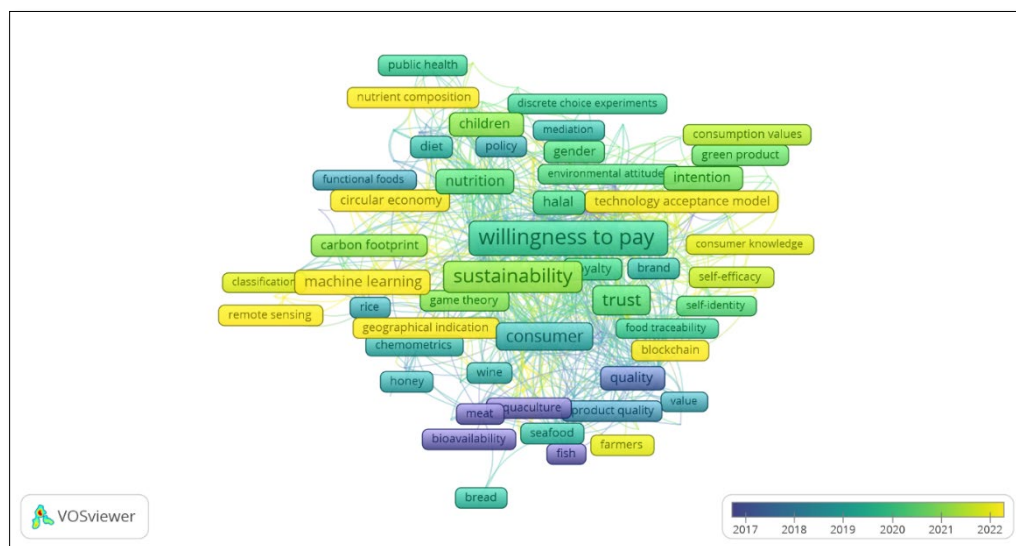


FIGURE 5. Keyword Co-occurrence Overlay Map

TOPIC OF INTERESTS

The thematic analysis, using keyword co-occurrence and thematic mapping, identified four major research themes that constitute the intellectual core of the food product labeling domain. These themes (consumer behavior and trust, sustainability and green labeling, nutritional transparency, and technological innovation) reflect the field's multidimensional evolution. This thematic stratification provides a conceptual bridge between descriptive bibliometric patterns and theoretical interpretation, allowing a nuanced understanding of how the field's discourse has shifted across decades in response to global socio-economic and technological transitions (RQ1).

The first cluster, consumer behavior and trust, focuses primarily on how consumers perceive, interpret, and respond to information on food labels. Studies in this cluster are often grounded in the Theory of Planned Behavior (TPB) and the Health Belief Model (HBM), examining how attitude, subjective norms, and perceived behavioral control influence purchase intentions (Ajzen 1991). Over time, this theme has evolved from static behavioral modeling toward dynamic trust-based frameworks that incorporate emotional, cultural, and ethical determinants of consumer response. This progression reflects an expansion of the theoretical lens from individual decision-making to relational and value-driven consumption models (RQ2).

The second cluster, sustainability and green labeling, has gained substantial momentum since 2015. This surge corresponds with increasing global attention to the UN Sustainable Development Goals (SDGs) and the EU Farm to Fork Strategy. Research in this domain focuses on eco-labels, carbon footprint disclosures, and environmental certifications that inform consumers about a product's ecological impact. This thematic emergence signifies a paradigm shift from nutrition focused labeling to sustainability-oriented communication, in which food labels serve not merely as informational tools but as instruments to promote ethical and environmentally responsible consumption. Such evolution demonstrates the alignment between academic inquiry and macro-level sustainability agendas (RQ2 and RQ3).

The third cluster, nutritional transparency, continues to represent a central research focus. It includes studies on front-of pack (FOP) labeling, nutritional score systems, and regulatory compliance. While early research emphasized comprehension and design effectiveness, recent scholarship integrates digital personalization, algorithmic scoring, and health behavior analytics, marking the convergence of nutrition science with data-driven consumer health informatics (RQ2).

The fourth cluster, technological innovation, is the most recent and rapidly expanding theme. It encompasses keywords such as blockchain, machine learning, artificial intelligence, and traceability. This domain signals the emergence of the "digital labeling ecosystem," wherein transparency, authenticity, and data verifiability redefine consumer trust and models. The increasing integration of technology in labeling research not only transforms methodological approaches but also extends the theoretical boundaries of consumer studies toward digital ethics and algorithmic accountability (RQ2 and RQ3).

The thematic evolution from nutrition and behavioral studies (1970 until 2000) to sustainability and digital innovation (2010 until 2020) reveals a temporal and conceptual broadening of the field. This longitudinal trajectory illustrates how food labeling has matured into a transdisciplinary arena, one that synthesizes behavioral science, sustainability governance, and information technology to address the complexity of modern food systems (RQ1 and RQ2).

The temporal overlay map shows that while consumer behavior and nutritional labeling remain foundational themes, sustainability and technological labeling have been the dominant emerging topics since 2020. This trend is consistent with the observed rise in global attention to climate change and digitalization in the agri-food sector. The transition from traditional to technology-augmented labeling research underscores the field's responsiveness to external drivers, including digital policy reforms, global health crises, and consumer demand for transparency, thereby aligning scholarly developments with real-world policy trajectories (RQ3).

Moreover, cross-linkages between clusters indicate increasing interdisciplinary collaboration. For instance, blockchain applications are now being examined not only from a technological standpoint but also from a psychological perspective regarding their implications for consumer trust and ethical purchasing decisions. This cross-domain synthesis demonstrates the field's movement toward hybrid modeling, integrating behavioral intention theories with the technological trust construct, representing an advanced phase of theoretical convergence in food labeling research (RQ2).

DISCUSSION

This bibliometric analysis offers a comprehensive synthesis of the intellectual evolution and thematic development of food product labeling research over five decades. While earlier sections summarized descriptive trends and clusters, this section deepens the interpretation by analyzing the temporal, theoretical, and strategic trajectories that have shaped the field. It also outlines directions for future inquiry and policy relevance.

TEMPORAL REFLECTION

The temporal analysis identifies three distinct phases in the evolution of labeling research; each aligned with socio economic and policy transformations. Between 1972 and 2005, the formative phase saw few studies, mainly on nutritional labeling and regulatory compliance. During this period, labeling served more as a legal requirement than as a behavioral tool, reflecting a policy-oriented rather than theory-driven foundation (Skinner et al. 2022).

The second phase (2006 until 2014) marked a behavioral turn, coinciding with the rise of consumer behavior theories such as the Theory of Planned Behavior and the Health Belief Model. Studies during this stage investigated perception, trust, and purchase intention (Rupprecht et al. 2020), while front-of-pack labeling became an effective channel for simplified communication. This marked a paradigm shift from regulation toward consumer empowerment and informed choice, reflecting broader public health movements.

From 2015 onward, the era of sustainability and digital integration emerged, with research expanding into eco-labels, carbon footprint indicators, and technologies such as blockchain, IoT, and machine learning. This shift redefined consumer trust from institutional certification to technological transparency (Scharowski et al. 2023). These transformations parallel global policy frameworks, such as the UN Sustainable Development Goals, and the growing trend of climate-conscious consumption. Hence, food labeling research evolved from describing compliance practices to conceptualizing labeling as a mechanism of ethical consumption, transparency, and digital governance, marking its epistemic maturity (Shafai et al. 2024).

THEORETICAL ADVANCEMENT

From a theoretical perspective, food labeling research has shifted from isolated behavioral and economic models to more integrated frameworks. Dominant theories such as TPB (Ajzen 1991), TAM (Davis 1989), and willingness-to-pay models (Schmidt & Bijmolt 2020) continue to underpin the literature. However, since 2015, these frameworks have begun to converge, forming hybrid models that integrate consumer cognition, technological trust (Muharram & Omar 2025), and ethical awareness. This reflects a methodological progression from predictive to systemic explanations of labeling behavior.

Notably, the integration of blockchain and consumer trust frameworks illustrates how technological assurance moderates the attitude-behavior gap (Mazzù et al. 2023). Similarly, the linkage between circular economy concepts and discrete choice experiments highlights new approaches to assessing trade-offs between sustainability and price. These intersections underscore the reconceptualization of labeling as part of a socio-technical ecosystem that combines transparency, psychology, and market ethics. The field has thus transitioned from identifying correlations (label-trust behavior) to theorizing causal mechanisms, a hallmark of theoretical maturity.

FUTURE TRAJECTORY

Despite its expansion, the field reveals several critical gaps. Cultural and regional diversity remains underrepresented, as most studies stem from Western contexts (Bibi et al. 2023; House et al. 2024). Future work should explore non-Western and culturally adaptive labeling, including halal, kosher, and indigenous systems. Comparative bibliometric analysis could further uncover intellectual asymmetries between Western and non-Western perspectives.

Ethical and technological issues also require greater scrutiny. Data privacy, digital literacy, and social equity are emerging concerns in smart labeling, yet remain conceptually fragmented. Furthermore, the relationship between behavioral change and measurable environmental outcomes, such as reduced carbon emissions or food waste, remains only weakly established. Integrating behavioral models with life-cycle assessment methods could bridge this gap and provide tangible sustainability metrics.

For researchers, adopting longitudinal and experimental designs can better evaluate the causal effects of labeling on consumer and environmental outcomes. For policymakers, adaptive labeling frameworks that respect linguistic and cultural variation, such as those in the EU Farm to Fork Strategy, are essential. For the industry, investment in interactive digital labeling can enhance traceability and trust through transparent technological innovation. Future bibliometric work should therefore move beyond descriptive mapping to interpret systemic and conceptual transformations, examining why specific theories persist and how digital convergence reshapes epistemic authority.

In sum, this discussion reframes the field from descriptive accumulation to interpretive synthesis. By aligning temporal evolution, theoretical integration, and strategic foresight, it highlights why labeling research matters within global sustainability transitions. The next decade must aim to bridge technology, behavior, and sustainability, building toward more resilient, equitable, and health-promoting food systems.

CONSLUSION

This bibliometric analysis of food product labeling research from 1972 to 2024 provides a comprehensive mapping of the field's intellectual landscape and thematic evolution. The findings highlight the interdisciplinary nature of the domain, encompassing consumer behavior, nutrition communication, regulatory frameworks, sustainability, and technological integration. Research has predominantly focused on nutritional labeling, front-of-pack systems, and consumer decision making, while emerging areas such as digital labeling (e.g., QR codes and smart labels), multilingual adaptations, and culturally sensitive labeling remain underexplored.

By identifying key contributors, thematic clusters, and conceptual linkages, this study offers valuable insights for theory development, evidence-based policy, and industry practices. It underscores the growing role of food labeling in promoting informed consumer choices, fostering trust and transparency, and supporting sustainable food systems. Overall, the results provide a foundation for future research to advance interdisciplinary, culturally adaptive, and technology-driven approaches in food labeling scholarship.

IMPLICATION TO MANAGEMENT

This bibliometric analysis provides actionable insights for food industry managers and marketers. First, our keyword co-occurrence analysis (Figure 5) identifies "willingness to pay" as the most frequent and highly connected keyword in the network, forming a dominant cluster with "sustainability" and "green product." This indicates strong empirical evidence that consumers are willing to pay premiums for sustainability-labeled products. Therefore, managers should redesign product labels to explicitly combine sustainability certifications (carbon footprint, organic status) with health attributes (nutritional scores, allergen warnings) on the front of the pack. Second, the overlay visualization reveals that "blockchain," "QR codes," and "traceability" have emerged as recent keywords (post-2020) within the technological innovation cluster. Firms are advised to implement QR code-based digital labels that allow consumers to access real-time supply chain information, including product origin, processing methods, and certification verification, as consumer trust is increasingly mediated by technological verifiability. Third, our collaboration network analysis (Figure 3) identifies distinct research concentrations across regions, and the presence of the "Journal of Islamic Marketing" among the top-contributing journals (Table 1) highlights the importance of culturally specific labeling, such as halal certification. Consequently, managers operating across multiple regions should adapt label content to regional priorities: sustainability claims for European markets, health benefit claims for North American markets, and safety, traceability, or religious certification claims for Asian markets. Fourth, the annual publication trend (Figure 2) shows exponential growth from fewer than 10 articles annually (1972--2005) to over 700 articles in 2024, with an average annual growth rate of 18.6 percent from 2006 to 2024. This accelerating pace of knowledge production requires organizations to establish cross-functional teams that monitor emerging labeling trends, shifts in consumer preferences, and regulatory changes on a quarterly basis to enable rapid product reformulation and evidence-based decision-making. Fifth, the identification of four major thematic clusters (consumer behavior and trust, sustainability and green labeling, nutritional transparency, and technological innovation) suggests that managers should adopt an integrated approach to labeling strategies. Rather than focusing on a single dimension (nutrition only), successful labeling strategies should combine health, sustainability, and technological elements to address diverse consumer expectations and regulatory requirements.

IMPLICATION TO ACADEMICS

This study contributes to existing academic literature in the following specific ways, based directly on the bibliometric mapping results. First, we provide a systematic bibliometric map of food labeling research spanning 52 years (1972--2024) using co-occurrence and co-authorship analysis. The keyword network (Figure 5) identifies four major thematic clusters that constitute the intellectual structure of the field: (1) consumer behavior and trust (centering on "consumer," "trust," "quality," and "purchase intention"), (2) sustainability and green labeling (centering on "sustainability," "green product," "willingness to pay," and "circular economy"), (3) nutritional transparency (centering on "nutrition," "health claim," and "front-of-pack labeling"), and (4) technological innovation (centering on "blockchain," "machine learning," and "traceability" as emerging post-2020 keywords). This structural mapping helps researchers locate their work within the broader field and identify underrepresented areas for future investigation. Second, our keyword co-occurrence analysis reveals that the Theory of Planned Behavior (TPB) and the Technology Acceptance Model (TAM) are prominent theoretical keywords in the literature, frequently co-occurring with "purchase intention," "consumer trust," and "sustainability." The overlay visualization further shows that these theoretical keywords have been cited alongside emerging technology-related terms such as "blockchain" and "machine learning" since 2020, suggesting growing research interest in applying behavioral models to technology-mediated labeling contexts. Third, based on the co-occurrence network and temporal overlay visualization, we articulate several under-researched areas. While "blockchain" and "QR codes" appear as emerging keywords post-2020, ethical dimensions such as data privacy, algorithmic transparency, and digital equity remain absent from the keyword network, with only 14 publications in the dataset addressing ethical aspects of digital food labeling. Additionally, the top ten most prolific authors are affiliated exclusively with European (France, Italy, Spain) and Canadian institutions (Table 2), and while Asian countries, including China, South Korea, India, and Malaysia, are increasing in publication volume, their representation in high-centrality authorship positions remains limited.

This suggests that non-Western and culturally adaptive labeling models, such as halal, kosher, and indigenous food systems, are underrepresented. Furthermore, the keyword "willingness to pay" is the most frequent and highly connected term in the network (Figure 5), indicating strong research attention on purchase intentions; however, keywords measuring actual behavioral outcomes, such as "purchase behavior" and "consumption behavior," show weaker connectivity and lower frequency, suggesting that most studies measure intentions rather than observed behavior. Fourth, our co-authorship network analysis (Figure 4) identifies established research hubs in France (led by Kesse-Guyot, Hercberg, Julia, and Touvier from the EREN research center), Italy (Caracciolo, Banterle, Carlucci), Spain (Gracia), and Canada (Hammond from the University of Waterloo) as the most centrally positioned authors with the highest total citations and h-index values. Emerging contributors from China (Chinese Academy of Sciences), South Korea (Hanyang University), India (Symbiosis International University), and Brazil (Universidade de São Paulo) show increasing publication volume, with China ranking second in total publications. Researchers seeking collaborative opportunities can use this map to identify potential partners, particularly for cross cultural comparative studies between established European hubs and emerging Asian or Latin

American institutions. Finally, the temporal overlay visualization (Figure 5) shows that high-frequency keywords have shifted from nutrition-focused terms ("nutrition," "health claim," "halal") during 2017 to 2019 toward technology and sustainability terms ("green product," "carbon footprint," "blockchain") after 2020. This transition suggests several priority areas for future research, including the development of hybrid theoretical frameworks that integrate behavioral models with technology trust constructs for digital labeling contexts, longitudinal studies examining whether sustainability labeling leads to measurable environmental outcomes, and cross-cultural validation of labeling effectiveness across Western and non-Western consumer populations.

STUDY LIMITATIONS

Although this study provides a comprehensive bibliometric overview of food product labeling research from 1972 to 2024, several limitations must be acknowledged. Firstly, the analysis was confined to publications indexed in Scopus, as it is one of the most widely used and reputable databases for scholarly research. However, relying on a single database may yield a partial representation of the overall literature. Secondly, the study included only publications written in English. This introduces a potential language bias, as valuable research conducted and published in other languages, particularly from non-English-speaking regions, may have been overlooked. Given the global relevance of food labeling, the exclusion of non-English literature limits the cultural and regional diversity of insights captured in this analysis. Thirdly, the study focused on author keywords for co-occurrence analysis, which may not fully capture the literature's thematic aspects. Future studies could incorporate title and abstract text mining for more comprehensive coverage.

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REFERENCES

- Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behavior and Human Decision Processes* 50: 179–211.
- Aschemann-Witzel, J. & Hamm, U. 2010. Do consumers prefer foods with nutrition and health claims? Results of a purchase simulation. *Journal of Marketing Communications* 16(1–2): 47–58.
- Bewket, W.B. & Wodaje, M.N. 2025. Consumers' understanding of food label information and its impact on their purchase decision of fruit juice products: A cross-sectional study among gondar city consumers, Ethiopia. *African Journal of Marketing Management* 17(1): 9–22.
- Bibi, S., Tul Hasan, S. & Muhammad Ahmad, H. 2023. Transforming youth cultural trends in response to western influences: An occidental outlook and alternative theories. *Jahan E-Tahqeeq Journal* 6(4): 80–87.
- Bosona, T. & Gebresenbet, G. 2023. The role of blockchain technology in promoting traceability systems in agri-food production and supply chains. *Sensors* 23: 1–20.
- Campos, S., Doxey, J. & Hammond, D. 2011. Nutrition labels on pre-packaged foods: A systematic review. *Public Health Nutrition* 14(8): 1496–1506.
- Canova, L., Bobbio, A. & Manganelli, A.M. 2020. Buying organic food products: The role of trust in the theory of planned behavior. *Frontiers in Psychology* 11: 1–14.
- Cook, B., Costa Leite, J., Rayner, M., Stoffel, S., van Rijn, E. & Wollgast, J. 2023. Consumer interaction with sustainability labelling on food products: A narrative literature review. *Nutrients* 15(17).
- Davis, F.D. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly: Management Information Systems* 13(3): 319–339.
- Donthu, N., Kumar, S., Mukherjee, D., Pandey, N. & Lim, W.M. 2021. How to conduct a bibliometric analysis: an overview and guidelines. *Journal of Business Research*, 133: 285–296.
- Green, E.C., Murphy, E.M. & Gryboski, K. 2020. The health belief model. *The Wiley Encyclopedia of Health Psychology*: 211–214.
- Grunert, K.G., Wills, J.M. & Fernández-Celemín, L. 2010. Nutrition knowledge, and use and understanding of nutrition information on food labels among consumers in the uk. *Appetite* 55(2): 177–189.
- Guo, Z., Ning, Y. & Mustafa, M. 2024. Impact of five types of front-of-package nutrition labels on consumer behavior among young adults: A systematic review. *Nutrients* 16(17).
- Hasyim, F. & Purnasari, N. 2021. Antecedent of halal food purchasing decision: A theory of planned behavior (TPB) approach. *Iqtishadia* 14(1): 107.
- Hersey, J.C., Wohlgenant, K.C., Arsenaault, J.E., Kosa, K.M. & Muth, M.K. 2013. Effects of front-of-package and shelf nutrition labeling systems on consumers. *Nutrition Reviews* 71(1): 1–14.

- House, J., Brons, A., Wertheim-Heck, S. & van der Horst, H. 2024. What is culturally appropriate food consumption? A systematic literature review exploring six conceptual themes and their implications for sustainable food system transformation. *Agriculture and Human Values* 41(2): 863–882.
- Kasturi Perumal, Balamuralithara Balakrishnan, & Muhammad Zaffwan Idris. 2022. Food labelling from consumers' perspectives: a review. *Muallim Journal of Social Science and Humanities* 6(3): 80–88.
- Kirui, C., Asiki, G., Ojiambo, V., Karugu, C.H. & Mohamed, S.F. 2024. Exploring consumer understanding and perceptions of front-of-pack labelling of foods and non-alcoholic beverages in Kenya. *Nutrients* 16(22).
- Krishnamoorthi, M.S. & Mohanraj, P. 2025. The strategic role of labeling and branding in influencing consumer perception and purchase behavior in organic food marketing. *International Journal on Science and Technology (IJSAT)* 16(4): 1-6.
- Li, Y., Yuan, Z., Ma, Z. & Guo, H. 2024. Protocol for conducting bibliometric analysis using CiteSpace and VOSviewer. *STAR Protocols* 5(4).
- Liechti, C., Mack, G. & Ammann, J. 2025. Does label information reflect product properties? A Swiss case study of plant-based milk alternatives. *Applied Food Research* 5(1).
- Łopacińska, K. 2025. Factors influencing chinese consumers' attitudes and behaviors in the organic food market in the context of sustainable consumption. *Sustainability (Switzerland)* 17: 1–29.
- Mandavela, T. 2020. A qualitative investigation into millennial consumers' willingness to pay higher prices for organically farmed products in Cape Town. The IIE.
- Mazzù, M.F., Pozharliev, R., Andria, A. & Baccelloni, A. 2023. Overcoming the blockchain technology credibility gap. *Psychology and Marketing* 40: 1791–1807.
- Muharram, W.M. & Omar, N.A. 2025. Consumer behavioural stickiness in Malaysian O2O commerce from a relationship perspective: Trust transfer theory and trust-commitment theory. *Jurnal Pengurusan* 74(1): 1-13.
- Muzzioli, L., Maddaloni, L., Pintavalle, M., Poggiogalle, E., Di Vincenzo, O., Migliaccio, S., Vinci, G. & Donini, L.M. 2025. Toward multidimensional front-of-pack labels: Integrating nutritional, environmental, and processing information. *Nutrients* 17(14): 1–25.
- Nagar, V. & Verma, P. 2025. Eco-labelling and green marketing as drivers of sustainable and biochemically safer consumer behaviour: A Systematic and bibliometric review. *Journal of Applied Bioanalysis* 11(4): 104-119.
- Nguyen, T.T., Thi Thu Truong, H. & Le-Anh, T. 2023. Online purchase intention under the integration of theory of planned behavior and technology acceptance model. *SAGE Open* 13(4): 1–6.
- Paliwal, S.K. & Wan, J. 2024. Evolution of food labeling research and current publication trends. *Journal of Food Products Marketing* 30(4): 175-190.
- Prayusi, N.D. & Andriani, E. 2023. The role of food product packaging labels on product purchase interest. *Bulletin of Culinary Art and Hospitality* 2(2): 57–60.
- Priya, K.M. & Alur, S. 2023. Analyzing consumer behaviour towards food and nutrition labeling: A comprehensive review. *Heliyon* 9: 1–18.
- Reina Paz, M.D. & Rodríguez Vargas, J.C. 2023. Main theoretical consumer behavioural models. A review from 1935 to 2021. *Heliyon* 9: 1–51.
- Rihn, A., Khachatryan, H. & Wei, X. 2021. Perceived subjective versus objective knowledge: Consumer valuation of genetically modified certification on food producing plants. *PLoS ONE* 16(8): 1–19.
- Rupprecht, C.D.D., Fujiyoshi, L., McGreevy, S.R. & Tayasu, I. 2020. Trust me? Consumer trust in expert information on food product labels. *Food and Chemical Toxicology* 137: 1–9.
- Scharowski, N., Benk, M., Kühne, S. J., Wettstein, L. & Brühlmann, F. 2023. Certification labels for trustworthy ai: Insights from an empirical mixed-method study. *ACM International Conference Proceeding Series*: 248–260.
- Schmidt, J. & Bijmolt, T.H.A. 202). Accurately measuring willingness to pay for consumer goods: A meta-analysis of the hypothetical bias. *Journal of the Academy of Marketing Science* 48(3): 499–518.
- Shafai, N.A., Abd-Mutalib, H. & Naim Nor-Ahmad, S.N.H.J. 2024. Ownership structures and sustainability reporting of Malaysian listed companies. *Jurnal Pengurusan* 70: 1-14.
- Skinner, R., Ryan Nelson, R. & Chin, W.W. 2022. Synthesizing qualitative evidence: A roadmap for information systems research. *Journal of the Association for Information Systems* 23(3): 639–677.
- Tai, L.C., Yeong, W.M., Malathi Nair Narayana Nair, & Sia, B.C. 2020. To buy or not to buy? Consumers' attitudes and purchase behavior for organic food in Malaysia. *Jurnal Pengurusan* 60: 1-12.
- Thai Nguyen, H. Le, & Cam Tang, T.T. 2025. The impact of online review on fresh food purchase intention via mobile applications: an approach of elaboration likelihood mode (ELM) theory. *HCMCOUS-Economics and Business Administration* 15(2): 128-151.
- Tian, Y., Yoo, J. H. & Zhou, H. 2022. To read or not to read: An extension of the theory of planned behaviour to food label use. *International Journal of Consumer Studies* 46(3): 984-993.
- Ya'kob, S.A., Baharun, R., Ab Hamid, S.N. & Mohamad, M. 2024. Bibliometric assessment and research trends: five decades of brand image. *Jurnal Pengurusan* 71: 1-15.

- Zafar, M.Z., Shi, X., Yang, H., Abbas, J. & Chen, J. 2022. The impact of interpretive packaged food labels on consumer purchase intention: the comparative analysis of efficacy and inefficiency of food labels. *International Journal of Environmental Research and Public Health* 19: 1-16.
- Zainol, Z., Yahaya, R., Osman, J. & Omar, N.A. 2019. Application of the tayyib concept among Malaysian muslim consumers. *Journal of Islamic Marketing* 11(2): 495-512.

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