Journal of Open Innovation: Technology, Market,and Complexity 12 (2026) 100803

Contents lists available at ScienceDirect

Journal of Open Innovation: Technology, Market, and Complexity

journal homepage: www.sciencedirect.com/journal/joitmc

From innovation to adoption: The complexities of the market for eco-sustainable food packaging and value co-creation by consumers

Marzia Ingrassia[a,*], Stefania Chironi[a], Sandro Galluzzo[a], Biagio Pecorino[b], Roberta Selvaggi[b]

[a] Department of Agriculture, Food and Forestry Sciences, University of Palermo, Palermo, Italy
[b] Department of Agriculture, Food and Environment (Di3A), University of Catania, Catania, Italy

ARTICLE INFO

Keywords:
Bio-based materials
Circular economy
Ethical behavior
Ethical communication
Green marketing
Industrial innovation
Open innovation in food marketing

ABSTRACT

This study investigates consumer acceptance of eco-sustainable and bio-based packaging as an innovation within the agri-food system, focusing on the multidimensional factors shaping market adoption and willingness to pay. A survey on 1054 consumers was carried out from 2023 to 2025 in four Italian metropolitan cities. Exploratory Factor Analysis was applied to identify the main factors driving consumer's behavior toward sustainable packaging, Simple Correspondence Analysis was used to explore associations between consumers' stated willingness to pay a premium for eco-friendly food packaging and their level of education, net household income, and sources of information. The findings reveal that consumer acceptance of eco-sustainable packaging is shaped by the interaction between environmental values, functional expectations, informational credibility, and economic constraints. Although willingness to pay a premium price remains moderate, acceptance increases when environmental and technological benefits are perceived credible and are clearly communicated. The results also highlight heterogeneous consumer responses and non-linear adoption dynamics, reflecting the complexity of sustainable consumption behaviors. Overall, the study suggests that the diffusion of eco-sustainable packaging depends not only on technological performance, but also on the ability of firms and institutions to reduce information asymmetries, foster trust, and support processes of value co-creation. From a managerial perspective, innovative bio-based packaging represents a strategic opportunity for product differentiation and sustainability-oriented market positioning within circular agri-food systems.

1. Introduction

While agriculture, processing, packaging, transportation, and storage represent key environmental hotspots requiring coordinated supply chain strategies, recent literature increasingly highlights inefficient packaging as a primary, yet still under-explored, factor underlying waste generation (Chiaraluce et al., 2021; Esposito et al., 2020; Veloso et al., 2025). Consequently, there is a growing demand for integrated frameworks that jointly optimize decisions regarding packaging, logistics, and inventory to mitigate food loss and its associated environmental impact (Ciccullo et al., 2021; Olabode et al., 2025; Versino et al., 2023).

Food packaging plays a crucial role in modern food systems, ensuring product protection, safety, shelf-life extension and convenience, while at the same time representing one of the main sources of plastic waste and environmental pressure. In recent decades, the growing awareness of climate change, resource depletion and marine pollution has accelerated the search for alternative materials to conventional petroleum-based plastics, which are criticized for greenhouse gas emissions, and misalignment with circular economy objectives, especially in high volume segments such as fresh food (Boz et al., 2020; Lin et al., 2025; Otto et al., 2021). In response, the development of sustainable and bio-based biodegradable, active and intelligent packaging has emerged as a key strategy within circular economy policies and agri-food innovation pathways because their use can reduce environmental impacts, maintain safety and quality, and help curb food (Cammarelle et al., 2021a; Cristofoli et al., 2023; Versino et al., 2023).

Several studies analyze various types of eco-sustainable packaging aimed at minimizing environmental impacts in terms of technology, biomaterials, edible and biodegradable film/coating formats, active and

* Corresponding author.
E-mail addresses: marzia.ingrassia@unipa.it (M. Ingrassia), stefania.chironi@unipa.it (S. Chironi), sandro.galluzzo@unipa.it (S. Galluzzo), biagio.pecorino@unict.it (B. Pecorino), roberta.selvaggi@unict.it (R. Selvaggi).

https://doi.org/10.1016/j.joitmc.2026.100803
Received 26 February 2026; Received in revised form 15 May 2026; Accepted 29 May 2026
Available online 4 June 2026

antimicrobial systems, nanocomposites, and smart packaging with sensors for monitoring freshness or time-temperature (Bócoli et al., 2025; D'Almeida and de Albuquerque, 2024; Lisboa et al., 2024; Mahmud et al., 2024; Pei et al., 2024). The aim of these studies is to provide sustainable alternatives to fossil-based plastics, while ensuring the mechanical properties and protective barriers essential for direct contact with food. It has been reported that edible starch films enriched with bioactive components (antioxidants, antimicrobials) improve the barrier properties of packaging and extend shelf life (Mahmud et al., 2024; Pei et al., 2024). Among them, materials obtained from agro-industrial residues, such as citrus processing by-products, represent a particularly promising option, as they simultaneously address waste valorization, resource efficiency and reduction of dependence on fossil-based polymers (Ingrassia et al., 2025). Systematic analyses and reviews about circular economy in agri-food supply chain show a strong emphasis on waste management, resource efficiency, and valorization of agricultural by-products, with packaging representing both a reduction target and a vehicle for circularity through biomass-based and recyclable materials, including bio-based, compostable and reusable solutions (Chiaraluce et al., 2021; Cristofoli et al., 2023; Gonçalves and Maximo, 2023; Nattassha et al., 2020; Osorio et al., 2021; Veloso et al., 2025; Versino et al., 2023; Zarbà et al., 2021).

However, an important distinction must be made between bio-based, biodegradable and compostable, which are often confused by consumers. Bio-based materials are not necessarily biodegradable, while biodegradable and compostable materials can also be produced from fossil resources. This conceptual ambiguity contributes to uncertainty and skepticism in the market and highlights the need for clear and standardized communication.

In this context, policymakers, firms, and researchers are accelerating the shift toward eco-sustainable, bio-based, biodegradable, active and intelligent packaging that can reduce environmental impacts, maintain safety and quality of food, and help curb food waste (Atta-Delgado et al., 2024; Califano et al., 2024; Cammarelle et al., 2021b, 2021a; Chinnici et al., 2025; Lin et al., 2025).

On the other hand, despite their technological potential, bio-based and biodegradable packaging solutions are still characterized by higher production costs and, in some cases, by performance attributes that are perceived as less reliable than those of conventional plastics.

Therefore, their market diffusion is strongly influenced not only by objective environmental benefits, but also by consumers' perceptions of quality, safety and credibility. Another important issue is the lack of adequate infrastructure for composting or recycling and issues of compliance with different global regulations (Bócoli et al., 2025; D'Almeida and de Albuquerque, 2024; Kumar et al., 2025; Lisboa et al., 2024; Mahmud et al., 2024; Pei et al., 2024; Selvam et al., 2025; Shi et al., 2025).

The year 2026 marks a regulatory turning point in Europe with the enforcement of new rules under the Packaging and Packaging Waste Regulation (PPWR) (Regulation (EU) 2025/40 of the European Parliament and of the Council of 19 December 2024, published in the Official Journal of the European Union on 22 January 2025). Most of its provisions will become binding from August 2026, from this date, all packaging placed on the EU market must comply with new sustainability criteria, including strict limits on hazardous substances. In Italy, also from January 2026, environmental contributions will be restructured to promote certified compostable bioplastic packaging. In fact, the Italian Consorzio Nazionale Imballaggi (National packaging consortium) has announced a restructuring of the environmental contribution specifically for compostable bioplastic packaging (CONAI, Consorzio Nazionale Imballaggi, comunicato stampa, 2025), ensuring true circularity (Design-for-Recycling), as stipulated by Article 6 of the PPWR. Following the EU Regulation 2025/40, by 2030, all packaging must be recyclable according to standardized criteria.

Understanding how consumers consider these innovative materials, especially in relation to fresh food, and how sustainability attributes are trusted, is therefore essential to assess their acceptance and to support the transition toward more circular and environmentally responsible behaviors inside the food system.

Several studies have shown that the average consumer often lacks clear and accurate information about the origin, production processes, functional performance, and environmental benefits of bio-based and biodegradable materials (Ingrassia et al., 2025). This information gap generates uncertainty and weakens the perceived value of technological innovation, making it difficult for consumers to fully appreciate the environmental, social, and economic benefits embedded in these solutions. When the environmental and functional advantages are not clearly understood, the price differential with respect to conventional plastic packaging is interpreted mainly as an economic disadvantage rather than as an investment in sustainability and circular economy. Numerous studies show that consumer perception, behavior and willingness to pay (WTP) are decisive for the commercial success of new packaging systems (Boz et al., 2020; Cammarelle et al., 2021b; Herrmann et al., 2022; Ketelsen et al., 2020; Otto et al., 2021). Extrinsic characteristics appearance and texture of the material, color, graphics, sustainability claims and labels – strongly influence quality expectations, trust and WTP for new food packaging (Cammarelle et al., 2021b; Ketelsen et al., 2020; Lignou and Oloyede, 2021; Plotkina et al., 2025; Reitano et al., 2026). However, consumers often misjudge environmental impact (e.g., overestimating glass and bioplastics and underestimating plastics), have limited knowledge of new materials, and exhibit a gap between attitudes and actual behavior (Boz et al., 2020; Ketelsen et al., 2020; Lin et al., 2025; Otto et al., 2021).

In particular, consumers of organic foods show positive intentions towards biodegradable, compostable and bio-based packaging solutions, but at the same time a low or heterogeneous WTP and an important role of attitudes, perceived behavioral control, emotions, information and price sensitivity (Aprile and Punzo, 2022; Califano et al., 2024; Cammarelle et al., 2021b, 2021a; Gagliardi et al., 2025; Lombardi et al., 2024; Valentina Maria Merlino et al., 2020).

In other studies, empirical evidence suggests that, regardless of income level, many consumers tend to prioritize lower-priced options in everyday purchasing decisions, especially for frequently purchased food products, even when these choices are less consistent with their stated ethical and environmental values. This attitude reflects a well-known attitude–behavior gap in sustainable consumption, whereby pro-environmental intentions (Ingrassia et al., 2004) do not always translate into actual willingness to pay a premium price (Selvaggi et al., 2025).

In the absence of adequate information and credible communication, the cost dimension becomes dominant, and innovative packaging solutions risk being penalized in the marketplace despite their superior environmental performance.

Furthermore, some consumer segments that are more sensitive to environmental sustainability issues may be more willing to pay a premium to purchase food products with eco-sustainable packaging, as this choice represents their personal values, with specific ideals and ethical motivations (Ingrassia et al., 2024). These consumers, mostly young people with a medium-high level of education, may choose to buy food products with eco-sustainable packaging, but in this case, income could be an important constraint that could influence purchasing choices, even though this is not what the consumer would have wanted to buy if they had had greater financial resources. Therefore, in this case, the problem of the probable difference between theoretical and actual or real willingness to pay may occur. In this case, communication would certainly play an important role, as would the consumer's level of knowledge, i.e. their level of education (which generally implies not only better knowledge but also better social positions and higher incomes). Only by enhancing consumers' knowledge and trust is it possible to foster a greater willingness to recognize and economically support the higher production costs associated with sustainable packaging solutions. However, at the same time, financial measures are also needed at national and supranational level to support agri-food

businesses that incur higher technology costs in order to use sustainable packaging for their products, but also to steer the entire supply chain towards a green transition.

1.1. Open innovation and consumer-driven adoption of sustainable packaging

In recent years, the transition toward eco-sustainable packaging in the agri-food sector has increasingly been interpreted through the lens of Open Innovation, which emphasizes the role of distributed knowledge, stakeholder interaction, and the permeability of organizational boundaries in the innovation process (Gajdzik et al., 2024; Noëth et al., 2024; Worakittikul et al., 2025). Within this perspective, innovation is no longer confined to firms or research institutions but emerges from the interaction between multiple actors, including consumers, who contribute to shaping, legitimizing, and diffusing new solutions.

In the context of eco-sustainable and bio-based packaging, consumers play a critical role not only as end-users but also as active participants in the innovation ecosystem (Jiménez-Guerrero et al., 2015).

Their perceptions, expectations, and willingness to accept trade-offs between environmental sustainability, functional performance, and price represent key mechanisms through which innovation is validated and scaled in the market (Siwiec et al., 2025; Worakittikul et al., 2025).

In particular, consumer acceptance can be interpreted as a form of ex-post evaluation of innovation, where perceived value, trust, and informational clarity determine whether new technologies successfully transition from niche solutions to mainstream adoption.

This perspective is particularly relevant for sustainable packaging innovations, which are characterized by high uncertainty, information asymmetry, and the need for behavioral change. The diffusion of such innovations depends not only on their technical performance but also on the capacity of firms and institutions to engage consumers through transparent communication, credible sustainability claims, and accessible knowledge (Gajdzik et al., 2024). Digital channels, social networks, and institutional communication contribute to shaping these knowledge flows, influencing how consumers interpret and evaluate innovation attributes.

Accordingly, understanding consumer perceptions and willingness to pay for eco-sustainable packaging becomes essential to capture the dynamics of user-driven innovation and value co-creation (Gagliardi et al., 2025). By identifying the latent dimensions that structure consumer evaluations and by analyzing how information sources and socio-economic characteristics influence acceptance, this study contributes to the understanding of how eco-sustainable packaging innovations are adopted, legitimized, and positioned within the agri-food innovation system.

1.2. Market complexity and heterogeneity in sustainable consumption

The adoption of eco-sustainable packaging also unfolds within a highly heterogeneous and non-linear market environment, which can be effectively interpreted through the context of Market Complexity. In such a context, consumer behavior cannot be reduced to simple, homogeneous responses to price or product attributes but emerges from the interaction of multiple dimensions, including socio-economic characteristics, cognitive factors, and information structures (Ajetunmobi and Laobangdisa, 2024; Allaire, 2004).

Market complexity is particularly evident in the case of sustainable consumption, where individuals simultaneously evaluate environmental values, functional expectations, and economic constraints (Koos, 2011). This multidimensional decision-making process generates heterogeneous responses across consumer segments, leading to differentiated levels of acceptance and willingness to pay for eco-sustainable innovations (Sheth and Parvatiyar, 2021; Van Quang and Thi Van, 2025). Income, education, and access to information play a crucial role in shaping these responses, acting as structural variables that influence both the perception of value and the ability to support price premiums.

Moreover, the presence of information asymmetries and varying levels of knowledge about sustainable packaging technologies contributes to non-linear adoption patterns (Davidescu et al., 2025). Consumers often exhibit an attitude–behavior gap, whereby positive environmental attitudes do not necessarily translate into actual purchasing behavior. This gap reflects the complexity of the decision-making process and highlights the importance of trust, perceived credibility, and informational clarity in reducing uncertainty and enabling adoption.

Within this framework, the interaction between different information channels such as institutional sources, digital platforms, and relational networks further amplifies market complexity by shaping diverse cognitive and behavioral responses (Davidescu et al., 2025). These channels not only provide information but also influence how consumers interpret sustainability attributes and justify potential price premiums (Sheth and Parvatiyar, 2021).

To capture this complexity, it is necessary to move beyond univariate approaches and adopt multivariate analyses aimed to identify patterns of associations among socio-economic variables, information sources, and willingness to pay (Herrmann et al., 2022; Mouchtaropoulou et al., 2024; Sgroi et al., 2023). In this study, the use of exploratory and correspondence-based techniques allows the identification of structured relationships within the market, providing insights into how different consumer profiles position themselves with respect to eco-sustainable packaging and its perceived value.

1.3. Research questions

In this context, the present study aims to investigate the adoption of eco-sustainable and bio-based packaging as an innovation within the agri-food system, by examining how consumers perceive, evaluate, and economically support these solutions. Rather than focusing solely on individual preferences, the study adopts a multidimensional perspective to explore the mechanisms through which such innovations are accepted, legitimized, and positioned in the market. Specifically, the study identifies the latent dimensions underlying consumers' perceptions of eco-sustainable packaging and examines how these dimensions reflect broader processes of innovation adoption. At the same time, it analyzes consumers' willingness to pay as an indicator of economic acceptance, considering the role of socio-economic characteristics and information sources in shaping heterogeneous responses within a complex market environment.

Furthermore, the study considers the role of communication processes and institutional frameworks in reducing information asymmetries and enhancing the credibility of sustainability-related attributes. In line with an open innovation perspective, these elements are interpreted as key mechanisms through which knowledge is diffused, and innovation is co-evaluated and legitimized by consumers.

Building on this framework, to know the variables that influence this market complexity, the study addresses the following research:

- RQ1. What are the main factors (variable drivers) that explain consumer behavior and perceptions regarding sustainable packaging?
- RQ2. What are the key dimensions that explain consumers' willingness to pay for sustainable packaging, and how does this willingness to pay a price premium correlates with average annual household income, sources of information on eco-sustainable packaging, and educational attainment?
- RQ3. Based on empirical evidence, how do perceptual, economic, and informational variables jointly contribute to positioning of eco-sustainable packaging, within a sustainability-oriented innovation system?

2. Materials and methods

2.1. Sampling survey

For this study, the Metropolitan Cities of southern Italy Catania, Palermo, and for northern Italy Bologna and Milan were identified as

having (in)homogeneous characteristics in terms of geographical location, number of inhabitants, population density and level of economic development.

For the sample survey, the statistical population of residents in 2025 (ISTAT, 2025) in Catania (N_1 = 298,054), Palermo (N_2 = 628,693), Bologna (N_3 = 390,151), and Milan (N_4 = 1365,698), was chosen as the starting statistical universe, which according to the latest ISTAT census (ISTAT, 2025) is equal to $N_1 + N_2 + N_3 + N_4 = N = 2682,596$ individuals. For this survey, with this initial stratification of population, a sample size of n = 1054, with hypothesis that level of confidence P = 0.954, p = q = 0.5, and an accepted sampling error = 3%, was deemed suitable.

The sample was drawn by a *quasi-probability* sampling method in relation to the sampling proportion, which is $Wh = \frac{Nh}{N}*100$, where N = 2682,596. With this proportion n_1 = 117 (= 11.11%) + n_2 = 247 (= 23.44%) + n_3 = 153 (= 14.54%) + n_4 = 537 (= 50.91%) = n (=100%) = 1054 respondents.

Moreover, the initial Population was further stratified by some socio-economic variables because we wanted to select a sample that consisted of a balanced distribution of the quantities of elements (respondents) across the groups identified for the various variables. The variables are: gender; age group; annual family income.

Regarding the age of participants, respondents were stratified into the following age ranges: up to 29 years old (Generation Z), 30–39 (Generation Y / Millennials), 40–49 (Generation X), 50 and above (Generation X and Baby Boomers).

The average family annual income was grouped by three main ranges. These thresholds were chosen based on official data from the Italian National Institute of Statistics (Istituto Nazionale di Statistica, ISTAT, 2025). Since the average net household income in Italy is approximately €39,500 per year, the €25,000–€50,000 bracket effectively captures the Italian middle class. Consequently, the < €25,000 bracket represents lower-to-middle-income households, while the > €50,000 bracket represents higher-income households. This division is a common and representative marker for socioeconomic studies in Italy.

These characteristics were considered relevant for the aims of the study. In fact, income variability is particularly relevant for exploring the multidimensional and heterogeneous nature of consumers' willingness to pay for eco-sustainable packaging within a complex market environment. Moreover, we wanted the final sample to include a light higher representation of younger individuals because of their and awareness of sustainability and innovation-related issues (Casalegno et al., 2022; Grijalvo et al., 2025; Ingrassia et al., 2024; Joshi and Rahman, 2019).

From a total database of 2423 collected questionnaires, the *quota-stratified-probability* sample (as described above) was randomly selected.

2.2. Questionnaire tool

A questionnaire was specifically designed for this survey and then tested by a panel of qualified individuals with specific expertise on the subject to ensure consistency and coherence. Subsequently, a pre-test of the paper questionnaire was carried out using the self-completion method with assisted administration to a small sample of individuals randomly selected from the university campus, with the aim of verifying the clarity of the questions, the simplicity of the language used, and the suitability of the type of response for each question to simplify and speed up the response process for respondents. Following the test, an online version of the questionnaire was created by using Google Forms tools and the link to the on-line version of the questionnaire was disseminated, from January 2023 to December 2025, via institutional emails and social media platforms (LinkedIn, Facebook, Twitter, Instagram). In the questionnaire it was asked to participants whether they wished to take part in the study and, if so, they provided an informed consent through a predefined statement.

2.2.1. Questionnaire structure

The questionnaire was structured with closed and open-ended questions, with alternating or multiple answers, as well as filter and barrier questions. According to previous literature, the questionnaire's structure was divided into four main sections with closed questions on the following topics:

1. sociodemographic data (biographical information, educational qualification, subject area of studies, occupation, and average income);
2. importance of use of eco-sustainable packaging for different products and importance of characteristics of eco-sustainable packaging for food and non-food products;
3. awareness of sustainable packaging, purpose of use and preferred characteristics of the eco-sustainable packaging;
4. stated willingness to pay a premium price for eco-sustainable packaging of fresh food products. In particular, the declared willingness to pay a premium (stated by consumers) for three types of products (i.e. 1 kg package of Italian IGP pasta, a 1 kg package of Italian IGP tomatoes, a 1 kg package of Sicilian IGP blood oranges, and a 1 liter of DOP extra virgin olive oil), with sustainable packaging was analyzed following previous studies but, in this case, with the aim to correlate it with other socio-economic characteristics of respondents by Simple Corresponding Analysis. Therefore, consumers were asked if they agreed to pay a premium price, and if "Yes", to select the ideal surcharge they we're willing to pay for each of the proposed products but with eco-sustainable packaging among the following average surcharge ranges: 0€ to €0.50; €0.50 to €1; €1 to €1.5. The question was: "How much more would you be willing to pay, on average, for each of the following products with eco-sustainable packaging instead of standard packaging?"

In addition, 5 qualitative variables, each with 10 items were chosen by the authors based on a review of relevant literature (Macht et al., 2023; Norton et al., 2023) on the topic, and a preliminary study of the characteristics of the use of environmentally sustainable packaging for food products in Italy. These items belong to 5 homogeneous macro topics (variables) with respect to the information that was sought to be acquired: Motivation to choose an eco-sustainable packaging – named "AIM", Characteristics of sustainable packaging – named "CAR_SUST_PKG", Characteristics of eco-packaging for food products – named "CAR_SUST_FOODPKG", Differentiation among packaging for different types of products – named "DIFF_PRODS", Visual attraction – named "VISUAL_ATTR". Specifically, each macro group consisted of 10 items, the macro topics, code of variables and items are displayed in Table A.1 of Appendix A. For each variable, respondents were asked to give a score (using a rating scale) from 1 to 10 to each of the 10 items based on their personal view where 1 = disagree or minimally agree and 10 = totally agree or maximum agreement in order to measure respondents' opinions, agreement or disagreement, and behaviors quantitatively.

2.3. Factor analysis

Factor Analysis (FA) was used in this study because the researcher's interest was to identify a smaller number of factors underlying many observed variables and items (as in this case) (Fabrigar and Wegener, 2011; Faris et al., 2022; Ingrassia and Chironi, 2010; Taherdoost, 2022). The purpose of the FA is not to perfectly reproduce variance, but rather to simplify the correlation matrix so that it can be explained in terms of a few underlying factors (Fabrigar and Wegener, 2011, 2011; Ingrassia and Chironi, 2010; Taherdoost, 2022). The components are real measurements, while the factors are hypothetical dimensions, which are estimated from the observed variables (Fabrigar and Wegener, 2011; Faris et al., 2022; Ingrassia and Chironi, 2010; Taherdoost, 2022).

In this study, we want to discover the main factors that constitute aggregates of motivation for consumers to choose or prefer eco-sustainable packaging for food products. Therefore, in this case, the Exploratory FA was applied as it can better reveal the underlying dimensions of all the variables (and items) considered (Ingrassia and Chironi, 2010; Taherdoost, 2022). No data standardization was applied because the analyzed variables had the same units of measurement, that is, in this case, the rating from 1 to 10; so, we imposed the same contribution of the original variables (Fabrigar and Wegener, 2011; Faris et al., 2022). Two tests were applied to evaluate the adequacy of data, as usual in the case of FA: the Kaiser–Meyer–Olkin (KMO), and the Bartlett's sphericity test. KMO statistics is a test that measures sample adequacy, it measures the proportion of variance among variables that might be common variance. It ranges from zero to one, where zero is inadequate, and values close to one are adequate; literature suggests accepting index values at least equal to 0.7 or higher (Chironi et al., 2017). Bartlett's Sphericity test is used for measuring goodness of fit. It compares the observed correlation matrix to the identity matrix (off diagonal is zero). As is well known, this test provides indications about goodness of factorization. In fact, when positive, it allows us to reject the null hypothesis that there is no correlation between the variables. Once the formal factorization requirements of the data have been met, the chosen factorial model can be applied. The extraction refers to the process of obtaining underlying factors or components. As far as the methods of extraction of factors are concerned, according to the literature on extraction methods (Fabrigar and Wegener, 2011; Taherdoost, 2022), the Principal Components Method has been chosen, because it maximizes the variance explained (no other methods of extraction of factors produce factors that explain a greater proportion of variance). One of the most common strategies for deciding on the number of factors is the rule of "eigenvalues greater than 1" (the Guttman—Kaiser criterion allows you to select the initial eigenvalues higher than 1). To identify the number of underlying factors from variables present in the Table 1 of the Appendix section, after factorial extraction both eigenvalues greater than 1, and the "Scree" test, which uses the decreasing graph of eigenvalues (i.e., the Scree Plot), were taken into consideration (Fabrigar and Wegener, 2011; Faris et al., 2022; Ingrassia and Chironi, 2010; Taherdoost, 2022). The decreasing graph of the eigenvalues allows us to identify from the graphical point of view (scree test) the number of factors that deserve to be considered, in this case, those whose eigenvalue is greater than 1. The rotation of factors helps to arrive at a simpler model of factorial weights, maximizing the high correlations and minimizing the low ones (Ingrassia et al., 2022). The factors are rotated using the "Varimax" orthogonal rotation technique, which is the most widely used in the literature (Fabrigar and Wegener, 2011; Faris et al., 2022; Taherdoost, 2022) because it provides good outputs for types of analysis like this. The data were analyzed using statistical software IBM SPSS Statistics 29.

2.4. Simple correspondence analysis

Simple Correspondence Analysis (SCA) was employed to explore the relations among modalities of one or more qualitative variables and visually represent the associations between categorical variables. SCA helps to determine the structure of any dependence between the row and the column of qualitative characters (Benzécri, 2019). Specifically, it was applied to discover latent associations between willingness to pay a price premium for eco-sustainable packaging and consumers' socio-economic characteristics like education level, household income and information sources related to eco-sustainable packaging. This technique is useful to highlight similar profiles among variables observed. SCA is a multivariate exploratory technique designed to analyze contingency tables and to summarize the structure of dependence between the row and column categories in a low-dimensional space, by decomposing the overall chi-square statistic into orthogonal factors (Benzécri, 2019; Greenacre, 2017). The method is based on the analysis of row and column profiles and on the computation of their distances from the average profile, weighted by the marginal frequencies. As initial data for SCA, three contingency matrices (m x n) were used, representing willingness to pay a premium in relation to the following qualitative variables: household income, level of education, and preferred or most frequently used sources of information about eco-sustainable packaging. Subsequently, row profiles and column profiles were calculated. In this method, each profile can be considered a coordinate of a point in a space with as many dimensions as there are categories of the variable placed in the row or column. This representation of the profiles allows us to conclude that the more similar the profiles of two rows (or columns) are, the closer the respective

Table 1
Sample characteristics.

Variables	**Variable character** (varchar)	**Frequence (%)**
Gender	Female	54.6
	Male	45.4
Age ranges	up to 29 y.o.	20.7
	30–39 y.o.	42.2
	40–49 y.o.	13.2
	50 y.o. and above	23.9
Education level	High school or less	30.7
	University Degree (any level)	56.6
	Postgraduate studies	12.7
Average annual household income	Less than €25,000	30.4
	€25,000 - €50,000	51.5
	Higher than €50,000	18.1
Job position	Student	13.0
	Employee (public/private)	49.1
	Researcher/Teacher/Professor	16.6
	Entrepreneur/freelancer	8.3
	Managers (public/private)	2.0
	Unemployed or inactive	11.0
Types of Studies	Economics/Justice/Political Science/Social Sciences	19.2
	Natural/Earth/Environmental/Agricultural Sciences	16.5
	Architectural/Engineering/Art Sciences	10.5
	Mathematics/Physics/Computer Science	8.5
	Humanities/Literature/Linguistics	28.0
	Pharmacy/Pharmaceutical Science and Technology	5.6
	Other	11.7

points in space will be to each other. Through singular value decomposition of the standardized residual matrix, SCA extracts a set of factorial axes that maximize the explained inertia (i.e., the proportion of total chi-square variance), allowing the complex pattern of associations among categories to be represented in a reduced number of dimensions. The resulting correspondence maps provide a geometric representation in which categories with similar distributional profiles are located close to each other, while categories with dissimilar profiles are positioned farther apart. The relative position of points with respect to the origin and along the main axes allows the identification of the strongest associations and oppositions between modalities.

All statistical analyses were performed using IBM SPSS Statistics 29.

3. Results

3.1. Sample characteristics (Research question Q1)

Table 1 shows the sample's characteristics. The statistical sample shows a homogeneous distribution with regards to gender (54.6% males, 45.4% females). The final sample included a number of respondents balanced for each age range but with a slight representation of younger individuals from 20 to 39 years old (as intended). Regarding the education level, the sample presents a light majority of respondents with a medium-to-high level of education, University Degree level of education (56.6%). The distribution across disciplinary backgrounds appears relatively diversified, supporting the analysis of heterogeneous attitudes toward eco-sustainable packaging and sustainability-oriented innovations. There is also a good diversification in the sample for different types of employment, as shown in Table 1, even if 11.0% are unemployed or inactive.

The average net family annual income of the sample shows a higher frequency in the central range between 25,000 and 50,000 euros (51.5%). Most respondents belong to a household with a medium income range (€25,000–50,000), 51.5% of the sample, followed by the lowest income group (30.4%) and the higher income group (18.1%).

The following table (Table 2) shows the income bracket of respondents' households in relation to their level of education. In all income ranges, people with a university degree represent the largest share, accounting for 56.6% of the sample, while respondents with a postgraduate degree represent 12.7% and those with a higher or lower secondary school diploma represent 30.6%. The most representative group in the sample consists of respondents with a university degree and a household income of between €25,000 and €50,000 (30.5%). The analysis showed that the generally high level of education is linked to the age of the respondents, most of whom are between 20 and 40 years old, and that these respondents mostly fall within the most prevalent household income bracket in Italy, between €25,000 and €50,000. At the same time, the variability observed across income and educational categories supports the analysis of heterogeneous consumer responses and differentiated willingness-to-pay patterns within the market for eco-sustainable packaging.

3.2. Consumer perceptions and preference patterns in eco-sustainable packaging (Research question Q1)

This section provides preliminary evidence on how consumers perceive eco-sustainable packaging as a sustainability-oriented innovation, highlighting the environmental and functional attributes shaping its perceived value and market acceptance.

The results show that respondents attribute the highest importance to environmental sustainability dimensions related to reducing environmental impact (8.92), facilitating recycling and reuse activities (8.73), and compliance with environmental sustainability principles (8.73) (Table 3). High scores were also assigned to resource efficiency aspects, such as lower consumption of raw materials and energy (8.63), and to packaging solutions capable of reducing disposal costs (8.59).

Overall, these findings suggest that consumers primarily evaluate eco-sustainable packaging through an environmental and circularity-oriented perspective, associating sustainable packaging innovations with waste reduction, resource efficiency, and responsible production practices. The relevance attributed to recycling, renewable energy use, and sustainability-oriented behaviors further indicates that environmental value represents a key dimension shaping the perceived legitimacy and acceptance of eco-sustainable packaging within the agri-food system.

In line with Otto et al., (2021), the results showed in Table 4 highlight that the main features that consumers prefer or consider important for environmentally sustainable food products' packaging mainly concern the use of materials that ensure good preservation (8.39), confirming that functional performance remains a critical condition for the acceptance of sustainability-oriented packaging innovations. At the same time, the information about disposal is fundamental for the consumers (8.14), as well as possibility of being able to recycle/reuse/compost the packaging (8.12). These findings suggest that consumers perceive informational transparency and end-of-life management as essential dimensions contributing to the legitimacy and perceived value of eco-sustainable packaging.

Conversely, lower scores were assigned to aesthetic design (5.45) and to advanced technological features such as hi-tech packaging or QR codes (6.63). This suggests that consumers currently display a more pragmatic than technology-oriented approach toward sustainable packaging, prioritizing functionality, usability, and environmental clarity over advanced digital innovation attributes. Overall, the results indicate heterogeneous levels of innovation readiness, where acceptance of eco-sustainable packaging appears to depend primarily on perceived utility, trust, and practical relevance.

High scores were also observed for liquid foods, and frozen/deep-freezing products, highlighting the importance attributed to sustainable packaging in contexts where preservation, food safety, and packaging functionality are particularly relevant.

At the same time, respondents also showed positive attitudes toward eco-sustainable packaging in non-food sectors such as electronics, clothing, and household appliances, suggesting a broader diffusion of sustainability-oriented packaging preferences across different consumption contexts.

However, these findings suggest that consumers assign greater value to eco-sustainable packaging in product categories characterized by frequent consumption and high packaging visibility.

Fig. 1 shows the main sources of information/learning from which respondents knew about environmentally sustainable packaging. The university and post-graduate studies appeared to be the first one (22.1%), followed by internet search (18.6%) and social networks (12.0

Table 2
Cross-distribution of education level and household income.

Education level	Household income bracket(%)			Total(%)
	25,000€ - 50,000€	Less than €25,000	Over €50,000	
High school or less	15.9	10.1	4.6	30.6
Degree (any level)	30.5	16.1	10.1	56.6
Postgraduate studies	5.1	4.2	3.4	12.7
Total	51.5	30.4	18.1	100.0

Table 3
Mean values of scores given to the characteristics that environmentally sustainable packaging should have.

Variables	Average of scores	St. dev.
Designed to create the least possible impact	8.92	2.04
Facilitate recycling/re-use activities	8.73	2.10
Designed packaging following rules of environmental sustainability	8.73	2.15
Lower consumption of raw materials and energy	8.63	2.09
Reduces disposal costs	8.59	2.19
Composed of recycled materials	8.47	2.16
Adopts and environmentally friendly behaviors	8.45	2.25
Made through the use of renewable energy	8.37	2.21
Contributes to economic/environmental sustainability	8.28	2.25
Contributes to social sustainability	8.20	2.26

Table 4
Mean values of scores given to the characteristics that environmentally sustainable food products' packaging should have.

Variables	Average of scores	St. dev.
Use of materials that ensure good preservation	8.39	2.32
Presence of information for its disposal	8.14	2.49
Ability to recycle/re-use/compost	8.12	2.32
Presence of detailed product and packaging information	8.02	2.33
Use of environmentally friendly materials	8.01	2.51
Practicality	7.93	2.51
Use of materials that do not significantly affect the final price of the product	7.91	2.46
Ability to choose from a variety of sizes	7.11	2.62
Use of innovations (hi-tech packaging, QR code)	6.63	2.81
Careful design	5.45	2.89

%). Overall, digital channels (web and social media) accounted for more than 30% of responses, while television still maintained a relevant informational role (9.2%). These findings suggest that both formal educational contexts and digital communication channels play a central role in shaping consumers' awareness and perceptions of sustainability-oriented packaging innovations. In particular, the growing importance of web-based and social media sources highlights the relevance of digital information ecosystems in supporting innovation diffusion, consumer engagement, and value co-creation processes.

Results are consistent with literature on knowledge and information channels. The literature indicates that consumers place less importance on sources such as friends/family than on labels, packaging information, and independent online research (Herbes et al., 2020; Ketelsen et al., 2020). Moreover, the literature confirms that knowledge about packaging sustainability and interest in sustainable packaging is generally limited and often concentrated among more educated individuals, typically university students or graduates (Chirilli et al., 2022; Ketelsen et al., 2020). The importance of universities as the primary source is therefore consistent with the idea that expertise on the subject is developed mainly in advanced and specialized educational contexts (Boesen et al., 2019; Chirilli et al., 2022; Norton et al., 2023). At the same time, recent research shows that consumers seek information on packaging sustainability mainly online (websites, popular articles, scientific studies) and through social media, which are considered key channels for the dissemination of educational messages and targeted campaigns (Boz et al., 2020; Herbes et al., 2020; Norton et al., 2023; Ruiz-de-Maya and Ferrer-Bernal, 2024). The fact that the web and social media reach a total of over 30% of respondents is in line with this evidence, as is the still significant role of television as a traditional information medium in national contexts such as Italy (Chamcham et al., 2024; Chirilli et al., 2022). Results show a relatively weak role of school, this is clearly understandable given that, considering the age of most respondents, when they were at school there was no talk of eco-sustainable packaging in general, let alone for food products. However, the lack of mention of schools is consistent with studies that emphasize how education on packaging sustainability is not yet structurally integrated into school curricula, even though it is recommended for younger generations (Norton and Lignou, 2024). Overall, the findings indicate that knowledge about eco-sustainable packaging is primarily concentrated among more educated consumers and disseminated through digital and institutional information channels. These patterns highlight the importance of communication and knowledge diffusion processes in shaping heterogeneous consumer perceptions and innovation acceptance within the sustainable packaging market.

3.3. Factor analysis (Research question Q1)

Exploratory Factor Analysis extracted six latent factors after seven iterations. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy reached a value of 0.969, indicating excellent suitability of the data for factor analysis. Bartlett's test of sphericity was highly significant (χ^2 = 72,472.781; df = 1225; $p < 0.001$), confirming the presence of sufficient correlations among variables and the appropriateness of the factorial model. The Scree plot (Fig. 2) provides further support for the six-factor solution, showing a clear inflection point ("elbow") after the sixth component. The first components display a sharp decrease in eigenvalues, followed by a flattening of the curve from the seventh component onward, where eigenvalues fall below the threshold of 1 and contribute only marginally to the explained variance. This pattern indicates that the first six factors capture the substantive underlying structure of the data, while the remaining components mainly reflect random error or residual variance and therefore have no statistical relevance.

Table 6 reports the eigenvalues and the percentage of variance explained by the extracted components before and after Varimax rotation. The first component shows a very high initial eigenvalue (26.840), accounting for 53.680% of the total variance in the unrotated solution, thus indicating a strong general dimension underlying the observed variables. The second component has an initial eigenvalue of 5.141 and explains an additional 10.283% of the variance, followed by a gradual decrease in the explanatory power of the subsequent components. As

Table 5
Mean values of scores according to the importance of eco-sustainability of packaging for certain products (food and non-food).

Variables	Average of scores	St. dev.
Fresh food products (fruits, vegetables, fresh-cuts, etc.)	8.57	2.22
Take-away food	8.24	2.56
Long-life food products at room temperature (pasta, dried fruits, canned products)	8.16	2.36
Beverages	8.09	2.44
Foods in liquid form (oil, vinegar, milk, etc.)	8.03	2.41
Frozen/Deep-freezing products	7.93	2.47
Electronics products and equipment	7.69	2.59
Other (publishing, stationery)	7.58	2.59
Clothing and accessories	7.52	2.60
Furniture and household appliances	7.38	2.59

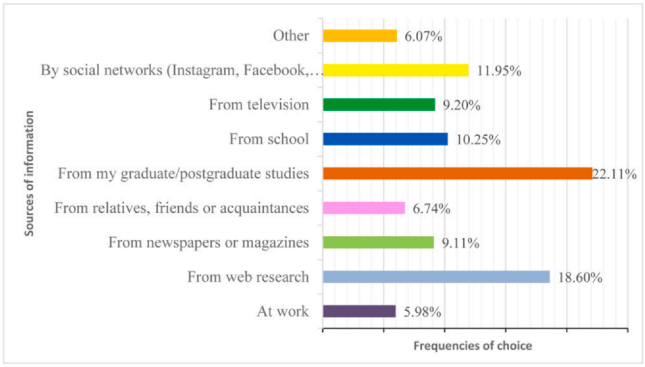

Fig. 1. Sources of information from which respondents knew about environmentally sustainable packaging.

commonly observed in exploration factor analysis, the unrotated solution is therefore largely dominated by the first factor, which concentrates most of the shared variance.

After Varimax rotation (Table 6), the distribution of explained variance becomes more balanced across dimensions. The first three rotated factors account for 19.518%, 18.967% and 15.613% of the total variance, respectively, showing comparable contributions and supporting the multidimensional nature of consumers' evaluations of eco-sustainable packaging. The fourth and fifth factors still explain a non-negligible share of variance (10.648% and 9.063%), while the sixth factor contributes an additional 5.318%. Overall, the six-factor solution explains 79.127% of the total variance, indicating a high level of information retention and confirming that the extracted latent structure provides a robust and parsimonious representation of the main dimensions underlying consumers' perceptions, attitudes and behavioral intentions toward innovative and eco-sustainable food packaging.

Fig. 3 shows the cumulative and individual percentages of variance explained by the six retained factors after rotation. The first factor accounts for 19.52% of the total variance, followed by the second (18.97%) and the third (15.61%), which together already explain more than half of the overall information content. The fourth (10.65%) and fifth (9.06%) factors still provide a relevant contribution, while the sixth factor explains an additional 5.32% variance. Overall, the six-factor solution captures 79.13% of the total variance, indicating a high explanatory power and a satisfactory synthesis of the original set of variables. The graphical representation highlights that, after rotation, the variance is no longer concentrated in a single dominant dimension but is rather more evenly distributed across the first three factors, confirming the multidimensional nature of consumers' perceptions and attitudes toward eco-sustainable food packaging. This balanced structure supports the interpretability and robustness of the extracted latent dimensions.

By analyzing the factorial coefficients (Table 7), it is possible to identify the main items for each factor extracted. These variables are those that contribute to determining the factors' variance. We can observe that 74.30% (0.8622) of the item's variance "Reduce the amount of unsorted waste for disposal" is explained by the first factor, as is 71.91% (0.8482) of the item "Contribute to public awareness of environmental protection issues", and so on. Only items with a coefficient higher than 0.5 were included.

Factor analysis revealed six main factors that together explain over 79% of the total variance, indicating a solid and interpretable structure

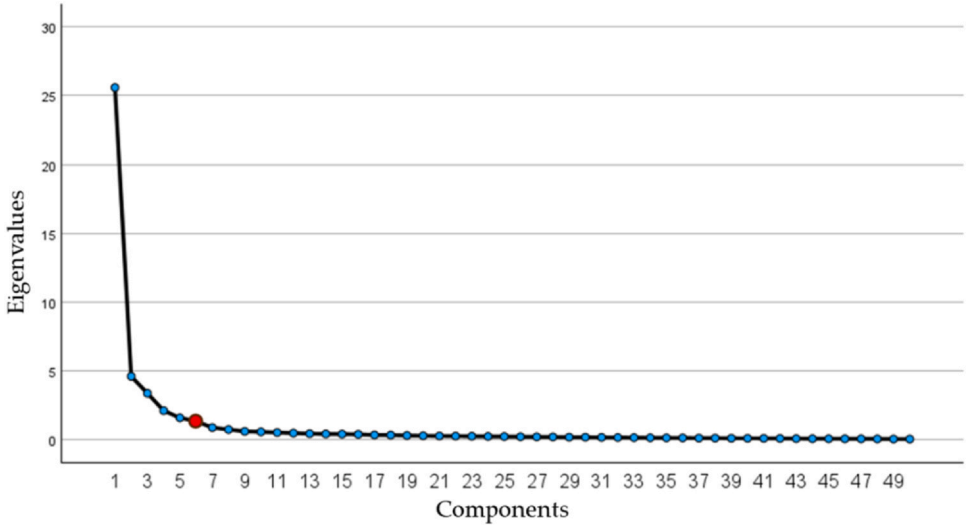

Fig. 2. Scree Plot of decreasing eigenvalues (scree test of eigenvalues > 1).

Table 6
Total explained Variance.

Comp.	Initial eigenvalues			Weights of non-rotated factors			Weights of rotated[a] factors		
	Total	% Variance	% Cumulated	Total	% Variance	% Cumulated	Total	% Variance	% Cumulated
1	26.840	53.680	53.680	26.840	53.680	53.680	9.759	19.518	19.518
2	5.141	10.283	63.963	5.141	10.283	63.963	9.483	18.967	38.485
3	3.009	6.018	69.981	3.009	6.018	69.981	7.806	15.613	54.098
4	2.200	4.400	74.381	2.200	4.400	74.381	5.324	10.648	64.746
5	1.290	2.580	76.962	1.290	2.580	76.962	4.531	9.063	73.809
6	1.083	2.165	**79.127**	1.083	2.165	**79.127**	2.659	5.318	**79.127**

[a] Varimax rotation.

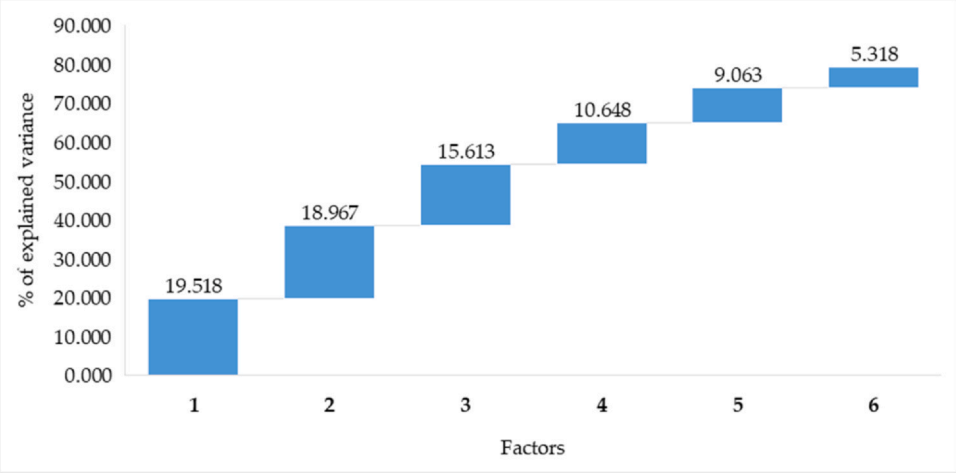

Fig. 3. Factors' percentage increases of the explained variance.

of consumer perceptions. The six factors identified are broadly consistent with empirical evidence on consumer attitudes and perceptions towards sustainable packaging. The extracted factors were labelled/named as follows:

- F1 – CONTRIBUTION to environmental sustainability;
- F2 – HEALTH through food safety;
- F3 – QUALITY of eco-friendly food packaging;
- F4 – VISUAL ATTRACTION of eco sustainable food packaging;
- F5 – PRODUCT (FOOD AND PACKAGING) INFORMATION;
- F6 – CIRCULAR AND SMART PACKAGING INFORMATION.

The first factor concerns consumer's desire to contribute to environmental protection (reduction of unsorted waste, recycling, reduction of toxic waste, improvement of air quality, reduction of waste management costs), reflects a strong value and normative orientation. The literature shows that personal norms, environmental concern and pro-social ethics are among the main antecedents of sustainable consumption and recycling behaviors (Han, 2021; Hosta and Zabkar, 2021). It is the most influential dimension and reflects a clearly value-driven orientation. The highest loadings are associated with items related to waste reduction, recycling, pollution abatement and public environmental awareness. In particular, the strong coefficients for "reducing unsorted waste", "recovering materials through recycling" and "reducing toxic waste". This highlights that, consumers associate sustainability primarily with reduction, reuse and recycling ("3Rs") and with the ability of packaging to contribute to circularity and mitigate environmental impacts throughout its life cycle (Boz et al., 2020; Dopico-Parada et al., 2021; Lignou and Oloyede, 2021). The presence of items referring to collective benefits, such as "improving air quality in metropolitan areas" and "reducing local waste management costs", further suggests that ethical and social responsibility considerations play a central role in shaping positive attitudes, beyond purely individual or utilitarian motivations. This is consistent with approaches that integrate the environmental and social dimensions of sustainability, and with the idea of packaging as a lever for shared responsibility in the transition to a circular economy (Dopico-Parada et al., 2021; Hosta and Zabkar, 2021; Lau and Wong, 2024).

The second factor focuses on food safety and preservation for sensitive categories (fresh-cut produce, frozen foods, preserves, liquids). It captures the importance attributed to characteristics of packaging as a function of the shelf-life of fresh food products and human health. Studies on innovative and bio-based packaging show that consumers recognize the crucial role of packaging in ensuring safety, shelf life and quality, but have reservations when they fear a potential functional compromise, especially for fresh and highly perishable products (Giannakourou and Tsironi, 2021; Versino et al., 2023; Yan et al., 2022). High loadings for fresh-cut, frozen, canned and liquid foods indicate that consumers strongly associate packaging choices with food safety and preservation requirements. Interestingly, although all product categories load on this factor, the relatively lower coefficient for fresh fruits and vegetables suggests a certain degree of skepticism about the ability of eco-sustainable materials to offer the same barrier and protection as conventional polymers (Giannakourou and Tsironi, 2021; Norton et al., 2022; Versino et al., 2023) for highly perishable products. This confirms the existence of a perceived trade-off between environmental sustainability and functional reliability, particularly relevant for fresh food.

The third factor groups items related to quality sustainability characteristics of packaging. High loadings for "reducing disposal costs", "facilitating recycling and reuse", "lower consumption of raw materials and energy" and "use of renewable energy" show that consumers adopt a holistic interpretation of sustainability, encompassing not only environmental impacts but also economic efficiency and social

Table 7
Matrix of rotated components.

Needs (Factors)	Differentiated needs (Variables' items)	Factorial coefficients
F1 – CONTRIBUTION to environmental sustainability	AIM_Reduce the amount of unsorted waste for disposal	0.862
	AIM_Contribute to public awareness of environmental protection issues	0.848
	AIM_Recover materials through recycling (circular economy development)	0.847
	AIM_Reducing the amount of toxic waste in the environment	0.846
	AIM_Facilitate waste disposal	0.846
	AIM_Contribute to the reduction of pollution	0.842
	AIM_Encourage the production of sustainable packaging	0.836
	AIM_Improving air quality and reducing decay in metropolitan cities	0.833
	AIM_Reducing local taxes for municipal waste disposal	0.758
	AIM_Having the possibility to buy products in recycled packaging	0.718
F2 – HEALTH through food safety	TYPE_FOODPROD_Fresh-cut foods	0.818
	TYPE_FOODPROD_Frozen food products	0.8
	TYPE_FOODPROD_Canned food	0.798
	TYPE_FOODPROD_Foods in liquid form (oil, vinegar, milk, etc.)	0.792
	TYPE_FOODPROD_Beverages	0.792
	TYPE_FOODPROD_Other	0.78
	TYPE_FOODPROD_Restaurants take-away food	0.778
	TYPE_FOODPROD_Take-out pizza and baked goods	0.773
	TYPE_FOODPROD_Long-life food products at room temperature (pasta, dried fruit, canned products)	0.761
	TYPE_FOODPROD_Fresh food products (fruit, vegetables, etc.)	0.686
F3 – QUALITY of eco-friendly food packaging	SUST_CAR_Reduces disposal costs	0.792
	SUST_CAR_Contributes to social sustainability	0.788
	SUST_CAR_Contributes to economic sustainability	0.771
	SUST_CAR_Facilitates recycling/reuse activities	0.764
	SUST_CAR_Designed to create the least possible impact	0.737
	SUST_CAR_Educates citizens to more correct and environmentally friendly behaviour	0.731
	SUST_CAR_Reduced consumption of raw materials and energy	0.725
	SUST_CAR_Made through the use of renewable energy	0.689
	SUST_CAR_Made from recycled material	0.683
	SUST_CAR_Packaging designed according to rules of environmental sustainability	0.654
F4 – VISUAL ATTRACTION of eco sustainable food packaging	VISUAL_ATTR_Colours and visual attractiveness in general	0.838
	VISUAL_ATTR_Overall design in general (shape, colours, materials)	0.831
	VISUAL_ATTR_Figures and drawings to publicise the product	0.806
	FOODPKG_CAR_Careful design	0.789
	VISUAL_ATTR_Sensations to the touch (smooth, rough, etc.)	0.686
F5 – PRODUCT (FOOD AND PACKAGING) INFORMATION	VISUAL_ATTR_Practicality	0.765
	VISUAL_ATTR_Handiness	0.753
	VISUAL_ATTR_Volume/Quantity Contained Ratio	0.712
	VISUAL_ATTR_Product certifications	0.645
	VISUAL_ATTR_Written information and/or particular words	0.585
	VISUAL_ATTR_Material	0.522
F6 – CIRCULAR AND SMART PACKAGING INFORMATION	FOODPKG_CAR_Presence of information for its disposal	0.601
	FOODPKG_CAR_Presence of detailed product and packaging information	0.559
	FOODPKG_CAR_Possibility to recycle/reuse/compost	0.536
	FOODPKG_CAR_Use of innovative materials (hi-tech, QR code)	0.502

*KMO and Bartlett test, main component extraction method, Varimax factor rotation, SPSS software v.29.

value. The inclusion of the item "educating citizens to environmentally responsible behavior" highlights that packaging is also perceived as a pedagogical and normative tool, capable of fostering more ethical consumption behaviors. This factor integrates aspects of disposal costs, ease of recycling/reuse, reduction of raw materials and energy, and use of renewable energy, presenting a vision of sustainability that includes environmental and economic dimensions and, through the item on citizen education, social dimensions as well. The literature confirms that consumers tend to evaluate sustainable packaging based on recyclability, biodegradability, waste reduction, and resource efficiency (Boz et al., 2020; Norton et al., 2022; Versino et al., 2023).

The fourth factor, relating to colors, design, graphic elements and tactile sensations, highlights that visual and sensory appeal have a significant driver of attention and evaluation. Numerous studies show that visual elements (like color, shape, graphics, layout) and tactile elements contribute to the perception of quality, sustainability and value of the product (Boz et al., 2020; Norton et al., 2023; Schifferstein et al., 2022; Spence and Van Doorn, 2022; Yan et al., 2022).

The fifth factor brings together practical characteristics (e.g. ease of handling, volume/content ratio), material characteristics and product characteristics, like certifications. It seems to capture a combined perception of usability, material quality, and verified product attributes, i.e. how suitable, reliable, and credible the packaged product is in practice, beyond just price or aesthetics.

The last factor, focusing on disposal instructions, detailed food information, recyclability, and technological tools, confirms the crucial role of information in reducing information asymmetries and supporting informed choices. This result is in line with contemporary literature about innovation in agri-food systems that is extending towards active smart packaging (Q. Chen et al., 2022; da Costa et al., 2023; Fernandez et al., 2023; Versino et al., 2023; Zuo et al., 2022). In particular, the integration of QR codes in food packaging may improve traceability and information symmetry along the chain, providing real-time data on origin, quality, and proper end-of-life management, including instructions for recycling and separate collection (Q. Chen et al., 2022; S. Chen et al., 2020; da Costa et al., 2023; Fernandez et al., 2023; Wu et al., 2025; Zuo et al., 2022). Such connectivity supports responsible post-consumer behavior and validates the environmental performance of products and packaging systems (S. Chen et al., 2020; da Costa et al., 2023; Fernandez et al., 2023; Versino et al., 2023; Wu

et al., 2025). Studies on understanding and perceptions of sustainable packaging show that consumers are often confused about materials, correct recycling methods and real sustainability, and that clear and detailed labels can change choices in favor of more sustainable solutions (Boz et al., 2020; Dopico-Parada et al., 2021; Lignou and Oloyede, 2021; Norton et al., 2022; Yan et al., 2022). The growing literature on smart, active and intelligent packaging also highlights how digital codes can convey additional information on sustainability, traceability and safety, strengthening trust and justifying any price premiums (Awlqadr et al., 2025; Kishore et al., 2024; Versino et al., 2023; Yan et al., 2022). This factor directly connects technological innovation with consumer information, suggesting that advanced bio-based packaging must be accompanied by clear and accessible informational content to enhance credibility and justify potential price premiums.

Overall, the factorial structure is consistent with the main ethical-environmental, safety and functionality, life cycle sustainability, design and visual communication, practicality and quality signals, information and packaging intelligence motivations that emerged in previous literature (Boz et al., 2020; Dopico-Parada et al., 2021; Lau and Wong, 2024; Versino et al., 2023; Yan et al., 2022). This reinforces the validity of the extracted dimensions and suggests that consumer perceptions are organized along axes that the literature has already identified as critical for the adoption and acceptance of sustainable packaging.

3.4. Analysis of self-reported willingness to pay and results of Simple correspondence analysis (Research question Q2)

Fig. 4 shows the correspondence map between income classes and willingness to pay a price premium for food products packaged with eco-sustainable materials. The spatial proximity between points indicates the strength of association between the categories. Dimension 1 is 'Ideal average overprices', Dimension 2 has been named 'Annual income'. If we observe the position of the variables, we see that 0.5 euro is on the vertical axis of the first dimension, therefore in a neutral position, while 1 euro and 1.5 euro are at opposite ends, i.e. inversely correlated. These positions highlight a variability among respondents' answers in relation to household income brackets. This result also confirms the link between income bracket and propensity towards different price increase brackets. In particular, the consumers with an annual income higher than €50,000 is positioned close to the highest premium level (€1.5), this highlights a stronger propensity among high-income respondents to accept a high price increase (overprice) for environmentally sustainable packaging of fresh foods. This association highlights that greater purchasing power is linked to a higher tolerance for the additional expenses associated with innovative and bio-based materials. Conversely, consumers with an annual income of less than €25,000 rank between €0.50 and €1, highlighting the difficulty these individuals have in identifying the correct premium for this packaging and therefore a lower level of awareness. This reflects lower price sensitivity and a tendency to support sustainability, even when the expense is not affordable for the household. The middle-income bracket (€25,000–50,000) appears closer to the "€0.5" surcharge level, suggesting a moderate willingness to pay a higher price, but the proximity between the two variables highlights the confidence and decisiveness of these consumers in attributing the surcharge. In particular, the "Do not change" category is positioned in the lower left quadrant, inversely correlated with both the highest and lowest income brackets. This confirms the previous result, namely the determination and confidence of respondents in the middle-income bracket in assigning the correct surcharge: 0.5 euro or 1 euro, or no surcharge, but never 1.5 euro.

Fig. 5 shows the correspondence map between willingness to pay a price premium and sources of information on eco-sustainable packaging. In this case, Dimension 2 is 'Information source'. Again, there is not much variability, which can be interpreted as a shared acceptance by most consumers of a surcharge between 0.5 euro and 1 euro (and a shared rejection of a surcharge of 1.50 euro). The highest premium level (€1.5) is mainly associated with the category "other" information sources, suggesting that such a relatively high surcharge is not strongly supported by any specific mainstream communication channel and remains acceptable only to a very limited and atypical segment of consumers. This confirms that most consumers are not willing to spend a high additional premium price on eco-sustainable packaging. This analysis highlights the connection between the various price premiums that consumers find acceptable or unacceptable and the sources of information from which they learned about eco-friendly packaging for food products. More interestingly, the intermediate premium level (€1) is clearly associated with non-institutional and relational information channels, such as social networks and family and friends. This finding confirms the importance of trust in the people we interact with and in word of mouth (or digital word of mouth) in receiving information and sharing behaviors. This proximity indicates that informal, trust-based and peer-to-peer communication plays a crucial role in legitimizing a moderate price premium and in strengthening consumers' confidence in the value of innovative and bio-based packaging solutions. In contrast, the lowest premium level (€0.5) appears closer to institutional and mass information sources, such as television, internet and school/university, suggesting that formal communication is currently effective in raising

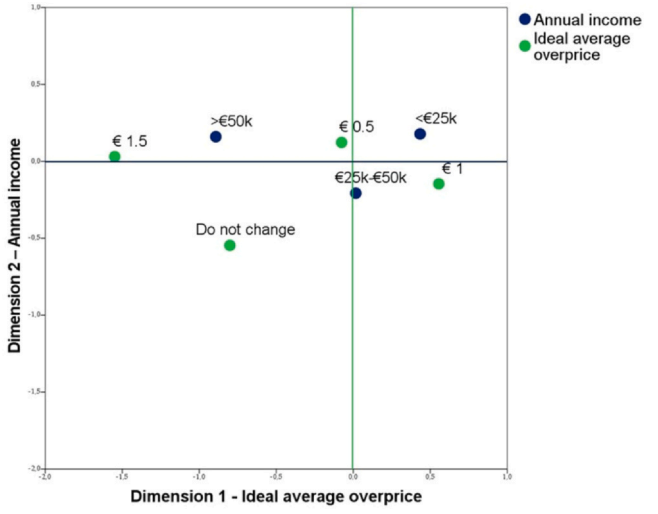

Fig. 4. Correspondence map between annual income classes and declared willingness to pay a premium price for food with eco-sustainable packaging.

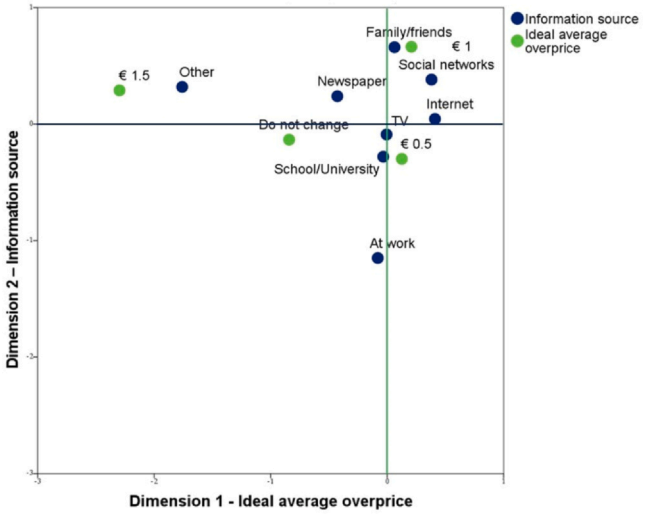

Fig. 5. Correspondence map between source of information on eco-sustainable food packaging and declared willingness to pay a premium price for food with eco-sustainable packaging.

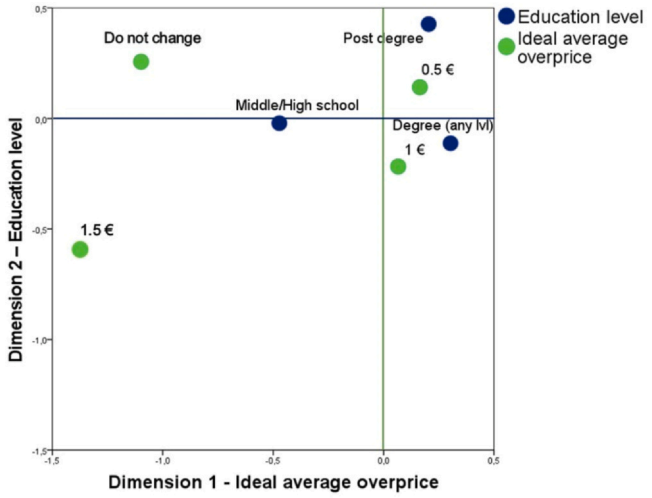

Fig. 6. Correspondence map between respondents' level of education and declared willingness to pay a premium price for food with eco-sustainable packaging.

the public's awareness and contributes to creating an objective ability to attribute a premium for these products, which is the lowest of the three proposed, and a more confident (informed) attitude in identifying or choosing the ideal premium.

Fig. 6 shows results of SCA between the respondents' level of education and declared willingness to pay a premium for food with eco-friendly packaging. In this analysis, Dimension 2 is the 'Education level'. Fig. 6 shows that results confirm the two previous analyses. The most acceptable surcharges for those with a degree or postgraduate qualification are €1 and €0.50. However, the €0.50 surcharge is most closely correlated with postgraduate qualifications. On the other hand, those with a diploma are closer to the €1 surcharge and the closest of all groups to the €1.50 surcharge. This result confirms the difficulty faced by those with lower educational qualifications (middle or high school) in accurately identifying the most appropriate price premium for this type of food packaging. Fig. 6 shows that the 1-euro surcharge is almost on the line that divides the Dimension 1 (value of the dimension = 0.0), in a neutral position, but those with higher educational qualifications (post degree level and degree level) are inversely correlated with those with lower educational qualifications (middle or high school) in the dimension of the ideal overprice. And in general, 1 euro is closer to graduates and postgraduates than to middle or high school diploma. The analysis once again highlights the indecision in the allocation of the overprice by the less educated and, above all, their propensity to allocate a higher surcharge than the more educated consumers.

3.5. Understanding market complexity and proposing product's positioning (Research question Q3)

The combined observation of sample characteristics (RQ1), factorial structure (RQ1), and correspondence analysis (RQ2) provides a multidimensional knowledge of consumers' acceptance of eco-sustainable packaging, their priorities and willingness to pay a premium price under economic, informational and educational conditions. This knowledge allowed to understand how ethical values, functional expectations, economic constraints, and communication processes interact in this complex market shaping consumer acceptance of eco-sustainable packaging for fresh food products and proposes a consistent, data-driven positioning of this product (RQ3).

Following results of RQ1. Overall, the results indicate that eco-sustainable packaging occupies a position oriented towards value, safety, and quality in the cognitive structure of respondents, while its acceptance is conditioned by economic capacity, level of education, and information exposure. Mean scores indicate that eco-sustainable packaging receives the highest importance evaluations for fresh food, take-away products, long-life foods, and beverages. The factorial structure confirms that consumer acceptance is organized around six interconnected dimensions: environmental contribution, food safety and preservation, holistic sustainability quality, visual and sensory attributes, practicality and usability, and circular/smart packaging information. Among these, environmental contribution emerges as the dominant dimension, reinforcing the role of circularity, waste reduction, and environmental responsibility in shaping the perceived legitimacy of eco-sustainable packaging. At the same time, the relevance of food safety and preservation confirms that sustainability-oriented innovations are accepted only when they maintain adequate functional reliability and product protection. Conceptually, the positioning of these packaging solutions combines environmental, functional and informational dimensions. This confirms that its relevance is greater in categories where food safety, shelf-life assurance, and environmental impact reduction converge. Non-food categories (e.g., electronics, clothing) receive lower importance, indicating that eco-sustainable packaging is primarily positioned in the food domain, especially within segments characterized by frequent consumption and high waste generation.

About results of RQ2 the simple correspondence analysis shows that eco-sustainable packaging is positioned within a moderate-cost framework. Specifically, €0.50 and €1.00 are the surcharges most consistently accepted across socio-economic groups. The €1.50 premium is generally rejected, except for a small subset of high-income respondents. This establishes eco-sustainable packaging as a moderately priced sustainable alternative, with limited tolerance for substantial price increases.

The results highlight that willingness to pay is not uniform but varies systematically by income (higher incomes are more inclined to higher premiums; middle incomes are more inclined to moderate premiums; low incomes appear with a notable level of uncertainty and lower confidence. With regard to education, higher education allows a more accurate and moderate assessment of premiums; contrarily a lower education shows a greater variability and association with higher or inconsistent premiums. Ultimately, about information sources, results show that formal and institutional sources of information align with the €0.50 premium price; relational/digital sources align with1.00 euros of premium price; marginal sources provide a weak support for a premium price of 1.50 euros.

These patterns position eco-sustainable packaging as a product that must maintain economic accessibility to avoid excluding lower-income and less-educated consumers.

Moreover, results showed that dominant sources of knowledge—-university education, web searches, and social media—indicate that eco-sustainable packaging is positioned within an informational context of digital channels and higher educational attainment. Contrarily, traditional and informal sources play a minor role. This suggests that effective positioning must rely on digital communication (web content, social media, online educational materials), clear and comprehensive on-pack information, and educational approaches grounded in scientific evidence. The importance of informational clarity, combined with the role of packaging as an educational tool identified in the factor analysis, indicates that eco-sustainable packaging is positioned as a knowledge-intensive and transparency-oriented product. In particular, similarly to Umpusinga et al. (2026), this study shows that institutional and educational communication channels are essential to provide correct information, and alike Jesus et al. (2026), digital and social networks are the most effective to transform information into engagement, trust and purchase intention (Ingrassia et al., 2024).

Therefore, in summary, integrating all the results obtained from the various analyses, eco-sustainable packaging is positioned (RQ3) as a packaging solution geared towards sustainability, safety and transparency of information that supports environmental protection and food

quality, requiring only a moderate surcharge that is acceptable to most consumers. This is a multidimensional positioning which reflects environmental values, functional performance, life cycle sustainability, practicality and information clarity, and that is influenced by socio-economic variables that moderate consumers' declared willingness to pay. Furthermore, this result highlights the need for an integrated communication strategy between businesses and institutions, but also for economic support from institutions for businesses that want to invest in innovative technologies for the sustainability of materials used in food packaging, so that the costs of the technology are not borne solely by end consumers.

The multidimensionality of this positioning and the non-linear interaction of consumer preferences directly align with established market complexity literature (Haynes and Alemna, 2022), proving empirically that the sustainable food packaging sector operates as a complex market system.

However, this product positioning, which is based on these analyses, represents a concrete contribution to open innovation and open solutions to market complexity. By being freely accessible and public, these findings provide shared strategic knowledge that benefits all industry firms and stakeholders, mitigating market information asymmetries through collective intelligence.

4. Discussion

4.1. Innovation adoption: interpreting consumer perceptions

The results of this study provide a comprehensive picture of the determinants of consumer acceptance of eco-sustainable packaging for fresh food, highlighting the interplay between ethical values, functional expectations, economic constraints and communication processes. The factorial structure revealed that attitudes and purchase intentions are driven by a multidimensional set of factors, including environmental ethics, perceived food safety and performance, sustainability attributes, aesthetic and practical features, and the quality of information provided (Bellia et al., 2025). These dimensions jointly shape consumers' trust and evaluation of innovative packaging solutions, confirming that technological innovation alone is not sufficient to ensure market acceptance. In this perspective, consumer evaluation does not merely reflect passive acceptance but contributes to the co-creation of value associated with eco-sustainable packaging. The perceived environmental, functional, and informational attributes of packaging are interpreted, negotiated, and validated by consumers, shaping the overall value proposition of the innovation. Rather, eco-sustainable packaging emerges as a multidimensional innovation, whose acceptance depends on the alignment between ethical values, functional reliability, and perceived usefulness. In particular, the prominence of environmental and circularity-related dimensions suggests that consumers interpret these solutions through a normative lens, associating them with waste reduction, recycling, and broader sustainability goals, in line with previous literature (Boz et al., 2020; Dopico-Parada et al., 2021; Hosta and Zabkar, 2021).

At the same time, the importance attributed to food safety and preservation confirms that innovation adoption is conditional upon functional trust. This reflects a structural trade-off between sustainability and performance, especially for fresh and perishable products, as widely discussed in the literature (Giannakourou and Tsironi, 2021; Versino et al., 2023; Yan et al., 2022). In this line, communication emerges as a strategic benefit. The environmental and functional benefits of eco-sustainable packaging must be clearly communicated and aligned with consumers' moral norms, risk perceptions and everyday practical needs in order to foster adoption and willingness to pay a price premium (D'Aniello et al., 2025; Herrmann et al., 2022; Ketelsen et al., 2020). Moreover, the relevance of informational attributes highlights that consumers require clear and credible communication to evaluate innovative materials, confirming that information asymmetries and knowledge gaps represent key barriers to adoption (Boz et al., 2020; Lignou and Oloyede, 2021; Norton et al., 2022).

Overall, these findings suggest that eco-sustainable packaging is not perceived merely as a technological improvement, but as a value-laden innovation embedded in broader ethical, functional, and informational considerations.

4.2. Market complexity and heterogeneous willingness to pay

The Simple Correspondence Analysis further reveals that declared willingness to pay for eco-sustainable packaging is embedded within a complex and heterogeneous market structure. Economic acceptance does not emerge as a uniform response but varies significantly across socio-economic groups and information contexts. In particular, the income-based map highlights a clear gradient, whereby higher-income consumers are more inclined to accept higher price premiums, while lower-income groups tend to tolerate only limited additional costs. The SCA further shows that higher-income segments are more inclined to accept larger premiums, highlighting the potential for targeted market segmentation and premium positioning. This confirms that economic capacity remains a key constraint in the adoption of sustainable innovations, in line with previous studies (Aprile and Punzo, 2022; Cammarelle et al., 2021b; Lombardi et al., 2024). At the same time, the results show that economic factors alone are not sufficient to explain consumer behavior.

Indeed, the interaction between information sources and willingness to pay highlights the importance of communication processes in shaping perceived value. Moderate premiums (around €1) are closely associated with relational and non-institutional channels, such as social networks and peer communication, whereas institutional sources are mainly linked to lower premiums. This suggests that trust-based and informal communication plays a crucial role in legitimizing sustainable innovations and translating knowledge into behavioral intention, confirming previous evidence (Boz et al., 2020; Herbes et al., 2020; Norton et al., 2023).

These findings reflect the non-linear nature of sustainable consumption and the persistence of the attitude–behavior gap, whereby positive environmental attitudes do not necessarily translate into economic commitment (Ketelsen et al., 2020; Otto et al., 2021). The coexistence of positive attitudes and moderate willingness to pay suggests that consumer behavior is shaped by a complex interaction of cognitive, economic, and informational factors, supporting the interpretation of the market as a complex adaptive system characterized by heterogeneity and constrained rationality.

4.3. Bridging innovation and market: positioning eco-sustainable packaging

By integrating perceptual, economic, and informational dimensions, the study provides a systemic interpretation of the market positioning of eco-sustainable packaging. The results indicate that such solutions occupy a position characterized by high perceived ethical value, conditional functional acceptance, and moderate economic tolerance. Although consumers still show limited knowledge about these packaging, results reveal a positive attitude and declared willingness to pay a premium price for fresh and high-quality food products. The fact that a large share of respondents accepts an additional cost in the range of €0.50–€1.00 suggests that sustainable packaging is already perceived as a value attribute that can be incorporated into product positioning and differentiation strategies. However, the limited acceptance of higher premiums confirms that economic accessibility remains a critical condition for broader market diffusion, in line with previous studies (Cammarelle et al., 2021b; Herrmann et al., 2022; Ketelsen et al., 2020).

At the same time, SCA shows that economic capacity alone is not sufficient to explain adoption dynamics. The willingness of certain consumer segments to support moderate premiums, combined with the influence of information and communication, suggests that market expansion may occur as awareness and knowledge increase (Alenazi,

2025; Herrmann et al., 2022). This reinforces the idea that eco-sustainable packaging represents a value-based innovation, whose adoption depends on the alignment between environmental meaning, functional performance, and perceived credibility (Norton et al., 2022; Plotkina et al., 2025).

Furthermore, the findings emphasize the central role of communication strategies in bridging the gap between technological innovation and market adoption. The environmental and functional benefits of eco-sustainable packaging must be effectively translated into perceived value through a combination of institutional credibility and the persuasive power of digital and relational communication channels (D'Aniello et al., 2025; Herrmann et al., 2022; Ketelsen et al., 2020; Ingrassia et al., 2024). This positioning is therefore not solely determined by firms, but emerges through an interactive process in which consumers actively contribute to defining the value and meaning of eco-sustainable packaging (Boz et al., 2020; Ingrassia et al., 2025; Ketelsen et al., 2020). In this sense, market positioning can be interpreted as the outcome of a co-creation process between innovation supply and consumer perception (Boz et al., 2020; Ingrassia et al., 2025; Ketelsen et al., 2020).

4.4. Theoretical and managerial implications in an open innovation perspective

From an open innovation perspective, the findings highlight the role of consumers as active participants in the innovation ecosystem, contributing to the evaluation, legitimization, and diffusion of eco-sustainable packaging solutions (Siwiec et al., 2025). They are engaging in processes of value co-creation through their perceptions, evaluations, and willingness to pay. In this framework, value is not embedded solely in the technological characteristics of packaging, but emerges from the interaction between firms, institutions, and consumers, who collectively shape its meaning, credibility, and market acceptance. Consumer acceptance emerges as a critical feedback mechanism through which innovation is co-created and validated in the market. The study confirms that the adoption of bio-based and sustainable packaging is influenced not only by environmental concern, but also by the credibility of communication and the clarity of information regarding environmental benefits and waste reduction (Aschemann-Witzel and Stangherlin, 2021; Kovač et al., 2025; Marrucci et al., 2025; Osorio et al., 2021; Versino et al., 2023). Consumer confidence increases when innovation is embedded within an integrated ecosystem in which public institutions ensure regulatory consistency and firms demonstrate verifiable technological performance and responsible end-of-life management (Chen et al., 2020; de Jong et al., 2025; Marques et al., 2025; Rosenboom et al., 2022).

Under these conditions, eco-sustainable packaging can evolve from a niche innovation, often hindered by confusion and skepticism, towards broader market adoption, supporting the transition to circular and sustainable agri-food systems (de Jong et al., 2025; Gururani et al., 2023; Sid et al., 2021; Versino et al., 2023). However, this transition requires coordinated efforts across the supply chain, including the integration of eco-design principles, improved recycling and composting infrastructures, and alignment between technological development and waste management systems.

From a policy perspective, the results highlight the need for institutional support to facilitate the adoption of sustainable packaging innovations (de Jong et al., 2025). The costs associated with new technologies should not be borne solely by firms and consumers, but require targeted interventions to support innovation, infrastructure development, and the diffusion of knowledge (Yan et al., 2022). Ultimately, the transition toward sustainable packaging is not only a technological challenge, but also a complex issue of governance, coordination, and alignment among stakeholders across the agri-food system (de Jong et al., 2025).

The higher costs of such innovations must be translated into perceived value through communication strategies that combine institutional credibility with the persuasive and relational power of digital and social channels.

5. Limitations

This study has some limitations that should be considered when interpreting the results. The study was conducted in four Italian cities, and the findings may not be fully generalizable to contexts characterized by different regulatory frameworks, particularly in countries where legislation on bioplastics and waste management differs substantially from the Italian case. As regulatory environments play a key role in shaping consumer perceptions and behaviors related to bioplastics, caution is warranted when extending these results to other national settings. Although a quasi-probabilistic sampling approach was adopted, data collection was not carried out through a professional survey agency, and questionnaires were disseminated by the research team. This may have influenced participation patterns and potentially introduced selection bias, despite efforts to standardize procedures. Moreover, the final sample included a slightly larger group of younger individuals and respondents with a medium-to-high level of education. Although these characteristics were relevant to this study given young people's sensitivity to sustainability and their greater awareness of sustainable behavior and innovation, the sample that is not representative of the current configuration of the Italian population and this could limit the generalizability of the results to all Italian consumers, particularly to older or less educated groups. In addition, the research relies on self-reported perceptions and stated willingness-to-pay intentions, which may not fully correspond to actual purchasing behaviors, thus reflecting the well-known attitude–behavior gap in sustainable consumption. Furthermore, given the exploratory and multidimensional purpose of the study, the adopted methodological approach did not develop construct operationalization and model validation as well as multivariate predictive model. However, in this first research phase, the applied methodology was considered appropriate for identifying latent perceptual dimensions and heterogeneous market patterns related to eco-sustainable packaging acceptance. Future research could complement the exploratory and multidimensional approach adopted in this study with predictive multivariate models aimed at estimating the relative influence of socio-economic, cognitive, and informational variables, and with additional data to validate the model on willingness to pay and innovation adoption behaviors.

6. Conclusion

The results of this study raise the issue that lies at the heart of the ecological transition, i.e. the shift from individual responsibility (of the producer or consumer) to systemic responsibility. This study provides empirical evidence on how Italian consumers of certain selected cities perceive and evaluate eco-sustainable and bio-based packaging for food products. By applying factorial and correspondence-based analyses, the research offers insights into the motivations underlying consumers' ethical behavior, preferences and purchasing intention for eco-sustainable food packaging. The findings show that eco-sustainable packaging is not perceived merely as a technological innovation, but as a value-based innovation whose market acceptance depends on the alignment between sustainability attributes, perceived reliability, and price acceptability (Ingrassia et al., 2025; Kozik-Kołodziej, 2026). Specifically, consumer acceptance of sustainable packaging is shaped by a multidimensional interaction of environmental values, functional expectations, informational credibility, and economic constraints (Kozik-Kołodziej, 2026; Norton et al., 2022).

While attitudes toward bio-based and environmentally friendly packaging are generally positive, declared willingness to pay a premium price remains moderate and is strongly influenced by income and trust in the communicated environmental and technological benefits (Alenazi, 2025; Herrmann et al., 2022). This suggests that higher production costs represent a significant, but not insurmountable, barrier to market diffusion. In this context, communication emerges as a strategic element for innovation diffusion and value co-creation. Institutional and educational channels contribute to providing credible information, while digital and relational networks play a crucial role in transforming knowledge into trust, engagement, and behavioral intention (Ingrassia

et al., 2024). Therefore, the successful diffusion of sustainable packaging depends not only on technological performance, but also on the ability of firms and institutions to reduce information asymmetries and enhance the perceived value of innovation.

From a managerial and policy perspective, the findings suggest that the transition toward circular packaging systems should be approached not only as an environmental or regulatory issue, but as part of a broader systemic transformation toward resilient and sustainable agri-food systems. The transition toward circular packaging systems requires not only technological progress, but also coordinated governance, stakeholder alignment, and shared value creation across the entire agri-food supply chain.

The study highlights how the diffusion of eco-sustainable packaging unfolds within a complex market environment characterized by heterogeneous consumer responses, informational asymmetries, and nonlinear adoption dynamics. In this context, value is not embedded solely in the technological characteristics of packaging, but emerges through processes of co-creation involving firms, institutions, and consumers, who collectively contribute to shaping the meaning, credibility, and market acceptance of sustainable innovations.

CRediT authorship contribution statement

Marzia Ingrassia: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Stefania Chironi:** Writing – original draft, Supervision, Investigation, Conceptualization. **Sandro Galluzzo:** Writing – original draft, Visualization, Software, Investigation, Data curation. **Biagio Pecorino:** Writing – original draft, Visualization, Validation, Supervision, Resources, Methodology, Conceptualization. **Roberta Selvaggi:** Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Funding acquisition, Conceptualization.

Informed consent and confidentiality

The authors declare that the work described does not involve patients or volunteers.

Ethical statement

This paper does not present the results of research conducted on animal and human subjects. During the preparation of this work the author(s) don't used IT tools.

Human and animal rights

The authors declare that the work described has not involved experimentation on humans or animals.

Funding information

APC was funded by Università degli Studi di Palermo.

Data Availability

Data will be made available on request.

Declaration of Competing Interest

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

Declaration of Generative AI and AI-assisted technologies in the writing process

This study did not use AI tools during manuscript preparation.

Declaration of Generative AI and AI-assisted technologies in the writing process

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Appendix A

Table A.1
Macro-topics, code of variables and items

Macro-topic	Code of variable	Items
Motivation to choose eco-sustainable packaging	**AIM**	• Reduce the amount of unsorted waste for disposal; • Contribute to public awareness of environmental protection issues; • Recover materials through recycling (circular economy development); • Reduce the amount of toxic waste in the environment; Facilitate waste disposal; • Contribute to the reduction of pollution; • Encourage the production of sustainable packaging; • Improve air quality and reduce decay in metropolitan cities; • Reduce local taxes for municipal waste disposal; • Possibility to buy products in recycled packaging.
Characteristics of sustainable packaging	**SUST_CAR**	• Designed to create the least possible environmental impact; • Facilitate recycling and reuse activities; • Designed according to environmental sustainability rules; • Reduced consumption of raw materials and energy; Reduce disposal costs; • Made from recycled materials; Use of renewable energy in production; • Contribute to economic sustainability; • Contribute to social sustainability; • Educate citizens to environmentally responsible behaviors.
Characteristics of food packaging	**FOODPKG_CAR**	• Use of materials ensuring good preservation; • Presence of disposal information; • Possibility of recycling/reuse/composting; • Presence of detailed product and packaging information; • Use of environmentally friendly materials; • Practicality of the packaging; • Price not significantly affecting the final product cost; • Availability of different package sizes;

(*continued on next page*)

Table A.1 (*continued*)

Macro-topic	Code of variable	Items
Importance of eco-packaging by product type	**TYPE_FOODPROD**	• Use of innovative materials (e.g. hi-tech, QR code); • Careful and attractive design. • Fresh food products; • Fresh-cut products; • Long-life food at room temperature; • Frozen food products; • Take-away food; • Baked and pizza take-out; Beverages; • Liquid foods (oil, milk, vinegar, etc.); • Canned food; Non-food products.
Visual and functional attributes	**VISUAL_ATTR**	• Colors and overall visual attractiveness; • Overall design (shape, colors, materials); • Figures and drawings; Sensations to the touch; • Practicality; • Handiness; • Volume/quantity ratio; • Product certifications; • Written information and keywords; • Packaging material.

References

Ajetunmobi, O.A., Laobangdisa, S., 2024. The Effect of Cultural and Socio-economics Factors on Consumer Perception. In: Bogueva, D. (Ed.), Consumer Perceptions and Food. Springer Nature Singapore, pp. 23–44. https://doi.org/10.1007/978-981-97-7870-6_2

Alenazi, S.A., 2025. Sustainability awareness, price sensitivity, and willingness to pay for eco-friendly packaging: a discrete choice and valuation study in the saudi retail sector. Sustainability 17 (16). https://doi.org/10.3390/su17167287

Allaire, G., 2004. Quality in economics: a cognitive perspective. Qual. Food 61–93.

Aprile, M.C., Punzo, G., 2022. How environmental sustainability labels affect food choices: Assessing consumer preferences in southern Italy. J. Clean. Prod. 332, 130046. https://doi.org/10.1016/j.jclepro.2021.130046

Aschemann-Witzel, J., Stangherlin, I.D.C., 2021. Upcycled by-product use in agri-food systems from a consumer perspective: A review of what we know, and what is missing. Technol. Forecast. Soc. Change 168, 120749. https://doi.org/10.1016/j.techfore.2021.120749

Atta-Delgado, M.X., Velazquez, G., Welti-Chanes, J., Torres, J.A., 2024. Assessing consumer perceptions of sustainable packaging solutions. CyTA - J. Food 22 (1), 2425403. https://doi.org/10.1080/19476337.2024.2425403

Awlqadr, F.H., Altemimi, A.B., Omar, A.M.A., Saeed, M.N., Qadir, S.A., Faraj, A.M., Al-Manhel, A.J.A., Salih, T.H., Hesarinejad, M.A., Vieira, I.R.S., 2025. Advancing sustainability in fruit and vegetable packaging: the role of nanotechnology in food preservation. eFood 6 (3), e70060. https://doi.org/10.1002/efd2.70060

Bellia, C., Chinnici, G., Pappalardo, G., Selvaggi, R., 2025. Knowledge and information for a sustainable and innovative agri-food system: insights from research and policy. Econ. Agro-Aliment. (2), 159–161. https://doi.org/10.3280/ecag2025oa20623

Benzécri, J.-P., 2019. Correspondence analysis handbook: V. 125. CRC Press, pp. xii. ⟨https://books.google.it/books?id=msqeyAEACAAJ&source=gbs_ViewAPI&redir_esc=y⟩ 665 p.

Bócoli, P.F.J., Gomes, V.E. de S., Maia, A.A.D., Marangoni Júnior, L., 2025. Perspectives on eco-friendly food packaging: challenges, solutions, and trends. Foods 14 (17). https://doi.org/10.3390/foods14173062

Boesen, S., Bey, N., Niero, M., 2019. Environmental sustainability of liquid food packaging: Is there a gap between Danish consumers' perception and learnings from life cycle assessment? J. Clean. Prod. 210, 1193–1206. https://doi.org/10.1016/j.jclepro.2018.11.055

Boz, Z., Korhonen, V., Koelsch Sand, C., 2020. Consumer considerations for the implementation of sustainable packaging: a review. Sustainability 12 (6). https://doi.org/10.3390/su12062192

Califano, G., Lombardi, A., Del Giudice, T., Caracciolo, F., Cembalo, L., 2024. Bioplastics in the basket of Italians: a hybrid framework for understanding the adoption of bioplastic food packaging. Aust. J. Agric. Resour. Econ. 68 (4), 826–846. https://doi.org/10.1111/1467-8489.12578

Cammarelle, A., Viscecchia, R., Bimbo, F., 2021a. Intention to purchase active and intelligent packaging to reduce household food waste: evidence from italian consumers. Sustainability 13 (8). https://doi.org/10.3390/su13084486

Cammarelle, A., Viscecchia, R., Bimbo, F., 2021b. Intention to purchase milk packaged in biodegradable packaging: evidence from italian consumers. Foods 10 (9). https://doi.org/10.3390/foods10092068

Casalegno, C., Candelo, E., Santoro, G., 2022. Exploring the antecedents of green and sustainable purchase behaviour: A comparison among different generations. Psychol. Mark. 39, 1007–1021. https://doi.org/10.1002/mar.21637

Chamcham, J., Pakravan-Charvadeh, M.R., Maleknia, R., Flora, C., 2024. Media literacy and its role in promoting sustainable food consumption practices. Sci. Rep. 14 (1), 18831. https://doi.org/10.1038/s41598-024-69627-6

Chen, S., Brahma, S., Mackay, J., Cao, C., Aliakbarian, B., 2020. The role of smart packaging system in food supply chain. J. Food Sci. 85 (3), 517–525. https://doi.org/10.1111/1750-3841.15046

Chen, Q., Qian, J., Yang, H., Wu, W., 2022. Sustainable food cold chain logistics: From microenvironmental monitoring to global impact. Compr. Rev. Food Sci. Food Saf. 21 (5), 4189–4209. https://doi.org/10.1111/1541-4337.13014

Chiaraluce, G., Bentivoglio, D., Finco, A., 2021. Circular economy for a sustainable agri-food supply chain: a review for current trends and future pathways. Sustainability 13 (16). https://doi.org/10.3390/su13169294

Chinnici, P., Bacarella, S., Chironi, S., Naselli, V., Ingrassia, M., 2025. How will artificial intelligence drive marketing in the beverage industry? - A bibliometric literature review. Future Foods, 100704. https://doi.org/10.1016/j.fufo.2025.100704

Chirilli, C., Molino, M., Torri, L., 2022. Consumers' awareness, behavior and expectations for food packaging environmental sustainability: influence of socio-demographic characteristics. Foods 11 (16). https://doi.org/10.3390/foods11162388

Chironi, S., Bacarella, S., Altamore, L., Columba, P., Ingrassia, M., 2017. Study of product repositioning for the Marsala Vergine DOC wine. Int. J. Entrep. Small Bus. 32 (1–2), 118–138. https://doi.org/10.1504/IJESB.2017.085982

Ciccullo, F., Cagliano, R., Bartezzaghi, G., Perego, A., 2021. Implementing the circular economy paradigm in the agri-food supply chain: The role of food waste prevention technologies. Resour. Conserv. Recycl. 164, 105114. https://doi.org/10.1016/j.resconrec.2020.105114

Cristofoli, N.L., Lima, A.R., Tchonkouang, R.D.N., Quintino, A.C., Vieira, M.C., 2023. Advances in the food packaging production from agri-food waste and by-products: market trends for a sustainable development. Sustainability 15 (7). https://doi.org/10.3390/su15076153

D'Almeida, A.P., de Albuquerque, T.L., 2024. Innovations in food packaging: from bio-based materials to smart packaging systems. Processes 12 (10). https://doi.org/10.3390/pr12102085

D'Aniello, A., Donato, C., Stagno, E., 2025. Packaging the future: a research agenda to unveil consumer trends in sustainable food and beverage choices. Bus. Strategy Environ. 34 (7), 8779–8831. https://doi.org/10.1002/bse.70037

da Costa, T.P., Gillespie, J., Cama-Moncunill, X., Ward, S., Condell, J., Ramanathan, R., Murphy, F., 2023. A systematic review of real-time monitoring technologies and its potential application to reduce food loss and waste: key elements of food supply chains and IoT technologies. Sustainability 15 (1). https://doi.org/10.3390/su15010614

Davidescu, M.A., Pânzaru, C., Mădescu, B.M., Poroșnicu, I., Simeanu, C., Usturoi, A., Matei, M., Doliș, M.G., 2025. Advances and challenges in smart packaging technologies for the food industry: trends, applications, and sustainability considerations. Foods 14 (24). https://doi.org/10.3390/foods14244347

de Jong, E., Goumans, I., Visser, R. (H.A., Puente, Á., Gruter, G.-J., 2025. The opportunities and challenges of biobased packaging solutions. Polymers 17 (16). https://doi.org/10.3390/polym17162217

Dopico-Parada, A., López-Miguens, M.J., Álvarez-González, P., 2021. Building value with packaging: development and validation of a measurement scale. J. Retail. Consum. Serv. 63, 102685. https://doi.org/10.1016/j.jretconser.2021.102685

Esposito, B., Sessa, M.R., Sica, D., Malandrino, O., 2020. Towards Circular Economy in the Agri-Food Sector. A Systematic Literature Review. Sustainability 12. https://doi.org/10.3390/su12187401

Fabrigar, L.R., Wegener, D.T., 2011. Exploratory Factor Analysis. Oxford University Presshttps://doi.org/10.1093/acprof:osobl/9780199734177.001.0001

Faris, H., Gaterell, Mark, Hutchinson, D., 2022. Investigating underlying factors of collaboration for construction projects in emerging economies using exploratory factor analysis. Int. J. Constr. Manag. 22 (3), 514–526. https://doi.org/10.1080/15623599.2019.1635758

Fernandez, C.M., Alves, J., Gaspar, P.D., Lima, T.M., Silva, P.D., 2023. Innovative processes in smart packaging. A systematic review. J. Sci. Food Agric. 103 (3), 986–1003. https://doi.org/10.1002/jsfa.11863

Gagliardi, F., Brogi, L., Betti, G., Riccaboni, A., Tozzi, C., 2025. Italian consumer willingness to pay for agri-food sustainable certification labels: the role of socio-demographic factors. Sustainability 17 (15). https://doi.org/10.3390/su17156792

Gajdzik, B., Siwiec, D., Wolniak, R., Pacana, A., 2024. Approaching open innovation in customization frameworks for product prototypes with emphasis on quality and life cycle assessment (QLCA). J. Open. Innov. Technol. Mark. Complex. 10 (2), 100268. https://doi.org/10.1016/j.joitmc.2024.100268

Giannakourou, M.C., Tsironi, T.N., 2021. Application of processing and packaging hurdles for fresh-cut fruits and vegetables preservation. Foods 10 (4). https://doi.org/10.3390/foods10040830

Gonçalves, M.L.M.B.B., Maximo, G.J., 2023. Circular economy in the food chain: production, processing and waste management. Circ. Econ. Sustain. 3, 1405–1423. https://doi.org/10.1007/s43615-022-00243-0

Greenacre, M. (2017). Correspondence Analysis in Practice (3rd ed.). Chapman and Hall/CRC. 〈https://www.taylorfrancis.com/books/mono/10.1201/9781315369983/correspondence-analysis-practice-michael-greenacre〉.

Grijalvo, B., Küster, I., Vila, N., 2025. Adopting sustainable attitudes and behaviors in Spanish universities: a study of moderating effects of education and age. International Journal of Sustainability in Higher Education. https://doi.org/10.1108/IJSHE-01-2025-0019.

Gururani, P., Bhatnagar, P., Dogra, P., Chandra Joshi, H., Chauhan, P.K., Vlaskin, M.S., Chandra Joshi, N., Kurbatova, A., Irina, A., Kumar, V., 2023. Bio-based food packaging materials: A sustainable and Holistic approach for cleaner environment- a review. Curr. Res. Green Sustain. Chem. 7, 100384. https://doi.org/10.1016/j.crgsc.2023.100384

Han, H., 2021. Consumer behavior and environmental sustainability in tourism and hospitality: a review of theories, concepts, and latest research. J. Sustain. Tour. 29 (7), 1021–1042. https://doi.org/10.1080/09669582.2021.1903019

Haynes, P., Alemna, D., 2022. A systematic literature review of the impact of complexity theory on applied economics. Economies 10 (8), 192. https://doi.org/10.3390/economies10080192

Herbes, C., Beuthner, C., Ramme, I., 2020. How green is your packaging—A comparative international study of cues consumers use to recognize environmentally friendly packaging. Int. J. Consum. Stud. 44 (3), 258–271. https://doi.org/10.1111/ijcs.12560

Herrmann, C., Rhein, S., Sträter, K.F., 2022. Consumers' sustainability-related perception of and willingness-to-pay for food packaging alternatives. Resour. Conserv. Recycl. 181, 106219. https://doi.org/10.1016/j.resconrec.2022.106219

Hosta, M., Zabkar, V., 2021. Antecedents of environmentally and socially responsible sustainable consumer behavior. J. Bus. Ethics 171 (2), 273–293. https://doi.org/10.1007/s10551-019-04416-0

Ingrassia, M., Altamore, L., Bellia, C., Grasso, G.L., Silva, P., Bacarella, S., Columba, P., Chironi, S., 2022. Visitor's Motivational Framework and Wine Routes' Contribution to Sustainable Agriculture and Tourism. Sustainability 14 (19). https://doi.org/10.3390/su141912082

Ingrassia, M., Bellia, C., Disclafani, R., Chinnici, P., Chironi, S., 2025. Eco-packaging and fresh food products. Analysis of demand and consumer behavior in Italy. Econ. Agro-Aliment. (3), 71–115. https://doi.org/10.3280/ecag2024oa17367

Ingrassia, M., & Chironi, S. (2010). Studio dell'attrattività delle strade del vino in Sicilia. Una analisi fattoriale per lo studio delle motivazioni che inducono i turisti a visitare le cantine, secondo il parere dei soggetti qualificati. 17, 260–266. https://iris.unipa.it/handle/10447/55184.

ISTAT (2025). La banca dati dell'Istituto Nazionale di Statistica. Available online at: https://esploradati.istat.it/databrowser/-.

Jesus, J.B., Besario, M.R.A., Bueno, N.L.E., Bonghanoy, C.L., Navaja, R.I., Basilisco, G.L., Ople-Alviola, C., 2026. Brand reputation in the age of AI: impact of AI-Driven Customer Interaction. Social. Media Engagem. Sustain. Messag. Consum. Trust. Purch. Intent.

Jiménez-Guerrero, J.F., Gázquez-Abad, J.C., Ceballos-Santamaría, G., 2015. Innovation in eco-packaging in private labels. Innovation 17 (1), 81–90. https://doi.org/10.1080/14479338.2015.1011055

Joshi, Y., Rahman, Z., 2019. Consumers' Sustainable Purchase Behaviour: Modeling the Impact of Psychological Factors. Ecol. Econ. 159, 235–243. https://doi.org/10.1016/j.ecolecon.2019.01.025

Ketelsen, M., Janssen, M., Hamm, U., 2020. Consumers' response to environmentally-friendly food packaging—A systematic review. J. Clean. Prod. 254, 120123. https://doi.org/10.1016/j.jclepro.2020.120123

Kishore, A., S, M.A., Kumar, P., Singh, A., Kumari, K., Kumar, N., 2024. Innovative packaging strategies for freshness and safety of food products: a review. Packag. Technol. Sci. 37 (5), 399–427. https://doi.org/10.1002/pts.2800

Koos, S., 2011. Varieties of environmental labelling, market structures, and sustainable consumption across europe: a comparative analysis of organizational and market supply determinants of environmental-labelled goods. J. Consum. Policy 34 (1), 127–151. https://doi.org/10.1007/s10603-010-9153-2

Kovač, I., Dunković, D., Kovač, B., 2025. Greenwashing and consumer skepticism toward eco-labels in Croatia: challenges and policy directions. Br. Food J. https://doi.org/10.1108/BFJ-02-2025-0122

Kozik-Kołodziej, N., 2026. Consumer attitudes and perceptions toward sustainable packaging: a systematic literature review. Sustainability 18 (3). https://doi.org/10.3390/su18031235

Kumar, V., Sonika, Ram, D.K., Sahu, G., Sahu, N.K., Verma, S.K., 2025. Sustainable modifications in food packaging: a comprehensive review of biodegradable material revolutions. Appl. Food Res. 5 (2), 101385. https://doi.org/10.1016/j.afres.2025.101385

Lau, C.C.I., Wong, C.W.Y., 2024. Achieving sustainable development with sustainable packaging: a natural-resource-based view perspective. Bus. Strategy Environ. 33 (5), 4766–4787. https://doi.org/10.1002/bse.3720

Lignou, S., Oloyede, O.O., 2021. Consumer acceptability and sensory profile of sustainable paper-based packaging. Foods 10 (5). https://doi.org/10.3390/foods10050990

Lin, J., Jaiswal, A.K., Jaiswal, S., 2025. A critical review of consumer perception and environmental impacts of bioplastics in sustainable food packaging. Sustainability 17 (4). https://doi.org/10.3390/su17041358

Lisboa, H.M., Pasquali, M.B., dos Anjos, A.I., Sarinho, A.M., de Melo, E.D., Andrade, R., Batista, L., Lima, J., Diniz, Y., Barros, A., 2024. Innovative and sustainable food preservation techniques: enhancing food quality, safety, and environmental sustainability. Sustainability 16 (18). https://doi.org/10.3390/su16188223

Lombardi, A., Califano, G., Caracciolo, F., Del Giudice, T., Cembalo, L., 2024. Eco-packaging in organic foods: rational decisions or emotional influences? Org. Agric. 14 (2), 125–142. https://doi.org/10.1007/s13165-023-00442-5

Macht, J., Klink-Lehmann, J., Venghaus, S., 2023. Eco-friendly alternatives to food packed in plastics: German consumers' purchase intentions for different bio-based packaging strategies. Food Qual. Prefer. 109, 104884. https://doi.org/10.1016/j.foodqual.2023.104884

Mahmud, Md.Z.A., Mobarak, M.H., Hossain, N., 2024. Emerging trends in biomaterials for sustainable food packaging: a comprehensive review. Heliyon 10 (1). https://doi.org/10.1016/j.heliyon.2024.e24122

Marques, C., Güneş, S., Vilela, A., Gomes, R., 2025. Life-Cycle assessment in agri-food systems and the wine industry—a circular economy perspective. Foods 14. https://doi.org/10.3390/foods14091553

Marrucci, L., Iovino, R., Iraldo, F., 2025. Environmental sustainability award winners: do they communicate their environmental performance without potential greenwashing? Corp. Soc. Responsib. Environ. Manag. 32, 2783–2794. https://doi.org/10.1002/csr.3088

Mouchtaropoulou, E., Mallidis, I., Giannaki, M., Koukaras, K., Früh, S., Ettinger, T., Benmehaia, A.M., Kacem, A., Achour, L., Detzel, A., Gianotti, A., Samoggia, A., Ayfantopoulou, G., Argiriou, A., 2024. Consumer willingness to pay for fair and sustainable foods: Who profits in the agri-food chain? (Scopus). Front. Sustain. Food Syst. 8. https://doi.org/10.3389/fsufs.2024.1504985

Nattassha, R., Handayati, Y., Simatupang, T.M., Siallagan, M., 2020. Understanding circular economy implementation in the agri-food supply chain: the case of an Indonesian organic fertiliser producer. Agric. & Food Secur. 9 (1), 10. https://doi.org/10.1186/s40066-020-00264-8

Noëth, E., Van Opstal, W., Du Bois, E., 2024. Introducing reusable food packaging: Customer preferences and design implications for successful market entry. Bus. Strategy Environ. 33 (7), 6507–6532. https://doi.org/10.1002/bse.3820

Norton, V., Lignou, S., 2024. Investigating UK School-Aged Children's sustainable food packaging disposal knowledge and engagement levels in ecologically valid settings. Sustainability 16 (16). https://doi.org/10.3390/su16167235

Norton, V., Oloyede, O.O., Lignou, S., Wang, Q.J., Vásquez, G., Alexi, N., 2023. Understanding consumers' sustainability knowledge and behaviour towards food packaging to develop tailored consumer-centric engagement campaigns: a Greece and the United Kingdom perspective. J. Clean. Prod. 408, 137169. https://doi.org/10.1016/j.jclepro.2023.137169

Norton, V., Waters, C., Oloyede, O.O., Lignou, S., 2022. Exploring consumers' understanding and perception of sustainable food packaging in the UK. Foods 11 (21). https://doi.org/10.3390/foods11213424

Olabode, O., Kumar, N., De, D., 2025. Food loss and waste management in the retail food supply chain: Methods and framework to achieve environmental sustainability. J. Environ. Manag. 387, 125718. https://doi.org/10.1016/j.jenvman.2025.125718

Osorio, L.L.D.R., Flórez-López, E., Grande-Tovar, C.D., 2021. The potential of selected agri-food loss and waste to contribute to a circular economy: applications in the food, cosmetic and pharmaceutical industries. Molecules 26 (2). https://doi.org/10.3390/molecules26020515

Otto, S., Strenger, M., Maier-Nöth, A., Schmid, M., 2021. Food packaging and sustainability – Consumer perception vs. Correlated scientific facts: a review. J. Clean. Prod. 298, 126733. https://doi.org/10.1016/j.jclepro.2021.126733

Pei, J., Palanisamy, C.P., Srinivasan, G.P., Panagal, M., Kumar, S.S.D., Mironescu, M., 2024. A comprehensive review on starch-based sustainable edible films loaded with bioactive components for food packaging. Int. J. Biol. Macromol. 274, 133332. https://doi.org/10.1016/j.ijbiomac.2024.133332

Plotkina, D., Rabeson, L., Bambauer-Sachse, S., 2025. The role of green brand image in explaining European consumers' reactions to different types of sustainable packaging. J. Retail. Consum. Serv. 84, 104228. https://doi.org/10.1016/j.jretconser.2025.104228

Reitano, M., Selvaggi, R., Zarbà, C., Bucca, M., Chinnici, G., 2026. How quality labels shape consumer behavior: a study on orange preferences. J. Agric. Food Res. 25, 102554. https://doi.org/10.1016/j.jafr.2025.102554

Rosenboom, J.-G., Langer, R., Traverso, G., 2022. Bioplastics for a circular economy. Nat. Rev. Mater. 7, 117–137. https://doi.org/10.1038/s41578-021-00407-8

Ruiz-de-Maya, S., Ferrer-Bernal, E., 2024. Sustainable food packaging: engagement through the public discourse on social networks. J. Product. Brand. Manag. 34 (2), 251–264. https://doi.org/10.1108/JPBM-10-2023-4768

Schifferstein, H.N.J., Lemke, M., de Boer, A., 2022. An exploratory study using graphic design to communicate consumer benefits on food packaging. Food Qual. Prefer. 97, 104458. https://doi.org/10.1016/j.foodqual.2021.104458

Selvaggi, R., Yagi, K., Maesano, G., Ting, C., Pappalardo, G., 2025. How much is sustainability worth in luxury food? The case of the Pistacchio Verde di Bronte PDO. Clean. Responsible Consum. 18, 100326. https://doi.org/10.1016/j.clrc.2025.100326

Selvam, T., Rahman, N.M.M.A., Olivito, F., Ilham, Z., Ahmad, R., Wan-Mohtar, W.A.A.Q.I., 2025. Agricultural waste-derived biopolymers for sustainable food packaging: challenges and future prospects. Polymers 17. https://doi.org/10.3390/polym17141897

Sgroi, F., Maenza, L., Modica, F., 2023. Exploring consumer behavior and willingness to pay regarding sustainable wine certification. J. Agric. Food Res. 14, 100681. https://doi.org/10.1016/j.jafr.2023.100681

Sheth, J.N., Parvatiyar, A., 2021. Sustainable marketing: market-driving, not market-driven. J. Macromark. 41 (1), 150–165. https://doi.org/10.1177/0276146720961836

Shi, X., Cui, L., Xu, C., Wu, S., 2025. Next-generation bioplastics for food packaging: sustainable materials and applications. Materials 18 (12). https://doi.org/10.3390/ma18122919

Sid, S., Mor, R.S., Kishore, A., Sharanagat, V.S., 2021. Bio-sourced polymers as alternatives to conventional food packaging materials: A review. Trends Food Sci. Technol. 115, 87–104. https://doi.org/10.1016/j.tifs.2021.06.026

Siwiec, D., Gajdzik, B., Gawlik, R., Wolniak, R., Pacana, A., 2025. Open eco-innovations in sustainable product development: model framework of design thinking in quality life cycle assessment (DT-QLCA). J. Open. Innov. Technol. Mark. Complex. 11 (1), 100480. https://doi.org/10.1016/j.joitmc.2025.100480

Spence, C., Van Doorn, G., 2022. Visual communication via the design of food and beverage packaging. Cogn. Res. Princ. Implic. 7 (1), 42. https://doi.org/10.1186/s41235-022-00391-9

Taherdoost, H., 2022. What are different research approaches? Comprehensive review of qualitative, quantitative, and mixed method research, their applications, types, and limitations. J. Manag. Sci. & Eng. Res. 5 (1), 53–63. https://doi.org/10.30564/jmser.v5i1.4538

Umpusinga, H.A., Alam, I.A., Habiburahman, H., Barusman, A.R.P., Siagian, A.O., 2026. Influence of digital customer experience, social media engagement, and brand trust on online purchase intention of electronic products. Int. J. Bus. Law Educ. 7 (1), 200–209. https://doi.org/10.56442/ijble.v7i1.1351

Valentina Maria Merlino, Brun, Filippo, Versino, Alice, Blanc, Simone, 2020. Milk packaging innovation: consumer perception and willingness to pay. AIMS Agric. Food 5 (2), 307–326. https://doi.org/10.3934/agrfood.2020.2.307

Van Quang, B., Thi Van, N., 2025. Exploring store image and green trust as predictors of food store loyalty: a structural model from an emerging market. J. Open. Innov. Technol. Mark. Complex. 11 (3), 100581. https://doi.org/10.1016/j.joitmc.2025.100581

Veloso, V., Santos, A., Carvalho, A., Barbosa-Póvoa, A., 2025. A comprehensive framework for assessing circular economy strategies in agri-food supply chains. Environ. Dev. Sustain. https://doi.org/10.1007/s10668-024-05755-3

Versino, F., Ortega, F., Monroy, Y., Rivero, S., López, O.V., García, M.A., 2023. Sustainable and bio-based food packaging: a review on past and current design innovations. Foods 12 (5). https://doi.org/10.3390/foods12051057

Worakittikul, W., Srisathan, W.A., Rattanpon, K., Kulkaew, A., Groves, J., Pontun, P., Naruetharadhol, P., 2025. Cultivating sustainability: harnessing open innovation and circular economy practices for eco-innovation in agricultural SMEs. J. Open. Innov. Technol. Mark. Complex. 11 (1), 100494. https://doi.org/10.1016/j.joitmc.2025.100494

Wu, J., Zou, Y., Liu, G., Xue, L., Shi, Z., Fedele, A., Manzardo, A., 2025. Reducing food loss and associated greenhouse gas emissions using a dynamic shelf life approach. Environ. Sci. & Technol. 59 (27), 13742–13753. https://doi.org/10.1021/acs.est.5c04093

Yan, M.R., Hsieh, S., Ricacho, N., 2022. Innovative food packaging, food quality and safety, and consumer perspectives. Processes 10 (4). https://doi.org/10.3390/pr10040747

Zarbà, C., Chinnici, G., La Via, G., Bracco, S., Pecorino, B., D'Amico, M., 2021. Regulatory elements on the circular economy: driving into the agri-food system. Sustainability 13 (15). https://doi.org/10.3390/su13158350

Zuo, J., Feng, J., Gameiro, M.G., Tian, Y., Liang, J., Wang, Y., Ding, J., He, Q., 2022. RFID-based sensing in smart packaging for food applications: a review. Future Foods 6, 100198. https://doi.org/10.1016/j.fufo.2022.100198

Marzia Ingrassia Holds a Degree in Economics and Business (Palermo, 1998) and got a Doctoral Degree in Agricultural Economics and Policy (Palermo, 2008). Previously got an international master in business administration (MBA) (Palermo, 2000). Assistant professor at the University of Palermo. Current research interests include economics and policy of agri-food systems, agri-food marketing with specific topics regarding quality food products, and wine business marketing and management.

Stefania Chironi Holds a Degree in Agricultural Sciences and Technologies (Palermo, 1989). Associate professor of Agricultural Economics and Agri-food Marketing, with particular reference to the wine sector. Research interests are mainly focused on wine marketing, market and valorization of regional and quality productions, and sustainability policies applied to the agricultural sector.

Sandro Galluzzo Holds a Degree in Entrepreneurship and Quality for the Agri-Food System and has obtained professional qualification as an agronomist (Palermo, 2022). He is currently pursuing a PhD in Biodiversity in Agriculture and Forestry. His current research interests include agri-food supply chains, the marketing and promotion of agri-food products, the quality of the agri-food system, and the agri-food economy.

Biagio Pecorino Holds a degree in Agricultural Sciences (Catania, 1990) and a PhD in Agricultural Economics and Land Management (Catania, 1995). Ordinary Professor of Economics and Rural Evaluation at the University of Catania. He has held senior positions such as the presidency of the Italian Society of Agri-Food Economics (SIEA). His research and institutional consulting activities focus on EU policies (CAP), the marketing of typical products, and the economic sustainability of rural supply chains, with a strong commitment to the development of the Sicilian territory. He deals with agricultural economics, business management, innovation, and development in the citrus sector.

Roberta Selvaggi Holds in Agricultural Science and Technology (Catania, 2012) and PhD in Agricultural Food and Environmental Science (Catania, 2021). Researcher in Agricultural Economics, Food Economics, and Rural Appraisal at the University of Catania. Her research activity is multidisciplinary, integrating the analysis of the circular economy and bioeconomy with the study of consumer behavior. These areas are complemented by the use of GIS technologies (geographic information systems), used to accurately map the energy potential of biomass and optimize the sustainability of production chains in Southern Italy.