

**DOCTORAL (PhD) DISSERTATION**

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**SUSTAINABILITY LABELLING ON FOOD PRODUCTS: A  
HUNGARIAN CONSUMER VIEWPOINT BASED ON  
PRIMARY QUANTITATIVE RESEARCH**

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## ABBREVIATIONS

|           |                                                                    |
|-----------|--------------------------------------------------------------------|
| EU        | European Union                                                     |
| PRISMA    | Preferred Reporting Items for Systematic Reviews and Meta-Analyses |
| SMS       | Systematic Mapping Study                                           |
| Nébih     | National Food Chain Safety Office of Hungary                       |
| Cross-tab | Cross-tabulation                                                   |
| SDGs      | Sustainable Development Goals                                      |
| NFRD      | Non-Financial Reporting Directive                                  |
| CSRD      | Corporate Sustainability Reporting Directive                       |
| USDA      | United States Department of Agriculture                            |
| HCA       | Hungarian Competition Authority                                    |
| WTP       | Willingness to pay                                                 |
| DV        | Dummy variable                                                     |
| SCLs      | Sustainability claims/labels                                       |
| USD       | United States Dollar                                               |
| EUR       | EURO                                                               |
| FSC       | Forest Stewardship Council                                         |
| MSC       | Marine Stewardship Council                                         |
| KMÉ       | Kiváló Minőségű Élelmiszer/Excellent Quality Food                  |
| FAO       | Food and Agriculture Organization                                  |
| FI        | Fairtrade International                                            |
| HQF       | High-Quality Food                                                  |
| IMMP      | The International Marine Mammal Project                            |
| PLA       | Eco-friendly polylactic acid                                       |
| HCSO      | Hungarian Central Statistical Office                               |

# 1. INTRODUCTION

The increasing urgency to move towards sustainable food systems is closely linked to the global climate agenda, including the Paris Agreement and the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda (United Nations, 2015; Willett et al., 2019; Eliasson et al., 2022; Teufer et al., 2023). Such a transition is not only policy-driven but also consumer-led (Willett et al., 2019). Consumers are instrumental in promoting innovation and sustainability in markets (UN Trade and Development, 2020). As consumer interest in sustainable products is increasing, people's choices are more and more driven by their environmental concerns, and as a result, more people are looking for products that carry this value (Gomes et al., 2023; Squires, 2019). Many consumers not only express a preference for sustainability-labelled products but are also willing to pay a premium for them (Aprile & Punzo, 2022; Asche & Bronnmann, 2017; Carlucci et al., 2015; Proi et al., 2023; Xuan, 2021). Moreover, in the specific field of product sustainability, market expansion is extremely fast (Rossi & Rivetti, 2020). Growing consumer demand has also driven the global proliferation of eco-labels, with the Ecolabel Index (2023) reporting 456 ecolabels currently in use across 199 countries and 25 industrial sectors.

As global environmental concerns intensify and consumer demand for sustainable products grows (Xu et al., 2024; Nawaz et al., 2026; Zhang et al., 2025), food labelling emerges as an important instrument for shaping consumer choices and promoting pro-environmental behavior (Anggia et al., 2025; Cook et al., 2023; Dorisse & Charry, 2025; Isabel et al., 2023; Bucca et al., 2026; Buse & Meyerding, 2025; Dreist et al., 2024; Tompa et al., 2025). Labels such as 'organic', 'sustainable', 'green', 'carbon-friendly', and even locally sourced are widely used to claim that products have certain environmental credentials or suggest that a product is environmentally friendly (Dihl et al., 2021; Duckworth et al., 2022; Feucht & Zander, 2018; Gorton et al., 2021; Kanay et al., 2021; Panzone et al., 2016; Imran et al., 2025; Liu et al., 2025; Meyerding et al., 2019; Roa-goyes & Pickering, 2024; Yao et al., 2025). Consumers who prioritize health, environment, and ethical considerations increasingly rely on these sustainability labels to guide their choices (Cook et al., 2023; Grunert et al., 2014). However, the widespread use of sustainability labels is also found to have led to an increase in greenwashing practices (Nugraha et al., 2024). Greenwashing is a situation where companies provide claims without solid evidence or provide misleading information (e.g., emphasizing the sustainability of packaging rather than the product itself) about their product or services to appear more environmentally friendly than they actually are (Alireza et al., 2025; Nugraha et al., 2024; Xu et al., 2025). Greenwashing has made it difficult for consumers to identify and find which products are genuinely sustainable in the market (Kahraman & Kazançoğlu, 2019; Nugraha et al., 2024), potentially undermining their trust in food producers and food products. To address this new challenge, it is necessary to explore and understand the general determinants of consumer behavior, particularly the usual factors on which consumers base their purchasing decisions (Nugraha et al., 2024). Multiple factors shape an individual's purchase decision, such as social density (Cai et al., 2021) and perceived status and identity (Xi et al., 2022).

Given these challenges, more robust and stronger regulation to curb misleading sustainability claims is needed. Additionally, it is important to understand consumer awareness or familiarity of existing sustainability labels on the market (Edirisooriya, 2025; Huang et al., 2024), as this awareness is crucial for assessing how well consumers can identify and interpret these labels

and the effectiveness of sustainability claims. Additionally, exploring the level of trust in sustainability labels is essential, since consumer trust is a basic condition for building confidence in sustainability claims (Ernawati et al., 2025; Rahman et al., 2025). Furthermore, comprehensive market segmentation to identify which consumers are most susceptible to greenwashing is equally important. Some consumer segments are more prone to falling victim to misleading claims. Identifying these groups is an essential step towards developing more effective strategies to protect them.

Moreover, the European Commission (2025a) also report that 53% of green claims made in the EU are misleading, vague, or false, and 40% of these claims have no support. This problem is particularly prominent within the food industry, with several greenwashing practices reported in several EU member states, including Germany, Italy, Denmark, Spain, and Poland (Apostolopoulos et al., 2025; Coyne, 2024; Dreist et al., 2025; Rudnik & Rudnik, 2025; Sciortino et al., 2025; The European Consumer Centre, 2024). Summarizing the results, the lack of harmonized standards for sustainability claims has left companies free to take advantage of regulatory loopholes, undermining consumer trust and making it more difficult for consumers to determine which products are truly sustainable.

To tackle these problems, the EU has introduced new legislative elements, such as the Green Claims Directive, which aims to regulate environmental claims and their scientific support (European Parliament, 2024; Hedemann-Robinson, 2025; Maclellan & Catelle, 2025), as well as the European Farm to Fork Strategy on food (within the European Green Deal), which intends to improve transparency and trust in food products, empowering consumers and lowering environmental footprints through the entire food chain (Antonioli & Ciaian, 2023; The European Commission, 2020; Maclellan & Catelle, 2025; Manuel, 2025). The Farm to Fork Strategy also aims at making food labelling more transparent and trustworthy, empowering consumers and reducing the environmental footprint throughout the food chain. However, the success of these policy initiatives largely hinges on what consumers understand and believe about sustainability claims.

As a medium-sized EU member state with an open, trade-intensive economy (exports and imports of goods and services together accounted for approximately 185% of GDP in 2022 (The World Bank, 2024), Hungary is deeply integrated into EU and global markets and is therefore exposed to the full range of international sustainability labelling practices and greenwashing challenges, making it a suitable and representative case for analysing consumer responses to sustainability claims. Regarding Hungarian consumers, previous research has demonstrated a positive attitude toward products with sustainability labels (Naz et al., 2020; Fekete et al., 2025; Mekler et al., 2025). This growing demand could create opportunities where greenwashing practices may proliferate. Moreover, the country also faces challenges, such as a rapidly changing market and regulatory gaps that facilitate companies taking advantage of the trust of consumers (Kundi & Ernszt, 2024). Besides, the prevention of greenwashing in Hungary is also weak and not yet sound because sectoral characteristics are different in preventability, and it was found that consumer awareness of these issues is low (Hungarian Competition Authority, 2024; Kundi & Ernszt, 2024). Furthermore, several cases of greenwashing practices have been found, especially in the food sector in Hungary (Hungarian Competition Authority, 2002, 2008; Kundi & Ernszt, 2024). A recent report has also revealed a rise in complaints to protection authorities by consumers



regarding false sustainability claims and advertisements (Embassy of Sweden in Budapest, 2022). In addition, cases of greenwashing practices have also been rising and detected in various industries, including the coffee and dairy industries (Hungarian Competition Authority, 2002, 2008; Kundi & Ernszt, 2024). Under these challenging conditions, Hungary provides excellent context for investigating the implementation of EU policies, such as the Green Claims Directive, and how greenwashing may be reduced in practice.

To fight greenwashing more effectively, it is important to understand how consumers perceive and assess sustainability labelling. Insufficient knowledge about sustainability standards and the lack of information make consumers more susceptible to false claims that, in turn, undermine their trust and reduce the influence of ethical business (Balluchi et al., 2020; Nurgül & Şenyapar, 2024; Nygaard & Silkoset, 2022; Volschenk et al., 2022). Furthermore, more attention should be paid to vulnerable consumers and disadvantaged groups, as individuals with particular socio-demographic characteristics and limited access to or understanding of environmental information are more susceptible to being influenced by misleading information (Fernandes et al., 2020; Seberini & Tokovska, 2024). These groups can also be targets of subtle and emotionally manipulative messages that leverage their moral or economic motivations. For that reason, understanding these segments is key to developing effective, inclusive, and targeted means of communication to raise consumer awareness and enable them to make informed, responsible choices.

This study contributes valuable policy implications for both Hungary and the broader EU context and supports the implementation of regulations such as the EU Green Claims Directive and other sustainability policies. By examining how consumers interpret sustainability labels and how susceptible they are to being misled, the findings will help policymakers and regulators enhance consumer understanding, clarify standards for assessing sustainability claims, and foster a more transparent and sustainable market. The research aligns with the EU's broader objectives of environmental sustainability, consumer protection, and responsible business practices.

## 2. OBJECTIVES

This study aims to examine the landscape of sustainability-related labelling in the food market, as well as consumer awareness and perceptions of greenwashing practices in Hungary, while assessing their potential impacts on consumer behavior and regulatory choices. This research seeks to enhance the developing literature on sustainable food consumption and sustainability claims. The following six primary objectives were followed in this research:

- I. To conduct a comprehensive systematic literature review on the prevalence and impacts of greenwashing in the food industry, including trends, case studies, and regulatory measures across different regions. This objective aims to deliver a thorough overview of the broader context of greenwashing in the food industry, establishing a robust foundation for further inquiry and providing insights to inform future research on greenwashing practices.
- II. To examine the distribution of domestically produced food products and sustainability labels among local and international retailers in Hungary for an inventory of sustainability labels and certifications in the retail sector.
- III. To evaluate Hungarian consumers' awareness, knowledge, and comprehension of sustainability labels in the food market. Additionally, it investigates the differences between consumers' self-assessment and the actual knowledge regarding sustainability labels, and how such overestimation correlates with the respondents' socio-demographic variables. Recognizing the sub-groups with overestimated self-knowledge aids in understanding the cognitive biases that may shape the sustainability-related consumer behavior and proposes the necessity to design specific educational strategies to address the sustainability labels in the food market.
- IV. To investigate Hungarian consumers' trust in sustainable labels, especially how it affects their purchase decisions and the effectiveness of such labels in promoting sustainable consumption trends.
- V. To perform an in-depth market segmentation analysis to identify vulnerable consumer groups in Hungary, particularly susceptible to greenwashing.

The research examines the market presence of sustainability-related labelling, the prevalence of greenwashing, and the effectiveness of current regulatory frameworks by addressing these objectives. Through a systematic literature review, it analyses greenwashing practices in the food sector, identifies key trends and case studies, and maps directions for future research. By exploring consumer trust and vulnerability, and the regulatory landscape in Hungary and the EU, the study provides insights into the challenges of building trust in sustainability claims. Finally, the findings contribute to the development of stronger regulatory frameworks to reduce misleading environmental claims and reinforce sustainable consumer behavior.

### 3. LITERATURE OVERVIEW

#### 3.1. Introduction to sustainability labelling in the food industry

Sustainability labelling in the food sector has recently emerged as an important instrument for promoting socially and environmentally responsible consumption, addressing the information gap between consumer and producer, and assisting consumers to make more sustainable food choices (Asioli et al., 2020; Brown et al., 2020; Cook et al., 2023; Grunert et al., 2014). Labels, such as eco-labels, general sustainability claims, and organic labels, aim to provide responsible consumers with information on ethical, environmental, and, in some instances, nutritional properties of food products in general (Asioli et al., 2020; Cook et al., 2023; Grunert et al., 2014; Tobi et al., 2019; Szente et al., 2015; Szente & Torma, 2015 ). However, the proliferation of such labels has created both opportunities and challenges, as the growing variety of schemes incorporating different sustainability criteria makes it increasingly difficult for consumers to navigate and compare claims (Brown et al., 2020; Grunert et al., 2014; Tobi et al., 2019).

Eco-labels basically act as a means of addressing the problem of information asymmetry between buyers and sellers, indicating that the products are produced under certain ecological and social conditions (Hartmann et al., 2025). The attributes of either animal welfare or organic production may be regarded as “credence attributes” and are characteristics that buyers find hard to check either before or even after buying (Daugbjerg et al., 2014; Hartmann et al., 2025). Labels serve as a signal to lower this uncertainty according to signaling theory and convert these unverified qualities into quasi-search attributes (Gorton et al., 2021; Osburg et al., 2022; Perrini et al., 2010). In return, this reduction in uncertainty enhances trust and positively influences the behavioral intention of the consumer to label usage when making decisions during purchase (Gefen et al., 2003; Morgan et al., 2021; Nuttavuthisit & Thøgersen, 2017; Wang et al., 2020).

Despite their positive functions, many sustainability labels raise concerns regarding market credibility and consumer perception. They often lack clear information, fail to attract consumer attention, or risk deceiving consumers (Brécard, 2014; Mcleod et al., 2024; Moon et al., 2017). Consumer confusion regarding the labelled information undermines the label’s performance, while dissatisfaction and distrust of the consumer can potentially arise due to the lack of clear information or inadequate information from the labels themselves (Moon et al., 2017). The increasingly used phenomenon known as the “green gap,” or “attitude-intention-behavior gap,” describes the failure of the consumer’s positive attitudes regarding sustainability to manifest in actual corresponding activities related to purchasing at the point-of-sale moment (Vermeir & Verbeke, 2006). A further concern is the possibility of deception in sustainability, often referred to as “greenwashing,” in relation to the vague or general comments made by organizations about the environment, such as “eco-friendly” and “biodegradable,” in the absence of sufficient evidence, resulting in erosion of consumer trust (Delmas & Burbano, 2011).

In the Hungarian setting, sustainability-related labelling has slowly gained momentum, but consumer awareness and understanding have remained relatively low (Kocsis & Kuslits, 2019; Nagy-Pércsi & Fogarassy, 2019). Hungarian consumers tend to prioritize attributes such as

freshness, price, or safety over sustainability, and awareness of recognizable sustainability labels remains limited in the country. Gombkötő et al. (2025) mentioned that the Hungarian food industry is adapting to the new regulations and reporting requirements of the European Union, with varying levels of preparedness across subsectors. Hungary's sustainability-related labelling is relatively high, driven by a unique interplay of consumer skepticism, high environmental consciousness, and national policy that specifically mandates transforming the Hungarian food system. This is underscored by the need to address the low institutional trust, compliance with the European Union, and the country's policy objectives, and to communicate the authenticity of the products to consumers effectively. Hungarian consumers still exhibit a high price sensitivity but have started to show greater environmental concern. Studies have shown the existence of distinct groups of eco-consumers who are price-sensitive or price-insensitive, underscoring the need to look beyond the niche market paradigm applied to sustainable products (Lányi et al., 2024). Labelling plays a crucial role in bridging the "attitude-intention-behavior gap" (Mazhar et al., 2025). Although environmental attitude alone does not consistently predict sustainable behavior, cultivating a positive attitude remains an important prerequisite for forming the intention to buy a green product. On the other hand, persistent green habits exercise the greatest effect on real sustainable behavior, making them the greatest influencing factor in green consumption (Alagarsamy et al., 2021; He et al., 2019; Mazhar et al., 2025; Nguyen et al., 2021). Additionally, labels serve as critical points of information to support these attitudes and behavior change towards green buying habits. This is evident in the works of Aydin et al. (2021), Ghazali et al. (2018), Mazhar et al. (2025), and Xiao et al. (2023). Price plays a paradoxical role, underscoring the necessity of labelling for validation. A low price will trigger consumer disbelief of an organic product's origin, while a higher price tag emboldens the perceived reliability of an organic product. Several studies have shared this perspective by Hemmerling et al. (2015), Krystallis et al. (2005), and Yin et al. (2016). Labels justify any price premium for sustainable goods, especially for consumers who would pay more for a product if it were healthier (Kovács et al., 2024; Szab et al., 2021; Szakos et al., 2022).

The national and EU policies are placing sustainability-related labelling in focus to ensure accountability and to drive systemic change. The Hungarian Competition Authority (HCA) intervened in response to the concerns about the credibility of sustainability statements and recommended the creation of a future sustainability and environmental impact labelling scheme (Lakatos, 2024). This complements the new EU directive, which banned the use of generalized eco-labels such as "eco-friendly" or "biodegradable" unless supported by evidence, to make sure only those sustainability claims supported by officially recognized certification schemes remain in the marketplace (Parkinson, 2024). Aligned with Hungary's objectives for sustainable food systems, the implementation of certified symbols and labels seeks to improve public understanding of environmental and sustainability issues, encourage informed consumption, and increase transparency within the food industry (Bencsik, 2022). Long-term aims of the Hungarian government include the adjustment of front-of-pack nutritional label systems and the development of front-of-pack sustainability label systems to empower consumers to make green purchase decisions (Bencsik, 2022). In general, these regulations seek to give consumers accurate, clear, and trustworthy information (Hartmann et al., 2025; Tonkin et al., 2015).

Labelling is essential for consumer categories that actively seek specific product information (Bonioli & Bazzani, 2025; Bugyi et al., 2023, 2024; Islam et al., 2024). Generation Z, in both major and small metropolitan locations, demonstrates great awareness and engagement

with sustainable food consumption trends (Kovács et al., 2024). Residents of big and small towns also have the highest level of trust in companies that care about sustainability and significantly more often trust the information that can be read on product labels when compared to those living in the capital and in villages (Kovács et al., 2024; Lendvai et al., 2022). Moreover, for these groups, a trusted label is vital to strengthening their confidence in purchasing safe, sustainable food. Sustainability labels are esteemed in Hungary as they tackle critical issues, including mitigating consumer skepticism, informing price-sensitive purchasing choices, and ensuring adherence to progressively rigorous regulations that protect the sustainability of the food industry through verifiable standards (Hartmann et al., 2025; Lakatos, 2024; Nagy-Pércsi & Fogarassy, 2019). As a result, the Hungarian food sector is modifying its practices to comply with these evolving regulations, with implementation approaches varying across subsectors to meet consumer expectations and compliance obligations (Gombkötő et al., 2025).

### 3.2. Sustainable food production and sustainable food consumer behavior

Sustainable food production and sustainable food consumer behavior have emerged as two interrelated pillars of a common food-system transformation in order to preserve environmental conditions, while simultaneously ensuring food and nutrition security. Sustainable food production is defined as practices in agriculture and agri-food systems that support ecosystem services, mitigate climate change, conserve biodiversity, optimize land, water, and nutrient use, and provide sufficient safe food (EUFIC, 2015; Foresight, 2011; Qu et al., 2024). Likewise, sustainable food consumer behavior consists of practices related to food choices (where those choices contribute to the minimization of negative environmental and social impacts), purchasing, and waste, for example, plant-rich diets; products with credible sustainability attributes; and reduced household food waste (Gallo et al., 2023; Nguyen et al., 2025; Ntai et al., 2025; Perussello et al., 2025; Wurzer-Mulders et al., 2026). Taken together, these two aspects create an interactive system in which sustainable production provides the structural and material basis for sustainable consumption, while consumer behavior generates market signals that may reinforce or constrain sustainable production.

### 3.3. Regulatory landscape and standards for the sustainability labels in Hungary

Sustainability-related labelling in Hungary's food business is predominantly influenced by European Union (EU) regulations, which each Member State is required to implement. Although Hungary has incorporated these recommendations into its national rules, it does not possess a cohesive standard for sustainability labels within the food sector. For example, certification for organic farming is managed by publicly certified organizations, with official labels on the product packaging (Maró et al., 2019). Moreover, different food industry sectors have distinct reporting procedures, i.e., dairy and fruit/vegetable processing industries usually give more thorough sustainability reports, especially when it comes to mitigating climate change, whereas the grain and bakery sectors tend to lag behind (Gombkötő et al., 2025; Lámfalusi et al., 2024). The absence of standards leads to consumer confusion, as the majority of consumers do not comprehensively grasp the implications of sustainability information on labels (Maró et al., 2019; Nagy-Pércsi & Fogarassy, 2019). As a result, the EU has commenced steps to standardize food sustainability-related labelling, while in Hungary, the implementation is being modified to conform to both EU directives and national regulatory standards.

Table 1 provides the key regulatory milestones and national adaptation. EU's "Farm to

Fork” Strategy and Green Deal policies are driving the need for a unified sustainability labelling scheme to help consumers counter “greenwashing”. The proposed “EU Sustainability Labelling Framework” and “Green Claims Directive” promote scientifically proven, third-party-verified claims that might replace or align with other labels (Arayess et al., 2022; Gokani, 2023; Lisa Clodoveo et al., 2022; Nes et al., 2024). The “organic” label is among the most established sustainability labels, restricted to products in which at least 95% of ingredients are produced through organic agriculture, under strict EU certification schemes (Lisa Clodoveo et al., 2022). In addition, the “Product Environmental Footprint” (PEF) method is being developed to standardize environmental claims across the EU, ensuring a scientifically robust basis for sustainability labelling (Rejman et al., 2023). The PEF is a standardized European Union Life Cycle Assessment (LCA) technique that encompasses sixteen life cycle impacts, including climate change, water usage, and the depletion of natural resources (Rejman et al., 2023). The EU standards are expanding beyond environmental claims to include social and nutritional aspects, with ongoing debates about the breadth and depth of the criteria (Arayess & De Boer, 2022; Lisa Clodoveo et al., 2022; Nes et al., 2024). Hungary has also considered aligning with European Union guidelines such as the NFRD and the CSRD, which have contributed to the development of sustainability reporting and its labelling across the country (Gombkötő et al., 2025; Lámfalusi et al., 2024). The process of sustainability reporting in the Hungarian food industry indicates increased interest in the adoption of sustainability-related labelling, but it is challenged by the lack of standard labelling indicators amid the variety of labelling standards (Gombkötő et al., 2025; Ornelas Herrera et al., 2025; Rejman et al., 2023).

**Table 1.** Key regulatory milestones and national adaptation

| EU<br>Regulation/Initiative   | Hungarian<br>Implementation and<br>Challenges       | References                                                                      |
|-------------------------------|-----------------------------------------------------|---------------------------------------------------------------------------------|
| Farm to Fork, Green Deal      | Ongoing adaptation, sectoral differences            | (Gokani, 2023; Gombkötő et al., 2025; Lámfalusi et al., 2024; Nes et al., 2024) |
| Organic Label (Reg. 834/2007) | Mandatory dual (EU + Hungarian) organic labelling   | (Lisa Clodoveo et al., 2022)                                                    |
| PEF, Green Claims Directive   | Early stages, need for harmonized national adoption | (Arayess & De Boer, 2022; Nes et al., 2024; Rejman et al., 2023)                |
| NFRD, CSRD                    | Gradual expansion to more companies, uneven uptake  | (Gombkötő et al., 2025; Lámfalusi et al., 2024)                                 |

Certification for sustainability labels in Hungary faces several significant challenges, both at the regulatory and practical levels. These issues impact the credibility, uptake, and effectiveness of sustainability-related labelling across sectors. Complex and fragmented regulations, high bureaucratic and administrative burden, lack of guidance and support, variable reporting quality and assurance, and market and policy gaps are some certification challenges. The Hungarian regulations for sustainability certification are often fragmented and lack information standards across sectors and company types. This fragmentation led to inconsistent compliance and

complicated the certification process, especially for state-owned and smaller enterprises (Boros & Fogarassy, 2019; Lámfalusi et al., 2024). The need to adapt to the evolving EU requirements adds further complexity, as Hungarian producers must frequently update practices to remain compliant (Hoyk et al., 2022; Mazurek-Kusiak et al., 2021). The certification process is perceived as highly bureaucratic, with extensive paperwork and administrative requirements. This is a major barrier for farmers and small businesses, who often lack the resources to navigate complex procedures (Mazurek-Kusiak et al., 2021). The necessity to use only approved materials like natural fertilizers in organic farming and to document compliance increases the workload and discourages participation (Mazurek-Kusiak et al., 2021). There is a shortage of accessible, high-quality advisory services to help producers understand and implement certification standards. This knowledge gap makes it difficult for new entrants to achieve and maintain certification (Lámfalusi et al., 2024; Mazurek-Kusiak et al., 2021). Moreover, sustainability reporting and certification quality vary widely, with larger and foreign-owned companies more likely to meet EU and Hungarian standards. Smaller domestic firms often provide less detailed or credible disclosures, undermining the overall trust in certification schemes (Lámfalusi et al., 2024; Pasko et al., 2021). Lastly, demand for certified sustainability products in Hungary remains much lower than in Western Europe, reducing incentives for producers to pursue certification (Hoyk et al., 2022; Lámfalusi et al., 2024). Policy strategies often prioritize digitalization or other goals over robust ecological standards, leading to gaps in effective sustainability governance (Hoyk et al., 2022).

### 3.4. Consumer perception and attitudes toward sustainability labels in Hungary

Perceptions of consumers, on the one hand, are influenced by issues related to consumers' education level, environmental values, and trust in certification institutions (Cook et al., 2023; Mancini et al., 2017; Nagy-Pércsi & Fogarassy, 2019). In the case of the Hungarian market, consumers tend to value price, health, quality, and food safety more than the sustainability criteria, while the absence of a commonly understood and distinctive sustainability mark is noted (Kocsis & Kuslits, 2019; Nagy-Pércsi & Fogarassy, 2019; Plasek et al., 2021, 2022 ). Regarding the trust of the Hungarian consumers in the national institutions, it is concluded that it is limited and oscillates between distrust and the lack of adequate knowledge to properly interpret the asserted sustainability (Kocsis & Kuslits, 2019; Nagy-Pércsi & Fogarassy, 2019). It is assumed that concerning the motivations of the consumers, some are driven by food-related health beliefs, while the rest are either influenced by price sensitivity or do not care about the issue of sustainability (Mancini et al., 2017; Nagy-Pércsi & Fogarassy, 2019; Tobi et al., 2019). Furthermore, segmentation analysis shows segments with "Health-Conscious", "Price-sensitive", and "Distrusting" consumers reacting distinctively to the sustainability information (Nagy-Pércsi et al., 2019; Yeh et al., 2020).

Third-party and government-supported labels are viewed as trustworthy to a greater extent than self- or private labels (Brach et al., 2018; Cook et al., 2023; Nagy-Pércsi & Fogarassy, 2019). Current awareness of sustainability and related labels, especially among younger and highly educated individuals, is increasingly recognized in Hungary. Nonetheless, general understanding and engagement with environmental issues are still lacking in comparison to Western European nations (European Investment Bank, 2024). The awareness of labels such as organic and organic-based EU labels is quite moderate. Also, in this case, many people are unable to identify various labels and interpret their meaning correctly. Among the various labels, the EU organic label ("green

leaf") is most often recognized in Hungary compared to the USDA (United States Department of Agriculture) Organic and India Organic labels (Nagy, 2024).

Moreover, awareness of organic logos has a positive correlation to purchasing frequency, such that consumers in general become more familiar with logos as their purchasing frequencies increase for organic foods (Nagy, 2024). Demographics have played a crucial role in determining how familiar someone might be with logos, such that women have generally been known to be more familiar than men for both Hungarian and Polish samples in logos for the EU organic label. Additionally, people with higher education have been found to be more familiar than others in Hungary with the logos for the EU organic label (Nagy, 2024).

Hungarian consumers, beyond the formal logo, place high value on product attributes, with trust levels varying according to the type of public authority providing certification. The effectiveness of sustainability labelling is therefore fundamentally linked to consumer trust, which remains a key challenge in Hungary. The country's socialist past has left a lasting legacy of low institutional trust in government and public institutions, as Nuttavuthisit et al. (2017) and Zander et al. (2015) explain. These make people rely on private and informal networks rather than official systems, according to Marozzi (2015). Credibility is narrowly defined as believability or plausibility, in which food producers or retailers should be credible to generate trust for consumers (McKnight & Chervany, 2001; Thorsøe et al., 2016). Moreover, lack of trustworthiness among the certification schemes and confusion among many labels are a hindrance to organic food (Nagy-Pércsi & Fogarassy, 2019; Yeh et al., 2020). Many Hungarian consumers are unfamiliar with the meaning of sustainability labels, which creates ambiguity and undermines informed purchasing decisions. Even for environmentally conscious, well-informed, or educated individuals, factors such as price, taste, and freshness question sustainability factors for food purchases.

Moreover, research underscores consumer confidence in food authorities and labelling in Hungary, as a 2018 European survey revealed that the Hungarian National Food Chain Safety Office (Nébih) is the most trusted public food safety authority among all EU Member States (European Food Safety Authority, 2019). In addition, Nébih also administers the "High-Quality Food (HQF)" (Kiváló Minőségű Élelmiszer) system, which incorporates sustainability requirements: producers applying for this trademark must comply with specific commitments to ensure product quality and environmentally responsible practices (Bencsik, 2022). HQF offers consumers a credible, authenticated choice for premium, sustainably sourced goods, thereby enhancing confidence in the local food industry.

Furthermore, the Hungarian Competition Authority (HCA) highlights the value of authentic and verifiable sustainability claims. Following the market study, the HCA recommends allowing only validated claims and providing consumers with tools to verify them (Lakatos, 2024). In addition, the HCA advises the use of specific rather than generalized consumer claims, which are misleading to the consumers (Lakatos, 2024). It also emphasizes the importance of avoiding generic or vague statements, which can mislead consumers and contribute to greenwashing, diminishing overall trust in the food industry (Delmas & Burbano, 2011). Building on these ideas, the HCA has proposed the creation of a future sustainability and environmental impact label to increase transparency and consumer trust in sustainable products (Lakatos, 2024).



Regarding Hungary, research indicates that consumers do not always understand the meaning of food labels and sustainability labels objectively; hence, there is a lack of confidence and impact (Nagy-Pércsi & Fogarassy, 2019). The influence of sustainability label confidence on purchasing decisions among some Hungarian consumers doesn't matter, but the confidence in the indicator cannot be said to be the key driver (Nagy-Pércsi & Fogarassy, 2019; Yeh et al., 2020). Research on segments indicates that only some segments, like "Health-Conscious Buyers," showed a positive attitude towards paying a higher price for products with trusted sustainability and organic labels (Yeh et al., 2020). There are some segments, like Hungarian consumers, who lack confidence in organic and sustainability labels and are not clear on their meaning; hence, the impact on purchasing decisions cannot be significant. Consumers in Hungary do not have a high level of trust in sustainability labels, including those offered by the Hungarian food authority. This lack of confidence comes from confusion, a lack of understanding, and a lack of trust in the certification systems. A significant proportion of consumers in Hungary do not understand the meaning behind sustainability labels, including those offered by the national authorities. This lack of understanding arises from the provision of different labels and the lack of a clear and coherent system (Nagy-Pércsi et al., 2019). Research showed that consumers from Hungary do not have confidence in the certifications from the same countries but would rather believe certifications from international levels (Cook et al., 2023). The lack and absence of clear and credible information on sustainability labels make the problem worse. This reduces the confidence and impact brought by the sustainability label from the Hungarian food authority (Nagy-Pércsi & Fogarassy, 2019).

### 3.5. The role of sustainability labelling in consumer purchasing decisions

Sustainability labelling within the Hungarian food supply chain can positively influence consumer attitudes and their willingness to pay, especially among health-conscious and environmentally aware individuals. Nonetheless, the tangible influence on purchasing decisions is limited, as price, freshness, and taste frequently supersede sustainability factors for the majority of consumers (Cook et al., 2023; Yeh et al., 2020). Organic and sustainability labels are most effective among buyers who are health-conscious and who are willing to pay a premium, but a significant portion of Hungarian consumers remain skeptical or indifferent to such labels (Nagy-Pércsi & Fogarassy, 2019; Yeh et al., 2020). Low awareness and limited understanding of sustainability labels, such as the EU organic logo, can reduce their effectiveness. Less than a quarter of Hungarian consumers know the purpose of the EU organic label, and trust in certification systems is a key determinant of label influence (Maró et al., 2019; Nagy-Pércsi & Fogarassy, 2019; Yeh et al., 2020). The proliferation of diverse labels and the lack of standardized sustainability criteria engender confusion, hindering consumers' ability to use labels as reliable decision-making tools (Nagy-Pércsi & Fogarassy, 2019). Moreover, Table 2 illustrates these patterns by presenting an overview of primary consumer groupings and their characteristics regarding green consumption.

**Table 2.** Overview of the main consumer segments and their green consumption habit traits.

| Segment/Cluster              | Key Characteristics                               | References                                                      |
|------------------------------|---------------------------------------------------|-----------------------------------------------------------------|
| Health-conscious/Young/Urban | High green intent, willing to pay more, eco-aware | (Fogarassy et al., 2020; Naz et al., 2020; Pércsi et al., 2024) |
| Price-sensitive              | Positive attitude, but low actual green           | (Fodor et al., 2024; Nagy-Pércsi & Fogarassy, 2019;             |

|                                  |                                                               |                                                                          |
|----------------------------------|---------------------------------------------------------------|--------------------------------------------------------------------------|
| Traditional/Convenience-oriented | purchases<br>Value taste,<br>convenience, and<br>local origin | Wu & Takács-György, 2022)<br>(Fodor et al., 2024; Mazhar & Zilahy, 2025) |
| Indifferent/No preference        | Low awareness, need<br>education and targeted<br>marketing    | (Fodor et al., 2024; Pércsi et al., 2023)                                |

Consumers' behavior in Hungary's food industry is gradually shifting towards green and sustainable consumption, but this transition is shaped by diverse motivations, knowledge levels, and socio-economic factors. The primary motivation for Hungarian consumers to choose organic or environmentally sustainable food is health, followed by food safety and environmental friendliness. This is consistent across age groups, with organic fruits and vegetables being the most popular (Nagy-Pércsi & Fogarassy, 2019; Pércsi et al., 2024; Wu & Takács-György, 2022). Segments of consumers, especially young, highly educated, and urban individuals, have demonstrated a strong environmental attitude, are most likely to recycle, and show higher willingness to pay for sustainable or circular food products (Boros & Fogarassy, 2019; Naz et al., 2020; Ornelas Herrera et al., 2025; Pércsi et al., 2023). Hungarians' preference for local and domestic food is common, driven by perceived quality and support for local economies and a lower ecological footprint (Fodor et al., 2024; Mazhar et al., 2025; Taralik et al., 2025; Oravecz et al., 2020; Fricz et al., 2020; László et al., 2024; Šedík et al., 2025). High prices remain a significant barrier for green consumption in Hungary, especially for younger and price-sensitive segments, limiting the actual purchase of products despite positive attitudes (Fodor et al., 2024; Nagy-Pércsi & Fogarassy, 2019; Wu & Takács-György, 2022). Mistrust in certification and the proliferation of different labels reduce the effectiveness of sustainability claims. Many consumers lack a clear understanding of what labels mean (Nagy-Pércsi & Fogarassy, 2019; Pércsi et al., 2024). Lack of education and awareness about the benefits of green consumption and sustainable food options hinders broader adoption, particularly among Generation Z and less-engaged segments (Fodor et al., 2024; Naz et al., 2020).

A survey conducted in Budapest utilizing structural equation modeling revealed that attitudes towards green food significantly enhance the intention to purchase green food, serving as the "only necessary condition" for such intentions, though with a low to moderate effect size (Mazharet al., 2025). A six-country experiment (including Hungary) on circular farming showed that eco-centric environmental attitudes and recycling behavior raise preference and willingness to pay (WTP) for circular/sustainable foods, while anthropocentric attitudes push choices toward less sustainable options (Ornelas Herrera et al., 2025). In Hungary, higher environmental awareness, and also knowledge about the environmental impact of food choices, is also important among organic consumers, but health is the strongest motivator (Pércsi et al., 2024). Hungarian university students show that environmental knowledge and willingness to pay strongly and positively influence green purchase behavior, indicating that pro-environmental concern can translate into action when supported by knowledge and WTP (Naz et al., 2020). Another student study found only one segment ("Conscious food consumers") with clearly health- and environment-oriented food choices, while most students showed low practical environmental consciousness in food consumption (Bauerné Gáthy et al., 2022).

Sustainability labels are expanding and are seen as one tool (not a standalone solution) to steer food systems toward healthier, more sustainable patterns, and Table 3 shows an overview of sustainability label types. Across 19 European countries, the share of new food products with sustainability claims/labels (SCLs) grew 2.8% per year from 2005 to 2021. With especially strong growth in environmental labels (68% of all SCLs) (Nes et al., 2024). Nearly half of new product launches globally now carry some sustainability claim, about 20% via logos (Cook et al., 2023). The global sustainable label market was valued at \$1.5B USD (United States Dollar) in 2023, projected to grow at 4.3% CAGR (compound annual growth rate) to 2034, with food and beverage packaging at the largest segment (Che Musa & Kadir, 2025).

**Table 3.** Overview of sustainability label types and effects.

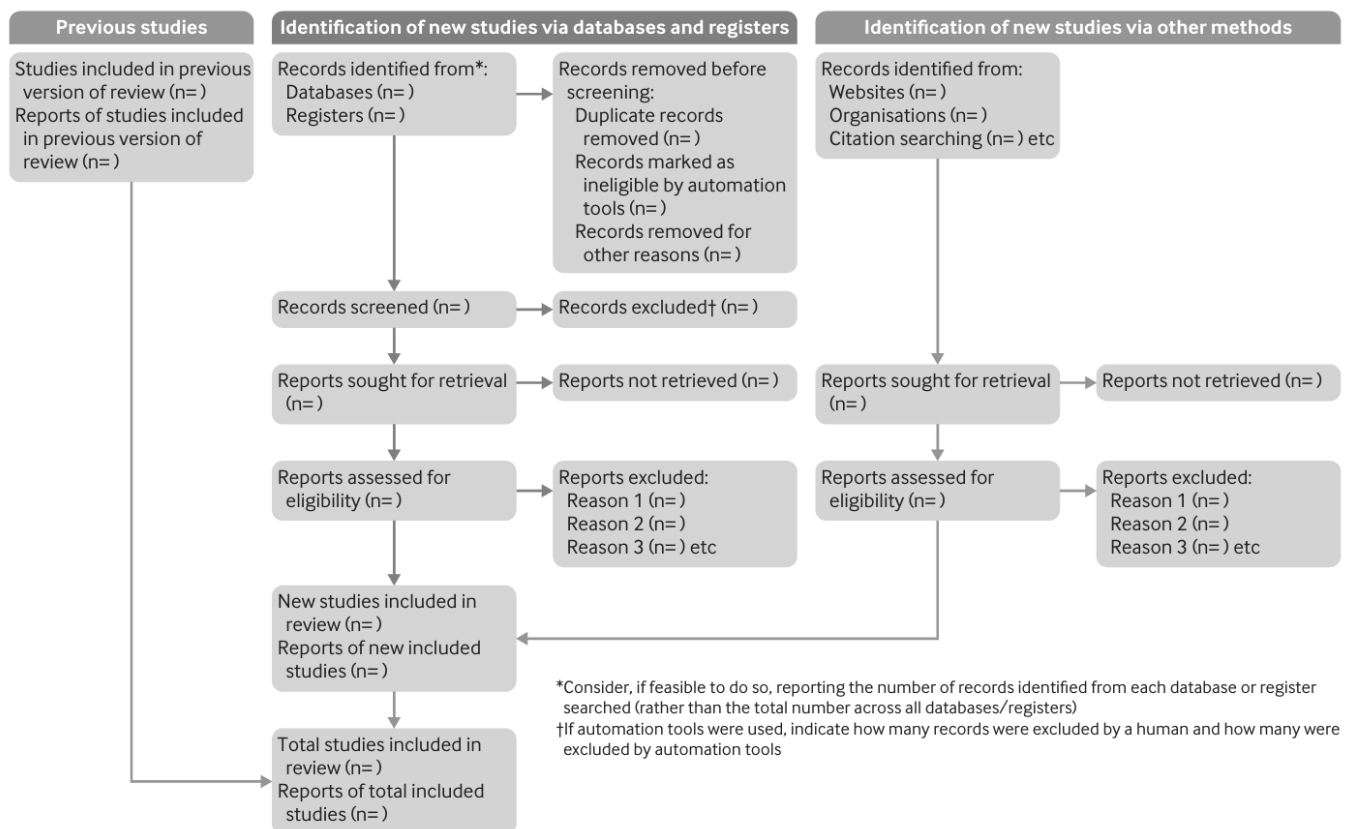
| Label/claim type                       | Typical impact/pattern                                                  | Citations                                                                                                   |
|----------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Environmental/eco/carbon labels        | Small-to-moderate boosts in selection and purchase; modest WTP premiums | (Brown et al., 2020; Cook et al., 2023; Duckworth et al., 2022; Piracci et al., 2024; Potter, et al., 2021) |
| Organic and “holistic” sustainability  | Often the highest willingness to pay; strong “health halo”.             | (Aprile & Punzo, 2022; Grunert et al., 2014; Tobi et al., 2019)                                             |
| Social-only labels (e.g., Fairtrade)   | Generally, less influential than environmental or mixed SCLs            | (Nes et al., 2024; Piracci et al., 2024; Tobi et al., 2019)                                                 |
| Simple, traffic-light, or logo formats | Better understood, faster decisions, strong effects                     | (Cook et al., 2023; Duckworth et al., 2022; Gârdan et al., 2025; Jürkenbeck, 2023)                          |

Systematic reviews show ecolabels reliably tilt choices towards more sustainable options, but effect sizes are typically small in real-world settings (Brown et al., 2020; Cook et al., 2023). Consumer understanding of “sustainability” is limited, and many labels are confusing; use depends strongly on motivation, understanding, and trust (Aprile & Punzo, 2022; Cook et al., 2023; Grunert et al., 2014; Kaczorowska et al., 2019). WTP meta-analyses find positive but highly variable price premiums, with social aspects valued less than environmental ones (Piracci et al., 2024). The EU Farm-to-Fork strategy plans a harmonized sustainability-related labelling framework and stricter rules on green claims, like replacing many private schemes (Gokani, 2023; Nes et al., 2024; Stein & de Lima, 2022). Experts and policymakers increasingly advocate for one mandatory, holistic, front-of-pack label, using clear scoring and applied to all products, embedded in a wider policy mix (education, taxes, reformulation incentives) (Brown et al., 2020; Futtrup et al., 2021; Kaczorowska et al., 2019; Beatrix et al., 2022; Stein & de Lima, 2022).

## 4. MATERIALS AND METHODS

### 4.1. Systematic literature review

In order to determine the prevalence and consequences of greenwashing in the food industry, this study began with a review of the literature. Researchers followed PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) principles to guarantee this study's transparency and rigor (Page et al., 2021), a well-established framework to meet both reporting and publication standards (Nugraha et al., 2024). According to the PRISMA guidelines, the review was conducted in a structured and reproducible manner, increasing the reliability and transparency of the results (Figure 1).



**Fig. 1.** Prisma 2020 flow diagrams (Page et al., 2021)

The purpose of the review was to package the state-of-the-art knowledge on greenwashing (from academia, industry, and regulatory bodies) by analyzing various studies. It flagged recurring trends in greenwashing, such as marketing ploys and false claims of sustainability (most prevalent in the food industry). The review also included real-world case studies that exemplify how greenwashing plays out and demonstrate its effects on consumers and brands.

The Systematic Literature Review (SLR) method is used in this study because it provides a more systematic approach to gathering, analyzing, and synthesizing information on a particular topic (Snyder, 2019). In addition, SLR follows a transparent, evidence-based, and replicable workflow, which improves accuracy and reduces the risk of bias (Vaio et al., 2023). This study employs a methodology that integrates the characteristics of two distinct approaches: PRISMA for

conducting a systematic review and a systematic mapping study (SMS) to identify research trends, visualize outcomes, and delineate themes within the examined subject area (Kalibatiene & Miliauskaitė, 2021; Page et al., 2021; Kalibatiene & Miliauskaitė, 2021; Page et al., 2021). Bibliometric analysis is also employed in this study to assess scientific production on greenwashing in the food industry, as it is the most accurate method for literature assessment (Kabil et al., 2021; Osareh, 1996). Bibliometric analysis provides a basis for improving academics' ability to observe, measure, and trace the growth of scientific publications and certain events around the world (Zakhiyahet al., 2021; Priatmoko et al., 2023).

#### 4.1.1. Data Extraction, retrieval, and management

The first phase of this research involved locating and extracting greenwashing-related publications from databases. This paper used Scopus as a database source because numerous reliable studies indicate that it is used by researchers for bibliometric research (Hallinger, 2020; Morandi et al., 2015; Netto & Tello-gamarra, 2020). Scopus is widely recognized as the world's largest and most reliable scientific database (Kabil et al., 2021; Salisbury, 2009). Scopus was the primary database used for this literature search since it offers a greater selection of pertinent journals than other databases (Mongeon & Paul-hus, 2015). According to Singh et al. (2021), for example, only 34% of Scopus-indexed journals are listed in Web of Science, whereas 99.11% of Web of Science-indexed journals are included in Scopus.

The Boolean operator chosen in the data collection of this study is quite general, which is "greenwashing" (Kabil et al., 2021; Scopus, 2020). The rationale for employing the Boolean "greenwashing" is that researchers utilizing excessively specific Boolean queries and restrictive keywords (e.g., incorporating terms such as label, food, or food industry) overlook numerous articles pertaining to greenwashing within the food sector. Hence, a more stringent Boolean construction that uses only a specific domain-specific term (e.g., food, food industry, or food labelling) was intentionally avoided. Although this adjustment makes methodological sense at the outset, the authors quickly acknowledged that it significantly reduced the number of available publications. Imposing this restriction would compromise the integrity and representativeness of the review results. Thus, the method highlighted in this study is sensitive and not over-specialized, which allows for the incorporation and fuller representation of contemporary discourse in academia by renaming the Boolean term at the forefront as "greenwashing."

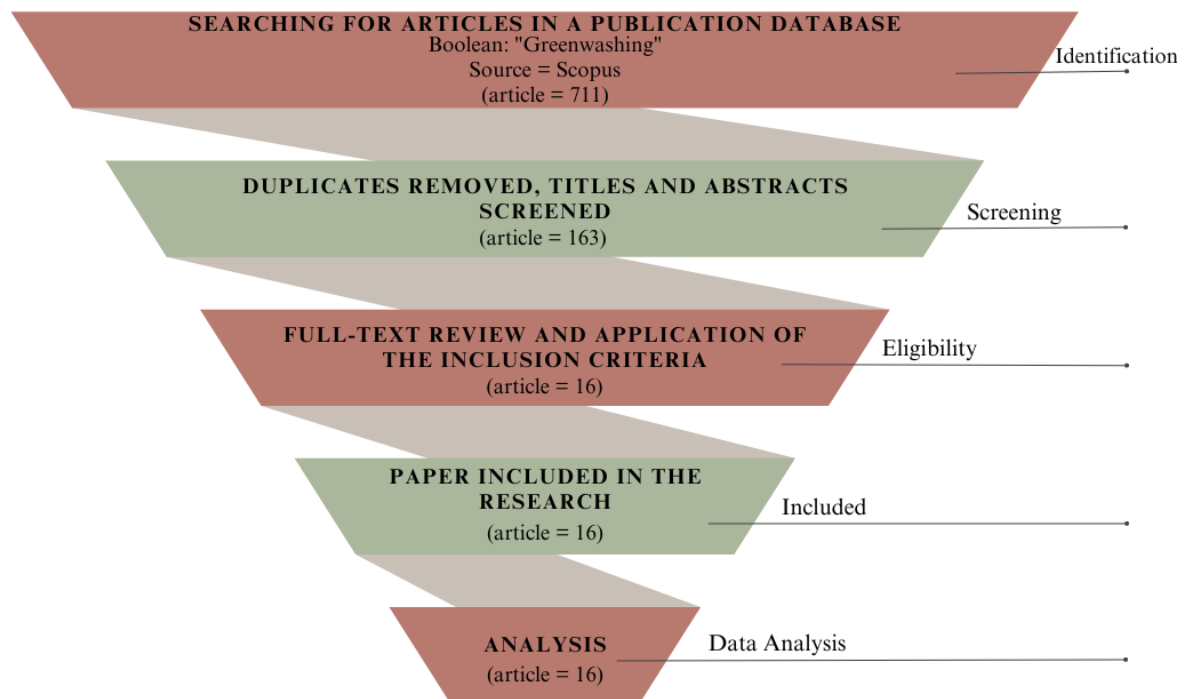
The objective was to present current examples of greenwashing to the public; hence, the search criteria were more rigorous and restricted, encompassing only publications from the last decade (2012 to 14 February 2023). The chosen manuscripts were composed in English. Once the search is done, the results can be exported as a CSV file. The data contains a multitude of variables, e.g., author bibliographies, keywords, and affiliations.

#### 4.1.2. Screening, inclusion criteria, and data analysis

A total of 711 articles were found through the search. In Colandr, a PRISMA flowchart was made to assess the reviews' accuracy and possible bias (Adli & Sjöfjan, 2022; Siddiqui et al., 2022). The process of evidence synthesis, which involves systematic reviews, may be facilitated by a free open-access platform such as Colandr (Cheng et al., 2018). In accordance with PRISMA guidelines, all recovered records were exported to the platform for additional processing.

In the initial screening phase of this study, duplicate publications were removed, followed by title and abstract screening. Four categories of literature were excluded from the analysis: literature

whose core topic was not greenwashing; abstracts or titles that did not fall within the three specified scope categories: (1) outside the scope of sustainability disclosure, environmental communication, or consumer perception studies; (2) non-peer-reviewed literature; (3) and articles not in English. This screening process reduced the initial set of 711 publications to the final 163 articles. The second screening phase encompassed full-text publications. At this point, stricter inclusion and exclusion criteria were implemented. Only articles that (1) investigated greenwashing at a theoretical or empirical level, (2) were situated in the food industry context or focused specifically on sustainability claims pertaining to food systems and/or (3) presented empirical results/conceptual frameworks/analyses aligned with our research goals were included. Studies were excluded if they: (1) mentioned greenwashing only in passing without analytical depth; (2) lacked full-text availability despite being indexed; (3) focused on unrelated industrial sectors (e.g., manufacturing, energy, finance) that do not transfer easily to food-related sustainability communication. This strict filtering led to the selection of 16 articles, which comprised the systematic review and then the analysis. In addition, Figure 2 depicts the PRISMA flowchart for this study.



**Fig. 2.** Flowchart of the PRISMA process frame (Nugraha et al., 2024)

RStudio and VOSviewer were used in this study to produce results that could be reasonably illustrated. RStudio and VOSviewer were chosen because they could display a thorough overview of the systematic review (Kabil et al., 2021; Plasek et al., 2021; Priatmoko et al., 2023). During the analysis, the density was also examined, and the visualization was rendered in an overlay network style. Based on terms commonly found in articles about greenwashing, the study's findings will identify the main cluster (driving force) for each research topic. In systematic review research, keywords are regarded as one of the most crucial components of a collection of papers undergoing scientific review (Gao et al., 2021; Kabil et al., 2021). Furthermore, the bibliometrics analysis method in RStudio is highly intriguing. After the data from the CSV file was loaded into the bibliometrics package in RStudio, a "cleaning" procedure based on string representations of record completeness (i.e., author and journal details) was applied, processing 698 out of 711 articles.

The main purpose of this systematic literature review is to identify emerging research trends, clarify conceptual underpinnings, and identify major research gaps in the field of greenwashing. This study aims to systematically identify undeveloped fields and discrepancies in prior results, leading to recommendations for future research directions based on the mapped intellectual structure of the literature. Accordingly, the bibliometric and visualization outputs are not only descriptive in their static nature but also analytical, as they underline the development of the conceptual framework/agenda of this work. As a result, the outcomes of this systematic literature analysis will guide the subsequent empirical inquiry in this study and inform the design of research opportunities.

4.2. Investigation of the distribution of sustainability labels and domestic food products between local and international retailers in Hungary

The research was conducted in two distinct phases to capture both domestic product distribution and sustainability-related labelling: the first phase, from August to October 2020, focused on the availability and proportion of domestic food products, while the second phase, from August to October 2023, examined the prevalence and distribution of sustainability labels across the same retail units. Both phases applied an identical methodological framework, including the selection of retail chains, store locations, product categories, and on-site data collection procedures, ensuring consistency and comparability of the findings across the two periods.

4.2.1. List of trademarks and labels used in this study

This section discusses the particulars of the trademarks and labels used in this study. Drawn from a comprehensive study of both online and offline market research, the authors identified several sustainability labels that were readily and commonly available in the market. In addition, each logo’s origin is explained in Table 4 as being directly or indirectly linked to sustainability-related labelling. It also explains why each logo is in this category.

**Table 4.** Hungarian consumers’ experiences with trademarks and sustainability labels on food products

| Logo                                                                                                                         | Origin | Certification /validation | Direct/indirect to sustainability labelling | Reason                                                                                                                                                                                                                                                                                                             | Reference                            |
|------------------------------------------------------------------------------------------------------------------------------|--------|---------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| <div> <div>The Magyar Termék</div>  </div> | Local  | Government -endorsed      | Indirect                                    | The Magyar Termék logo, which identifies products primarily composed of domestic raw materials processed and manufactured in Hungary, promotes sustainability by supporting local agriculture and reducing the carbon footprint associated with international transportation. Although not specifically focused on | (Horváth, 2024; Magyar Termék, 2025) |

|                                                                                                                                                                                                           |               |                                                 |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------------------------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
|                                                                                                                                                                                                           |               |                                                 |          | measuring environmental impact, its prioritization of domestically sourced and minimally foreign-sourced ingredients indirectly supports sustainability goals, including lower transportation emissions and support for local economies.                                                                                                                                                                                                                                                     |                                                      |
| <p>Kiváló Minőségű Élelmiszer (KMÉ)</p>   | Local         | Government-authorized                           | Indirect | <p>As the only authorized national quality system for food in Hungary, the Kiváló Minőségű Élelmiszer (KMÉ) indirectly contributes to sustainability labelling by stipulating that applicants must meet at least one of the sustainability criteria defined by the KMÉ. One of the criteria is to ensure the adoption of sustainable production technologies. The certification fosters more environmentally sound, sustainable production practices by enforcing stricter requirements.</p> | (Food Chain Safety Nonprofit Ltd. (ÉLBC Ltd.), 2025) |
| <p>EU Organic logo</p>                                                                                                  | International | EU-regulated certification                      | Direct   | <p>The logo promotes transparency, harmonization, and consumer trust in the EU single market. Following Council Regulation (EC) No 834/2007 and its accompanying guidelines, the EU organic label was adopted in 2010 and became mandatory in 2012. It promotes ecological farming to protect biodiversity, soil fertility, water resources, and pollution</p>                                                                                                                               | (Janssen & Hamm, 2012)                               |
| <p>EU Ecolabel</p>                                                                                                      | International | EU-regulated certification                      | Direct   | <p>EU Ecolabel is one of the schemes the EU developed to create a voluntary certification system for labelling environmentally friendly products. It creates labels for products that exceed the EU's environmental performance threshold by providing a rating based on years of empirical and lifecycle research.</p>                                                                                                                                                                      | (European Commission, 2025a)                         |
| <p>The Környezetbarát Termék</p>                                                                                                                                                                          | Local         | Independent certification (Herman Ottó Intézet) | Direct   | <p>The Környezetbarát Termék ecolabel directly aligns with sustainability labelling by promoting products designed with a reduced environmental footprint. The Környezetbarát</p>                                                                                                                                                                                                                                                                                                            | (Herman Ottó Intézet Nonprofit Kft., 2024)           |





Termék ecolabel, as a certification program, encourages products that have less of an impact on the environment; by using strict, science-based life-cycle criteria to look at how raw materials are used the main goal of the label is to protect the environment by promoting less pollution, less use of dangerous chemicals, better recycling, and more efficient use of energy and natural resources.

Bio  
Garancia



Local

Independent  
certification

Direct

Bio Garancia, an authority on the organic market in Hungary that is also one of the oldest and most prominent organic certifying bodies, directly serves sustainability labelling by guaranteeing compliance with exacting EU organic standards.

(Bio  
Garancia  
Ltd., 2024)

Biokultúra



Local

Independent  
certification

Direct

As the primary certification body for organic farming in Hungary, Biokontroll Hungária Nonprofit Kft. provides underpinning support for sustainability labelling by conducting audits to ensure that products labelled as organic, ecological, or bio comply with European and national legislation (i.e., compliance testing).

(Biokultúra,  
2025)

Biokontroll  
Hungária



Local

Independent  
certification

Direct

Founded in 1983 by the Biokultúra Egyesű (now Hungarian Biokultúra Szövetség), Biokontroll Hungária Nonprofit Kft. is a locally owned, nonprofit certifying organization that supports Hungarian farmers. Since its establishment, both the organization and domestic organic farming have grown in size and quality while upholding the same goals: to make it possible for as many domestic producers and processors to receive organic certification, encourage organic farming methods among market

(Biokontroll  
Hungária,  
2025)

participants, and guarantee that consumers both domestically and abroad can rely on the verified quality of Hungarian organic products. The group advocates farming practices that conserve biodiversity and the environment.

|                                                                                                                                   |               |                           |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------|---------------|---------------------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| <p>The Rainforest Alliance Certified</p>          | International | Independent certification | Direct | <p>The Rainforest Alliance is a voluntary certification program that recognizes sustainability in environmental protection, social equity, and economic resilience in agriculture.</p>                                                                                                                                                                                                                                                                                                                                                                            | (The Rainforest Alliance Certified, 2023)        |
| <p>Forest Stewardship Council (FSC)</p>         | International | Independent certification | Direct | <p>Forest Stewardship Council (FSC) labelled items have been audited for forest management and supply chain compliance. Forest Stewardship Council (FSC) is a complex environmental governance structure that certifies sustainably managed forests and forest products with a ‘tick-tree’ mark. This indication includes complex verification methods that integrate research and policy to improve forestry, which I assess through the lens of science and technology studies. Environmental sustainability and conservation are key to FSC accreditation.</p> | (Forest Stewardship Council International, 2024) |
| <p>Fairtrade</p>                                | International | Independent certification | Direct | <p>Fairtrade is an international sustainability and ethical trade certification that aims to improve the livelihoods of small-scale farmers, not specifically.</p>                                                                                                                                                                                                                                                                                                                                                                                                | (Fairtrade, 2025)                                |
| <p>Carbon Footprint Product Labels (CFPLs)</p>  | International | Independent certification | Direct | <p>Carbon Footprint Product Labels (CFPLs) educate consumers about the environmental impacts of product manufacture and delivery, encouraging more conscientious purchases.</p>                                                                                                                                                                                                                                                                                                                                                                                   | (Soe & Ketkaew, 2025).                           |

|                                                                                   |               |                           |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |
|-----------------------------------------------------------------------------------|---------------|---------------------------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| Dolphin Safe label                                                                |               |                           |        | The Dolphin Safe label received its first eco-label in 1990 and began protecting dolphins through consumer market influence as a result of the International Marine Mammal Project (IMMP) of the Earth Island Institute.                                                                                                                                                                                                                               | (Dolphin Safe Fishing, 2024)       |
|   | International | Independent certification | Direct |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |
| Marine Stewardship Council (MSC)                                                  |               |                           |        | The Marine Stewardship Council (MSC) is a global non-profit organization that establishes a Fisheries Standard for ecologically sustainable fishing, grounded in the Food and Agriculture Organization (FAO) of the United Nations' Code of Conduct for Responsible Fishing. Fisheries may conduct a pre-assessment, a more expedited and less comprehensive study than full certification, to identify deficiencies before seeking MSC certification. | (Marine Stewardship Council, 2023) |
|  | International | Independent certification | Direct |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |

#### 4.2.2. Selection of the retail units and the data collection

In 2020, Hungary had 157,267 various business units, including food and beverage establishments, furnishing stores, and others, with approximately 37,392 of these being food-related enterprises such as supermarkets and hypermarkets (Hungarian Central Statistical Office, 2023). The Hungarian food retail business is fragmented and dominated by ten major retailers, comprising seven foreign and three national chains (European Supermarket Magazine, 2023a; Statista, 2020). In addition, research on domestic food products and sustainability labels among local and international retailers in Hungary was conducted twice. The distribution of domestic food products was assessed in the first study, conducted in August 2020 and October 2020, whilst the second one analysed the distribution of sustainability labels during August 2023 and October 2023. Both investigations followed the same methodology, including food retailer selection, retail unit selection, product category selection, and on-site investigation methods.

**Table 5.** List of food retailers selected for the investigation

| Retail chain's name | Retail classification | Retail format              | Total annual revenue in millions € (2020) | Store number (2020) | Market share in Hungary (2020) |
|---------------------|-----------------------|----------------------------|-------------------------------------------|---------------------|--------------------------------|
| Aldi                | International         | Discounts                  | 977.7                                     | 226                 | 5.85%                          |
| Auchan              | International         | Hypermarkets               | 1,157.1                                   | 24                  | 6.93%                          |
| CBA                 | National              | Supermarkets, Hypermarkets | 1,484.4                                   | 1,987               | 8.88%                          |
| Coop                | National              | Supermarkets               | 1,791.1                                   | 4,063               | 10.72%                         |
| Lidl                | International         | Discounts                  | 2,281.7                                   | 186                 | 13.51%                         |
| Metro               | International         | Cash and Carry stores      | -                                         | 13                  | -                              |
| Penny Market        | International         | Discounts                  | 1,021.4                                   | 226                 | 6.11%                          |
| Reál                | National              | Supermarkets               | 1,172.2                                   | 1,189               | 7.01%                          |
| Spar                | International         | Supermarkets, Hypermarkets | 2,023.6                                   | 588                 | 12.11%                         |
| Tesco               | International         | Supermarkets, Hypermarkets | 2,042.9                                   | 201                 | 12.09%                         |
| Total               |                       |                            | 13,952.1                                  | 8,703               | 83.21%                         |

Source: Researchers' calculation (Hungarian Central Statistical Office (HCSO), 2020; Kasza et al., 2024; Metro, 2023; Sonja Leković, 2016; Trade Magazin, 2021)

Table 5 highlights the leading 10 retailers in Hungary, categorized by kind, format, classification, total revenue, and market share (expressed as a percentage). The selected retail chains collectively manage 8,703 stores across 348 settlements in Hungary. Food assortments vary throughout retail chains; nonetheless, selections are consistent within a specific chain. This is especially important for well-known discount stores like Aldi and Lidl, but central provisions are also important for other stores, including domestic ones like CBA, Coop, and Reál. It is often hard to figure out what a supermarket or hypermarket's market share is because that information is usually private and not available to the public (Anant et al., 2020; Ben, 2020). However, based on total revenue, the study effectively included Hungary's biggest domestic and foreign retail

companies (European Supermarket Magazine, 2023b; Trade Magazin, 2021) based on total revenue (Blake et al., 2010) to cover the entirety of the food retail sector in Hungary. The ten retailers have approximately 13,952.1 million EUR (EURO) in retail sales, which represents 83.21% of Hungary's retail sales. For Metro, there is no market share data available; as such, the authors estimate its contribution to retail sales at around 2-3%. Taking everything into account, the 10 biggest retail chains in the study make up about 85% of Hungary's retail market. This means that our main findings can be extrapolated to the whole country.

#### 4.2.3. Selection of retail units

A total of 60 stores were sampled from six units of each chain to ensure an equitable distribution across Hungary's three major statistical regions: Central Hungary, the Great Plain, and Northern and Transdanubia. Each chain was allocated the supply format that was most substantial. For example, the researchers chose to investigate the function of hypermarket-sized establishments in Hungary, as both Tesco and Spar operate supermarkets and hypermarkets.

No advance notice was given of the times when on-site inspections took place, and the specific retail units visited were not selected in advance. However, transparency and accountability were already contentious issues at the time of data collection. Upon their arrival at the retail store, the owner or the manager was informed that they had come to pay a visit. The researchers introduced themselves, displayed their letter of permission, and provided an explanation of the study. As a result, the data collection was not concealed and could be verified by on-site personnel employed by the retail chains and by photographs taken during the efforts (as will be further elaborated upon in the subsequent sections).

#### 4.2.4. Selected product categories

To determine the food categories, a roundtable discussion was held on July 27, 2020, by the Hungarian Chamber of Agriculture, the Institute of Agricultural Economics, the Hungarian University of Agriculture and Life Sciences (with working group expertise at Codex Alimentarius Hungaricus), and representative organizations of the Hungarian food retailing and processing sectors. This expert consultation served as the study's key phase to guarantee that the classification reflected both industrial importance and national food system characteristics. 16 categories were selected for which Hungary has a reasonable level of self-sufficiency based on local resources, manufacturing capabilities, and customs. At this point, the discussion yielded a unique, shared categorization scheme comprising 16 baseline product categories, which became the reference scheme for the first dataset (2020 data collection).

Product categories covered by the 2020 dataset:

1. Packaged fresh pork
2. Packaged fresh chicken meat
3. Meat products 1: hams
4. Meat products 2: salamis, dry sausages
5. Meat products 3: Parizer (Bologna sausage), wiener, and frankfurter sausages
6. Milk: fresh milk, ESL milk, UHT milk

7. Dairy products 1: yoghurts (including fruit-flavoured types)
8. Dairy products 2: cottage cheese, kefir, sour cream
9. Dairy products 3: cheeses (extra hard, hard, semi-hard, and soft cheeses)
10. Dairy products 4: butter
11. Eggs (chicken eggs)
12. Honey
- Seasonal fruits, vegetables (apples, grapes, peaches, apricots, nectarines, tomatoes,
13. green peppers, carrots, cucumbers, onions, potatoes, garlic)
14. Fruit jams (apricots, plums, strawberries, cherries, raspberries)
15. Dry pasta
16. Canned food: cherry compote, sweet corn

According to the Hungarian Central Statistical Office (HCSO), (2020) the chosen product categories accounted for 67% of the total sales value in the Hungarian food retail market in 2019. Product categories (such as fish and exotic fruits) that Hungarian farmers are unable to produce were not recorded. Many relevant categories (such as beverages, fish, cattle, and confectionery) were left out due to financial constraints, but they will be included in further research.

It is important to note that this study is based on two methodologically comparable datasets, the 2020 and 2023 datasets, collected at different points in time. The data set for 2023 was compiled as an extension and upgrade of the initial categorization system from 2020, making it possible to compare the sustainability labelling methods used in Hungarian retail trade over time.

Moreover, in order to explore the distribution of sustainability labelling in Hungary's retail sector, this study extended slightly on the original data set of 16 products selected in 2020 (Kasza et al., 2024). To improve measurement accuracy and capture sustainability-related labelling in the Hungarian market, this second dataset contained a greater level of granularity, while preserving the conceptual foundations of the 2020 categorization.

In particular, whereas the 2020 dataset consisted of 16 aggregate product categories, the 2023 dataset used these specific types to disaggregate several categories into more detailed product subtypes. This was due in part to market changes and improved data availability, but also to our desire to enable more granular comparative analysis across time periods. For example, in calculating the 2020 fruit and vegetable category, it was a single calculation, whereas for the 2023 data collection, it became 2 categories, and this expanded the total number of food categories to 21 products as follows:

1. Fresh chicken breast, chicken thigh
2. Fresh pork shoulder
3. Fresh whole boneless chicken, chicken breast, chicken meat
4. Fresh pork
5. Fresh minced pork
6. Fresh fruits (Apple)
7. Fresh vegetables
8. Fruit jams and preserves
9. Processed meats 1: ham (from pork)
10. Processed meats 2: salami, dry sausages

11. Processed meats 3: Parisian, sausage
12. Canned goods (corn)
13. Canned goods (cherry preserves)
14. Honey
15. Dry pasta
16. Dairy products: fresh milk, ESL milk, UHT milk
17. Dairy products 1: yogurt
18. Dairy products 2: cottage cheese, kefir, sour cream
19. Dairy products 3: cheeses
20. Dairy products 4: butter
21. Eggs

The study's investigation of the distribution of sustainability labels and domestic food products between local and international retailers in Hungary comprises a two-wave dataset (2020 and 2023), with the latter being an improved version of the former in terms of variables. The increment from 16 to 21 categories does not reveal the change in the research design, but it carries an extra intervention and analytical resolution towards sustainability-related labelling assessment instead.

#### 4.2.5. Method of the on-site investigation

The research procedure for this study had to be created since the authors could not locate descriptions of these techniques in international academic literature. Experience from earlier Hungarian studies (Kasza et al. 2011) and (Kasza et al. 2015) was used, and stakeholders were consulted before our method's ultimate approach was adopted. The clear objective of coming to a solid consensus on the methodology was a widely accepted strategy that was necessary for the research findings to be generally accepted.

Pre-packaged goods that are easily accessible to consumers were included in the field study (bulk products like fruit and vegetables were excluded). Inspections were carried out by professionals with field experience and relevant qualifications (BSc or higher). Each of the 16 product categories structured in the shelving units was represented, and experts documented the units with high-resolution photographs. In each retail outlet, products in the 16 selected categories were examined and documented with close-up photographs. Once the outbreak survey was conducted, products were documented based on the photographs. The product's name and brand, complete manufacturer and/or trader information, country of origin, package type, unit size (e.g., kg), and, in the case of meat products, the processing plant's EU registration number (oval stamp) were all included in the documented data.

During data entry, every food item was categorized as either domestic or imported. For determining Hungarian origins, the data source was the product packaging, which indicated the origin or place of production. For cases of animal-derived products, when the aforementioned information was not indicated, the origin was determined by the details of the oval stamp. For non-prepacked fruits and vegetables, the origin was determined based on the price tag or the information on the box.

The data collection for this research study was conducted between August 11, 2020, and October 28, 2020. A total of 39,964 different items were collected. The photo documentation and

field notes have a retention period of 5 years.

### 4.3. Quantitative consumer study

#### 4.3.1. Survey method and questionnaire design

The self-administered questionnaire was administered offline from November 2, 2023, to January 26, 2024, in ten towns in Hungary: Budapest, Mezőkövesd, Szolnok, Sárbogárd, Várpalota, Kecskemét, Veszprém, Füzesabony, Győr, and Székesfehérvár. The cities had been chosen to represent distinct social categories and regions of Hungary. The questionnaire design and data collection were conducted in Hungarian.

The questionnaire utilized in this study was created by a mixed-methods approach, including modified items from pertinent prior studies (Ricci et al., 2018; Zhang et al., 2018; Hartmann et al., 2021; Aasmäe, 2021; Pickering et al., 2022; Sharma & Mehta, 2023; Ackermann, 2023; Cook et al., 2023; B Lab Europe, 2023) grounded in common theoretical frameworks and original items formulated by the authors to align with the specific setting of this research. The reference studies, despite covering diverse themes, methodically altered their measurement concepts to maintain relevance and alignment with the objectives of this study. The full set of the translated questionnaire (in English) used in this study is available in the Appendix.

The majority of the data was collected through in-person interviews. The researchers visited high-traffic locations, such as parks and train stations, to conduct interviews and obtain more respondents and a more representative sample of the population. In accordance with the EU's General Data Protection Regulation, each participant was given detailed information about the study's aims, the sorts of data collected through survey forms, and the processes for handling and processing their personal information. After all relevant information had been provided, each participant decided whether to participate in this survey. The study would safeguard respondents' identities; their participation would be entirely voluntary, and no identifying information would be collected.

The survey included three parts: (1) introduction to sustainable labelling; (2) responses to various items related to perception and preference for sustainable labelling in different products; and (3) demographic factors, including age, sex, income, etc. There were a few questions on the survey that used a multiple-choice format, and the remaining were rated on a 5-point Likert scale to ensure that all respondents' opinions were fairly addressed.

#### 4.3.2. Socio-demographic characteristics of the sample

The study collected 1,013 respondents and reflects the Hungarian population by gender, age, and geographical location. Table 6 compares the sample's socio-demographic characteristics to those of the Hungarian population, using data from the 2022 Census provided by the Hungarian Central Statistical Office (KSH). This comparison demonstrates the sample's representativeness relative to the reference population. In terms of gender composition, our sample is fairly typical of the country's population. 51.70% are women and 48.30% are men, compared to 51.97% and 48.03%, respectively, at the national level. These numbers show that the sample is very close to a



balanced sex ratio, but also fluctuates slightly.

With respect to age, the sample follows a distribution similar to that of information available from national sources. The 18-29-year-olds make up 17.40% of the sample, slightly overrepresented relative to the 16.22% national average. The age group 30- to 39-year-olds accounts for 14.50% of the sample, slightly less than the national population percentage (15.51%). A good match is found for middle-aged users: 40-59-year-olds are observed in both the sample (36.50%) and the population (35.86%). The elderly aged 60 and above account for 31.60% of the sample, which is like the national distribution of 32.40%, suggesting the sample's age distribution is representative of the population at large.

At the regional level, the sample also closely mirrors the national distribution. Central Hungary accounts for 32.80% of the sample (slightly higher than the national average of 31.42%). Data in the other regions (Central Transdanubia: 10.70%; Western Transdanubia: 11.60%; Northern Hungary: 11.40%; Northern Great Plain: 14.00% and Southern Great Plain: 12.60%) are very close to Hungarian figures, there is only small variation in some areas like Southern Transdanubia (6.90% in the sample, versus 8.89% in population) or Southern Great Plain (12.60%, versus 12.50%).

**Table 6.** Socio-demographic of the sample in comparison to the Hungarian Central Statistical Office (KSH) population for representativeness (n=1,013)

| Variable | Description           | Sample (%) | Population based on the Census of 2022 (%)<br>(Hungarian Central Statistical Office (HCSO), 2022) |
|----------|-----------------------|------------|---------------------------------------------------------------------------------------------------|
| Gender   | Women                 | 51.70      | 51.97                                                                                             |
|          | Men                   | 48.30      | 48.03                                                                                             |
| Age      | 18-29                 | 17.40      | 16.22                                                                                             |
|          | 30-39                 | 14.50      | 15.51                                                                                             |
|          | 40-59                 | 36.50      | 35.86                                                                                             |
|          | 60 and above          | 31.60      | 32.40                                                                                             |
| Region   | Central Hungary       | 32.80      | 31.42                                                                                             |
|          | Central Transdanubia  | 10.70      | 11.00                                                                                             |
|          | Western Transdanubia  | 11.60      | 10.23                                                                                             |
|          | Southern Transdanubia | 6.90       | 8.89                                                                                              |
|          | Northern Hungary      | 11.40      | 11.33                                                                                             |
|          | Northern Great Plain  | 14.00      | 14.63                                                                                             |
|          | Southern Great Plain  | 12.60      | 12.50                                                                                             |

In summary, the socio-economic profile of individuals in the sample is very similar to that of the Hungarian population, based on KSH 2022 Population Census data. Any small deviations in sex, age, or region relative to the population are unlikely to unduly compromise the sample's representativeness. Hence, the sample can be regarded as highly representative of the Hungarian population, thereby ensuring the external validity of the present study.

Table 7 presents the sociodemographic profile of the sample, including place of residence (settlement), income, and education. Based on the settlement, the majority of respondents (58.40%) live in urban areas (cities, excluding the capital), while those in the capital account for 24.60%, and those living in rural villages account for 17.10%. This distribution is indicative of a largely urban sample, with concentration evident in cities and the capital. The sample shows a clear majority of average-income earners (66.60% of respondents), with 17.50% high-income earners and 16.00% low-income earners. This indicates that most respondents are in the middle-income category, and a minority are in the high- or low-income categories. The sample is characterized mainly by high educational attainment, with 54.90% of respondents holding a degree and 35.00% graduating from secondary school. Vocational school was also attended by fewer (7.90%), and only 2.20% had completed elementary school (grade 8 or below). This means the sample was well educated, with an overwhelming majority having at least a secondary education.

**Table 7.** Socio-demographic of the sample (n=1,013)

| Variable   | Description                         | Sample (%) |
|------------|-------------------------------------|------------|
| Settlement | Village                             | 17.10      |
|            | City                                | 58.40      |
|            | Capital                             | 24.60      |
| Income     | Low                                 | 16.00      |
|            | Average                             | 66.60      |
|            | High                                | 17.50      |
| Education  | Elementary school (grade 8 or less) | 2.20       |
|            | Vocational school                   | 7.90       |
|            | Senior high school                  | 35.00      |
|            | Higher education                    | 54.90      |

#### 4.4. Applied statistical methods

This study examines the impact of sustainability labelling and greenwashing practices in Hungary and their potential relevance to consumers' choices. The following statistical methods were used to meet the study's aims: systematic literature review, descriptive statistics, cross-tabulation, non-parametric analysis, and market segmentation using hierarchical and k-means clustering. These approaches were selected to provide an overview of the core elements of sustainability labelling and greenwashing in Hungary, thereby offering useful insights into their influence on consumer confidence and behavior, as well as the regulatory landscape. All statistical analyses in this study were conducted using IBM SPSS Statistics 27, RStudio 2025.05.0, and VOSviewer 1.6.20.

##### 4.4.1. Descriptive statistics

Descriptive statistics were used to describe the socio-demographic characteristics of the

sample and Hungarian consumers' attitudes, behaviours, and knowledge regarding sustainability labels on food products. This information, summarized as percentages and frequency distributions, was instrumental in making proactive decisions based on consumer trends. Another area assessed the relevance of sustainability certificates to consumers, which was quantified using a Likert-type scale. Attitudes towards sustainability labels. The importance of sustainability labels varied, with a substantial proportion of consumers rating them as slightly or highly important.

Descriptive statistics were also used to explore consumer engagement with sustainability labels, including the percentage of consumers who had ever bought products carrying a sustainability certification. This study brought to the fore different (un) familiarisation and experience types with products labeled as sustainable within this sample group. Moreover, consumers' familiarity with sustainability labels was classified into high-, medium-, and low-knowledge groups to provide a general picture of respondents' awareness of sustainability labelling practices.

Regarding consumers' experience with individual sustainability labels, summary statistics were used to analyse how often a label was known or searched for, providing information on recognition and impact across certification categories. Likewise, trust in sustainability labels was discussed, including a comparison between government-certified and privately certified labels. The findings suggested favouring government-endorsed certifications, which were perceived as most trustworthy by the majority of consumers. Confidence in environmental allegations made by authorities, such as the National Food Chain Safety Authority of Hungary (Nébih), and the impact of that trust on sound consumer decisions were also measured.

Descriptive statistics have been essential to analyse consumer awareness, confidence, and willingness to buy food labelled as sustainable. By categorizing respondents by their attitudes toward sustainability labels, the study provided important findings on levels of awareness, trust, and willingness to purchase green products. In general, descriptive statistics were fundamental for summarizing complex data and provided a clear overview of Hungarian consumers' attitudes and perceptions toward sustainability labels on foodstuffs.

#### 4.4.2. Non-parametric analysis

The data were not normally distributed, so a non-parametric test was applied to address the violation of normality assumptions. The primary objective for employing non-parametric testing was to analyze how various factors influence the risk of greenwashing in the food business (Nugraha et al., 2024). Furthermore, the tests were used to investigate differences in the distribution of local products between domestic and international retailers in Hungary. The aim of our research was to create a nuanced picture of the phenomena underlying greenwashing, as well as to assess the market presence differences between local and foreign foodstuffs in Hungary.

Moreover, this study also analyzed the correlation between knowledge of sustainability-related labelling and various socio-demographic factors. A non-parametric method, the Kruskal-Wallis test, was implemented to evaluate this relationship. This method is appropriate for comparing multiple independent groups when the dependent variable is ordinal. The level of knowledge regarding sustainability-related labelling, categorized into three levels (1 = low, 2 =

medium, 3 = high), is the dependent variable in this instance. These categories were employed to illustrate the diverse levels of comprehension among participants regarding sustainability-related labelling practices.

#### 4.4.3. Market segmentation analysis

Market segmentation analysis was conducted to identify specific consumer groups in Hungary that may be perceived as more vulnerable to greenwashing practices. The first objective of the analysis was to identify natural groupings based on consumers' trust, knowledge, and intentions regarding sustainability labelling. This was done by conducting a two-step data analysis: the first step involved applying hierarchical clustering to group respondents, and dendrogram plots were used to visualize the cluster structure and determine the optimal number of clusters. This technique enabled an initial grouping of consumers by the attributes they shared.

The consumer clusters were then further refined and identified using k-means clustering. K-means clustering was instrumental in grouping consumers based on key variables such as trust in sustainability labels, vulnerability to greenwashing, and other explanatory factors, while accounting for their socio-demographic characteristics. The purpose of this method was to reveal different consumer classes and to help identify which subgroups were more vulnerable to deceptive sustainable claims. These findings are important for developing effective communication and intervention strategies to mitigate the influence of greenwashing on specific consumer segments.

#### 4.4.4. Cross-tab analysis

Cross-tabulation (cross-tab) analysis was used to investigate associations among categorical variables, such as demographic characteristics (e.g., gender, age, household income) and consumer behaviors or attitudes toward sustainability labels. Cross-tab analysis was used to examine patterns and associations among categorical variables and to better understand how different parts of the population think about sustainability-related issues. Cross-tab analysis was also used to test whether socio-demographic variables among clusters showed significant differences. Additionally, this test is also used to investigate the significant differences in the distribution of local and international sustainability labels across product categories in Hungarian retail units

#### 4.4.5. Binary logistic model

There are several reasons why consumers tend to overestimate their comprehension of sustainability-related labelling, including their level of understanding, behavioral variables, and sociodemographic factors. Binary (logit and probit) models could be used to assess whether consumers often overstate their comprehension of the sustainability label to address this issue. These models are appropriate for this kind of research because they pinpoint specific consumers who tend to overestimate their comprehension and provide insights into the precise factors that drive this behavior. This approach is consistent with several earlier investigations (Pedregal & Pe, 2010; Scarpato et al., 2016; Yang et al., 2022), which employ similar statistical approaches but address distinct subjects. For example, Yang et al. (2022), examined the relationship between sociodemographic traits and consumer behavior, focusing on how these factors influence

consumers' inclination to scan QR codes for detailed product information before making a final purchase decision. Furthermore, Scarpato et al. (2016) also investigated how consumer behavior is influenced by purchasing habits and perceptions of food safety features in order to identify the key elements influencing consumers' attention to food safety. Because of their methodological congruence, the Logit and Probit models were employed in this work to examine the pertinent data, as demonstrated below:

$$Y_i = \alpha + \beta_x + \varepsilon \quad (1)$$

$Y_i$ , the dependent variable is a binary response that indicates whether a responder overestimates their comprehension of sustainability labelling.

$$Y = \begin{cases} 0 & \text{if no} \\ 1 & \text{if yes} \end{cases}$$

In Equation (1),  $Y_i$  is unobservable,  $x$  are independent variables, and  $\beta$  is the regression coefficient associated with unknown parameters, and  $\varepsilon$  represents the error term in a normal distribution. Hence,  $Y_i$  can be determined with two possible outcomes: a respondent has an overestimation of the overestimation understanding of sustainability labels ( $Y_i = 1$ ), and a consumer has no overestimation of their understanding ( $Y_i = 0$ ).

The Logit model, or logistic regression model, can delineate Equation (2), representing the Cumulative Distribution Function (CDF) of the logistic distribution (for example,  $\Lambda(x'\beta)$ ), whereas the Probit model can express a conditional probability, as given in Equation (3), where  $F(x'\beta)$  denotes the standard normal cumulative distribution function. Both exhibit projected probabilities constrained between 0 and 1.

$$F(x'\beta) = \Lambda(x'\beta) = \frac{e^{x'\beta}}{1 + e^{x'\beta}} = \frac{e^{x'\beta}}{1 + \exp(e^{x'\beta})} \quad (2)$$

The Probit model's probability can be articulated as Equation (3):

$$F(x'\beta) = \Phi(x'\beta) = \int_{-\infty}^{(x'\beta)} \phi(z) dz \quad (3)$$

The model coefficients are determined using the maximum likelihood method. Moreover, Equation (4) presented the equation for optimizing the log-likelihood:

$$\log = yF(x'\beta) + 1(1 - y)[1 - F(x'\beta)] \quad (4)$$

This study can also compute marginal effects (ME) to obtain a probability interpretation of the independent variables. The marginal effects denote the proportional alteration in the likelihood of the dependent variable ( $y = 1$ ) resulting from a one-unit change in the independent variable  $x$ . The ME for the Logit model is articulated in Equation (5):

$$\frac{\partial p}{\partial x_j} = \Lambda(x'\beta) [1 - \Lambda(x'\beta)]\beta_j = \frac{e^{x'\beta}}{(1 + e^{x'\beta})^2} \beta_j \quad (5)$$

Additionally, Equation (6) illustrates the marginal effects for the Probit model:

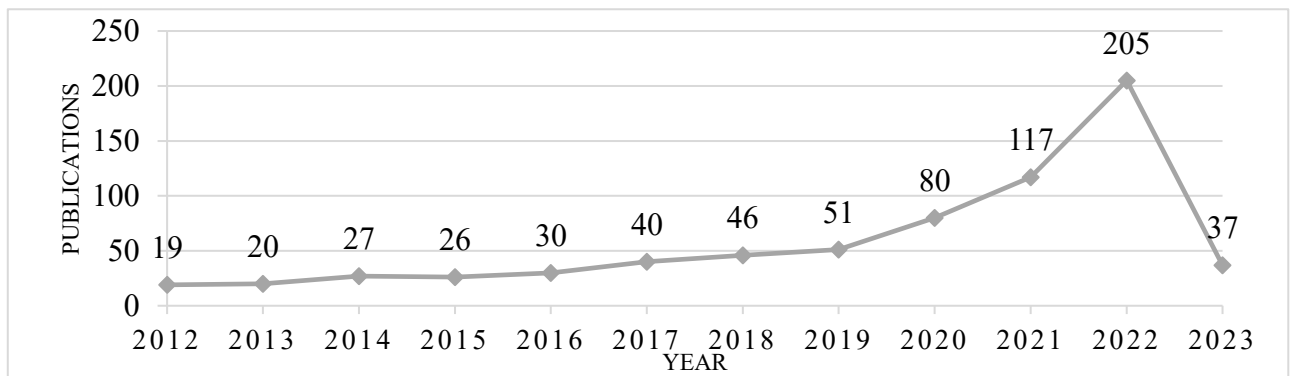
$$\frac{\partial p}{\partial x_j} = \Phi(x'\beta) \beta_j \quad (6)$$

If the estimated parameters of the independent variables and the marginal effects are significant for both the Logit and Probit models, the independent variable will be considered significant and will provide additional explanatory power.

## 5. RESULTS AND DISCUSSION

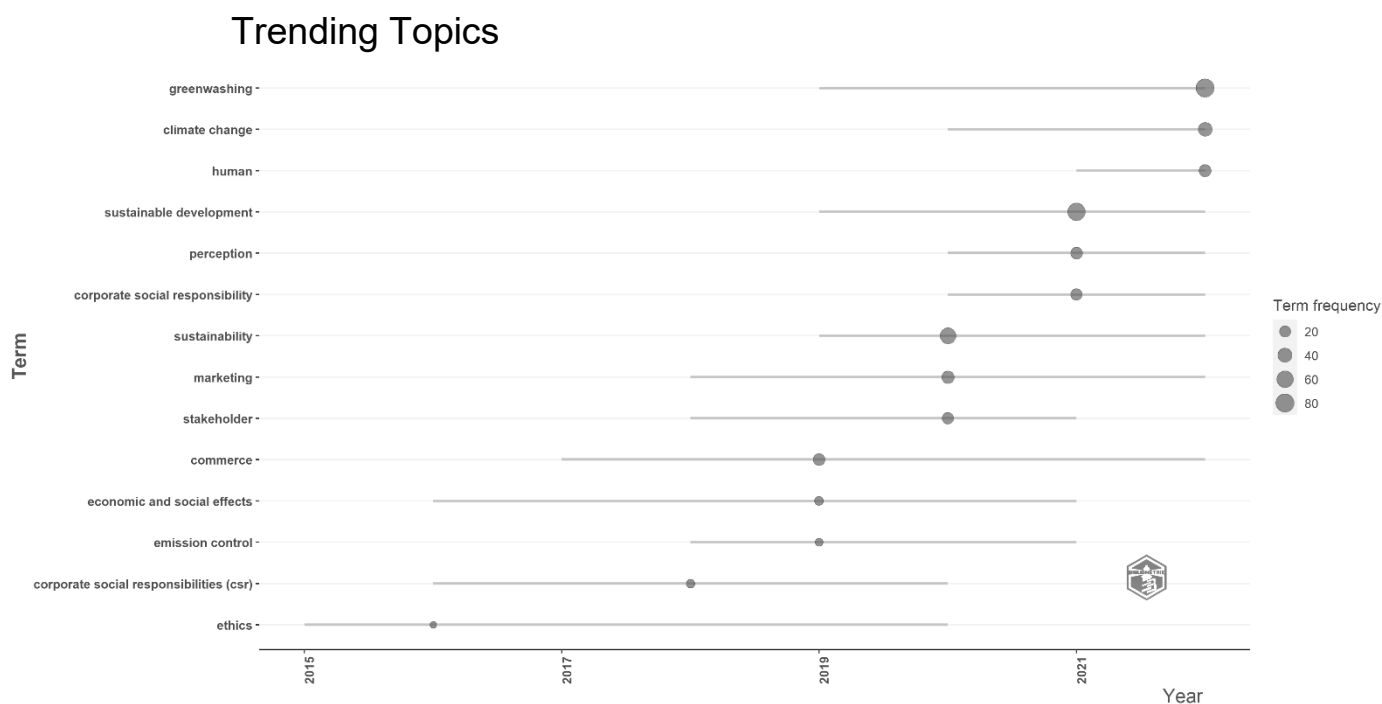
- 5.1. Experiment 1: Systematic literature review on the prevalence of greenwashing practices in the food sectors
  - 5.1.1. Bibliometric mapping of existing studies and the dynamics of research topics and research trends

Figure 3 demonstrates that the quantity of academic papers on greenwashing has increased dramatically over the last decade, with an exponential growth rate of around 978.95%. This suggests that the issue of greenwashing is becoming more prevalent in academia and is projected to grow even more in the coming years. This increasing trend of greenwashing is intrinsically tied to the rise in greenwashing that has been observed in a range of industries, particularly food-related firms, on practically every continent, including North America, Europe, Asia, and Africa (Chitaka, 2021; European Commission, 2023b; GITNEX, 2023; Raj, 2022).



**Fig. 3.** Scientific paper on greenwashing disclosure (\*Data from 2023 were only analyzed till the end of February).

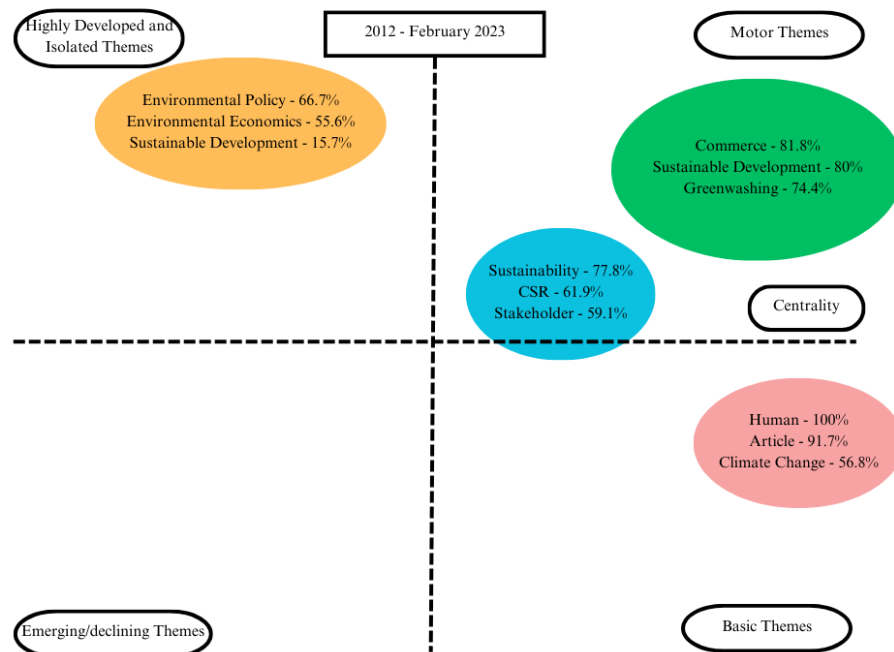
In order to find disciplines or topics that are receiving more attention and becoming emerging trends, burst keyword analysis looks at keywords that have featured in a remarkable number of recently published papers in order to understand the emphasis and emerging trends in research hotspots in bibliometrics (Wang et al., 2021). Fig. 4 also shows a level of emphasis on some studies by varying the burst term's power. Ethics is the primary theme identified in the 2016 greenwashing research. The term greenwashing for CSR also became popular in 2018 and remained so until 2021. Between 2018 and 2020, there was a growing body of evidence about greenwashing in the areas of marketing, sustainability, stakeholders, economic and social effects, and emissions control. The increased marketing of the SDGs has raised consumer awareness of environmental challenges and heightened perceptions of greenwashing by several SDG-related players (Munro, 2021). Greenwashing has previously been extensively documented and recognized as a consumer deception in a number of businesses. As a result, the idea of "greenwashing" has gained popularity recently, especially when it comes to people (consumers) and the environment (climate change).



**Fig. 4.** Top 14 trends in greenwashing-related topics from 2012 to February 2023.

Considering the foremost emerging topics identified over the last decade via burst keyword analysis, the dynamics of the last ten years' research themes would be better integrated, as more comprehensive research outcomes are likely to be generated. Figure 4 depicts the most prevalent issues with the highest centrality and density in greenwashing research: commerce, sustainable development, sustainability, CSR, and stakeholders. Furthermore, the analysis shows an increased emphasis on the relationship between greenwashing and human and climate change, implying that these topics are critical to the study of greenwashing. The relationship between greenwashing and environmental policy, environmental economics, and sustainable development is widely discussed. In principle, the results of Figures 5 and 4 are interdependent and mutually supportive, demonstrating consistency and a high degree of accuracy in empirical findings. The empirical results of this research provide a snapshot of issues and themes in the domain of greenwashing studies over the last decade.



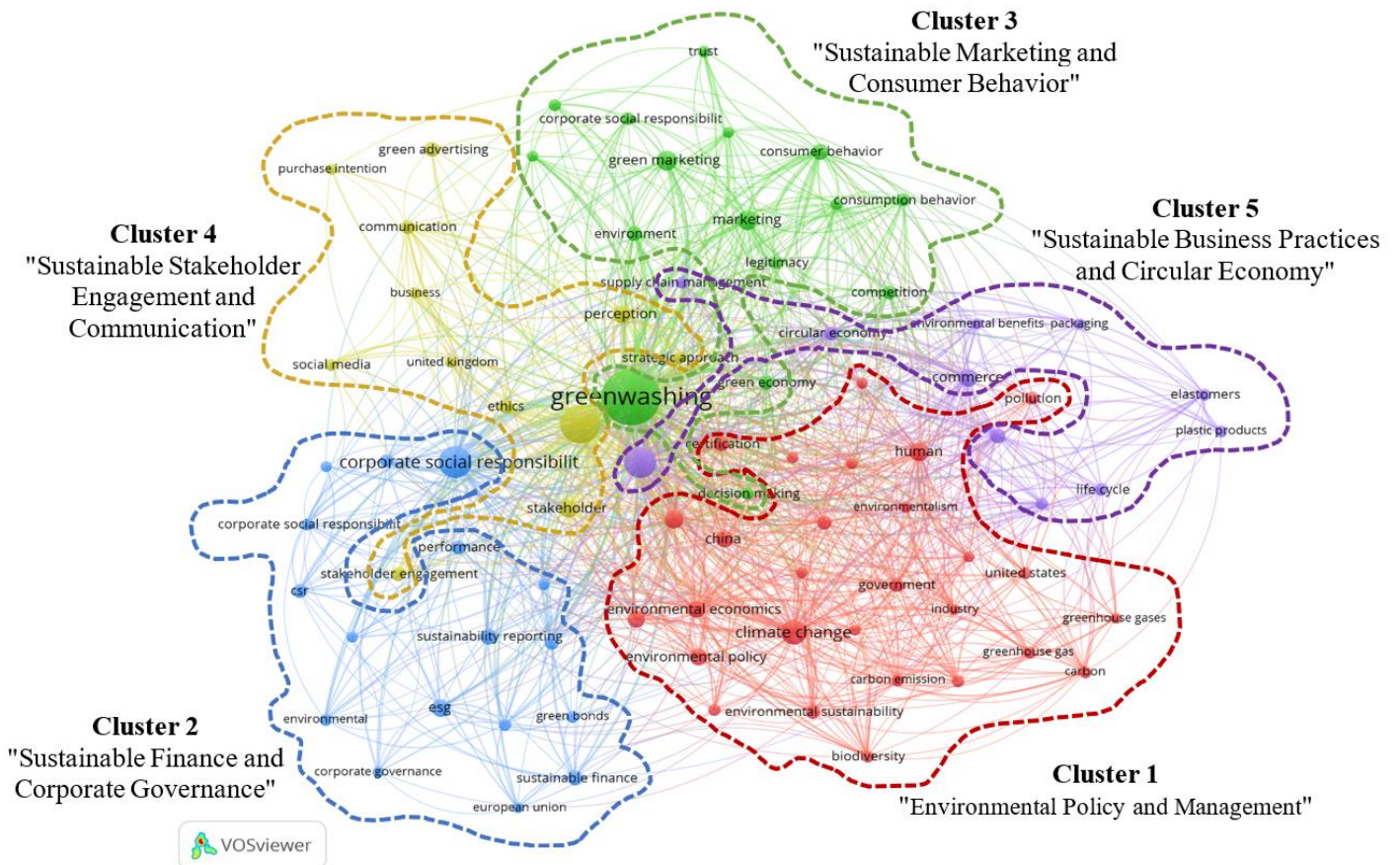


**Fig. 5.** The proportional positions of several themes in studies on greenwashing conducted between February 2023 and 2012.

#### 5.1.2. Co-words analysis for identifying a hotspot

According to Gao et al. (2021), keywords in a publication provide useful data that help in the detection of research trends both in the past and in the present (Wahyuningrum et al., 2023). A total of 711 publications were compiled from 431 journals across 44 nations, resulting in 3,295 keywords. VOSviewer was employed to examine the data, revealing keyword hotspots and assessing keyword co-occurrence. Out of 3,295 keywords, 86 surpassed the threshold of three occurrences. Furthermore, keywords not pertinent to the constructs employed in this investigation were excluded.

The connections between terms and occurrences in the research on greenwashing can be visually displayed (Fig. 5). The nodes are dimensioned based on the frequency and significance of the phrases (Wahyuningrum et al., 2023). In Fig. 6, color variability serves to differentiate each cluster associated with distinct topics. Furthermore, Fig. 7 will provide a detailed analysis by extracting the top five terms from each cluster.



**Fig. 6.** Co-word analysis network of greenwashing literature.

The first cluster was designated "Environmental Policy and Management" due to its focus on themes of greenwashing, including the interaction between humans and the environment, with strategies to mitigate environmental issues and foster sustainability. Numerous recent studies have linked the phenomenon of greenwashing to climate, environmental issues, and societal impacts (Braga Junior et al., 2019; Chitaka, 2021; Montero-Navarro et al., 2021). This is because consumers understand how important it is to preserve the environment for a fair and prosperous future (Kim & Chung, 2011; Yadav & Pathak, 2017). As a result, consumers change their behavior to become more environmentally conscious in order to promote environmental conservation, particularly by buying products with eco-friendly labelling (Yadav & Pathak, 2017). Although the shift in consumer attitudes has been observed in a number of industries, earlier studies show that companies respond to the food industry (Guyader et al., 2017; Sirieix et al., 2013), tourism (Font et al., 2017), fashion (Rausch & Kopplin, 2021), and the beauty industry (Alevizou, 2021) with increasing amounts of greenwashing. Due to the lack of private monitoring and public verification, the growing frequency of greenwashing instances has prompted social and environmental audits (Seele & Gatti, 2017). The removal of greenwashing is essential due to the enormous economic cost associated with the practice, and the cost associated with sustainable initiatives is greater than the potential gain from the practice, which is essential to the prosperity of sustainable development (Biancardi, Colasante, & D'Adamo, 2023; Biancardi, Colasante, D'Adamo, et al., 2023; Caferra et al., 2023).

The researchers designated the second cluster as “Sustainable Finance and Corporate Governance” due to its representation of the social and ecological aspects of finance alongside the governance aspects of responsible and sustainable business practices concerning the issue of greenwashing. In addition, understanding consumer behavior toward sustainability, the phenomenon of green marketing, and the marketing of green products are all part of the third cluster, "Sustainable Marketing and Consumer Behavior". The fourth cluster, entitled “Sustainable Stakeholder Engagement and Communication,” aims to understand, address, and manage stakeholder interactions related to sustainability, ethics, and the discussion surrounding sustainability within the framework of responsible greenwashing techniques. The fifth cluster, titled “Sustainable Business Practices and Circular Economy,” emphasizes the application of circular economy principles and sustainable business practices to enhance sustainable impacts across the product life cycle, thereby contributing to the achievement of the Sustainable Development Goals, as influenced by studies on greenwashing.



**Fig. 7.** The five primary keywords derived from the co-word network analysis of greenwashing literature.

Fundamentally, the five clusters can be viewed as one, unified, and supportive system. From the five clusters, it can be inferred that greenwashing is always associated with environmental, consumer, marketing, industrial, CSR, economic, and stakeholder issues.

Moreover, the co-word analysis reveals areas of prior research that have been understudied, as well as promising topics for future research (Priatmoko et al., 2023). Based on the analysis of existing clusters, it is concluded that there is a significant gap in the literature on greenwashing, particularly in studies of the food industry. This is especially pertinent given the numerous documented cases of greenwashing across industries (Guyader et al., 2017; Font et al., 2017; Rausch & Kopplin, 2021; Alevizou, 2021), it is well recognized that the food sector is most affected by greenwashing practices (Foodcycler, 2021). Not only are an increasing number of food companies failing to prove the eco-friendly claims made on their products (European Commission, 2023b); but investors and consumers are also beginning to lose trust in producer claims and invest in the food sector (Gatti et al., 2021). There is no doubt that operational support through specialist third-party analysis is needed. Academic help is essential to tackle the problem of greenwashing in the food business and, crucially, to rebuild trust among consumers and investors. Moreover, it may equip stakeholders and policymakers with essential instruments to develop recommendations for restoring faith in eco-labels.

#### 5.1.3. Greenwashing practices in the food industry

Table 8 indicates that, although our study encompasses only the past decade, there was a notable surge in publications post-2017, while merely one paper prior to 2016 examined greenwashing in the food industry. Furthermore, the food industry greenwashing literature has developed in the past decade across six primary research themes (Figure 8, results from Figures 6, 7, and Table 8): certifications & labels, retailers, corporate social responsibility (CSR), consumers, food supply chain, and food safety. Our results show that several industries, particularly the food sector, are still understudied despite growing scholarly concern over greenwashing. This underscores the primary purpose of the study, which is to ascertain the extent of greenwashing within the food business. This study enhances comprehension of the key aspects within the food industry's greenwashing literature and advocates for viable interventions to reveal and tackle the most vulnerable regions to greenwashing (Figure 8).

In general, environmental concerns are the main focus of studies on greenwashing practices in the food business. Based on the 16 publications examined using the PRISMA method, Table 8 offers a more thorough summary of greenwashing tactics found and documented in scholarly literature over the previous ten years.



**Fig. 8.** The predominant focus of greenwashing research has been inside the food industry over the last ten years.

Regarding greenwashing, certification, and labelling, the authors may reference the reports by Nguyen et al., 2019. Over fifty percent of research on greenwashing in the food sector concentrated on product labelling and certification. Instances of greenwashing in labelling occur when food companies provide misleading information to consumers, implying that their products are sustainable, although they likely are not. Over fifty percent of the studies on greenwashing in the food business focused on labelling and certification. Food manufacturers frequently engage in greenwashing through labelling, misleading the public into believing their products are environmentally sustainable when they are not (Montero-Navarro et al., 2021). This was the case in Vietnam when the public interest in green products increased, and many stores and food businesses started selling organic products, but when the public requested proof of the organic status, they provided no evidence (Nguyen et al., 2019). Moreover, some corporations in North America altered the color of their food product labels to green to persuade consumers of their environmental friendliness, resulting in widespread deception (Guyader et al., 2017). The rising occurrences of greenwashing demonstrate that the shortcomings of this practice render sustainable labelling an ineffective mechanism for enhancing and transforming food systems (Parker et al., 2021).

A further factor leading to greenwashing is the inadequate knowledge and comprehension of eco-friendly products by corporate owners (Chitaka, 2021). As an example of this, several South African restaurants replace plastic straws with what they misinterpret as more eco-friendly polylactic acid (PLA) straws (Chitaka, 2021). Nevertheless, when queried regarding PLA straws, restaurant owners were unaware that these straws did not satisfy the ASTM D 6691 standards for classification as biodegradable in aquatic environments, despite their support for mitigating plastic pollution in the

ocean.

Greenwashing happened in certain German supermarkets and cheap retailers, which, despite asserting their commitment to selling and fostering the development of sustainable products, do not genuinely participate in such practices (Saber & Weber, 2019). German supermarkets and discounters have been characterized as reluctant to report on the negative environmental impacts of their activities, to be perceived as environmentally friendly (Saber & Weber, 2019). Moreover, large retailers such as TESCO, when they start putting their own eco-friendly labels on their products, in the eyes of consumers, such a practice can create a misconception as TESCO may be perceived as a fully sustainable retailer, while not all products it sells, distributes, and promotes are sustainable (Sirieix et al., 2013). Additionally, TESCO was accused of trying to incorporate an eco-label along with its other, non-environmentally friendly labels on the same product, which some consumers considered to be one of the greenwashing examples (Sirieix et al., 2013).

Additionally, certain researchers have commenced investigating methods to combat greenwashing in the food industry (Brécard, 2017; DeFries et al., 2017; Liute & De Giacomo, 2022; Stecker, 2016). According to Brécard, 2017; DeFries et al., 2017; Liute & DeGiacomo, 2022; and Stecker, 2016, third-party certifications offered by NGOs are considered to have significant effectiveness when it comes to combating greenwashing in the food sector because they are comparatively stricter in the assessment process for verifying the eco-friendly labels. Recently, however, some NGOs like B Corp have eco-friendly labels, which have now been accused of greenwashing (Liute & De Giacomo, 2022). As claimed by some critics of B Corp, they have an eco-friendly label offered in one of the 5 areas of sustainability (Governance, Workers, Community, Environment, and Customers) in which a corporation need not focus on all of them as they can choose, and if the selected area constitutes a value of above 80, then that corporation is deemed to have an eco-friendly label (Liute & De Giacomo, 2022). This way, some companies focus on the ignored area of the environment and have less score (Liute & DeGiacomo, 2022), which is described as an eco-label that is not perfect (Brécard, 2017). Moreover, (vanTulder & Rodrigues, 2021) pointed out that one of the reasons for the increasing tendency of the 'greenwashing' phenomenon is the poor quality of the sustainability-related self-regulatory frameworks.

In addition, (DeFries et al., 2017) proposed that voluntary certification could be a plausible approach for fulfilling sustainable development goals, as it is non-monetary and has other features that differ from greenwashing. Moreover, Toussaint et al. (2021) noted that consumers want traceability labels to avoid greenwashing. However, it is crucial to research traceability and voluntary labelling to determine whether these measures can counter the growing greenwashing practices in the food sector.

The rising prevalence of greenwashing in the food industry, coupled with insufficient oversight and regulation from eco-friendly certification providers (Stecker, 2016) endangers numerous firms that are not participating in greenwashing. This is attributable to eco-incident sensitivity, necessitating that consumers and investors approach their purchasing and investment decisions in the food sector with prudence (Gatti et al., 2021; Urbański & Ul Haque, 2020). This will impact sales, and the quest for investors in the food sector is apparent. Therefore, more help is needed, including further academic work on food sector greenwashing practices, to help consumers and businesses understand and avoid falling victim to the misleading information. Also, at this stage, further research on communication about food sector greenwashing practices will help stakeholders construct evidence-based frameworks,

including academic papers, to facilitate decisions based on solid evidence (Kasza et al., 2022). Furthermore, the lack of transparency among food producers, consumers, and investors needs to be addressed.

**Table 8.** Overview of greenwashing efforts in the food industry from 2012 to February 2023.

| No | Greenwashing practices identified                                                                                                                                                                                                   | Explanation of greenwashing practices                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Reference             |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| 1  | - Labelling                                                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>- Notwithstanding forecasts indicating an increase in demand for eco-friendly products in Vietnam, individuals persist in their skepticism regarding claims of green food.</li> <li>- Greenwashing methods are evident among numerous food manufacturers and shops in Vietnam's major cities, particularly in Ho Chi Minh City. Retailers and the food business assert the sale of organic products however do not prove this claim to consumers.</li> </ul>                                                                                                                                                          | (Nguyen et al., 2019) |
| 2  | - Food labelling                                                                                                                                                                                                                    | <ul style="list-style-type: none"> <li>- This study asserts that food labelling with sustainable labels is ineffective in transforming food systems due to its susceptibility to greenwashing and reductionism.</li> <li>- This research indicates that labelling is frequently unsuccessful in facilitating transformative change in food systems for three reasons: Labelling is inadequate to transfer power from dominant entities to persons marginalized by the food system; Susceptible to greenwashing and reductionism; More aligned with commercial segmentation than collective political engagement.</li> </ul>                                  | (Parker et al., 2021) |
| 3  | <ul style="list-style-type: none"> <li>- Misinterpretation of polylactic acid (PLA) straws by major merchants and restaurant chains in South Africa</li> <li>- Lack of information and knowledge regarding green-claimed</li> </ul> | <ul style="list-style-type: none"> <li>- In response to the discourse around plastic straws, some prominent retail and restaurant enterprises in South Africa have opted to transition to alternatives such as PLA instead of endorsing measures aimed at mitigating water pollution. During the interview, respondents (restaurant owners) asserted that they selected alternative materials, such as PLA for straws, due to their belief that PLA could biodegrade under all conditions. Researchers discovered that PLA failed to comply with ASTM D 6691 requirements for designation as biodegradable in aquatic environments. Consequently,</li> </ul> | (Chitaka, 2021)       |



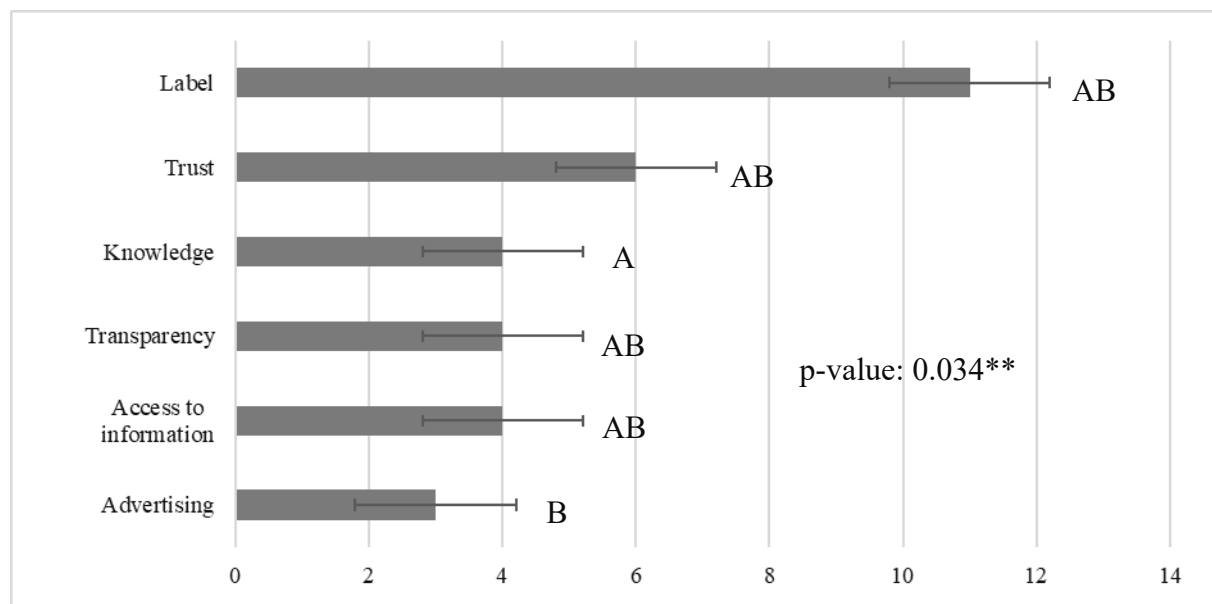
|   |                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |
|---|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
|   |                                                                        | prominent retail and restaurant enterprises in South Africa participated in greenwashing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                |
| 4 | - Labelling and packaging                                              | - In the food industry, greenwashing frequently occurs in labelling and packaging, where companies deceive consumers regarding the environmental effects of their products.                                                                                                                                                                                                                                                                                                                                                                                                                               | (Montero-Navarro et al., 2021) |
| 5 | - Lack of information about the product on the food companies' website | - Greenwashing in the food industry frequently occurs when companies assert that their products are sustainable while providing consumers with misleading information.<br>- To absolve themselves of allegations of greenwashing, the food industry must credibly disclose accurate information, including external validation presented on their website or product packaging.                                                                                                                                                                                                                           | (Gider & Hamm, 2019)           |
| 6 | - CSR labels on food businesses                                        | - Consumers are finding it more difficult to recognize ethical food companies as more eco-friendly label claims emerge. Even for ethical food companies, this may lead to less successful CSR initiatives.<br>- It was found that consumer responses to food enterprises are influenced by third-party external CSR accreditation.<br>- A great tool to reduce greenwashing and promote a really responsible environment is an external rating system for businesses or their CSR projects.                                                                                                               | (Gosselt et al., 2019)         |
| 7 | - Label and product coloring                                           | - A lot of products on the market use the color green to tell consumers that they are environmentally friendly.<br>- People who are ignorant and closely examine the goods and their labels will thus be tricked into buying them (greenwashing).<br>- This study indicates that consumers who are well-informed about green and eco-friendly items would not be deceived by greenwashing visualization techniques, such as the use of green colors on non-green products and labelling. 95.5% of 5296 home goods were found to have greenwashing issues, such as deceptive labels, insufficient proof of | (Guyader et al., 2017)         |



|    |                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |
|----|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
|    |                          | claims, or unclear claims, indicating that greenwashing is becoming more common in North America.                                                                                                                                                                                                                                                                                                                                                                                                                                  |                            |
| 8  | - Imperfect eco-label    | - Third-party verified eco-labels frequently have more stringent certification standards, especially if the eco-label is controlled by a non-governmental organization (NGO). Greenwashing is made possible, though, when eco-labels approved by authorities and NGOs have laxer regulations. This is why it is called an incomplete eco-label.                                                                                                                                                                                    | (Brécard, 2017)            |
| 9  | - Sustainability reports | - It was demonstrated that, although they are not very active in their day-to-day operations, supermarkets and discount stores in Germany typically establish strategies to solve environmental challenges.<br>- Some German retailers appear to be engaging in greenwashing by promoting sustainability despite not actually practicing it.<br>- Several German retailers also found that they were reluctant to disclose the detrimental effects of their business to maintain the impression that retail helps the environment. | (Saber & Weber, 2019)      |
| 10 | - Labelling              | - Consumers are worried about greenwashing by stores like Tesco/Nature that supply eco-friendly labels for themselves. Although not all of Tesco's products carry an eco-friendly label, it is thought that this would give the company a green image.<br>- Consumers view TESCO's attempts to combine eco-friendly labels with several labels at the same time as greenwashing.<br>- Consumers in Ireland are also dubious about the Quality-Origin certification because it is unclear what quality is being assessed.           | (Sirieix et al., 2013)     |
| 11 | - Certification          | - This study indicates that B Corp certification is not a guarantee against greenwashing.<br>- B Corp cannot guarantee that a firm has good environmental performance because it may select a sustainable area (Governance, Workers, Community, Environment, and Customers) with a minimum indicator                                                                                                                                                                                                                               | (Liute & De Giacomo, 2022) |

|    |                                                     |                                                                                                                                                                                                                                                |                             |
|----|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
|    |                                                     | value of 80 while ignoring another sustainable area.                                                                                                                                                                                           |                             |
|    |                                                     | - When it was shown that the certification lacked a system to assess business claims, allowing corporations to make false or inaccurate claims, B Corp began to lose confidence.                                                               |                             |
| 12 | - Purchasing behaviour                              | - Greenwashing may negatively affect consumers' intentions to buy green products.                                                                                                                                                              | (Urbański & Ul Haque, 2020) |
| 13 | - Voluntary certification                           | - Schemes for voluntary certification in the food business (i.e., agricultural commodities) do not support the idea that they are merely greenwashing, and they may occasionally aid in achieving sustainable development goals.               | (DeFries et al., 2017)      |
| 14 | - Certification                                     | - Annual reports on products with eco-friendly labels that lack verification and explicit rules have raised concerns among investors and consumers on their investment and purchasing decisions.                                               | (Stecker, 2016)             |
| 15 | - Food supply chain value in the food sector        | - To mitigate greenwashing practices, consumers favor promoting traceability throughout the food supply chain due to several transparency challenges related to labelling and certification.                                                   | (Toussaint et al., 2021)    |
| 16 | - Greenwashing's Impact on investment possibilities | - An increasing number of instances of "greenwashing" are being uncovered, involving businesses who falsify their claims and employ misleading strategies for their benefit, thereby constraining investment opportunities for company growth. | (Gatti et al., 2021)        |

Furthermore, Table 8 delineates the primary factors explaining the frequency of greenwashing in the food industry. The causes encompass advertising, information accessibility, transparency, knowledge, trust, and labelling (refer to Figure 9).



**Fig. 9.** Primary elements leading to the prevalence of greenwashing within the food sector. The Kruskal–Wallis test was employed, and the existence of identical letters within a variable signifies no significant difference across the categories. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ .

Growing consumer apprehensions about identifying sustainable alternatives amid the multitude of newly launched sustainable products, particularly in light of the increasing prevalence of greenwashing in the food sector. Previous studies (Nguyen et al., 2019; Parker et al., 2021; Chitaka, 2021; Montero-Navarro et al., 2021; Gider & Hamm, 2019; Gosselt et al., 2019; Guyader et al., 2017; Brécard, 2017; Gatti et al., 2021; Toussaint et al., 2021) identified labels and trust as the primary factors that concern the greenwashing tendencies within the food industry. The labels on food products that claim to be sustainable usually do not provide sufficient information or evidence, which adds to consumers' growing concerns (European Commission, 2023b). Moreover, companies like TESCO combine their own brand with other labels, creating confusion and leading consumers to believe their own brand is sustainable. Many large firms have sought to improve their greenwashing image, but this has increased the risk of greenwashing (Sirieix et al., 2013).

Figure 9 illustrates the critical differentiation between the components of knowledge and advertising and their functions in sustaining greenwashing in the food sector. Moreover, insufficient awareness of sustainability labels, transparency, and the accessibility of sustainability-related information is recognized as a principal element contributing to greenwashing (Chitaka, 2021; Toussaint et al., 2021; Nguyen et al., 2019; Sirieix et al., 2013).

Due to increased identification of greenwashing in the food industry, the European Union has begun developing Green Claims guidance, which assists and protects consumers from potential deception (European Commission, 2023b). The EU's newly proposed law aims to enable consumers to make informed choices about purchase options by guaranteeing the truthfulness and reliability of environmental labels and claims (European Commission, 2023b). This initiative aims to systematically eliminate what has been characterized as one of the most critical obstacles to the adoption of sustainable practices (Avila et al., 2017). The regulatory framework established by the European Union has shifted the focus toward adopting sustainable

practices in the food industry. D'Adamo (2023) encourages the food business to embrace policies that bolster consumer trust and adopt sustainability reporting measures. Reporting on sustainability practices mitigates the risk of greenwashing and educates the public regarding the food industry's sustainability efforts.

Furthermore, establishing a resilient community can mitigate greenwashing by: (1) Certification Communities offering credible certifications that authenticate companies' environmental assertions and misleading ads. Caferra et al. (2023) reported that certifications are a stabilizing factor in the chain reaction to eliminate greenwashing, as well as in the encouragement of virtuous supply chains, thereby fostering trust relationships with consumers; (2) Transparency Platforms help monitor and report the sustainability efforts of companies. These platforms can help companies substantiate their environmental claims by encouraging honesty. Transparency and information access are two important elements that assist consumers in making purchasing (Toussaint et al., 2021); (3) Consumer Education Groups enhance the understanding of the potentially misleading greenwashing, thereby enabling people to identify authentic sustainable practices and avoid deception. Trust from collaborating firms towards these groups can be established through transparency. Furthermore, investigations into the sustainable labelling idea and standards from both top-down and bottom-up initiatives should be prioritized, since both approaches possess potential and may provide valuable insights (Lakerveld & Tulder, 2017). Looking into these sides can provide avenues for addressing the greenwashing issue. More authentic and open sustainable practices can be ensured by combining top-down regulation and bottom-up initiatives.

The SLR technique allows analysts to articulate many ideas that can underpin future research directions (Vaio et al., 2023). In light of the SLR findings from this research investigation, the authors propose the following propositions:

- Proposition 1: Assess consumers' understanding of and attitudes towards sustainable, eco-friendly, or green labelling.
- Proposition 2: Assess the impact of greenwashing on consumers and how it affects their purchasing decisions towards sustainable products.
- Proposition 3: Investigate the role of third-party organizations and commercial firms in developing and certifying sustainable labels.
- Proposition 4: Analyze consumer acceptance and willingness to pay for products bearing specific greenwashing labels, as well as the financial implications of such labelling.

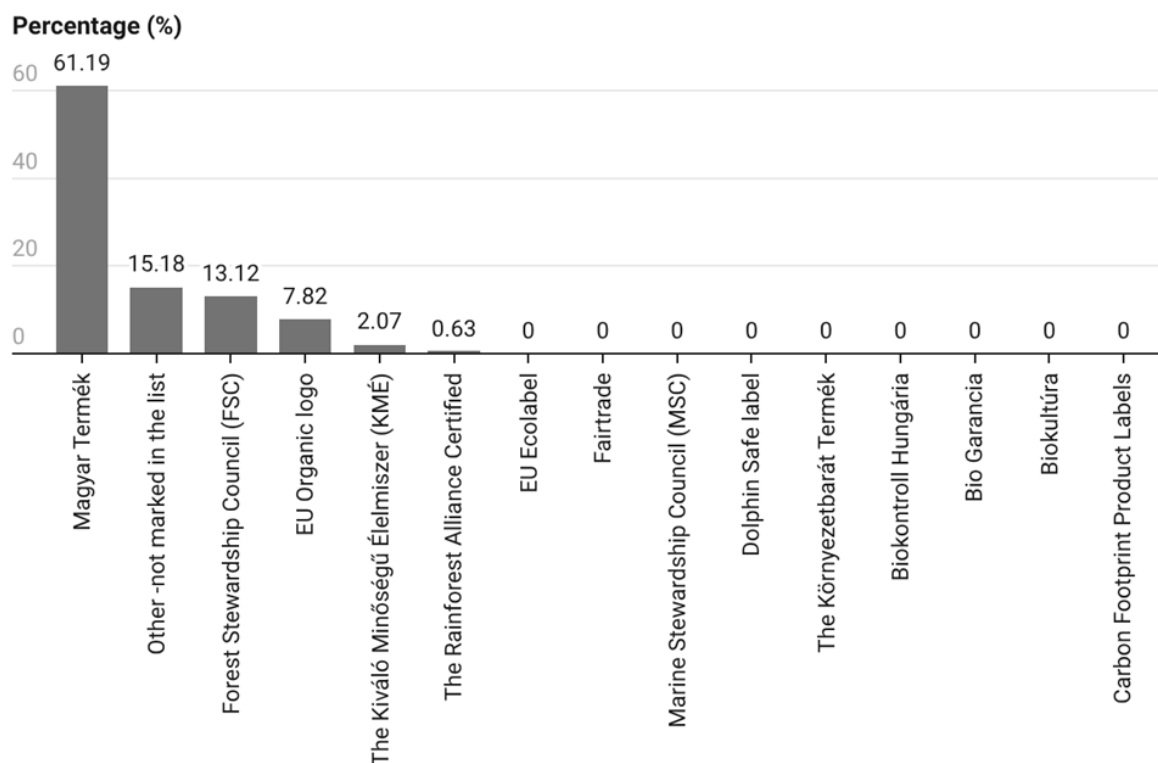
The propositions from the systematic literature review provide a robust theoretical underpinning for this research by capturing relevant academic insights into consumer perceptions, behaviors, institutional involvement, and the economic consequences of greenwashing and sustainability labelling. These propositions are not just a summary of prior research but an integrative conceptual framework that directs the direction, structure, and analysis of subsequent empirical investigation. As a result, this systematic literature review serves as a crucial theoretical framework that guides the formulation of hypotheses, improves methodological coherence, and guarantees that the study is firmly rooted in accepted scholarly discourse while continuing to be focused on filling identified research gaps.

## 5.2. Experiment 2: Retail study “The presence of sustainability labels and distribution of domestic food products across local and international retailers in Hungary”

This study examines sustainability-related trademarks and labels used in Hungarian retail and their relationship to consumer preferences. As consumers endeavor to make more informed and responsible purchasing decisions, sustainability labels, such as those indicating organic, fair trade, or environmentally friendly production methods, have become increasingly significant. The objective of this study is to assess the prevalence and distribution of these labels in Hungarian retail outlets, encompassing a variety of food product categories. In doing so, the study aims to offer consumers a unique perspective on how these sustainability certifications are perceived and on their influence on the promotion of environmentally responsible consumption.

Additionally, the investigation examines the growing significance of local sustainability labels relative to international ones, focusing on the extent to which domestic certifications, such as Magyar Termék, resonate with Hungarian consumers. The research examines the potential of these local labels to foster consumer confidence in supporting local products and to promote sustainable practices within the Hungarian food system. The objective of the research is to illuminate the broader implications of sustainability-related labelling in retail, providing valuable insights into the potential of sustainability labels to promote environmental and economic sustainability in Hungary’s agricultural and retail sectors.

Through these examinations, the study could contribute to the ongoing discourse on the significance of sustainability in retail by highlighting labels’ potential to increase consumer awareness and facilitate the transition to more sustainable food systems. This is achieved through this analysis.

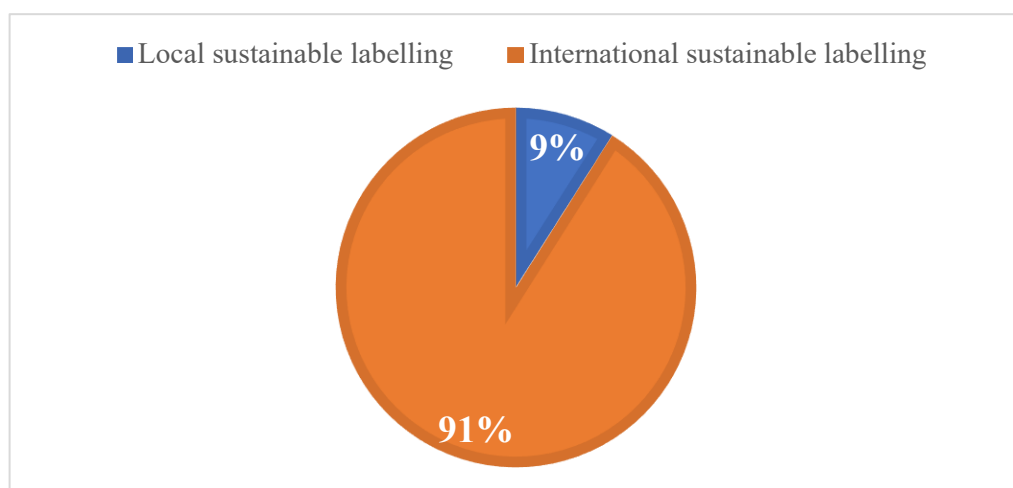


**Fig. 10.** The distribution of sustainability-related labelling in Hungarian retail in percentage (%) among products with sustainability-related labels

Figure 10 shows the distribution of various sustainability-related trademarks and labels across the retail units analyzed. However, it is essential to make it clear that Figure 10 only shows products that have one of the sustainability-related labels. This means that it does not include the many products that do not have any such labels. This should be considered when interpreting the data because the figure does not depict the entire product variety in the market; rather, it only shows the labeled products within the chosen food categories under analysis. As indicated, the most common label is Magyar Termék, appearing on 61.19% of products, followed by Other (not listed) at 15.18% and FSC at 13.12%. Other labels, with smaller shares in the mix, include EU Organic, KMÉ, and The Rainforest Alliance (7.82%, 2.07%, and 0.63%, respectively). The absence of several labels in the Figure 10 list, with 0% availability, can be traced back to time, budgetary, and product checking constraints. These types of issues caused the exclusion of some seafood products and, as a result, the omission of the Dolphin Safe and MSC labels. It is expected that further studies will be able to provide a wider range of products at Hungarian retailers (Kasza et al., 2024).

This analysis links directly to findings in the study (Figure 12), which showed that domestic products have accounted for a significantly larger share of Hungarian retail units than international retail chains. The product offerings consisted mostly of local goods (61.19%), which aligns with our findings on preference for local goods, making Magyar Termék dominant. This prominence of Magyar Termék reflects consumer confidence in domestic goods but also indicates that local sustainability labels can significantly influence the promotion of environmentally sustainable practices among Hungarian retailers. Through an analysis of market penetration and the role of these sustainability labelling, this work highlights the important function they play in raising consumer awareness and facilitating environmental and economic sustainability in Hungary's agriculture and retail sectors.

Based on the results outlined previously, which emphasize that local labels dominate in Hungarian retail units, it may be stated that domestic labels (e.g., Magyar Termék) are most prominent. As such, this demand for both regional products and local certifications closely correlates with consumer confidence in Hungarian brands and a desire to support the local economy's growth. Additionally, the results showed a huge difference in availability between domestic and international labels, indicating that Hungarian consumers preferred locally sourced products (Kasza et al., 2024; Szegedyné Fricz et al., 2020). As illustrated in the chart (Figure 11), 91% of the products in the sample were appropriately labeled as sustainable at local sources, contrasting with only 9% that had a sustainable label at international sources. This result also highlights the importance of ongoing support for local sustainable production initiatives that strengthen the link between domestic consumers and environmentally responsible production practices.



**Fig. 11.** The distribution of local and international sustainability labelling in Hungarian retail

Following previous findings on local and international sustainability labels in Hungarian retail, Table 9 provides detailed insight into the distribution of these labels across product categories. In this work, data analysis was performed on 5,980 products across a range of retail units in Hungary (60 units), showing the distribution of products bearing local and international sustainability labels, as well as the combination of both labelled products.

The dataset shows wide differences in the prevalence of sustainability labels across product categories. The statistical significance of these results indicates that the presence of sustainability labels is strongly related to the product type, suggesting that certain categories are more likely to carry these labels than others. In terms of local sustainable labelling, the largest categories are honey (28.00%), dairy products 1: yogurt (14.33%), dairy products: fresh milk, ESL milk, and UHT milk (8.67%), dairy products 2: cottage cheese, kefir, and sour cream (7.58%), and processed meats 1: ham from pork (6.67%). These products are clearly correlated with domestic production in Hungary, and, notably, the horse clasps more strongly in sectors such as dairy and honey, which are integral parts of Hungarian agriculture.

On the contrary, international sustainable labelling is more closely related to products such as dairy 2: cottage cheese, kefir, and sour cream (37.76%), dried pasta (17.13%), fruit jams and preserves (12.59%), eggs (12.59%), and fresh vegetables (11.19%). These aspects have a greater representation of international certifications with common characteristics in processed products or categories where packaging and exportations are more common.

An interesting outcome is the duality of local and international sustainable labelling, which is mainly observed in dried pasta (88.42%). This means that for certain product categories, multiple sustainability marks may exist that correspond to both international and domestic sustainability standards. However, the combination of labels remains relatively rare in most categories, with only a few other items, including butter (5.26%), fresh vegetables (4.21%), and others, together showing local & international affiliations.

Among the 5,980 products in total, honey is (23.09%), dairy products 2: cottage cheese,

kefir, and sour cream (12.65%), dairy products 1: yogurt (10.94%), dried pasta (10.82%), and dairy products: fresh milk, ESL milk, and UHT milk (7.53%); these are more sustainable labels associated with categories. Conversely, products such as fresh chicken breast, chicken thigh, and other fresh meats have either very few or no sustainability labels.

**Table 9.** Distribution of local and international sustainability labels across product categories in Hungarian retail units

| Products                                                   | Local sustainable-related labelling | International sustainable-related labelling | Combine both local and sustainable-related labelling | Significant |
|------------------------------------------------------------|-------------------------------------|---------------------------------------------|------------------------------------------------------|-------------|
| Fresh chicken breast, chicken thigh                        | 0%                                  | 0%                                          | 0%                                                   | <.001***    |
| Fresh pork shoulder                                        | 0.25%                               | 0.00%                                       | 0.00%                                                |             |
| Fresh whole boneless chicken, chicken breast, chicken meat | 5.08%                               | 1.75%                                       | 0.00%                                                |             |
| Fresh pork                                                 | 3.67%                               | 0.00%                                       | 0.00%                                                |             |
| Fresh minced pork                                          | 1.17%                               | 0.00%                                       | 0.00%                                                |             |
| Fresh fruits (Apple)                                       | 0.67%                               | 1.05%                                       | 0.00%                                                |             |
| Fresh vegetables                                           | 4.33%                               | 11.19%                                      | 4.21%                                                |             |
| Fruit jams and preserves                                   | 0.83%                               | 12.59%                                      | 0.00%                                                |             |
| Processed meats 1: ham (from pork)                         | 6.67%                               | 0.35%                                       | 0.00%                                                |             |
| Processed meats 2: salami, dry sausages                    | 4.17%                               | 0.00%                                       | 0.00%                                                |             |
| Processed meats 3: Parisian, sausage                       | 1.00%                               | 1.40%                                       | 1.05%                                                |             |
| Canned goods (corn)                                        | 0.25%                               | 0.35%                                       | 0.00%                                                |             |
| Canned goods (cherry preserves)                            | 5.00%                               | 0.00%                                       | 0.00%                                                |             |
| Honey                                                      | 28.00%                              | 10.14%                                      | 0.00%                                                |             |
| Dried pasta                                                | 3.17%                               | 17.13%                                      | 88.42%                                               |             |
| Dairy products: fresh milk, ESL milk, UHT milk             | 8.67%                               | 5.24%                                       | 0.00%                                                |             |
| Dairy products 1: yogurt                                   | 14.33%                              | 0.35%                                       | 0.00%                                                |             |
| Dairy products 2: cottage cheese, kefir, sour cream        | 7.58%                               | 37.76%                                      | 1.05%                                                |             |
| Dairy products 3: cheeses                                  | 1.67%                               | 0.00%                                       | 0.00%                                                |             |
| Dairy products 4: butter                                   | 2.75%                               | 0.35%                                       | 5.26%                                                |             |
| Eggs                                                       | 0.83%                               | 12.59%                                      | 0.00%                                                |             |
| <b>Total</b>                                               | <b>100.0%</b>                       | <b>100.0%</b>                               | <b>100.0%</b>                                        |             |

This in-depth breakdown of dynamics within the sustainability labels shows that local labels play a larger role for product categories directly linked to domestic agricultural practices. In contrast, international ones have a higher concentration in processed and packaged goods. This preponderance of local sustainable labelling across categories from dairy to honey and fresh meats underscores the prominence of both local production and certification in retail in Hungary. Moreover, the reasonable presence of international labels in fresh and minimally processed categories demonstrates consumers' affinity for local products and certified goods. Consequently, these findings underscore the close connection between local food systems and sustainability



labelling, showing how efforts towards sustainability are adapted to meet local markets' preferences and agricultural practices.

Local sustainability labels significantly impact consumer behavior towards sustainable practices in the Hungarian retail market. The Magyar Termék label was identified as the most popular in the market, with locally sourced labels such as FSC and EU Organic coming next on the list. This trend illustrates the preference Hungarian consumers have for locally sourced, certified, and organic products. The findings show that sustainability-labeled, locally sourced products could potentially increase consumer trust and enhance the environmental sustainability of food systems by encouraging their use.

These insights provide the potential to impact policymakers and stakeholders focused on the food sector's sustainability. Results show Hungarian consumers are influenced more by local sustainability labels than by international ones. Therefore, future policy could focus on promoting local sustainability initiatives through awareness campaigns and incentives for locally focused retailers. Since consumers lean towards local offerings, policies that increase the availability of locally sourced products at retail outlets will also support the local market and promote sustainability. Further, policies could strengthen the degree to which sustainability is integrated into national labelling systems to keep domestic products aligned with local and international sustainability standards.

Moreover, this study also seeks to analyze the distribution of domestic food products and sustainability labels among local and international retailers in Hungary. It focuses on the positioning of these products in the marketplace, with a specific concern about sustainability labels, which are becoming important cues to environmental and social awareness within consumer products (Cook et al., 2023). The emphasis is on how these products are framed in the market, especially regarding sustainability-related labelling, which has become an influential sign of environmental and social performance. With sustainability a critical topic of interest to consumers and producers alike, this is particularly relevant for food items, where sourcing, production methods, and environmental impact can all inform the marketing of sustainability labels (Huang et al., 2024; Potter, et al., 2021). Knowing the presence and distribution of such labels in Hungary can help clarify whether sustainability is part of Hungarian consumers' perspective, as reflected in their consumption behaviour.

This work on the distribution of domestically produced food items and various sustainability labels in Hungarian shops is intrinsically connected to broader studies on sustainability-related labelling in food products. Both studies investigate consumer preferences and behaviours, with an emphasis on the increasingly relevant factor of sustainability in food choices. By focusing on the distinction between local and international retailers, this research examines how domestic food products, often associated with local and sustainable practices, are positioned in the retail market compared with international products that may not always adhere to the same environmental or social standards. The examination of both the distribution of domestic products and sustainability-related labelling together is important not only because it emphasises the value consumers place on local production, but also because it shows how domestic products and sustainability labels affect consumer attention and product purchase intentions (Kinawy, 2025; Rana et al., 2026). Therefore, both studies are essential for understanding how

sustainability-related labelling is evolving in Hungary and how it contributes to the development of more sustainable food systems.

The results of the study indicate that 70.53% of the products were categorized as domestic across 16 product categories in the examined retail locations. The supply ratio of Hungarian items showed significant variability between international and domestic chains, at 66.79% and 79.26%, respectively (Table 10).

The study indicated that 70.53% of the products across 16 categories in the examined retail units were classified as domestic. There were notable disparities in the percentage of Hungarian products in international and domestic chain stores, at 66.79% and 79.26%, respectively (Table 10).

**Table 10.** Proportion of domestic food goods in retailers' assortments

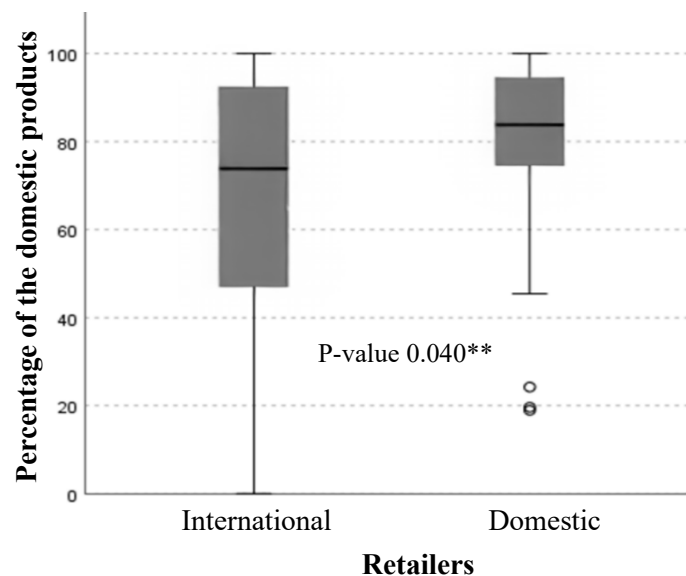
| Product category                                                                                                                                   | All<br>retailers | International<br>retail<br>companies | Domestic<br>retail<br>companies | Difference<br>between<br>domestic and<br>international<br>retailers |
|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------------------------|---------------------------------|---------------------------------------------------------------------|
| Honey                                                                                                                                              | 97.18%           | 95.98%                               | 100.00%                         | 4.02%                                                               |
| Milk: fresh milk, ESL milk, UHT milk                                                                                                               | 95.61%           | 94.86%                               | 97.35%                          | 2.49%                                                               |
| Packaged fresh chicken meat                                                                                                                        | 93.85%           | 93.85%                               | -                               | -                                                                   |
| Eggs (chicken eggs)                                                                                                                                | 93.37%           | 92.28%                               | 95.93%                          | 3.65%                                                               |
| Dairy products 2: cottage cheese, kefir, sour cream                                                                                                | 89.39%           | 87.41%                               | 94.02%                          | 6.61%                                                               |
| Meat products 3: Parizer (Bologna sausage), wiener, and frankfurter sausages                                                                       | 83.49%           | 78.51%                               | 95.11%                          | 16.59%                                                              |
| Packaged fresh pork meat                                                                                                                           | 81.84%           | 81.84%                               | -                               | -                                                                   |
| Seasonal fruits, vegetables (apples, grapes, peaches, apricots, nectarines, tomatoes, green peppers, carrots, cucumbers, onions, potatoes, garlic) | 76.98%           | 73.97%                               | 84.01%                          | 10.04%                                                              |
| Canned food: cherry compote, sweet corn                                                                                                            | 73.96%           | 67.99%                               | 87.88%                          | 19.89%                                                              |
| Meat products 2: salamis, dry sausages                                                                                                             | 73.60%           | 71.84%                               | 77.70%                          | 5.85%                                                               |
| Dry pasta                                                                                                                                          | 64.53%           | 56.02%                               | 84.40%                          | 28.38%                                                              |
| Fruit jams                                                                                                                                         | 54.76%           | 47.06%                               | 72.72%                          | 25.66%                                                              |
| Dairy products 4: butter                                                                                                                           | 50.76%           | 41.06%                               | 73.40%                          | 32.33%                                                              |
| Dairy products 3: cheeses (extra hard, hard, semi-hard, and soft cheeses)                                                                          | 46.68%           | 39.86%                               | 62.59%                          | 22.73%                                                              |
| Meat products 1: hams                                                                                                                              | 38.26%           | 27.41%                               | 63.60%                          | 36.19%                                                              |

|                                                              |               |               |               |               |
|--------------------------------------------------------------|---------------|---------------|---------------|---------------|
| Dairy products 1: yoghurts (including fruit-flavoured types) | 19.41%        | 18.75%        | 20.94%        | 2.19%         |
| <b>Mean</b>                                                  | <b>70.85%</b> | <b>66.79%</b> | <b>79.26%</b> | <b>15.47%</b> |

Excluding honey, the majority of fresh items are positioned at the top of the list: chicken, pork, seasonal fruits and vegetables, eggs, and milk. Hungary is among the foremost honey-producing countries in the EU (European Commission, 2026), and Hungarian beekeepers are particularly eloquent regarding their involvement in agriculture and rural development, which may clarify this exceptional result. Regarding perishable commodities, over 75% were supplied by local businesses.

It should be pointed out that packed fresh meat was not available in the Hungarian retail establishments that were examined. Typically, it is marketed as a non-prepackaged item given to the consumer upon request; in this case, the product label is not attached to the package. In many instances, the Hungarian retail establishments maintain a contract with an independent butcher who operates a small shop within the leased premises of the retail unit. The butcher's sales are segregated from the marketing of retail chains.

The authors were unable to uncover comparable studies from other nations that could be used as standards to evaluate the current results. This demonstrates how new the research findings are. However, earlier studies were carried out in Hungary, which could provide a foundation for comparison (Kasza et al. 2011; 2015).



**Fig. 12.** Distribution of food products produced in Hungary between domestic and foreign retail establishments (using the Mann-Whitney U test)

Additionally, Hungarian retailers show a significantly higher percentage of local goods than foreign retailers (Figure 12). The gap in the percentage of local products between foreign

and local retail is, apart from variations in their buying structures, attributed to the retail buying bias toward incorporating local products (Wicaksana & Utama, 2018). It has also been suggested that legislation be enacted to ensure retailers source at least 80% of their products from local sources (Wicaksana & Utama, 2018). Raising the ratio of domestic products is necessary but not sufficient. Keeping the focus on local products through appropriate marketing techniques is essential in building consumer awareness of the importance of domestic products in a sustainable food system (Ffoleau & Dourian, 2020), sustainable rural development (Rossi et al., 2019), and sustainable local economies (European Commission, 2022, 2023a; European Parliament Council, 2022). In this regard, consumers are important, as they have the capacity to influence upstream activities through their purchasing power (Hatanaka, 2020). This allows them to drive change in the supply chain and enhance the sustainability of the food and agriculture system. This is what is commonly referred to as food citizenship (Hatanaka, 2020). (Rossi et al., 2019) emphasized the necessity for a more connected and adaptable network of linkages to attain a comprehensive and sustainable agrifood system.

According to these results, this study demonstrates the predominance of domestic items among Hungarian consumers, which may be explained by the large proportion of domestically sourced goods in retail establishments. This local preference may be due to consumers' greater trust in local products. Moreover, the growing preference for domestic products underscores the value of efforts to raise consumer awareness and encourage support for local production. These results underscore the importance of consumer actions in promoting sustainability. When Hungarian consumers choose local products, it supports the local farming sector and helps reduce some of the environmental downsides of imports, leading toward a sustainable food system.

### 5.3. Experiment 3: Quantitative consumer study

#### 5.3.1. Hungarian consumers' awareness or familiarity with sustainability-related labels

This research covers 15 types of trademarks and labels commonly used on the Hungarian foodstuffs market. The results in Table 11 indicate substantial differences regarding Hungarian consumers' familiarity, awareness, and interaction with food trademarks and labels. Magyar Trademark ranks among the top three most popular labels among Hungarian consumers, with 52.78% of consumers looking for products featuring this logo. This indicates a strong brand presence and market demand for the product. The Environmentally Friendly Product (Környezetbarát Termék) label is also popular among Hungarian consumers, with about 46.47% having likely seen and possibly purchased food products with this label. However, only 12.43% of Hungarian users actively seek out products featuring this logo. Bio Garnica is the third-most recognized label in Hungary. Approximately 36.82% of Hungarian consumers have seen and may have bought Bio Garnica-labeled food products. Also, only 9.31% of Hungarian consumers consciously seek out products featuring this logo.

**Table 11.** Hungarian consumers' experiences with trademarks and sustainability-related labels on food products

| Logo                                                                                | I consciously seek out the products that feature this logo. | I am not actively seeking out this logo, but I have probably already purchased a product with it. | I have seen this logo before, but I probably have not bought a product with it yet. | I am not familiar with it. |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------|
|    | 52.78%                                                      | 38.07%                                                                                            | 3.50%                                                                               | 5.66%                      |
|    | 12.43%                                                      | 46.47%                                                                                            | 13.70%                                                                              | 27.40%                     |
|    | 9.31%                                                       | 36.82%                                                                                            | 16.74%                                                                              | 37.13%                     |
|    | 9.25%                                                       | 36.59%                                                                                            | 9.46%                                                                               | 44.69%                     |
|   | 7.98%                                                       | 35.74%                                                                                            | 14.26%                                                                              | 42.02%                     |
|  | 7.78%                                                       | 30.56%                                                                                            | 15.44%                                                                              | 46.22%                     |
|  | 7.61%                                                       | 30.76%                                                                                            | 13.64%                                                                              | 47.99%                     |
|  | 7.21%                                                       | 37.22%                                                                                            | 12.62%                                                                              | 42.95%                     |
|  | 7.13%                                                       | 25.11%                                                                                            | 11.38%                                                                              | 56.38%                     |
|  | 6.86%                                                       | 34.32%                                                                                            | 12.14%                                                                              | 46.67%                     |
|  | 6.65%                                                       | 28.19%                                                                                            | 10.77%                                                                              | 54.38%                     |
|  | 4.86%                                                       | 25.24%                                                                                            | 15.95%                                                                              | 53.96%                     |
|  | 4.66%                                                       | 25.32%                                                                                            | 14.19%                                                                              | 55.83%                     |
|  | 4.39%                                                       | 26.23%                                                                                            | 14.56%                                                                              | 54.82%                     |



3.24%

25.13%

14.02%

57.61%

Source: Own data collection

On the other hand, Hungarian consumers have also been found to be less familiar with, aware of, and interested in certain labels. Only 3.24% of Hungarian consumers are interested in purchasing food products with the Biokontroll logo, representing the lowest product awareness and preference in Hungary. Dolphin Safe does not even show high awareness or preference, with only 4.39% of consumers showing interest and familiarity. In line with this trend, this study also found that only 3.24% of consumers are familiar with and seek out EU Ecolabel products.

Moreover, the labels and trademarks analyzed in Table 11 were selected through comprehensive market research conducted in this study of the Hungarian food market. These labels were reported to be the most widely used on food products in Hungary. However, it is important to note that not all of these labels and trademarks are interpreted as directly supporting greenwashing practices. Some of these labels and trademarks do have sustainability standards or criteria, but they do not primarily focus on sustainability. For example, the labels Magyar Termék and KME primarily focus on local production or product quality standards rather than on sustainability. However, these labels require verification of specific sustainability aspects to be certified and to meet certain criteria. Hence, this work not only assesses sustainability labels and greenwashing practices but also examines food labels and trademarks in terms of market presence and consumer recognition.

These findings indicate that, while certain labels (e.g., EU Ecolabel and Biokontroll Hungária) face challenges in achieving consumer recognition, others (e.g., Magyar Trademark, Környezetbarát Termék, and Bio Garancia) achieve relatively high practical awareness. Elevating the profile of these labels and educating consumers about them may lead to greater consumer engagement and influence purchasing behavior.

Moreover, Table 12 provides additional analysis of Table 11 and provides evidence of substantial differences in Hungarian consumers' awareness, familiarity, and preferences between sustainability-related labels. This work found that Hungarian consumers tend to have a higher preference for direct sustainable-related labelling; however, they tend to be more familiar with indirect sustainability-related labelling. These results also relate to several former results, like in Figures 10 and 11, as Hungarian consumers tend to be more familiar with local sustainability-related labelling. Additionally, this study found that local labels are more actively used than foreign ones, with about 15.55% of respondents consciously looking for products with such marks. Also, approximately 29.99% of Hungarian consumers have seen and probably have purchased these products with this logo before. On the other hand, about 6.34% of Hungarian consumers consciously seek out products featuring this logo.

**Table 12.** An overview of Hungarian consumers' experiences of sustainability-related labels

Respondents' awareness, purchase experience, and familiarity with sustainability-related labels by origin of labelling

| Origin of labelling | I consciously seek out the products that feature this logo. | I am not actively seeking out this logo, but I have probably already purchased a product with it. | I have seen this logo before, but I probably have not bought a product with it yet. | I am not familiar with it. | Total |
|---------------------|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------|-------|
| International       | 6.34%                                                       | 29.99%                                                                                            | 13.59%                                                                              | 50.08%                     | 100%  |
| Local               | 15.55%                                                      | 31.18%                                                                                            | 12.78%                                                                              | 40.49%                     | 100%  |

Respondents' awareness, purchase experience, and familiarity with sustainability-related labels by type of sustainability-related labelling

| Direct/indirect to sustainability-related labelling | I consciously seek out the products that feature this logo. | I am not actively seeking out this logo, but I have probably already purchased a product with it. | I have seen this logo before, but I probably have not bought a product with it yet. | I am not familiar with it. | Total |
|-----------------------------------------------------|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------|-------|
| Direct                                              | 9.20%                                                       | 38.24%                                                                                            | 45.81%                                                                              | 6.75%                      | 100%  |
| Indirect                                            | 2.56%                                                       | 21.29%                                                                                            | 45.04%                                                                              | 31.12%                     | 100%  |

Source: Own data collection

The results conclude that Magyar Termék is a well-known trademark among Hungarian consumers, who highly value it. This is in line with earlier findings, which indicate that Hungarian consumers are highly conscious of the Magyar Termék trademark and view it as an important characteristic (Horváth et al., 2024; Szakaly et al., 2016). Although the Magyar Termék trademark is not specifically referred to a sustainable trademark, but this could be considered a sustainable trademark, as this trademark not only by promoting that low carbon footprints are made every time since all ingredients come from Hungary, and also ensuring that production is carried out in the country, implying zero transport emissions concerns; also, this trademark concentrates on ensuring considerable social and economic benefits for the local community (MAGYAR TERMÉK Nonprofit Kft., 2025). With a focus on locally sourced materials and producers, the label aims to reduce its environmental impact by promoting a closer, more independent network of suppliers, thereby lowering transportation costs and reducing waste. Furthermore, the label strengthens the local economy by supporting Hungarian businesses, creating job opportunities, and fostering regional development (MAGYAR TERMÉK Nonprofit Kft., 2025). This holistic approach to sustainability, encompassing both environmental responsibility and socio-economic growth, contributes to the long-term sustainability of the Magyar Termék trademark.

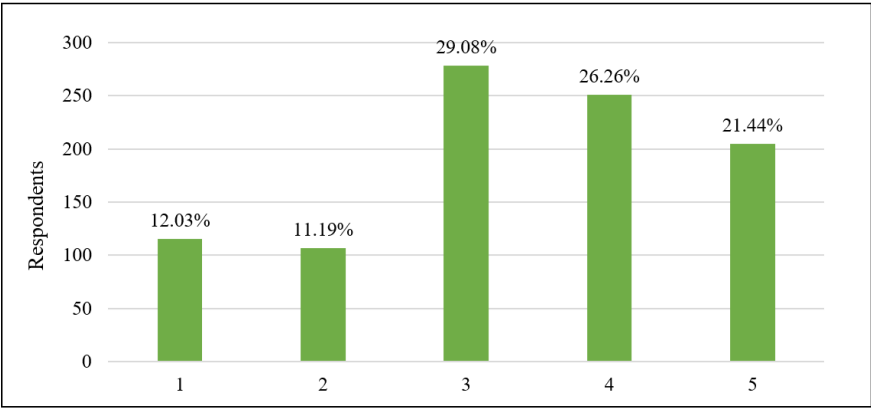
This study also demonstrated that Hungarian consumers are more aware of and interested in domestic trademarks and sustainability labelling than in international ones. In particular, Hungarian consumers are more likely to prefer and be aware of local sustainability labels such as Környezetbarát Termék and Bio Garancia. These results imply that local sustainability labels are

more likely to be familiar with and knowledgeable about local trademarks and labels. The main reasons behind the Hungarian consumers' demand for domestic trademarks and a sustainable label are due to the consumer's desire to support the local economy (Horváth et al., 2024), perception that domestic products are more reliable, safer, fresher, healthier, nutritious (Horváth et al., 2024; Szakaly et al., 2016), as well as ethnocentrism (patriotism) (Mucha & Vinogradov, 2025). Furthermore, this study aligns well with a study conducted in Slovakia, which found that one of the main consumer reasons for buying local products is due to their ethnocentrism and the consumer desire to support the domestic economy and increase the country's economic welfare, and to reduce unemployment (Čvirik, 2021). Hence, consumers' purchasing decision is not only mainly focused on the price and the quality of the products, but also on the place of the product's origin (Czine et al., 2024).

### 5.3.2. The importance of sustainability-related labelling among Hungarian consumers

Over the last 40 years, several public and private initiatives have communicated information about food sustainability to consumers through labels and logos in retail outlets and on food packaging (Grunert et al., 2014). European Commission (2024) (European Commission, 2024) also reported that around 200 sustainable-related labels are currently available on the market, and the number keeps increasing (European Commission, 2025b). Today, there are many logos out there to indicate sustainable stuff, e.g., organic (Kaczorowska et al., 2019; Shaikh et al., 2024), the Rainforest Alliance logo (Annunziata et al., 2019; Jones et al., 2024), fair trade (Cook et al., 2023; Kaczorowska et al., 2019), various carbon index schemes (Cook et al., 2023; Holenweger et al., 2023), etc. These logos or labels aim to inform consumers by signaling different aspects of environmental or ethical responsibility.

This explosion of sustainability labels is indicative of a broader shift in market dynamics, where sustainability increasingly commands visibility and recognition. The rising popularity of such labels indicates that sustainability is increasingly crucial for consumers (Agarwal et al., 2025; Gomes et al., 2023; Theocharis & Tsekouropoulos, 2025) reflecting a need for greater food system transparency and accountability. This phenomenon highlights the nature of sustainability claims as emerging informational and strategic market signals to influence consumer behaviour and industry practices.

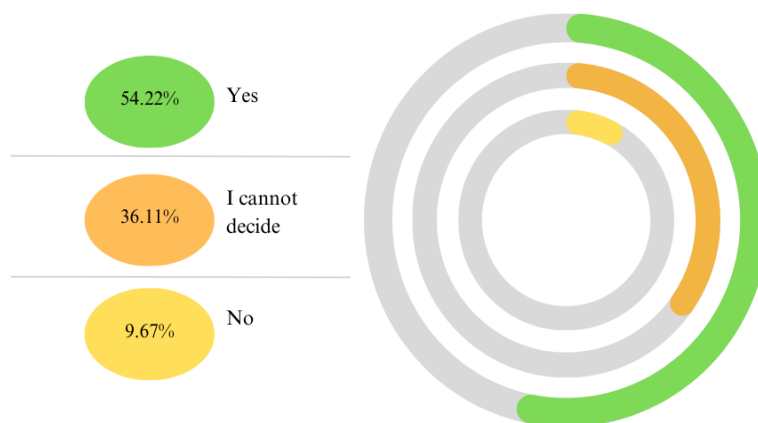


**Fig. 13.** How important is a sustainability certificate to respondents (mean percentage results based on a 1-5 Likert scale: 1 corresponded to "not important at all"; while 5 meant "very important")



The present phenomenon illustrates how sustainability claims can be understood as market signals, both informational and strategic, which frame consumer action and firm practices. Consistent with this movement, the current results provide further support for the increasing importance of sustainability certification among consumers. According to Figure 13, approximately 47.70% of Hungarian consumers reported that sustainability is important. The increased consumer concern about food products labelled as sustainable can be attributed to factors such as awareness and knowledge of environmental issues (Naz et al., 2020). Additionally, the growing interest among Hungarian consumers in buying local food plays a significant role in the trend toward sustainable food consumption (Garai-Fodor et al., 2022; Kasza et al., 2024), making sustainable labelling an important tool to help consumers achieve their sustainability goals.

In addition, the significance of sustainability for Hungarian consumers is evident not only in their attitudes but also in their buying patterns. As shown in Figure 14, approximately 54.22% of Hungarian consumers have bought food labelled with sustainability claims. This result is important because it aligns with the earlier finding (Fig. 13), which found that approximately 76.78% of Hungarian consumers considered sustainability certification an important attribute when purchasing food products. The match between perceived importance and actual purchase suggests that, for most Hungarian consumers, sustainability dimensions are not merely vague preferences but an integrated part of their consumption decision-making.



**Fig. 14.** The proportion of Hungarian consumers who have previously bought food products with a sustainable label.

These findings are in line with prior research, indicating that sustainability labels have the potential to affect consumer buying decisions when recognized, trusted, and meaningful (Z. Cai et al., 2017; Kaczorowska et al., 2019; Taufique et al., 2017). Several earlier studies have reported that consumers in Hungary show a higher preference for sustainable products (Lehota, 2015), particularly if they are locally produced and organic (Kasza et al., 2024; Nagy-p & Fogarassy, 2019; Stricht et al., 2023; Vinogradov, 2025). This trend is not limited to Hungary; other EU (i.e., Poland, France, Germany, Finland, Sweden, Belgium, etc.) and non-EU countries (U.K., U.S.A., Japan, Brazil, China, Taiwan, etc.) show similar patterns, where consumers increasingly prefer buying food products related to sustainability (Cook et al., 2023; Efraim et al., 2017;

Kaczorowska et al., 2019; Lee et al., 2018; Peschel et al., 2016; Potter, et al., 2021; Rokka & Uusitalo, 2008; Seo et al., 2019; Shaikh et al., 2024). This further suggests that consumers worldwide are paying more attention to the sustainability of their food choices.

In Hungary, 54.22% of consumers showed a positive disposition toward sustainability labelling, suggesting the emergence of a market segment aligned with ethical and environmental considerations. It implies a transformation in which certification and labelling systems operate as a bridge between consumers' moral beliefs and their purchasing activities. Aligning perceived importance with actual choices is a positive step toward the convergence of intentions and actions, indicating progress toward sustainable food systems. This conveys to producers, retailers, and policymakers the alignment of the various elements of the food system, the design and implementation of strategic awareness campaigns focused on food labelling, and targeted campaigns that are practical rather than merely theoretical or symbolic, helping steer consumers toward more responsible and sustainable food use.

### 5.3.3. Overestimation of knowledge level regarding sustainability-related labelling among Hungarian consumers

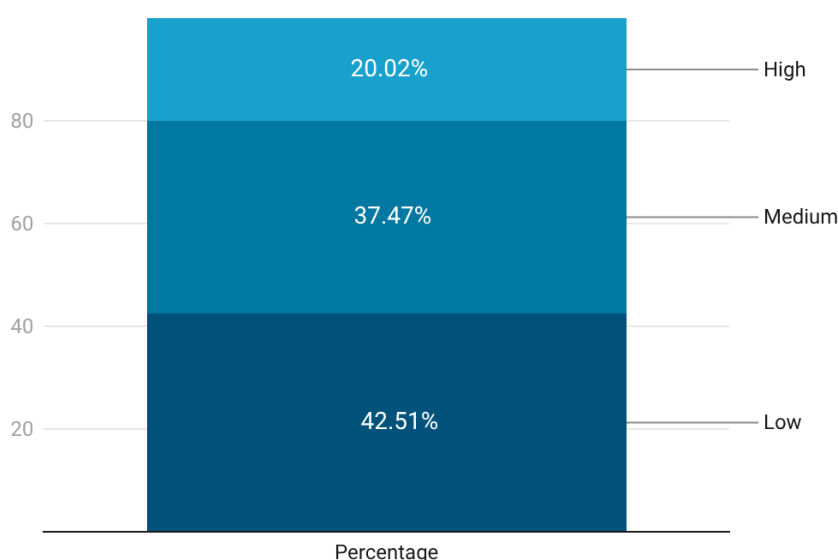
Given that most Hungarian consumers value sustainability labels (Figure 13) and have purchased products with such claims (Figure 14), it is crucial to examine not only the determinants of their selection but also their understanding of the relevant information. This is consistent with the report from (Sharief & Panghal, 2024), highlighting that the primary mode of communication regarding the sustainability measures taken with products is labelling the product; therefore, it is important to assess consumer understanding and knowledge of sustainability labelling. Additionally, it was found that many consumers take sustainability labels into consideration when making purchasing decisions (Cook et al., 2023; Dorisse & Charry, 2025; Sharief & Panghal, 2024).

In this study, consumers were asked to rate their understanding of sustainability-related labelling on a scale of 1 to 10, with 1 denoting "no understanding" and 10 denoting "complete understanding," to gauge their subjective knowledge. This self-assessment provided a subjective measure of consumers' confidence in their expertise. Additionally, four true-or-false questions were used to gauge consumers' actual understanding of sustainability-related labelling. A score between 0 and 2.5 was assigned to each question. Additionally, the maximum possible score is 10 points, with 0 denoting a false response and 2.5 denoting a right response per question. Overestimation was used when perceived knowledge exceeded actual knowledge. The following are the true-false questions:

- The sustainability label unequivocally proves that the product is environmentally friendly.
- The concept of sustainability-related labelling encompasses social and ethical aspects, such as the prohibition of child labor.
- Packaging has the greatest negative environmental impact in the food industry
- The production of animal products generates more carbon dioxide per kilogram than plant-based products.

To some extent, Hungarian consumers' attitudes and buying behavior prioritize sustainability within the food system; however, the effectiveness of these products depends on

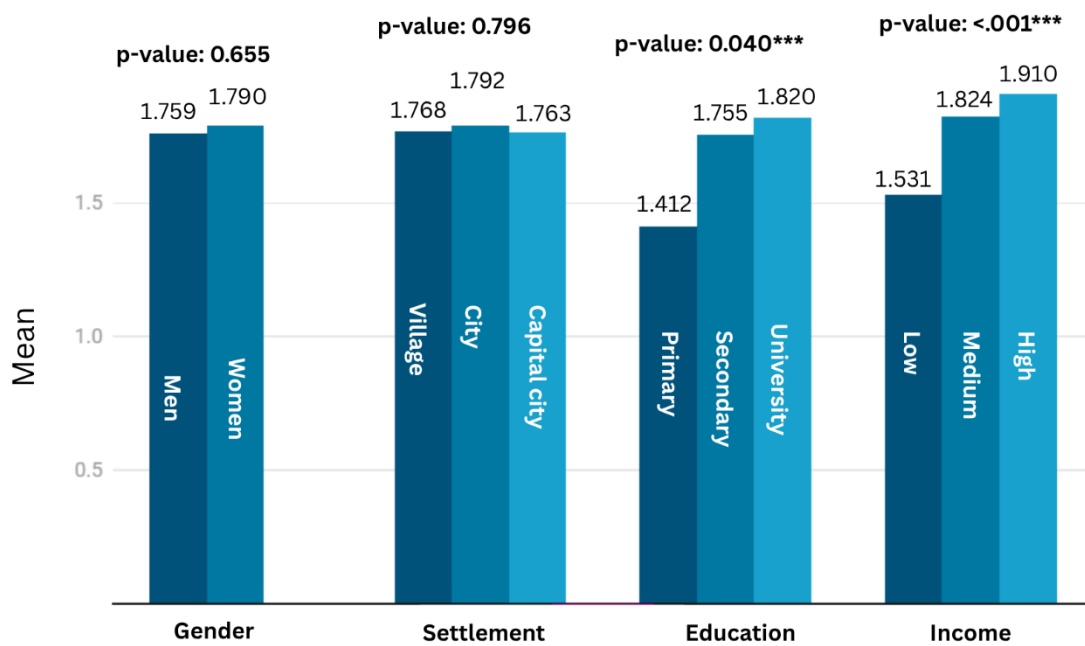
consumers' understanding and confidence in sustainability labels. As the sustainability claims become more common on food products, there is an increasing amount of misleading environmental advertising, often called greenwashing, in the food market (Guyader et al., 2017; Montero-Navarro et al., 2021; Parker et al., 2021; Sirieix et al., 2013). As greenwashing practices increase, communicating honestly and transparently becomes more complex than simply identifying and classifying products. A thorough understanding of consumer attitudes and the cognitive processing of the accompanying claims is critical (Nugraha et al., 2024). Improving consumer understanding and awareness in this area serves to maintain esteem and trust, in addition to supporting the accomplishment of the overarching goal of sustainable food systems within the expected time frame (Nugraha et al., 2024).



**Fig. 15.** The Hungarian knowledge level about sustainability labelling.

Three categories of Hungarian consumer knowledge were found in this study (Figure 15). The results show that most Hungarian consumers (42.51%) have little understanding of sustainability-related labelling, indicating that increasing consumer awareness would be crucial. Furthermore, 37.47% of Hungarian consumers indicated having medium understanding of sustainability-related labelling, while 20.02% reported having better knowledge. Understanding these knowledge categories is crucial because they indicate which consumer groups may have limited comprehension of sustainability information. Consumers with less knowledge can benefit most from educational interventions, especially when it comes to lowering the gap between subjective and actual understanding.

Furthermore, this study used a non-parametric test (Kruskal-Wallis test) to investigate correlations between consumer knowledge levels regarding sustainability-related labelling and demographic factors (Figure 16). Because it enables systematic determination of which groups are more likely to have low, medium, or high levels of knowledge, this approach to identifying specific consumer segments is essential. These observations constitute the foundation for targeted actions designed to improve comprehension of sustainability data.



**Fig. 16.** The relationship between the level of knowledge about sustainability-related labelling and socio-demographic factors. The Kruskal-Wallis test was employed to compare groups, with significance denoted as \*\*\* $p < 0.01$  and \*\* $p < 0.05$ . The dependent variable denotes the level of knowledge of sustainability labelling, categorized as 1 = low, 2 = medium, and 3 = high.

Consumers with limited understanding of sustainability-related labelling may struggle to interpret social and environmental claims, which could reduce the overall effectiveness of environmental initiatives. Policymakers can create customized communication strategies, increase label visibility, and provide readily available instructional resources by examining the factors that influence knowledge levels. This approach improves consumer confidence in sustainability certifications, closes the gap between subjective and objective understanding, encourages responsible consumption across the market, and helps consumers make informed decisions.

This study discovered that consumers with higher levels of education had a better grasp of sustainability-related labelling, with mean scores rising across primary, secondary, and university schooling. Furthermore, consumers with higher incomes had a greater knowledge of sustainability-related labelling than those with middle and lower incomes. The findings suggest that an individual's socioeconomic status (i.e., income) and educational background have a considerable impact on their knowledge of sustainability labels. The findings suggest that initiatives aimed at increasing eco-label literacy and reducing vulnerability to deceptive information should focus on consumers with less than a university education and low incomes, as they are more likely to have a limited understanding of sustainability labels.

These findings are consistent with prior research indicating that those with lower educational attainment have a greater knowledge gap in understanding sustainability labels (Aprile & Punzo, 2022; Obrad et al., 2021; Paola et al., 2020). This is because consumers with a

lesser level of education engagement struggle to grasp the complete notion of sustainability and are less aware of it (Characteristics et al., 2022; Susanty et al., 2021). Characteristics et al. (2022) also indicate that Hungarian consumers with lower levels of education are less likely to consider environmental factors when making purchasing decisions. These considerations emphasize their increased vulnerability to greenwashing efforts. This study also shows that Hungarian consumers' knowledge of sustainability labels is significantly influenced by their financial level. Middle and low-income respondents have a weaker knowledge of sustainability labels. According to the literature, high-income consumers respect and comprehend sustainability labelling (Economics et al., 2024; Obrad et al., 2021; Paola et al., 2020; Piao, 2023).

Additionally, this study aims to investigate consumers' subjective and actual comprehension of sustainability-related labelling. The aim of this study was to determine the extent to which Hungarian consumers overestimate their understanding of sustainability-related labelling on food products. According to the study, consumers' average perceived knowledge (subjective knowledge) was 5.88 on a scale of 1 to 10. However, after further investigation to ascertain their actual level of understanding, it was found to be roughly 5.58. According to cognitive bias theory, consumers frequently think they are more knowledgeable than they actually are, and this difference between subjective and actual knowledge shows that there is a substantively moderate overconfidence bias (Table 13). Overconfidence is a cognitive bias that might lead consumers to believe they have more complete or accurate knowledge than they actually do (Serfas, 2011), which could increase the probability of falling prey to greenwashing practices. Additionally, Table 14 also shows that around 45% of the consumers tend to overestimate their understanding of sustainability labelling. The difference between perceived and actual knowledge was used to measure overconfidence or overestimation. Overestimation was used when perceived knowledge exceeded actual knowledge.

**Table 13.** Consumer knowledge evaluation related to understanding sustainability labelling (paired sample t-test)

| Variable                      | Mean | Std. Dev. | Std. Error mean | p-value |
|-------------------------------|------|-----------|-----------------|---------|
| Actual knowledge              | 5.58 | 3.18      | 0.11            | 0.017** |
| Consumer knowledge perception | 5.88 | 2.08      | 0.07            |         |

Note: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ .

This result is in line with that of earlier studies showing consumers tend to have a substantively modest overestimate or be overconfident about their knowledge of food labelling (Bhawra et al., 2022; Buratto & Lotti, 2023; Islam et al., 2024). (Buratto & Lotti, 2023) also point out that when consumers are overly confident in their understanding of sustainability judgments on labels, they face a higher challenge in accurately judging them. (Hwang & Nam, 2021) reported that consumers who exhibit overconfidence in their knowledge are more likely to perceive higher subjective knowledge than objective knowledge. The discrepancy between subjective and actual knowledge is concerning, especially when it comes to making informed, accurate, and wise purchasing decisions. Without a clear understanding of the actual environmental impact of products, consumers may unintentionally fall victim to greenwashing practices. This

overconfidence is in clear contrast to the normative model, where rational decisions would imply verifying in-depth the information provided about sustainability that appears on labels.

The current situation in which consumers often overrate their knowledge (Bhawra et al., 2022; Buratto & Lotti, 2023; Islam et al., 2024) stressed the necessity of clear communication and additional education on sustainability labels (Kuehl et al., 2022; Mae & Estrada, 2024; Urbański & Ul Haque, 2020). Additionally, as consumers increasingly rely on heuristics and cognitive shortcuts, particularly when confronted with complex sustainability claims, targeted interventions are necessary to bridge the knowledge gap. These interventions should aim to equip consumers with the skills necessary to evaluate sustainability labels effectively, without falling victim to cognitive biases. These interventions could also help ensure that consumers accurately interpret the meaning of sustainability labelling and, more importantly, contribute significantly to combating greenwashing. With the rapidly increasing greenwashing in the food industry (Montero-Navarro et al., 2021; Nugraha et al., 2024) and higher consumer demand for clarity and transparency (European Commission, 2025a; Lajos Bognár et al., 2020; Marketing et al., 2025), it is important that food producers, regulators, and advocacy groups guarantee that the sustainability labels they provide are genuine, transparent, and easily comprehensible (Aprile & Punzo, 2022; Cook et al., 2023; European Commission, 2025a). Enhancing consumer understanding may alleviate the risks of overconfidence and may reduce vulnerability to greenwashing practices. This could also promote the adoption of more sustainable consumer habits.

When addressing the risks associated with greenwashing, considering the gap between subjective and actual knowledge is crucial (Nugraha et al., 2024); also, it is equally important to identify specific consumer segments that are most likely to overestimate their understanding of sustainability labels. This arises from the fact that identifying a specific group is crucial, as there is no single, monolithic consumer profile, and different demographic segments react quite differently to sustainability issues (Carrero et al., 2016). This knowledge could assist in formulating tailored educational strategies and policy measures to enhance consumer comprehension and mitigate the effects of misleading assertions about sustainability. This study explores the relationship between consumers' knowledge of sustainability labelling and their tendency to overestimate their knowledge of it. Based on these findings, this work further explores whether specific socio-demographic characteristics are associated with the understanding and overestimation of sustainability labelling.

Additionally, this study examines variables linked to consumers' overconfidence or overestimation of their knowledge and the potential connection to the propensity to fall for greenwashing. "Overestimation" is the dependent variable in the binary logistic models. It is operationalized as a dummy variable (DV) that indicates whether a respondent thinks they overestimate their expertise. The remaining variables, which relate to the respondents' sociodemographic and sustainability-related beliefs, are independent and take the form of continuous, ordinal, and dummy measures. In light of these metrics, the binary logistic models seek to evaluate each variable's role in both consumer vulnerability to greenwashing and overestimation of expertise. Moreover, the summary of the sample variables used in the binary models is listed in Table 14.

**Table 14.** Sample and variable definitions used in the binary logistic model

| Variables                                           | Description                                                                                                           | Mean   | SD     |
|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|--------|--------|
| Overestimation or overconfidence                    | DV = 1 if the consumer overestimates their understanding of sustainability labelling, 0 = otherwise.                  | 0.455  | 0.498  |
| Actual knowledge                                    | CV measured on a 0-10 scale, where 0 = low knowledge and 10 = high knowledge of sustainability labelling.             | 5.560  | 3.207  |
| Perceived importance of sustainability certificates | OD is measured on a 5-point Likert scale, with 1 indicating "not important at all" and 5 indicating "very important". | 3.624  | 1.229  |
| Female                                              | DV = 1 if the consumer is female, 0 = otherwise.                                                                      | 0.517  | 0.500  |
| Village                                             | DV = 1 if the consumer lives in the village, 0 = otherwise.                                                           | 0.171  | 0.376  |
| City                                                | DV = 1 if the consumer lives in the city, 0 = otherwise.                                                              | 0.584  | 0.493  |
| Capital                                             | DV = 1 if the consumer lives in the capital city of Budapest, 0 = otherwise.                                          | 0.246  | 0.431  |
| Elementary schools                                  | DV = 1 if the consumer graduated from elementary school, 0 = otherwise.                                               | 0.021  | 0.143  |
| Secondary schools                                   | DV = 1 if the consumer graduated from secondary school, 0 = otherwise.                                                | 0.097  | 0.296  |
| University                                          | DV = 1 if the consumer graduated from university, 0 = otherwise.                                                      | 0.527  | 0.499  |
| Age                                                 | CV; years of age.                                                                                                     | 49.533 | 16.869 |
| Income                                              | OD code: 1 = low income, 2 = medium income, 3 = high income.                                                          | 2.015  | 0.578  |

Note: SD stands for standard deviation, DV for dummy variables, CV for continuous variables, and OD for ordinal variables.

The binary logistic regression model (probit and logit) is used to identify distinct specific consumers who overestimate their understanding of sustainability labelling (Table 15). Both the logit and probit models are appropriate and fit for assessing which specific Hungarian consumers tend to overestimate their understanding of sustainability labelling. This is supported by numerous goodness-of-fit tests, including the Wald chi-square statistic ( $\chi^2(11)$ ,  $p < 0.01$ ), which is significant for both models, meaning that both models explain the variation of the dependent variable. The pseudo  $R^2$  of the logit model and probit model are 0.560 and 0.557, respectively, and both values indicate that the independent variables explain a large portion of the variation in overestimation.

**Table 15.** Binary logistic regression analysis of factors associated with the overestimation of sustainability knowledge

| Variables               | Logit model |        |          | Probit model |        |          |
|-------------------------|-------------|--------|----------|--------------|--------|----------|
|                         | Coefficient | ME     | p-value  | Coefficient  | ME     | p-value  |
| Actual knowledge        | -0.940      | -0.085 | 0.000*** | -0.525       | -0.089 | 0.000*** |
| Perceived importance of | 0.309       | 0.028  | 0.005*** | 0.173        | 0.029  | 0.003*** |

|                             |          |        |         |          |        |          |
|-----------------------------|----------|--------|---------|----------|--------|----------|
| sustainability certificates |          |        |         |          |        |          |
| Female                      | 0.018    | 0.002  | 0.940   | 0.010    | 0.002  | 0.937    |
| City                        | -0.156   | -0.014 | 0.615   | -0.109   | -0.019 | 0.512    |
| Capital city                | -0.327   | -0.030 | 0.363   | -0.219   | -0.037 | 0.265    |
| Elementary school education | 0.106    | 0.010  | 0.907   | 0.076    | 0.013  | 0.874    |
| Secondary school education  | -0.042   | -0.004 | 0.934   | -0.025   | -0.004 | 0.928    |
| Age                         | 0.017    | 0.002  | 0.016** | 0.009    | 0.001  | 0.019**  |
| Income                      | 0.387    | 0.035  | 0.059   | 0.217    | 0.037  | 0.044    |
| _cons                       | 2.443    |        | 0.000   | 1.377    |        | 0.000*** |
| ll(null)/null model         | -561.481 |        |         | -561.481 |        |          |
| ll(model)/fitted model      | -247.084 |        |         | -248.811 |        |          |
| AIC                         | 514.168  |        |         | 517.621  |        |          |
| BIC                         | 561.212  |        |         | 564.665  |        |          |
| Wald chi-square statistic   | 225.930  |        |         | 246.830  |        |          |
| ( $\chi^2(11)$ )            |          |        |         |          |        |          |
| Prob > $\chi^2$             | 0.000*** |        |         | 0.000*** |        |          |
| Pseudo R <sup>2</sup>       | 0.560    |        |         | 0.557    |        |          |

Note: \*\* p<0.05; \*\*\* p<0.01. ME refers to the estimated marginal effect.

Although both models meet standard benchmarks, most fit-comparison metrics indicate that the logit model is marginally better. Consider the model-fit log-likelihood metrics first. The logit model's log-likelihood ( $ll(model) = -247.084$ ) is lower than the probit model's ( $ll(model) = -248.811$ ), suggesting that the logit model better explains the observed data. The logit model also has better information criteria metrics. The logit model's Akaike Information Criterion (AIC) is better at 514.168 compared to the probit model's 517.621, and the logit model's Bayesian Information Criterion (BIC) is better at 561.212 compared to the probit model's 564.665. Lower AIC and BIC indicate that the model is a better fit. Collectively, these indicators, in conjunction with the marginally elevated pseudo R<sup>2</sup> and analogous marginal effects. Taken together with the logit model, the pseudo R<sup>2</sup> and marginal effects are marginally higher; hence, this study concludes that both models are good, but the logit model is a bit better and has the best overall fit in identifying the consumer segments most likely to underestimate their knowledge of sustainability labelling. Thus, the study's explanation will focus on the logit model.

The results from the logit model show several factors that impact the likelihood that consumers overestimate their understanding of sustainability labelling. Knowledge, in particular, has a strong and significant negative relationship with overestimation, and marginal effects indicate that the likelihood of overestimation decreases by approximately 8.5% for each additional unit of knowledge. This research indicates that consumers possessing greater actual knowledge are less prone to overestimate their comprehension, underscoring the safeguarding function of objective information against overconfidence. Each unit increase in perceived significance of sustainability certificates corresponds with a 2.8% increase in the likelihood of overestimation. This indicates that consumers place great emphasis on the sustainability certification or labelling, which may overestimate their knowledge, potentially reflecting enthusiasm without sufficient factual understanding.



The findings of this study illustrate the extent to which Hungarian consumers' tendency to overestimate their understanding of sustainability labelling is affected by both the actual knowledge and the value of sustainability certificates. More specifically, the greater the actual knowledge, the less the overestimation, reinforcing the idea that knowledge is crucial in limiting overestimation. In contrast, consumers who place a high value on sustainability certifications are more likely to overestimate their expertise, suggesting that passion or interest in sustainability does not always translate into precise comprehension. These findings indicate that in response to the growing interest in sustainability labelling among Hungarian consumers (Lehota, 2015), the government needs to run targeted educational campaigns, establish clear and consistent labelling regulations, and promote simple access to verified sustainability certification resources. In the face of potentially deceptive claims, such actions would improve consumers' factual understanding, align their perceptions with objective knowledge, and bolster their ability to make confident, well-informed purchasing decisions.

Moreover, age also shows a small but statistically significant effect, suggesting that older consumers tend to have a slightly greater tendency to overestimate their understanding, although the marginal effect per year is small. This overconfidence may stem from older consumers relying on broader life experience rather than actual knowledge, and the implications (Prims & Moore, 2017). (Prims & Moore, 2017) also reported that life experience does not always result in accurate judgments; instead, it can enhance overconfidence, increasing the probability of errors in label evaluation and a higher likelihood of engaging in greenwashing practices.

In short, Table 15 also concluded that Hungarian consumers' propensity to overestimate their understanding of sustainability labelling is influenced by both their actual knowledge and the perceived significance of sustainability certifications. In accordance with a prior study, Atir et al. (2024) reported that increased actual knowledge of the consumers diminishes overestimation or overclaim, supporting the view that knowledge is an essential element in reconciling subjective and actual comprehension. In contrast, this study found that consumers who have a high interest in sustainability tend to overrate their knowledge. This indicates that apprehension or sympathies regarding environmental issues do not necessarily equate to a precise understanding (Jagers, 2009). The growing interest among Hungarian consumers in sustainably labelled items may increase the risk of encountering greenwashing if it is not supported by the appropriate understanding levels of sustainability labelling.

This study also highlighted the importance of understanding sustainability labelling, which has the potential to tackle greenwashing practices in the food industry. The Elaboration Likelihood Model (ELM) of persuasion posits that individuals process information through either a central or peripheral route (Dreist et al., 2025). Central processing generally transpires when individuals are deeply engaged and possess adequate information and knowledge, enabling them to critically assess the substance of a message; conversely, peripheral processing is prevalent among individuals with minimal engagement and limited understanding, who rely on simplistic cues or surface features of the message that may be extraneous to its overall significance (Dreist et al., 2025; Walters & Long, 2012). As a result, consumers who are less involved and knowledgeable are more likely to be misled by inaccurate label information (Dreist et al., 2025). On the other hand, those who have a strong interest in the topic are less susceptible to greenwashing since they tend to assess labels more critically and understand their substance more

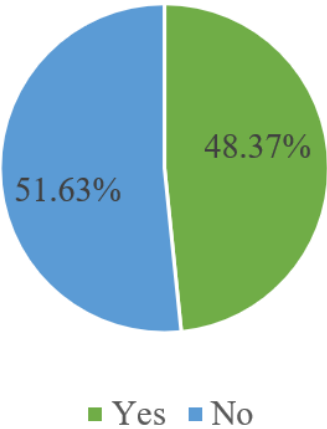
precisely (Dreist et al., 2025), especially when they are backed by sufficient information and knowledge (Dreist et al., 2025; Lieke et al., 2024; Rose et al., 2019; Schmuck et al., 2018).

The findings of this study indicate that a lack of understanding of sustainability-related labelling, as well as overestimation, are important factors that have likely contributed to the increased risk of Hungarian consumers being exposed to greenwashing practices. This study does not directly assess exposure to misleading claims, misclassification errors, or behavioral outcomes; however, the identified knowledge gaps and patterns of overestimation correspond with prior theoretical assertions that consumers who lack knowledge of sustainability-related labelling and overestimate their understanding are more susceptible to being influenced by misleading sustainability claims (Iovino et al., 2024; Urbański & Ul Haque, 2020; Buratto & Lotti, 2023).

Addressing the gaps in understanding and overestimation of sustainability knowledge is crucial, as they heighten the risk of consumer deception by misleading claims. Implementing targeted education to increase consumer understanding, simpler labelling, and clear regulatory frameworks is vital to enhancing trust in sustainable food systems and decreasing the potential of being trapped in greenwashing practices. This study elucidates the practical significance of consumer understanding in reducing the risk of falling for greenwashing and underscores the need to mitigate overestimation through tailored communication and awareness strategies. Ultimately, by advocating for transparent labelling, standardized information, and enforceable regulations, these findings help formulate more effective strategies to foster responsible, informed consumer behavior in the marketplace.

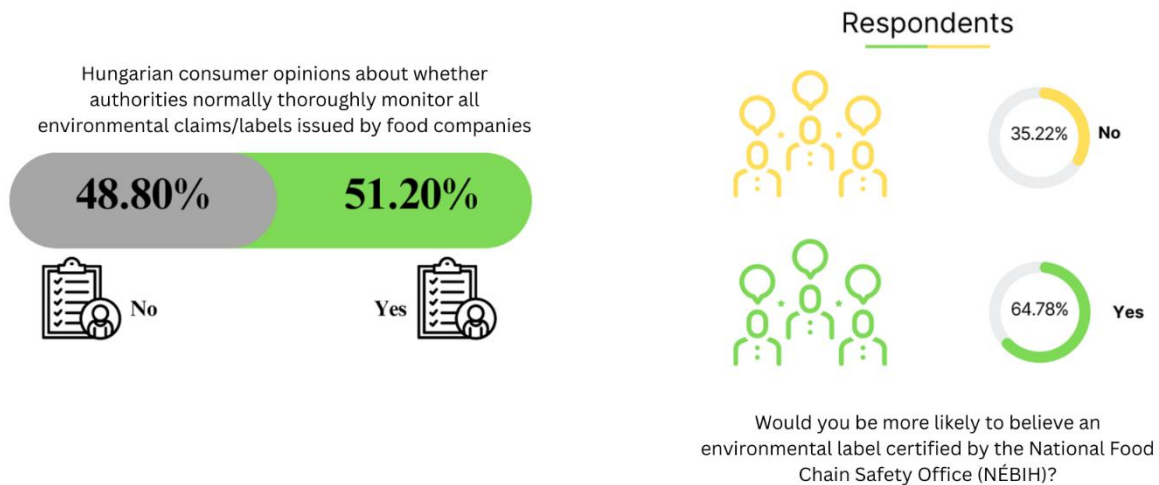
5.3.4. Trust level in sustainability claims among Hungarian consumers and their preference for food labels derived from the local government.

Since this study found that local sustainability labels are more recognizable and may represent local environmental concerns, Hungarian consumers may find them more relevant, which could explain the higher level of involvement with these labels. International labels, on the other hand, struggle to achieve widespread familiarity and trust despite some passive recognition. This is probably because of their global nature, which may not connect as strongly with local values. Based on the results, it can be concluded that international sustainability labels have greater future potential, but local ones are currently more familiar and trusted among Hungarian consumers.



**Fig. 17.** The sustainability label certified by government authorities is more reliable than those certified by private businesses or civil organizations.

This discussion is further supported by the pie chart (Figure 17), which presents Hungarian consumers' perceptions of sustainability labels by certification source. Compared with those certified by private companies or civil organizations, a slightly higher share of respondents (51.63%) report trusting government-issued sustainability labels, although 48.37% do not, indicating that there is still a tendency for Hungarians to trust sustainability-related labelling provided by the local government. This trust and preference are corroborated by the results in Table 12, which show that people find government-endorsed sustainability-related labels more trustworthy.



**Fig. 18.** How do Hungarian consumers perceive the effectiveness of authorities in monitoring environmental labels, and how likely are they to trust labels certified by the national food chain safety office (Nébih)?

Moreover, the reasons Hungarian consumers prefer local labels over foreign ones are further illustrated in Figure 18. Based on the figures, more than two-thirds of respondents (64.78%) are more readily persuaded by environmental or sustainability labels certified by the National Food Chain Safety Office of the government (Nébih). This study also found that Hungarian consumers have tremendous confidence in government-issued certifications. This result aligns with the study in Table 12, which found that local labels experienced substantially more consumer interaction than foreign labels. By trusting the Nébih-certified label, Hungarian consumers show a preference towards a locally relevant certification that complies with national regulatory standards. This aligns with the argument that local labels are more familiar and easier to relate to regarding their sustainability expectations and values.

This work also examines in more detail the importance of Nébih's sustainability labels. It is interesting to note that consumer opinions also vary by age (Table 16). The older respondents (60 years and above, 71.59%) assigned the highest meaning to Nébih-certified labels, followed by those aged 40–59 years (64.50%), 18–29 years old (62.21%), and 30–39 years old (55.47%). This study also reveals a notable disparity: consumers aged 18 to 39 are less likely to choose Nébih's sustainability labels than those aged 40 to 49. The statistical analysis shows that older age groups (over 40 years old) have much higher esteem for government certification labels.

**Table 16.** Importance of sustainability labels from Nébih among different demographic groups

| Variable   |                                     | Mean  | Post Hoc | p-value |
|------------|-------------------------------------|-------|----------|---------|
| Gender     | Women                               | 67.81 |          | 0.051   |
|            | Men                                 | 61.67 |          |         |
| Age        | 18-29                               | 62.21 | A        | 0.011** |
|            | 30-39                               | 55.47 | AB       |         |
|            | 40-59                               | 64.50 | ABC      |         |
|            | 60 and above                        | 71.59 | C        |         |
| Settlement | Village                             | 65.54 |          | 0.989   |
|            | City                                | 64.97 |          |         |
|            | Capital                             | 64.84 |          |         |
| Income     | Low                                 | 61.90 |          | 0.284   |
|            | Average                             | 66.96 |          |         |
|            | High                                | 61.15 |          |         |
| Education  | Elementary school (grade 8 or less) | 66.67 |          | 0.794   |
|            | Vocational school                   | 69.70 |          |         |
|            | Senior-high school                  | 65.71 |          |         |
|            | University                          | 63.82 |          |         |

Note: \*\*\*p < 0.01, \*\*p < 0.05.

#### 5.3.5. Exploring the market segmentation in relation to vulnerability to greenwashing practices

Cluster analysis was used to investigate Hungarian consumers' susceptibility to greenwashing by examining their knowledge, trust, and intentions regarding sustainability labels on food products. It aimed to explore how these variables influence consumers' perceptions and behaviors regarding sustainability claims and greenwashing practices. Through this examination, the research offers a constructive exploration of how consumer knowledge, trust, and intention toward sustainability influence greenwashing practices.

**Table 17.** Variable definitions and percentage statistics for consumer clustering

| Variable                                                                                                     | Description                                                                   | Percentage (%) |
|--------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|----------------|
| Knowledge<br>(Consumers answered 3 questions about sustainability labelling, with scores given from 0 to 10) | 0                                                                             | 11.35          |
|                                                                                                              | 3                                                                             | 31.16          |
|                                                                                                              | 7                                                                             | 37.47          |
|                                                                                                              | 10                                                                            | 20.02          |
| Trust<br>(The level of consumer trust in sustainability labels on food products)                             | 1<br>(I believe that almost all the statements are false)                     | 0.80           |
|                                                                                                              | 2<br>(I believe that a significant portion of these statements is misleading) | 7.80           |
|                                                                                                              | 3<br>(I believe that some statements may be false)                            | 30.50          |
|                                                                                                              | 4<br>(I believe that these statements are generally fair)                     | 45.70          |
|                                                                                                              | 5                                                                             | 15.20          |
|                                                                                                              |                                                                               |                |

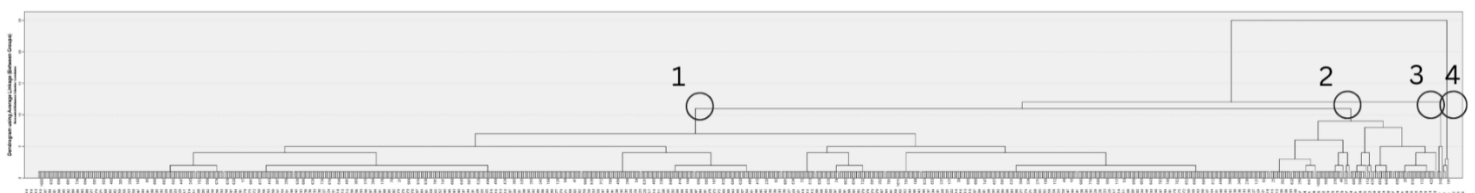
|                                                              | (I believe that these statements<br>are true and rigorously verified)           |       |
|--------------------------------------------------------------|---------------------------------------------------------------------------------|-------|
| Intention                                                    | 1                                                                               | 1.10  |
| (Consumer intention to purchase<br>sustainably labeled food) | (I do not like such labels)                                                     |       |
|                                                              | 2                                                                               | 9.30  |
|                                                              | (I am not interested, so, the<br>information is neutral for me)                 |       |
|                                                              | 3                                                                               | 67.20 |
|                                                              | (It is good to have such a label,<br>but it is not my primary<br>consideration) |       |
|                                                              | 4                                                                               | 22.30 |
|                                                              | (This is very important for me)                                                 |       |

Source: Own data collection

Additionally, Table 17 indicates that most respondents had low knowledge of sustainability-related labelling, as assessed by consumer knowledge analysis (42.51%, with a score of 6-10 out of 10). In response to how much trust they had in the sustainability labels, more than half (60.90%) and 39.10% were skeptical that some claims might be misleading. Additionally, this study found that 67.20% of Hungarian respondents are interested in sustainability labels, and about 22.30% consider them essential.

Table 18 presents a cluster analysis using standardized z-scores for each variable to evaluate consumer segments based on their sustainability knowledge, trust, and intentions to purchase products with a sustainability label. This normalization was necessary because the study's categorical variables were measured on different scales. By standardizing all variables to z-scores, the scale of measurement is adjusted so that comparisons can be made more precisely and meaningfully. This solution helps prevent any single variable from dominating the analysis, thereby improving the reliability and stability of the clustering results.

Additionally, the hierarchical clustering dendrogram provides a principled approach to estimating the optimal number of clusters in a dataset (Boyko & Tkachyk, 2023). In the context of K-means clustering, this hierarchical analysis helps determine the optimal value of k (the number of clusters) (Boyko & Tkachyk, 2023). Unlike K-means, which requires prior knowledge of the number of clusters (Fahim, 2021), Hierarchical clustering offers a more natural, visual approach to determining the number of clusters. Cutting at 4, which divides the data points into three groups, yields the most reasonable solution based on the dendrogram (Figure 19). Thus, four clusters are the ideal choice, as they balance simplicity and meaningful segmentation of the data.



**Fig. 19.** A hierarchical clustering dendrogram result

In addition, the analysis of k-means reveals significant differences among clusters across

all three variables: trust, knowledge, and intention (Table 18). This indicates that trust, knowledge, and intentions toward sustainability labels vary across consumer groups.

Due to the increasing preference for sustainability labelling among Hungarian consumers (Yeh et al., 2020), examining trust, knowledge, and the intention to purchase sustainable products is important for understanding environmentally sustainable consumption and assisting in addressing greenwashing practices (Isac et al., 2025; Saragi, 2025; H. Wang et al., 2019; Yudistira et al., 2025). Trust is a key factor in the extent to which consumers can be expected to trust sustainability claims when making purchase decisions (Cai et al., 2025; Isac et al., 2025; Wang et al., 2019). Clear, transparent information enables consumers to distinguish between genuine sustainability and false marketing (Nugraha et al., 2024). Now, in the age of greenwashing and other deceptive corporate claims surrounding environmental responsibility, these two points are front and centre. Greenwashing undermines the credibility of sustainability labels among consumers, making it more difficult for authentic sustainability to gain attention (Nugraha et al., 2024). By examining the dynamics of trust, knowledge, and purchase intentions, researchers can identify vulnerable consumer segments most likely to engage in greenwashing and inform strategies to enhance label transparency and authenticity, ensuring that sustainability claims remain credible and compelling.

**Table 18.** Evaluating consumer clusters on sustainability knowledge, trust, and purchase intentions

| Variables | Cluster                        |                                         |                                          |                                 | F       | p-value  |
|-----------|--------------------------------|-----------------------------------------|------------------------------------------|---------------------------------|---------|----------|
|           | Selective adopters<br>(50.96%) | Primary greenwashing target<br>(22.04%) | Moderate greenwashing target<br>(17.09%) | Green label skeptics<br>(9.91%) |         |          |
| Trust     | 0.229                          | 0.708                                   | -1.089                                   | -0.927                          | 233.440 | <.001*** |
| Knowledge | 0.784                          | -1.056                                  | -0.893                                   | -0.245                          | 736.247 | <.001*** |
| Intention | 0.279                          | 0.268                                   | 0.022                                    | -2.062                          | 297.648 | <.001*** |

Note: \*\*\* $p < 0.01$ , \*\* $p < 0.05$ .

Based on sustainability knowledge, trust, and purchase intent, the K-means cluster analysis revealed four different consumer segments, emphasizing significant variations across these characteristics. The largest group, “Selective Adopters” (50.96%), showed moderate purchase intention, high sustainability knowledge, and moderate levels of trust. According to this profile, these consumers are careful and discriminate in their purchases, as they are knowledgeable about sustainability and use critical judgment when assessing green products. This segment is a key target for transparent, educational sustainability marketing, as their informed decision-making can reinforce genuine green practices and encourage market accountability.

In addition, the “Primary Greenwashing Target” segment (22.04%) had low understanding, moderate purchase intention, and high trust of sustainability-related labelling. Due to their limited understanding of sustainability and trust, but with moderate purchase intention, these consumers in this segment appear more vulnerable to greenwashing, making them more likely to accept green marketing claims without critical consideration. Moreover, the “Moderate Greenwashing Target” segment (17.09%) displayed low trust, low knowledge, and moderate buying intention for sustainability labelling, suggesting consumers who are somewhat aware of sustainability but have less confidence and engagement with sustainable products. Although less

vulnerable than the primary target, this segment can nevertheless be swayed by misleading marketing in some circumstances, emphasizing the importance of complex marketing tactics that meet varied levels of consumer knowledge and trust. To capture the range of consumers susceptible to greenwashing, the primary and intermediate greenwashing objectives were often combined for analytical purposes. This combined group discovered that over 39.13% of Hungarian consumers are susceptible to misleading sustainability claims, indicating that a significant portion of the market may be influenced by greenwashing and emphasizing the importance of identifying and understanding these specific consumer segments.

Based on sustainability knowledge, trust, and purchase intents, the K-means cluster analysis revealed four different consumer segments, emphasizing significant variations across these characteristics. The largest group, "Selective Adopters" (50.96%), showed moderate purchase intention, high sustainability knowledge, and moderate levels of trust. According to this profile, these consumers are careful and discriminating in their purchases, as they are knowledgeable about sustainability and use critical judgment when assessing green products. This segment represents a key target for transparent and educational sustainability marketing, as their informed decision-making can reinforce genuine green practices and encourage market accountability.

In addition, the "Primary Greenwashing Target" segment (22.04%) had low understanding, moderate purchase intention, and high trust of sustainability-related labelling. Due to their limited understanding of sustainability and trust, but with moderate purchase intention, these consumers in this segment appear more vulnerable to greenwashing, making them more likely to accept green marketing claims without critical consideration. Moreover, the "Moderate Greenwashing Target" segment (17.09%) displayed low trust, low knowledge, and moderate buying intention for sustainability labelling, suggesting consumers who are somewhat aware of sustainability but have less confidence and engagement with sustainable products. Although less vulnerable than the primary target, this segment can nevertheless be swayed by misleading marketing in some circumstances, emphasizing the importance of complex marketing tactics that meet varied levels of consumer knowledge and trust. To capture the range of consumers susceptible to greenwashing, the primary and intermediate greenwashing objectives were often combined for analytical purposes. This combined group discovered that over 39.13% of Hungarian consumers are susceptible to misleading sustainability claims, indicating that a significant portion of the market may be influenced by greenwashing and emphasizing the importance of identifying and understanding these specific consumer segments.

Additionally, the "Green Label Sceptics" segment (9.91%) showed low purchase intention, low understanding, and low trust in sustainability labelling. This group is strongly resistant to green marketing and is extremely skeptical of sustainability claims, indicating a cautious approach that stresses evidence and reliability over promotional messaging. Understanding this group is critical for marketers and policymakers, as it will provide a baseline for consumer scrutiny and shed light on the performance of genuine environmental measures.

This study found an interesting finding that there is a considerable group of Hungarian consumers (39.13%) who become greenwashing targets (Primary greenwashing target and Moderate greenwashing target). The majority of the primary greenwashing target group reports moderate trust and intends to buy food with sustainable labelling, but knowledge remains low; hence, consumers are easily deceived by false environmental claims. Brouwer (2016) also found

that consumers with high trust in sustainability but insufficient knowledge are particularly vulnerable to greenwashing practices. This type of consumer may find it hard to distinguish genuine from non-genuine sustainability claims; thus, increasing transparency and providing clearer information on sustainability (Nugraha et al., 2024) is important. In addition, 43.19% of Hungarian consumers are identified as selective greens, with moderate knowledge and intentions but low trust in the sustainable label. Such consumers still intend to buy, but because they have greater knowledge of sustainable labelling, they tend to be more selective and can also affect trust. Furthermore, when consumers are well-informed about sustainability labelling, they become more selective in their food choices. Kovač et al. (2025) reported that when consumers encounter unclear or vague product claims, this can lead to scepticism and further erode their trust in the label. Moreover, to lower the perceived risk of adopting more sustainable consumption behaviours among these consumers, it is worth exploring ways to influence consumer perceptions of sustainability and improve label credibility.

Taken together, these findings highlight the diversity of consumer reactions to sustainability labelling and greenwashing, suggesting that consumer behavior cannot be treated uniformly. Investigating specific consumer segments using clustering methods is thus crucial for developing targeted interventions, improving marketing communications, and ensuring that sustainability efforts reach their intended audience. The study emphasizes the need for targeted methods not only to reduce the impact of greenwashing but also to improve informed consumer participation, promote transparency, and support more responsible consumption patterns across markets.

**Table 19.** Demographic profile of consumer segments in greenwashing study (%)

| Variable   | Description                         | Cluster            |                             |                              |                      | p-value  |
|------------|-------------------------------------|--------------------|-----------------------------|------------------------------|----------------------|----------|
|            |                                     | Selective adopters | Primary greenwashing target | Moderate greenwashing target | Green label skeptics |          |
|            |                                     | (50.96%)           | (22.04%)                    | (17.09%)                     | (9.91%)              |          |
| Gender     | Women                               | 52.85%             | 25.54%                      | 15.72%                       | 5.89%                | <.001*** |
|            | Men                                 | 48.96%             | 18.33%                      | 18.54%                       | 14.17%               |          |
| Age        | 18-29                               | 53.14%             | 20.57%                      | 16.00%                       | 10.29%               | 0.907    |
|            | 30-39                               | 48.23%             | 19.86%                      | 19.86%                       | 12.06%               |          |
|            | 40-59                               | 50.00%             | 22.25%                      | 18.13%                       | 9.62%                |          |
|            | 60 and above                        | 51.96%             | 23.86%                      | 15.03%                       | 9.15%                |          |
| Education  | Elementary school (grade 8 or less) | 30.00%             | 35.00%                      | 20.00%                       | 15.00%               | 0.007*** |
|            | Vocational school                   | 33.78%             | 31.08%                      | 16.22%                       | 18.92%               |          |
|            | Senior-high school                  | 53.73%             | 23.28%                      | 15.22%                       | 7.76%                |          |
|            | University                          | 54.29%             | 19.43%                      | 17.14%                       | 9.14%                |          |
| Settlement | Village                             | 48.17%             | 26.83%                      | 15.24%                       | 9.76%                | 0.068    |
|            | City                                | 53.27%             | 22.30%                      | 15.58%                       | 8.85%                |          |
|            | Capital                             | 50.21%             | 16.17%                      | 21.28%                       | 12.34%               |          |
| Job        | Active worker (employee)            | 50.91%             | 21.50%                      | 16.63%                       | 10.95%               | 0.422    |



|        |                                   |        |        |        |        |          |
|--------|-----------------------------------|--------|--------|--------|--------|----------|
|        | Entrepreneur<br>(self-employed)   | 52.44% | 18.29% | 17.07% | 12.20% |          |
|        | Retired,<br>disabled<br>pensioner | 51.63% | 23.17% | 16.67% | 8.54%  |          |
|        | Jobseeker                         | 54.55% | 4.55%  | 36.36% | 4.55%  |          |
|        | Housemaker                        | 55.56% | 33.33% | 0.00%  | 11.11% |          |
|        | Student                           | 55.32% | 23.40% | 15.96% | 5.32%  |          |
| Income | Low                               | 32.64% | 31.94% | 22.92% | 12.50% | <.001*** |
|        | Average                           | 55.28% | 20.33% | 15.77% | 8.62%  |          |
|        | High                              | 60.12% | 18.40% | 11.04% | 10.43% |          |

Note: \*\*\*p < 0.01, \*\*p < 0.05.

Moreover, these behavioral insights are further enhanced when considered alongside the demographic profiles of each group, showing that susceptibility to greenwashing is influenced by Socio-demographic (i.e., gender, education, age, etc.) factors in addition to knowledge, trust, and purchase intention (Table 19). It is clear from combining cluster features with demographic trends that various groups react differently to sustainability-related labelling. This relationship emphasizes how crucial it is to integrate behavioral and demographic analysis in order to completely comprehend consumer heterogeneity and to develop more accurate, focused marketing communication and policy intervention methods. This integration highlights the necessity of accounting for both behavioral and demographic aspects to understand consumer variability and generate precise, targeted marketing communications and policy actions (Caferra et al., 2025; Clarke et al., 2024; Theodorakopoulos et al., 2026; Yang & Nugraha, 2021).

The demographic characteristics of the consumer categories provide insights into the behavioral patterns revealed in the clustering study and vice versa. Significant variations were found between the segments, particularly in gender disparities. Women were slightly more represented than men among the Selective Adopters (53.37% and 46.63%), which aligns with the segment's profile of high sustainability knowledge, moderate trust, and moderate purchase intention. The implication is that the women in this category may be more cautious about product information and more selective about sustainability claims, thereby confirming their status as informed and discerning consumers who make conscious buying decisions.

On the other hand, unique gender trends were also seen in the Primary and Moderate Greenwashing Target groups, which together accounted for nearly 39% of consumers. Women made up a larger percentage of the Primary Greenwashing Target than men (59.63% and 40.37%), suggesting that women in this group are especially susceptible to greenwashing due to their lower understanding and strong belief or trust in sustainability labels. On the other hand, men were slightly more prevalent (52.66% vs 47.34%) in the Moderate Greenwashing Target, suggesting that factors such as reduced involvement or skepticism toward sustainability messaging may affect susceptibility in this group. These variations show how important it is to examine each consumer segment separately, as vulnerability to greenwashing is neither consistent nor independent of demographic traits.

Moreover, the Green Label Skeptics (9.91%) were predominantly male (69.39% men vs. 30.61% women), which is consistent with their cluster features of small purchase intention, low knowledge, and low trust. Strong opposition to green marketing is evident in this section, which emphasizes a cautious strategy that puts credibility and proof ahead of promotional claims. In line with the study from Yu, (2020) on gender differences in perceptions of eco-labels, the preponderance of men in this segment may suggest that male consumers are more skeptical of

green marketing.

In short, combining both behavioral and demographic research allows for a more robust and nuanced understanding of consumer behavior within the context of sustainability (Kasza et al., 2023). The results highlight the heterogeneity of consumer responses and the need to design marketing and policy strategies for different segments. Marketers and policymakers need to take into account different levels of knowledge, trust, engagement, and demographic characteristics when designing messages that effectively reach the target population. To reduce misleading claims, increase transparency, and encourage educated and responsible consumption patterns across markets, it is important to study and identify consumer segments that are more sensitive to greenwashing (Nugraha et al., 2024; Persakis et al., 2025).

The analysis showed that education level, in addition to gender, is a significant factor in differentiating consumer categories. The majority of consumers across sectors held a university degree, with the highest percentage among Selective Adopters (57.46%). This is consistent with the cluster characteristics, indicating that higher education is associated with a better understanding of sustainability and a more critical assessment of green claims (Aminravan et al., 2025; Grunert et al., 2014). The Primary greenwashing target shows that consumers with a senior high school or lower education level tend to be the primary target, as they lack a higher level of understanding but still trust and intend to buy food with a sustainability label. For the moderate greenwashing targets, this is somewhat unique: consumers tend to have low knowledge and trust but still intend to buy, and the majority of this group are consumers with a university degree. These criteria were also found to be the same in the green-label skeptic group.

These results highlight how consumer reactions to sustainable labelling are influenced by education, knowledge, trust, and purchasing intention. While consumers with less formal education, especially those in the target categories for greenwashing, are more vulnerable to persuasive marketing tactics, consumers with higher levels of education typically exhibit greater discernment and resistance to false claims. The complexity of vulnerability to greenwashing is shown by integrating educational profiles with behavioral and gender data, which also emphasizes the significance of segment-specific approaches for marketing communication and policy formulation. To encourage educated decision-making, lessen the impact of false claims, and improve overall consumer involvement with genuine sustainable products, the sustainability message must be tailored to the cognitive and educational traits of each group.

Moreover, this study found that income is significantly associated with consumer segmentation in greenwashing (Apostolopoulos et al., 2025; Rehman et al., 2025), highlighting the socio-economic factors that influence susceptibility to sustainability claims. The majority of Selective Adopters fall into the average- to high-income category, with a smaller share in the low-income category. This shows that moderate- and higher-income consumers, who have higher educational attainment, are the most knowledgeable group, capable of critically examining sustainability labels and making intentional purchasing decisions.

In contrast, low-income consumers are more prevalent in the Primary Greenwashing Target and Moderate Greenwashing Target categories, whereas high-income consumers are less prevalent. These trends suggest that consumers with lower incomes may be more susceptible to greenwashing because they have fewer resources, are less knowledgeable about sustainability, and rely more on marketing claims. Both groups show moderate purchase intentions despite wealth disparities, indicating that accessibility and cost may interact with trust and knowledge to affect susceptibility to greenwashing. In addition, the distribution of Green Label Skeptics also shows a similar pattern with the consumers in the Primary Greenwashing Target and Moderate Greenwashing Target categories, as the consumers in this group tend to have an average and lower income.

In general, the combination of income with gender, education, and behavioral characteristics highlights the intricate interaction between socioeconomic and cognitive aspects in determining how consumers react to greenwashing and sustainability labelling. While lower-income consumers are disproportionately concentrated in the vulnerable greenwashing-target sectors, higher-income and better-educated consumers typically display more informed and selective purchasing behavior. These results highlight the need for customized communication tactics that take socioeconomic circumstances, as well as knowledge and trust, into account to ensure fair access to trustworthy sustainability information and lessen the impact of deceptive green marketing.

Overall, these results show that a variety of behavioral, cognitive, and sociodemographic characteristics, such as knowledge, trust, purchase intention, gender, education, and income, influence how consumers react to sustainability labelling. Lower-income and less-educated consumers are more susceptible to greenwashing, especially within the Primary and Moderate Greenwashing Target groups, whereas Selective Adopters exhibit greater discernment and resistance. This emphasizes the importance of researching specific consumer groups to develop targeted marketing and regulatory initiatives. Additionally, policy actions should aim to increase transparency and consumer literacy, such as stronger labelling regulations, more accessible educational initiatives, and monitoring of false claims. Businesses must customize their communication strategies to segment characteristics, guaranteeing credible, evidence-based messaging for vulnerable consumers while engaging informed segments with value-driven sustainability programs. These findings emphasize the importance of combining behavioral and demographic profiles to capture consumer heterogeneity, allowing for more effective interventions to promote informed decision-making, limit the effects of greenwashing, and encourage responsible purchasing.

**Table 20.** Examining the association between trust in sustainability labels and consumers' purchase experiences across different segments

| Variable                                              | Description     | Cluster            |                             |                              |                      | p-value  |
|-------------------------------------------------------|-----------------|--------------------|-----------------------------|------------------------------|----------------------|----------|
|                                                       |                 | Selective adopters | Primary greenwashing target | Moderate greenwashing target | Green label skeptics |          |
|                                                       |                 | (50.96%)           | (22.04%)                    | (17.09%)                     | (9.91%)              |          |
| Gov-certified sustainability labels are more reliable | Yes             | 54.13%             | 63.69%                      | 52.58%                       | 55.10%               | 0.094    |
|                                                       | No              | 45.87%             | 36.31%                      | 47.42%                       | 44.90%               |          |
| Bought food with a sustainability label before        | Yes             | 63.68%             | 45.73%                      | 59.39%                       | 22.68%               | <.001*** |
|                                                       | I cannot decide | 10.85%             | 6.10%                       | 9.09%                        | 15.46%               |          |
|                                                       | No              | 25.47%             | 48.17%                      | 31.52%                       | 61.86%               |          |

Note: \*\*\*p < 0.01, \*\*p < 0.05.

Furthermore, the relationship between clusters in sustainability-related labelling and prior purchase experiences sheds light on disparities in consumer behavior (Table 20). Significant differences were seen among groups, especially in their purchasing experience with sustainability-related labelling. Selective Adopters had the highest proportion of prior purchases of sustainability-related products, indicating greater awareness, moderate trust, and educated

decision-making. This finding is consistent with prior research from Mabangure & Fatahi Valilai (2025), which has shown that well-informed and critically engaged consumers are more likely to act on sustainability knowledge when making purchasing decisions. Importantly, both the Primary Greenwashing Target and the Moderate Greenwashing Target groups indicated a substantial number of prior purchases of food labelled as sustainable. This pattern suggests that a significant proportion of Hungarian consumers, despite limited comprehension of sustainability labels, continue to make purchases based on confidence in or perceived legitimacy of the labels. As a result, these sectors are especially prone to greenwashing, as their increased purchasing activity, combined with a lack of information, enhances their susceptibility to misleading sustainability claims. These findings are consistent with previous research showing that consumers with limited sustainability literacy can nevertheless be swayed by marketing cues, highlighting the potential for greenwashing among less knowledgeable but active buyers (Nabi Khan et al., 2025; Nugraha et al., 2024).

These findings have major policy and practice implications. Policymakers and regulatory authorities should prioritize targeted training programs to improve awareness of sustainability-related labelling, particularly among consumers in the Primary and Moderate Greenwashing Target categories. Businesses' sustainability communications should emphasize transparent, evidence-based assertions to guarantee that confidence is backed up by verifiable data. Interventions tailored to each consumer segment's knowledge, trust, and purchasing behavior can help to reduce the impact of greenwashing, promote responsible consumption, and boost confidence in genuine sustainability efforts.

## 6. CONCLUSIONS, RECOMMENDATIONS, AND FUTURE DIRECTIONS

### 6.1. Conclusions, recommendations, and implications

The systematic literature review highlights the increasing incidence of greenwashing in the food sector, particularly regarding labelling strategies, transparency, and consumer behavior. It underscores the pressing need for stricter rules, regulations, and better consumer information to combat false environmental claims. Key drivers of greenwashing were the lack of transparency and confusion over eco-labelling, indicating the need for unambiguous regulation, particularly at the EU level, to establish a harmonized legal framework across the internal market, enabling authorities, NGOs, and professional organizations to jointly advance anti-greenwashing strategies and agendas. The challenge requires a continuous investigation of consumer knowledge, preferences, expectations, and misbeliefs regarding sustainability-related labelling, the prevalence of greenwashing and its effect on purchase behavior, and the role of third-party certification in combating deceptive practices. The primary studies reported in this thesis addressed research gaps by analyzing the actual supply in retail chains with special regard to sustainability labels and collecting quantitative consumer data on sustainability-related awareness and preferences supporting targeted interventions against greenwashing.

The findings include a list of the most prevalent sustainability-related labels in the Hungarian retail sector, where the most widely available one was the Magyar Termék label (indicating the local origin), covering 61.19% of the analyzed products. This was followed by the FSC label (13.12%) and the EU Organic label (7.82%). These findings imply that domestic sustainability labels are more popular among Hungarian consumers, whereas international labels are less common and are mostly found on packaged or processed goods like fruit jams and dry pasta. Additionally, the study showed that 70.53% of the products were domestic, and local retailers offered a greater percentage of domestic products than international retailers (79.26% and 66.79%). The results show that Hungarian consumers have faith in and trust locally made, sustainably certified goods, underscoring the importance of local food systems and domestic labels in shaping consumer demand and encouraging sustainable business practices.

The present research also highlights the importance of sustainability-related labelling in consumer decision-making, finding that 47.70% of consumers in Hungary have a strong belief that sustainability is an important criterion in food purchases, and 54.22% have purchased products, being aware of the sustainability labels they carry. The study's findings highlight the importance of sustainability-related labelling to consumer choice, particularly among Hungarian consumers. The growing interest in sustainability labels when purchasing is another indication that Hungarian food consumption is becoming more environmentally conscious. The study finds that Hungarian consumers exhibit a slight overconfidence, overestimating their understanding of sustainability-related labelling, yet the growing consumer interest in sustainability should nonetheless be recognized as a positive foundation for future engagement. These results also suggest that Hungarian consumers may be more vulnerable to deceptive sustainability claims if they overestimate their level of knowledge and have a poor comprehension of sustainability-related labelling.

This study also shows that while simple enthusiasm or curiosity may inflate perceived skill, knowledge acts as a buffer against overconfidence. Consumers who have a thorough understanding of sustainability-related labelling are less likely to overestimate their knowledge, whereas those who are more interested in sustainability but do not fully understand it may exaggerate their perceived abilities. This overconfidence may increase vulnerability to false information and lead to the misinterpretation of sustainability claims.

The research additionally revealed a negligible effect of age on overestimation. Older consumers demonstrated a slightly higher propensity to overestimate their understanding of sustainability-related labelling compared to younger consumers. This may stem from older consumers relying on substantial life experience rather than exact, correct information. This overconfidence may increase the likelihood of errors in assessing sustainability claims and heighten susceptibility to misleading labels.

Given these results, it is imperative to facilitate clear communication and education about sustainable-related labelling in Hungary to enhance consumer knowledge and mitigate overestimation. This study has practical implications for understanding sustainability-related labelling and its influence on greenwashing. Given the growing interest in sustainability-related labelling among Hungarian consumers, targeted initiatives to improve education and inform the public about the real significance of sustainability certifications could help mitigate the risks of greenwashing and enable consumers to make informed decisions. This research establishes a basis for promoting informed and responsible consumption by identifying consumer segments at risk and addressing their knowledge gaps through targeted education and enhanced labelling practices. Moreover, these findings may aid policymakers, stakeholders, and the Hungarian government in enhancing consumer protection against greenwashing in sustainable purchasing, in alignment with the European Commission's Green Claims initiative.

Additionally, the research finds that Hungarian consumers are more familiar with and trust government-supported sustainability labels, as official government authorization (i.e., Nébih) plays an important role in building consumer trust. In addition, k-means cluster analysis reveals additional consumer heterogeneity by identifying four distinct segments based on sustainability knowledge, trust, and purchase intentions: Selective Adopters (50.96%), Primary Greenwashing Targets (22.04%), Moderate Greenwashing Targets (17.09%), and Green Label Skeptics (9.91%). Selective Adopters have more information, moderate trust, and thoughtful purchase behavior, making them ideal candidates for educational sustainability programs that encourage informed decisions. In contrast, the Primary and Moderate Greenwashing Target categories, although with lower knowledge and variable confidence levels, demonstrate significant past buying behavior for sustainability-labelled products. This suggests that a substantial proportion of Hungarian consumers (39.13%) are vulnerable to greenwashing, as their purchase decisions are not necessarily informed by a thorough understanding of sustainability claims. Green Label Skeptics, defined by low trust, knowledge, and purchasing intent, serve as a baseline for critical analysis, emphasizing cautious participation with sustainable-related labelling.

Building on these findings, this study suggests numerous important policy implications for combating greenwashing in the food industry, particularly regarding sustainability labels. Given the heterogeneity highlighted by the cluster analysis, interventions should be tailored to

the specific requirements and vulnerabilities of each section. Decision-makers need to establish clear, standardized rules for sustainability labels to reduce misleading claims. Furthermore, increasing consumer awareness through public service advertising and educational programs is critical, especially for at-risk groups. These methods will provide consumers with accurate information, reduce susceptibility to greenwashing, and encourage more informed and responsible purchasing behaviors, ultimately improving trust and engagement with genuine sustainability projects.

In addition, government-supported sustainability labels should be considered as potential intervention instruments, as they are more trusted by Hungarian consumers. This trust advantage is particularly important in a market environment characterized by proliferating labels, information asymmetry, and varying levels of consumer understanding around sustainability claims. Thus, broader adoption of recognized and established certification programs can protect against misleading private claims, increase market transparency, and improve the overall credibility of sustainability communication. Thus, public authorities act as regulators and anchor points for trust, providing relative stability for consumers in their interpretation of sustainability-related information. To sum up, the fight against greenwashing requires a comprehensive strategy with robust labeling systems, targeted consumer education, and government enforcement to support responsible, informed consumption behaviors while ensuring that sustainability claims are scientifically verified and comparable across products and markets.

This need for coherence and enforceability in the framework is more clearly illustrated by Directive (EU) 2024/825, which has been adopted to combat the ongoing fragmentation of consumer protection laws between Member States regarding environmental claims and sustainability-related information. By creating a uniform baseline across the EU internal market, the Directive addresses legal divergence and regulatory gaps that previously led to uneven enforcement of greenwashing practices. Member States will have to implement the Directive into national law by March 27, 2026. Implementation will be phased, beginning with a six-month period before the full rollout on September 27, 2026. The purpose of this staggered timeline is to ensure legal certainty while allowing sufficient national adaptation on the institutional and administrative fronts.

Directive (EU) 2024/825 addresses this systematic information gap and therefore strengthens the EU consumer protection architecture by improving existing standards to provide better information on product durability, reparability, and environmental performance. It strengthens protections against deceptive environmental claims and implements measures to ensure they are carried out by establishing, in the Unfair Commercial Practices Directive, a new mechanism for penalizing ambiguous, unsupported, or potentially misleading "green" marketing techniques. The Directive also harmonizes horizontal consumer law provisions by amending the Unfair Commercial Practices Directive and the Consumer Rights Directive. This guarantees a closer match with the objectives of both the Circular Economy Action Plan and the European Green Deal. These changes strengthen national-level policy tools, such as government-backed sustainability labels, by embedding them within a wider EU-level regulatory structure designed to better coordinate information, reduce consumer confusion, and systematically clamp down on greenwashing opportunities across the internal market.

## 6.2. Limitations and future directions

Despite the significant advantages of the present study, there are still certain limitations. The principal limitation of this study is the lack of direct measurement of consumers' exposure

to deceptive sustainability claims, misclassification errors, or behavioral responses, which hinders its ability to address and empirically validate whether knowledge overestimation correlates with increased susceptibility to greenwashing. While numerous studies have validated the theoretical link between overconfidence and vulnerability to deceptive assertions, this relationship has not been examined in this context. Additional study may address this disparity through experimental designs, longitudinal tracking, or real-world purchasing data to evaluate the relationship between overestimation of sustainability knowledge and exposure to greenwashing and its impact on consumer behavior. This research would enhance the empirical foundation for mechanisms elucidating consumer vulnerability and guide the development of effective strategies to mitigate the effects of deceptive labels. Moreover, this study did not directly measure the effects of greenwashing on economic performance or environmental outcomes. Consequently, the findings may not fully capture the broader implications of greenwashing practices. Future research is recommended to quantitatively assess how greenwashing affects both economic indicators and environmental sustainability, thereby providing a more comprehensive understanding of its impact.



## 7. NEW SCIENTIFIC RESULTS

- I. In Hungarian retail, sustainability-related labels in the analyzed product categories are predominantly local, accounting for approximately 91% of label presence, with international labels constituting the remaining 9%.
- II. A significant part (43%) of Hungarian consumers has only a limited understanding of sustainability-related labelling, and about 46% tend to overestimate their understanding of sustainability labels. Age was found to play a significant role (logistic regression,  $p < 0.05$ ) in the level of overestimation related to sustainability-related labelling, which could be used for targeted awareness raising against greenwashing.
- III. Actual knowledge of sustainability-related labelling is a significant negative predictor of knowledge overestimation among Hungarian consumers (logistic regression,  $p < 0.05$ ), indicating that consumers with lower objective knowledge systematically overestimate their understanding, while those with higher knowledge demonstrate more accurate self-assessment.
- IV. Hungarian consumers express greater confidence in and a preference for sustainable food labels issued by the government. About 51% of consumers consider these “official” labels to be more reliable, 51% perceive them as compliant with stricter regulations, and 65% report trusting specific sustainability-related labelling from a government-issued sustainability label (Nébih).
- V. A substantial share (39%) of Hungarian consumers was classified as “greenwashing targets (combination of primary and moderate greenwashing target)”, characterized by low knowledge, low-to-moderate trust in sustainability claims, and moderate purchase intention toward sustainability-related labelled products, representing a consumer segment that is particularly susceptible to misleading environmental claims. Gender, education, and income were found to influence consumers’ vulnerability to greenwashing practices (cross-tab,  $p < 0.05$ ).

## 8. SUMMARY

This study examined the prevalence and effects of greenwashing in the food industry, particularly concerning sustainability-related labelling, consumer perceptions, and trust within the Hungarian market. Greenwashing is found to be a major challenge because of misleading environmental claims, lack of transparency, and inconsistent labelling. The study assessed consumer understanding, familiarity, trust, intention, and behavior regarding sustainability labels, and identified at-risk consumer groups. The contribution of government-issued certifications in increasing transparency and curbing misrepresentation was also evaluated.

Most sustainability-oriented labels in the Hungarian retail market were FSC and Organic labels, at 13.12% and 7.82%. The Magyar Termék label accounted for 61.19% of all sustainability-related labelled products, with FSC (13.12%) and EU Organic (7.82%) following it at a distance. This distribution reflects the structural dominance of domestic certification in Hungarian retail rather than consumer choice patterns. Overall, 70.53% of sampled products were of domestic origin, with domestic retailers carrying a significantly higher share of local goods than their international counterparts (79.26% vs. 66.79%). Together, these findings suggest that domestic sourcing and local certification are structurally embedded in Hungarian retail, though the extent to which this reflects active consumer demand needs further investigation. It was found that sustainability-related labelling is important to 47.70% of Hungarian consumers, and 54.22% have already bought products labelled as sustainable in the past. Despite this high level of interest, many people overestimate their knowledge of sustainability labels. The gap between perceived and actual knowledge was most pronounced among lower-performing respondents. This overconfidence can make consumers more susceptible to greenwashing. The sociodemographic factors of consumers (i.e., age) had a substantial impact on consumer knowledge and susceptibility to greenwashing. Older consumers, in particular, tended to overestimate their knowledge of sustainability labels.

The research found that Hungarian consumers generally trust government-supported sustainability labels (e.g., Nébih) more than other labels. 64.78% of respondents were more trusting of items with government-issued certification, and more than half thought that governmental labels were more reliable and regulated. This discovery underscores the significance of governmental institutions in reinforcing consumer confidence and enhancing label credibility.

A substantial consumer segment (39.13%) was identified as subject to moderate and high greenwashing risk (combination of moderate and primary greenwashing targets). Members of this group were generally found to have moderate purchase intention in sustainable products and low-to-moderate trust in sustainability labels, but limited ability to critically evaluate the validity of sustainability claims, making them particularly susceptible to misleading or unsubstantiated label messages. Gender, level of educational attainment, and income level were significantly associated with the probability of belonging to this cluster.

In summary, this study indicates the need for more transparent sustainability-related labelling regulations and a stronger role for policymakers and competent authorities in protecting consumers from greenwashing practices in the food industry. There is great potential for

government-backed certification programs to enhance transparency and consumer confidence. A holistic approach of tighter regulation, credible certification, and targeted consumer education is required to safeguard consumers and promote sustainable consumption. Findings also carry implications for future research, particularly concerning consumer behavior, sustainability communication, and the role of certification systems in mitigating greenwashing.

## 9. LIST OF PUBLICATIONS IN THE FIELD OF STUDY

### 9.1. Publications in Journals

#### **First Author Publications**

- Nugraha, W. S.**, Szakos, D., Süth, M., & Kasza, G. (**2024**). Greenwashing in the food industry: A systematic review exploring the current situation and possible countermeasures. In *Cleaner and Responsible Consumption*, 15. <https://doi.org/10.1016/j.clrc.2024.100227> – **IF 5.3, D1**
- Nugraha, W. S.**, Kasza, G., Süth, M., & Szakos, D. Consumer understanding and its impact on tackling misleading environmental claims in the Hungarian food sector – Discover Food – Under Review (2026)
- Nugraha, W. S.**, Nguyen, M-T., Ma'ruf, M, I., Chun, B-X., Szakos, D., Kasza, G. The impact of climate variability on horticulture production: Is it different in Indonesia? – Heliyon – Under Review (2024)
- Nugraha, W.S.**, Yudhistira, B., Ardiyanto, A., Alfian, B., Karim, I., Szakos, D., & Kasza, G. Exploring Non-Muslim Consumer Acceptance and Market Strategies for Halal Meat Products: A Critical Review – Discover Food – Under Review (2026)
- Nugraha, W.S.**, Rachmawati, A, N., Rizkaprilisa, W., Assegaf, S., Szakos, D., Hardiyanti, M., Nafula, M., Süth, M., & Kasza, G. A comprehensive review of food donation systems: assessing quality and safety standards and exploring possible countermeasures – Food Policy – Under Review (2026)
- Nugraha, W. S.**, Kasza, G., Süth, M., & Szakos, D. Positioning food sustainability labels in Hungary: Exploring familiarity, trust, knowledge, and intention – International Journal of Consumer Studies – Under Review (2026)

#### **Corresponding Author Publications**

- Yang, S-H., Yeh, C-H., **Nugraha, W. S.**, Kasza, G. Consumer Preference for Animal Welfare, Traceability, and Farm Brand in Fresh Egg Products: Evidence from Taiwan. In *Cleaner and Responsible Consumption*. <https://doi.org/10.1016/j.clrc.2026.100438> – **IF 5.3, D1**
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- Siddiqui, S. A., Karim, I., Shahiya, C., Shityakov, S., **Nugraha, W. S.**, & Kasza, G. (**2024**). A critical review of consumer responsibility in promoting sustainable cocoa production. In *Current Research in Food Science*, 9. <https://doi.org/10.1016/j.crfs.2024.100818> – **IF 7.0,**

## D1

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## Co-authored Publications

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- Kasza, G., Izsó, T., Szakos, D., **Nugraha, W. S.**, Tamimi, M. H., & Süth, M. (2023). Insects as food - Changes in consumers' acceptance of entomophagy in Hungary between 2016 and 2021. *Appetite*, 188. <https://doi.org/10.1016/j.appet.2023.106770> – IF 3.8, Q1
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- Kunszabó, A., Süth, M., Szakos, D., **Nugraha, W. S.**, Kasza. Bio-waste Sorting Behaviour of Residents: A Systematic Review – Cleaner Waste Systems – Under Review (2025)
- Hardiyanti, M., Kasza, G., Kurniati, I., **Nugraha, W. S.**, & Szakos, D. Evaluating Nutrient Composition in Surplus Food Redistribution Programs: Evidence from Yogyakarta, Indonesia – Food Science & Nutrition – Under Review (2026)
- Kasza, G., Lámfalusy, T., Szakos, D., **Nugraha, W. S.**, & Ózsvári, L. New insights into fish consumption analysis: A combined animal protein-transition approach – Discover Food – Under Review (2026)

## Oral Presentations

**Nugraha, W. S.**, Kasza, G., Süth, M., & Szakos, D. Food sustainability label in Hungary:

understanding awareness, trust, and consumer intentions. **FOODBALT 2026 - 19th Baltic Conference on Food Science and Technology**. Jelgava, Latvia. (2026)

- Szakos, D., Süth, M., A. Kunszabó, A., Oláh, J., Popp, J., Lakner, Z., Dorkó, A., Izsó, T., **Nugraha, W.S.**, & Kasza, G. 11th International Conference on Sustainable Solid Waste Management (RHODES 2024). Rhodes Island, Greece. (2024)
- Nugraha, W. S.**, Szakos, D., Süth, M., & Kasza, G. The Influence of Consumer Awareness on Mitigating Greenwashing Practices in Hungary. **NUTRICON 2025 - 12th Annual, International and Scientific Macedonian Food Quality and Safety, Health and Nutrition Congress**. Ohrid, North Macedonia. (2025)
- Nugraha, W. S.**, Szakos, D., Süth, M., & Kasza, G. The role of consumer awareness in reducing greenwashing practices in Hungarian food market. 4th International Conference on Responsible Consumption and Production (EURECA-PRO). Chania, Greece. (2025)
- Nugraha, W. S.**, Szakos, D., Süth, M., & Kasza, G. The effect of consumer knowledge on limiting greenwashing in Hungary. 40. Óvári Tudományos Napok Mosonmagyaróvár. Győr, Hungary. (2025)
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- Hardiyanti, M., Kasza, G., Kurniati, I., **Nugraha, W. S.**, & Szakos, D. Assessing the Nutritional Adequacy of Food-Rurplus Redistribution Menus in Yogyakarta, Indonesia. 11th International Congress of Food Technologists, Biotechnologists and Nutritionists. Zagreb, Croatia. (2025)
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### **Poster Presentations**

- Rendora, K.A., **Nugraha, W. S.**, Szakos, D., & Kasza, G. From Minimalist to Holistic: Segmenting Consumers by Sustainability Engagement in Food Choices. 39th **EFFoST International Conference 2025**. Porto, Portugal. (2025)

## 10. APPENDICES

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### Consumer survey on sustainable-related labelling

Dear participant

We are interested in understanding your knowledge and preferences about sustainability-related labelling. We would like to invite you to fill out this survey. The survey is anonymous. This will take about 5-10 minutes. The survey will be used only for academic purposes. If you have any questions, please feel free to contact me at Nugraha.Widya.Satya@phd.uni-mate.hu

**MATE PhD student – Widya Satya Nugraha**

**Advisors: Dr. Gyula Kasza; Dr. Dávid Szakos**

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**Have you purchased food and beverage products labeled as 'sustainable/green/environmentally friendly' in the past year?**

*Please only choose one answer.*

☐ Yes

☐ No

☐ I can't decide

**When buying food, how important is a sustainability certificate to you?**

*Mark one answer.*

☐ Not important at all

☐ Slightly important

☐ Moderately important

☐ It's more important

☐ Extremely important

**Are you the person who normally does grocery shopping at home?**

☐ Yes, most of the time

☐ Shared responsibility

☐ No, not at all

Have you ever met the following logos / labels? *Choose one per line.*

| Logo                                                                                | I consciously seek out the products that feature this logo. | I'm not actively seeking out this logo, but I've probably already purchased a product with it. | I've seen this logo before, but I probably haven't bought a product with it yet. | I'm not familiar with it. |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|---------------------------|
|    | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |
|    | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |
|    | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |
|    | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |
|  | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |
|  | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |
|  | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |
|  | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |
|  | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |
|  | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |
|  | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |
|  | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |
|  | <input type="checkbox"/>                                    | <input type="checkbox"/>                                                                       | <input type="checkbox"/>                                                         | <input type="checkbox"/>  |

|                                                                                   |                          |                          |                          |                          |
|-----------------------------------------------------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
|  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
|  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

**Have you purchased food and beverage products labeled as 'sustainable/green/environmentally friendly' in the past year?**

*Please only choose one answer.*

☐ Yes

☐ No

☐ I can't decide

**Please indicate the appropriate answer according to your judgment.**

| Statement                                                                                                                                                         | Yes                      | No                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|
| The green or environmental claim is a marketing message that implies a product or service is environmentally friendly.                                            | <input type="checkbox"/> | <input type="checkbox"/> |
| The sustainability label unequivocally proves that the product is environmentally friendly.                                                                       | <input type="checkbox"/> | <input type="checkbox"/> |
| The sustainability label certified by government authorities is more reliable than those certified by private businesses or civil organizations.                  | <input type="checkbox"/> | <input type="checkbox"/> |
| The green/environmentally friendly label always uses green color for labelling.                                                                                   | <input type="checkbox"/> | <input type="checkbox"/> |
| The concept of sustainability labelling encompasses social and ethical aspects, such as the prohibition of child labor.                                           | <input type="checkbox"/> | <input type="checkbox"/> |
| Packaging has the greatest negative environmental impact in the food industry.                                                                                    | <input type="checkbox"/> | <input type="checkbox"/> |
| The production of animal products generates more carbon dioxide per kilogram than plant-based products.                                                           | <input type="checkbox"/> | <input type="checkbox"/> |
| The environmental claim on the label does not necessarily mean that the manufacturing company employs environmentally friendly business practices in all aspects. | <input type="checkbox"/> | <input type="checkbox"/> |
| Sustainability labels do not always rely on credible data.                                                                                                        | <input type="checkbox"/> | <input type="checkbox"/> |
| Authorities rigorously inspect all environmental claims/labels used by food companies.                                                                            | <input type="checkbox"/> | <input type="checkbox"/> |
| If the National Food Chain Safety Office (NÉBIH) were to certify an environmental label, I would trust it more.                                                   | <input type="checkbox"/> | <input type="checkbox"/> |

**What comes to mind when you hear the term 'sustainable/green/environmentally friendly'?** *You can choose multiple answers.*

- |                                                   |                                                |                                    |                                               |
|---------------------------------------------------|------------------------------------------------|------------------------------------|-----------------------------------------------|
| <input type="checkbox"/> Environmental protection | <input type="checkbox"/> Consumers             | <input type="checkbox"/> Community | <input type="checkbox"/> Welfare of employees |
| <input type="checkbox"/> Government               | <input type="checkbox"/> Sustainable packaging | <input type="checkbox"/> Marketing | <input type="checkbox"/> Other, especially:   |

**Are you interested in purchasing products labeled as 'sustainable/green/environmentally friendly' in the future?**

*Please only choose one answer.*

- ☐ This is a very important question for me.
- ☐ It's good to have such a label, but it's not my primary consideration.
- ☐ I'm not interested in such labels, so this information is neutral to me.
- ☐ I don't like such labels, so I consider this information negative.

**In case you are not interested in the 'sustainable/green/environmentally friendly' labels, what is the reason for this?** *If you are interested in these labels, please skip this question and proceed to the next one. You can choose multiple answers.*

- ☐ I generally not trust these statements.
- ☐ I'm worried that these 'sustainable products' may be harmful to health.
- ☐ In general, these products are more expensive than the others.
- ☐ It's great to have such labelling, but it's not my primary area of interest.
- ☐ I'm concerned that these sustainable products might be of lower quality.
- ☐ I've had a bad experience with these products.
- ☐ There are only a few of these products on the market, so I don't pay attention to these labels.
- ☐ I'm worried that none of these statements are verified by any official organization.
- ☐ My family and friends aren't really interested or critical about this concept.

**How much do you trust the 'sustainable/green/environmentally friendly' claims on food packaging?**

*Please only choose one answer.*

- ☐ I believe that these statements are true and rigorously verified.
- ☐ I believe that these statements are generally fair.
- ☐ I believe that some statements may be false.
- ☐ I believe that a significant portion of these statements is misleading.
- ☐ I believe that almost all of the statements are false.

**Please evaluate your familiarity with the concept of 'sustainable/green/environmentally friendly labelling'.**

*Rate from 0 to 10: 0: Not aware at all; 10: Fully aware.*

|                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <input type="radio"/> 0 <input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5 <input type="radio"/> 6 <input type="radio"/> 7 <input type="radio"/> 8 <input type="radio"/> 9 <input type="radio"/> 10 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

In order to process the research results, please answer the following questions about yourself. The research is anonymous, and the method of processing guarantees that you **cannot be identified** in the survey.

**Gender:** ☐Female ☐ Man

**Year of birth:** \_\_\_\_ \_

**Place of residence (type of settlement):** ☐Village ☐City ☐Capital

**Residence (county):** \_\_\_\_\_

**The highest level of education you have completed**

- ☐Elementary school (grades 8 or less)
- ☐Vocational school (vocational education)
- ☐Graduation
- ☐College, university diploma

**If you graduated from college or university, do you have a science degree?**

- ☐Yes
- ☐No

**Your economic status (please select only one option)**

- |                                                       |                                               |
|-------------------------------------------------------|-----------------------------------------------|
| <input type="checkbox"/> Active worker (employee)     | <input type="checkbox"/> Job seeker           |
| <input type="checkbox"/> Entrepreneur (self-employed) | <input type="checkbox"/> Household, GYES-GYED |
| <input type="checkbox"/> Retired, disabled pensioner  | <input type="checkbox"/> Student              |

**Is your previous or current work related to food production, catering, or food trade?**

- ☐Yes
- ☐No

**people living in your household: \_\_\_\_\_ people**

**Are there any children under the age of 15 in your household?**

- ☐Yes
- ☐No

**Is there a reason you need a special diet?**

- ☐Yes, diabetics
- ☐Yes, you are sensitive to flour or gluten (coeliac disease)

- ☐ Yes, lactose sensitive (lactose intolerance)
- ☐ Yes, milk protein allergy
- ☐ Yes, you want to lose weight
- ☐ Yes, vegetarian/ vegan
- ☐ Yes, you follow a special diet (e.g., alkalizing, paleolithic, raw food)
- ☐ Yes, for other reasons
- ☐ There is no such reason

**Who is the "food manager" in your household, i.e., who makes the decisions regarding food purchases and food preparation?**

- ☐ You                      ☐ are working together                      ☐ Another person

**Which statement is true about your household's income level?**

- ☐ Even buying the most necessary things is difficult
- ☐ Modestly, but we make a living
- ☐ Our income level is average, and we can buy what we consider important
- ☐ Our income level is above average
- ☐ Our income level is outstanding

**Thank you for completing this questionnaire. Your feedback will aid in the study of consumers' perceptions and attitudes regarding sustainable foods. All responses will remain confidential and used for scholarly purposes only. Thank you for your time and assistance.**

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### 10.2.1. Ethical Statement

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University of Veterinary Medicine Budapest



Vice rector for Research and Innovation

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**Dr Dávid Szakos**

Approval code: 2026/02/09/1

**University of Veterinary Medicine Budapest**

**Institute of Food Chain Science**

**Department of Applied Food Science**

Subject: Decision of the Scientific and Innovation Committee

Dear Dr Szakos,

We would like to inform you about the decision of the Scientific and Innovation Committee in the ethical aspect of the study you and your research partners carry out on sustainability labelling on food products among consumers in Hungary.

**The methodology of the survey is in the Commission's view ethically justified.**

Budapest, 09 February 2026



**Dr. Akos Jertzsele**

president

Scientific and Innovation Committee

## ACKNOWLEDGEMENT

I would like to start by thanking Allah, without whose guidance and help this journey would not have been possible. I give God all the glory for this, and I am truly grateful for His blessing.

My special thanks also go to my supervisors, Dr. Gyula Kasza and Dr. David Szakos. Their knowledge, advice, and unfailing encouragement have been crucial to the success of my research. There is not a day that goes by that I am not grateful for their insistence on critical thinking and pursuit of excellence, which has molded me into the scholar I never knew I could become. Thank you so much for taking me under your wings and investing your time and energy in my development.

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I would further like to acknowledge the Hungarian University of Agriculture and Life Sciences (MATE) and the Doctoral School of Food Science. The professors, resources, environment, and facilities at MATE have a significant impact on my personal and academic development. I am grateful to have attended such a great doctoral school and university.

I would like to express my heartfelt gratitude to my wife, Robiatul Adawiya, for her support and patience along the way. Although it has only brought much strength, it would not be possible without her love and support. Additionally, I could not have done it without her sacrifice and belief in me. The success I am celebrating today is as much of hers as it is mine, and I'm deeply grateful for the part she played in achieving it. Her backing has been a lynchpin in my success, and for that, I can never be grateful enough. This is her victory as much as mine.

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Moreover, this success could not have been achieved without the unwavering support of my family. To my sister and brother, your support and faith in me have been a great source of strength, inspiration, and comfort every step of the way. Furthermore, I am grateful to my parents (my mother and father) for their sacrifice, wisdom, and unconditional love, which have been the foundation on which I have grown academically and personally. Their guidance, nurturing, and support throughout this process were invaluable.

This doctorate is the result of years of hard intellectual work and unwavering commitment. I recognize the unstinting quest for knowledge, intellectual development, and indomitable spirit that were needed to wade through the intricacies of academic rigor. The road has not been easy, but with steadfast diligence and dedication to my studies, I have come this far. Achievement reflects the value I place on knowledge, and a strong sense of intellectual integrity has typified our journey.

This achievement is attributed to the efforts and commitment of many people. I am truly grateful to everyone who has joined me on this wonderful journey. Your contributions have been integral to my academic journey and personal development.

This is not the end - not for me, but just the beginning of another chapter, and I look forward to what the future has for me with a heart full of gratitude towards all those people and experiences that contributed to this journey. Thank you all for joining me on this incredible adventure.