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SUSTAINABLE FOOD PACKAGING IN FOCUS: HOW ENVIRONMENTAL LITERACY AND ATTITUDES SHAPE CONSUMER PREFERENCES AND PERCEPTIONS

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Abstract

This study explores how environmental literacy and attitudes shape consumer preferences and perceptions of sustainable food packaging, focusing on recycled and biodegradable options. Using a structured survey and experimental design, the findings reveal that consumers with higher environmental literacy and stronger attitudes are significantly more likely to choose sustainable packaging over conventional alternatives. Additionally, highly literate consumers perceive biodegradable packaging as having greater environmental benefits than recycled packaging. These insights contribute to understanding the cognitive and affective drivers of sustainable decision-making, offering valuable guidance for businesses and policymakers aiming to align packaging strategies with consumer expectations.

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Introduction:

The food packaging sector has become a crucial point in discussions about sustainability due to its environmental impact. Conventional packaging, mainly plastics, with over 30% of its production destined for food packaging ("Everything You Need to Know about Plastic Pollution" 2023), contributes significantly to pollution and resource depletion, increasing consumers, industry, and policymakers' concerns. As sustainability gains focus, there is also an increase in interest in sustainable food packaging alternatives, such as recycled and biodegradable materials, which offer a way to mitigate the environmental challenges posed by the packaging industry.

Despite the growing interest in sustainable food packaging, consumer preferences and their perceptions of it in this area are influenced by different factors. Research has extensively examined the roles of price, availability, and convenience in shaping consumer preferences and perceptions. However, less attention has been given to the influence of environmental literacy (knowledge) and ecological concern (attitudes) on choosing sustainable packaging over conventional options. These cognitive and affective dimensions are key in driving pro-environmental behaviors, yet their role in sustainable packaging choices remains underexplored. Furthermore, while sustainable packaging is often treated as a broad category, consumer perceptions of specific packaging types, such as recycled and biodegradable materials, should be more frequently examined. This study addresses these gaps by focusing on how literacy and concern influence the preference for sustainable options, particularly among consumers with high literacy and strong concern, and how consumers perceive the environmental benefits of biodegradable versus recycled materials. These objectives are reflected in the following research questions:

RQ1: How do environmental literacy and environmental concern influence consumers' preferences for sustainable packaging (recycled or biodegradable) over conventional packaging, particularly among consumers with high literacy and high concern?

RQ2: Among consumers with high environmental literacy, how do perceptions of the environmental benefits of biodegradable packaging compare to those of recycled packaging?

To help answer these questions, the study tests the following hypotheses:

- **H1:** Consumers with higher levels of environmental literacy (knowledge) and stronger environmental concerns (attitudes) are more likely to choose sustainable packaging (recycled or biodegradable) over conventional packaging.
- **H2:** Among consumers with high environmental literacy, biodegradable packaging is more likely to be perceived as having greater environmental benefits compared to recycled packaging.

This study explores how environmental literacy and attitudes shape consumer preferences and perceptions of sustainable food packaging, focusing on recycled and biodegradable options. The findings aim to help businesses and policymakers design packaging strategies that align with consumer expectations and support sustainability.

Literature Review:

Sustainability in Food and Packaging:

According to the United Nations Brundtland Commission (1987), sustainability is defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs.". Since then, organizations, corporations, NGOs, and policymakers have refined and adapted this definition to address specific contexts (Boz, Korhonen, and Koelsch

Sand 2020). In the context of food systems and sustainable eating, sustainability emphasizes creating value across three interconnected dimensions: economic, social, and environmental. This holistic approach aims to ensure that food systems remain economically viable, socially advantageous, and environmentally sustainable, fostering either a neutral or positive environmental impact (H. Nguyen, n.d.). Directly tied to the environmental dimension of sustainability is the role of food packaging in balancing functionality with ecological responsibility, addressing the challenges of resource efficiency and resource depletion. This represents the practical application of the 1987 Brundtland Report's concept of sustainability—meeting current needs without compromising the ability of future generations—by emphasizing materials and designs that minimize environmental harm (Martinho et al. 2015).

Packaging plays a significant role in modern food systems by balancing functionality with consumer needs while addressing sustainability challenges. To better comprehend its impact, it is important to understand its role and functions as well as the distinctions between conventional and sustainable approaches.

The Role of Packaging: Conventional vs. Sustainable Approaches

Packaging, at its core, is expected to serve multiple purposes, including product protection and preservation, enabling efficient transportation and storage, and playing a vital role in reducing food waste by extending shelf life and ensuring products reach consumers in optimal condition (Boz, Korhonen, and Koelsch Sand 2020; Baruk and Iwanicka 2016; Steenis et al. 2017). Equally important, packaging is a key component of the marketing mix, shaping consumers' first impressions and expectations of a product (Norton et al. 2022; Steenis et al. 2017; Magnier and Crié 2015; Lindh, Olsson, and Williams 2016; Santos, Gomes, and Nogueira 2021).

While packaging offers numerous benefits, it also presents significant environmental challenges. Conventional food packaging primarily relies on materials such as petrochemical plastic polymers, paper, metal, and glass. Among these, plastic is the most widely used due to its versatility and cost-effectiveness (Asgher et al. 2020; Siracusa et al. 2008). However, conventional food packaging materials, especially plastic, can have a negative environmental impact and are considered one of the most prevalent types of waste (UNEP 2018), significantly contributing to pollution and demanding substantial resources for production and disposal (A. T. Nguyen et al. 2020). Plastic's non-biodegradable nature, chemical leaching into food, and persistence in ecosystems make it a major source of pollution and a growing concern for both human health and the environment (Ncube et al. 2020; Asgher et al. 2020) . In response to these challenges, sustainable packaging aims to address environmental concerns by incorporating eco-friendly practices into the design and production of packaging materials. Research indicates that consumers often rely on material and structural cues to assess the sustainability of packaging (Steenis et al. 2017). By emphasizing recyclability, biodegradability, and resource efficiency, sustainable packaging not only fulfills its primary functions but also aligns with broader objectives such as reducing ecological impact, fostering a circular economy, and actively contributing to sustainable development. Furthermore, it plays a significant role in encouraging sustainable behaviors and fostering commitment to environmental responsibility (Branca, Resciniti, and Babin 2024).

Sustainable packaging can be characterized as packaging that, according to life-cycle assessment models, has a minimal environmental impact (Steenis et al. 2017; Glavič and Lukman 2007). It has great potential to contribute to sustainable and economic development while helping with product protection and reducing degradation and associated waste (Martinho et al. 2015; Lindh, Olsson, and Williams 2016; A. T. Nguyen et al. 2020). A more comprehensive definition is offered by the Sustainable Packaging Coalition (2011), a

stakeholder-based organization. This definition incorporates principles such as using recycled and renewable materials and designing for recyclability or biodegradability to minimize waste. It emphasizes life cycle thinking, considering environmental impacts from material sourcing to disposal while prioritizing systems that encourage reuse, recycling, and investments in infrastructure to support a circular economy.

While sustainable packaging encompasses a wide range of approaches, recycled and biodegradable materials have emerged as two of the most prominent options due to their potential to reduce environmental impact and widespread adoption in recent years. This study focuses on these two types of packaging to explore their unique benefits and limitations, as well as their relevance in understanding and shaping consumer preferences and perceptions.

Types of Sustainable Packaging: Recycled vs. Biodegradable:

Recycled Packaging:

Recycled packaging involves the creation of packaging materials from post-consumer or post-industrial waste, reducing the reliance on virgin resources and conserving natural materials. This process requires less energy and raw materials, contributing to a circular economy in which materials are reused multiple times, thereby decreasing landfill waste and reducing the demand for new resources (Ibrahim et al. 2023). According to the European Environment Agency (2020), less than 10% of all plastics produced globally have been recycled. However, companies are increasingly committing to sustainability, with many pledging to incorporate 15% to 50% recycled content into their packaging by 2025 (“Advanced Recycling: Opportunities for Growth | McKinsey,” n.d.).

While recycled packaging offers many environmental benefits, it also comes with challenges. Recycling can be resource-intensive, often requiring chemicals to facilitate the procedure.

Additionally, each recycling cycle degrades the quality of certain materials, limiting the number of times they can be effectively reused (Ibrahim et al. 2023). For food packaging, the use of recycled plastics introduces safety concerns due to the potential for contamination. However, these risks can be mitigated through advanced technologies and strict quality control measures during the recycling process ("Advanced Recycling: Opportunities for Growth | McKinsey," n.d.). Despite these challenges, the adoption of recycled packaging is growing, driven by advancements in recycling technologies and increased awareness of its role in sustainability. By addressing its limitations, such as material degradation and contamination risks, recycled packaging can continue to play a vital role in reducing waste and conserving resources, aligning with global efforts to create a more sustainable future.

Biodegradable Packaging:

As a response to conventional packaging, especially plastic, biodegradable packaging has emerged as a sustainable alternative. Biodegradable plastic, as defined by the American Society for Testing and Materials (ASTM), refers to a type of plastic that decomposes through the activity of naturally occurring microorganisms like bacteria, fungi, and algae. During decomposition, these plastics primarily break down into water, carbon dioxide, inorganic materials, or organic biomass, which helps reduce waste accumulation and benefits the environment ("Standard Specification for Compostable Plastics," n.d.). According to Statista (2024), the global market value of biodegradable plastic packaging, which was approximately $2.8 billion in 2020, is projected to grow to nearly $9 billion by 2026.

Biodegradable packaging is designed to naturally decompose through microbial activity, returning to the environment without leaving harmful residues. However, the decomposition process depends on various environmental factors, such as temperature and humidity, and may still involve significant resource use or leave behind unintended residuals under certain

conditions (Zhao et al. 2023). Additionally, it faces several challenges and limitations, including compostability requirements, potential undesirable material properties, reliance on consumer awareness, the need for specialized production facilities, dependence on processing plants, and a shorter lifespan compared to conventional packaging options (Ivankovic et al. 2017). Despite these challenges, the demand for biodegradable packaging has grown significantly due to rising consumer awareness, increased interest in sustainable practices, and advancements in biopolymer technology (Hussain et al. 2024). The benefits of biodegradable materials include lower energy consumption during production, easier recycling, non-toxicity, reduced reliance on fossil fuels, lower CO_2 emissions, and the use of renewable raw materials (Ivankovic et al. 2017; Ferreira and Silva 2024).

Rising Consumer Consciousness:

In recent years, sustainability has become an increasingly significant topic among consumers, driven by growing awareness of environmental issues and the desire to make better and more eco-friendly choices, making them key players in the shift towards opting for more sustainable packaging (Raphael Bemporad, Hebard, and Bressler 2012; Steenis et al. 2017). The packaging industry has been a significant contributor to plastic waste, and it was identified in 2015 as the largest contributor to plastic waste across all sectors (Geyer, Jambeck, and Law 2017). This environmental impact, combined with shifts in consumer lifestyles and preferences, has accelerated the demand for sustainable alternatives as consumers increasingly prioritize brands and products that align with their environmental values and expectations (Santos, Gomes, and Nogueira 2021). The impact of this growing awareness is evident in the findings from a McKinsey study (2020), which found that more than half of consumers are significantly concerned about the environmental challenges posed by the packaging industry, prompting many to reconsider their purchasing choices. These concerns not only influence individual

behaviors but also put pressure on companies to innovate and adapt their packaging strategies to meet sustainability goals and consumers' expectations (Chirilli, Molino, and Torri 2022; Guiné et al. 2020). Additionally, various global regulations and directives have accelerated the demand for sustainable packaging by encouraging the use of materials like recycled and biodegradable options (Boz, Korhonen, and Koelsch Sand 2020; Celine Cherel-Bonnemaison et al. 2022). This broader consumer consciousness is shaping global market trends, compelling industries to transition away from conventional materials and adopt eco-friendly alternatives, including bio-based and renewable materials (Chirilli, Molino, and Torri 2022; Guiné et al. 2020). By actively advocating for sustainability, consumers are not only driving demand for innovation but also redefining industry priorities. As awareness grows, consumers increasingly seek products and brands that reflect their environmental values, further amplifying the need for sustainable solutions in the packaging industry (Otto et al. 2021; A. T. Nguyen et al. 2020).

As consumers' environmental consciousness grows, it not only influences market trends but also shapes their perceptions and preferences for sustainable packaging options, particularly for recycled and biodegradable materials. Understanding their preferences and perceptions is key to evaluating the broader impact of sustainability on consumer behavior.

Consumer's Perceptions and Preferences:

While the rising awareness of sustainability underscores a positive shift in consumer attitudes, understanding their specific preferences for sustainable packaging remains critical. Studies suggest that packaging choices can influence how eco-friendly a product is perceived; however, the connection between these perceptions and actual purchasing behaviors is still not fully explored (Rokka and Uusitalo 2008; Santos, Gomes, and Nogueira 2021). For many consumers, sustainable packaging is synonymous with materials perceived as eco-friendly, such as recycled and biodegradable options (Deloitte LLP 2023). These perceptions often

shape purchasing decisions, with biodegradable packaging frequently viewed as the most environmentally friendly option, followed by recycled materials, while conventional plastic packaging is regarded as the most damaging to the environment (Herrmann, Rhein, and Sträter 2022). This aligns with findings from prior research, which emphasize that consumers' willingness to pay for sustainable products is strongly influenced by the perceived environmental benefits of these materials (Steenis et al. 2017; Chirilli, Molino, and Torri 2022; Daniela Carbinato, Magali Deryckere, and Yoni Shiran 2023). Moreover, consumers' sustainable preferences are reinforced by broader market trends. Research highlights that 66% of buyers now consider sustainability before making a purchase decision (Imran Amed et al. 2020), further emphasizing the critical role of eco-friendly packaging solutions in shaping and driving consumer behavior. Beyond preferences, consumer actions, such as avoiding excessive packaging, underscore their readiness and willingness to adopt environmentally conscious practices (Daniela Carbinato, Magali Deryckere, and Yoni Shiran 2023). These insights demonstrate that consumer perceptions are not only shaped by their environmental awareness but also by the type of packaging material and its alignment with their values. This highlights the need for continued research into how consumers differentiate between packaging types and the factors driving their preferences.

While consumer preferences and perceptions for sustainable packaging reflect their views on eco-friendliness and environmental impact, these choices are influenced by a range of underlying factors. Exploring these influences is essential to unpack the complexity of consumer decision-making and to understand what drives preferences for specific packaging materials and how they are perceived.

Factors Influencing Consumer's Packaging Preferences & Perceptions:

Consumer preferences and perceptions of sustainable packaging materials differ widely due to several factors (Norton et al. 2022). Differences in understanding the environmental impacts of various packaging materials often lead to diverse preferences. For instance, some consumers may overestimate the sustainability of biodegradable materials while underestimating the benefits of recyclable ones (Boz, Korhonen, and Koelsch Sand 2020). Additionally, cultural and regional differences, such as local recycling infrastructure and cultural norms, play a significant role. For example, regions with robust recycling systems often see a preference for recyclable materials (Martinho et al. 2015; David Feber et al. 2023). Other demographic factors, such as age, education, and income, further shape packaging preferences. Beyond these demographics and cultural influences, personal values, attitudes, knowledge, and perceptions are critical drives of preferences. Consumers frequently rely on perceptions rather than factual information about sustainability, which can result in varied preferences (Piracci, Boncinelli, and Casini 2023). For instance, some consumers might prioritize waste reduction or prefer materials perceived as "natural," which significantly impacts their decision-making (Boz, Korhonen, and Koelsch Sand 2020). Price sensitivity is another critical factor, as the cost of sustainable packaging materials impacts consumers' willingness to pay for them (David Feber et al. 2023). Finally, practical concerns such as durability, ease of use, and the visual appeal of packaging materials also play a role in shaping consumer preferences (Boz, Korhonen, and Koelsch Sand 2020).

While these factors provide valuable insights, this study emphasizes environmental literacy (knowledge) and environmental concern (attitude) as primary drivers of consumers' preferences and perceptions of sustainable packaging and its types. These factors are particularly important as they can significantly influence consumer evaluations of both

conventional and sustainable packaging options as they delve into the cognitive and affective dimensions of decision-making, which offers a deeper understanding of why individuals favor specific types of packaging. Previous research suggests that environmental knowledge and attitudes are key in understanding and interpreting how consumer assess packaging sustainability, thereby shaping their preferences and purchasing intentions (Shimul and Cheah 2022; Anquez et al. 2022; Biswas 2020; Canio, Martinelli, and Endrighi 2021; Debora Indriani, Rahayu, and Hadiwidjojo 2019; Liu, Teng, and Han 2020; Norton et al. 2022). Moreover, the interplay between cognitive understanding and affective responses underscores the importance of these factors in consumer behavior. (Sofi, Mir, and Baba 2020)

Environmental Literacy:

Environmental literacy, which encompasses the ability to understand and evaluate environmental challenges, plays a crucial role in shaping sustainable consumption behavior and intentions (Mostafa 2007; Debora Indriani, Rahayu, and Hadiwidjojo 2019; Popovic, Bossink, and Van Der Sijde 2019; Aktan and Kethüda 2024; Liu, Teng, and Han 2020; Biswas 2020; Flamm 2009; Aktan and Kethüda 2024). It includes an understanding of the facts, concepts, and interconnections related to the natural environment and ecosystems, as well as an awareness of the responsibilities necessary for sustainable development (Khan et al. 2020). Furthermore, the extent of a consumer's understanding of environmental issues and their solutions significantly influences their product choices, particularly when assessing the broader impact of these products on individuals and the environment (Debora Indriani, Rahayu, and Hadiwidjojo 2019). Prior research highlights that this knowledge is considered crucial for fostering pro-environmental behaviors and influencing consumers' preferences (Gifford and Nilsson 2014; Popovic, Bossink, and Van Der Sijde 2019). Moreover, research has revealed that individuals with higher environmental literacy are more likely to adopt behaviors and make choices that align with sustainability goals, underscoring its importance as a key factor in

promoting sustainable practices (Khan et al. 2020; Aktan and Kethüda 2024; Liu, Teng, and Han 2020). On the other hand, however, a lack of environmental knowledge often prevents individuals from acting responsibly toward the environment (Khan et al. 2020). While studies like those by Khan et al. (2020) demonstrate a generally positive link, other research has shown that knowledge alone is often insufficient to drive behavior and indicates that additional factors may have an impact on how knowledge translates into behavior. For instance, environmental knowledge has been identified as one of the least influential predictors of purchase intention in some cases (Debora Indriani, Rahayu, and Hadiwidjojo 2019). This underscores the need to consider additional factors, such as attitudes, to fully understand how knowledge translates into action intention.

Environmental Concern:

Environmental Concern is often described as an individual's predisposition to form favorable or unfavorable beliefs about a specific object, action, or issue, which can shape an individual's intentions and actions. In environmental studies, the concept of ecological attitude has been widely discussed. It is defined as a "psychological tendency expressed by evaluating perceptions of or beliefs regarding the natural environment, including factors affecting its quality, with some degree of favor or disfavor" (Taciano Lemos Milfont, n.d.). These attitudes play a crucial role in determining green behaviors, as decisions to adopt environmentally friendly practices often rely on an individual's cognitive judgments about protecting and promoting the environment. Studies have shown that consumers with high environmental concerns are more likely to engage in pro-environmental behaviors, such as choosing sustainable food packaging. Furthermore, attitudes have been shown to act as predictors of purchasing intentions and behavior, with more favorable attitudes increasing the likelihood of choosing eco-friendly products over conventional alternatives (Khan et al. 2020). Research consistently indicates that environmental concern strongly influences consumers' sustainable

purchase intentions, with those who are more concerned about the environment showing a greater preference for eco-friendly packaging options (Canio, Martinelli, and Endrighi 2021). However, there is often a gap between consumers' expressed environmental concerns and their actual purchasing behavior. This gap is referred to as the attitude-behavior gap in the literature and suggests that while consumers may express a desire to make pro-environmental choices, various factors—like convenience, price, and availability—can hinder the translation of these attitudes into real actions (Park and Lin 2020; Zhuo, Ren, and Zhu 2022).

Interaction Between Literacy and Concern

The interplay between environmental literacy and concern can amplify their influence on consumer preferences. Hines's Model of Responsible Environmental Behavior highlights that both knowledge and attitudes are essential components of pro-environmental actions. Key variables include knowledge of environmental issues, knowledge of action strategies, and strong pro-environmental attitudes (Hines, Hungerford, and Tomera 1987). Research indicates that consumers with higher levels of literacy and concern are more likely to engage in eco-friendly behaviors, including purchasing sustainable packaging (Schultz 2000; Prakash and Pathak 2017). For instance, individuals with greater environmental literacy often exhibit more positive attitudes, which in turn drive green purchasing behaviors (Flamm 2009). This synergy between knowledge and concern underscores their importance in fostering sustainable consumption patterns and shaping preferences for packaging types.

Methodology:

This study investigates how environmental literacy, and attitudes influence consumer preferences and perceptions of sustainable food packaging, specifically focusing on recycled and biodegradable materials. A structured survey (Appendix A) was employed to collect quantitative data to achieve this. The survey design enables the evaluation of specific

hypotheses through statistical analysis, providing a robust and reliable foundation for the study. The following sections outline the methodology in detail, including the participants and study design, survey structure and operationalization, and data analysis.

Participants & Study Design

Participants were recruited using a convenience sampling technique by disseminating the survey via email and social media platforms (e.g., Instagram, LinkedIn, and WhatsApp). The survey was conducted in English and Portuguese to increase accessibility and facilitate diversity in responses. A total of 352 participants responded to the survey; however, only 327 responses were included in the final analysis. Exclusions were made due to incomplete responses or participants failing to complete critical sections of the survey required for the analysis. The final sample represented a heterogeneous group in terms of gender, age, and geographic location. Randomization was used to assign participants to one of the three experimental groups (BvsC, RvsC, Control). In all groups, participants were shown a granola bar product, and the only variable manipulated was the description of the type of packaging. Group 1 (BvsC) was presented with a choice between a granola bar with biodegradable packaging and one with conventional packaging. Group 2 (RvsC) was presented with a choice between a granola bar with recycled packaging and one with conventional packaging. The control group was presented with a choice between two granola bars with conventional packaging.

Survey Structure and Operationalization:

The survey was structured into five blocks to gather data on socio-demographics, behavioral preferences, perceptions, knowledge, and environmental literacy and attitudes. The first block introduced the study, explaining its purpose, confidentiality, and estimated completion time.

The second block collected demographic information, including age, gender, and nationality, to describe the sample and assess potential demographic influences on packaging preferences.

The third block measured behavioral preferences by presenting participants with one of three experimental conditions. Participants were randomly assigned to one of three experimental groups. In all groups, participants were shown a granola bar product, and the only variable manipulated was the description of the type of packaging, with a slight price increase for the sustainable option. Group 1 (BvsC) chose between biodegradable and conventional packaging, Group 2 (RvsC) chose between recycled and conventional packaging, and the control group chose between two conventional options. Preferences were indicated on a 5-point Likert scale (1 = "Granola Bar A," 5 = "Granola Bar B"). The fourth block assessed participants' self-reported perceptions, knowledge, and attitudes toward sustainability using a combination of Likert-scale and categorical questions. Construct scores were created for perceived knowledge (literacy) and attitudes, allowing for a more comprehensive analysis of participants' sustainability-related characteristics The final block objectively measured environmental literacy and pro-environmental attitudes using validated scales. Environmental literacy was assessed with a four-item multiple-choice scale adapted from the work of Murat Aktan and Önder Kethüda (2024), which evaluates participants' factual knowledge of key environmental concepts. Correct answers were summed to create a composite score (range: 0–4), and participants were categorized as "high" or "low" literacy based on a median split. Pro-environmental attitudes were measured with a four-item, 5-point Likert scale adapted from the Environmental Attitudes Inventory (EAI), developed by Taciano L. Milfont and John Duckitt (2010). Reverse-coded items ensured higher scores reflected stronger attitudes. Composite scores were averaged, and participants were divided into "high" and "low" concern groups using a median split.

The study used a five-point Likert scale for all questions requiring a degree of agreement or importance. This scale was chosen because researchers strongly recommend it to improve the rate and quality of responses and to decrease participant frustration.

Data Analysis:

A series of statistical tests were employed and performed with SPSS to analyze the data. For H1, a binomial test was used to assess whether participants with high literacy and strong attitudes showed a significant preference for sustainable packaging (biodegradable or recycled) over conventional packaging. Chi-square tests were conducted to compare preferences within the treatment-specific groups, such as biodegradable versus conventional and recycled versus conventional packaging. For H1, the analysis focused on participants with high environmental literacy and strong environmental concerns, as these individuals are most likely to evaluate sustainability attributes critically and prioritize environmental considerations in their preferences. Including participants with low literacy or concern could introduce noise into the data, as their choices may be driven by external factors like price or convenience. This decision aligns with the study's objective and is supported by the Value-Belief-Norm Theory (Stern et al. 1999) and Theory of Planned Behavior (Ajzen 1991), which suggest that pro-environmental behavior occurs when individuals possess both the knowledge and motivation to act on their values.

For H2, a Chi-Square Goodness of Fit test was used to evaluate whether participants with high environmental literacy perceived biodegradable packaging as having greater environmental benefits compared to recycled packaging. Participants with high literacy were chosen for this analysis because perceiving nuanced differences in sustainability attributes requires foundational knowledge of environmental principles, such as biodegradability and the role of recycling systems. Participants with lower literacy may lack the understanding necessary to

form such distinctions. For example, biodegradable packaging may be seen as more environmentally friendly due to its natural decomposition, whereas recycled packaging depends on proper waste management systems to achieve its benefits. By isolating the high-literacy group, the analysis focuses on participants most capable of critically evaluating these differences. Neutral responses were excluded from all analyses to focus on meaningful preferences and ensure that the results captured distinct patterns in consumer behavior. This approach aligns with the study's aim to investigate the role of environmental knowledge and attitudes in shaping preferences for sustainable packaging.

Results:

This section presents the findings of the study, which investigates how environmental literacy and attitudes influence consumer preferences and perceptions of sustainable packaging. The results are organized to address each hypothesis, starting with the analysis of participants' preferences for sustainable packaging (biodegradable or recycled) compared to conventional packaging (H1), followed by their perceptions of the environmental benefits of biodegradable versus recycled packaging (H2). Descriptive statistics is included to provide additional insights into the data. All statistical analyses and relevant outputs are presented in the appendix for reference.

Descriptives:

The final sample for this study consisted of 327 participants representing diverse demographic and geographic characteristics (Appendix B). Participants varied in gender, age, and country of origin, providing a heterogeneous sample to support the analysis. The age of participants ranged from 18 to 85 years, with a mean age of 38.83 years (SD = 15.75). In terms of gender, the majority of participants identified as female (66.1%), followed by male (32.4%), and a

small proportion identified as non-binary or preferred not to disclose their gender (1.5%). Participants were recruited from multiple countries, with Brazil being the most represented (56.9%), followed by Germany (11.9%) and Portugal (6.7%).

Participants' sustainability literacy and pro-environmental attitudes were assessed using both construct scores and individual scale scores derived from validated scales in previous studies. The construct scores were calculated by aggregating responses to related survey items to provide an overall measure of perceived knowledge and attitudes, while the scale scores, designed to measure objective knowledge and attitudes, were derived directly from participants' responses to specific questions. The mean construct score for knowledge/literacy was 3.57 (SD = 0.83), indicating a moderate to high level of understanding of sustainability-related concepts, such as recyclable and biodegradable packaging. When analyzing specific knowledge indicators, the mean score for "Recyclable vs. Biodegradable Knowledge" was 3.99 (SD = 0.97), while "Recycled Knowledge" was lower, at 3.22 (SD = 0.99). These findings suggest that participants are relatively more familiar with the concept of recyclability than biodegradability. The literacy scale score, based on correct responses to sustainability-related knowledge questions, ranged from 0 to 4, with a mean score of 2.70 (SD = 0.90). This scale score aligns with the construct score findings, highlighting an intermediate level of literacy across the sample.

Environmental attitudes, measured through both construct and scale scores, demonstrated participants' moderate to high levels of concern and engagement with sustainability. The environmental attitudes construct score had a mean of 3.53 (SD = 0.83), while the attitude scale score averaged 4.09 (SD = 0.61). The analysis of specific components revealed a particularly strong inclination toward making eco-friendly efforts (M = 4.01, SD = 0.84), suggesting that participants actively strive to make environmentally conscious decisions.

These descriptive results (Appendix C) provide valuable insights into participants' sustainability literacy and attitudes. While the construct scores were not directly used in the hypothesis testing, they offer a broader understanding of the sample's characteristics and help contextualize the findings. Specifically, the strong environmental attitudes and intermediate literacy levels observed in the sample may influence participants' preferences for sustainable packaging options, as explored in the hypothesis testing.

Hypothesis 1: Preference for Sustainable Packaging Over Conventional Packaging

To test the hypothesis that participants with high levels of environmental literacy and positive pro-environmental attitudes would show a significant preference for sustainable packaging (biodegradable or recycled) over conventional packaging, a binomial test was conducted (Appendix D). A filter was applied to include only participants categorized as having high environmental literacy and attitudes, excluding the control group to focus on behavioral preferences under experimental conditions. This filtering process resulted in 22 participants being included in the final analysis. The binomial test compared the observed proportion of participants choosing sustainable packaging (CHOICE_BINARY = 1) to a null hypothesis proportion of 50% (equal preference for sustainable and conventional packaging). Among the 22 valid cases, 19 participants (86%) preferred sustainable packaging, while only 3 participants (14%) chose conventional packaging. The binomial test revealed that this observed preference for sustainable packaging was statistically significant, with an exact p-value of < 0.001 (two-tailed). These results provide strong support for the hypothesis, indicating that participants with higher environmental literacy and positive attitudes are significantly more likely to choose sustainable packaging over conventional packaging. This finding emphasizes the importance of targeting informed and environmentally conscious consumers when promoting sustainable product options.

Hypothesis 2: Perception of Biodegradable vs. Recycled Packaging

To test the hypothesis that participants with high environmental literacy would perceive biodegradable packaging as having greater environmental benefits compared to recycled packaging, a Chi-Square Goodness of Fit test was conducted (Appendix E). A filter was applied to include only participants with high environmental literacy, and neutral responses were excluded to focus on participants with a clear preference between the two options. This resulted in a sample size of 58 participants. The analysis revealed that 39 participants (67.2%) perceived biodegradable packaging as having greater environmental benefits, while 19 participants (32.8%) perceived recycled packaging as better. Under the null hypothesis of equal preference (50% for each option), the expected frequency for both options was 29. The observed frequencies deviated significantly from these expectations, with a Chi-Square value of $\chi^2(1) = 6.897$ and a p-value of 0.009. These results support the hypothesis that biodegradable packaging is more likely to be perceived as having greater environmental benefits compared to recycled packaging among participants with high environmental literacy.

Interpretation of Findings:

The results for Hypothesis 1 underscore the critical role of environmental literacy and attitudes in shaping consumer preferences for sustainable packaging. This aligns with previous research, such as Debora Indriani et al. (2019), who found that environmental knowledge significantly influences pro-environmental behavior. Similarly, Peschel et al.(2016) demonstrate that higher levels of environmental literacy drive sustainable consumer choices. Additionally, Rusyani, Lavuri, and Gunardi (2021) highlight that environmental knowledge and concern are strong predictors of green purchasing behavior. Together, these studies reinforce the finding that informed and motivated consumers are more likely to choose eco-friendly options, supporting the link between literacy, attitudes, and sustainable decision-making observed in this study.

The findings for Hypothesis 2 indicate a strong perception of environmental benefits associated with biodegradable packaging compared to recycled packaging, particularly among participants with high literacy. Similarly, a study by Steenis (2017) indicated that consumers with high environmental literacy were more prone to perceive biodegradable packaging as more sustainable than recycled packaging. This choice comes from the idea that biodegradable materials help minimize long-term environmental waste by decomposing naturally (Piracci, Boncinelli, and Casini 2023). Together, these results provide actionable insights for businesses seeking to design and promote sustainable packaging solutions effectively. The summary of the hypotheses and their corresponding results is presented in Table 1.

Table 1. Study Hypothesis Conclusions

Hypothesis	*Result*	*Conclusion*
***H1**: Consumers with higher levels of environmental literacy and stronger attitudes are more likely to choose sustainable packaging over conventional packaging.*	Supported	High-literacy and high-attitude participants showed a significant preference for sustainable packaging.
***H2**: Among consumers with high environmental literacy, biodegradable packaging is more likely to be perceived as having greater environmental benefits compared to recycled packaging.*	Supported	Biodegradable packaging was perceived as offering greater environmental benefits than recycled packaging.

Note: All five of the hypotheses were supported, $p < .50$.

Discussion & Conclusion:

Theoretical contributions

This study contributes to the growing body of research on sustainable consumer behavior and sustainability-focused offerings by exploring the influence of environmental literacy and attitudes on packaging preferences and perceptions. The findings support theoretical models such as Hines's Model of Responsible Environmental Behavior (Hines, Hungerford, and Tomera 1987), which emphasizes the interplay between knowledge and attitudes in driving

pro-environmental actions, demonstrating how informed individuals with positive attitudes are more likely to engage in environmentally responsible actions. Moreover, the significant preference for sustainable packaging options among high-literacy and high-attitude consumers aligns with previous research on the cognitive and affective dimensions of consumer behavior (Flamm 2009; Steenis et al. 2017). Furthermore, this study addresses gaps by examining how consumers perceive specific types of sustainable packaging, such as biodegradable and recycled options, rather than grouping all sustainable packaging under a single, broad category. By revealing that biodegradable packaging is perceived as offering greater environmental benefits among high-literacy participants, the study highlights the significance of specific sustainability attributes in shaping consumer decisions. These insights extend prior discussions of the attitude-behavior gap (Taciano L. Milfont and Duckitt 2010; Zhuo, Ren, and Zhu 2022) by demonstrating that informed consumers are more likely to translate attitudes into sustainable choices when the packaging's environmental benefits are clear.

Managerial Implications:

The findings suggest that businesses should prioritize offering sustainable packaging options overall as consumer demand for eco-friendly choices continues to grow. By adopting multiple sustainable approaches, companies can position themselves as leaders in environmental responsibility. Among these strategies, biodegradable packaging shows significant potential, as it was preferred by high-literacy and high-attitude consumers in this study. However, the potential of recycled packaging should not be overlooked, as it remains a key component of sustainable solutions. While the study highlights the importance of targeting environmentally informed and concerned consumers, it is equally critical for businesses to engage with broader consumer segments. Simplifying sustainability messaging and using behavioral nudges (Amiri, Jafarian, and Abdi 2024), such as default sustainable options or targeted incentives, can help

make eco-friendly choices more appealing and accessible. These inclusive strategies ensure that sustainable behavior is fostered not only among informed consumers but also across diverse demographic groups, maximizing the impact of sustainability initiatives.

Limitations & Future Research:

This study has several limitations that suggest opportunities for future research. First, it mainly focuses on participants with high environmental literacy and strong pro-environmental attitudes, excluding deeper insights from less informed or neutral groups. Expanding to diverse literacy and attitudinal profiles could reveal broader consumer perspectives. Second, the study examines only biodegradable and recycled packaging, overlooking other potential alternative materials. Future research could explore these other options for a more complete understanding of sustainable packaging preferences. Third, as a cross-sectional survey, the study captures preferences at one point in time. Longitudinal research could explore how preferences change with evolving environmental awareness, policies, or market dynamics. Lastly, this study focuses on literacy and attitude as the primary factors influencing consumer preferences and perceptions of sustainable packaging, while other variables, such as price sensitivity, demographics, and cultural differences, are not explicitly addressed. Future research could integrate these additional factors to provide a more comprehensive understanding of the complexities shaping consumer decision-making. Additionally, it is important to note that the sustainability of recycled versus biodegradable packaging is still a topic of debate in the academic and environmental communities. This study focuses on consumer perceptions and preferences rather than definitive environmental outcomes, and while these findings provide a useful starting point, they also highlight the need for further research to address the broader question of what truly constitutes the most sustainable packaging option.

Conclusion:

This study addresses the research aim of understanding how environmental literacy and attitudes influence consumer preferences and perceptions of sustainable packaging. The findings indicate that consumers with strong environmental attitudes and higher levels of knowledge are more inclined to choose sustainable packaging over conventional options, emphasizing the importance of targeting informed and environmentally conscious audiences. Additionally, consumers perceived biodegradable packaging as having greater environmental benefits, underlining the need for clear and effective sustainability messaging. While these findings provide a solid foundation for guiding business practices and policymaking, they also emphasize the need for continued research. Addressing the limitations outlined above will help build a more comprehensive understanding of sustainable consumer behavior and support the development of packaging solutions that meet both environmental and consumer needs.

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Appendix

Appendix A

Survey Questionnaire **:**

Block 1: Introduction to study

Dear participant,

This survey is part of a research study for my **Master's thesis at Nova School of Business and Economics**. In the following sections, you will be presented with different product options and asked questions about your preferences. This study aims to explore consumer preferences and decision-making factors related to sustainable eating. Your responses will help provide insights into the role that sustainability and other factors play in consumer decision-making.

Your responses are completely anonymous and will contribute valuable insights to this study. The survey will take approximately **8 minutes** to complete.

If you have any questions regarding the survey, please do not hesitate to contact me at 58492@novasbe.pt

Thank you for your time and thoughtful participation.

Block 2: demographic information

Q1 How old are you?

Q2 What gender are you?

- ○ Male
- ○ Female
- ○ Non-binary / third gender
- ○ Prefer not to say

Q3 Where are you from?

▼ Afghanistan (1) ... Zimbabwe (1357)

Block 3: experimental conditions - behavioral preferences

Treatment group 1: Biodegradable vs. Conventional

Q4/T1 Imagine you are at the supermarket and need to choose between the following granola bars:

Granola Bar A: This granola bar is packaged in conventional plastic. It contains a blend of oats, honey, and almonds, providing a classic, slightly sweet taste with a crunchy texture. **Price: €1.50**

Granola Bar B: This granola bar comes in biodegradable packaging made from organic material, which decomposes naturally or can even grow wildflowers if planted in soil. It is organic and contains oats, honey, almonds, and chia seeds, adding a subtle nutty flavor and extra fiber. **Price: €2.10**

On a scale of 1 to 5, how likely are you to choose Granola Bar A over Granola Bar B?

- ○ 1- Granola Bar A (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5- Granola Bar B (5)

Treatment Group 2: Recycled vs. Conventional

Q4/T2 Imagine you are at the supermarket and need to choose between the following granola bars:

Granola Bar A: This granola bar is packaged in conventional plastic. It contains a blend of oats, honey, and almonds, providing a classic, slightly sweet taste with a crunchy texture. **Price: €1.50**

Granola Bar B: This granola bar is packaged in 100% recycled material, helping to reduce waste by reusing materials. It is organic and contains oats, honey, almonds, and chia seeds, adding a subtle nutty flavor and extra fiber. **Price: €2.10**

On a scale of 1 to 5, how likely are you to choose Granola Bar A over Granola Bar B?

- ○ 1- Granola Bar A (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5- Granola Bar B (5)

Control Group: Conventional option only

Q4/Control Imagine you are at the supermarket and need to choose between the following granola bars:

Granola Bar A: It contains a blend of oats, honey, and almonds, providing a classic, slightly sweet taste with a crunchy texture. **Price: €1.50**

Granola Bar B: It is organic and contains oats, honey, almonds, and chia seeds, adding a subtle nutty flavor and extra fiber. **Price: €2.10**

On a scale of 1 to 5, how likely are you to choose Granola Bar A over Granola Bar B?

- ○ 1- Granola Bar A (1)
- ○ 2 (2)
- ○ 3 (3)
- ○ 4 (4)
- ○ 5- Granola bar B (5)

Block 4: participants' self-reported perceptions, knowledge, and attitudes toward sustainability

Q5 How important is sustainability to you in your daily life?

- ○ Not at all important (1)
- ○ Slightly important (2)
- ○ Moderately important (3)
- ○ Very important (4)
- ○ Extremely important (5)

Q6 To what extent do you agree with the statement: **"I actively seek to make environmentally conscious choices whenever possible"**?

- ○ Strongly disagree (1)
- ○ Disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Agree (4)
- ○ Strongly agree (5)

Q7 To what extent do you agree with the statement: **"I can identify the differences between recycled and biodegradable"**?

- ○ Strongly Disagree (1)
- ○ Disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Agree (4)
- ○ Strongly agree (5)

Q8 To what extent do you agree with the statement: **"I believe that choosing biodegradable packaging has a more positive impact on the environment than choosing recycled packaging"**?

- ○ Strongly disagree (1)
- ○ Disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Agree (4)
- ○ Strongly agree (5)

Q9 How knowledgeable are you regarding **recycled** packaging?

- ○ Not knowledgeable at all (1)
- ○ Slightly knowledgeable (2)
- ○ Moderately knowledgeable (3)
- ○ Knowledgeable (4)
- ○ Very knowledgeable (5)

Q10 How knowledgeable are you regarding **biodegradable** packaging?

- ○ Not knowledgeable at all (1)
- ○ Slightly knowledgeable (2)
- ○ Moderately knowledgeable (3)
- ○ Knowledgeable (4)
- ○ Very knowledgeable (5)

Q11 Which packaging type do you believe has the greatest environmental benefit: recycled or biodegradable?

- ○ Recycled (1)
- ○ - (2)
- ○ Neutral (3)
- ○ - (4)
- ○ Biodegradable (5)

Q12 How much does packaging sustainability influence your choices in fresh produce or perishable food items?

- ○ None at all (1)
- ○ Slightly (2)
- ○ Moderately (3)
- ○ Significantly (4)
- ○ Very Strongly (5)

Q13 How much more are you willing to pay for food products packaged sustainably?

- ○ I am not willing to pay more (1)
- ○ Up to 5% more (2)
- ○ Up to 10% more (3)
- ○ Up to 20% more (4)
- ○ More than 20% (5)

Block 5: environmental literacy and pro-environmental attitudes through validated scales

Literacy Scale:

Q14 Approximately 70% of all freshwater is used for:

- ○ drinking
- ○ cooking
- ○ washing people and clothing
- ○ irrigation

Q15 There are many different kinds of animals and plants, and they live in many different types of environments. What word is used to describe this idea?

- ○ multiplicity
- ○ biodiversity
- ○ socio-economics
- ○ evolution

Q16 Which of the following has the greatest impact on the earth's environment?

- damming rivers
- overpopulation
- severe weather
- nuclear and power plants

Q17 Which action can have the greatest impact on reducing the threat of global warming?

- recycling
- reducing energy use
- composting
- planting a tree

Attitude Scale:

Q18 I do not believe that the environment has been severely abused by humans

- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q19 In my daily life I try to find ways to conserve water or power.

- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q20 Protecting the environment is more important than protecting economic growth.

- Strongly disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)

○ Strongly agree (5)

Q21 The benefits of modern consumer products are more important than the pollution that results from their production and use.

○ Strongly disagree (1)

○ Disagree (2)

○ Neither agree nor disagree (3)

○ Agree (4)

○ Strongly agree (5)

Appendix B

Demographic Characteristics of the Respondents

Items	Categories	N	%
Gender	Male	106	32.4
	Female	216	66.1
	Non-binary/Third Gender	2	0.6
	Prefer not to say	3	0.9
Age Groups	18–21	43	13.1
	22–25	112	34.3
	26–30	86	26.3
	31–35	66	20.2
	36–40	12	3.7
	41+	8	2.4
Country	Brazil	186	56.9
	Germany	39	11.9
	Portugal	22	6.7
	Other	80	24.5

Appendix C

Descriptives

Descriptive Statistics

	N	Minimum	Maximum	Mean
AGE	327	16	85	38.83
Sustainability_Importance	327	1	5	3.54
Eco-Friendly_Effort	327	1	5	4.01
Packaging_Influence	327	1	5	3.05
Construct_SCORE	327	1.33333333	5.00000000	3.53007136
Recyclable_vs_Biodegradable_Knowledge	327	1	5	3.99
Biodegradable_Perception	327	1	5	4.07
Recycled_Knowledge	327	1	5	3.22
Biodegradable_Knowledge	327	1	5	3.02
Construct_SCORE	327	1.50	5.00	3.5734
Literacy_Scale_Score	327	0	4	2.70
Attitude_Scale_Score	327	2.00	5.00	4.0887
Valid N (listwise)	327			

Descriptive Statistics

	Std. Deviation
AGE	15.749
Sustainability_Importance	1.014
Eco-Friendly_Effort	.844
Packaging_Influence	1.098
Construct_SCORE	.833658154
Recyclable_vs_Biodegradable_Knowledge	.966
Biodegradable_Perception	.839
Recycled_Knowledge	.988
Biodegradable_Knowledge	1.055
Construct_SCORE	.68756
Literacy_Scale_Score	.904
Attitude_Scale_Score	.61376
Valid N (listwise)	

Appendix D

SPSS Output for Hypothesis 1 (H1)

Binomial Test

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
CHOICE_BINARY	Group 1	1.00	19	.86	.50	<.001
	Group 2	.00	3	.14		
	Total		22	1.00		

Appendix E

SPSS Output for Hypothesis 2 (H2)

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Preferred_Packaging_Type	58	1.33	.473	1	2

Chi-Square Test

Frequencies

Preferred_Packaging_Type

	Observed N	Expected N	Residual
1	39	29.0	10.0
2	19	29.0	-10.0
Total	58		

Test Statistics

	Preferred_Packaging_Type
Chi-Square	6.897[a]
df	1
Asymp. Sig.	.009

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 29.0.

Literacy_Group * Preferred_Packaging_Type Crosstabulation

			Preferred_Packaging_Type		
			1	2	Total
Literacy_Group	1.00	Count	190	47	237
		Expected Count	184.0	53.0	237.0
		% within Literacy_Group	80.2%	19.8%	100.0%
		% within Preferred_Packaging_Type	83.0%	71.2%	80.3%
	2.00	Count	39	19	58
		Expected Count	45.0	13.0	58.0
		% within Literacy_Group	67.2%	32.8%	100.0%
		% within Preferred_Packaging_Type	17.0%	28.8%	19.7%
Total		Count	229	66	295
		Expected Count	229.0	66.0	295.0
		% within Literacy_Group	77.6%	22.4%	100.0%
		% within Preferred_Packaging_Type	100.0%	100.0%	100.0%