Food Quality and Preference 122 (2025) 105291

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

An investigation on the interplay between Front-of-Pack nutritional labels and plastic packaging materials in healthy foods

Marco Francesco Mazzù [a,*], Carmela Donato [b], Veronica Marozzo [c]

[a] Marco Francesco Mazzù, Professor of Practice in Marketing, Luiss Business School and Luiss University
[b] Carmela Donato, Assistant Professor (tenure track) in Economics and Business Management, Department of Management and Business Administration, University G. d'Annunzio, Pescara (Italy)
[c] Veronica Marozzo, Assistant Professor in Economics and Business Management, University of Messina

ARTICLE INFO

Keywords:
Front-of-Pack Nutritional Labels
Plastic Packaging
Sustainable Packaging Labels
NutrInform Battery
Nutri-Score
Perceived trust
Perceived Product Quality

ABSTRACT

Over the last decades, Front-of-Pack Nutritional Labels (FOPLs) have been introduced in multiple forms as a strong signal to support consumers in making more informed and healthier food choices. Limited attention has been devoted to how such labels interact with other package cues in affecting customers' food selection processes. Our research aims to investigate the under-explored topic of how the interplay between Front-of-Pack Nutritional Labels and package material affects food quality perception.

By exploring the case of healthy foods in plastic packages through a multi-method research approach, we demonstrate across 3 studies (N=524) that healthy foods (e.g., cereals, salads) packed in plastic packages featuring FOPLs (*versus* no FOPLs) are perceived as more trustworthy by consumers, moreover we showed that compared to directive labels like the Nutri-Score, non-directive labels such as the NutrInform Battery increase perceived trust in the packaging material, which in turn generates higher perceptions of food health quality. Furthermore, we found that this effect is magnified when the plastic food packaging contains virtuous elements signaling sustainability. This research advances existing knowledge on food labels by offering new insights into their role as external cues that affect not only perceptions of food quality but also perceptions of packaging materials. This includes materials like plastic, which are negatively evaluated by consumers but are in some cases essential for food storage and preservation.

Our findings provide valuable insights for both policymakers and managers aiming at designing initiatives to promote healthy food in the presence of packaging materials perceived as unhealthy or unsustainable.

1. Introduction

In the current era of globalization, consumers are offered multiple alternatives for their individual diets, with a wide range of products available on retailers' shelves (Grandi et al., 2021) in different forms of storage. These include products once distributed as loose items (e.g., vegetables, fruits) now available in pre-packed sealed packages to ensure longer preservation periods both on the shelf and at home.

The interplay between the food itself and its packaging is creating evolving "food systems" that include multiple signals and are becoming progressively complex for consumers to evaluate (Hoek et al., 2017). This tends to create uncertainty for consumers (FAO (Food and Agriculture Organization), 2018) with consequent concern about how to avoid unsafe food and unhealthy dietary choices, which are significant factors to the worldwide increase in overweight and obesity (WHO, 2020).

Therefore, given the complexity of available food alternatives and their presentation on shelves, policymakers are acting to provide a set of reliable information that can support consumers in making healthier, safer, more sustainable, and more informed food choices.

In this perspective, Front-of-Pack Nutritional Labels (FOPLs) have been one of the main interventions to provide consumers with timely and clear information about the nutritional value of their food choices, and that represent an important and practical tool to assist consumers when making informed and healthier choices (Spiro & Wood, 2021, Butcher et al., 2019, WHO, 2019).

FOPLs might include a list of information, such as fat and calories, indicators derived from algorithms signaling the healthiness of standard

* Corresponding author.
E-mail address: mmazzu@luiss.it (M. Francesco Mazzù).

https://doi.org/10.1016/j.foodqual.2024.105291
Received 24 May 2024; Received in revised form 2 August 2024; Accepted 2 August 2024
Available online 6 August 2024

sizes of food, and health claims related to the food (e.g., Ares et al., 2022; Van Loo et al., 2021), thus ensuring that consumers can utilize useful information about the food they purchase (Donini et al., 2023; Priya & Alur, 2023).

In addition to signaling health, food producers want to signal sustainability to their consumers (Magnier et al., 2016), as food packaging is frequently perceived as a source of waste that has a negative impact on the environment. (Brennan et al., 2021). To counter these trends, more and more food companies are shifting to sustainable packaging (i.e., with more environmentally friendly materials), intending to reduce the product's environmental footprint (e.g., Granato et al., 2022; Grönman et al., 2013; Magnier & Schoormans, 2015; Vila-Lopez & Küster-Boluda, 2021). In that sense, previous research provided evidence that sustainable packaging is able not only to increase consumers' affective attitudes and purchase intention (Magnier & Crié, 2015) but also to positively influence consumers' food evaluation, as perceived quality (Donato et al., 2021a; Magnier et al., 2016), perceived taste and healthiness expectations (Donato et al., 2021b; Chandon, 2013) and perceived satiation (Donato et al., 2021a). Based on the above, it would appear that sustainable product packaging and FOPL, singularly taken, are able to affect the consumers' perceptions and dispositions towards foodstuffs.

However, while FOPLs effectively provide information about the healthiness of foodstuffs (i.e., nutritional information), the same cannot be said about the sustainability signal that can be given by packaging, as it is not always possible to offer a sustainable alternative for packing foodstuff. Then, an interesting dilemma emerges: often healthier food choices may conflict with the perceived environmental sustainability of their packaging. In fact, for some foods, including healthy ones, plastic is essential at the moment for longer storage periods and food preservation on the shelf (Peng et al., 2020; White & Lockyer, 2020; Kim et al., 2014; Bolin et al., 1977). Typical examples of this challenge are ready-made salads in bags, baskets containing fruit (e.g., strawberries, berries), and nets containing fruit (e.g., oranges and lemons) or cereals. While these offer a convenient solution for consumers on the go, they are often packed in plastic containers, thus contributing to consumers raising concerns about the growing problem of environmental pollution.

It seems, therefore, that for some healthy foods, plastic packaging is nowadays necessary, as recognized by the legislation[1] (European Commission, 2021; European Commission, 2022a,b), for the preservation and to guarantee the integrity of the product during the transport phases, when necessary to protect very sensitive foods from impact (e.g., berries), or if it decays very quickly and is exposed to microbiological risks (e.g., salad in a bag).[2]

Consequently, considering this need for plastic packaging for various healthy food products, a crucial research question arises: *can FOPLs support consumers not only on the proper perception of foodstuffs but also on the perception of plastic packaging?* This question opens the door to a more in-depth analysis of the role of FOPLs in guiding consumer choices, not only in terms of dietary decisions but also in the broader assessment of the "food system" (food plus package) consumers acquire, including the perception of the appropriateness of packaging in healthy food decision-making.

In particular, leveraging on the Signaling Theory (Spence, 1973; Rao et al., 1999), which assumes that signals tend to be predominantly effective if they are useful to eliminate ambiguity and appear credible and trustworthy (Atkinson & Rosenthal, 2014), and on the Cue Consistency Theory (Maheswaran & Chaiken, 1991), according to which consumers are more likely to rely on the presence of multiple cues during their evaluations, we demonstrated through a mixed method research design that healthy foods (e.g., cereals, salads) packed in plastic packaging featuring FOPLs are perceived as more trustworthy by consumers. Moreover, we showed that, compared to directive labels like the Nutri-Score, non-directive labels such as the NutrInform Battery (see Appendix A) increase perceived trust in the packaging material, which in turn generates higher perceptions of food quality. Additionally, we found that this effect is magnified when the plastic food packaging contains virtuous elements signaling sustainability, such as the "tidy man[3]" or the recycling logos.

The rest of the article is structured as follows. Initially, we present the theoretical basis of our research and a qualitative study that helped us to define the basis of our theorizing. Subsequently, we shed light on our quantitative methodology and showcase the results of our analyses. Finally, we conclude with a discussion of the findings and presentation of implications for managers and policymakers.

2. Theoretical background

2.1. Front-of-Pack nutritional labels as a relevant cue in food decision-making

In the domain of food labels, researchers are dedicating particular attention to FOPLs by showing their effects on consumers' understanding (e.g., Mazzù et al., 2023a; Shrestha et al., 2023; Mazzù et al., 2021), food consumption and purchasing (e.g., Croker et al., 2020); food choice (e.g., Egnell et al., 2020; Talati et al., 2017), and food-evoked emotions (e.g., David et al., 2023). Specifically, as stated by the World Health Organization (2019), "*the principal aim of FOPL is to provide convenient, relevant and readily understood nutrition information or guidance on food packs, to assist all consumers to make informed food purchases and healthier eating choices*".[4] In the last decades, multiple different FOPL systems have been developed by Governments and policy-makers, following different underlying approaches. According to the European Union classification (EU European Commission, 2021), FOPLs can be segmented based on their directiveness in guiding consumers' choices (Appendix A), with at the extreme of the classification non-directive Numerical Labels, that provide numerical information on the content of critical nutrients (e.g., the NutrInform Battery), and directive Graded Indicators, that provide a synthetic algorithmic appreciation displayed through colors and letters of the standard size of a product's overall nutritional value (e.g., the Nutri-Score).

2.2. Signaling Theory and food choices

Consumers require information to make decisions in situations where contrasting, non-congruent, or potentially ambiguous information is present (Spence, 1973). Signaling Theory assumes that individuals have the ability to effectively assess the quality of their choice through a set of observable signals (Connelly, 2016), compensating for the lack of proper information on decision-making elements or counteracting the ambiguity of available information between the sender and the receiver (Connelly et al., 2011). Individuals, in fact, make up for the lack of essential information by establishing causal links between the information conveyed through signals and their anticipated consequences (Kardes et al., 2004).

In the context of food, Signaling Theory has been used to clarify information processing in the presence of organic food production

[1] Annex V of the legislation, from which you can read that "for single-use packaging of fresh fruit and vegetables, use below 1,5 kg shall be prohibited unless the need to avoid water leakage, turgidity, microbiological hazards or impacts is demonstrated".

[2] https://www.greenme.it/ambiente/rifiuti-e-riciclaggio/stop-alle-buste-di-plastica-e-ai-campioncini-ma-rimane-linsalata-confezionata-raggiunto-laccordo-europeo-sugli-imballaggi/.

[3] Symbol from Keep Britain Tidy representing a reminder to be a good citizen, disposing of the item in the most appropriate manner (https://www.recyclenow.com/how-to-recycle/recycling-symbols).

[4] https://www.who.int/publications/m/item/guidingprinciples-labelling-promoting-healthydiet.

(Abdullah et al., 2022), and to understand consumer perceptions of food authenticity (Kim & Song, 2020), safety (Song et al., 2017) and sustainability (Sigurdsson et al., 2022).

Specifically, food labels compensate for the ineffectiveness of markets in providing information (Mojduszka & Caswell, 2000), have proven to be effective as signaling mechanisms of food quality when backed by technology (Treiblmaier & Garaus, 2023), and, in the case of FOPLs, are considered effective signals in forming positive food attitudes (Mazzù et al., 2022a).

Information and signals are essential not only for inferring the quality of the food itself but may also extend to the food system offered for purchase, which is defined as the combination of the food and its packaging.

In the case of healthy foods stored in plastic envelopes, consumers are confronted with a significant asymmetry of information. On one hand, plastic packaging is sometimes associated with negative attitudes (Menzel et al., 2021), perceptions (Fernqvist & Ekelund, 2014), and feelings (Fernqvist et al., 2015), which could lead customers to avoid choosing food packaged in plastic, including recyclable plastic, by requesting recyclable alternatives (Otto et al., 2021). On the other hand, consumers' awareness of the impact of plastic is uneven (de Sousa, 2023), including the regulatory requirements that mandate plastic packaging to store healthy foods.

In the presence of information asymmetries, labels are often used as a tool to provide customers with additional information (Akdeniz & Talay, 2013), helping them infer quality (Temple, 2020), understand product healthiness (Franco-Arellano et al., 2020), increase trust (Talati, 2019) and differentiate between offerings (Boulding & Kirmani, 1993).

As packaging (Sarkar & Rehman, 2024) can signal virtuous choices through sustainability, this is particularly expected for healthy foods (Hoek et al., 2017). However, it is not always possible to use sustainable packaging, especially for healthy foods, necessitating the use of plastic. This creates potential inconsistencies in consumers' perceptions and trade-offs about whether to purchase the proposed food system—packaging plus food—if their attitude toward the packaging outweighs the necessity of eating healthy foods. We then investigate whether FOPLs, as a quality signal (Jürkenbeck & Spiller, 2021) of food healthiness, can also transfer this positive perception to packaging, especially when unsustainable packaging is necessary. Given the abovementioned positive effects of FOPLs on food evaluations (e.g., Croker et al., 2020; Egnell et al., 2020; Talati et al., 2017), we expect that FOPLs can also positively affect food packaging material. To explore this, we conducted a qualitative study on a large sample of respondents.

2.3. Qualitative research: Exploring the relationship between FOPLS and package material trust

In this first study, we delivered a set of four predetermined open-ended questions – with no variation between interviewees (Appendix B) – to 178 respondents through the Qualtrics Platform. The panel consisted of a convenience sample of Master of Science university students (42.3 % female; M_{age} = 22.84, SD_{age} = 1.20), who were rewarded with extra points on their final grade.

To ensure respondents properly understood the meaning of FOPLs, we provided a detailed explanation of their purpose in helping consumers make informed decisions towards healthier food choices. Since our sample consisted of students who may not necessarily be familiar with FOPLs, this explanation was essential. To avoid biasing responses, we included examples of three different FOPLs: NutrInform Battery, Nutri-Score, and the KeyHole (see Appendix C). Given the qualitative nature of our study, it was crucial that respondents comprehended the FOPLs to accurately respond and articulate their views.

Additionally, before answering each question, respondents were shown a transparent plastic package containing cereals (Appendix D). The envelope included also the "Tidyman" symbol, "a well-known and recognizable symbol […] to encourage people to dispose of their litter responsibly" (Keep, 2024). No specific symbol of the typology of plastic (i.e., recycled/recyclable *vs.* non-recycled/non-recyclable) was added to the package. We selected cereals because, although dieticians assert that there are no inherently healthy or unhealthy foods and that the focus should be on whether a diet is appropriate or inappropriate (Hawkes, 2009), consumers often perceive some foods as unhealthy and others as healthy (Plasek et al., 2020). Cereals are generally perceived as healthier compared to other types of foods (Fenko et al., 2016). We selected a plastic package because some typologies of such are often associated with the perception of unhealthiness and unsustainability (Bou-Mitri et al., 2021, Koenig-Lewis et al., 2022).

The cereal package was displayed to participants before each question to maintain consistency in the stimulus presented. The four questions aimed at capturing individuals' perspectives on product, package, and manufacturer, as well as the relation between those elements. Specifically, the first question: *"What do you think of these cereals in plastic packaging, in terms of healthiness, reliability, authenticity? Why?"* aimed at exploring their perception of the interplay between a package that can be perceived as unsustainable/ unhealthy, with food often perceived as healthy (Plasek et al., 2020).

The second question explored the perception of the bag itself ("*What do you think of this plastic bag in terms of reliability? Why?*"). The last two questions investigated the perceived interplay of the label with the perception of the package in general ("*Do you think that the presence of FOPL can improve or worsen your perception of packaging? Why?*") and when the need for a specific material is considered essential for food preservation ("*There are some food products, such as fresh vegetables, for which the use of plastic is necessary. Do you think that the presence of a FOPL could improve the perception of such plastic packaging? Why?*").

After a careful reading of the transcripts, we organized our analysis into two streams. First, we independently coded respondents who were in agreement *versus* disagreement on the four questions to validate the direction of our initial hypothesis. The coders discussed discrepancies in coding to achieve a resolution. Next, we organized the transcripts to generate relevant insights valuable for the subsequent steps of the research, while reaching "theoretical saturation" on recurring similar information.

2.4. Results

The analysis of the transcripts highlighted an initial strong and deep-rooted negative connotation about plastic, both in terms of environmental impact ("*Plastic is not ideal for the environment")* and its negative effect on the product (*"The plastic bag gives me the idea of inconsistency vs. cereal authenticity"*). Plastic is in fact believed to be a potential cause of chemical contamination (*"Plastic can release harmful substances"; "plastic can contaminate food with harmful substances"*), which can negatively interact with food, thereby worsening the perception of healthiness (*"the plastic packaging reduces my perception of the healthiness of the product"*) and reliability (54 % of respondent do not consider a plastic bag as reliable). This perception decreases if the plastic is perceived as recycled *("If it were made of recycled plastic, I would not see anything wrong with it"*). By contrast, certain attributes associated with plastic might generate positive implications, such as "transparency". Due to the increased ability to see inside the package (*"The plastic packaging makes what's inside transparent"*), package transparency might generate, in fact, a perception of product reliability, healthiness, and authenticity.

The majority of respondents (87 %) highlighted that the presence of a FOPL might improve the perception of the package in general. This remains consistent (72 %) even in the case of food products, such as fresh vegetables, for which the use of plastic is deemed necessary ("*For products that require plastic packaging such as vegetables, FOPL adds value, making that product perceived as part of a conscious choice for a healthy lifestyle, despite the need to use plastic"*). In general, FOPLs improve the perception of packaging, leading to more "holistic" considerations of how to evaluate the plastic packaging itself *("It undoubtedly improves my*

perception because it allows me to better understand the product, ensuring that I overlook the fact that the packaging may have a high environmental impact"; "The plastic bag, while not ideal from an environmental perspective, can be perceived as reliable for product storage due to the durability of the material. The presence of labeling provides detailed and immediate information on the nutritional composition, indicating that the manufacturer is committed to transparency and consumer education, aspects that enhance trust in the reliability of the brand"). This finding is confirmed in situations where plastic packaging is deemed necessary (*"The plastic bag remains a particular choice with regards to packaging in 2024, however, some products must be placed in plastic, however, recycled materials could be used"*).

Table 1 presents the main categories identified, along with their frequencies and representative quotes from the participants.

Table 1
Qualitative evidences organized by topic.

Topic	% of inteviewees	Quotes
Impact of plastic packaging on Food reliability	30 % with a positive Food reliability perception in the presence of Plastic Package	Interview #5: "In terms of reliability I would say they are reliable" Interview #8: "The free visibility of the product [*granted by the plastic envelope*] it is likely to have a positive impact in terms of reliability" Interview #20: "I think that these cereals, thanks to the use of transparent packaging, give the perception of a highly genuine product. The fact that you can see the contents increases the perception of healthiness but above all of reliability." Interview #43: "Transparent packaging gives me confidence in what I see inside"
Impact of plastic packaging on Food healthiness	56 % with a positive Food healthiness perception in the presence of Plastic Package	Interview #15: "The simple packaging gives me the idea of a natural and healthy product." Interview #12: "The presence of a FOPL helps to positively evaluate authenticity as well as healthiness" Interview #114: "The plastic packaging, if recycled, does not create any problems for me, and the presence of the label […] makes me think that the product is healthy." Interview #144: "Cereals tend to be found in plastic packages enclosed in a larger rectangular cardboard package. Therefore […] the only consideration I feel like making is that through this packaging the consumer is able to directly see the final product […], consequently, I believe I perceive the product as better both in terms of healthiness."
Impact of plastic packaging on Food authenticity	33 % with a positive Food Authenticity perception in the presence of Plastic Package	Interview #20: "I think that these cereals, thanks to the use of transparent packaging, give the perception of a highly genuine product." Interview #67: "Plastic may raise ecological issues, but does not affect the authenticity of the product." Interview #97: "The transparent plastic packaging allows you to see the contents and therefore perceive the authenticity of the product."
Impact of FOPLs on package perception	87 % highlighting an impact	Interview #13: "Reliability depends on the transparency of the label." Interview #30: "The presence of the label brings the perception of greater reliability." Interview #62: "The cereal package seems healthy to me because it shows the nutritional label on the front packaging which provides information regarding fats, sugars, salt." Interview #80: " package of cereal packaged in plastic gives me concerns about its food safety and the environment. Without a certification logo, it is difficult to evaluate its reliability." Interview #146: "I believe that the presence of FOPL tends to improve perception as it offers greater clarity." Interview #149: "In my opinion, the presence of FOPL can certainly improve the perception of the packaging and the product because it helps to focus on the healthiness of the product."
Impact of sustainable production practices on plastic package perception	11 % of respondents with positive perception when sustainable practices in manufacturing plastic packages were present	Interview #46: "Cereals in transparent plastic packaging can have different aspects to consider in terms of healthiness, reliability and authenticity. The clear plastic used for cereal packaging is generally BPA-free." Interview #49: "I think that plastic packaging does not pose particular problems in terms of healthiness unless it is made with harmful materials." Interview #53: "Packaging plastic could be a potential source of chemical contamination if the materials have not been adequately tested for food safety."
Impact on health concerns	10 % highlighted potential health concerns connected to the use of a plastic package	Interview #46: "Some plastics can release harmful chemicals into food, especially when exposed to high temperatures." Interview #53: "Packaging plastic could be a potential source of chemical contamination if the materials have not been adequately tested for food safety."Interview #95: "I attribute junk food (such as potato chip packaging) to plastic packaging. Plastic would also raise concerns for me about the chemicals it might release." Interview #160: "Plastic could be a source of concern for me as it could contain harmful chemicals that can migrate into cereals, and is also more prone to damage, compromising the freshness and integrity of the product."
Impact on environmental concerns	78 % highlighted potential concerns connected to the sustainability of the plastic package	Interview #49: "The plastic packaging of a product could have a negative influence on the environment and sustainability." Interview #33: "Using plastic to promote a healthy product like cereal may seem unstrategic. It would be more coherent to adopt ecological materials to underline the commitment to health and sustainability." Interview #173: "The manufacturer is certainly not interested in sustainability."

3. Hypotheses development

3.1. Directive versus non directive Front-of-Pack nutritional labels

The qualitative study yielded two key findings. First, the presence of a Front-of-Pack Nutritional Label on packages perceived as unsustainable (i.e., plastic) can influence the perception of the packaging material and the perceived quality of the food. Second, there is a varied level of knowledge among the panel regarding plastic, with some participants recognizing specific situations where the material can be considered more sustainable or necessary.

These insights will serve as the foundation for further investigations aimed at validating these results and guiding policymakers and manufacturers in their decisions. The initial step will be to identify which FOPL has the highest potential in this context, followed by examining how the relationship evolves if additional signals about the sustainability of the packaging are present.

Specifically, food products with FOPLs are considered more reliable and trustworthy (Talati et al., 2019). FOPLs mediate the effect between consumers' attitudes and their intention to buy (Mazzù et al., 2023a), for different target segments including people suffering from non-communicable diseases (Mazzù et al., 2023b).

Previous studies have investigated these labels in terms of perceived trust, with non-directive labels such as the NutrInform Battery – alone (Mazzù et al., 2022b) or in combination with other labels (Mazzù et al., 2023a) – being perceived as more trustworthy than directive labels as the Nutri-Score. FOPLs also generate a halo effect (Franco-Arellano et al., 2020), mitigating the impact of other claims (Stoltze et al., 2021), and influencing both virtue and vice products (Ikonen et al., 2020).

In light of the above, we expect a spillover effect of perceived trust in the label on the perceived trust in material packaging, with labels performing in line with existing research findings. We then hypothesize that the presence of the NutrInform Battery (*vs.* Nutri-Score) on plastic food packaging will increase the trust perception of the packaging and, consequently, the perceived quality of the food. Formally, we propose that:

> **H_1:** The presence of the NutrInform Battery (*vs.* Nutri-Score) on plastic food packaging will increase the trust perception of the packaging and, consequently, the perceived quality of the food.

3.2. Cue consistency theory and the presence of Front-of-Pack nutritional labels

When assessing food quality and deciding on their preferences, consumers rely on a set of cues, available on the packaging. Those include package transparency to assess food quality (Sabri et al., 2020), package material (Otto et al., 2021), package sustainability (Donato & Adiguzel, 2024) images on the front of the pack (Chu et al., 2021), color of the package (Marozzo et al., 2020), and nutritional information (Medina-Molina et al., 2021). The various pieces of information directly included in the packaging, or inferred from the package material, significantly influence consumer behavior. When properly bundled together, they might improve consumers' subjective understanding and appreciation of available information (Mazzù et al., 2023a).

In such perspective, credence cues – extrinsic cues that are widely viewed as being true and that are built on trust (Kim et al., 2022) – exert a growing influence on consumers' food choices. Hence, labels and information conveying credence assume significance as search attributes. While consumers may not accurately assess credence cues, the expectations they evoke impact perceived quality and sensory experiences (Fenkvist & Ekelund, 2014).

Moreover, according to Cue Consistency Theory (Maheswaran & Chaiken, 1991), consumers are more inclined to count on the presence of multiple cues that offer supporting (rather than contrasting) information during their evaluations. Specifically, in food decision-making, when multiple coherent and virtuous signals are present, they generate a positive effect on consumers' perceptions (Cao & Zhang, 2024). For example, Donato et al. (2021) found that healthy (*vs.* unhealthy) food packed in sustainable (*vs.* unsustainable) packaging is perceived as having higher quality and being more satiating. The authors demonstrated that this positive halo effect was due to the coherence of the two virtuous cues communicated by the food packaging.

Finally, among different FOPLs, non-directive labels such as the NutrInform Battery have been shown to reduce conflicting nutritional information derived from pre-existing customer knowledge or external sources, increasing the perceived credibility of the FOPL and generating a positive attitude toward the FOPL itself (Mazzù et al., 2024).

On the basis of the abovementioned contributions, we argue that the positive effect of utilizing a non-directive label like the NutrInform Battery, which aims to communicate virtuous (healthy) information, combined with additional virtuous cues—such as sustainable logos—that produce coherent and virtuous signals related to the packaging, generates a positive halo effect on perceived food quality. Accordingly, we propose that:

> **H_2:** Compared to a situation where the plastic package has no FOPL, the mediating effect of trust in the package on the relationship between the NutrInform Battery and perceived food quality is stronger when the food manufacturer ensures that the plastic package contains at least some sustainable virtuous elements.

Fig. 1 illustrates our conceptual model.

4. Materials and method

Through two quantitative experimental studies, we aimed to examine how Front-of-Pack Labels (FOPLs) influence consumers' trust in packaging plastic material and, consequently, their perception of food quality. Specifically, in Study 2, we compared the effectiveness of two distinct FOPLs: the Nutri-Score (NS) and the NutrInform Battery (NIB), and their effect on perceived trust towards plastic packaging. In Study 3, we focused solely on the NutrInform Battery and varied the type of plastic packaging offered by a food producer. We differentiated between non-virtuous packaging (without any sustainable logos) and virtuous packaging (with sustainable logos), demonstrating that consumers show higher trust towards plastic material presenting the NIB when the packaging includes at least some virtuous elements, such as recommendations for proper disposal (e.g., the "tidy man" logo) or the presence of recycled material (e.g., the recycling logo). In each study we used healthy food (i.e., green salad) packaged in conventional plastic.

4.1. Study 2

The objective of Study 2 was twofold: firstly, to confirm and generalize the findings of our qualitative study, and second to confirm H1 according to which the presence of a FOPL can improve the perception of plastic food packaging and, in turn, enhance the perceived food quality. We examined ready-made salads in plastic bags featuring two commonly used FOPLs in Europe: the Nutri-Score and the NutrInform Battery.

One hundred sixty-seven European participants responsible for their food shopping (52 % female, 36 % aged between 25–34 years), (see Appendix E) were enlisted through Prolific Academic in exchange for a small monetary reward. Participants were randomly exposed to one of the two conditions. Two fictitious salads in plastic bags, each featuring a NutrInform Battery or a Nutri-Score FOPL, were created. Moreover, each package contained the "tidy man" logo, aimed at implicitly communicating the company's attention towards the correct disposal of the plastic pack. To ensure correct exposure, the labels were shown using a simulated visual zoom (see Appendix F). Additionally, to ensure an accurate perception of our manipulation, the stimulus was re-presented for each item in our measurements.

Participants were first informed that an anonymous food brand was

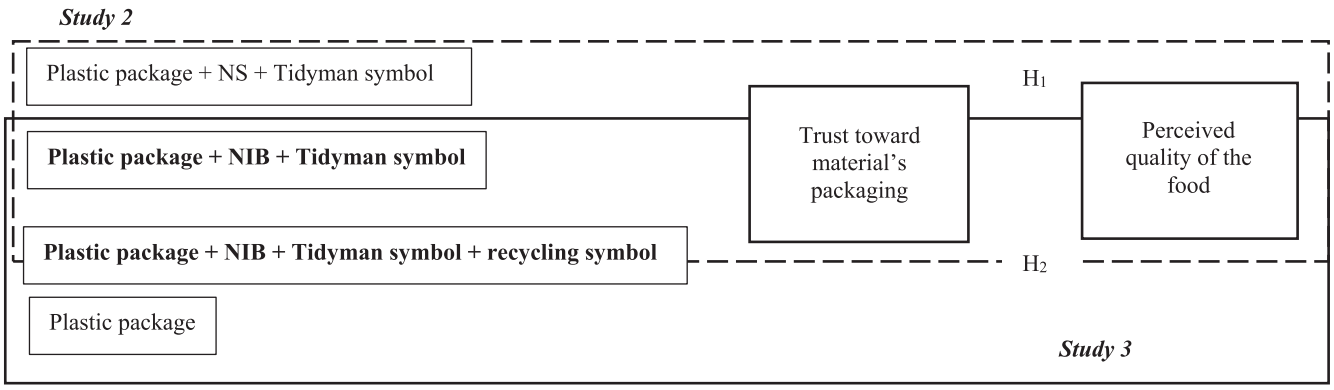


Fig. 1. Conceptual model.

planning to use a FOPL certification for their salads in plastic bags and that they would be asked to evaluate this product. Depending on the condition, participants were randomly exposed to a salad in a plastic package featuring either a NutrInform Battery or a Nutri-Score label. We then asked participants to rate the perceived health quality of the food (α = 0.89, Fenko et al., 2016) and their perceived trust towards the packaging material used by the anonymous food brand (r = 0.77, adapted from Mazzù et al., 2022b). Additionally, we measured participants' health concerns (α = 0.84, Tarkiainen & Sundqvist, 2005).

Finally, participants reported their demographics, were debriefed, and compensated. All measurement items were evaluated using a seven-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree) (see Appendix G).

4.2. Study 3

In Study 3, given the results of the previous study, we delve deeper into the Study 2 effect, focusing our attention exclusively on NutrInform Battery FOPL thus excluding other potential labels as the Nutri-Score. We manipulated the virtuosity of the type of plastic packaging a food producer can offer (i.e., plastic (i) without any sustainable logo, (ii) containing the "tidy man" logo with the NutrInform Battery, and (iii) containing the "tidy man" plus the "recycling" logos with the NutrInform Battery, see Appendix H), considering perceived food quality as the dependent variable. We propose that, compared to a situation where the plastic package has no FOPL, the mediating effect of package material trust on the relationship between the NutrInform Battery and perceived food quality is stronger when the food manufacturer ensures that the plastic package contains at least some virtuous elements, such as recommendations for proper disposal (e.g., the "tidy man" logo) or the presence of recycled material (e.g., the recycling logo).

One hundred seventy-nine European participants responsible for their food shopping (46% female, 42,5% aged between 25–34 years) (Appendix E) were enlisted through Prolific Academic in exchange for a small monetary reward. Participants were randomly exposed to one out of the three conditions. Three fictitious salads in plastic bags, one without any label cues, and the other two featuring the NutrInform Battery presenting the tidy man, and the tidy man plus the recycling logo, respectively were created. As in the previous study, to ensure correct exposure, the NutrInform Battery, when present, was shown using a simulated visual zoom (see Appendix H).

Participants were first informed that an anonymous food brand was launching a salad in plastic bags and that they would be asked to evaluate this product. We used a 3x1 between-subject design, depending on the condition, participants were randomly exposed to a salad in a plastic package without any label logo (control condition), or a salad in a plastic package with the tidy man logo featuring the NutrInform Battery logo or a salad in a plastic package with the tidy man and the recycling logo featuring the NutrInform Battery. We then asked participants to rate the perceived quality of the food (r = 0.86, White et al., 2016), their perceived trust towards the packaging material used by the anonymous food brand (r = 0.78, adapted from Mazzù et al., 2022b) and the perceived sustainability of the previously shown package (r = 0.88, adapted from Donato et al., 2021a). Additionally, we measured participants' environmental concerns (α = 0.89, Lin & Huang, 2012) and health concerns (α = 0.87, Tarkiainen & Sundqvist, 2005).

Finally, participants reported their demographics, were debriefed, and compensated. Similary to Study 2, all measurement items were assessed using a seven-point Likert scale (see Appendix G).

5. Results

5.1. Study 2

In order to test our H_1 we ran a mediation model (Model 4 PROCESS, Hayes, 2017) in which the type of FOPL was set as our independent variable (1 = NIB, 0 = NS), the perceived trust towards the packaging material as our mediator, and the perceived food health quality as our dependent variable.

Results show that the package featuring the NutrInform Battery positively affected the package material trust (b = 0.50, t = 2.55, p = 0.02) that in turn, positively affected perceived food health quality (b = 0.36, t = 4.98, $p < 0.001$). Moreover, the package featuring the NutrInform Battery FOPL positively affected food perceived health quality (b = 0.67, t = 3.57, $p < 0.001$).

More importantly, these effects were qualified by a significant indirect effect (c = 0.18, SE=0.08, CI [0.0524; 0.3645].[5]

5.2. Study 3

We first checked the goodness of our manipulation by running a one-way ANOVA considering the type of plastic as our independent variable and the package sustainability mean score as our dependent variable. Results confirm that participants perceived a significant difference in terms of perceived sustainability among the three packages ($M_{control}$ = 2.88, SD=1.61 *vs.* M_{tidy_NIB}=3.46, SD=1.46 *vs.* $M_{recycling\_NIB}$=3.93, SD=1.55; $F(2, 176) = 6.92$, $p = 0.001$). In particular, a post-hoc analysis comparison revealed that the control condition (i.e., the package without any logo) was perceived as less sustainable than the package showing the tidy man logo and the NutrInform Battery FOPL, despite this difference was not statistically significant ($M\Delta = -0.58$, p = ns), and it was perceived as statistically less sustainable than the package showing the recycling and tidy man logos and the NutrInform Battery FOPL ($M\Delta = -1.05$, $p < 0.001$).

[5] The results were consistent in terms of sign and significant when controlling for participants' health concerns (D= 0.17 SE= 0.08, CI [0.03; 0.34].

Subsequently, in order to corroborate previous findings, we conducted an additional one-way ANOVA considering the type of plastic as our independent variable and the perceived material trust of the package as our dependent variable. Results confirmed that participants perceived a significant difference in terms of perceived material trust among the three packages ($M_{control} = 3.73$, SD=1.55 *vs.* M_{tidy_NIB}=4.70, SD=1.32 *vs.* $M_{recycling\_NIB}$=4.87, SD=1.23; $F(2, 176) = 11.94$, $p < 0.001$). In particular, a post-hoc analysis comparison revealed that the package without any logo (control condition) was perceived as composed of a less trustworthy material than the package showing the tidy man logo and the NutrInform Battery FOPL ($M\Delta = -0.97$, $p < 0.001$), and that the package showing the recycling logo and the NutrInform Battery FOPL ($M\Delta = -1.14$, $p < 0.001$). There was no statistically significant difference in terms of package material trust between the package showing the tidy man logo and the NutrInform Battery FOPL and the package showing the recycling logo and the NutrInform Battery FOPL ($M\Delta = -1.17$, p = ns). These results confirm previous findings, according to which the presence of the NutrInform Battery FOPL increases package material perceived trust. Then, in order to test our H_2 we ran a mediation model (Model 4 PROCESS, Hayes, 2017) in which the type of plastic was our independent variable (1 = control, 2 = package featuring tidy man logo and NutrInform Battery FOPL, 3 = package featuring both tidy man and recycling logos plus the NutrInform Battery FOPL), the perceived trust towards the packaging material our mediator, and the perceived food quality our dependent variable.

Results showed that compared to the control condition both the package showing the tidy man logo and the NutrInform Battery FOPL ($b = 0.97$, $t = 3.85$, $p < 0.001$) and the package showing the recycling and tidy man logos and the NutrInform Battery FOPL ($b = 1.14$, $t = 4.52$, $p < 0.001$), significantly increased perceived package material trust. Perceived package material trust, in turn, significantly increased perceived food quality ($b = 0.42$, $t = 7.24$, $p < 0.001$). Both packages showing the tidy man logo and the NutrInform Battery FOPL ($b = 0.05$, $t = 0.22$, p = ns) and the package showing the recycling and tidy man logos and the NutrInform Battery FOPL ($b = 0.09$, $t = 0.48$, p = ns) did not affect perceived food quality.

More importantly, these effects were qualified by two significant indirect effects, the one of the package showing the tidy man logo and the NutrInform Battery FOPL ($D1 = 0.40$, SE=0.13, CI [0.18; 0.69], and the one of the package showing the recycling and tidy man logos and the NutrInform Battery FOPL ($D2 = 0.48$, SE=0.13, CI [0.26; 0.76]. Consistent with our theorizing, the indirect effect of the package showing the recycling logo and the NutrInform Battery FOPL (D2) was higher than the indirect effect of the package showing the tidy man logo and the NutrInform Battery FOPL (D1; $\Delta = 0.07$).[6]

6. Discussions

For some foods, especially healthy ones, plastic is essential for preservation and to guarantee the integrity of the product during transport (e.g., Peng et al., 2020). Consequently, consumers sometimes face a dilemma between the health benefits of the food and the unsustainability of its packaging, creating discrepancies in their choices. This trade-off between the virtuosity of food (i.e., healthy food) and the perceived not virtuosity of packaging (i.e., plastic package) raises crucial questions about how consumers evaluate and make decisions about the foods they buy. In this research, we shed light on this trade-off by analyzing the impact of FOPLs on the perception of plastic packaging material for healthy foods.

Specifically, through a mixed-method approach, we showed that consumers attribute higher trust to plastic food packaging when a FOPL is present (Study 1). Respondents indicated that FOPLs generally improve the perception of the packaging, especially in cases of healthy products such as fresh vegetables, or when the use of plastic is considered essential for storage and conservation purposes. In summary, FOPLs contribute to enhancing the perception of the entire food system, influencing both food quality and packaging. This prompts a more "holistic" assessment of plastic packaging itself.

Study 2 quantitatively confirmed the findings of Study 1 demonstrating that the presence of a FOPL can improve trust perception towards plastic package material, and in turn, food perceived health quality. In particular, the study compared two types of FOPLS: the Nutri-Score and the NutrInform Battery, demonstrating that the latter is able to increase perceived trust in the packaging material, which in turn generates higher perceptions of food health quality. In Study 3, given the above results, we focused solely on the NutrInform Battery, excluding other labels as the Nutri-Score, with the objective to demonstrate that the positive effect between the FOPL (NutrInform Battery) and perceived trust in the packaging material is magnified when the plastic packaging includes ecological virtuous elements, such as the "tidy man" symbol or the recycling logo.

The results of the present research make several important theoretical contributions. First, our results add to the food label literature (e.g., Mazzù et al., 2023a; Shrestha et al., 2023) by identifying FOPLs, particularly the NutrInform Battery label, as not only useful tools for providing consumers with information about food composition and helping them make more conscious, informed, and healthy decisions but also as external cues capable of modifying perceptions of food packaging materials. This finding is particularly relevant for foods, especially healthy ones, that rely on plastic packaging—generally negatively evaluated by consumers but essential for food storage and preservation (e.g., Peng et al., 2020; White & Lockyear, 2020).

Moreover, we add to the existing literature by examining how package labels and materials influence consumers' perception of food quality (e.g., Donato et al., 2021a; Magnier et al., 2016) by specifically concentrating on FOPLs, another largely unexplored extrinsic package characteristic. Finally, we contribute to sustainable packaging literature (e.g., Magnier et al., 2016; Steenis et al., 2018), demonstrating that even for plastic packages, the presence of sustainable cues (e.g., the recycling logo) has a positive effect on food perceived quality, when combined with the presence of FOPLs.

Our findings offer significant insights for food managers who are keen on devising strategies to enhance perceptions of healthy food quality when they must use plastic packaging materials. Based on our findings, even when non-mandatory, we recommend incorporating Front-Of-Pack Nutritional Label certifications for healthy foods, even if they are not strictly necessary given the healthy nature of the food. Their presence can improve perceived food quality and mitigate the negative connotations of unsustainable packaging. Interestingly, this positive effect is stronger for plastic packages that feature virtuous cues, such as the "tidy man" symbol and the recycling logo. Therefore, we suggest that companies using plastic packaging should also incorporate sustainable solutions.

This can also improve manufacturer perception when employing plastic packages, as testified by some spontaneous comments collected during the qualitative study. Although the perception of manufacturer reliability is linked to various elements – such as details provided, care of the package, production practices, etc. – and plastic is generally viewed negatively, the combination of the presence of a FOPL and package transparency can modify this perspective (*"The company has nothing to hide if it adds a FOPL and utilizes a transparent envelope for its packaging"*). Moreover, the presence of a FOPL increases the perception that the manufacturer is honest, reliable, and credible, with nothing to hide. If the bag is transparent in combination with a FOPL, the manufacturer is also seen as more transparent (*"The company has nothing to hide if it puts a FOPL and utilizes a transparent envelope for its packaging")* and the package more reliable *("The presence of FOPL improves the perception of the packaging as it shows the company's interest in communicating important*

[6] The results were consistent in terms of sign and significant when controlling for participants' environmental and health concerns ($D1$= 0.41 SE= 0.13, CI [0.20; 0.71] and ($D2$= 0.48, SE= 0.13, CI [0.27; 0.78].

information that affects my health").

Regarding FOPLs, our results confirm that, compared to more directive graded indicators like the Nutri-Score, solutions providing numerical information on the content of nutrients, like the NutrInform Battery, have a higher positive spillover effect on packaging materials. This finding should be considered by policymakers in their search for a standardized solution at the European Level (From Farm to Fork Strategy, European Commission, 2020).

It is important to acknowledge the demographic and regional characteristics of our sample. Our study predominantly included young, highly educated respondents (mainly aged 18–44). While we recognize that different age groups and cultural contexts might perceive and respond to FOPLs and plastic packaging differently, this demographic is particularly relevant because younger consumers (including young adults) are often early adopters of new food trends and technologies, including FOPLs. Their familiarity with digital information and health-conscious attitudes makes them a suitable group for exploring perceptions of FOPLs on plastic packaging. Moreover, our European sample was intentionally chosen to align with the regulatory environment and consumer behavior trends in the European Union, where FOPLs are gaining prominence. As with all academic studies, this study has limitations. First, our studies relied on self-reported data. Future research should focus on monitoring food choice and consumption to acquire the most accurate data possible about food perceptions.

Second, although we intentionally asked participants in Study 1 to write about their perceptions of the effect of FOPL on the package, we did not investigate additional elements that could be the focus of new research streams. These elements include the role of package transparency in the interplay between FOPL and packaging, how the perception of specific factors that affect purchase intention—such as product authenticity, freshness, and quality—are related to the combination of external cues like packaging and FOPLs, and the impact on manufacturers' perception in terms of honesty and reliability. Third, to maximize the realism of our results, we specifically focused on healthy foods packaged in conventional plastic, thereby excluding alternative sustainable solutions such as bioplastics. Fourth, our studies exclusively examined the impact of non-sustainable packaging on healthy foods, without evaluating whether the observed effects also apply to unhealthy foods or sustainable packaging options.

Fifth, our analysis revealed that consumers are not entirely aware of the meaning of some sustainability-related packaging cues. For instance, the "tidy man" logo was perceived as a sustainability signal, comparable to the recycling logo, despite it only being a recommendation rather than indicating any sustainable intervention. Future research can delve deeper into consumers' understanding of food packaging cues, particularly those indicating sustainability.

Finally, as already mentioned, our studies used convenience samples of highly educated consumers from Europe. To strengthen the results, future studies should collect data from samples representative of the general population across different countries and regions, including those in Asia or Africa, with varying levels of education.

Funding statement

The research received non-conditional funding from Federalimentare.

Ethical statement

All research is conducted in accordance with ethical principles.

CRediT authorship contribution statement

Marco Francesco Mazzù: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Carmela Donato:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Veronica Marozzo:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

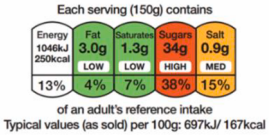
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

Appendix

A. Front-of-Pack Labels Taxonomy.

Taxonomies		Examples
Non-directive: FOPLs that include information elements only in different forms without any interpretative or evaluative aim	• **Numerical Labels** provide numerical information typically on core nutrients and the energy value, sometimes adding numerical signal on their relevance on daily reference intake	• **NutrInform Battery** 
Semi-directive: FOPLs that combine numerical information with evaluative elements such as colours	• **Colour-coded labels** provide numerical information typically on core nutrients and on the energy value with colours used to classify those nutrients as "low" (green), "medium" (amber), or "high" (red)	• **Multiple Traffic Light** 

(*continued on next page*)

(*continued*)

Taxonomies		Examples
Directive: interpretative or evaluative FOPLs are often based on algorithms that display aggregated results in one symbol or icon.	• **Endorsement Logos** provide a logo displaying a synthetic appreciation of a product's overall nutritional value	• **Keyhole logo** 
	• **Graded Indicators** provide a synthetic appreciation of a product's nutritional value through a "graded indicator" displayed in letters and colours	• **Nutri-Score** 

Source: Adapted from Storcksdieck *et al.* (2020).

B. Qualitative research – Question of the semi-structured interview

- What do you think of these cereals in plastic packaging, in terms of healthiness, reliability, authenticity? Why?
- What do you think of this plastic bag in terms of reliability? Why?
- Do you think that the presence of FOPL (labelling) can improve or worsen your perception of packaging? Why?
- ("There are some food products, such as fresh vegetables, for which the use of plastic is necessary. Do you think that the presence of a FOPL could improve the perception of such plastic packaging? Why?

C. Qualitative research – Introduction to FOPLs

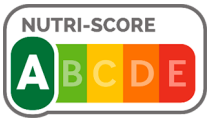
Front-of-pack nutrition labelling (FOPL) aims to help consumers make food choices by providing nutritional information at a "glance" and is increasingly seen as a tool to support strategies for the prevention of non-communicable diseases related to nutrition. It is, therefore, a complementary element to the nutrition declaration, which aims to ensure a greater and more immediate understanding of the composition of the food.

There is currently no harmonized FOPL for all countries in Europe, so the most widely used will be listed below.

The **Nutrinform Battery** is the complementary labelling to the nutrition declaration recommended in Italy. It is a FOP label that shows the amount of energy, fat, saturated fat, sugar and salt per serving. Finally, by means of a percentage visually represented as the filling of a battery, the amount of each nutrient is reported compared to the reference daily intake, expected in the context of the overall diet. Here is an example:

.

The **Nutri-Score** is a FOPL currently used in Central Europe. It's a "synthetic label", because it doesn't report information about the nutrient content of the food but it provides a visual judgment communicated through letters and colors. The judgment is calculated by an algorithm, which takes into account the content of different nutrients and refers to a predefined amount of 100 g of product. An example of this is:



.

The **Keyhole** is a FOPL used in Northern European countries. It is a logo that identifies food products, present within the same category (for example, cheese, ready meals and cereals), which comply with certain conditions about the content of specific nutrients, in accordance with the nutritional recommendations of the countries where it is adopted. Below is an example:

.

D. Stimulus for the qualitative Study

.

E. Socio-demographics of Study 2 and Study 3

Variable	Study 2		Study 3	
	N	%	N	%
How old are you?				
18–24 years old	30	17.8	40	22.3
25–34 years old	78	46.2	76	42.5
35–44 years old	40	23.7	41	22.9
45–54 years old	13	7.7	18	10.1
55–64 years old	6	3.6	4	2.2
65 + years old	1	0.6	–-	–-
Prefer not to say	1	0.6	–-	–-
How do you describe yourself?				
Male	87	51.5	97	54.2
Female	75	44.4	78	43.6
Non-binary/third gender	4	2.4	4	2.2
Prefer not to say	3	1.8	–-	–-
What is the highest education level that you completed?				
Secondary School	–-	–-	2	1.1
High School	41	24.3	51	28.5
College Degree	59	34.9	73	40.8
Master, PhD	67	39.6	52	29.1
Other	1	0.6	1	0.5
Prefer not to say	1	0.6	–-	–-
What best describes your employment status over the last three months?				
Working full-time	110	65.1	99	55.2
Working part-time	15	8.9	20	11.2
Unemployed and looking for work	10	5.9	18	10.1
A homemaker or stay-at-home parent	1	0.6	3	1.7
Student	30	17.8	35	19.6
Retired	1	0.6	2	1.1
Other	1	0.6	2	1.1
Prefer not to say	1	0.6	–-	–-
What is your gross annual household income in Euros?				
Less than 25,000 Euros per year	62	36.7	65	36.3
25,000—-49,999 Euros per year	66	39.1	67	37.4
50,000—-99,999 Euros per year	22	13.0	26	14.5
100,000—-199,999 Euros per year	4	2.4	3	1.7
Prefer not to say	15	8.9	18	10.1
I am responsible for food shopping				
Just for myself	63	37.3	77	43.0
For my family	100	59.2	97	54.2
I don't care about food shopping	3	1.8	5	2.8
Prefer not to say	3	1.8	–-	–-

F. Stimuli Study 2.

.

G: Measurements items, sources, and reliability of study instrument.

Variables	Measurement Items	Source	Cronbach Alpha or Pearson's r correlation	
			Study 2	Study 3
Perceived health quality of the food	I expect this product to be healthy I would consider this product as good for me This product sounds healthy This product looks healthy This product looks low in calories I have an impression that this product is healthy This product looks healthier than similar product category	Fenko et al. (2016)	$\alpha = 0.89$	–-
Trust toward material's packaging	The material this packaging is made inspires me with confidence The material this packaging is made is reliable and trustworthy	Mazzù et al. (2022b)	$r = 0.77$	$r = 0.78$
Health concern	I choose food carefully to ensure good health I think of myself as a health-conscious consumer I think often about health issues	Tarkiainen & Sundqvist (2005)	$\alpha = 0.84$	$\alpha = 0.87$
Perceived quality of the food	I think this product has … Bad quality/Good quality I think this product has … Low quality/High quality	White et al. (2016)	–-	$r = 0.86$
Sustainability Packaging	To what extent do you perceive the packaging containing the product as sustainable? To what extent do you perceive the material of the packaging containing the product as sustainable?	Donato et al. (2021a)	–-	$r = 0.88$
Environmental concern	I make a special effort to buy product that are made of sustainable materials I have changed which products I use because of sustainability reasons I have avoided buying a product because it had potentially harmful effects to people/or the environment	Lin & Huang (2012)	–-	$\alpha = 0.89$

H. Stimuli Study 3

Control condition	NutrInform Battery + Tidyman logo	NutrInform Battery + Tidyman logo + Recycling logo
		

References

Akdeniz, M., & Talay, M. (2013). Cultural variations in the use of marketing signals: A multilevel analysis of the motion picture industry. *Journal of the Academy of Marketing Science, 41*(5), 601–624. https://doi.org/10.1007/s11747-013-0338-5

Abdullah, Z., Putri, K. Y. S., Raza, S. H., & Istiyanto, S. B. (2022). Contrariwise obesity through organic food consumption in Malaysia: A signaling theory perspective. *BMC Public Health, 22*(1), 99.

Ares, G., Velázquez, A. L., Vidal, L., Curutchet, M. R., & Varela, P. (2022). The role of food packaging on children's diet: Insights for the design of comprehensive regulations to encourage healthier eating habits in childhood and beyond. *Food Quality and Preference, 95*, Article 104366.

Atkinson, L., & Rosenthal, S. (2014). Signaling the green sell: The influence of eco-label source, argument specificity, and product involvement on consumer trust. *Journal of Advertising, 43*(1), 33–45.

Bolin, H. R., Stafford, A. E., King, A. D., & Huxsoll, C. C. (1977). factors affecting the storage stability of shredded lettuce. *Journal of Food Science, 42*, 1319–1321.

Boulding, W., & Kirmani, A. (1993). A consumer-side experimental examination of signaling theory: Do consumers perceive warranties as signals of quality? *Journal of consumer research, 20*(1), 111–123.

Bou-Mitri, C., Abdessater, M., Zgheib, H., & Akiki, Z. (2021). Food packaging design and consumer perception of the product quality, safety, healthiness and preference. *Nutrition & Food Science, 51*(1), 71–86.

Brennan, L., Langley, S., Verghese, K., Lockrey, S., Ryder, M., Francis, C., & Hill, A. (2021). The role of packaging in fighting food waste: A anadatized review of consumer perceptions of packaging. *Journal of Cleaner Production, 281*, Article 125276.

Butcher, L. M., Ryan, M. M., O'Sullivan, T. A., Lo, J., & Devine, A. (2019). Food-insecure household's self-reported perceptions of food labels, product attributes and consumption behaviours. *Nutrients, 11*(4), 828.

Cao, C., & Zhang, X. (2024). What triggers consumers to purchase eco-friendly food? The impact of micro signals, macro signals and perceived value. *British Food Journal*.

Chu, R., Tang, T., & Hetherington, M. M. (2021). The impact of food packaging on measured food intake: A systematic review of experimental, field and naturalistic studies. *Appetite, 166*, Article 105579.

Connelly, B. L., Certo, S. T., Ireland, R. D., & Reutzel, C. R. (2011). Signaling theory: A review and assessment. *Journal of Management, 37*(1), 39–67.

Connelly, B. L. (2016). Signal theory. In C. E. Carroll (Ed.), The SAGE Encyclopedia of Corporate Reputation, 1–2 pp. 745–747). SAGE Publications, Inc.

Croker, H., Packer, J., Russell, S. J., Stansfield, C., & Viner, R. M. (2020). Front of pack nutritional labelling schemes: A systematic review and meta-analysis of recent evidence relating to objectively measured consumption and purchasing. *Journal of human nutrition and dietetics, 33*(4), 518–537.

Chandon, P. (2013). How package design and packaged-based marketing claims lead to overeating. *Applied Economic Perspectives and Policy, 35*(1), 7–31.

David, I. A., Gomes, F. S., Silva, L. A., Coutinho, G. M., Pacheco, L. B., Figueira, J. S., & Campagnoli, R. R. (2023). Use of event-related potentials to measure the impact of front-of-package labels on food-evoked emotion. *Food Quality and Preference, 104995*.

de Sousa, F. D. B. (2023). Consumer awareness of plastic: An overview of different research areas. *Circular Economy and Sustainability, 3*(4), 2083–2107.

Donato, C., & Adıgüzel, F. (2024). The effects of visual design on eco-labels evaluations: Guidelines for effective green advertising. *Journal of Marketing Theory and Practice*, 1–18.

Donato, C., Barone, A. M., & Romani, S. (2021a). The satiating power of sustainability: The effect of package sustainability on perceived satiation of healthy food. *British Food Journal, 123*(13), 162–177.

Donato, C., Barone, A. M., & Romani, S. (2021b). The Effect of Sustainable Package on Taste Perception of Healthy Foods. *Micro & Macro Marketing, 2*, 333–356.

Donini, L. M., Berry, E. M., Folkvord, F., Jansen, L., Leroy, F., Şimşek, Ö., & Lenzi, A. (2023). Front-of-pack labels:"Directive" versus "informative" approaches. *Nutrition, 105*, Article 111861.

Egnell, M., Talati, Z., Galan, P., Andreeva, V. A., Vandevijvere, S., Gombaud, M., & Julia, C. (2020). Objective understanding of the Nutri-score front-of-pack label by European consumers and its effect on food choices: An online experimental study. *International Journal of Behavioral Nutrition and Physical Activity, 17*, 1–13.

European Commission (2021)—Inception Impact Assessment. Food Labelling—Revision of Rules on Information Provided to Consumers. 2021. Available online: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12749-Food-labelling-revision-of-rules-on-information-provided-to-consumers_en (accessed on July 2023).

European Commission, 2022, Rules of procedure of the European Parliament and the Council on packaging and packaging waste – Annex V [Accessed on May 2024].

European Commission, 2022. Farm to Fork strategy for a fair, healthy and environmentally-friendly food systemhttps://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en [Accessed on May 2024].

FAO (Food and Agriculture Organization), (2018). Empowering consumers to make healthy food choices and support sustainable food systems. Available at: https://openknowledge.fao.org/server/api/core/bitstreams/17ac735b-b5cf-4037-82e6-4acdc2a36bc8/content [Accessed on May 2024].

Fernqvist, F., & Ekelund, L. (2014). Credence and the effect on consumer liking of food–A review. *Food Quality and Preference, 32*, 340–353.

Fernqvist, F., Olsson, A., & Spendrup, S. (2015). What's in it for me? Food packaging and consumer responses, a focus group study. *British Food Journal., 117*(3), 1122e1135.

Fenko, A., Lotterman, H., & Galetzka, M. (2016). What's in a name? The effects of sound symbolism and package shape on consumer responses to food products. *Food Quality and Preference., 51*. https://doi.org/10.1016/j.foodqual.2016.02.021

Franco-Arellano, B., Vanderlee, L., Ahmed, M., Oh, A., & L'abbé, M. (2020). Influence of front-of-pack labelling and regulated nutrition claims on consumers' perceptions of product healthfulness and purchase intentions: A randomized controlled trial. *Appetite, 149*, Article 104629.

Granato, G., Fischer, A. R., & van Trijp, H. C. (2022). The price of sustainability: How consumers trade-off conventional packaging benefits against sustainability. *Journal of Cleaner Production, 365*, Article 132739.

Grandi, B., Burt, S., & Cardinali, M. G. (2021). Encouraging healthy choices in the retail store environment: Combining product information and shelf allocation. *Journal of Retailing and Consumer Services, 61*, Article 102522.

Grönman, K., Soukka, R., Järvi-Kääriäinen, T., Katajajuuri, J. M., Kuisma, M., Koivupuro, H. K., & Linnanen, L. (2013). Framework for sustainable food packaging design. *Packaging Technology and Science, 26*(4), 187–200.

Hawkes, C. (2009). Defining "healthy" and "unhealthy" foods. An international review. Prepared for the Office of Nutrition Policy and Promotion. Health Can. 2009. Available online: https://www.canada.ca/en/healthcanada/services/food-nutrition/healthy-eating/nutrition-policy-reports/defining-healthy-unhealthy-foodsinternational-review-2009-executive-summary.html [Accessed on May 2024].

Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Guilford publications.
Hoek, A. C., Pearson, D., James, S. W., Lawrence, M. A., & Friel, S. (2017). Shrinking the food-print: A qualitative study into consumer perceptions, experiences and attitudes towards healthy and environmentally friendly food behaviours. *Appetite, 108*, 117–131.
Ikonen, I., Sotgiu, F., Aydinli, A., & Verlegh, P. W. (2020). Consumer effects of front-of-package nutrition labeling: An interdisciplinary meta-analysis. *Journal of the academy of marketing science, 48*, 360–383.
Jürkenbeck, K., & Spiller, A. (2021). Importance of sensory quality signals in consumers' food choice. *Food Quality and Preference, 90*, Article 104155.
Kardes, F. R., Posavac, S. S., & Cronley, M. L. (2004). Consumer inference: A review of processes, bases, and judgment contexts. *Journal of consumer psychology, 14*(3), 230–256.
Keep Britain Tidy organization, https://www.keepbritaintidy.org/brand-licensing, [Accessed on May 2024].
Kim, J. H., & Song, H. (2020). The influence of perceived credibility on purchase intention via competence and authenticity. *International Journal of Hospitality Management, 90*, Article 102617.
Kim, J., Kim, J., & Wang, Y. (2022). Changes in the effect of credence cues on restaurant delivery service under different health risks. *International Journal of Contemporary Hospitality Management, 34*(2), 737–758.
Koenig-Lewis, N., Grazzini, L., & Palmer, A. (2022). Cakes in plastic: A study of implicit associations of compostable bio-based versus plastic food packaging. *Resources, Conservation and Recycling, 178*, Article 105977.
Lin, P. C., & Huang, Y. H. (2012). The influence factors on choice behavior regarding green products based on the theory of consumption values. *Journal of Cleaner production, 22*(1), 11–18.
Magnier, L., & Crié, D. (2015). Communicating packaging eco-friendliness: An exploration of consumers' perceptions of eco-designed packaging. *International Journal of Retail & Distribution Management, 43*(4/5), 350–366.
Magnier, L., & Schoormans, J. (2015). Consumer reactions to sustainable packaging: The interplay of visual appearance, verbal claim and environmental concern. *Journal of Environmental Psychology, 44*, 53–62.
Magnier, L., Schoormans, J., & Mugge, R. (2016). Judging a product by its cover: Packaging sustainability and perceptions of quality in food products. *Food quality and preference, 53*, 132–142.
Maheswaran, D., & Chaiken, S. (1991). Promoting systematic processing in low-motivation settings: Effect of incongruent information on processing and judgment. *Journal of Personality and Social Psychology, 61*(1), 13–25.
Marozzo, V., Raimondo, M. A., Miceli, G. N., & Scopelliti, I. (2020). Effects of au naturel packaging colors on willingness to pay for healthy food. *Psychology & Marketing, 37*(7), 913–927.
Mazzù, M. F., Romani, S., & Gambicorti, A. (2021). Effects on consumers' subjective understanding of a new front-of-pack nutritional label: A study on Italian consumers. *International journal of food sciences and nutrition, 72*(3), 357–366.
Mazzù, M. F., Romani, S., Baccelloni, A., & Lavini, L. (2022a). Introducing the Front-of-Pack Acceptance Model: The role of usefulness and ease of use in European consumers' acceptance of Front-of-Pack Labels. *International Journal of Food Sciences and Nutrition, 73*(3), 378–395.
Mazzù, M. F., Baccelloni, A., Romani, S., & Andria, A. (2022b). The role of trust and algorithms in consumers' front-of-pack labels acceptance: A cross-country investigation. *European Journal of Marketing, 56*(11), 3107–3137.
Mazzù, M. F., Marozzo, V., Baccelloni, A., & Giambarresi, A. (2023a). The effects of combining front-of-pack nutritional labels on consumers' subjective understanding, trust, and preferences. *Psychology & Marketing, 40*(8), 1484–1500.
Mazzù, M. F., Baccelloni, A., & Romani, S. (2023b). Counteracting noncommunicable diseases with front-of-pack nutritional labels' informativeness: An inquiry into the effects on food acceptance and portions selection. *British Food Journal, 125*(13), 562–578.
Mazzù, M. F., He, J., & Baccelloni, A. (2024). Unveiling the impact of front-of-pack nutritional labels in conflicting nutrition information–A congruity perspective on olive oil. *Food Quality and Preference, 105202*.
Medina-Molina, C., Rey-Moreno, M., & Periáñez-Cristóbal, R. (2021). Analysis of the moderating effect of front-of-pack labelling on the relation between brand attitude and purchasing intention. *Journal of Business Research, 122*, 304–310.
Menzel, C., Brom, J., & Heidbreder, L. M. (2021). Explicitly and implicitly measured valence and risk attitudes towards plastic packaging, plastic waste, and microplastic in a German sample. *Sustainable Production and Consumption, 28*, 1422–1432.
Mojduszka, E. M., & Caswell, J. A. (2000). A test of nutritional quality signaling in food markets prior to implementation of mandatory labeling. *American Journal of Agricultural Economics, 82*(2), 298–309.
Otto, S., Strenger, M., Maier-Nöth, A., & Schmid, M. (2021). Food packaging and sustainability–Consumer perception vs. correlated scientific facts: A review. *Journal of Cleaner Production, 298*, Article 126733.
Plasek, B., Lakner, Z., & Temesi, Á. (2020). Factors that influence the perceived healthiness of food. *Nutrients, 12*(6), 1881.
Peng, H., Sthapit Kandel, J., & Michelmore, R. W. (2020). Identification of Factors Affecting the Deterioration Rate of Fresh-Cut Lettuce in Modified Atmosphere Packaging. *Food Bioprocess Technol, 13*, 1997–2011.
Priya, K. M., & Alur, S. (2023). Analyzing consumer behaviour towards food and nutrition labeling: A comprehensive review. *Heliyon, 9*, e19401.
Rao, A. R., Qu, L., & Ruekert, R. W. (1999). Signaling unobservable product quality through a brand ally. *Journal of marketing research, 36*(2), 258–268.
Sabri, O., Doan, H. V., Malek, F., & Bachouche, H. (2020). When is transparent packaging beneficial? *International Journal of Retail & Distribution Management, 48*(8), 781–801.
Sarkar, S., & Rehman, J. (2024). Influence of Food Packaging Cues on Consumer Buying Behavior. *IUP Journal of Marketing Management, 23*(1).
Shrestha, A., Cullerton, K., White, K. M., Mays, J., & Sendall, M. (2023). Impact of front-of-pack nutrition labelling in consumer understanding and use across socio-economic status: A systematic review. *Appetite, 106587*.
Sigurdsson, V., Larsen, N. M., Pálsdóttir, R. G., Folwarczny, M., Menon, R. V., & Fagerstrøm, A. (2022). Increasing the effectiveness of ecological food signaling: Comparing sustainability tags with eco-labels. *Journal of Business Research, 139*, 1099–1110.
Spence, M. (1973). Job market signaling. *The Quarterly Journal of Economics, 87*(3), 355–374.
Song, H., Turson, R., Ganguly, A., & Yu, K. (2017). Evaluating the effects of supply chain quality management on food firms' performance: The mediating role of food certification and reputation. *International Journal of Operations & Production Management, 37*(10), 1541–1562.
Spiro, A., & Wood, V. (2021). Can the concept of nutrient density be useful in helping consumers make informed and healthier food choices? A mixed-method exploratory approach. *Nutrition Bulletin, 46*, 354–372.
Steenis, N. D., Van der Lans, I. A., van Herpen, E., & Van Trijp, H. C. (2018). Effects of sustainable design strategies on consumer preferences for redesigned packaging. *Journal of Cleaner Production, 205*, 854–865.
Stoltze, F. M., Busey, E., Taillie, L. S., & Carpentier, F. R. D. (2021). Impact of warning labels on reducing health halo effects of nutrient content claims on breakfast cereal packages: A mixed-measures experiment. *Appetite, 163*, Article 105229.
Talati, Z., Norman, R., Pettigrew, S., Neal, B., Kelly, B., Dixon, H., & Shilton, T. (2017). The impact of interpretive and reductive front-of-pack labels on food choice and willingness to pay. *International Journal of Behavioral Nutrition and Physical Activity, 14*, 1–10.
Talati, Z., Egnell, M., Hercberg, S., Julia, C., & Pettigrew, S. (2019). Consumers' perceptions of five front-of-package nutrition labels: An experimental study across 12 countries. *Nutrients, 11*(8), 1934.
Tarkiainen, A., & Sundqvist, S. (2005). Subjective norms, attitudes and intentions of Finnish consumers in buying organic food. *British food journal, 107*(11), 808–822.
Temple, N. J. (2020). Front-of-package food labels: A narrative review. *Appetite, 144*, Article 104485.
Treiblmaier, H., & Garaus, M. (2023). Using blockchain to signal quality in the food supply chain: The impact on consumer purchase intentions and the moderating effect of brand familiarity. *International Journal of Information Management, 68*, Article 102514.
Van Loo, E. J., Grebitus, C., & Verbeke, W. (2021). Effects of nutrition and sustainability claims on attention and choice: An eye-tracking study in the context of a choice experiment using granola bar concepts. *Food Quality and Preference, 90*, Article 104100.
Vila-Lopez, N., & Küster-Boluda, I. (2021). A bibliometric analysis on packaging research: Towards sustainable and healthy packages. *British Food Journal, 123*(2), 684–701.
White, K., Lin, L., Dahl, D. W., & Ritchie, R. J. (2016). When do consumers avoid imperfections? Superficial packaging damage as a contamination cue. *Journal of Marketing Research, 53*(1), 110–123.
White, A., & Lockyer, S. (2020). Removing plastic packaging from fresh produce – what's the impact? *Nutrition Bulletin, 45*, 35–50. https://doi.org/10.1111/nbu.12420
WHO (World Health Organization). (2019). *World Health Organization Guiding principles and framework manual for front-of-pack labelling for promoting healthy diet*. Geneva: Switzerland.
WHO (World Health Organization), (2020). Obesity and overweight factsheet. Available at: https://www.who.int/news-room/factsheets/detail/obesity-and-overweight [Accessed on May 2024].

Further Reading

Kim, J. G., Luo, Y., & Gross, K. C. (2004). Effect of package film on the quality of fresh-cut salad savoy. *Postharvest Biology and Technology, 32*(1), 99–107.
Wang, J., Tao, J., & Chu, M. (2020). Behind the label: Chinese consumers' trust in food certification and the effect of perceived quality on purchase intention. *Food Control, 108*, Article 106825.