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Comparing apples to oranges: Consumer ambivalence regarding an eco-innovation – laser marking of organic fruits

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Abstract

Laser marking is an innovative and eco-friendly alternative to plastic sticker labeling of organic fruits, with no known negative side effects. Still, based on Ram and Sheth's innovation resistance theory, we predict that this food eco-innovation applied to the produce may lead to ambivalent responses, with consumers valuing its eco-friendliness but fearing health risks. Drawing on Festinger's cognitive dissonance theory, we predict that consumers actively attempt to resolve the ambivalence by adapting their beliefs about laser marking to situation-specific realities. Finally, based on Nemeroff and Rozin's contagion theory, we predict that an important situation-specific reality for this eco-innovation is fruit peel edibility, which moderates the found relationships. These hypotheses are tested in three between-subjects experiments (Study 1 – 396 participants; Study 2 – 390 participants; Study 3 – 346 participants). Participants were exposed to scenarios presenting an organic fruit with a laser-marked or plastic sticker label, on an edible or non-edible peel. As predicted, we find that laser marking decreases perceived eco-friendliness, because of anticipation of food waste, and reduces perceived healthfulness, because of fear of contamination, both depending on whether the fruit's peel is edible or

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not. Implications for managers include the need to educate consumers about the benefits and risks of this technology. For a start, laser marking should probably be limited to fruits with non-edible peels.

Keywords
Cognitive dissonance theory, contagion theory, laser marking, organic labeling, perceived eco-friendliness, perceived healthfulness

Introduction

In 2020, an average EU inhabitant generated about 180 kg of packaging waste (Eurostat, 2023). Packaging waste is growing despite a general trend toward more responsible consumption, calling for new regulation (European Commission, 2022). For example, despite consumers asking for reduced packaging (Tobler et al., 2011) and perceiving plastic packaging as harmful to the environment (Lindh et al., 2016a; Sokolova et al., 2023), most fruits and vegetables are still sold in plastic bags or wrapping, and organic fruits and vegetables even more so due to legal labeling requirements. Sometimes plastic stickers are used to indicate the organic quality of fresh fruits and vegetables, which reduces packaging, but the stickers are usually made of polyethylene and adhesives, which are not biodegradable or compostable (Nosowitz, 2018). Also, the production of self-adhesive stickers consumes resources like energy, paper, and water, and they contain chemicals and polluting substances, such as glue or ink, that may also pose health risks if ingested (Tanuvi, 2021). These adverse effects are inconsistent with ecologically responsible consumer behavior, such as avoiding unnecessary plastic and buying organic food products. Especially many consumers perceive the size and quantity of the packaging of organic fresh food or the use of plastic wrap on organic food as inappropriate (Ismael and Ploeger, 2020) and inconsistent with the organic promises of eco-friendliness (Pfiffelmann et al., 2024). This perceived inconsistency may lead to cognitive dissonance (Festinger, 1957), negatively impacting consumers' attitudes toward these products (Pfifelmann et al., 2024).

To overcome this perceived inconsistency in product attributes, some organic fruit producers have started to replace plastic wrapping or stickers by laser marking the produce. The laser marking technology uses a focused CO_2 laser beam to remove a thin layer of the fruit's peel without any additives or chemicals and without altering the fruit's taste or shelf life (Puértolas et al., 2024). The use of this technology for marking fruits is authorized by the European Union (European Commission, 2013) and the U.S. Food and Drug Administration (FDA), and it is already used at an industrial scale in some countries (Sood et al., 2009). Companies producing this type of laser highlight its many advantages over conventional signage (i.e., stickers). However, independent studies are still lacking on, for example, the climate impacts of laser marking compared with stickers or aspects such as shelf life, food quality, or human health (Puértolas et al., 2024). Under all circumstances, consumer responses remain crucial for the future success of this technology.

Laser marking is generally viewed as an eco-innovation (Fussler and James, 1996; Sumrin et al., 2021) since it reduces environmental impacts, especially packaging waste (Samoggia and Nicolodi, 2017; Pfiffelmann et al., 2024). Therefore, the laser-marked organic label responds to consumers' demand for more sustainable packaging, not least for organic products (Liu et al., 2019). However, laser marking scores low on some basic functions of packaging, such as protection and communication (Prendergast and Pitt, 1996). Hence, with laser marking, consumers get more responsible packaging at the expense of other valued attributes, including the protection function of packaging. Research has found that the positive evaluation of eco-friendly packaging can spill over to the evaluation of the product (Granato et al., 2022), but at the same time, eco-friendly packaging is often perceived as less attractive (Macht et al., 2023; Prendergast and Pitt, 1996). As we will elaborate below, consumers may also perceive health risks from the new technology. Since lower perceived performance on other valued attributes and higher perceived risks may lead to consumer resistance against new technology, even when it is perceived as eco-friendly, it is imperative for innovating companies to understand consumers' ambivalence and how it influences their responses to the new technology.

Despite research mentioning consumer resistance toward the use of laser marking on fruits and vegetables, there is a lack of evidence of consumer ambivalence in evaluating this technology. To understand consumer resistance toward new technologies, such as laser marking, innovation resistance theory provides a useful lens (Ram and Sheth, 1989; Samoggia and Nicolodi, 2017). However, we propose that when applied to an eco-innovation that consumers are ambivalent about, such as laser marking, a better understanding of their responses can be obtained by supplementing innovation resistance theory with cognitive dissonance theory (Festinger, 1957). The core proposition of cognitive dissonance theory is that inconsistent or conflicting beliefs or attitudes lead to mental discomfort, which people are motivated to avoid or reduce by adjusting their beliefs, attitudes, and/or behaviors (Festinger, 1957; Harmon-Jones and Harmon-Jones, 2007). Furthermore, Festinger (1957) argued that these adjustments will follow the path of least resistance. This means that people typically do not try to distort "hard realities" but primarily adjust more subjective or uncertain beliefs, such as, for example, dissonant eco- or health-related perceptions about a phenomenon. We further propose that when applying cognitive dissonance theory to innovation within the food domain, contagion theory (Nemeroff and Rozin, 1989) offers an interesting perspective for understanding some "hard realities." Contagion theory suggests that the risk of cognitive dissonance is higher for products that are eaten because of their passage into the body, which implies a transfer of physical, behavioral, or moral properties from the products to the body (Nemeroff and Rozin, 1989). For the studied eco-innovation, the edibility of the fruit peel determines whether the laser marking is being ingested or not. Therefore, an edible peel is a "hard reality" that makes health risks from laser marking more salient to the consumer, and which may tip the consumer ambivalence toward rejecting laser marking, whereas consumers may be more likely to lean toward acceptance when the peel is not edible.

By means of three randomized online experiments, we empirically investigate the adjustments consumers make to their perceptions, attitudes, and intentions about laser marking of organic fruits and the possible moderating effect of the edibility of the fruit peel for these relationships. An important theoretical contribution is the combination of three theoretical lenses to inform our understanding of how consumers resolve their ambivalence about this food eco-innovation, using cognitive dissonance theory to qualify predictions based on innovation resistance theory and using contagion theory to qualify predictions based on cognitive dissonance theory.

Literature review and hypotheses

Packaging and eco-friendliness

Several aspects of the packaging can contribute to its eco-friendliness, including its basic functions of protection, ease of handling, and communication (Lindh et al., 2016b). Examples include the ability to use the entire contents of a packaged product, ease of handling along the supply chain, and carrying extensive, often legally required, product and packaging information. By protecting the product from external influences, such as heat, moisture, and so on, the packaging reduces the risk of the product degrading and, therefore, product and packaging waste. Thereby, food packaging also helps secure the food supply, which is important, not least in view of the worldwide increase in food demand. It is also increasingly demanded that the packaging is easy to recycle. Hence, to properly evaluate packaging, a complete product life cycle analysis is needed (ECR Europe, 2009).

The marketing literature has assessed the environmental quality of packaging mainly in three dimensions: its quantity (including the possible absence of packaging), its type, and its technology (Herbes et al., 2020; Nguyen et al., 2020). Table 1 presents a non-exhaustive summary of the different ways in which packaging can be made eco-friendlier.

Packaging cannot be distinguished from the product it contains (Grönman et al., 2013). Hence, an integrated product and packaging viewpoint is crucial for the creation of eco-friendly packaging (Macht et al., 2023). The importance of eco-friendly packaging is amplified for products positioned as eco-friendly, such as organic products, which are nonetheless typically sold plastic-wrapped or with plastic stickers (in the case of organic fruit and vegetables), to label them and distinguish them from non-organic items. Here the product and packaging system as a whole determines the criteria and limitations for eco-friendly packaging (Lindh et al., 2016b). Protecting the environment is one of the motives for buying organic products (Hughner et al., 2007; Thøgersen, 2011), and since over-packaging or plastic sticker-labeling is not consistent with the products' perceived eco-friendliness, this inconsistency can make consumers experience cognitive dissonance (Festinger, 1957; Thøgersen, 2004).

Packaging and healthfulness

The tensions between different packaging demands for organic products, with their higher constraints and legal requirements than conventional products, are not limited to the eco-friendliness dimension. Despite a lack of scientific proof that organic food is healthier than conventional (Vigar et al., 2020), consumers generally associate organic food with better healthfulness (Hughner et al., 2007; Thøgersen, 2011).

When it comes to food supply chain management practices and innovation strategies, consumers generally lack knowledge (Mesías et al., 2021), which can give rise to food safety concerns (Michaelidou and Hassan, 2008) and to resistance against eco-innovations (Ram and Sheth, 1989). While consumers generally trust natural food and its production methods, they are often wary of novel foods and food technologies (Huotilainen and Tuorila, 2005). Understanding consumer perceptions about potential health risks is crucial to predicting their responses to novel food technologies (Rozin, 2005; Rozin et al., 2004).

Laser marking

Laser marking is an alternative to plastic wrapping, especially plastic stickers (Samoggia and Nicolodi, 2017). Drouillard and Kanner (1997) were the first to apply for a patent in the United States on a laser marking method for fresh products, mainly vegetables and citrus fruits, with pulsed CO_2 laser applications. This idea was extended by Longobardi (2007), who filed a patent in the EU on marking fruits (melons and apples) using a low-energy carbon dioxide laser beam (10,600 nm) to create pinhole depressions leaving visible markings on the product's surface. In this way, a little of the pigmented top layer of the peel is removed, exposing the unpigmented sub-layer (Chen et al., 2009; Puértolas et al., 2024). Laser marking uses little energy and, therefore, leads to low carbon emissions, but its relative environmental impact compared with conventional plastic stickers is still not systematically researched (Puértolas et al., 2024). Nevertheless, Samoggia and Nicolodi (2017) found that almost 60% of consumers perceive the laser marking of organic fruits as positive due to its reduced harm to the environment. Especially, laser marking responds to consumers' demand for less and more sustainable packaging (Liu et al., 2019). Hence, laser marking offers producers an opportunity to satisfy consumers' increasing demand for eco-friendly products (Michaelidou and Hassan, 2008; Prakash et al., 2019; Schwepkar and Cornwell, 1991). With reference to Table 1, this solution is characterized by the absence of packaging (and plastic) and new and advanced technology.

On the negative side, there is evidence of consumer concerns about laser marking impacting the natural integrity of the product (Samoggia and Nicolodi, 2017) and posing health risks (Pfiffelmann et al., 2024). Hence, while laser marking may solve inconsistencies from using plastic packaging or stickers on organic products, it may generate a new inconsistency between the perceived healthfulness of organic products and perceived health risks from the use of an "unnatural," high-tech, and seemingly intrusive technology for the marking. While we have little evidence of how consumers perceive laser marking in terms of environmental friendliness or healthfulness, we suspect that a perceived inconsistency between the nature of the product and new technology applied to the fruit may raise doubt about food safety, at least if the peel is edible and is

Table 1. Summary of greener packaging actions.

Dimension	Eco-friendly cues
Packaging size	Absence of packaging (Magnier and Crié, 2015) Absence of over-packaging (Eberhart and Naderer, 2017; Elgaaïed-Gambier, 2016; Magnier and Crié, 2015) Smart shapes that help reduce packaging material (Magnier and Crié, 2015) Small size relative to the packaged product (Magnier and Crié, 2015; Nguyen et al., 2020) Bigger containers instead of many small containers (Magnier and Crié, 2015)
Packaging material	Biodegradable (Bhardwaj, 2019; Herbes et al., 2020; Lewis and Stanley, 2012; Magnier and Crié, 2015) Non-toxic (Herbes et al., 2020) Easily decomposed (Herbes et al., 2020) Reusable (Bhardwaj, 2019; Herbes et al., 2020; Lewis and Stanley, 2012; Scott and Vigar-Ellis, 2014) Recyclable (Bhardwaj, 2019; Herbes et al., 2020; Lewis and Stanley, 2012; Magnier and Crié, 2015; Scott and Vigar-Ellis, 2014; Young, 2008) Paper- or cardboard-based (Allegra et al., 2012; Herbes et al., 2020; Lewis and Stanley, 2012; Nguyen et al., 2020) Not plastic (Nguyen et al., 2020)
Packaging technology	Production causing no harm to the environment (Herbes et al., 2020) Natural and organic sources of materials used in production (Herbes et al., 2020; Palombini et al., 2017) New and advanced technology for production (Herbes et al., 2020; Scott and Vigar-Ellis, 2014)

meant to be ingested. Prior research also unanimously identifies eco-friendliness and healthfulness as the key attributes that consumers associate with organic food (Hughner et al., 2007; Thøgersen, 2011). Therefore, we specifically focus on consumers' conflicting perceptions of these two dimensions in our experimental studies of the impact of consumer ambivalence on their acceptance of this eco-innovation.

Laser-marked organic labeling and eco-friendliness

Perceived eco-friendliness is consumers' subjective evaluation that a product has environmental benefits, such as a low environmental footprint (Sokolova et al., 2023). Driven by the "natural is better" heuristic (Hagen, 2021; Meier et al., 2019), consumers may perceive fruits without plastic stickers as more eco-friendly than fruits with plastic stickers. In line with this, engraving-based laser making has been called "natural branding," when brand logos or names are marked on fresh fruits (Pullman, 2017).

Packaging amount also influences eco-friendliness perceptions, drawing on the "less is better" logic (Sokolova et al., 2023). Even though consumers often lack the information needed to accurately judge a packaging's eco-friendliness (Gifford, 2011), they can easily see the amount of product packaging (Sokolova et al., 2023). Following this logic and the fact that consumers often perceive the packaging of organic food as inappropriate due to the size, quantity, and use of plastic material (Ismael and Ploeger, 2020), organic fruits with plastic stickers may be considered better for the environment than plastic wrapped organic food but worse than laser-marked organic fruits that do not contain plastic or any other packaging.

The perceived negative environmental impact of plastic packaging and stickers is inconsistent with consumers' concerns for the environment, which is one of the drivers of the consumption of organic products (Caruana, 2007); an inconsistency that is likely to be especially salient for "green" consumers (Barbarossa and De Pelsmacker, 2016). Hence, plastic wrapping or stickers contradict consumers' ecological intentions when buying organic products and, therefore, may create a feeling of discomfort. By using laser marking instead of plastic wrapping or stickers, the packaging can be eradicated, which removes the discomfort. Thus, laser marking can potentially remove a source of cognitive dissonance (Festinger, 1957) for organic consumers by allowing more consistency between their beliefs, attitudes, and behaviors (Harmon-Jones and Harmon-Jones, 2007). As highlighted by Samoggia and Nicolodi (2017), this is something that consumers generally value about this technology. Accordingly, we hypothesize:

> *Hypothesis 1 (H1).* Organic fruits are perceived as more eco-friendly when labeled with laser marking than with plastic stickers.

Fruit peel edibility and eco-friendliness

Previous research indicates that the anticipation of food waste is higher for more perishable products because they are thrown away more quickly (Tsiros and Heilman, 2005). While there is no empirical evidence that laser marking reduces fruits' shelf life (Puértolas et al., 2024), laser marking can stress the product's surface, depending on the laser output power and the type of epidermal cell layer or pericarp, so damage to products has to be prevented (Marx et al., 2013). According to the Max Rubner Institute (2024), damage to the outer peel layer can affect the shelf life of the fruit, depending on the type of fruit. For fruits with soft or thin peels, like apples, it is challenging to hit the exact dosing of the laser and the fruit may therefore be more at risk of spoilage after laser treatment.

If consumers at least intuitively understand this risk, they may be more likely to believe that laser marking is detrimental to fruits' shelf life when the peel is edible. Fruits with edible peels are delicate. Most consumers have encountered situations where fruits with edible peels ended up being inedible due to rapid deterioration or deteriorated faster than anticipated because they accidentally bumped them. Therefore, consumers may perceive laser marking as not suitable, especially for fruits with delicate, thin, or edible peels, fearing that the treatment may damage or puncture the peel, making the fruit more susceptible to deterioration. This could undermine the perception that laser marking is eco-friendly since it might increase food waste. The reduction in cognitive dissonance from replacing plastic stickers with laser marking is thus less likely or less pronounced for fruits with edible peels. Thus, the following hypotheses are proposed:

> *Hypothesis 2 (H2).* Organic fruits are anticipated to be wasted more when labeled with laser marking than with plastic stickers.

> *Hypothesis 3 (H3).* The effect of laser marking (compared with plastic stickers) of organic fruits on anticipated food waste is stronger for fruits with edible than non-edible peel.

> *Hypothesis 4 (H4).* Higher anticipated food waste negatively influences the perceived eco-friendliness of organic fruits.

> *Hypothesis 5 (H5).* The positive effect on perceived eco-friendliness of laser marking (compared with plastic stickers) of organic fruits is weaker for fruits with edible than non-edible peel.

Eco-friendliness, consumers' attitudes, and intentions

Due to the increased focus on global warming and other environmental problems, modern consumers are more willing than ever to buy eco-friendly products, including products with reduced packaging (Prakash et al., 2019). Therefore, companies have an incentive to enhance eco-friendliness to improve the consumers' attitude toward their products (Punyatoya, 2015). Also, consumers who question the eco-friendliness of a product may develop a negative attitude toward it (Punyatoya, 2015; Trueman et al., 2012). A consumer's attitude toward a product – the degree to which they like or dislike it (Ajzen and Fishbein, 1977, 1980) – is an important determinant of buying intentions and product choice (Bagozzi et al., 1999; Dabholkar, 1994). Hence, the following hypotheses are proposed:

> *Hypothesis 6a (H6a).* Irrespective of how it is labeled, perceived eco-friendliness of an organic fruit exerts a positive influence on the attitude toward an organic fruit.

Hypothesis 6b (H6b). And on the intention to try the organic fruit.

Laser-marked organic labeling and healthfulness

Organic labeling using plastic stickers is generally considered safe, non-toxic, and causes no physical harm to consumers (Dormer, 2018). The health authorities test the stickers to ensure they pose no harm if consumed accidentally. However, the mechanical and photodegradation of plastics, in general, leads to microplastic exposure. The effects may be harmful, especially in case of chronic exposure (Wang et al., 2016). Thus, plastic contamination should be avoided. Laser marking of the organic label on the fruits' surface is an alternative to plastic stickers. According to existing evidence, the fruit mesocarp and shelf life are unaffected by the laser marking (Etxeberria et al., 2009; Sood et al., 2009), and it does not present any known food safety risks (Danyluk et al., 2010; Puértolas et al., 2024). Nevertheless, consumers may be skeptical of the new "high-tech" laser marking technology and consequently resist it. Due to the anticipation of potential risks, consumers are generally suspicious of new products and technology (Cardello et al., 2007; Frewer et al., 2011; Siddiqui et al., 2022). They value natural, fresh foods that have not been processed and are free from artificial additives (Lavilla and Gayán, 2018). Attitudes toward new technologies are partly formed through associations with other concepts, following a top-down attitude formation process where the new attitude is inferred from existing attitudes toward more abstract and general concepts (Deliza and Ares, 2018). In this way, the mental representation of new technology is incorporated into a multidimensional structure composed of many interrelated concepts that can influence the attitude toward the new technology (Olsen et al., 2010; Scholderer and Frewer, 2003; Søndergaard et al., 2005). For example, when forming an attitude toward laser marking of organic products, the more abstract and general attitudes that are drawn upon might be related to the environment, laser technology in general, or laser treatment for medical purposes. Research has found that patients in general fear laser treatment, for example, for diabetic retinopathy screening and treatment (Lewis, 2015) or for caries treatment (Sarmadi et al., 2014). Laser technology is "high-tech" and many people do not understand how it works. Most consumers also have only a vague idea about other technological processes applied to food (Cardello, 2003; Nielsen et al., 2009). This lack of understanding can lead to fear or apprehension about the technology and, together with negative associations toward laser treatment, to negative attitudes toward laser marking technology.

The laser marking may induce psychological resistance if consumers feel that this "high-tech" technology alters the fruit's integrity or naturalness (Samoggia and Nicolodi, 2017). Because organic is associated with naturalness (Berry et al., 2017; Gifford and Bernard, 2011; Lockie, 2006), interfering with the natural image of organic fruits through laser marking may also reduce perceived health benefits (Rozin, 2005). Even if consumers value the laser marking of organic products' ability to reduce environmental harms, if they believe that it poses a personal health risk, this ambivalence may add a new source of discomfort (Merle et al., 2016) or cognitive dissonance (Festinger, 1957). To overcome cognitive dissonance, people are motivated to alter either their behavior or their belief system (Thøgersen, 2004). This is typically done through the path of least resistance (Festinger, 1957), and it is often easier to alter one's beliefs than one's actions. Hence, there are reasons to expect that a laser-marked organic label might induce doubts or skepticism about the product's healthfulness, leading to the following hypothesis:

Hypothesis 7 (H7). Organic fruits are perceived as less healthful when labeled with laser marking than with plastic stickers.

Fruit peel edibility and healthfulness

When applied to fruits with non-edible peels, consumers can remove the laser-marked organic label by peeling the fruit. In other cases, consumers eat the fruits' peels and, thus, also the laser-marked organic label, which is applied directly to the peel. Thus, consumers may be more likely to perceive a food safety risk when the laser marking is applied to fruits with edible peels. According to contagion theory, offensive properties of products are believed to transfer to the human body through physical contact, more specifically through their consumption (Lin and Shih, 2016; Nemeroff and Rozin, 1989). The theory establishes that when an external substance is incorporated into a product, it makes the product contaminated, which creates disgust and contamination concerns (Rozin et al., 1986). Hence, the theory suggests that consumers may experience discomfort when consuming a fruit peel that has been laser-treated because the laser mark is getting into direct contact with their body (Gallen, 2005). Especially the thought of eating the laser-marked peel may reinforce the negative affect associated with laser technology on the perceived healthfulness of organic fruits. Accordingly, the following hypotheses are proposed:

Hypothesis 8 (H8). Organic fruits are perceived as more contaminated when labeled with laser marking than with plastic stickers.

Hypothesis 9 (H9). This effect of laser marking (compared with plastic stickers) of organic fruits on perceived contamination is stronger for fruits with edible than non-edible peel.

Hypothesis 10 (H10). Perceived contamination negatively influences perceived healthfulness of organic fruits.

Hypothesis 11 (H11). The negative effect of laser marking (compared with plastic stickers) of organic fruits on perceived healthfulness is stronger for fruits with edible than non-edible peel.

Healthfulness, consumers' attitudes, and intentions

According to some research, healthfulness is the third most important food attribute when buying food products, after taste and price (International Food Information Council Foundation, 2022). There is also plenty of research finding a favorable effect of health and nutrition claims on consumers' overall product evaluations and purchase intentions (Andrews et al., 1998; Bates et al., 2009; Berry et al., 2017; Chandon and Wansink, 2007). The positive effect of perceived healthfulness is even more pronounced for organic food (Hughner et al., 2007; Janssen, 2018; Kushwah et al., 2019; Lodorfos and Dennis, 2008; Thøgersen et al., 2015; Thøgersen and Zhou, 2012). On this background, the following hypotheses are proposed:

Hypothesis 12a (H12a). Irrespective of how it is labeled, perceived healthfulness of an organic fruit exerts a positive influence on the attitude toward an organic fruit.

Hypothesis 12b (H12b). And toward the intention to try the organic fruit.

Attitude and intention to try the product

Social-cognitive theories, such as the theory of reasoned action (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975) and the theory of planned behavior (Ajzen, 1991), suggest a positive relationship between attitude and behavioral intention. Also, in empirical marketing research, it is generally found that consumers' positive attitude toward a product enhances the likelihood of a positive behavioral response (Jiang and Benbasat, 2007; Rucker and Petty, 2006). More specifically, numerous studies confirm the positive relationship between consumers' attitudes toward organic products and buying intentions (Boobalan et al., 2021; Dorce et al., 2021; Rana and Paul, 2017; Sultan et al., 2020; Teixeira et al., 2022; Thøgersen and Zhou, 2012). Hence, for completeness, we formulate this last hypothesis:

Hypothesis 13 (H13). Irrespective of how it is labeled, a more positive attitude toward an organic fruit increases the intention to try it.

All hypotheses are integrated and illustrated in the conceptual model in Figure 1.

Method

Design, procedure, and measures

We use experimental survey studies to examine how consumers respond to an eco-innovation, laser-marked (vs plastic sticker) labeling for organic

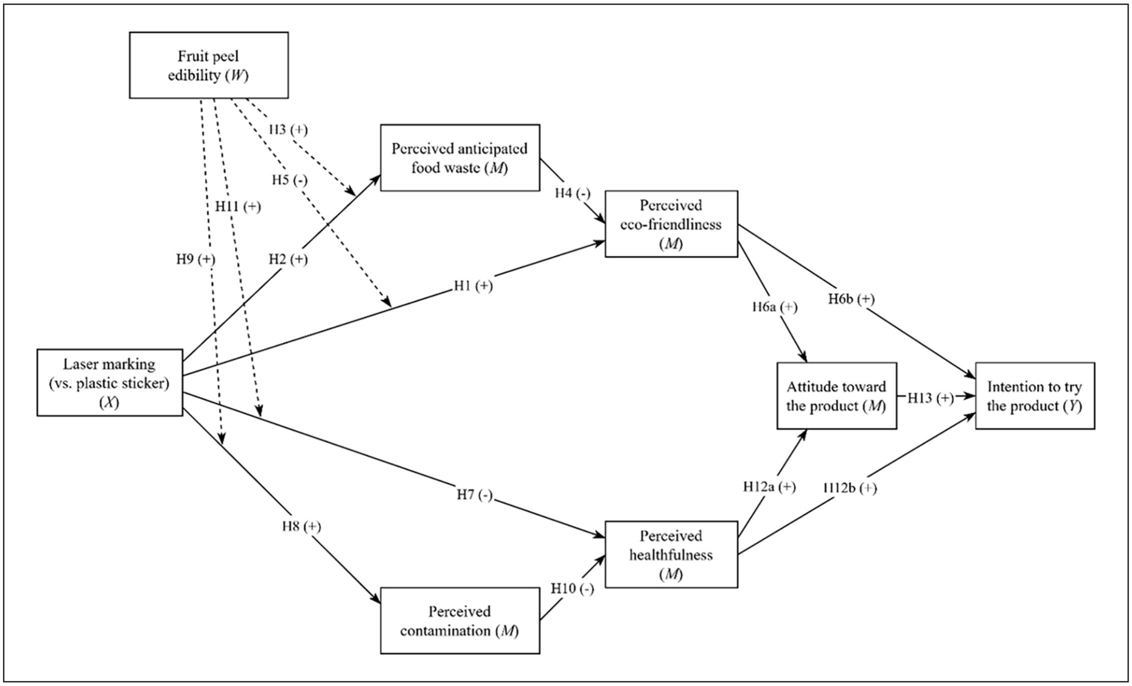

Figure 1. Conceptual model.

fruits, and the moderating role of fruit peel edibility for these responses. We conducted three 2 (label: plastic sticker vs laser marking) × 2 (fruit peel edibility: non-edible peel vs edible peel) factors between-subjects online experiments. All experiments were implemented in Qualtrics, using samples of US Prolific panel participants randomly allocated to the four different conditions. In the first study, we investigated the impacts of laser marking on an organic fruit's perceived eco-friendliness, perceived healthfulness, the consumer's attitude toward the product, and intention to try it. In the second and third studies, we test the assumed mediating role of perceptions about food waste on the fruit's perceived eco-friendliness and of the perceived risk of contamination on its perceived healthfulness.

To ensure that participants knew what an organic label is, in all three studies, they first read a text defining organic food as high-quality products that are produced within a system that respects nature's cycles and systems and contributes to biological diversity, and the external inputs are restricted to a minimum of naturally derived substances (taken from EC Regulation 834/2007). After questions measuring their environmental and health concerns in general, participants were randomly exposed to a stimulus corresponding to one of the four experimental conditions: a picture of an organic fruit (apple, pear, peach, banana, orange, or pomegranate) on which a plastic sticker or a laser-marked organic label was applied on the fruit's peel (Appendix 1). To make sure all participants were fully informed about the labeling solution, each picture was accompanied by a text mentioning that a laser (in two conditions) or a plastic sticker (in the two other conditions) was applied on the peel to inform consumers that the fruit is organic. Orange, banana, and pomegranate have non-edible peels, while peach, pear, and apple have edible peels. After being exposed to the experimental stimulus, participants completed the rest of the questionnaire.

We measured all constructs on 7-point Likert-type scales or semantic differentials taken from prior research (reported in full in Appendix 2). Participants were also asked questions about demographics, such as biological sex, age, and education. In addition, they reported their organic food purchase frequency and the percentage of their food budget allocated to organic food products. Finally, as an attention check, we asked participants in all studies whether the fruit they saw had a plastic sticker organic label or a laser-marked organic label and, as a manipulation check, about the edibility of the fruit's peel using a single-item semantic differential scale (Definitively uneatable/ Definitively eatable).

Method of analysis

To test the hypotheses summarized in our conceptual model (Figure 1), we used Hayes' (2017) PROCESS macro for SPSS (version 3.5) with 5,000 bootstrap samples and mean centering. The PROCESS macro has become a standard approach to test mediation, moderation, and moderated mediation in consumer research and other fields (Hayes, 2017). A moderated mediation model enables us to evaluate conditional indirect effects, which cannot be examined when testing mediation and moderation in isolation (Borau et al., 2015). We also obtain more rigorous and accurate results through the generation of confidence intervals for significance testing with the bootstrap method (Hayes, 2017).

Study 1

Design, procedure, and measures

The first objective of Study 1 is to examine how consumers respond to laser-marked (vs plastic sticker) labeling for organic fruits in terms of perceptions of eco-friendliness and healthfulness as well as mediated effects on attitudes toward and intention to try the product. The second objective is to examine the moderating role of fruit peel edibility in these relationships. To do so, we conducted a 2 (label: plastic sticker vs laser marking) × 2 (fruit peel edibility: non-edible peel vs edible peel) factors between-subjects online experiment using a sample of 433 US Prolific panel participants. We removed 6 participants who failed the first attention check question and 31 who failed the second attention check question, for a final sample of 396. The sample was randomly allocated to four different conditions: (1) fruit with a plastic sticker organic label and non-edible peel ($n=90$), (2) plastic sticker organic label and edible peel ($n=99$), (3) laser-marked organic label and non-edible peel ($n=102$), and (4) laser-marked organic label and edible peel ($n=105$). The youngest participant was 19 years old and the oldest 69 ($M=37.79$, $SD=12.22$). The majority of participants identified as female ($n=271$, 68.7%), had completed at least a Bachelor's degree ($n=233$, 58.8%), and purchased organic food twice a month or less ($n=259$, 65.4%). On average, participants allocate 22.3% of their food budget to organic food (Table 2).

Willingness to try is often viewed as a more useful response indicator than purchase intention for a completely new, innovative product (Hémar-Nicolas et al., 2022; Kamalanon et al., 2022; Mathur et al., 2022). Therefore, we measured participants' willingness to try the previously seen product in the future using two items from Puzakova and Kwak (2023) ($M=4.25$, $SD=1.83$, Cronbach's $\alpha=0.943$). In addition, we measured participants' attitudes toward the fruit they saw previously with four items from Holbrook and Batra (1987) ($M=4.92$, $SD=1.64$, Cronbach's $\alpha=0.958$), its perceived eco-friendliness with three items taken from Chen et al. (2015) ($M=4.77$, $SD=1.43$, Cronbach's $\alpha=0.955$), and its perceived healthfulness with three items from Ware (1976) ($M=4.43$, $SD=1.21$, Cronbach's $\alpha=0.843$).

Manipulation check, participant characteristics, and randomization check

The perceived fruit peel edibility differed significantly between the fruit peel edibility conditions ($M_{non\text{-}edible}=3.08$, $M_{edible}=4.90$, $t=-8.562$, 394 df., $p<0.001$), confirming that the fruit peel edibility manipulation worked as expected. Having three fruits randomly presented in each fruit peel edibility condition reduced the risk that preferences for or against a specific fruit would confound the impact of the edibility of the peel. Confirming that this precaution worked as intended, the difference in the mean attitudes toward the fruits in the two conditions is non-significant ($M_{non\text{-}edible}=4.98$, $M_{edible}=4.86$, $t=0.745$, 394 df., $p=0.457$).

Table 2. Survey participants' characteristics.

Demographic variable	Category	Study 1		Study 2		Study 3	
		n	%	*n*	%	*n*	%
Age	18–25	71	17.9	47	12.1	37	10.7
	26–35	117	29.5	132	33.8	114	32.9
	36–45	111	28.0	109	27.9	89	25.7
	46–55	52	13.1	52	13.3	63	18.2
	⩾55	45	11.4	50	12.8	43	12.4
Gender	Female	271	68.7	198	50.8	177	51.2
	Male	125	31.3	192	49.2	169	48.8
Education level (highest diploma obtained)	No diploma	0	0.0	3	0.8	3	0.9
	Secondary education	10	2.5	5	1.3	4	1.2
	High school degree	106	26.8	100	25.6	85	24.6
	Associate's degree	47	11.9	46	11.8	32	9.2
	Bachelor's degree	161	40.7	158	40.5	141	40.8
	Master's degree	57	14.4	63	16.2	66	19.1
	Ph.D. degree	15	3.8	15	3.8	15	4.3
Organic food purchase frequency	Less than once a month	116	29.3	100	25.6	98	28.3
	Once a month	64	16.2	74	19.0	86	24.9
	Twice a month	79	19.9	68	17.4	57	16.5
	Three times per month	50	12.6	49	12.6	31	9.0
	More than three times a month	87	22.0	99	25.4	74	21.4
Percentage of budget allocated to organic food products		396	22.3	390	27.6	346	25.2

Randomization checks were conducted using a series of chi-square tests and a *t*-test for independent samples between the labeling variable (plastic sticker vs laser-marked) and the demographic variables. No statistically significant associations were found between the labeling variable and age group ($\chi^2(4)=3.810$, $p=0.432$), the education level ($\chi^2(5)=2.969$, $p=0.705$), the organic food purchase frequency ($\chi^2(4)=1.195$, $p=0.879$), or the percentage of budget allocated to organic food products ($t=-0.668$, $p=0.505$). However, a chi-square test of independence yielded a significant association with gender ($\chi^2(1)=4.537$, $p<0.05$), and therefore, we replicated the main analysis controlling for gender in addition to the labeling variable as the independent variable. Including gender as a covariate did not change any of the results, so we report results without gender as a covariate in the following.

Results

Because the model we tested in Study 1 contains moderated parallel and serial mediations, we designed a customized PROCESS model for this purpose (Appendix 3). We specified labeling as a dichotomous independent variable (0=plastic sticker, 1=laser-marked) (*X*), perceived eco-friendliness as the first parallel mediator (*M*), perceived healthfulness as the second parallel mediator (*M*), the attitude toward the product as the third serial mediator (*M*), intention to try as the dependent variable (*Y*), and fruit peel edibility as a dichotomous moderator (*W*). Table 3 reports the unstandardized regression weights for all estimated paths in the model.

It appears that, overall, laser marking (compared with a plastic sticker) does not directly change perceived eco-friendliness ($b=0.224$,

Table 3. PROCESS results (Study 1).

	Perceived eco-friendliness (*M*)			Perceived healthfulness (*M*)			Attitude toward the product (*M*)			Intention to try the product (*Y*)		
	b	*SE*	*t*	*b*	*SE*	*t*	*b*	*SE*	*t*	*b*	*SE*	*t*
Constant	4.768	0.072	66.623***	4.425	0.061	73.127***	1.213	0.283	4.293***	–0.796	0.265	–3.006**
Laser marking (vs plastic sticker) (*X*)	0.224	0.143	1.563[a]	–0.045	0.121	–0.374[a]	–0.549	0.129	–4.266***	0.076	0.121	0.634[a]
Fruit peel edibility (*W*)	0.015	0.143	0.102[a]	–0.010	0.121	–0.079[a]						
XW Interaction	–0.658	0.287	–2.293*	–0.666	0.242	–2.748**						
Perceived eco-friendliness (*M*)							0.673	0.048	14.144***	0.257	0.054	4.804***
Perceived healthfulness (*M*)							0.112	0.056	1.991*	0.103	0.052	1.998*
Attitude toward the product (*M*)										0.685	0.046	14.804***
R^2	0.019, $F(3, 392) = 2.566$[a]			0.019, $F(3, 392) = 2.567$[a]			0.399, $F(3, 392) = 86.767$***			0.598, $F(4, 391) = 145.697$***		
ΔR^2	0.013, $F(1, 392) = 5.258$*			0.019, $F(1, 392) = 7.552$**								

[a]Not significant.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

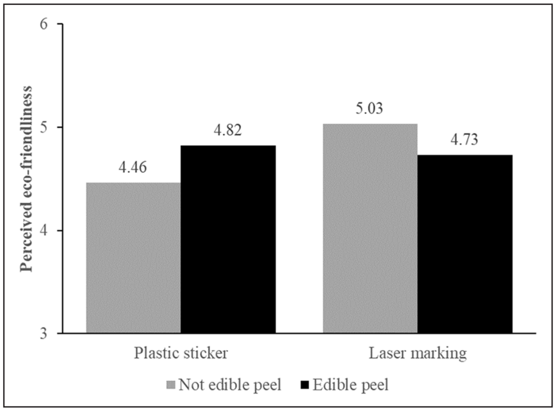

Figure 2. Means of perceived eco-friendliness by experimental condition.

SE = 0.143, *p* = 0.119, 95% confidence interval (CI) = [–0.058; 0.506]), perceived healthfulness (*b* = –0.045, *SE* = 0.121, *p* = 0.708, 95% CI = [–0.284; 0.193]), or intention to try the product (*b* = 0.076, *SE* = 0.121, *p* = 0.526, 95% CI = [–0.161; 0.313]), rejecting H1 and H7.

The interaction between labeling and fruit peel edibility has a negative effect on perceived eco-friendliness (*b* = –0.658, *SE* = 0.287, *p* < 0.05, 95% CI = [–1.221; –0.094]), confirming H5. The meaning of this interaction is clarified by Figure 2, which shows the means for perceived eco-friendliness in the four experimental conditions. As shown in the graph (and in the descriptive statistics in Table 4), the perceived eco-friendliness is higher for the laser-marked label than for the plastic sticker label when the fruit peel is not edible (*b* = 0.563, *SE* = 0.206, *p* < 0.01, 95% CI = [0.158; 0.968]), but the difference in perceived eco-friendliness is not significant when the fruit peel is edible (*b* = –0.095, *SE* = 0.199, *p* = 0.635, 95% CI = [–0.487; 0.297]). This means that a laser-marked organic label (vs plastic sticker) positively influences the fruit's perceived eco-friendliness, but only when its peel is not edible.

Confirming H6a and H6b, perceived eco-friendliness has a positive effect on the attitude toward the product (*b* = 0.673, *SE* = 0.048, *p* < 0.001, 95% CI = [0.579; 0.766]) and also a small direct effect on the intention to try the product (*b* = 0.257, *SE* = 0.054, *p* < 0.001, 95% CI = [0.152; 0.363]) after controlling for the attitude. Consistent with these hypotheses and the moderation analysis reported earlier, the index of moderated mediation (i.e., the direct quantification of the linear association between the indirect effect and the putative moderator of that effect) between laser marking and intention to try the product through the eco-friendliness path is negative and significant (index = –0.303, *SE* = 0.138, 95% CI = [–0.583; –0.033]), meaning that the positive effect of laser marking on perceived eco-friendliness leads to a positive effect on the intention to try the product when the peel is non-edible.

Furthermore, the interaction between labeling and fruit peel edibility also has a negative effect on perceived healthfulness (*b* = –0.666, *SE* = 0.242, *p* < 0.01, 95% CI = [–1.143; –0.190]), as predicted by H11. This interaction is illustrated in Figure 3, which presents the means for perceived healthfulness in the four experimental conditions. The perceived healthfulness is lower for the laser-marked label than for the plastic sticker label when the fruit peel is edible (*b* = –0.368, *SE* = 0.169, *p* < 0.05, 95% CI = [–0.700; –0.037]), but not when the fruit peel is not edible (*b* = 0.298, *SE* = 0.174, *p* = 0.088, 95% CI = [–0.044; 0.640]). This means that a laser-marked organic label (vs plastic sticker) negatively influences the fruit's perceived healthfulness, but only when the peel is edible.

The significant, positive effect of perceived healthfulness on the attitude toward the product (*b* = 0.112, *SE* = 0.056, *p* < 0.05, 95% CI = [0.001; 0.222]) and (weaker) on intention to try (*b* = 0.103, *SE* = 0.052, *p* < 0.05 95% CI = [0.002; 0.205]), after controlling for the attitude, confirms H12a and H12b. However, the index of moderated mediation between labeling and intention to try the product through the perceived healthfulness path is not significant (index = –0.051, *SE* = 0.034, 95% CI = [–0.129; 0.001]).

The results also show that laser marking, compared with plastic sticker labeling, has a significant negative direct impact on the attitude toward the product (*b* = –0.549, *SE* = 0.129, *p* < 0.001, 95% CI = [–0.802; –0.296]) after controlling for perceived eco-friendliness and perceived healthfulness. Hence, it appears that laser marking provokes

Table 4. Means and standard deviations by experimental condition (Study 1).

Experimental condition			Perceived eco-friend-liness	Perceived healthfulness	Attitude toward the product	Intention to try the product	*N*
Laser marking	Non-edible peel	Orange	5.13 (1.14)	4.76 (0.94)	5.18 (1.37)	4.64 (1.58)	35
		Banana	4.93 (1.58)	4.74 (1.10)	4.71 (1.91)	4.38 (1.12)	33
		Pomegranate	5.02 (1.17)	4.20 (1.37)	4.88 (1.65)	4.48 (1.80)	34
		Total	5.03 (1.30)	4.57 (1.17)	4.93 (1.64)	4.50 (1.83)	102
	Edible peel	Peach	4.64 (1.62)	4.01 (1.21)	4.57 (1.94)	3.94 (2.13)	37
		Pear	4.78 (1.55)	4.26 (1.33)	4.77 (1.70)	3.84 (1.85)	35
		Apple	4.78 (1.37)	4.48 (1.24)	4.23 (1.59)	3.83 (1.83)	33
		Total	4.73 (1.51)	4.24 (1.26)	4.53 (1.76)	3.87 (1.93)	105
	Total		4.87 (1.41)	4.40 (1.23)	4.72 (1.71)	4.18 (1.90)	207
Plastic sticker	Non-edible peel	Orange	4.65 (1.37)	4.41 (1.06)	5.56 (1.25)	4.58 (1.61)	30
		Banana	4.49 (1.61)	4.39 (1.31)	5.08 (1.81)	4.14 (2.02)	31
		Pomegranate	4.24 (1.39)	4.01 (1.49)	4.46 (1.69)	3.57 (1.64)	29
		Total	4.47 (1.46)	4.27 (1.30)	5.04 (1.65)	4.11 (1.80)	90
	Edible peel	Peach	5.11 (1.49)	4.62 (1.22)	5.33 (1.34)	4.50 (1.81)	29
		Pear	4.87 (1.59)	4.64 (1.09)	5.38 (1.48)	4.60 (1.73)	35
		Apple	4.53 (1.12)	4.57 (0.95)	4.93 (1.39)	4.51 (1.57)	35
		Total	4.82 (1.42)	4.61 (1.07)	5.21 (1.41)	4.54 (1.68)	99
	Total		4.65 (1.44)	4.45 (1.19)	5.13 (1.53)	4.33 (1.75)	189
Total	Non-edible peel	Orange	4.91 (1.26)	4.60 (1.00)	5.35 (1.32)	4.61 (1.58)	65
		Banana	4.72 (1.60)	4.57 (1.21)	4.89 (1.86)	4.26 (2.06)	64
		Pomegranate	4.66 (1.32)	4.11 (1.42)	4.69 (1.67)	4.06 (1.77)	63
		Total	4.76 (1.40)	4.43 (1.24)	4.98 (1.64)	4.32 (1.82)	192
	Edible peel	Peach	4.85 (1.57)	4.28 (1.24)	4.90 (1.73)	4.19 (2.00)	66
		Pear	4.83 (1.56)	4.46 (1.22)	5.07 (1.61)	4.22 (1.82)	70
		Apple	4.65 (1.25)	4.53 (1.09)	4.59 (1.52)	4.18 (1.73)	68
		Total	4.77 (1.46)	4.42 (1.19)	4.86 (1.63)	4.20 (1.84)	204
	Total		4.77 (1.43)	4.43 (1.21)	4.92 (1.63)	4.25 (1.83)	396

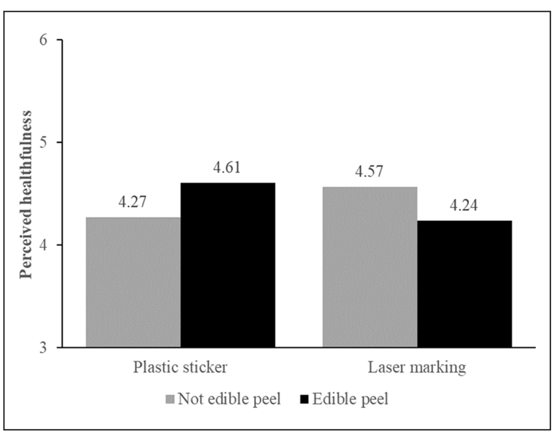

Figure 3. Means of perceived healthfulness by experimental condition.

psychological resistance not only due to perceived health risks but also for other reasons. Finally, as expected, the attitude toward the product exerts a positive influence on the intention to try the product ($b = 0.685$, $SE = 0.046$, $p < 0.001$, 95% CI = [0.594; 0.776]), confirming H13.

Discussion

Study 1 broadly confirms that consumers perceive laser-marked organic fruits as more eco-friendly and less healthful than plastic sticker labeled, but depending on whether the peel is edible. They perceive it as more eco-friendly only when the peel is non-edible and less healthful only when it is edible. Via perceptions of eco-friendliness and healthfulness, laser marking also influences consumer attitudes toward and intention to try the organic fruit. These results confirm the predicted consumer ambivalence toward laser marking of organic fruits. In addition, there is a negative direct impact of laser marking on the attitude toward the product, which suggests a general animosity toward laser marking that goes beyond perceptions about eco-friendliness and healthfulness. We will discuss the implications of these findings after reporting the results of the next two studies, where we dig deeper into consumer perceptions of the environmental and health consequences of laser marking.

Study 2

Design, procedure, and measures

The aim of Study 2 was to test the mediating role of anticipation of food waste between laser marking and perceived eco-friendliness of an organic fruit and the moderating role of fruit peel edibility for this relationship. To do so, we again conducted a 2 (label type: plastic sticker vs laser marking) × 2 (peel edibility: non-edible vs edible) between-subjects online experiment, following the same procedure and using the same stimuli as in Study 1 (Appendix 1) and using a sample of 422 US Prolific panel participants. After removing 32 participants who failed the attention check question, the final sample included 390 participants, randomly assigned to one of four conditions: (1) fruit with a plastic sticker organic label with non-edible peel (n=84), (2) plastic sticker organic label with edible peel (n=96), (3) laser-marked organic label with non-edible peel (n=105), and (4) laser-marked organic label with edible peel (n=105). Participants ranged from 18 to 82 years old (M=39.19, SD=12.89) (Table 2). The majority had at least a Bachelor's degree (n=236, 60.5%) and purchased organic food two times or less a month (n=242, 62.9%), and about half identified as female (n=198, 50.8%). Participants allocate an average of 27.6% of their food budget to organic products.

For this study, we again measured perceived eco-friendliness (M=4.60, SD=1.26, Cronbach's α=0.931) using the same scale as in the previous study. In addition, we measured food waste anticipation due to produce damage (M=3.45, SD=1.41, Cronbach's α=0.917) using 1 item adapted from Petit et al. (2020) and 3 items created for the purpose of this study (e.g., "I doubt I will be able to use this fruit before it goes bad"; Appendix 2).

Manipulation check, participant characteristics, and randomization check

As expected, the edible peel condition prompted a significantly stronger perception of fruit peel edibility than the non-edible peel condition ($M_{\text{non-edible}}$ = 3.05, M_{edible} = 5.21, t = –10.990, 399 df., $p < 0.001$), providing support for our experimental manipulation. Randomization checks showed no significant associations between the labeling variable and age group ($\chi^2(4) = 7.624$, $p = 0.106$), gender ($\chi^2(1) = 0.108$, $p = 0.743$), education ($\chi2(6) = 4.743$, $p = 0.577$), or the percentage of budget allocated to organic food products ($t = 1.704$, $p = 0.089$). However, there was a significant association with organic food purchase frequency ($\chi^2(4) = 15.159$, $p < 0.01$). We do not report calculations with this variable as a covariate because it does not impact the results.

Results

We tested our hypotheses using Hayes' (2017) PROCESS macro for SPSS (version 3.5, Model 7) with 5,000 bootstrap samples and mean centering. Like in Study 1, the type of labeling was specified as a dichotomous independent variable (0 = plastic sticker, 1 = laser-marked) (X) and fruit peel edibility as a dichotomous moderator (W) (Appendix 4). Food waste anticipation was specified as the mediator (M) and perceived eco-friendliness as the dependent variable (Y). Consistent with Study 1, the data analysis confirmed that laser marking (compared with a plastic sticker) does not directly impact the perceived eco-friendliness of an organic fruit (b = 0.162, SE = 0.130, p = 0.214, 95% CI = [–0.094; 0.418]), rejecting H1 (Table 5).

New in Study 2 and confirming H2, we find that laser marking significantly increases anticipations of food waste (b=0.624, SE=0.140, p<0.001, 95% CI = [0.349; 0.899]), contradicting the perception of laser marking as eco-friendly. As expected in H4,

Table 5. PROCESS results (Study 2).

	Food waste anticipation (*M*)			Perceived eco-friendliness (*Y*)		
	b	*SE*	*t*	*b*	*SE*	*t*
Constant	3.457	0. 070	49.518***	5.135	0.171	30.066**
Laser marking (vs plastic sticker) (*X*)	0.624	0.140	4.457***	0.162	0.130	1.2446[a]
Fruit peel edibility (*W*)	0.089	0.140	0.634[a]			
XW Interaction	0.577	0.280	2.058*			
Food waste anticipation (*M*)				–0.154	0.046	–3.344***
R^2	0.060, $F(3, 386) = 8.146$***			0.029, $F(2, 387) = 5.727$**		
ΔR^2	0.010, $F(1, 386) = 4.237$*					

[a]Not significant.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

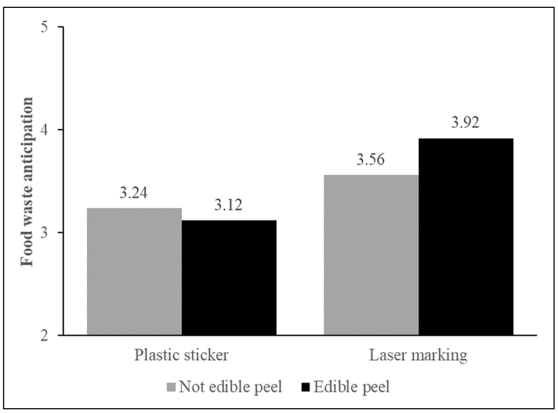

Figure 4. Means of food waste anticipation by experimental condition.

food waste anticipation has a negative effect on the perceived eco-friendliness of the fruit ($b=–0.154$, $SE=0.046$, $p=0.001$, 95% CI=[–0.244; –0.063]).

However, the relationship between labeling type and anticipations of food waste is qualified by a positive interaction between labeling and fruit peel edibility ($b=0.577$, $SE=0.280$, $p<0.05$, 95% CI=[0.026; 1.128]), confirming H3. As shown in Figure 4 and in the descriptive statistics (Table 6), the food waste anticipation is higher for the laser-marked label than for the plastic sticker label when the fruit peel is edible ($b=0.904$, $SE=0.195$, $p<0.001$, 95% CI=[0.521; 1.286]), but the difference between the two labeling types is not significant when the fruit peel is not edible ($b=0.327$, $SE=0.202$, $p=0.106$, 95% CI=[–0.070; 0.723]). This means that a laser-marked organic label (vs plastic sticker) increases the anticipation of food waste, but only when the peel of the fruit is edible. This is also reflected in the index of moderated mediation, which is significant and negative (index=–0.089, $SE=0.053$, 95% CI=[–0.207; –0.002]), meaning that the positive effect of laser marking on food waste anticipation leads to a negative effect on perceived eco-friendliness when the peel is edible.

Discussion

Study 2 confirms that, overall, a laser-marked organic fruit is not perceived as more (nor less) eco-friendly than an organic fruit marked with a plastic sticker. Study 2 also explains why Study 1 found that consumers perceive laser-marked organic fruits as more eco-friendly when the peel is non-edible: because they expect that laser marking of a fruit with edible peel increases the risk that it deteriorates before it is eaten and hence leads to more food waste. This expectation appears to neutralize the perceived eco-friendliness of laser marking for fruits with edible peel. We will discuss the implications of this finding after reporting the results of Study 3, where we dig deeper into consumer perceptions of the health consequences of laser marking.

Study 3

Design, procedure, and measures

Study 3 is identical to Study 2 except that the mediator is perceived contamination and the dependent

Table 6. Means and standard deviations by experimental condition (Study 2).

Experimental condition			Food waste anticipation	Perceived eco-friendliness	N
Laser marking	Non-edible peel	Orange	3.62 (1.55)	4.68 (1.26)	34
		Banana	3.78 (1.33)	4.53 (1.31)	36
		Pomegranate	3.29 (1.43)	4.27 (1.08)	35
		Total	3.56 (1.44)	4.49 (1.22)	105
	Edible peel	Peach	3.62 (1.46)	4.89 (1.15)	36
		Pear	4.04 (1.33)	4.22 (1.52)	34
		Apple	4.11 (1.28)	5.22 (0.97)	35
		Total	3.92 (1.37)	4.78 (1.29)	105
	Total		3.74 (1.41)	4.63 (1.26)	210
Plastic sticker	Non-edible peel	Orange	3.40 (1.39)	4.70 (1.24)	31
		Banana	3.39 (1,45)	3.97 (1.55)	27
		Pomegranate	2.87 (1.23)	4.69 (1.15)	26
		Total	3.24 (1.37)	4.47 (1.35)	84
	Edible peel	Peach	2.85 (1.36)	4.76 (1.15)	33
		Pear	2.99 (1.43)	4.86 (1.31)	29
		Apple	3.19 (1.22)	4.38 (1.15)	34
		Total	3.01 (1.33)	4.66 (1.21)	96
	Total		3.12 (1.35)	4.57 (1.28)	180
Total	Non-edible peel	Orange	3.52 (1.47)	4.69 (1.24)	65
		Banana	3.62 (1.39)	4.29 (1.43)	63
		Pomegranate	3.11 (1.35)	4.45 (1.12)	61
		Total	3.42 (1.41)	4.48 (1.28)	189
	Edible peel	Peach	3.25 (1.46)	4.83 (1.15)	69
		Pear	3.56 (1.46)	4.51 (1.45)	63
		Apple	3.66 (1.33)	4.81 (1.13)	69
		Total	3.49 (1.42)	4.72 (1.25)	201
	Total		3.45 (1.42)	4.60 (1.27)	390

variable perceived healthfulness. Else, this study replicates the procedures of the previous experiments and uses the same stimuli (Appendix 1). Again, we used a sample of US participants from the Prolific panel, $N=408$. After removing 62 participants who failed the attention check, the final sample consisted of 346 participants, randomly assigned to one of four experimental conditions: (1) fruit with a plastic sticker organic label and non-edible peel ($n=74$), (2) plastic sticker organic label and edible peel ($n=79$), (3) laser-marked organic label and non-edible peel ($n=99$), and (4) laser-marked organic label and edible peel ($n=94$).

Participants ranged from 18 to 78 years old ($M=39.71$, $SD=12.55$). The majority had completed at least a Bachelor's degree ($n=222$, 64.1%) and reported purchasing organic food once a month or less ($n=184$, 63.2%). About half identified as female ($n=177$, 51.2%) and on average they allocated 25.2% of their food budget to organic products (Table 2).

We measured perceived healthfulness ($M=4.42$, $SD=1.26$, Cronbach's $\alpha=0.885$) using the same scale as in Study 1 and perceived contamination with four items from White et al. (2016) ($M=3.46$, $SD=1.50$, Cronbach's $\alpha=0.925$; Appendix 2).

Manipulation check, participant characteristics, and randomization check

Again, we found a significant difference in perceived fruit peel edibility between the conditions with edible and non-edible peels ($M_{\text{non-edible}}=3.12$,

Table 7. PROCESS results (Study 3).

	Perceived contamination (*M*)			Perceived healthfulness (*Y*)		
	b	*SE*	*t*	*b*	*SE*	*t*
Constant	3.466	0.078	44.432***	5.232	0.168	31.176***
Laser marking (vs plastic sticker) (*X*)	0.679	0.157	4.321***	–0.091	0.135	–0.675[a]
Fruit peel edibility (*W*)	0.329	0.156	2.108*			
XW Interaction	0.629	0.314	2.003*			
Perceived contamination (*M*)				–0.235	0.045	–5.259***
R^2	0.073, $F(3, 342) = 8.913$***			0.083, $F(2, 343) = 15.620$***		
ΔR^2	0.011, $F(1, 342) = 4.011$*					

[a]Not significant.
*$p < 0.05$; ***$p < 0.001$.

$M_{edible} = 4.66$, $t = –6.928$, 347 df., $p < 0.001$), confirming the effectiveness of the manipulation. Randomization checks showed no significant associations between the labeling variable and various demographic variables, including age group ($\chi^2(4) = 3.388$, $p = 0.495$), gender ($\chi^2(1) = 0.501$, $p = 0.479$), education ($\chi^2(6) = 9.041$, $p = 0.171$), frequency of organic food purchases ($\chi^2(4) = 2.162$, $p = 0.706$), or the percentage of the budget allocated to organic food products ($t = 0.032$, $p = 0.974$).

Results

We again employed Hayes' (2017) PROCESS macro for SPSS (version 3.5, Model 7) to test the hypotheses using 5000 bootstrap samples and mean centering. As in the previous studies, we specified labeling as the dichotomous independent variable (0 = plastic sticker, 1 = laser-marked) (*X*) and fruit peel edibility as a dichotomous moderator (*W*). New in this study, perceived contamination is the mediator (*M*) and perceived healthfulness is the dependent variable (*Y*) (Appendix 5). Consistent with what we found in Study 1, we again find that laser marking (compared with a plastic sticker) did not directly affect the perceived healthfulness of the organic fruit ($b = –0.091$, $SE = 0.135$, $p = 0.500$, 95% CI = [–0.356; 0.174]), rejecting H7 (Table 7).

New in Study 3, we find that laser marking significantly increases perceived contamination ($b = 0.679$, $SE = 0.157$, $p < 0.001$, 95% CI = [0.370; 0.988]), confirming H8. As expected in H10,

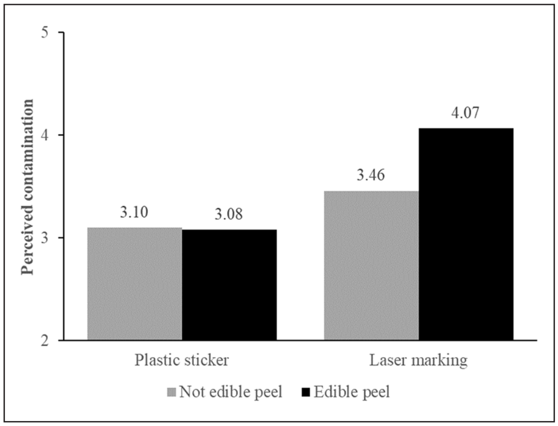

Figure 5. Means of perceived contamination by experimental condition.

perceived contamination negatively impacts the perceived healthfulness of the organic fruit ($b = –0.235$, $SE = 0.045$, $p < 0.001$, 95% CI = [–0.323; –0.147]). However, the impact of laser marking on perceived contamination is qualified by a positive interaction between labeling type and fruit peel edibility ($b = 0.629$, $SE = 0.314$, $p < 0.05$, 95% CI = [0.011; 1.247]), confirming H9. Figure 5 and Table 8 show that the perceived contamination is higher for the laser-marked label compared with the plastic sticker label when the fruit peel is edible ($b = 0.993$, $SE = 0.221$, $p < 0.001$, 95% CI = [0.558; 1.429]), but the difference is not significant when the peel is non-edible ($b = 0.364$, $SE = 0.223$, $p = 0.103$, 95%

Table 8. Means and standard deviations by experimental condition (Study 3).

Experimental condition			Perceived contamination	Perceived healthfulness	*N*
Laser marking	Non-edible peel	Orange	3.13 (1.58)	4.73 (1.28)	34
		Banana	3.75 (1.26)	4.39 (1.42)	33
		Pomegranate	3.52 (1.43)	4.17 (1.26)	32
		Total	3.46 (1.44)	4.43 (1.33)	99
	Edible peel	Peach	3.77 (1.29)	4.14 (1.28)	32
		Pear	4.78 (1.11)	4.02 (1.22)	29
		Apple	3.73 (1.67)	4.35 (1.35)	33
		Total	4.07 (1.46)	4.18 (1.28)	94
	Total		3.76 (1.47)	4.31 (1.31)	193
Plastic sticker	Non-edible peel	Orange	3.19 (1.56)	4.31 (1.32)	27
		Banana	2.81 (1.21)	4.48 (1.14)	22
		Pomegranate	3.25 (1.42)	4.36 (1.42)	25
		Total	3.10 (1.41)	4.38 (1.29)	74
	Edible peel	Peach	3.08 (1.61)	4.73 (1.06)	21
		Pear	3.21 (1.37)	4.56 (1.01)	30
		Apple	2.93 (1.57)	4.90 (1.16)	28
		Total	3.08 (1.49)	4.73 (1.08)	79
	Total		3.09 (1.45)	4.56 (1.19)	153
Total	Non-edible peel	Orange	3.16 (1.56)	4.54 (1.31)	61
		Banana	3.37 (1.31)	4.43 (1.30)	55
		Pomegranate	3.40 (1.42)	4.25 (1.32)	57
		Total	3.31 (1.43)	4.41 (1.31)	173
	Edible peel	Peach	3.50 (1.45)	4.37 (1.22)	53
		Pear	3.98 (1.47)	4.29 (1.14)	59
		Apple	3.36 (1.66)	4.61 (1.29)	61
		Total	3.62 (1.55)	4.43 (1.22)	173
	Total		3.46 (1.50)	4.42 (1.26)	346

CI = [–0.074; 0.802]). This shows that laser-marked labeling (vs plastic sticker) leads to increased perceived contamination of the fruit, but only when the fruit peel is edible. Finally, the index of moderated mediation is negative and significant (index = –0.148, *SE* = 0.081, 95% CI = [–0.318; –0.001]), showing that laser marking leads to a decrease in perceived healthfulness due to an increase in perceived contamination when the peel is edible.

Discussion

Study 3 confirms that overall laser-marked organic fruit is not perceived as less (nor more) healthful than fruit marked with a plastic sticker. However, when the edibility of the peel is included as moderator, Study 1 found that consumers perceive laser-marked organic fruits as less healthful than sticker labeled when the peel is edible. Study 3 explains why: because consumers fear that laser marking of organic fruit with edible peel poses a risk of contamination of the fruit. This fear leads to a perception of a health risk when laser marking fruits with edible peel. We will discuss the implications of this together with findings from the other two studies next.

Discussion

Summary and contributions

The results of the three online experiments confirm most of our hypotheses, especially that consumers perceive a laser-marked organic fruit as eco-friendlier than one with a plastic sticker label when the fruit peel is not edible and as less healthful when the fruit peel is edible, with the expected indirect effects on the attitude toward and the intention to try the product via perceived eco-friendliness. In addition, we find that the reason why consumers do not perceive a laser-marked organic fruit as eco-friendlier when the fruit peel is edible is that they anticipate producing damage and, therefore, more food waste. Furthermore, the reason why they perceive laser-marked organic fruit as less healthful when the fruit peel is edible is that they fear that laser marking contaminates the fruit. We also found a direct, negative impact of laser marking on consumers' attitude toward the product after controlling for perceived healthfulness and eco-friendliness, which suggests additional sources of consumer resistance to this technology, over and above potential health risks, and despite an overall positive evaluation of its eco-friendliness.

The main theoretical contribution of this article is its successful combination of three theoretical lenses: innovation resistance theory (Ram and Sheth, 1989; Samoggia and Nicolodi, 2017), cognitive dissonance theory (Festinger, 1957), and contagion theory (Nemeroff and Rozin, 1989), to analyze how consumers' ambivalence impacts their acceptance of a new eco-innovation. Innovation resistance theory proposes that perceived functional shortcomings and psychological barriers make consumers resist new technology, whereas cognitive dissonance theory emphasizes that ambivalence in itself creates mental discomfort, which people are motivated to relieve following the path of least resistance. Within the food domain, contagion theory offers a useful lens for understanding "hard realities" stemming from food peel being ingested, which makes beliefs about health risks less likely to yield in attempts to achieve cognitive consistency. For the studied eco-innovation, this is manifested in the edibility of the fruit peel determining the salience of health risks from laser marking and the likelihood that the consumer ambivalence tips toward rejecting or accepting this eco-friendly new technology.

In line with innovation resistance theory (Ram and Sheth, 1989), we find that consumers tend to resist the new laser marking technology despite appreciating its environmental benefits. One of the reasons appears to be psychological barriers emanating from conflicts in the consumer's belief system (Yu and Chantatub, 2016), leading to resistance against this eco-innovation (Kushwah et al., 2019; Ram and Sheth, 1989). Our first experiment revealed that, even though consumers perceive laser marking as an eco-innovation, the attitude toward a fresh fruit product is more negative when laser marking than when a plastic sticker is used for organic labeling, also after controlling for the fruit's perceived eco-friendliness and healthfulness. This appears to reflect a fundamental psychological resistance toward new technology such as this, perhaps a type of technophobia (Gilbert et al., 2003) and/or perceiving "high-tech" and "natural" as antagonist concepts (Samoggia and Nicolodi, 2017). Under all circumstances, we find that this resistance leads to lower willingness to try the product.

For most consumers, beliefs about the eco-friendliness and the healthfulness of organic food are aligned due to motivated reasoning (Thøgersen, 2011) and "halo" effects (Prada et al., 2017; Untilov and Ganassali, 2020). We find that laser marking of organic fruits interferes with this alignment when the fruit peel is edible but not when the peel is not edible. Hence, when it comes to laser marking organic fruit and vegetables, peel edibility appears to be the main contingency for aligning or misaligning eco-friendliness and healthfulness.

In line with previous research (Pfiffelmann et al., 2024; Samoggia and Nicolodi, 2017), we find that consumers rightly perceive laser marking as inherently eco-friendlier than a plastic sticker label, and they value that as reflected in perceived eco-friendliness positively impacting their attitude toward the product and intention to try the product. However, this effect appears to be neutralized for fruits with edible peels. As found in Study 2, a reason is that consumers fear that laser marking reduces the shelf life of fruits with thin, edible peels, thus increasing food waste, which would be bad for the environment and inconsistent with the general environmental image of organic products. For consumers characterized by some degree of technofear or technophobia (Gilbert et al., 2003), cognitive dissonance theory suggests that the fear of reduced shelf life might stem from searching for arguments to rationalize their rejection of laser marking for these fruits.

Related, contagion theory (Nemeroff and Rozin, 1989) helps make sense of the finding that consumers fear that laser marking poses a health risk when peels are edible, but not when it is not edible, and how they respond to the ambivalence created by this perceived health risk. According to Study 3, some consumers appear to fear that laser marking contaminates fruits with edible peel and, when consumed, the contamination can transfer to the human body and, thus, lead to contagion (Lin and Shih, 2016). This fear of health risks undermines the general consumer belief in organic products' superior health qualities (Hughner et al., 2007; Thøgersen, 2011). There is no evidence or logical reason for suspecting such contamination, so this fear might also at least partly stem from technophobic consumers searching for arguments to rationalize their rejection of the laser marking of these fruits.

Limitations and future research

Like all other research, this research also has limitations that call for further research. All participants came from the United States, a Western, Educated, Industrialized, Rich, and Democratic (WEIRD) country. As Thøgersen (2010) noted, macro factors, such as food culture and environmental policy, play a role in organic food consumption, which means that the results of this research might not necessarily generalize to other and especially non-WEIRD countries.

Another limitation is that our experiments were conducted using online questionnaires, picturing a technology most consumers are not familiar with. In real life, shoppers' behavior is more an experience than simply an act; thus, a host of presentation and sensory factors impact their decision-making (Bressoud, 2013). Hence, future research should test responses to laser marking in real shopping contexts or more immersive shopping scenarios. This would increase ecological validity and provide additional insight into consumers' perceptions, attitudes, and intentions in real-world settings. Furthermore, laser-marked labeling might affect perceptions about other (positive and negative) outcomes than those included in this research, such as food quality, traceability, or label trust.

Next, when manipulating peel edibility with six different fruits, we did not measure participants' pre-existing liking and consumption of these fruits. We believe this to be of minor consequence since respondents were randomly allocated to the different conditions and three fruits were used in each condition, meaning that the potential effect of pre-existing liking or disliking of a specific fruit should be leveled out. In this research, we only used aggregate responses across three fruits with either edible or non-edible peels and the attitude toward the two categories of fruits did not differ significantly across conditions. Nevertheless, future research might control for pre-existing liking toward the fruits when examining the effects of fruit peel edibility.

Consumers, to a different degree, resist food product innovations due to perceiving them as unsafe (Gallen et al., 2019). A possible reason is food neophobia (Pliner and Hobden, 1992), the tendency to avoid unfamiliar foods, and future research might study the effect of this variable on consumer resistance to laser marking, as well as other factors found to impact the ecolabel adoption process, such as consumer expertise, experience, and trust in the certifying organizations (Thøgersen et al., 2019).

Another limitation is that this research only focused on laser marking for organic labeling. Future research might investigate consumer perceptions of laser marking for other types of information, such as production method (e.g., regenerative agriculture or permaculture), country of origin, sustainability certifications (e.g., Fair Trade or Rainforest Alliance), nutritional information (e.g., vitamin or mineral content), or social and environmental impact (e.g., fair labor practices or carbon footprint). Since packaging plays an important role in brand perception (Pantin-Sohier, 2009) and taste imagery (Thomas and Capelli, 2018), it might also be worth investigating the effects of laser marking of the brand logo on these and other consumer responses.

Finally, future research might investigate if consumers' perceptions of laser marking differ between fruits and vegetables. In contrast to fruits, vegetables are typically prepared and processed before consumption, which might result in a lower perceived health risk of laser marking. It might also be worth investigating if laser marking acceptance differs between imported versus home country-grown fruits and vegetables because food familiarity reduces consumers' suspicion and anxiety about foods (Tuorila and Hartmann, 2020). Familiar products are generally preferred over unfamiliar products, but novel foods often become acceptable through the familiarization process, which means that consumers' acceptance of laser marking may increase over time.

Managerial implications

The introduction of new eco-friendly packaging solutions is riddled with challenges and tensions for companies (Turkcu and Tura, 2023). The present research can help managers develop strategies for easing some of the tensions regarding laser marking. The fact that consumers perceive laser-marked labeling as eco-friendlier than alternatives represents an opportunity for producers to increase customer value. However, the benefits of laser marking need to be communicated better to distributors, retailers, and consumers. By highlighting the environmental benefits of laser marking, producers can differentiate their offerings in a way that appeals to environmentally conscious consumers.

It is also necessary to inform consumers that laser marking does not harm the peel's edibility or shelf life and does not present a health risk. As long as consumers perceive laser-marked labeling as eco-friendlier only when the fruit peel is not edible and as a health risk when the fruit peel is edible, farmers and producers should probably restrict the use of laser marking to products with inedible peels, such as bananas and citrus fruits. However, when consumers become more familiar with and better informed about laser marking, it can be extended to fruits with edible peel, such as apples and pears. But for now, the retail industry should provide more laser-marked fruits to consumers while limiting the negative association of laser marking with health risks and shorter shelf life. To do so, they should primarily rely on salespersons and in-store communication.

Also, distributors and retailers can use this research to develop more effective marketing strategies for laser-marked organic fruits. They can emphasize the environmental benefits of laser marking in their advertising and promotional materials to appeal to and create value for environmentally conscious consumers. In this way, distributors and retailers can also help raise awareness about sustainable agricultural and food production practices and encourage consumers to make more environmentally conscious buying decisions.

The European Commission's (2022) work on a new regulation to reduce packaging waste can benefit from this research to better understand how laser marking is positioned in consumers' minds compared with other packaging solutions. Regulatory bodies and certifying organizations can use the results to further develop organic certification standards and labeling requirements. Especially, they could use our findings when revising guidelines on labeling for different product types, considering the impact of the type of labeling on consumer perceptions of eco-friendliness. By taking consumer perceptions of eco-friendliness and healthfulness into account, they could increase consumer trust in laser-marked organic labeling and encourage more consumers to accept laser marking for organic fruits.

Finally, environmental and advocacy groups can use this research to promote more sustainable agricultural and food production practices and raise awareness about the importance of laser marking to reduce plastic packaging of organic fruits. Specifically, they should consistently promote the use of laser marking as a more sustainable alternative to plastic sticker labels and do it more effectively. Environmental and advocacy groups can also help educate consumers about the environmental benefits of laser marking and clarify misperceptions about health risks and shorter shelf life to help build public trust in and support for the technology.

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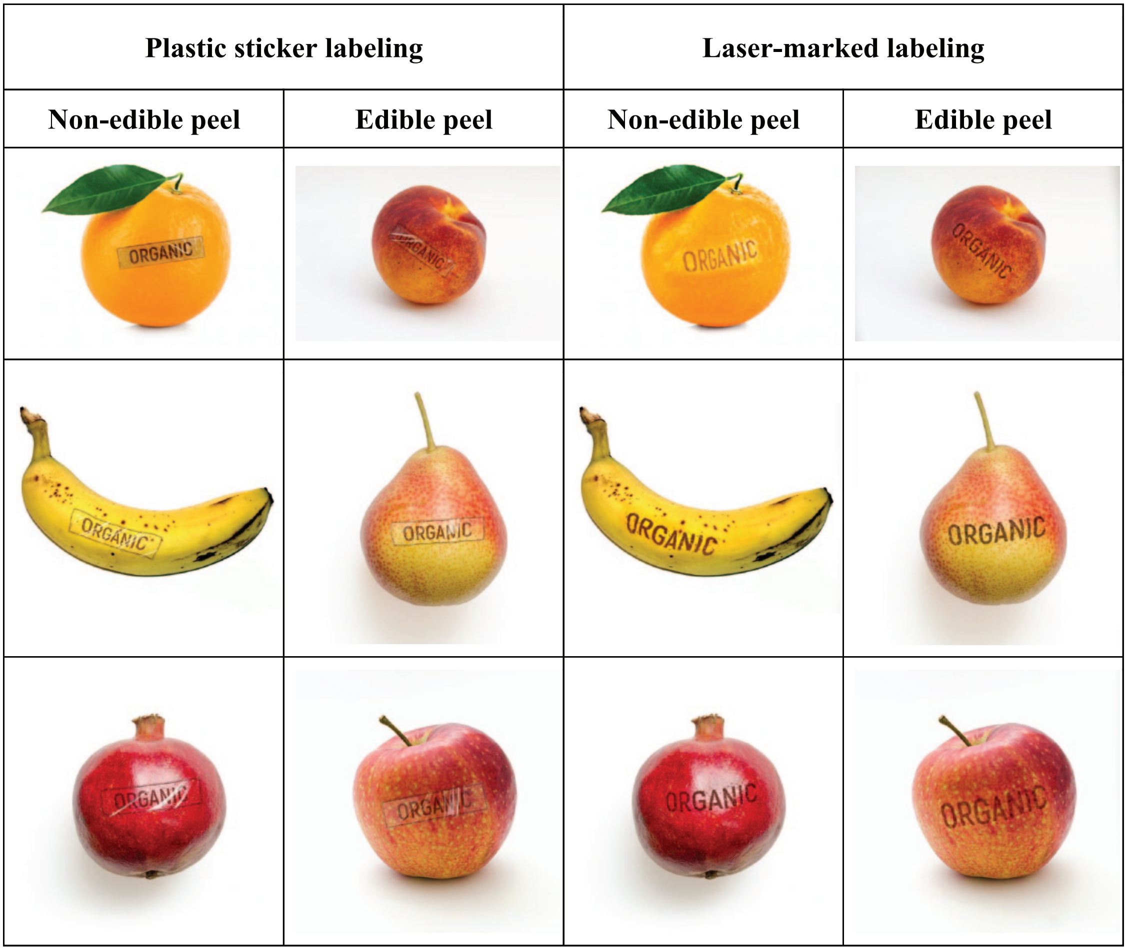
Appendix 1



Stimuli used in the experiment.

Plastic sticker labeling		Laser-marked labeling	
Non-edible peel	Edible peel	Non-edible peel	Edible peel

Appendix 2

Measurement scales.

Constructs, scale sources, and items	Cronbach's α and factor loadings		
	Study 1	Study 2	Study 3
Intention to try[b] (Puzakova and Kwak, 2023)	α = 0.943	—	—
Do you intend to try this product in the future? - Very unlikely/Very likely	0.972	—	—
- Definitely would not try/Definitely would try	0.972	—	—
Attitude toward the product[b] (Holbrook and Batra, 1987)	α = 0.958	—	—
What is your opinion about the fruit you saw previously? - I don't like (vs I like) these products.	0.948	—	—
- I react unfavorably (vs favorably) to these products.	0.943	—	—
- I have a negative (vs positive) feeling about these products.	0.952	—	—
- These products are bad (vs good).	0.930	—	—
Perceived eco-friendliness[a] (Chen et al., 2015)	α = 0.955	α = 0.931	—
The purchase of the fruit . . . - Is environmentally friendly, in my opinion.	0.960	0.937	—
- Can reduce environmental impact, in my opinion.	0.956	0.930	—
- Is more environmentally friendly, compared with other products, in my opinion.	0.959	0.947	—
Perceived healthfulness[a] (Ware, 1976)	α = 0.843	—	α = 0.885
After the purchase of the fruit . . ., - You think your health will be better in the future than it is now.	0.863	—	0.893
- In the near future you expect to have a better life than people you know.	0.877	—	0.903
- You expect to have a very healthy life.	0.876	—	0.910
Perceived anticipated food waste[a] (Petit et al., 2020)	—	α = 0.917	—
Imagine that you want to buy some fruits to take home. How high risk do you think there is that you will waste some of these fruits?": – No risk at all/A very high risk[b]	—	0.856	—
- There is a high risk this fruit will end up being wasted because it will decline in quality rapidly.	—	0.912	—
- There is a high risk this fruit will not last long in storage and will be thrown away.	—	0.924	—
- I doubt I will be able to use this fruit before it goes bad.	—	0.888	—
Perceived contamination[b] (White et al., 2016)	—	—	α = 0.925
To what extent do you perceive the fruit you previously saw as: - Unpolluted/Polluted	—	—	0.908
- Clean/Dirty	—	—	0.915
- Sanitary/Unsanitary	—	—	0.897
- Uncontaminated/Contaminated	—	—	0.894

Higher number = more agreement/favorable.
[a]Measured with 7-point Likert-type scales.
[b]Measured with 7-point semantic differentials.

Appendix 3

PROCESS syntax and output from the PROCESS procedure for SPSS (Study 1)

```
PROCESS syntax for the customized model:

process y=IT/m=EF PH ATP/x=LABEL/w=EDIB/plot=1/decimals=F10.3/center=1/
bmatrix=1,1,0,1,1,1,1,1,1,1/wmatrix=1,1,0,0,0,0,0,0,0,0/

Run MATRIX procedure:
**************** PROCESS Procedure for SPSS Version 3.5 ****************

       Written by Andrew F. Hayes, Ph.D.       www.afhayes.com
    Documentation available in Hayes (2018). www.guilford.com/p/hayes3

************************************************************************
Model    : CUSTOM
    Y    : IT
    X    : LABEL
   M1    : EF
   M2    : PH
   M3    : ATP
    W    : EDIB

Sample
Size: 396

************************************************************************
OUTCOME VARIABLE:
 EF

Model Summary
          R       R-sq        MSE          F        df1        df2          p
       ,139       ,019      2,028      2,566      3,000    392,000       ,054

Model
              coeff         se          t          p       LLCI       ULCI
constant      4,768       ,072     66,623       ,000      4,628      4,909
LABEL          ,224       ,143      1,563       ,119      -,058       ,506
EDIB           ,015       ,143       ,102       ,919      -,267       ,296
Int_1         -,658       ,287     -2,293       ,022     -1,221      -,094

Product terms key:
 Int_1:        LABEL      x       EDIB

Test(s) of highest order unconditional interaction(s):
      R2-chng          F        df1        df2          p
X*W      ,013      5,258      1,000    392,000       ,022
----------
```

```
       Focal predict:  LABEL     (X)
             Mod var:  EDIB      (W)

Conditional effects of the focal predictor at values of the moderator(s):

         EDIB       Effect        se         t        p        LLCI      ULCI
        -,515         ,563      ,206     2,732     ,007        ,158      ,968
         ,485        -,095      ,199     -,475     ,635       -,487      ,297

Data for visualizing the conditional effect of the focal predictor:
Paste text below into a SPSS syntax window and execute to produce plot.

DATA LIST FREE/
       LABEL       EDIB       EF .
BEGIN DATA.
       -,523      -,515      4,467
        ,477      -,515      5,029
       -,523       ,485      4,825
        ,477       ,485      4,730
END DATA.
GRAPH/SCATTERPLOT=
LABEL      WITH      EF      BY      EDIB .

************************************************************************
OUTCOME VARIABLE:
PH
Model Summary
         R       R-sq       MSE         F       df1        df2        p
      ,139       ,019     1,450     2,567     3,000    392,000     ,054

Model
              coeff        se          t         p       LLCI        ULCI
constant      4,425      ,061     73,127      ,000      4,306       4,544
LABEL         -,045      ,121      -,374      ,708      -,284        ,193
EDIB          -,010      ,121      -,079      ,937      -,248        ,229
Int_1         -,666      ,242     -2,748      ,006     -1,143       -,190

Product terms key:
Int_1:        LABEL      x      EDIB

Test(s) of highest order unconditional interaction(s):
          R2-chng        F        df1        df2        p
X*W          ,019    7,552      1,000    392,000      ,006
----------
     Focal predict: LABEL        (X)
           Mod var: EDIB         (W)

Conditional effects of the focal predictor at values of the moderator(s):
```

```
      EDIB       Effect        se         t        p        LLCI        ULCI
     -,515         ,298      ,174     1,710     ,088       -,044        ,640
      ,485        -,368      ,169    -2,184     ,030       -,700       -,037

Data for visualizing the conditional effect of the focal predictor:
Paste text below into a SPSS syntax window and execute to produce plot.

DATA LIST FREE/
      LABEL      EDIB      PH      .
BEGIN DATA.
        -,523         -,515         4,274
         ,477         -,515         4,572
        -,523          ,485         4,613
         ,477          ,485         4,244
END DATA.
GRAPH/SCATTERPLOT=
  LABEL      WITH      PH      BY      EDIB      .

**************************************************************************
OUTCOME VARIABLE:
  ATP

Model Summary
         R       R-sq        MSE         F       df1        df2         p
      ,632       ,399      1,622    86,767     3,000    392,000      ,000

Model
              coeff        se         t         p        LLCI        ULCI
constant      1,213      ,283     4,293      ,000        ,658       1,769
LABEL         -,549      ,129    -4,266      ,000       -,802       -,296
EF             ,673      ,048    14,144      ,000        ,579        ,766
PH             ,112      ,056     1,991      ,047        ,001        ,222
**************************************************************************
OUTCOME VARIABLE:
  IT

Model Summary
         R       R-sq        MSE           F       df1        df2         p
      ,774       ,598      1,361   1 45,697     4,000    391,000      ,000

Model
              coeff        se         t         p        LLCI        ULCI
constant      -,796      ,265    -3,006      ,003      -1,317       -,276
LABEL          ,076      ,121      ,634      ,526       -,161        ,313
EF             ,257      ,054     4,804      ,000        ,152        ,363
PH             ,103      ,052     1,998      ,046        ,002        ,205
ATP            ,685      ,046    14,804      ,000        ,594        ,776
```

```
****************** DIRECT AND INDIRECT EFFECTS OF X ON Y *****************

Direct effect of X on Y
      Effect        se         t         p       LLCI       ULCI
        ,076      ,121      ,634      ,526      -,161       ,313

Conditional and unconditional indirect effects of X on Y:
INDIRECT EFFECT:
 LABEL       ->      EF      ->      IT

      EDIB       Effect       BootSE      BootLLCI      BootULCI
     -,515         ,145         ,067          ,033          ,294
      ,485        -,024         ,055         -,137          ,084

Index of moderated mediation (difference between conditional indirect
effects):
          Index        BootSE        BootLLCI        BootULCI
SKIN      -,169          ,091           -,372           -,017
---

INDIRECT EFFECT:
 LABEL       ->       PH       ->       IT

          SKIN       Effect       BootSE      BootLLCI     BootULCI
         -,515         ,031         ,029         -,007         ,104
          ,485        -,038         ,030         -,110         ,003

Index of moderated mediation (difference between conditional indirect
effects):
          Index           BootSE           BootLLCI          BootULCI
EDIB      -,069             ,051             -,192              ,004
---

INDIRECT EFFECT:
LABEL       ->       ATP       ->       IT

      Effect        BootSE         BootLLCI        BootULCI
       -,376          ,094            -,568           -,193

INDIRECT EFFECT:
LABEL       ->       EF       ->       ATP       ->       IT

      SKIN        Effect       BootSE       BootLLCI      BootULCI
     -,515          ,259         ,097           ,075          ,460
      ,485         -,044         ,095          -,237          ,143

Index of moderated mediation (difference between conditional indirect
effects):
```

```
        Index       BootSE       BootLLCI       BootULCI
EDIB    -,303         ,138         -,583          -,033
---

INDIRECT EFFECT:
LABEL       ->       PH       ->        ATP       ->        IT
        EDIB         Effect       BootSE        BootLLCI       BootULCI
       -,515           ,023         ,020           -,005           ,072
        ,485          -,028         ,020           -,076           ,002

Index of moderated mediation (difference between conditional indirect
effects):
          Index         BootSE         BootLLCI         BootULCI
EDIB      -,051           ,034           -,129             ,001
---

********************** ANALYSIS NOTES AND ERRORS ***********************

Level of confidence for all confidence intervals in output:
     95,0000

Number of bootstrap samples for percentile bootstrap confidence
intervals:
     5000

NOTE: The following variables were mean centered prior to analysis:
        EDIB         LABEL

------ END MATRIX -----
```

Appendix 4

Output from the PROCESS procedure for SPSS (Study 2)

```
Run MATRIX procedure:

***************** PROCESS Procedure for SPSS Version 4.2 ****************

        Written by Andrew F. Hayes, Ph.D.        www.afhayes.com
      Documentation available in Hayes (2022). www.guilford.com/p/hayes3

**************************************************************************
Model  : 7
   Y   : EF
   X   : LABEL
   M   : FW
   W   : EDIB
```

```
Sample
Size: 390

**************************************************************************
OUTCOME VARIABLE:
FW

Model Summary
        R       R-sq       MSE        F         df1        df2        p
     ,244       ,060     1,898   8,146       3,000   386,000     ,000

Model
             coeff          se            t        p          LLCI          ULCI
constant    3,457        ,070       49,518     ,000         3,319         3,594
LABEL        ,624        ,140        4,457     ,000          ,349          ,899
EDIB         ,089        ,140         ,634     ,527        -,186          ,363
Int_1        ,577        ,280        2,058     ,040          ,026         1,128

Product terms key:
Int_1:       LABEL       x       EDIB

Test(s) of highest order unconditional interaction(s):
      R2-chng        F       df1         df2       p
X*W       ,010   4,237     1,000    386,000     ,040
----------
        Focal       predict:  LABEL        (X)
             Mod var: EDIB       (W)

Conditional effects of the focal predictor at values of the moderator(s):

        EDIB     Effect        se          t        p         LLCI        ULCI
       -,515       ,327      ,202      1,620     ,106       -,070        ,723
        ,485       ,904      ,195      4,645     ,000        ,521       1,286

Data for visualizing the conditional effect of the focal predictor:
Paste text below into a SPSS syntax window and execute to produce plot.

DATA LIST FREE/
      LABEL       EDIB       FW         .
BEGIN DATA.
      -,538       -,515       3,235
       ,462       -,515       3,562
      -,538        ,485       3,013
       ,462        ,485       3,917
END DATA.
GRAPH/SCATTERPLOT=
  LABEL       WITH       FW       BY       EDIB .

**************************************************************************
```

```
OUTCOME VARIABLE:
EF

Model Summary
       R       R-sq       MSE         F       df1       df2        p
    ,170       ,029     1,565     5,727     2,000   387,000     ,004

Model
              coeff         se          t        p       LLCI       ULCI
constant      5,135       ,171     30,066     ,000      4,799      5,470
LABEL          ,162       ,130      1,244     ,214      -,094       ,418
FW            -,154       ,046     -3,344     ,001      -,244      -,063

****************** DIRECT AND INDIRECT EFFECTS OF X ON Y *****************

Direct effect of X on Y
        Effect         se          t        p       LLCI       ULCI
          ,162       ,130      1,244     ,214      -,094       ,418

Conditional indirect effects of X on Y:

INDIRECT EFFECT:
LABEL       ->       FW       ->       EF

       EDIB       Effect       BootSE       BootLLCI       BootULCI
      -,515        -,050         ,038          -,137           ,011
       ,485        -,139         ,057          -,262          -,041

Index of moderated mediation (difference between conditional indirect
effects):
            Index       BootSE       BootLLCI       BootULCI
EDIB        -,089         ,053          -,207          -,002

********************** ANALYSIS NOTES AND ERRORS ************************

Level of confidence for all confidence intervals in output:
  95,0000

Number of bootstrap samples for percentile bootstrap confidence
intervals:
  5000

NOTE: The following variables were mean centered prior to analysis:
       EDIB       LABEL

------ END MATRIX -----
```

Appendix 5

Output from the PROCESS procedure for SPSS (Study 3)

```
Run MATRIX procedure:

***************** PROCESS Procedure for SPSS Version 4.2 *****************

             Written by Andrew F. Hayes, Ph.D.        www.afhayes.com
     Documentation available in Hayes (2022). www.guilford.com/p/hayes3

**************************************************************************
Model  : 7
    Y  : PH
    X  : LABEL
    M  : CO
    W  : EDIB

Sample
Size: 346

**************************************************************************
OUTCOME VARIABLE:
CO

Model Summary
        R       R-sq        MSE         F        df1       df2         p
     ,269       ,073      2,103     8,913      3,000   342,000      ,000
Model
               coeff        se          t         p       LLCI       ULCI
constant       3,466      ,078     44,432      ,000      3,312      3,619
LABEL           ,679      ,157      4,321      ,000       ,370       ,988
EDIB            ,329      ,156      2,108      ,036       ,022       ,636
Int_1           ,629      ,314      2,003      ,046       ,011      1,247

Product terms key:
 Int_1     :     LABEL     x     EDIB

Test(s) of highest order unconditional interaction(s):
      R2-chng       F       df1       df2       p
X*W      ,011   4,011     1,000   342,000    ,046
----------
      Focal predict: LABEL        (X)
         Mod var: EDIB            (W)

Conditional effects of the focal predictor at values of the moderator(s):

         EDIB       Effect        se        t        p        LLCI      ULCI
        -,500         ,364      ,223    1,634     ,103       -,074      ,802
         ,500         ,993      ,221    4,487     ,000        ,558     1,429
```

```
Data for visualizing the conditional effect of the focal predictor:
Paste text below into a SPSS syntax window and execute to produce plot.

DATA LIST FREE/
        LABEL        EDIB        CO        .
BEGIN DATA.
        -,558        -,500        3,098
         ,442        -,500        3,462
        -,558         ,500        3,076
         ,442         ,500        4,069
END DATA.
GRAPH/SCATTERPLOT=
LABEL      WITH      CO      BY      EDIB      .

***********************************************************************
***
OUTCOME VARIABLE:
PH

Model Summary
      R       R-sq       MSE         F       df1       df2       p
    ,289      ,083     1,471    15,620     2,000   343,000    ,000

Model
             coeff       se          t        p       LLCI       ULCI
constant     5,232     ,168     31,176     ,000      4,902      5,562
LABEL        -,091     ,135      -,675     ,500      -,356       ,174
CO           -,235     ,045     -5,259     ,000      -,323      -,147

***************** DIRECT AND INDIRECT EFFECTS OF X ON Y ****************
Direct effect of X on Y
        Effect       se          t        p       LLCI       ULCI
         -,091     ,135      -,675     ,500      -,356       ,174

Conditional indirect effects of X on Y:

INDIRECT EFFECT:
  LABEL      ->       CO      ->       PH

        EDIB       Effect       BootSE       BootLLCI       BootULCI
       -,500        -,086         ,055          -,200           ,013
        ,500        -,233         ,074          -,392          -,101

Index of moderated mediation (difference between conditional indirect
effects):
          Index       BootSE       BootLLCI       BootULCI
EDIB      -,148         ,081          -,318          -,001
```

```
********************** ANALYSIS NOTES AND ERRORS ************************

Level of confidence for all confidence intervals in output:
95,0000

Number of bootstrap samples for percentile bootstrap confidence
intervals:
5000

NOTE: The following variables were mean centered prior to analysis:
        EDIB        LABEL

------ END MATRIX -----
```