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Published Version

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Aschemann-Witzel, J., Asioli, D. ORCID: <https://orcid.org/0000-0003-2274-8450>, Banovic, M., Perito, M. A. and Peschel, A. O. (2022) Communicating upcycled foods: frugality framing supports acceptance of sustainable product innovations. *Food Quality and Preference*, 100. 104596. ISSN 0950-3293 doi: <https://doi.org/10.1016/j.foodqual.2022.104596> Available at <https://centaur.reading.ac.uk/104419/>

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To link to this article DOI: <http://dx.doi.org/10.1016/j.foodqual.2022.104596>

Publisher: Elsevier

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Contents lists available at ScienceDirect

Food Quality and Preference

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

Communicating upcycled foods: Frugality framing supports acceptance of sustainable product innovations

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ARTICLE INFO

Keywords:

Upcycled food
Benefit framing
Consumer acceptance
Frugality
Climate
Sustainability

ABSTRACT

Future sustainable food systems should more efficiently use natural resources and reduce food waste. Upcycled food – foods elevated in value through ingredients otherwise wasted or previously thought inedible – constitutes a new approach contributing to this much needed transition. Successful market launches of such foods requires favourable consumer perception of these products, knowing the factors determining acceptance, and an adequate communicational framing of the new concept. However, consumer perception of upcycled food is yet under-researched, in particular across food categories and countries, and the concept of frugality has not been explored in this context. In a consumer survey assessing the factors of influence on attitude towards upcycled food and with a sample across five Northern and Southern European countries, we show that stressing the aspect of traditional frugality and to appeal to frugal orientation appears a favourable communication frame for upcycled food. Product categories that match with the region are perceived as more favourable. Environmental concern determines attitude while food neophobia acts as a barrier. Our results lead us to recommend that marketing for upcycled food should focus on the environmentally concerned consumer segment and use a framing that communicates the frugality benefit and frugal resource use. Findings further provide insights into the psychology of consumer acceptance and attitudes. These can be used in communicating the nature of upcycled foods to the public and to food consumers.

1. Introduction

One of the sustainable development goals that the United Nations have committed themselves to is halving food waste (UN, 2015). Food waste is understood as the umbrella term for both food loss earlier in the supply chain, and waste of food ready for human consumption. Exploring this major sustainability challenge further, one soon finds that most of the food waste in affluent societies is caused by consumers (Alexander et al., 2017; Xue et al., 2017). Thus, consumers play a crucial role in future food waste reduction. In fact, accounts show that consumers can reduce their personal emissions by 12% if they avoid all avoidable food waste in their home (Hoolohan et al., 2013). In addition to consumers themselves, an important role is played by actors determining purchase and behaviour contexts, such as for example retailers.

Consequently, an increasing stream of research is exploring the factors that cause consumer household food waste (for an overview e.g. Aschemann-Witzel, 2016; Carmo & Barcellos, 2018), the potential interventions to reduce food disposal in homes (e.g. van der Werf et al. 2019; Read & Muth, 2021), or the consumer-retailer interface (Aschemann-Witzel et al., 2021).

It has thus been well established that consumers themselves as well as the context influencing consumer behaviour is responsible for food waste in households. However, consumers can also address food loss earlier in the supply chain through the types of foods they buy. This aspect of consumers role in food waste reduction remains yet under-explored. Food potential is lost when a food ingredient is deviated as a side-stream and ends as feed or fuel, or food potential is lost because an ingredient that could become food does not even enter the food chain in

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<https://doi.org/10.1016/j.foodqual.2022.104596>

Received 13 February 2022; Received in revised form 20 March 2022; Accepted 25 March 2022

Available online 31 March 2022

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the first place. This early food loss is partly due to an anticipated lack of demand and an assumption of end-consumer rejection. Consumers can contribute even more to emission reduction and resource efficiency, if they not only avoid wasting the food that they bought but are also diversifying their purchase and broadening what they consider edible (Aschemann-Witzel et al., 2019), amongst others by buying foods made from ingredients otherwise or not previously used as food. With food contributing to 20–35% of global greenhouse gas emission (GHG) equivalents (Foley et al., 2011; Vermeulen et al., 2012), consumer behaviour changes in what we purchase and consume is an important aspect of the transition towards a more sustainable food system.

Foods made from ingredients currently not used as food help to reduce food loss or the loss of a potential food source in the supply chain. The terms used to describe such foods and ingredients are for example upcycled food, waste-to-value, side-streams and co-products, or value-added surplus food (Bhatt et al., 2018, 2020; Coderoni & Perito, 2020; Grasso & Asioli, 2020; Peschel & Aschemann-Witzel, 2019, 2020; Spratt et al., 2020; Teigiserova et al., 2020). Spratt et al. (2020) developed the following definition through a Delphi expert study among food manufacturers in the USA: “Upcycled food products elevate ingredients that would otherwise be wasted to higher uses and have tangible benefits to the environment and society” (p. 8).

Thus, consumers can make a positive contribution through choosing foods made with ingredients otherwise wasted. This is not a bad story to tell. However, framing and communication research shows that it is crucial which selling point is focused on, and which of various benefits is given most salience (Entman, 1993; Smith & Petty, 1996). Communicating the concept of frugality – in short described as ‘careful management of material resources’ (Merriam-Webster, 2021) - has yet not been explored in this context, even though the definition clearly entails such an aspect. Moreover, acceptance might depend on the target group, the cultural background, and the product in question. There is an increasing stream of research on upcycled food, but so far little cross-category and cross-country research has been conducted, nor have different benefit framings been explored (Aschemann-Witzel & Stangherlin, 2021). To further the uptake of upcycled food, it is essential to understand how food producers should communicate about the use of by-products and side-streams in upcycled food (Goodman-Smith et al., 2021), to know which is the most advantageous benefit to highlight. Upcycled food could potentially refer to the frugality concept, along or in addition to the environmental or climate effect.

We explore the following research questions “Which framing of upcycling information explain a more favourable attitude towards the practice of upcycled ingredient use in food?” and “Which background of consumers explain attitudes towards upcycling in food across European countries?” The study is designed across countries, representing both Southern and Northern European regions. The contribution is twofold: First, we analyse the yet-under-researched concept of framing in communication of upcycled food, including the so far overlooked aspect of the ‘frugality’ benefit inherent in the idea of upcycled food. Second, we explore variables of potential relevance as they have emerged in previous research with national samples, but we do so at a cross-country level and across food categories. The research thus contributes to a better understanding among food sector stakeholders of how they should communicate about the use of side-streams in their foods, and which of the potential benefits is best suited to be portrayed as the unique selling point.

2. Background and theory

2.1. State of art of consumer research on waste-to-value and upcycled food

Societal barriers to the circular economy (EC, 2018) have been found to be more critical than technical factors (Kirchherr et al., 2018). Thus, there is a need to explore the consumer perception of upcycled foods,

and which factors can be influential for end-users’ perception. Existing literature available in the area of upcycled foods and consumers is limited so far (Aschemann-Witzel & Stangherlin, 2021). The circular economy is about establishing re-use cycles for technical and biological substances or ‘nutrients’ (as Braungart et al., 2007, call it) including ‘upcycling’ (Bridgens et al., 2018), but yet very little is known about how consumers react to the reuse of ‘biological nutrients’ in the food area (Donner et al., 2020). Both consumer sociodemographic and psychographics characteristics such as for example beliefs, attitudes and values are relevant factors to investigate (e.g., Lähteenmäki, 2013; Fernqvist & Ekelund, 2014). A range of aspects have been given particular focus in the literature so far, as explained in the following.

Some authors suggest that waste-to-value products can be marketed to consumers who are concerned about the environment (McCarthy et al., 2020; Zhang et al., 2020). Indeed, consumers with a positive attitude towards sustainable consumption are more likely to choose waste-to-value alternatives (Perito et al., 2019; Grasso & Asioli, 2020). Van der Werff et al. (2013) found that consumer identities can explain the type of person whose actions are environmentally friendly, anticipating feelings of guilt when not behaving in ways consistent with their self-identity. Furthermore, Peschel and Aschemann-Witzel (2020) found that guilt and self-perception influence consumer choice for waste-to-value products.

Purchase research so far has looked more in-depth into consumer purchase and willingness-to-pay (WTP) (Bhatt et al., 2021). It has been found that communication on the food waste avoidance aspect can improve perception of the product (Aschemann-Witzel and Peschel, 2019; Altintzoglou et al., 2021), and asking respondents to imagine the favourable effect on the environment can increase purchase intention (Yang et al., 2021). Goodman-Smith et al. (2021) found that supermarket shoppers across the board are rather open to upcycled food in the store assortment. However, Peschel and Aschemann-Witzel (2020) found that consumers do not necessarily perceive that upcycled foods should be more expensive, a finding which is confirmed by Bhatt et al. (2021) who found that consumers are more price sensitive with upcycled food compared to conventional food. In addition, recent research cautions of the negative association with ‘waste’ when the food waste avoidance aspect is communicated. Such negative association can lead to a reduction in demand, and authors recommend rather communicating the societal benefits (Visser-Amundson et al., 2021).

Rejection and scepticism towards waste-to-value or upcycled food has been identified as stemming from fear of new or unfamiliar foods (food neophobia) and consequently can determine the acceptance, or not, of waste-to-value products among consumers (Perito et al., 2019; Coderoni & Perito, 2020; Grasso & Asioli, 2020). This unfamiliarity can also hold for the food technology involved in new food processing procedures, called food technophobia (Perito et al., 2019). Consumers who are sceptical about new food products might often tend to prefer familiar or traditional food. According to Guerrero et al. (2009), European consumers perceive a traditional food product as a product frequently consumed and made according to the gastronomic heritage. Tradition is an important element of the cultural heritage and constitutes an important influence factor on food choices. Zhang et al. (2020) found that quality concerns can be a barrier for acceptance, particularly for Generation Z. Quality concerns or perceived risks might be drivers of scepticism towards upcycled food. In this sense, Bhatt et al. (2021) found that the presence of a certification logo can improve quality perception.

Demographic variables can also determine acceptance of waste-to-value products, with some authors finding evidence that women have a more favourable attitude towards these products than men (Coderoni & Perito, 2020) while other authors found that being a woman reduces purchase intention of upcycled food (Aschemann-Witzel & Peschel, 2019). Henchion et al. (2016) showed that younger females were more likely to be disgusted by waste-to-value products and older respondents were more likely to accept them. Coderoni and Perito (2020) showed the opposite: older people have lower purchase intentions than younger

generations. Moreover, overall positive attitudes towards waste-to value products are higher for highly educated people (Cattaneo et al., 2018; Coderoni & Perito, 2020), especially educated women (Perito et al., 2019). With regard to age, it can be assumed that different attitudes and practices with regard to e.g. waste or climate issues across generations may explain the reason for differences in acceptance of upcycled foods. However, acceptance might also simply differ from one study to the next in accordance with the food product or ingredient in question – as for example, if a product category appeals more to a younger than an older segment.

In this research, as one of the two contributions, we explore which background of consumers explain more favourable attitude towards the practice of upcycled ingredient use in food across European countries, including both sociodemographic and psychographic variables which have been identified as important in previous research.

2.2. Framing in communication

Framing is unavoidable when communicating about complex pro-environmental behaviours such as reducing food waste or choosing upcycled food (Peschel & Aschemann-Witzel, 2020). By framing a message, certain parts of relevant information are elevated in salience, which increases the probability that the audience will notice the communicated information, distinguish its meaning, process it and remember it (Entman, 1993; Smith & Petty, 1996; Tversky & Kahneman, 1985). The way messages are framed influences the degree to which they are attended to (Banovic & Barone, 2021), how much information and knowledge is gained (Cheng, Woon, & Lynes, 2011), how positively (or negatively) these framed messages are assessed (Amatulli et al., 2019), and how effective they are in inciting intentions towards pro-environmental behaviour (Spence et al., 2014).

There is considerable debate in marketing and advertising on the type of benefit framing and whether messages should promote benefits for self or for others (Fisher & Hopp, 2020; White & Peloza, 2009; Yucel-Aybat & Hsieh, 2021). It has been found that the way individuals see themselves in relation to others can impact their behaviour (Banovic & Barone, 2021; Cross et al., 2010; Lee & Pounders, 2019). Self-benefit appeals are those related to self-interest such as health and taste usually highlight the individual as the main beneficiary (Banovic, Aschemann-Witzel, & Deliza, 2021; Banovic & Otterbring, 2021; Evans, 2011). Other-benefit appeals (e.g. climate contribution, protecting the environment) refer to those related to altruistic or self-transcendent interests that highlight other individuals or society as the main beneficiaries (Bolderdijk et al., 2013; Evans et al., 2013). Some studies seem to show that other-benefit framing is more effective in promoting pro-environmental behaviour, and they also suggest that communication of economic benefits can reduce consumer interest in sustainable behaviours (Bolderdijk et al., 2013; De Dominicis, Schultz, & Bonaiuto, 2017; Evans et al., 2013).

Generally, food waste avoidance is discussed in terms of both other- and self-oriented goals, given both saving the environment from resource overuse is discussed, but also food security for poorer populations. The debate on food waste reduction and its advantages also names the benefits of saving money for the household or feeling good about oneself (Aschemann-Witzel et al. 2018).

As previous studies on framing emphasise, the type of benefit made more salient can influence product perception, attitude, and pro-environmental behaviours. In this study, as one of the two contributions, we explore which type of framing of the information explains more favourable attitude towards the practice of upcycled ingredient use in food across European countries, comparing environmental versus frugal versus a taste benefit framing.

2.3. Frugality concept

The dictionary defines frugality as ‘careful management of material

resources’ (Merriam-Webster, 2021). This is well in line with definitions cited in research (de Young, 1986), though a more detailed definition is provided by Lastovicka et al. (1999, p. 88) who define frugality as “a unidimensional consumer lifestyle trait characterized by the degree to which consumers are both restrained in acquiring and resourceful in using economic goods and services to achieve longer-term goals.”.

Across the literature discussing ‘frugality’, it becomes clear that it has many potential antecedents and causes. This might explain why Goldsmith et al. (2014) argue that there are inconsistencies in how it is conceptualized in research. Frugality is described to have a religious, economic, self-help and psychological perspective (Lastovicka et al., 1999) as well as a cultural, religious, psychological and economic perspective (Goldsmith et al., 2014). Both external and internal factors can be relevant, such as in the first case, the current economic condition, or in the latter case, a person’s values such as materialism (Goldsmith et al., 2014). Frugality is conceptualized as a consumer trait and lifestyle (Goldsmith et al., 2014; Lastovicka et al., 1999) as well as an identity (Gatersleben et al., 2017), and this trait, lifestyle or identity manifests itself in a range of frugal behaviours. Studies accordingly find that frugal behaviour is rooted in personal identities and value orientations, lifestyle beliefs and interests (Hernández et al., 2012; Hüttel et al., 2018; Pan et al., 2019; Yeniaras et al., 2016, Goldsmith et al., 2014).

Most researchers tend to operationalize and find that ‘frugality’ focuses on the desire to avoid waste of resources (including money) and ‘make do’ with what one has, which can mean limiting consumption and engaging in reusing, repairing, and recycling activities (Muiños et al., 2015). However, in defining frugality it is worth noting that there is a relation to traits and behaviours that are more an indication of ‘thriftiness’, deal seeking, or ‘penny-pinching’. Frugality is nevertheless distinct from these aspects. Several authors outline the difference. For example, Goldsmith et al. (2014) explain that “Frugal persons are distinct “from “tightwads” in that they enjoy saving money rather than hate spending it” (p. 176). Gatersleben et al. (2017, p. 19) distinguish that while frugal is about “avoid wasting things—money, energy, food”, the term thrifty is about “try to get as much as possible for as little as possible”.

Frugality as ‘voluntary restriction’ (Muiños et al., 2015), efficient use of resources and avoidance of waste, has a clear potential for more environmentally friendly behaviour (Gatersleben et al., 2017) given the reduction of (over-)consumption that it entails as well as the outcome of a prolonged use of products instead of replacing them with new purchases. Consequently, it has been found that frugality can be a driver of more sustainable product choice (Whitmarsh and O’Neill, 2010; Gil-Giménez et al., 2021). Some research suggests that encouraging frugality can lead to sustainable forms of consumption (Evans, 2011; Thøgersen, 2018).

Based on previous research indications, we propose that the upcycled food concept might appeal to consumers in particular when they show respective frugal traits or frugal consumption orientations, as measured by adequate previously tested variables. In this study, we operationalize the communication of frugality through using the phrasing by the Upcycled Food Association (Upcycled Food Association, 2021). This phrasing portrays frugality as a tradition and ‘using all of what you have’ and ‘doing more with less’. This constitutes frugality as a ‘careful management of resources’ and ‘make do’ with what one has.

2.4. Hypotheses

We propose that most upcycled food will communicate other-oriented benefits. This is inherent in the definition of upcycled foods. However, to which extent the aspect of environmental benefit (Perito et al., 2019; Grasso & Asioli, 2020) versus the role of frugality is more or less important to communicate, remains under-researched. A main question that we explore is thus whether (H1) there is a difference in attitude towards upcycled food, depending on whether the framing puts the benefit of reduced environmental impact and thus climate change

alleviation in focus, or instead appeals to a frugal resource use connecting back to traditions. We compare these two framings with a phrasing that simply re-assures of the good taste.

In line with previous research, we also have a range of expectations about the role of consumer background characteristics, as explained in the following.

Younger consumers are more concerned about climate (Pomarici & Vecchio, 2014), and their attitude could affect the acceptance of upcycled ingredients (Coderoni & Perito, 2021). There is very limited empirical literature on young consumer's preferences for upcycled foods (Coderoni & Perito, 2021), but it is observed that they are more concerned about climate change (Asioli & Grasso, 2021). Thus, we hypothesize (H2) that younger consumers (aged 18–34) are more favourable towards upcycled food when it is framed as a contribution to solving environmental issues and climate change.

Traditional, local and familiar food can influence the attitude towards upcycled food. A consumer may better accept upcycled food if used in food categories that are from their traditions and region of residence (Guerrero et al., 2009). According to some authors, consumers prefer organic, local and familiar food even if enriched with innovative ingredients (Perito et al., 2020). So far, none of the studies have focused on differences between North and South European countries. We hypothesize that (H3) the concept is better accepted when presented in food categories that are from and typical for the own region of residence (Guerrero et al., 2009). Given the Southern European countries have stronger food traditions, this might also be reflected in that (H4) the framing on frugal resource use is relative more favourably received in the South compared to the North, because frugality can be interpreted as something more traditional through making do with the resources in a frugal way (H4 thus expecting an interaction between the region and the framing). Combining these variables (framing, region, and product category origin), a more favourable perception of the framing on frugal resource use in the South might hold in particular (H5) when the product categories are also typical for the Southern region (that is, Southern consumers react more favourably when Southern product categories are presented with a frugal framing).

Regarding socio-demographics characteristics, we expect to find that (H6) higher education is related to greater acceptance of upcycled food in general (Cattaneo et al., 2018; Coderoni & Perito, 2020), and similarly, we hypothesize that (H7) females (Coderoni & Perito, 2020; Perito et al., 2019), and (H8) younger consumers have a more favourable attitude towards upcycled food (Coderoni & Perito, 2020; Zhang et al., 2020).

In the globalized market, consumers show an increasing interest in “natural food” (Vidigal et al., 2015) and this trend makes consumers less prone to accept new technological food (Ritchey et al., 2003). The consumer attitude towards new food is very important to determine the success of products in the marketplace (Frewer et al., 2011; Van Kleef et al., 2005). However, food neophobia has been found to be factor of negative influence on also upcycled food (Aschemann-Witzel & Stangherlin, 2021). We thus hypothesize that (H9) food neophobia is linked to a less favourable attitude towards upcycled products (Coderoni & Perito, 2020; Perito et al., 2019; Grasso & Asioli, 2020). Regarding the psychographic variables of environmental concern and frugal orientation, we expect that we confirm previous research (Aschemann-Witzel & Stangherlin, 2021) in that (H10) stronger environmental concern is related to more positive attitude (McCarthy et al., 2020; Zhang et al., 2020). We expect that same for frugality orientation (H11) (Whitmarsh and O'Neill, 2010; Gil-Giménez et al., 2021; Evans, 2011; Thøgersen, 2018).

3. Methodology

3.1. Experimental design and framing

We used a between-subjects design by varying three framing

information about benefits of upcycled foods (i.e. climate, frugal, and taste). All framings (see Fig. 1) contained the same basic definition of upcycled food but differed in the phrasing of the first section leading up to it. The phrasings all took departure in the formulation by the Upcycled Food Association (Upcycled Food Association, 2021). In the first group, participants were introduced to upcycled food referring to the environmental benefits and climate change alleviation. In the second group, participants were given information that referred to frugality by phrasing it as an ‘ancient tradition’ of ‘using all what you have’ and as an efficient ‘doing more with less’. In the third group, the introduction referred to the products focusing on quality, nutrition, and taste. We did not include a separate nutrition/health benefit framing as it can be expected to have a similar effect as environmental aspects, as shown by Asioli & Grasso (2021). In addition, we posit that upcycled food will in most cases need to be communicated with a normative and others-related benefit - i.e., not all waste-to-value use is healthier for the consumer, but in nearly all cases the point is that it is more resource efficient.

In each of the three framing condition, participants were presented with a range of either Northern or Southern product categories, in both countries of the Northern or Southern European region, thus making it a $3 \times 2 \times 2$ between-subjects design (see Table 1). We kept the broad categories (e.g. bread, protein drink, sweet and savoury snacks) constant across all experimental groups. We also used similar by-products across all groups (whey, used coffee ground, fruit and seed pressing, by-product from beer or wine production and by-product from oil production). We varied, however, which exact product example and by-product was used in the region in question. This was done in order to ensure that a) the assortment was realistic and b) the assortment was more typical for the region.

3.2. Product choice and stimuli

To test our hypotheses, we selected a range of different upcycled foods that jointly explain the concept of upcycling. These products were from the following categories: bakery products, dairy, sweet and salty snacks. These products have been identified due to their use in previous research (e.g. Aschemann-Witzel and Peschel, 2019; Grasso & Asioli, 2020; Perito et al., 2019) and/or because there are companies that produce upcycled foods of this type in the current market. We decided to not use upcycled food from meat to avoid possible food safety concern and disgust as well as having to account for dietary restrictions among participants. Thus, the participants assessed, for the greatest part of the survey, the concept of upcycling in general and along an assortment and did not assess single product examples. Each product in the assortment was described as text and visualized with an image (see Fig. 2).

3.3. Survey and procedure

Participants stated their attitude towards the upcycled foods which was measured with three statements (Grunert, Bredahl, & Scholderer, 2003; Urala & Lähteenmäki, 2004) on a 7-point Likert scale. They also stated their likelihood to buy using a scale from 0% to 100%. 0% means that consumers would never purchase the product, 100% means that consumers would always purchase the products, and 50% means that consumers are indifferent. The likelihood to buy was the only variable measured for each single product, all other questions referred to the assortment of products shown.

Moreover, we developed a range of statements on the importance of various factors for preferring such products, which respondents assessed on a 7-point Likert agree-disagree scale. In order to investigate individual differences, we measured several psychographic variables. These were environmental concern (Haws et al., 2014), frugality orientation (taking departure from: Gatersleben et al., 2017; Goldsmith et al., 2014; Lastovicka et al., 1999), and food neophobia (Ritchey et al., 2003; based on Pliner & Hobden, 1992). All showed satisfactory reliability measured

Climate Framing	Frugal Framing	Taste Framing
<p>Upcycling food is an approach aimed to reduce the negative environmental impact and fight climate change. It is about smart and efficient natural resource use to have a positive impact on the environment.</p>	<p>Upcycling food is an ancient tradition based on the philosophy of using all of what you have. It's about doing more with less, and elevating all food to its highest and best use.</p>	<p>Upcycling food is an approach for creating high quality, nutritious food products with even better taste to enjoy.</p>
<p>Upcycled foods use ingredients that otherwise would not have gone to human consumption. This reduces food waste.</p>	<p>Upcycled foods use ingredients that otherwise would not have gone to human consumption. This reduces food waste.</p>	<p>Upcycled foods use ingredients that otherwise would not have gone to human consumption. This reduces food waste.</p>
<p>The pictures on the right show upcycled foods. How do you feel about buying or eating these products with fibre and protein from ...</p>	<p>The pictures on the right show upcycled foods. How do you feel about buying or eating these products with fibre and protein from ...</p>	<p>The pictures on the right show upcycled foods. How do you feel about buying or eating these products with fibre and protein from ...</p>

Upcycling food is an approach aimed to reduce the negative environmental impact and fight climate change. It is about smart and efficient natural resource use to have a positive impact on the environment.

Upcycled foods use ingredients that otherwise would not have gone to human consumption. This reduces food waste.

The pictures on the right show upcycled foods. How do you feel about buying or eating these products with fibre and protein from ...

Rye bread with spent grain from beer brewing

Crisps with oilcake from oil pressing of sunflower, rapeseed and hemp

Muesli bar with berry skin from smoothie pressing

Protein drink with whey from cheese production

Chocolate oat cookie with used coffee ground



Note: Text is partly based on the definition text of the Upcycled Food Association (Upcycled Food Association, 2021)

Fig. 1. Communication framing conditions and example stimuli.

with Cronbach alpha, and the items were converted to summated variables (see Table 2). Lastly, we surveyed sociodemographic characteristics, which apart from the quota variables of age, gender, and region, were education level, self-assessed financial status, household composition, and living and/or being brought up in a city or rural area. The complete questionnaire can be provided upon request. The translations

and translation checks were done by the author team and a student assistant who combined are native in the five languages involved.

3.4. Participants

The data used in this study is drawn from the online survey,

Table 1
Experimental design and sample in each cell.

	Climate Framing (548n)	Frugal Framing (508n)	Taste Framing (547n)
Northern respondents (963n)	Northern products (179n) Southern products (164n)	Northern products (157n) Southern products (151n)	Northern products (152n) Southern products (160n)
Southern respondents (640n)	Northern products (104n) Southern products (101n)	Northern products (99n) Southern products (101n)	Northern products (134n) Southern products (101n)

Notes. n = 1603.

involving 1,603 consumers (age M = 43.94 years, SD = 15.47) from five North and South European countries (United Kingdom, Denmark, Germany, Portugal, and Italy), of which 52.7% were females, and 47.3% were males. Data was collected randomly recruiting from representative online panels in collaboration with the ESOMAR certified market research agency Userneeds in May 2021. Quotas ensured a fair distribution of age, gender and region to reflect the proportion of population for each country; approximately the same number of respondents was recruited in each country to allow for comparison. To ensure the samples contained consumers who at least occasionally shop food, we screened out respondents who answered “Never or very rarely” to the question “How often do you buy groceries for your household?”. Only adult (18 years and older) respondents were included. Respondents who used

	Product assortment description	Images symbolizing categories
Northern products	Rye bread with spent grain from beer brewing	
	Crisps with oilcake from oil pressing of sunflower, rapeseed and hemp	
	Muesli bar with berry skin from smoothie pressing	
	Protein drink with whey from cheese production	
	Chocolate oat cookie with used coffee	
Southern products	Bread with oilcake from oil pressing of olive oil	
	Taralli salted snack with grape skin from wine production	
	Yoghurt with kiwi flesh from smoothie pressing	
	Protein drink with whey from cheese production	
	Cantucci with used coffee ground	
Southern products (in Portugal)	Bread with oilcake from oil pressing of olive oil	
	Bolo de arroz with grape skin from wine production	
	Yoghurt with orange flesh from smoothie pressing	
	Protein drink with whey from cheese production	
	Pastel de nata with used coffee ground	

Fig. 2. Product conditions.

Table 2
Measure and variable characterisation.

Variable	Item	Mean (SD)
Scale for all	To what extent do you agree or disagree on these statements? 1 = strongly disagree 7 = strongly agree	
Environmental concern	It is important to me that the products I use do not harm the environment. My purchase habits are affected by my concern for our environment. I would describe myself as environmentally responsible. I am willing to be inconvenienced in order to take actions that are more environmentally friendly.	4.98 (1.35) Cronbach alpha = 0.914
Frugality	I would never throw away things that are still useful. I only buy what I need. If I can re-use an item I already have, there's no sense in buying something new.	5.51 (1.20) Cronbach alpha = 0.811
Food neophobia	I am afraid to eat things I have never had before. If I don't know what is in a food, I won't try it. I don't trust new foods. I eat almost anything. (reverse) At dinner parties, I will try a new food. (reverse) I am constantly sampling new and different foods. (reverse)	3.35 (1.09) Cronbach alpha = 0.711

Notes. n = 1603.

three minutes or less were excluded from further analysis under the assumption that the survey length means the survey cannot be filled out in less than this time. We obtained informed consent from all the participants of the study. Only fully anonymous data was transferred from Userneeds to the researchers. The study was pre-registered and approved by the Research Ethics Committee of the affiliation of the first author. Table 3 provides sample characteristics separated for Northern and Southern countries given the further analysis only differentiates by region of Europe.

3.5. Data analysis

In order to test our hypotheses and investigate the influence of communication framing, sociodemographic and psychographic variables on attitude towards upcycled food, we conducted Analysis of Variance (ANOVA) with all main factors, all 2-way interactions between the experimental design factors, and the hypothesized interactions. The experimental design factors are framing, region and product category origin, the socio-demographic variables included are gender, age group, and education (higher education yes or no), and the psychographic

Table 3
Sample and measure characterization per region.

Consumer characteristics	North	South
Sample size (n)	963	640
Share of gender, male (%)	48.8	45.0
Age in years (mean /SD)	45.2 (15.8)	42.0 (14.7)
Age brackets (%)		
18–34	30.1	35.6
35–49	28.0	29.7
50–75	41.8	34.7
Education, higher (%)	40.0	41.3
Environmental concern	4.7	5.4
Frugality orientation	5.4	5.7
Food neophobia	3.4	3.3

Notes. North = Denmark, Germany, UK; South = Italy, Portugal. If not indicated otherwise, the mean is given for the psychographic variables.

variables are environmental concerns, frugality orientation and food neophobia. In addition, descriptive statistics and simple bivariate tests were used to explore the factors assessed as important and the likelihood of purchase. We used SPSS 28 and RStudio Version 1.1.414 using the default stats and the psych package (Revelle, 2020) for analysis.

A manipulation check was conducted to test whether the products we used were indeed perceived as typical for the Southern and the Northern region, and whether the different communicational framings were understood as expected. The Southern products were perceived as more typical for the Mediterranean area (Mean = 4.62, SD = 1.52) compared to the Northern products (Mean = 3.90, SD = 1.61, $F(1) = 83.98, p < 0.0001$) (with the statement being “These product categories are typical foods for the Mediterranean area”). The Northern products were perceived as more typical for Northern Europe (Mean = 4.31, SD = 1.50) compared to the Southern products (Mean = 3.98, SD = 1.50, $F(1) = 19.02, p < 0.0001$) (with the statement being “These product categories are typical foods for Northern Europe”), confirming our choice of products. Differences in the framing show a trend towards the intended perception (with the statements used as follows: “The products aim to contribute to fighting climate change and environmental pollution”, “The products aim to take up the ancient tradition of using all of what we have”, “The products aim to taste better than alternative products”). This indicates that the wording of the framing is understood as intended. However, they are only significantly different across groups for the frugal condition ($F(2) = 3.52, p < 0.05$) (see Table 4).

4. Results

The ANOVA results (see Table 5) show that several main effects and one interaction are significant. Firstly, we look at the experimental design factors. Neither the region of residence (whether respondents are surveyed in the Northern region represented by Denmark, the UK and Germany, or the Southern region represented by Italy and Portugal; $F(2) = 0.008, p = 0.926$) nor the origin of the shown products ($F(2) = 2.823, p = 0.093$), is significantly related to attitude. However, which framing (climate, frugal, taste) was used to introduce upcycled food played a significant role for attitude ($F(2) = 3.664, p = 0.026$). Exploring this further with a post-hoc Scheffe test reveals that attitude is significantly higher in the frugal framing condition compare to the taste framing condition ($M = 4.96, SD = 1.34$ vs. $M = 4.72, SD = 1.44$), while attitude in the environmental and climate framing condition ranged in-between the other two framings, without being significantly different from the first or the latter ($M = 4.87, SD = 1.42$). This result confirms H1 (see Table 6 for a list of the hypotheses).

We do not find that younger consumers are more inclined to react positively to the environmental and climate framing condition. This is concluded based on the fact that the interaction between age groups and framing is not significant, and thus, that respondents of different do not react differently to the framing conditions (disconfirming H2; $F(2) = 1.603, p = 0.171$). In turn, we observe that there is an interaction effect

Table 4
Manipulation check communication framing conditions.

To which extent do you agree or disagree that the following descriptions of the products match with how you understand it?	Climate (n = 548) Mean (SD)	Frugal (n = 508) Mean (SD)	Taste (n = 547) Mean (SD)
The products aim to contribute to fighting climate change and environmental pollution.	5.36 (1.57)	5.26 (1.47)	5.24 (1.59)
The products aim to take up the ancient tradition of using all of what we have.	5.10 (1.53)	5.30 (1.52) [±]	5.06 (1.58) [±]
The products aim to taste better than alternative products.	4.19 (1.52)	4.27 (1.52)	4.34 (1.54)

Note: *Tukey HSD posthoc test reveal significant difference at $p = 0.1$, ±Tukey HSD posthoc test reveal significant difference at $p < 0.05$.

Table 5
Influence of communication framing, sociodemographic and psychographic variables on attitude towards upcycled food.

Independent variables	F value	p value	Partial η^2
Experimental design factors:			
Framing (climate, frugal, taste)	3.664	0.026	0.005
Product (northern, southern)	2.823	0.093	0.002
Region (north, south)	0.008	0.929	0.000
Sociodemographic variables:			
Education (low vs high)	0.809	0.368	0.001
Gender (male vs female)	4.319	0.038	0.003
Age (15–34, 35–49, 50–75)	21.148	0.000	0.026
Psychographic variables:			
Environmental concern	198.189	0.000	0.111
Frugality orientation	6.399	0.012	0.004
Food neophobia	177.607	0.000	0.101
Interactions:			
Region × Product	4.318	0.038	0.003
Framing × region	0.387	0.679	0.000
Framing × product	0.174	0.840	0.000
Framing × age group	1.603	0.171	0.004
Region × Product × Framing	0.815	0.443	0.001

Notes. $n = 1603$. ANOVA. All main effects and all two-way interactions between the experimental design factors, and the hypothesized interactions are included in the model. The Levene test of the model with the signification factors indicates equality of error variance is given.

Table 6
Hypotheses.

Nr	Hypotheses	Result
1	Attitude towards upcycled food is more favourable in the climate or the frugal framing compared to the taste framing.	confirmed
2	Respondents in the age bracket 18–34 show a more favourable attitude towards upcycled food in case it is framed as a climate contribution compared to the frugal framing (interaction effect age and framing).	disconfirmed
3	Attitude towards upcycled food is more favourable when the respondent is from the region for which the product that are shown (interaction effect region and product).	confirmed
4	Attitude towards upcycled food is more favourable in the framing condition on frugal resource use in the southern region compared to the northern region (interaction effect region and framing).	disconfirmed
5	Attitude towards upcycled food is more favourable in the framing condition in the southern region for the southern products, compared to the northern region (interaction effect region, product and framing).	disconfirmed
6	Highly educated respondents show a more favourable attitude towards upcycled food compared to less educated respondents.	disconfirmed
7	Female respondents show a more favourable attitude towards upcycled food compared to male respondents.	confirmed
8	Younger respondents (in the age bracket 18–34) show a more favourable attitude towards upcycled food compared to older respondents.	confirmed
9	Respondents showing higher food neophobia are more likely to show less favourable attitude towards upcycled food.	confirmed
10	Respondents showing stronger environmental concern are more likely to show favourable attitude towards upcycled food.	confirmed
11	Respondents showing more pronounced frugality orientation are more likely to show favourable attitude towards upcycled food.	confirmed

between the region in which consumers are surveyed, and the product categories being typical for one or the other region ($F(1) = 4.318, p = 0.038$). Exploring this further, we find that H3 is confirmed: attitudes to products from the own region are assessed more favourable both in the Northern region and in the Southern region (Northern region: northern products $M = 4.80, SD = 1.42$ vs southern products $M = 4.66, SD = 1.46$; Southern region: northern products $M = 4.95, SD = 1.30$ vs southern products $M = 5.13, SD = 1.27$), but this is more pronounced in the

Southern region, resulting in a significant difference between northern and southern product conditions in the Southern regions (independent t-Test showing that $t(638) = -1.718, p = 0.043$).

Neither an interaction between region and framing, nor between region, framing and product category is found, disconfirming H4 ($F(2) = 0.387, p = 0.679$) and H5 ($F(2) = 0.815, p = 0.443$).

Regarding the sociodemographic variables, education is not found to significantly explain attitude (disconfirming H6; $F(2) = 0.809, p = 0.368$). However, in line with previous research, there is a significant effect of female gender (H7) ($F(1) = 4.319, p = 0.038$) and age (H8) ($F(2) = 21.148, p = 0.000$). Partial least square values (0.026) indicate that the role of the age groups is particularly relevant. Exploring this further, we can see that it is the older age group (50–75 years) that is least favourable towards the upcycled food products presented to them. Indeed, parameter estimates indicate it is the older group (i.e. 50–75 years) who sets itself significantly apart from the up to 34, or 35 to 49 year old ($M = 4.62, SD = 1.50$ among the older age group, but $M = 4.90, SD = 1.37$ among the 35–40 year olds, and $M = 5.08, SD = 1.28$ among the up to 34 year olds).

All psychographic variables are found to have a role in explaining attitude towards upcycled food (confirming H9-11): Environmental concern ($F(1) = 198.189, p = 0.000$), frugality orientation ($F(1) = 6.399, p = 0.012$) and food neophobia ($F(1) = 177.607, p = 0.000$) are all significant. Partial least square values indicate that relatively more impactful are environmental concern (0.111) as well as food neophobia (0.101). As expected, environmental concern and frugality orientation has a positive, and food neophobia a negative impact on attitude.

Descriptively exploring which factors respondents assessed most important (see Table 7), we find that a similar sequence of importance emerges across the Northern and the Southern region, while respondents in the Southern region tend to answer more positively on the given scale. The most important factor according to the assessment by the consumers is the environmental or climate aspect, the familiarity of the ingredients, and organic or local production.

Moreover, we also explored the likelihood of purchase per product category, for Northern versus Southern products, per region and framing condition (see Table 8). There are no significant differences between experimental groups within regions, but respondents in the Southern region answer more positively across most products and conditions. Some patterns can be observed, as e.g. that there is a higher aggregate likelihood to buy in the climate framing condition for Northern products in the Northern region. Meanwhile, in the Southern region, the highest likelihood to buy the product category for most Northern products falls into the frugal framing conditions. From the product categories shown, in the Northern region, especially the upcycled protein drink appears unappealing to buy given respondents assessed a lower likelihood of purchase compared to the common version. Also, the sweet product (Cantucci/Pastel de nata) appears less appealing as an upcycled product

Table 7
Importance of aspects to accept upcycled food products across regions.

I would prefer these products more, if ...	North (n = 963) Mean (SD)	South (n = 640) Mean (SD)
... they have a lower environmental or climate footprint than the common product I know.	4.93 (1.72)	5.48 (1.43)
... I recognize all the ingredients as familiar.	4.87 (1.64)	5.17 (1.44)
...they are from organic production.	4.60 (1.79)	5.34 (1.47)
... I can see it is a local product.	4.53 (1.71)	5.00 (1.51)
...they are produced by a small farm.	4.38 (1.66)	4.78 (1.57)
...they are from a well-known food brand.	4.35 (1.68)	4.61 (1.56)
...they are produced by a young start-up company.	4.11 (1.70)	4.64 (1.49)

Note: Ordered from most important to least important. All mean values differ significantly at $p < 0.05$ across Northern and Southern respondents, but the order of acceptance is mostly the same across regions. Note that none of the factors offered to assess for respondents directly addressed ‘frugality’.

Table 8
Likelihood to buy product, per product, region, and framing condition.

		North			South		
		Climate	Frugal	Taste	Climate	Frugal	Taste
Northern products		n=179	n=157	n=152	n=104	n=99	n=134
	Rye bread	60.52 (27.12)	56.87 (26.54)	55.59 (26.30)	61.78 (27.94)	65.60 (25.15)	61.07 (25.68)
	Crisps	58.21 (29.07)	53.50 (27.60)	54.59 (29.85)	51.64 (30.45)	58.32 (27.25)	52.78 (29.79)
	Muesli bar	60.15 (29.45)	52.85 (29.93)	53.98 (33.74)	60.35 (29.69)	61.75 (27.35)	58.80 (26.95)
	Protein drink	49.33 (33.45)	44.59 (30.35)	44.67 (32.77)	55.68 (31.84)	54.94 (29.16)	52.95 (29.30)
	Chocolate oat cookie	55.22 (33.19)	51.10 (30.06)	50.95 (33.48)	61.22 (31.16)	65.20 (26.82)	61.54 (28.24)
	Aggregate	56.68 (25.19)	51.74 (24.09)	51.96 (26.05)	58.13 (27.09)	61.16 (22.84)	57.43 (23.9)
Southern products		n=164	n=151	n=160	n=101	n=101	n=101
	Bread	57.84 (28.06)	54.08 (28.83)	51.16 (28.47)	65.04 (24.95)	66.41 (23.90)	63.31 (25.01)
	Taralli salted snack / Bolo de arroz	52.45 (30.09)	50.64 (31.11)	47.16 (29.18)	64.01 (27.17)	60.60 (28.42)	63.31 (25.01)
	Yoghurt	55.31 (30.66)	55.71 (31.21)	48.27 (33.45)	61.22 (28.38)	59.97 (28.85)	62.06 (27.79)
	Protein drink	48.02 (31.91)	47.15 (32.19)	42.33 (34.63)	58.23 (30.98)	57.23 (30.75)	58.23 (29.70)
	Cantucci / Pastel de nata	48.45 (33.03)	48.46 (32.86)	43.34 (33.32)	63.50 (27.32)	61.28 (29.58)	63.56 (29.51)
	Aggregate	52.41 (27.00)	51.21 (26.95)	46.45 (27.81)	62.40 (23.31)	61.10 (24.99)	62.06 (25.6)

Note: The question was “How likely is it that you will buy this product [product named], compared to the common version [product named] that you know?”. The scale was “Please state on a scale from 0% to 100% how likely it is. 0% means you would never purchase this, 100% means you would always. 50% means you are indifferent”. Values displayed as mean (SD). Values in **bold** indicate highest value per row. Shaded cells indicated preference for the regular alternative. Regional differences are significant within experimental conditions, except for the climate group for the Northern products. There are no significant differences between experimental groups within regions.

in the Northern region, and in the same region, a lack of likelihood to purchase is more often seen in the taste framing condition.

5. Discussion

Consumer perception and reaction to upcycled food is an under-researched area so far. Consumers can play an even larger role for food loss and waste reduction than current estimations indicate, considering that a shift in their product choices towards embracing foods that make use of yet-undervalued side-streams also plays a role for avoiding wastage and more efficient natural resource use. On this background, we explored which framing of information – with a particular focus on exploring the concept of frugality - and which background characteristics of consumers explain favourable attitude towards a set of different product categories, in a sample of consumers from five European countries. A broad set of hypotheses was explored, making the study explorative in nature, which might also explain why only a share of hypotheses could be confirmed.

5.1. Benefit framing in communication and frugality orientation

We find that framing the benefit in terms of climate or frugality aspects, thus other than taste, has a significant effect on favourable attitude. This holds in particular for the framing that portrays upcycled food as a frugal tradition. It has to be noted though, the strength of this effect is relatively minor compared to the role of age, and especially compared to the effect of environmental concern and food neophobia.

It has been shown previously that benefit framing of the food waste avoidance aspect can improve favourable perception of upcycled food (Aschemann-Witzel & Peschel, 2019). So far, research on upcycling has emphasized the environmental effect (Grasso & Asioli, 2020), but less so explored the ‘frugality’ aspect entailed in the concept. We show that framing upcycled food might gain from emphasizing the frugality aspect more than is currently done in the communication on these products, given attitude towards the product was higher when this framing was used in the experiment. Thus, apart from writing out that the upcycled

food product helps reducing food waste, the communication could portray this as a frugal act by the company or the consumer buying the respective product. For example, sentences on the product or its communication referring to the principle or philosophy of ‘using all what you have’ or doing more with less’, would frame the product in this sense and appeal to consumers with a respective trait or identity.

We cannot determine, though, which element in the frugality framing text is most relevant and why precisely. The text might appeal to frugality orientation or identity, but because it also makes a reference to the ‘ancient tradition’, it might also mean that the concept appears more as traditional and familiar. Frugality in current consumer behaviour trends is an ‘old’ concept that is currently receiving renewed interest. It was up to the study participant whether to associate the text more with tradition or as something re-invented as a modern idea. Which of these aspects are more relevant and for whom could be of interest for further future research in this area, as for example through a qualitative approach. Also, it could be interesting to study whether placing a greater emphasis on frugality in the framing of upcycled food could alleviate the potential negative association of ‘waste’ (de Visser-Amundson et al., 2021).

It is striking that all three psychographics (environmental concern, frugality orientation, and food neophobia) were found to be significant. It is well in line with several previous research findings that environmental concern is not only a significant factor, but also a relatively strong one (Grasso & Asioli, 2020). The same holds for food neophobia (Perito et al., 2019). What we add to literature as a new observation is the role that frugality orientation plays, even though of relatively less importance. The findings underline that the aspect of frugality in the upcycled food concept is worth addressing in communication.

What sets upcycled food apart from other products that are relatively more sustainable – as e.g. plant-based alternatives or insect food – is that producers of upcycled foods have a different framing to choose from, namely the frugality narrative and reference to such a frugal approach being traditional. The other sustainable products do not have that option. Where food producers compete for the attention of sustainability-interested consumer groups, using this framing or narrative might be a

good choice in order to communicate differently.

5.2. Background characteristics explaining favourable attitude to upcycled food

In line with our expectation and previous research showing that familiarity and/or local produce is an important factor for consumer product perception (Guerrero et al., 2009), we find that respondents show a relatively more favourable attitude for upcycled food presented in categories typical for the own region. This general observation entails that introducing an upcycled food ingredient in categories that are better known in the target region is more advisable.

Some studies have shown that older and younger generations may differ in preferences for upcycled food (Perito et al., 2020). Our results indicated that young people are more willing to accept waste-to-value products than older people. Against our expectations, we do not find that younger consumers react more favourably to the environmental and climate framing condition. Our findings of a greater willingness to accept might be explained by various reasons, amongst others that younger consumers are more strongly motivated to change their dietary choices for environmental reasons, and the upcycled food concept, independent of the framing, appeals to such motivation. Disconfirmation of an interaction between framing and age might be explained by that not necessarily the age bracket, but the generation could be the relevant group to explore (Zhang et al., 2020). Regarding gender, we find that females are more in favour of the upcycled foods and that can be explained by the fact that they are more environmentally aware when it comes to food products than men (Aschemann-Witzel & Peschel, 2019; Hartmann and Siegrist, 2017).

As a limitation it can be noted that countries might differ in terms of sustainability understanding and types of associations, familiarity with upcycled food and the degree to which such products are already on the market. Further research is needed to test the robustness of our findings, for example with other types of upcycled foods. Similar studies should also be conducted in other countries given the expected increase in upcycled food business in many parts of the world (e.g. United States, Asia, etc.). Moreover, future studies should further investigate consumers' preferences and willingness to pay for upcycled foods with other methods, such as non-hypothetical experiments using experimental auctions (Lusk and Shogren, 2007), multiple price list (MPL) (Asioli et al., 2021) or real choice experiments (RCE) (Alfnes & Rickertsen, 2010). Moreover, testing upcycled foods could be combined with sensory evaluations of upcycled foods (Asioli et al., 2017). Using these diverse methods can contribute to obtaining a comprehensive understanding of consumer reactions to upcycled foods, as well derive practical implications for the market.

6. Conclusion

This cross-category and cross-country online survey study explored which framing information and which background characteristics of consumers explain favourable attitude towards upcycled food. The findings contribute to a better understanding of consumer perception and consumer target characteristics among food sector stakeholders and entrepreneurs, who are engaged in furthering food loss reduction and more efficient resource use via upcycling side-streams into new food products.

From the various findings, two conclusions are especially important to stress. Firstly, we conclude that benefit framing in communication addressing frugality and appealing to the frugality orientation of consumers is worthwhile. Thus, producers of upcycled foods should stress this aspect of the concept overall and for their product. Secondly, we conclude that from the other background variables studied, especially environmental concern is a driver while food neophobia is a barrier for favourable attitude, consequently, both are particularly important psychographic consumer characteristics to be aware of in approaching the

consumer group most favourable towards upcycled foods. Our results provide insights into consumers' acceptance psychology that can be useful for effectively communicating the potential benefits of upcycled foods to the public to maximize the chances of making them commercially viable. This, in turn, contributes to the sustainable transition of food systems. The research underlines that consumers contribution to food waste avoidance is both by avoiding food waste in their own households, but also by changing their purchase patterns and product perceptions towards embracing waste-to-value approaches in the food chain and upcycled foods.

Transparency reporting

Pre-registration of the study is available in https://aspredicted.org/blind.php?x=/G6T_94W.

Ethical approval

The study was approved by the Aarhus University Research Ethics Committee (Journal nr 2021-0227441, Approval nr. 2021-33).

Declaration of Competing Interest

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

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