Irish Journal of Agricultural and Food Research

Circular eating: a pilot study in France and Ireland exploring the factors affecting the willingness to consume upcycled food products containing peels and trimming from fruit and vegetables

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Abstract

Significant amounts of fruit and vegetables are lost or wasted along their supply chain. A possible way to achieve reduction of food waste is to reuse the lost materials as upcycled ingredients. The aim of this study was to explore what factors influence the willingness of students from two countries with different culinary traditions to consume foods containing these ingredients. An online survey was distributed to students in France (n = 86) and Ireland (n = 99), gathering data on sociodemographic characteristics, food choice motives, food disgust and neophobia and willingness to consume different food products before and after being provided with information on the origin of the ingredients. Items related to food disgust and neophobia were negatively correlated with willingness to consume the investigated products. The findings showed that willingness to consume products containing upcycled ingredients may be product related in each country as participants in France were more willing to consume ice cream than their Irish counterparts, who after being informed that upcycled ingredients were used were more willing to consume crisps. These differences could be linked to differences in the food choice motives, as students in France considered familiarity, convenience, affordability and tradition important, while naturalness was important for the participants from Ireland. For both groups, paired t-test showed that willingness to consume the foods reduced after participants were informed about the origin of the ingredients. The findings of this pilot study provide the basis for further product development of foods containing upcycled ingredients.

Keywords

Introduction

Fruit and vegetables are major components of a healthy diet as they are important sources of nutrients, dietary fibre, vitamins and minerals (Angelino *et al.*, 2019). However, 45% of the production is wasted by the stakeholders along the food supply chain (FAO, 2019). The wasted material is either lost having been discarded before it reaches retail outlets or wasted at retail and consumer level (FAO, 2019). Fruit and vegetable loss and waste are also contributing to the waste of important resources such as land, energy, water and labour (Augustin *et al.*, 2020), and when disposed in landfills, they lead to the formation of excessive greenhouse gas emissions (Carlsson-Kanyama, 1998; Dorward, 2012; Sanciolo *et al.*, 2022). Moreover, while there are concerns about food insecurity, food waste contributes to lost nutrients that could be used to feed people (Nogueira *et al.*, 2021).

Reducing food waste by half by 2030 is one of the requirements of United Nations (UN) Sustainable Development Goal 12.3 that refers to sustainable consumption and production (UNDP, 2015). Therefore, there is a need for change and adoption of more sustainable and ecological food consumption behaviours. Since some of this waste is unavoidable it is important to find ways to reduce levels where possible. One way to achieve this reduction is through circular approaches (Teigiserova *et al.*, 2020). For example, edible safe material captured prior to being classified as waste or losses can be upcycled and potentially used as food for low-income households contributing to a balanced diet of this population improving food security (Nogueira *et al.*, 2021) and contributing to Sustainable Development Goal 2 towards zero hunger (Tchonkouang *et al.*, 2023). Alternatively, they can

be redistributed by the retailer sector leading to lower costs and higher environmental savings (Albizzati *et al.*, 2019). It is also possible to add value to these edible materials by incorporating them as ingredients to produce novel foods which are often characterised as upcycled (Bhatt *et al.*, 2018; Aschemann-Witzel *et al.*, 2023a,b). The consumption of foods containing upcycled ingredients has been characterised as circular eating (Aschemann-Witzel & Peschel, 2019; Aschemann-Witzel & Stangherlin, 2021; Aschemann-Witzel *et al.*, 2023a,b). As a result of growing awareness about food waste and the different consequences it can have on the environment, many companies are following this idea to turn food waste into brand-new products that people might be willing to purchase (Coderoni & Perito, 2020). This shows the importance of studies exploring people's perception of these products and their willingness to consume them, as this will help to develop products which are deemed acceptable to consumers.

Studies conducted to date and the reviews conducted by Moshtaghian *et al.* (2021) and Aschemann-Witzel & Stangherlin (2021) have shown that the factors affecting willingness to consume upcycled foods are mostly individual, context and product related, following the concept of general food choices described by Köster (2009). Specifically, age, gender, educational background (Cattaneo *et al.*, 2019), attitudes towards waste management and sustainability, environmental concerns (Coderoni & Perito, 2020; Asioli & Grasso, 2021), food neophobia and food technology neophobia (Cattaneo *et al.*, 2019; Coderoni & Perito, 2020, 2021) can impact acceptability of upcycled ingredients (Aschemann-Witzel & Stangherlin, 2021; Moshtaghian *et al.*, 2021).

In relation to product characteristics there are studies that have explored the willingness to consume prototypes (Cattaneo *et al.*, 2019; Coderoni & Perito, 2020; Asioli & Grasso, 2021) and a few studies tested real products containing upcycled ingredients (Grasso & Asioli, 2020). These studies revealed that price, quality, clear labelling and taste are important factors affecting the choice of these products. Moreover, the source of the ingredients, the country of origin and the industry from which the ingredients originated were also very important (Goodman-Smith *et al.*, 2021). Traceability is a common concern among consumers and companies and a major challenge in the use of upcycled ingredients (Moshtaghian *et al.*, 2021; Fox *et al.*, 2023a,b). Environmental impact, nutritional value and health had also a positive impact on willingness of Italian consumers to buy foods containing upcycled ingredients (Coderoni & Perito, 2020). A recent study with Irish consumers found that food safety concerns were a potential barrier to acceptance of circular eating; however, the use of clear information on packs and sensory appeal were viewed as potential facilitators (Fox

et al., 2023b). Rethinking the promotion of upcycled foods, specifically how it is framed to different consumer segments could be another potential way of encouraging acceptance; for example, Aschemann-Witzel *et al.* (2022) found that framing the benefits of upcycled foods focusing on climate and frugality rather than taste alone could improve product acceptance.

A cross-cultural study exploring the willingness of consumers in China and the USA found that more participants in China were aware of the concept, but liking was higher in the USA, while in both countries familiarity with the products was low. Although in both countries the preferred by-products were plant-based, there were differences in the final products preferred in each country (Grasso *et al.*, 2023). A recent study exploring consumer associations with the concept of upcycled foods in five European Union (EU) countries found that consumers mostly react positively; however, there is an expectation among them that products should be safe and taste good and may be rejected if this is not achieved (Aschemann-Witzel *et al.*, 2023a,b). Taste and texture were also important sensory attributes found in a recent study on the upcycling of chicken eggshell into baked goods by Chang *et al.* (2023).

These studies reveal that even though there are similarities in the attitudes of consumers from different countries, there are differences in the type of products that would be acceptable. Therefore, the need for more cross-sectional studies is important. The aim of the current study was to explore the willingness of students studying in France and Ireland to consume products that contain fruit and vegetable trimmings, peels or other by-products which could be characterised as upcycled ingredients (Bhatt *et al.*, 2018; Aschemann-Witzel & Peschel, 2019). Although previous research has shown that younger educated individuals are more aware of sustainability issues (Barone *et al.*, 2019), there is a lack of literature on the views of participants in these two countries (Ireland and France) which differ considerably in their culinary traditions.

The main objectives of this study were:
(1) To investigate if there was a significant difference on the willingness to consume four products (sweet and savoury, healthy and less healthy) before and after knowing the source of ingredients.
(2) To explore if the willingness to consume was affected by consumer-related factors such as country of study or diet and lifestyle factors related to food habits (fruit and vegetable consumption, what participants do with their food waste), food choice motives, food neophobia and food disgust.

The outcomes of this study will assist in forming the basis to develop food products containing such ingredients.

Materials and methods

Survey development and distribution

A review of the literature (conducted in May 2021) helped to identify the themes associated with the subject of circularity and the acceptance of upcycled foods, which aided in building the questionnaire at the time of the study. Some of these were food choice motives, food neophobia and disgust, management of food waste, food habits referring to consumption of fruit and vegetables and sociodemographic characteristics such as age, gender and educational background.

An online survey was approved by the Research Ethics Committee of the Institute of Technology Sligo (IT Sligo – currently ATU Sligo) in Ireland (Ref: 2020046). An explanatory sequential mixed methods approach was used, where participants were asked to give quantitative responses initially followed by a qualitative response in the form of an open-ended question, detailing the reason for their initial quantitative response.

The survey was divided into three parts: (1) the sociodemographic characteristics of participants, (2) their food habits and food choices and (3) their willingness to consume the products presented to them in pictures (prototypes) as seen in Figure 1. The specific sociodemographic questions asked were age and gender (Culliford & Bradbury, 2020), field of study, area of residence and farming background (Hoek et al., 2021). Food neophobia (Coderoni & Perito, 2020), food disgust (Hartmann & Siegrist, 2018) and food choice motives (Tobler et al., 2011) were also included, along with questions related to diet and lifestyle such daily consumption of fruit and vegetables and ways of disposal of waste. Questions on the willingness to consume four different food products were also asked. The products selected were a vegetable soup, an ice cream, vegetable crisps and a vegetable juice. These foods were created and photographed by the authors. The reason behind this choice was to have a variety of healthy and less healthy foods, including both sweet and savoury options,

in order to overcome potential bias in answers towards a preference for one specific type of food.

Participants were instructed, based on the pictures shown in Figure 1 as follows, "Pictured is a bowl of vegetable soup, would you consume this soup". Furthermore, they were asked to score their willingness to consume the product using an unstructured line scale from 0 that corresponds to extremely unlikely to 100 that corresponds to extremely likely. Then, they were provided with information in relation to the origins of the ingredients "If you were told that this soup comes from fruit and vegetable peels and trimmings generated during food processing, would you consume it" and were asked to score again their willingness to consume using a line scale from 0 to 100. The same wording was used for all four products presented to the respondents. Open-ended questions followed the line-scale questions to facilitate comments from participants who were asked to justify their responses. Qualitative data were collected in this way, to increase the validity of the responses before and after being informed that the products are being produced from fruit and vegetable peels and trimmings. The survey was developed using Qualtrics XM (2005).

The survey was distributed to students in Ireland and France between 21 May and 8 June 2021. It was provided in English and in French. The French translation was conducted by a registered translator in conjunction with the French student and the French questions were back-translated into English. Students in both countries were recruited by email and were asked to complete the online survey. The email was sent to the participants via the internal email system of IT Sligo, Galway and Mayo Institute of Technology (GMIT), Ireland and Polytech Clermont, France. The email included a description of the study and the link to the survey. The survey was also posted on different social media outlets such as LinkedIn and Facebook, targeting student groups. To avoid including students studying in other countries, when participants started the survey if they answered that they study in a country other than France or Ireland, they were guided to the end of the survey.

Figure 1. Pictures of foods presented in the survey, vegetable soup, ice cream, vegetable crisps and vegetable juice.

This convenience sample (Teddlie & Yu, 2007) of third-level students was chosen on the basis that university students are more aware of sustainability issues (Sun *et al.*, 2019), and there is a lack of literature on the views of this population group. A total of 203 participants answered the survey, and after removing incomplete surveys, 185 participants (*n* = 86 participants studying in France and *n* = 99 participants studying in Ireland) were included in the analysis.

Analysis of quantitative data
To achieve the objectives of the study, described in the Introduction section, the statistical tests described in Table 1 were conducted using the statistical software SPSS (IBM SPSS Statistics Version 29, IBM Corp, Armonk, NY, USA). The effect of the different parameters on the willingness to consume upcycled products was tested on all the participants (pooled data), and on participants studying in France and Ireland, to see if there were any differences between the two groups. Table 1 also presents the research questions this study aims to answer.

Analysis of qualitative data
Qualitative data collected through the open-ended questions in the form of comment boxes were analysed to find themes, by first finding codes and subthemes following the process of thematic analysis (Braun & Clarke, 2021). Coding of the data helped to find patterns in the answers given to the question "please justify your answer" followed by each willingness question. A hybrid approach was selected with most themes generated based on existing literature following deductive reasoning, while in some cases themes were generated by the researcher following inductive reasoning (Fereday & Muir-Cochrane, 2006). Content analysis was

also used to measure the frequency of responses when comparing responses from participants from France and Ireland (Vaismoradi *et al.*, 2013); percentages are used in the graphs presented in the results. Coding was completed by two researchers (L. El Gourari and M. Dermiki) until agreement was reached. The translator also assessed the data to ensure validity and reliability.

Results

Sociodemographic profile of the participants
The sociodemographic characteristics of the participants can be seen in Table 2. There is an almost equal representation of participants from each country and from the two genders, as 54% are studying in Ireland, and 59% are women. However, as expected from this profile of students, the vast majority (78%) are in the 18–29 years age group, and there is underrepresentation of the 30+ age group.

When comparing the two groups of participants, there were no differences in the gender distribution or in the distribution of people eating more than five portions of fruit and vegetables per day. However, there were fewer participants older than 30 years in France (χ^2 (1) = 39.693, *P* < 0.01), more participants in Ireland lived in a rural area (χ^2 (1) = 16.257, *P* < 0.01) and more participants in France were discarding their fruit and vegetable waste in the general waste bin (χ^2 (4) = 47.155, *P* < 0.01) possibly because they lived in urban areas.

Effect of product-related characteristics on the willingness to consume the food products
When testing if there were differences in the willingness to consume the products (research question from Table 1:

Table 1: Statistical tests used to assess the research questions of the study and to investigate the effect of the different factors on the willingness to consume the four products presented visually in the survey

Effect of (factor)		On	Research question	Statistical tests used
Product-related factors	Effect of product type	Willingness to consume the different products	Are there any differences in the willingness to consume the products?	One-way ANOVA
	Effect of knowledge of the origin of the ingredients		What is the effect of knowledge of the origin of the ingredients on the willingness to consume the products?	Paired t-test
Consumer-related factors	Place of study, fruit and vegetable consumption		What is the effect of consumer-related factors on willingness to consume the products?	Independent t-test
	What to do with food waste			One-way ANOVA
	Food disgust, food neophobia and food choice motives		What is the effect of food habits on willingness to consume the product?	Pearson's correlation

ANOVA = analysis of variance.

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Table 2: Sociodemographic characteristics of the participants' pooled data (*n* = 185)

Factors	Percentage
Place of study	
Ireland	**54% (*n* = 99)**
France	46% (*n* = 86)
Age group (years)	
18–29	**78% (*n* = 144)**
Over 30	22% (*n* = 41)
Gender	
Men	40% (74)
Women	**58.5% (*n* = 108)**
Prefer not to say	1% (*n* = 2)
Other	0.5% (*n* = 1)
Highest level of education	
Secondary	19% (*n* = 35)
Third level	33% (*n* = 61)
Post-graduate	**48% (*n* = 89)**
Fields of studies	
Environmental science and engineering	14% (*n* = 26)
Food and nutrition	21% (*n* = 40)
Food or biological engineering	18% (*n* = 33)
Business and social science	3% (*n* = 6)
Other	**43% (*n* = 80)**
Fruit and vegetable consumption	
Less than five portions	**51% (*n* = 94)**
More than five portions	49% (*n* = 91)
Farming background	
Yes	21% (*n* = 40)
No	**79% (*n* = 145)**
Currently living in	
A rural area	40% (*n* = 74)
An urban area	**60% (*n* = 111)**

The highest percentages are presented in bold.

Are there any differences in the willingness to consume the products?), it was found that the willingness to consume vegetable juice was lower compared to the other three products before knowing the origin of the ingredients (*P* < 0.001). This was the case for the pooled data and for the students in Ireland. Moreover, the students in France were more willing to consume ice cream compared to the vegetable juice or crisps. When comparing the willingness to consume the four products after knowing the origin of their ingredients, it was found that participants were more willing to consume

crisps compared to the vegetable juice and the ice cream (*P* < 0.001), while there were no differences between soup, crisps and ice cream. The students in France were less willing to consume vegetable juice compared to ice cream and the students in Ireland were less willing to consume vegetable juice compared to crisps.

The next research question as seen in Table 1 examined whether information on the origin of the ingredients had an effect on the willingness to consume the suggested foods. As seen in Table 3 when observing the pooled data (all products *P* < 0.001) and the data for the participants in Ireland (all products *P* < 0.001), it was found that provision of information significantly reduced the willingness to consume all four foods, while for participants in France, information affected the willingness to consume the soup and ice cream (*P* < 0.001).

Effect of consumer-related characteristics on the willingness to consume the food products

Sociodemographic characteristics
The effect of most of the sociodemographic characteristics was not tested on the willingness to consume the four products presented before and after disclosing information about the origin of the ingredients, due to the small sample size. The only characteristic studied was the country of study, which, as seen in Table 3, had an effect on the willingness to consume ice cream with students from France being more willing to consume versus students from Ireland (*P* = 0.021). Alternatively, students from Ireland were more willing to consume crisps after knowing about the origin of the ingredients compared to students from France (*P* = 0.048).

Diet and lifestyle
When exploring the effect of diet such as the daily consumption of fruit and vegetables, there was a significant effect on the willingness to consume the products before and after disclosing information on the origin of the ingredients (see Supplementary Table S1). In the pooled data, there were significant differences in the willingness to consume the soup, with the participants who consume more than five portions of fruit and vegetables daily more willing to consume the soup before (*P* = 0.001) and after knowing about the origin of the ingredients (*P* < 0.001). They were also more willing to eat ice cream after the information on the origin of ingredients was disclosed (*P* = 0.031). While the chi-square test showed no differences in the consumption of fruit and vegetables between the two countries, when looking at the individual countries (see Supplementary Table S2), the results showed that participants in France who consume more than five portions of fruit and vegetables daily were more willing to consume soup after knowing about the origins of the ingredients (74.0 ± 21.6) in comparison to those

Table 3: Pairwise comparison of willingness to consume the four products presented before and after being informed that ingredients used contained upcycled ingredients such as peel or trimmings from fruit and vegetables and comparison of willingness of participants in the two countries to consume the products

	Pairwise comparison before and after being informed of the origin of the ingredients	Pooled data (*n* = 185)		France (*n* = 86)		Ireland (*n* = 99)		Comparison of participants from France and Ireland
		Mean ± s.d.	Significance (paired t-test)	Mean ± s.d.	Significance (paired t-test)	Mean ± s.d.	Significance (paired t-test)	Significance (independent t-test)
Pair 1	Vegetable soup (before)	77.0 ± 25.8	*P* < 0.001	76.8 ± 23.4	*P* < 0.001	78.2 ± 27.2	*P* < 0.001	*P* = 0.870
	Vegetable soup (after)	64.7 ± 29.1		62.2 ± 26.6		67.6 ± 30.8		*P* = 0.252
Pair 2	Ice cream (before)	82.4 ± 25.3	*P* < 0.001	86.9 ± 20.5	*P* < 0.001	78.8 ± 28.5	*P* < 0.001	*P* = 0.021
	Ice cream (after)	67.2 ± 31.4		70.1 ± 27.3		65.4 ± 34.6		*P* = 0.302
Pair 3	Vegetable crisps (before)	75.7 ± 29.2	*P* < 0.001	74.0 ± 29.9	*P* = 0.135	77.5 ± 28.7	*P* < 0.001	*P* = 0.458
	Vegetable crisps (after)	70.7 ± 31.2		65.6 ± 30.8		75.1 ± 31.1		*P* = 0.048
Pair 4	Vegetable juice (before)	62.4 ± 33.5	*P* < 0.001	63.1 ± 30.8	*P* = 0.177	61.8 ± 35.8	*P* < 0.001	*P* = 0.789
	Vegetable juice (after)	57.5 ± 34.8		54.9 ± 33.1		59.8 ± 36.3		*P* = 0.409

who consume less than five portions daily (51.8 ± 26.5, $P < 0.001$). This group was also more willing to consume ice cream after knowing the origin of the ingredients (78.1 ± 24.2) in comparison to those who consumed less than five portions daily (62.5 ± 28.6, $P = 0.004$). For participants in Ireland, differences were evident between the two groups (consumption of more than five portions of fruit and vegetables daily in comparison to those who consume less than five portions) in the case of soup before ($P = 0.009$) and after knowing the origin of the ingredients ($P = 0.039$).

The participants who discard their fruit and vegetable material in general waste disposal also scored lower willingness to consume soup ($P = 0.016$) and crisps ($P = 0.019$) after knowing about the origin of the ingredients versus the participants who either threw them in the compost bin or used them for the preparation of other products or use them as animal feed (see Supplementary Table S3).

Food choice motives

The importance of different food habits was explored focusing on what participants from both countries value in relation to the foods they consume on a typical day (see Supplementary Table S4). There were results showing statistical significance indicating differences in food habits between students in France and Ireland, on key food choice motives such as convenience ($P = 0.000$), affordability ($P = 0.010$), familiarity ($P = 0.021$) and meeting religious, cultural or traditional requirements ($P = 0.000$), which were more important for the participants in France. On the contrary, naturalness, as in foods without excessive preservatives or processing, was more important for students in Ireland ($P = 0.043$).

Pearson's correlation tested the effect of the food habits discussed previously on the willingness to consume the products presented to the participants (Figure 1) before and after information about the origin of the ingredients has been disclosed (see Supplementary Tables S5–S7 for details). According to the results for the pooled data, healthiness had a positive effect on the willingness to consume the soup before ($r = 0.199$, $P = 0.007$) and after disclosing the origin of the ingredients ($r = 0.277$, $P = 0.007$). There was also a positive relationship between the food being natural and willingness to consume the soup (before $r = 0.216$, $P = 0.003$, after $r = 0.145$, $P = 0.049$) and the vegetable crisps after ingredient information has been disclosed ($r = 0.151$, $P = 0.041$). However, visual appeal was negatively correlated with willingness to consume the vegetable crisps before ($r = −0.163$, $P = 0.027$) and after providing information on the ingredients used ($r = −0.159$, $P = 0.031$). The food choice motive "environmentally friendly" was positively correlated with willingness to consume the soup (before $r = 0.204$, $P = 0.005$ and after $r = 0.159$, $P = 0.031$) and positively correlated with willingness to consume the crisps when presented with the information on the origins of ingredients ($r = 0.182$, $P = 0.013$). The food choice motive "natural" was negatively correlated with willingness to consume all products apart from ice cream, highlighting again the importance of familiarity in the acceptance of novel food products. A negative correlation was also evident for the food choice motive "fits in with my religion/tradition or culture" specifically for the soup before providing ingredient information ($r = −0.312$, $P = 0.000$) and after ($r = −0.202$, $P = 0.006$), along with the vegetable crisps after ingredient information has been disclosed ($r = −0.157$, $P = 0.033$).

Food neophobia and disgust

Table 4 details a summary of Pearson's correlation results for the food neophobia and food disgust statements with willingness to consume the products presented to the participants. As anticipated, there was a positive correlation for the pooled data, for the soup ($r = 0.263$, $P = 0.000$), ice cream ($r = 0.227$, $P = 0.002$) and vegetable juice ($r = 0.184$, $P = 0.012$) after provision of information on the ingredients used, with the statement "I am constantly trying new and different foods". Those participants who do not trust new foods were significantly less likely to consume products after information about the use of upcycled ingredients has been disclosed (negative correlation). All products (before and after disclosure of ingredient information) were negatively correlated with the statements "if I don't know what is in a food, I won't try it" and "I'm afraid to eat things I have never tried before". This was to be expected based on the strong correlation for the food choice motive "it is important to me that the food I eat on a typical day is familiar". These results highlight the potential negative impact of food neophobia on acceptance of upcycled food products.

In terms of the statements related to food disgust, each of the four statements (detailed in Table 4) showed a significant positive correlation with willingness to consume the products presented to the participants before and after provision of ingredient information, apart from the ice cream before ingredient information was provided, which was non-significant. This confirms that participants who would consume overripe fruit and vegetables are more positively disposed to the consumption of upcycled food products made from peels or trimmings from fruit and vegetables. Supplementary Tables S8–S10 show more detailed information of the pooled data, and the data for the participants from France and Ireland.

Qualitative data – other factors affecting willingness to consume the food product

Open-ended questions were asked so that participants could justify their willingness to consume a product or not, after being provided with information on the origins of ingredients. This generated qualitative data which inform and help further explain the quantitative data presented previously. The frequencies (in parenthesis) of each theme (in the central figure) and subtheme (in the rectangular boxes) are shown in Figure 2.

The qualitative data displayed a major emphasis on sensory attributes, with the term "taste" included in over 100 open-ended responses. Participants were concerned that the product should taste good or similar to the normal version of the product; again, this is with reference to the products presented in Figure 1 (soup, ice cream, crisps and vegetable juice). This result explains the results collected on food habits as taste was one of the most important factors affecting the

Table 4: Summary of results for food neophobia and food disgust statements' correlations with willingness to consume the products presented to participants (Figure 1) before and after disclosing information about the origin of the ingredients (pooled data)

Product	Food neophobia				Food disgust			
	I am constantly trying new and different foods	I don't trust new foods	If I don't know what is in a food, I won't try it	I am afraid to eat things I have never tried before	I eat overripe fruit	I would eat an overripe cucumber that can already be bent	I would eat the brown-coloured avocado pulp	I would eat hard cheese from which mould had been cut off
Soup (before)	n.s.	n.s.	**(–)	**(–)	**(+)	**(+)	**(+)	**(+)
Soup (after)	**(+)	**(–)	**(–)	**(–)	**(+)	**(+)	**(+)	**(+)
Ice cream (before)	n.s.	n.s.	**(–)	n.s.	n.s.	n.s.	n.s.	**(+)
Ice cream (after)	**(+)	**(–)	**(–)	**(–)	**(+)	**(+)	**(+)	**(+)
Vegetable crisps (before)	n.s.	*(–)	*(–)	**(–)	**(+)	**(+)	**(+)	**(+)
Vegetable crisps (after)	n.s.	**(–)	**(–)	**(–)	**(+)	**(+)	**(+)	**(+)
Vegetable juice (before)	n.s.	**(–)	**(–)	**(–)	**(+)	**(+)	*(+)	**(+)
Vegetable juice (after)	*(+)	**(–)	**(–)	**(–)	**(+)	**(+)	**(+)	**(+)

(+) represents a positive correlation, (–) represents a negative correlation, n.s. represents non-significant.
**Correlation is significant at the 0.01 level (two-tailed).
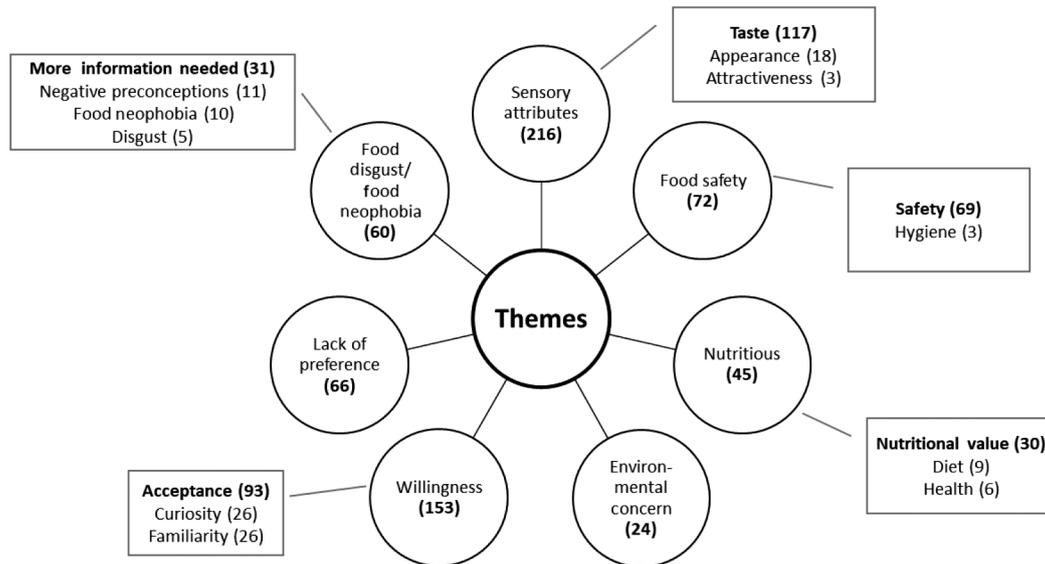*Correlation is significant at the 0.05 level (two-tailed).

Figure 2. Main themes and subthemes (with the frequencies) generated from the qualitative data collected in the open-ended questions justifying responses to willingness to consume the products presented in Figure 1.

choice of the food participants eat a typical day. However, surprisingly, taste (Supplementary Table S6) did not have an effect on the willingness of students in France or Ireland to consume any of the product presented.

Willingness and acceptance were another main theme and subtheme in the qualitative data, as expected due to the nature of the questions asked in the survey. It was however interesting to see "familiarity" and "curiosity" coming through as subthemes, showing a potential interest in upcycled foods. Food safety was another main theme, and potentially a concern as participants were wondering how the food would be produced and if using food considered "waste" would be a danger to health. According to the responses, there are more mentions of participants willing to consume upcycled foods than participants completely rejecting the idea or being disgusted by it. This agrees with the quantitative results as the means for the willingness to consume the products were often over 50 (in the 100-point line scale). Food neophobia was also referenced in the qualitative data, with participants expressing the need for more information before they accept upcycled products. Nutritional value and environmental concerns were also mentioned but to a lesser extent. There was also a cohort of participants who lacked any preference for the samples presented.

The qualitative results presented in Figure 2 and detailed above are from the pooled data. Figure 3 shows the percentage frequencies of the main themes associated with the students from France and Ireland, highlighting some differences between both groups.

The findings are quite similar between French and Irish participants for the theme food neophobia/disgust. However, there were more mentions of nutrition and food safety from participants from Ireland. Environmental concern, although not frequently mentioned overall (N = 24), was more frequently mentioned by participants from Ireland. Participants from Ireland also had a higher frequency in terms of a lack of preference, with some of these participants stating that "they preferred not to know the origin of the ingredients". Participants from France were marginally more concerned with food neophobia and food disgust in terms of willingness to consume upcycled products.

Figure 4 shows the key themes associated with acceptance or rejection of the potential upcycled products presented in this study. In this instance, food neophobia and food disgust represent potential rejection. There were more mentions of "willingness" for the soup than any other product. Ice cream had more mentions of potential rejection and vegetable juice had the highest frequency for lack of preference. The latter was also reflected in the analysis of variance (ANOVA) results detailed in the quantitative analysis. Vegetable crisps had more mentions for willingness but also a non-negligible amount of mention for lack of preference.

Based on the comments collected and the quotation shown below, soup is what participants are the most willing to eat as many responses stated that they assume they already buy and consume an upcycled version of it, or they cook themselves food with damaged ingredients.
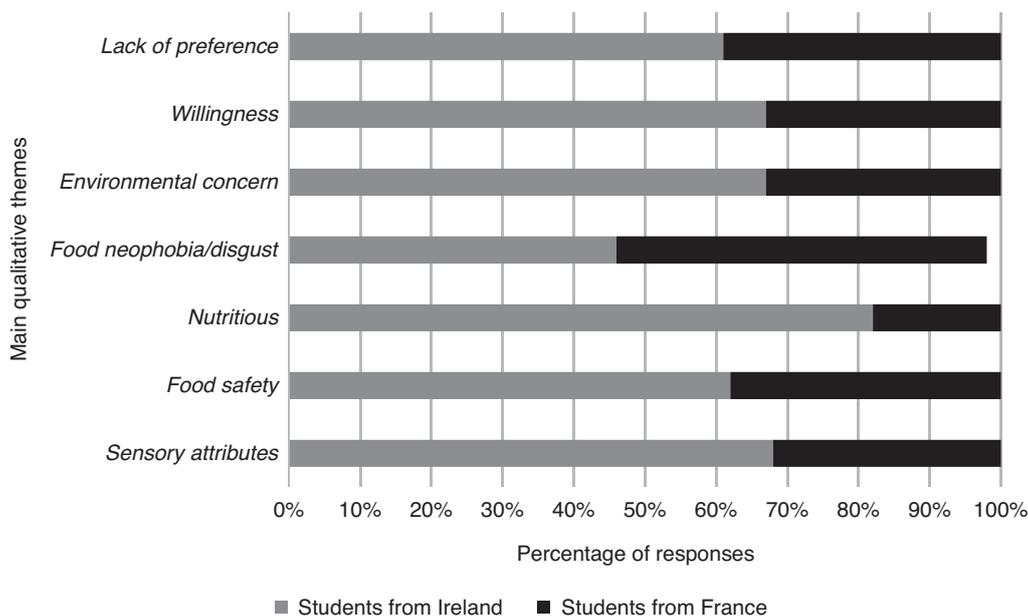
Figure 3. Comparison of the percentage of qualitative themes between the participants from France and from Ireland (calculated based on the number of responses for each theme listed).
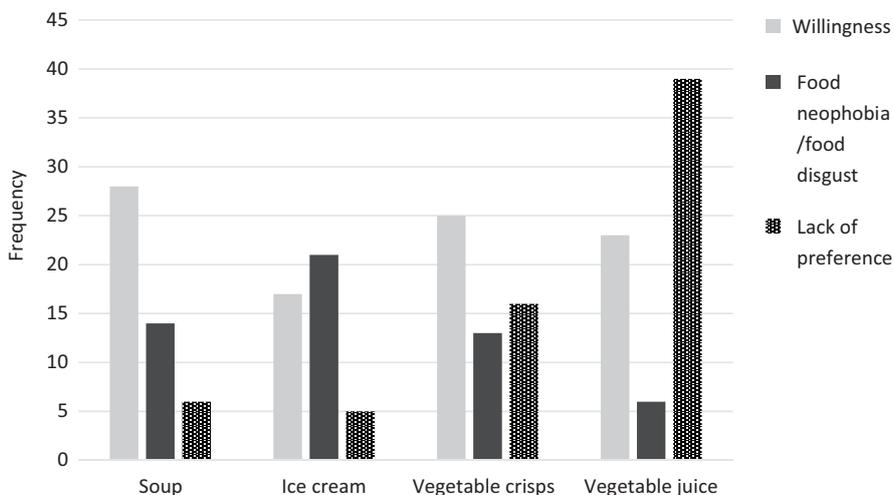

Figure 4. Comparison of frequencies of the themes associated with willingness, food neophobia/disgust (reasons for rejection) and lack of preference for each product.

"Nothing wrong with peels or trimmings – would eat peels off fresh veg why wouldn't you eat it in a soup."

However, food safety issues were also expressed.

"Not a chance, the peelings would have to have any residual pesticides, organic toxins, pathogens, etc. removed."

Ice cream is what participants were the least willing to consume. There was a lot of confusion in the answers about the process and how an ice cream could be made with upcycled ingredients. If there was more information on the flavour, the results might have been different. Vegetable juice was the product that participants had the least interest in, which was evident in the quantitative

Table 5: Summary of the main outcomes from this study, showing the factors explored and their significance related to either the product or the country of study

Factor explored	Significance	
	Product related	**Country related**
Product	✓	✓
Provision of information on upcycled ingredients	✓	✓
Sociodemographic characteristics (age, gender, level of education, field of study and place of residence)	Not tested	Not tested
Country of study	✓	✗
Diet and lifestyle		
Consumption of fruit/vegetables	✓	✗
Management of food waste	✓	✓
Food choice motives (health, taste, natural, affordability, convenience, familiar, environmentally friendly, fits in with culture/tradition/religion)	✓	✓
Food neophobia and disgust	✓	✓

Significance is indicated by a tick (✓), where ✓ denotes that there was an effect and ✗ indicates that there was no effect.

data and confirmed in the qualitative data, as the following quotation explains.

"Not a big fan of vegetable juice so wouldn't really eat it regardless of where it came from."

The qualitative data indicate that the product itself was a major factor in the acceptance of upcycled products. For example, the participants reacted in different ways to each product, with the qualitative data showing the justification for their responses towards unwillingness to consume a product not only connected to food neophobia but was also due to a lack of preference for a particular food. For example, the participant may have no interest in a vegetable crisp or vegetable juice, with or without upcycled ingredients.

It was evident from the combined qualitative and quantitative data summarised in Table 5 that acceptance of upcycled foods was impacted by the country of study of the consumer, while the product type was also another major contributing factor.

Discussion

This study explored the effect of provision of information on the use of upcycled ingredients, such as trimmings, peels or other by-products from the fruit and vegetable sector, on the willingness to consume a range of sweet and savoury foods. To explore this, willingness to consume these products before and after being informed of the origin of ingredients was measured. A selection of products was tested, since previous studies had suggested that the product type may be a contributing

factor in willingness to consume (Aschemann-Witzel & Peschel, 2019; Asioli & Grasso, 2021). It was also important to choose both healthy (vegetable soup and juice) and less healthy options (crisps and ice cream) within this selection to explore product-related factors in greater detail. This study also explored if willingness to consume the upcycled products presented was affected by sociodemographic characteristics (country of study: France versus Ireland), food habits (daily fruit and vegetable consumption and current management of food waste), food choice motives, food neophobia and food disgust.

Table 5 presents a summary of the quantitative findings highlighting that both the product and the country of study affected willingness to consume foods containing upcycled fruit and vegetable ingredients. The qualitative responses provided by the participants confirmed that the acceptance was product-dependent, since there was certain like or dislike for some of the products presented in the survey. For example, the vegetable juice was the least preferred option, while some of the participants questioned how ice cream could be upcycled. Moreover, the country of study of the participants was also seen to have an effect on the acceptance of certain products. For instance, the students studying in France were more willing to consume upcycled ice cream than students studying in Ireland, while the latter were more willing to consume crisps after being informed about the presence of upcycled ingredients. The results of this study agree with those of other cross-country studies on upcycled ingredients or upcycled food products, finding similarities in the level of acceptance and differences related to the product acceptability (Goodman-Smith *et al.*, 2021; Aschemann-Witzel *et al.*, 2023a,b; Grasso *et al.*, 2023). These findings show the

need to consider not only reduction in food waste, guaranteed sensory attributes and maintenance of food safety but also the culture and traditions of the country or region, which may lead to differences in product preferences. This approach may aid in maximising the acceptance of upcycled products.

Some sociodemographic factors, such as level of education, have been shown in a previous study by Cattaneo *et al.* (2019) to have an effect on the acceptance of upcycled food products. However, due to the small sample size, which was a limitation of this study, the effect of the sociodemographic characteristics such as gender, age and field of study was not studied. Other consumer-related factors that were investigated and are shown in Table 5 were diet and lifestyle, which were unsurprisingly associated with the daily consumption of fruit and vegetables and the management of food waste, as was the focus of this study. For participants who consume more than five portions of fruit and vegetables per day, there was a significant effect on willingness to consume the vegetable soup before and after the provision of information on the ingredients used. These results are to be expected as these participants are potentially used to consuming products like vegetable soup frequently and may have a bias towards the ingredients used. It was also anticipated, as revealed from the literature (Aschemann-Witzel & Peschel, 2019), that participants who recycle or reuse their waste are more likely to consume upcycled foods as they are potentially more environmentally conscious. This was evident in the results of the present study connected with the consumption of the vegetable soup before and after the provision of ingredient information and their management of food waste. This knowledge highlights the importance of clear information and education on novel upcycled foods to increase the level of acceptance by utilising circular eating as a means to help reach the food waste reduction targets (UNDP, 2015). Of course, this study showed that product-related factors such as addressing food safety and ensuring traceability might impact consumer acceptance, as was also confirmed by other studies (Moshtaghian *et al.*, 2021; Fox *et al.*, 2023a,b).

Food choice motives could explain the willingness to consume or not most of the products. For example, for the pooled data, environmental friendliness and naturalness were positively correlated with the willingness to consume soup before and soup and crisps after the provision of information. This can be explained by the fact that these products could be considered to contain natural ingredients and no preservatives, contrary to the ice cream for which many participants, as revealed in the qualitative data, were questioning the method of its production. Familiarity and tradition on the other hand were negatively correlated with the willingness to consume most products. Food choice motives differed between participants in each country, which was in agreement with previous findings (Coderoni & Perito, 2020). For example, convenience

and familiarity were more important for participants in France, while naturalness was more important for participants from Ireland. Naturalness was positively correlated with willingness of participants in Ireland to consume crisps and juice before being provided with information, and healthiness was positively correlated with the willingness to consume the same products after being informed about the origin of the ingredients. For participants in France, familiarity was positively correlated with the acceptance of ice cream after the provision of information. Although taste was very frequently cited in the qualitative results, it was not significantly correlated with willingness to consume any of the products presented in this study. It was also surprising that affordability was not significantly correlated with willingness to consume upcycled products, as this has been found in other studies (Cattaneo *et al.*, 2019; Coderoni & Perito, 2020; Asioli & Grasso, 2021). Given the fact that the demographic in this study was a student population, affordability would have been anticipated as a concern, particularly as students are among the poorest in the population. For example, in France, there are almost 20% of students living under the poverty line (Euronews, 2022) and over a third of Irish students face severe financial problems (The Irish Times, 2024).

The effect of food neophobia and disgust was evident in this study, showing both product- and country-related effects, particularly on the willingness to consume products after being informed about the upcycled ingredients used. This corroborates the findings of other researchers (Cattaneo *et al.*, 2019; Coderoni & Perito, 2020, 2021; Aschemann-Witzel & Stangherlin, 2021; Moshtaghian *et al.*, 2021). This result is potentially linked to the significant negative correlation of familiarity with the willingness to consume most of the products, showcasing a key area for further investigation.

The present study confirmed the findings of previous studies on the acceptance of upcycled ingredients, but it also highlighted through a mixed methods approach that in addition to consumer-related factors that impact willingness to consume upcycled food products, there is also an impact of product-related factors, which may warrant further exploration. There were however some limitations, such as the small sample size and the focus on student population. As both universities have a food science programme, there was a high number of responses from students who have a background in food who were more willing to complete a survey which is of interest to them. It is recommended for future studies with student cohorts to encourage recruitment across all disciplines to try to get a more diverse response. Due to the importance of creating awareness of circularity in global food systems through new upcycled foods, it is also suggested to expand this study to a broader section of the population in terms of age, gender and other sociodemographic characteristics such as educational background.

Conclusions

The aim of this study was to identify what factors influence the willingness of students studying in Ireland and France to consume upcycled foods, specifically four selected products representing sweet and savoury options. The findings showed that multiple factors may influence the willingness of the participants to consume these products. Although sociodemographic characteristics did not have a significant impact, possibly due to a relatively small number of participants, specific factors connected to fruit and vegetable consumption and management of food waste affected the willingness to consume the foods containing upcycled ingredients. This indicates that those participants with more knowledge and awareness on food waste may be more open to circular eating and increased education and awareness campaigns would be required to promote this sustainability measure to the wider population. Food neophobia is an area that may hinder this acceptance; however, increased transparency, traceability and guaranteed food safety should help to change mindsets.

The acknowledgement that there are differences in food habits between countries highlights the importance of considering the different cultures and traditions of the region when developing and marketing upcycled food products to create acceptance. Even though sensory attributes were not significantly correlated with willingness to consume, possibly because participants were not tasting the product, they were evident in the qualitative data. This emphasises the impact of the product selected for upcycling, in terms of consumer acceptance. Sensory perception and familiarity are key factors to garner for achieving success.

Overall, the differences between the students studying in France and Ireland were minimal, perhaps due to France and Ireland being in western Europe, or due to the limitations of this study such as the sample selected (students, mostly under 30 years of age from a food science course) or the small sample size. Repeating the study with a larger and more representative group of the population in the two countries or more countries in the EU would be recommended for future studies. This study highlights important factors to consider when marketing upcycled or upcycled foods, such as considering the nuances of the region it will be sold in and linking this information with their food choice motives and the product itself. Education and awareness campaigns are needed to gain the acceptance of the consumer. The younger generations are open to the idea of upcycled foods, especially as they are more aware of environmental issues. Emphasising the benefits for the environment and the climate, by producing and consuming upcycled foods, could be a good approach for marketing them to university students.

The findings from this study will benefit the food industry by creating awareness of the need to consider the specific "product" in terms of development of upcycled foods, depending on the region. It is important to consider the voice of the consumer when assessing acceptance of new upcycled foods. Future studies could build on this knowledge by incorporating co-creation with consumers and sensory evaluation of the developed foods. These steps will ensure acceptability and consumption of food products containing upcycled ingredients, consequently resulting in more sustainable consumption.

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Supplementary materials

Table S1: Effect of daily portions of fruit and vegetables on the willingness to consume the products presented to the participants before and after information about the origin of the ingredients has been disclosed (pooled data)

Portions of fruit and vegetables consumed per day	Willingness to consume the products with and without knowledge of the inclusion of waste-to-value ingredients having been provided (mean results ± s.d.)							
	Soup (before)	Soup (after)	Ice cream (before)	Ice cream (after)	Vegetable crisps (before)	Vegetable crisps (after)	Vegetable juice (before)	Vegetable juice (after)
Less than five portions per day (n = 95)	**71.6 ± 27.2**	**56.5 ± 29.1**	82.1 ± 24.3	**63.0 ± 31.4**	73.6 ± 30.9	67.0 ± 32.1	60.6 ± 33.8	53.3 ± 35.9
Five or more portions per day (n = 91)	**82.7 ± 22.9**	**73.1 ± 26.7**	82.7 ± 26.5	**71.6 ± 31.1**	77.9 ± 27.2	74.5 ± 29.8	64.2 ± 33.2	61.3 ± 33.8
Significance (independent t-test)	**P = 0.001**	**P < 0.001**		**P = 0.031**				

In bold are the values that differ significantly.

Table S2: Effect of daily portions of fruit and vegetables on the willingness to consume the products presented to the participants before and after information about the origin of the ingredients has been disclosed (comparing France and Ireland)

Country of study	Portions of fruit and vegetables consumed per day	Willingness to consume the products with and without knowledge of the inclusion of waste-to-value ingredients having been provided (mean results ± s.d.)								Statistical test
		Soup (before)	Soup (after)	Ice cream (before)	Ice cream (after)	Vegetable crisps (before)	Vegetable crisps (after)	Vegetable juice (before)	Vegetable juice (after)	
France	Less than five portions per day (n = 47)	**72.7 ± 25.3**	**51.8 ± 26.5**	85.8 ± 19.5	**62.5 ± 28.6**	73.6 ± 30.8	62.5 ± 32.5	63.5 ± 28.3	51.7 ± 31.9	
	Five or more portions per day (n = 52)	**81.4 ± 19.0**	**74.0 ± 21.6**	88.2 ± 21.6	**78.1 ± 24.2**	74.5 ± 29.1	70.0 ± 28.3	62.6 ± 34.2	58.9 ± 34.6	Independent t-test
	Significance	**P = 0.039**	**P < 0.001**		**P = 0.004**					
Ireland	Less than five portions per day (n = 48)	70.4 ± 29.3	61.3 ± 31.1	78.4 ± 28.0	63.6 ± 34.3	73.7 ± 31.4	71.6 ± 31.4	57.6 ± 33.8	54.9 ± 39.8	
	Five or more portions per day (n = 40)	83.7 ± 25.7	72.3 ± 30.2	78.7 ± 29.1	66.8 ± 34.9	80.4 ± 25.8	77.8 ± 30.7	57.6 ± 38.8	63.1 ± 33.4	
	Significance	**P = 0.009**	**P = 0.039**							

In bold are the values that differ significantly.

Table S3: Effects of management of fruit and vegetable waste on willingness to consume the products presented to the participants before and after information about the origin of the ingredients has been disclosed

What do you usually do with the fruit and vegetable waste at home?	Willingness to consume the products with and without knowledge of the inclusion of waste-to-value ingredients having been provided (mean results ± s.d.)							
	Soup (before)	Soup (after)	Ice cream (before)	Ice cream (after)	Vegetable crisps (before)	Vegetable crisps (after)	Vegetable juice (before)	Vegetable juice (after)
I throw them in the general waste bin (n = 73)	73.1 ± 24.4	**56.5 ± 28.9**	84.5 ± 29.0	64.9 ± 31.3	71.7 ± 29.8	**62.3 ± 30.3**	63.5 ± 29.4	57.1 ± 32.0
I throw them in the compost bin (n = 90)	79.9 ± 27.2	**69.2 ± 29.0**	79.8 ± 28.9	68.2 ± 33.4	78.1 ± 28.8	**75.2 ± 31.5**	60.1 ± 36.3	57.6 ± 36.5
I use waste as animal feed (n = 12)	80.8 ± 24.4	**82.0 ± 17.8**	85.3 ± 19.8	78.8 ± 17.9	89.6 ± 14.2	**86.9 ± 17.3**	63.8 ± 37.4	61.7 ± 36.5
I use waste in food preparation (n = 8)	82.0 ± 16.6	**67.0 ± 40.8**	81.0 ± 29.7	67.5 ± 42.7	75.1 ± 34.2	**78.3 ± 32.5**	68.4 ± 31.2	71.6 ± 29.9
Other (n = 4)	71.3 ± 20.1	**73.0 ± 20.7**	86.3 ± 10.0	76.7 ± 23.1	60.7 ± 33.0	**62.0 ± 33.4**	61.0 ± 52.8	61.7 ± 53.5
Significance (one-way ANOVA)		**P = 0.016**				**P = 0.019**		

In bold are the values that differ significantly.
ANOVA = analysis of variance.

Table S4: Food choice motives for pooled data and for students in France and Ireland and comparison of food choice motives between the two countries

Food choice motives – It is important to me that the food I eat on a typical day:	Importance (mean results ± s.d.)			
	Pooled data	France	Ireland	France vs. Ireland
Is healthy	3.79 ± 0.85	3.72 ± 0.80	3.89 ± 0.91	
Is a way of monitoring my mood (e.g., a good feeling or coping with stress)	2.71 ± 1.37	2.64 ± 1.07	2.80 ± 1.20	
Is convenient (in buying and preparing)	3.32 ± 1.03	**3.71 ± 0.97**	**3.00 ± 0.99**	*P* = 0.000
Is natural (does not contain too many preservatives or it has not undergone too much processing)	3.36 ± 1.06	**3.16 ± 0.94**	**3.48 ± 1.15**	*P* = 0.043
Is tasty	4.11 ± 0.76	4.13 ± 0.75	4.09 ± 0.78	
Looks appealing	3.11 ± 1.04	3.13 ± 0.99	3.14 ± 1.08	
Is affordable	3.63 ± 0.95	**3.80 ± 0.91**	**3.47 ± 0.93**	*P* = 0.010
Is familiar	2.83 ± 1.02	**3.01 ± 0.93**	**2.67 ± 1.08**	*P* = 0.021
Is environmentally friendly	3.22 ± 1.02	3.19 ± 0.94	3.26 ± 1.07	
Fits in with my religion/tradition/culture	1.84 ± 1.23	**2.31 ± 1.33**	**1.49 ± 1.02**	*P* = 0.000
	χ^2 (9) = 491.526, *P* = 0.000	χ^2 (9) = 222.800, *P* = 0.000	χ^2 (9) = 311.644, *P* = 0.000	

In bold are the values that differ significantly between the two countries.

Table S5: Pearson's correlation exploring the effect of food habits on willingness to consume the products presented to the participants before and after information about the origin of the ingredients has been disclosed (pooled data n = 185)

It is important to me that the food I eat on a typical day:	Willingness to consume the products with and without knowledge of the inclusion of waste-to-value ingredients having been provided (mean results ± s.d.)							
	Soup (before)	Soup (after)	Ice cream (before)	Ice cream (after)	Vegetable crisps (before)	Vegetable crisps (after)	Vegetable juice (before)	Vegetable juice (after)
Is healthy	**r = 0.199****	**r = 0.227****	r = 0.000	r = 0.109	r = 0.090	r = 0.093	r = 0.079	r = 0.131
Is a way of monitoring my mood (a good feeling or coping with stress)	r = −0.094	r = −0.043	r = −0.036	r = −0.025	r = −0.048	r = −0.010	r = 0.018	r = 0.016
Is convenient (to buy and prepare)	r = −0.134	r = −0.055	r = 0.125	r = 0.059	r = −0.048	r = −0.134	r = −0.113	r = 0.106
Is natural (does not contain too many preservatives/or is not over processed)	**r = 0.216****	**r = 0.145***	r = 0.002	r = 0.048	r = 0.132	**r = 0.151***	r = 0.064	r = 0.094
Is tasty	r = −102	r = −0.017	r = 0.050	r = −0.021	r = −0.059	r = −0.072	r = 0.003	r = −0.057
Looks appealing	r = −0.131	r = −0.088	r = −0.006	r = −0.068	**r = −0.163***	**r = −0.159***	r = 0.044	r = −0.010
Is affordable	r = 0.103	r = 0.082	r = 0.115	r = 0.072	r = 0.043	r = −0.007	r = 0.044	r = 0.025
Is familiar	**r = −0.250****	**r = −0.324****	r = −0.019	**r = −0.245****	**r = −0.312****	**r = −0.320****	**r = −0.221****	**r = −0.256****
Is environmentally friendly	**r = 0.204****	**r = 0.159***	r = −0.023	r = 0.048	r = 0.139	**r = 0.182***	r = 0.008	r = 0.112
Fits in with my religion/tradition or culture	**r = −0.312****	**r = −0.202****	r = −0.043	r = 0.032	**r = −0.157***	r = −0.141	r = 0.001	r = −0.054

In bold are significant correlations.
**Correlation is significant at the 0.01 level (two-tailed).
*Correlation is significant at the 0.05 level (two-tailed).

Table S6: Pearson's correlation exploring the effect of food habits on willingness to consume the products presented to the participants before and after information about the origin of the ingredients has been disclosed (participants in France $n = 86$)

It is important to me that the food I eat on a typical day:	Willingness to consume the products with and without knowledge of the inclusion of waste-to-value ingredients having been provided (mean results ± s.d.)							
	Soup (before)	Soup (after)	Ice cream (before)	Ice cream (after)	Vegetable crisps (before)	Vegetable crisps (after)	Vegetable juice (before)	Vegetable juice (after)
Is healthy	**r = 0.336****	r = 0.016	r = 0.109	r = −0.107	r = 0.107	r = 0.050	**r = 0.279****	r = 0.139
Is a way of monitoring my mood (a good feeling or coping with stress)	r = 0.086	r = 0.171	r = −0.025	r = 0.121	r = 0.077	r = −0.088	r = −0.034	r = −0.134
Is convenient (to buy and prepare)	r = 0.032	**r = 0.268***	**r = 0.215***	r = −0.016	r = 0.069	r = −0.018	**r = −0.223***	r = −0.126
Is natural (does not contain too much preservatives/or is not over processed)	**r = 0.434****	r = −0.040	r = 0.011	**r = −0.249***	**r = 0.218***	r = 0.052	**r = 0.254***	r = 0.153
Is tasty	r = 0.127	r = 0.051	r = 0.193	r = −0.077	r = 0.182	r = −0.018	r = −0.164	r = −0.166
Looks appealing	r = −0.015	**r = 0.353****	**r = 0.258***	r = 0.176	r = −0.172	r = −0.106	r = −0.115	r = −0.209
Is affordable	r = 0.080	**r = 0.226***	**r = 0.219***	r = −0.003	r = 0.106	r = −0.054	r = −0.160	r = −0.150
Is familiar	**r = −0.425***	**r = 0.440****	**r = 0.278****	**r = 0.516****	r = −0.082	**r =−0.240***	**r = −0.443****	r = −0.353
Is environmentally friendly	**r = 0.228***	r = 0.063	r = 0.111	r = −0.148	r = 0.193	r = −0.023	r = 0.195	r = 0.148
Fits in with my religion/tradition or culture	**r = 0.229***	r = 0.044	r = 0.122	r = −0.008	**r = 0.256***	r = 0.048	r = 0.044	r = −0.168

In bold are significant correlations.

**Correlation is significant at the 0.01 level (two-tailed).

*Correlation is significant at the 0.05 level (two-tailed).

Table S7: Pearson's correlation exploring the effect of food habits on willingness to consume the products presented to the participants before and after information about the origin of the ingredients has been disclosed (participants in Ireland *n* = 99)

It is important to me that the food I eat on a typical day:	Willingness to consume the products with and without knowledge of the inclusion of waste-to-value ingredients having been provided (mean results ± s.d.)							
	Soup (before)	Soup (after)	Ice cream (before)	Ice cream (after)	Vegetable crisps (before)	Vegetable crisps (after)	Vegetable juice (before)	Vegetable juice (after)
Is healthy	r = 0.172	r = −0.014	r = 0.004	r = −0.095	**r = 0.419****	**r = 0.246***	**r = 0.392****	**r = 0.248***
Is a way of monitoring my mood (a good feeling or coping with stress)	r = 0.142	r = 0.126	r = −0.037	**r = 0.239***	r = −0.025	r = 0.110	**r = 0.239***	r = 0.053
Is convenient (to buy and prepare)	r = 0.000	r = 0.067	r = −0.118	r = 0.127	**r = −0.205***	**r = −0.235***	r = 0.033	r = −0.099
Is natural (does not contain too many preservatives/or is not over processed)	r = 0.135	r = −0.102	r = −0.028	r = −0.149	**r = 0.261****	r = 0.158	**r = 0.319****	r = 0.125
Is tasty	r = 0.125	r = −0.062	r = −0.033	r = −0.065	r = −0.026	r = −0.122	r = −0.016	r = 0.088
Looks appealing	r = 0.166	**r = 0.204***	r = 0.092	**r = 0.212***	r = −0.129	r = −0.029	r = −0.026	r = −0.035
Is affordable	r = 0.021	r = 0.004	r = −0.076	r = 0.047	**r = 0.211***	r = 0.110	r = 0.093	r = 0.138
Is familiar	**r = −0.275****	**r = 0.328****	**r = 0.284****	**r = 0.489****	**r = −0.255***	**r = −0.274****	r = −0.196	**r = −0.365****
Is environmentally friendly	r = 0.097	r = 0.078	r = 0.130	r = 0.115	**r = 0.242***	r = 0.076	**r = 0.199***	r = 0.084
Fits in with my religion/tradition or culture	r = −0.098	**r = 0.314****	**r = 0.252***	**r = 0.295****	r = −0.177	r = −0.071	r = 0.026	**r = −0.207***

In bold are significant correlations.

**Correlation is significant at the 0.01 level (two-tailed).

*Correlation is significant at the 0.05 level (two-tailed).

Table S8: Pearson's correlation exploring the impact of food neophobia and food disgust on the willingness to consume the products presented to the participants before and after information about the origin of the ingredients has been disclosed (pooled results *n* = 185)

Please rate your agreement with the following statements	Willingness to consume the products with and without knowledge of the inclusion of waste-to-value ingredients having been provided (mean results ± s.d.)							
	Soup (before)	Soup (after)	Ice cream (before)	Ice cream (after)	Vegetable crisps (before)	Vegetable crisps (after)	Vegetable juice (before)	Vegetable juice (after)
I am constantly sampling new and different foods	r = 0.096	**r = 0.263****	r = 0.075	**r = 0.227****	r = 0.105	r = 0.058	r = 0.142	**r = 0.184***
I don't trust new foods	r = −0.074	**r = −0.218****	r = −0.040	**r = −0.237****	**r = −0.189***	**r = −0.199****	**r = −0.247****	**r = −0.267****
If I don't know what is in a food, I won't try it	**r = −0.241****	**r = −0.256****	**r = −0.193****	**r = −0.259****	**r = −0.174***	**r = −0.237****	**r = −0.250****	**r = −0.258****
I am afraid to eat things I have never had before	**r = −0.205****	**r = −0.347****	r = −0.075	**r = −0.300****	**r = −0.285****	**r = −0.281****	**r = −0.224****	**r = −0.253****
I eat overripe fruits	**r = 0.264****	**r = 0.428****	r = 0.105	**r = 0.312****	**r = 0.284****	**r = 0.317****	**r = 0.195****	**r = 0.305****
I would eat an overripe cucumber that can already be bent	**r = 0.274****	**r = 0.398****	r = 0.039	**r = 0.215****	**r = 0.248****	**r = 0.278****	**r = 0.164****	**r = 0.197****
I would eat brown-coloured avocado pulp	**r = 0.248****	**r = 0.381****	r = 0.036	**r = 0.236****	**r = 0.206****	**r = 0.219****	**r = 0.145***	**r = 0.233****
I would eat hard cheese from which mould has been cut off	**r = 0.368****	**r = 0.452****	**r = 0.271****	**r = 0.384****	**r = 0.299****	**r = 0.311****	**r = 0.235****	**r = 0.312****

In bold are significant correlations.
**Correlation is significant at the 0.01 level (two-tailed).
*Correlation is significant at the 0.05 level (two-tailed).

Table S9: Pearson's correlation exploring the impact of food neophobia and food disgust on the willingness to consume the products presented to the participants before and after information about the origin of the ingredients has been disclosed (participants in France *n* = 86)

Please rate your agreement with the following statements	Willingness to consume the products with and without knowledge of the inclusion of waste-to-value ingredients having been provided (mean results ± s.d.)							
	Soup (before)	Soup (after)	Ice cream (before)	Ice cream (after)	Vegetable crisps (before)	Vegetable crisps (after)	Vegetable juice (before)	Vegetable juice (after)
I am constantly sampling new and different foods	r = 1	**r = −0.343****	**r = −0.295****	**r = −0.463***	**r = 0.267***	**r = 0.312****	**r = 0.318****	r = 0.143
I don't trust new foods	**r = −0.343****	r = 1	r = 0.209	**r = 0.489****	**r = −0.226***	**r = −0.276***	**r = −0.228***	**r = −0.328****
If I don't know what is in a food I won't try it	**r = −0.295****	r = 0.209	r = 1	**r = 0.348****	r = −0.115	r = −0.063	r = −0.152	r = −0.084
I am afraid to eat things I have never had before	**r = −0.463****	**r = 0.489****	**r = 0.349****	r = 1	**r = −0.213***	r = −0.114	**r = −0.368****	**r = −0.366****
I eat overripe fruits	**r = 0.267***	**r = −0.226***	r = −0.115	**r = −0.213***	r = 1	**r = 0.467****	**r = 0.286****	**r = 0.386****
I would eat an overripe cucumber that can already be bent	**r = 0.312****	**r = −0.276***	r = −0.063	r = −0.114	**r = 0.467****	r = 1	**r = 0.516****	**r = 0.514****
I would eat brown-coloured avocado pulp	**r = 0.318****	**r = −0.228***	r = −0.152	**r = −0.368****	**r = 0.286****	**r = 0.516****	r = 1	**r = 0.486****
I would eat hard cheese from which mould has been cut off	r = 0.143	**r = −0.328****	r = −0.084	**r = −0.366****	**r = 0.386****	**r = 0.514****	**r = 0.486****	r = 1

In bold are significant correlations.
**Correlation is significant at the 0.01 level (two-tailed).
*Correlation is significant at the 0.05 level (two-tailed).

Table S10: Pearson's correlation exploring the impact of food neophobia and food disgust on the willingness to consume the products presented to the participants before and after information about the origin of the ingredients has been disclosed (Participants in Ireland *n* = 99)

Please rate your agreement with the following statements	Willingness to consume the products with and without knowledge of the inclusion of waste-to-value ingredients having been provided (mean results ± s.d.)							
	Soup (before)	Soup (after)	Ice cream (before)	Ice cream (after)	Vegetable crisps (before)	Vegetable crisps (after)	Vegetable juice (before)	Vegetable juice (after)
I am constantly sampling new and different foods	*r* = 1	**r = −0.305****	*r* = −0.132	**r = −0.299****	**r = 0.246***	**r = 0.205*** (**P = 0.042**)	**r = 0.434**** (**P = 0.000**)	*r* = 0.161
I don't trust new foods	**r = −0.305****	*r* = 1	**r = 0.311****	**r = 0.393****	*r* = −0.176	*r* = −0.170	*r* = −0.142	*r* = −0.159
If I don't know what is in a food, I won't try it	*r* = −0.132	**r = 0.311****	*r* = 1	**r = 0.399****	*r* = −0.110	*r* = −0.097	*r* = −0.115	**r = −0.293****
I am afraid to eat things I have never had before	**r = −0.299****	**r = 0.393****	**r = 0.339****	*r* = 1	*r* = −0.196	*r* = −0.140	**r = −0.245***	**r = −0.258****
I eat overripe fruits	**r = 0.246***	*r* = −0.176	*r* = −0.110	*r* = −0.196	*r* = 1	**r = 0.496****	**r = 0.435****	**r = 0.395****
I would eat an overripe cucumber that can already be bent	**r = 0.205***	*r* = −0.170	*r* = −0.097	*r* = −0.140	**r = 0.496****	*r* = 1	**r = 0.414****	**r = 0.355****
I would eat brown-coloured avocado pulp	**r = 0.434****	*r* = 0.142	*r* = −0.115	**r = −0.245***	**r = 0.434****	**r = 0.414****	*r* = 1	**r = 0.299****
I would eat hard cheese from which mould has been cut off	*r* = 0.162	*r* = −0.159	**r = −0.293****	**r = −0.258****	**r = 0.395****	**r = 0.355****	**r = 0.299****	*r* = 1

In bold are significant correlations.

**Correlation is significant at the 0.01 level (two-tailed).

*Correlation is significant at the 0.05 level (two-tailed).