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Influence of the involvement in food waste reduction on attitudes towards sustainable products containing seafood by-products

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ABSTRACT

This study sought to uncover how consumers' first associations and attitudes are influenced by involvement in food waste reduction and if this can be explained by consumer personality characteristics. This study investigated consumer attitudes towards products in three categories: (i) processed food, (ii) nutrition supplements and (iii) cosmetics. Products were presented to consumers in the UK as containing by-product ingredients (control) vs possessing either a health or an environmental benefit (experimental conditions). The findings indicate that consumers in general responded positively to the product when told that it contributes to food waste reduction or improved public health via use of the entire raw material, such as whole shrimp, crab or mussel, except in the case of cosmetics. Consumers with a high involvement in food waste reduction tended to be more sceptical in the control group than those who were given product definitions that included benefits. By applying hybrid methods, this study showed that consumers could respond positively towards products containing seafood by-products accompanied by information about environmental or health benefits. There is great potential for consumer education about empowered choices of food and nutrition supplements that are environmentally friendly at the ingredient level.

1. Introduction

Historically, in agriculture production the common strategy has been to increase production and correct environmental impacts later. Thus far, this strategy has failed (Tseng et al., 2013). However, current food production methods can enable sustainable growth that reaches the United Nations Sustainable Development Goal, SDG 12.3, for Responsible consumption and production with the ambition to "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses" (GA UN, 2015; Foley et al., 2011). Consumer research can contribute to reduction of food waste and sustainable development of the food sector (Aschemann-Witzel et al., 2019); yet, a political strategy addressing environmental challenges needs to be developed in collaboration with producers, consumers and other key stakeholders (Tukker et al., 2008). With the increasing global population, food production must rely on the total use of all resources, so minimising food surplus waste and ensuring sustainable use of resources is crucial at both the industrial and household levels (Papargyropoulou et al., 2014; Williams et al., 2012). The Food and Agriculture Organization (FAO, 2014) of the United Nations (UN) reported that in the food industry, the physical impacts of production were the greatest for meat, milk, grains and vegetables. The highest figures were related to greenhouse gas (GHG) emissions, waste quantity and land occupation, and lower values were attributed to such activities as water use.

However, increased awareness and a focus on greener and more viable production methods have also led to increased interest in sustainable use of marine resources and the amount of waste generated from fisheries and aquaculture, which is the most promising source of protein for the future (Guillen et al., 2018; Hurst et al., 2016; UN, 2019). About 60 million tons of biomass are being wasted or used for low-value products in global fisheries and aquaculture each year (Guillen et al., 2018; Stevens et al., 2018). Shellfish aquaculture discharge is estimated to be about 75% of the total biomass or close to 2 million tons (Morris et al., 2019; Stevens et al., 2018). Much of the marine biomass that is considered a by-product is used to make low-value products, and the rest is incinerated, discharged back into the ocean or sent to be used as landfill.

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This biomass does, however, contain fats, proteins, minerals and biopolymers that have further exploitation potential for use in products of value (Guillen et al., 2018; Vang et al., 2017). While much attention has been placed on creating value from the ingredients in underused resources, the commercialisation of new products for human consumption has been slow (Hurst et al., 2016; Vang et al., 2017). The reason for this lack of commercialisation is complex and comprises a mix of technological, manufacturing, regulatory and market challenges (Guillen et al., 2018; Hurst et al., 2016; Vang et al., 2017).

In this article we investigate the consumer perspective on the commercialisation of products made from marine side streams or waste to meet commercial challenges. This study uses the by-products or underutilised biomass from the shellfish industry as a case example and investigates consumer perception of total utilisation of shrimp, crab or mussels. The purpose of this study is to investigate and account for consumer associations and attitudes towards by-products of seafood in the product categories of (i) processed food, (ii) nutrition supplements and (iii) cosmetics. Products were presented to consumers as having either a health or an environmental benefit. In applying a hybrid approach to data analysis, this study seeks to uncover how consumers' associations and attitudes are affected by their own personal involvement with food waste reduction and to explain the results based on personality characteristics.

1.1. Theoretical background

Many factors can influence food choice (Köster, 2009). Firstly, traditions and the food consumers eat can influence impulsive choices (Mishra and Mishra, 2010; Yangui et al., 2016). Personality characteristics such as food neophobia, food involvement, neuroticism, conscientiousness, self-esteem, openness to experience, extraversion, agreeableness and many more, as well as values and motives can significantly influence food choice (Chen, 2007; Carrillo et al., 2012; Grebitus and Dumortier, 2016; Bazzani et al., 2017). For example, consumers that are more extroverted and open exhibit a greater need to learn and are therefore more positive about food traceability labels (Chang et al., 2013).

From a marketing point of view, a food product is the combination of an edible raw material and the surrounding information that influences expectations (Jaeger and MacFie, 2001). The probability that consumers will choose a food product increases when the information on the packaging is read and fits the product in the best possible way (van Ooijen et al., 2017). Consumers generally report a preference for environmentally friendly products and even report a willingness to pay more for them, as they expect such products to be better for their health and of higher quality (Forbes et al., 2009). When by-product ingredients are used in processed food, nutrition supplements and cosmetics, it could be argued that information about food waste reduction in the definition could lead to less positive attitudes than information about health, due to the use of the word "waste", especially when the ingredients are of seafood origin (Blichfeldt et al., 2015; Debucquet et al., 2012). Producers driven by their environmental values report not receiving a price premium for their efforts (Gabzdylova et al., 2009). Consumers may be reluctant to buy and consume products that they consider waste (Bhatt et al., 2017), and they may consider the products to be unsafe or be disgusted by the thought that the product may be suitable for the trash. However, consumers with positive self-perception could be more accepting of such products (Peschel and Aschemann-Witzel, 2020). Environmentally concerned producers and consumers may have an increased awareness of recycling their waste, but there is a strong indication that a larger effect on behaviour change may arise by a shift in focus from recycling to waste reduction, as observed in other non-food-product sectors (Boyle, 1999; Sadef et al., 2016). Consumer awareness and associated environmental behaviour is potentially affected by the perceived urgency to act towards protecting the environment (Brown and Stone, 2007). Very recent consumer studies indicate that consumer preferences towards waste-to-value food products, nutrition supplements and cosmetics may be leaning towards increased acceptance, starting as usual in the early adopter segment, assisted by the appropriate information (Coderoni et al., 2020; Grasso et al., 2020). The pricing of such products can be a challenge though, as the majority of consumers may not be willing to pay high prices for upcycled products, with only few gaining appreciation when properly informed (Peschel et al., 2019; Bhatt et al., 2020). When products that use waste by-products are presented in the market, they may also be considered novel, which may have a positive influence on consumer acceptance by providing relevant cues to help consumers evaluate these products (Aschemann-Witzel and Peschel, 2019; Bhatt, 2017). There are indications that consumers may be sceptical about the labelling of sustainable, organic food due to issues of trust towards such labelling systems (Vittersø and Tangeland, 2015). However, consumers respond positively to sustainability labels when labelling is clear and shows a balanced reduction of carbon emissions through the value chain, (Groening et al., 2015). This effect could vary between countries, product types, income, price sensitivity and the importance consumers place on climate change (Grebitus et al., 2016; Canavari and Coderoni, 2019). There are also strong indications in the literature that involvement with seafood and concerns about the marine environment may positively influence the perception of the benefits of seafood consumption (Jacobs et al., 2015), which suggests the relevance of including this involvement in the present study.

There is evidence from studies on the consumer household level that moral attitudes towards food waste and perceived behavioural control determine how they plan their shopping routines and avoid food waste (Stefan et al., 2013). Perceived behavioural control and moral attitudes towards food waste could influence consumers' reactions to reduced food waste by companies that use raw material from side-streams for financial benefit, potentially leading to scepticism towards products with a positive environmental impact (Bugg Holloway et al., 2009). The industry could openly communicate the possibilities of using by-products in the development of high-value products, which could also be used as sustainability marketing and labelling. Buying labelled products enables consumers to engage in making informed decisions and expressing their opinions about issues related to the ethics of food production (Brom, 2000). This facilitation of informed consumer choices through the provision of additional information about production methods and the reasoning behind them could lead to a positive effect on consumer empowerment and perceived consumer effectiveness. The latter would balance the potential effect of scepticism towards food production practices.

Previous research has shown that cleaner production can have a positive effect on consumers' openness to change when choosing food (Caracciolo et al., 2016). Due to consumers' low level of familiarity with the idea of by-product ingredients being used in processed food, nutrition supplements and, potentially, cosmetics, it was expected that domain-specific innovativeness (Bartels and Reinders, 2010; Goldsmith and Hofacker, 1991) and the need for uniqueness (Tian et al., 2001) would have positive effects on consumer attitudes towards product definitions. This was because consumers that express high innovativeness and the need for uniqueness could be early adopters of products and ingredients of which others may be sceptical. Identifying such an effect could provide a deeper understanding of the character of consumers'

reactions to such products. A factor that was also expected to influence consumer attitudes was social motivation (Fitzmaurice and Comegys, 2006; Moschis, 1981), which is often linked to the need for uniqueness and innovativeness. This factor could reveal the way the mechanism of attitudes towards these products and ingredients could be explained by the expression of innovativeness and the need for uniqueness as an effort to differentiate oneself in a social setting.

We expect that consumer attitudes towards processed food, nutrition supplements and cosmetics will vary, with consumer attitudes towards buying such products improving when consumers receive additional information about their benefits related to public health or reduced food waste. We suspect, however, that besides recent indications of low consumer egocentrism (McCarthy et al., 2020), a less positive effect of communicating this benefit will be that it leads to consumer associations of the ingredients with waste (food waste reduction). We expect that consumers involved with food waste reduction will differ in their attitudes towards buying these products and report more positive attitudes towards buying products that contain ingredients from sustainable production that utilises the whole shrimp, crab or mussel vs consumers with a lower involvement with food waste reduction. However, this effect may appear only in some combinations between product categories and benefit communication, which will be shown in the results as an interaction effect. This expected interaction would indicate how informed consumers respond, which is potentially different from the response of consumers with average involvement in food waste reduction. The following hypotheses were put forward:

A) Consumer attitudes towards products containing ingredients from the product categories (i) processed food, (ii) nutrition supplements and (iii) cosmetics will vary, with potentially more positive attitudes towards the processed food and nutrition supplement categories.
B) Consumer attitudes towards buying these products will be improved when information about public health or reduced food waste is provided to them.
C) Consumers involved with food waste reduction will report more positive attitudes towards buying these products than consumers with a lower involvement with food waste reduction.
D) Additional variables such as domain-specific innovativeness, social motivation, the need for uniqueness and innovativeness will positively influence consumer attitudes towards buying the products.

This paper continues with a description of the methods, results, discussion, implications and conclusions.

2. Methods

2.1. Study design

The experimental survey followed a 3 × 3 factorial between-group design, as reflected in Table 1. The first factor varied in terms of product category (referred to as *products* in this paper from now on), with three levels (i) processed food products (e.g. soup): (ii) nutrition supplements (e.g. protein supplement), and (iii) cosmetic products (e.g. cream). These product groups were selected because they reflect the use of the same type of ingredients in the market as in this study. The second factor varied in the definition of holistic products as (i) contributing to public health, (ii) contributing to food waste reduction and (iii) control (with reference neither to public health nor to food waste).

2.2. Survey instrument

There are numerous articles reporting the features that are important for choosing seafood products; these cover every relevant parameter, such as health, taste, price, sustainability, convenience and several more (Carlucci et al., 2015; Bronnmann and Hoffmann, 2018; Zander and Feucht, 2018; Brayden et al., 2018; Hinkes and Schulze-Ehlers, 2018; Alfnes et al., 2006; Hilger et al., 2019; Soley et al., 2019; Menozzi et al., 2020). There have also been several studies reporting findings about consumer behaviour related to food waste reduction and many relevant factors that influence it (e.g. Aschemann-Witzel et al., 2018; do Carmo Stangherlin et al., 2019; Gracia and Gómez, 2020; Petit et al., 2020; Di Muro et al., 2016; Choi et al., 2020). However, the novelty and evolving nature of the topic of food waste reduction makes it vulnerable to the potential to overlook important elements when establishing survey variables. A qualitative approach could provide a deep understanding of consumers' associations with the topic (e.g. Peschel and Aschemann-Witzel, 2020). In this study, a hybrid approach was chosen to support and complement the quantitative measures with Open-Ended Questions (OEQs). A hybrid methodology can uncover what consumers consider important when they are in the shop or when planning food purchases (Altintzoglou et al., 2018). Following the hybrid approach, it is expected that this study will uncover deeper insights into what consumers deem important during decision-making when exposed to the new concept of products made with seafood by-products.

The survey began with a definition of holistic seafood products, based on the group assignment of each participant, followed by a generic text that described the importance and procedure of filling in the survey. On a new page, participants answered the following question: "Holistic seafood products are *products* that contain ingredients from sustainable production that utilises the whole shrimp, crab or mussel to contribute to:" and could choose from the options (i) improving public health, (ii) food waste reduction and (iii) none of the above. This measurement ensured that all of the participants read the definition of holistic seafood products and could recall the specific definition each group received. To ensure continuous validity of the use of the term "holistic seafood products", the definition was repeated on each page of the survey as an information box.

The survey continued with an OEQ: "Imagine that you are at a shop/supermarket to buy *products* and see that they are holistic seafood products. Please write below the first three thoughts that come to your mind, using one or two words." This aimed to collect the first associations the participants made about holistic seafood products without any additional input from the survey (Altintzoglou et al., 2018).

To test hypotheses a and b, the survey then focused on participant attitudes towards buying holistic seafood products, rated on three different 7-point scales from 1 = *foolish*, *reasonable* or *negative* to 7 = *wise, unreasonable* or *positive*, respectively (Honkanen and Verplanken, 2004). A positive moral attitude scale was used to measure anticipated positive feelings using three items: "Buying holistic seafood products would feel like making a personal contribution to something better", "Buying holistic seafood products would feel like the morally right thing" and "Buying holistic seafood products would make me feel like a better person". These statements were measured on a 7-point scale from 1 = *strongly disagree*, 7 = *strongly agree* (Arvola et al., 2008).

Social consumption motivation related to buying brands was measured using the following questions: "Before I buy a product, it is important for me to know what others think about the different products or brands", "Before I buy a product, it is important for me to know what kinds of people buy these products or brands",

Table 1
Experimental design and definitions provided to the sample in each experimental cell.

	Holistic seafood product definition		
Product Category*	Public Health	Reduced Waste	Control
Processed food products	Holistic seafood products are processed food products (e.g. soup) that contain ingredients from a sustainable production process that utilises the whole shrimp, crab or mussel to contribute to improved public health.	Holistic seafood products are processed food products (e.g. soup) that contain ingredients from a sustainable production process that utilises the whole shrimp, crab or mussel to contribute to food waste reduction.	Holistic seafood products are processed food products (e.g. soup) that contain ingredients from a sustainable production process that utilises the whole shrimp, crab or mussel.
Nutrition supplements	Holistic seafood products are nutrition supplement products (e.g. protein) that contain ingredients from a sustainable production process that utilises the whole shrimp, crab or mussel to contribute to improved public health.	Holistic seafood products are nutrition supplement products (e.g. protein) that contain ingredients from a sustainable production process that utilises the whole shrimp, crab or mussel to contribute to food waste reduction.	Holistic seafood products are nutrition supplement products (e.g. protein) that contain ingredients from a sustainable production process that utilises the whole shrimp, crab or mussel.
Cosmetic products	Holistic seafood products are cosmetic products (e.g. cream) that contain ingredients from a sustainable production process that utilises the whole shrimp, crab or mussel to contribute to improved public health.	Holistic seafood products are cosmetic products (e.g. cream) that contain ingredients from a sustainable production process that utilises the whole shrimp, crab or mussel to contribute to food waste reduction.	Holistic seafood products are cosmetic products (e.g. cream) that contain ingredients from a sustainable production process that utilises the whole shrimp, crab or mussel.

* *products*.

"Before I buy a product, it is important for me to know what others think about people who use these products or brands" and "Before I buy a product, it is important for me to know what brands or products I should buy to make a good impression on others", rated on a 7-point scale from 1 = *strongly disagree* to 7 = *strongly agree*; a rating of 4 represented *neither agree nor disagree* (Fitzmaurice and Comegys, 2006; Moschis, 1981).

As described in the introduction, consumers can make informed choices to express themselves in terms of ethics and morals, which influences the sales of products with an environmental label. Subjective knowledge about holistic seafood products and food waste reduction were therefore measured using the items "I feel that I know a lot about holistic seafood products", "I feel that I know a lot about food waste reduction", "Compared to my friends, I know a lot about holistic seafood products", "Compared to my friends, I know a lot about food waste reduction", "Compared to experts, I know a lot about holistic seafood products" and "Compared to experts, I know a lot about food waste reduction", rated on a 7-point scale from 1 = *strongly disagree* to 7 = *strongly agree*; a rating of 4 represented *neither agree nor disagree* (Park et al., 1994). In addition, perceived consumer effectiveness adapted to food waste was measured using the items "There is not much that only one individual can do about food waste reduction", "The efforts of one person about food waste reduction are useless as long as other people don't act in a similar way" and "As one person has no effect on food waste reduction, there is no point in me attempting to do so", rated on a 7-point scale from 1 = *strongly disagree* to 7 = *strongly agree*; a rating of 4 represented *neither agree nor disagree* (adapted from Ellen et al., 1991; Straughan and Roberts, 1999).

To define consumer involvement with food waste and support the testing of hypothesis c, we used the items "Food waste reduction means a lot to me", "I care a lot about food waste reduction" and "Food waste reduction is very important to me", rated on a 7-point scale from 1 = *strongly disagree* to 7 = *strongly agree*; a rating of 4 represented *neither agree nor disagree* (Pieniak et al., 2008).

Following up on consumers' scepticism about the industry and labels, trust in governmental control and trust in producers of *products* was evaluated using six statements for each, based on the completed versions of the items "… can generally be trusted", "… is honest and truthful", "… is trustworthy", "… can be counted on to do what is right", "I have great confidence in …" and "… has high integrity", rated on a 7-point scale from 1 = *strongly disagree* to 7 = *strongly agree*; a rating of 4 represented *neither agree nor disagree* (Bugg Holloway et al., 2009).

To explain the potential effect on consumer attitudes towards new products and ingredients (hypothesis d), the participants also reported their domain-specific innovativeness (Bartels and Reinders, 2010; Goldsmith and Hofacker, 1991) and need for uniqueness regarding the products they buy (Tian et al., 2001), based on the items "I often try to avoid products that are bought by the general population", "The more common a product is among the general population, the less interested I am in buying it", "When products I like become extremely popular, I often lose interest in them", "Products that everybody buy, have less value to me", "I buy new types of food earlier than other people", "Normally I'm one of the first among my friends to buy new types of food", "Normally I'm one of the first among my friends to know about new types of food" and "I like to buy new and different types of food even if I have not tasted it before", rated on a 7-point scale from 1 = *strongly disagree* to 7 = *strongly agree*; a rating of 4 represented *neither agree nor disagree*.

Finally, we surveyed participants' age, gender, education level, occupation, weekly household income and household situation and the number of children in the household to complete a social and demographic description of the sample. The order of all item lists within questions was randomised for each participant.

2.3. Recruitment and fieldwork

Recruitment took place in May 2018, and the inclusion criterion was to have used the assigned product category at least once in the last month. The exclusion criterion was having any allergies related to seafood. A balanced sample, representative of the sophisticated market in the United Kingdom was urged, with flexibility on expected differences per product category. Recruitment and online data collection were performed by a professional recruitment company, thus ensuring data quality. This study was approved by NSD, the Norwegian Centre for Research Data.

2.4. Data collection and framework of analysis

Only the first out of the three OEQ reports that represent the first top-of-mind associations were coded into categories and counted. After this count, they were organised in a contingency table based on the study's 3 × 3 factorial design and reported as observed comparisons in the results. The category "waste reduction"—which included at least five associations per experimental

cell—was chosen as the threshold of relevant categories, with the lowest total count of 13 across experimental cells. Correspondence analysis was the multivariate test used for data analysis. Correspondence analysis is the most appropriate type of analysis for categorical data and often used in the analysis of OEQ data (Greenacre, 1984; Olsen et al., 2015). The three attitudinal variables (foolish−wise, reasonable−unreasonable and negative−positive) were compiled into one, following reversal of reasonable−unreasonable. The final construct was considered reliable and was reported as attitudes, based on a Cronbach's alpha of 0.825.

The main effects and interactions of the independent variables product category and definition were tested using one-way ANOVA and LSD post hoc tests. General linear model (GLM) analysis was used to examine the main effects and interactions between product category and definition, with the addition of low vs high involvement with food waste reduction groups. These groups were defined using the median = 5 of the involvement with food waste construct, confirmed by a Cronbach's alpha of 0.967 and had a 42%/58% membership, which led to a similarly balanced membership in the experimental conditions. Positive moral attitude, social motivation based on brands, subjective knowledge, perceived consumer effectiveness, trust in governmental control, trust in producers, domain-specific innovativeness and need for uniqueness (Cronbach's alpha: 0.950, 0.946, 0.919, 0.846, 0.969, 0.967, 0.915 and 0.928, respectively) were added to the GLM model as covariates.

Data analysis was performed using syntax in IBM SPSS statistics 26 and Past3.

3. Results

3.1. Sample description

The resulting sample consisted of 1867 participants, representative of the British population, distributed in balanced experimental groups. The social and demographic characteristics of the sample are described in Table 2.

3.2. Open-ended questions

Table 3 illustrates the results of asking participants to report what comes to mind when they imagine that they are at a shop/supermarket to buy *products* and see that they are holistic seafood products. The table shows that the association reported the most was "healthy", followed by "don't know/no answer", which is common for OEQ data. The next useable association was "sustainable", followed by "smelly", "natural", "interesting", "yuck", "weird", "different", "fishy", "good for the environment", "strange", "disgusting", "overpriced expensive", "unusual", "new", "seafood", "what is holistic", "what is this", "good", "surprising", "nutritious" and "waste reduction". As an overall impression, it is a noticeable mix of positive and negative associations on various levels. Many of the associations reported by the participants were not included in the relevant literature that could act as a source of survey items. Consumer associations clearly indicate that the participants were not familiar with this type of information, although they had been recruited as users of the relevant *products*. There are obvious differences between experimental cells, in terms of *products* and definitions, which will be presented in the next paragraph.

A closer examination of the results in Table 3 highlights the potential relationships between the reported factors presented in Fig. 1. The analysis shown explains 38.8% of the variance on the first axis and 21.4% of the variance on the second. There was a tendency for the waste reduction definition to lead to associations related to the environment and waste reduction that matched processed food and nutrition supplements. This message fitted the latter two product types in a way that led to more positivity, in terms of associations such as "nutritious", "good" and "sustainable". Nutrition supplements and processed food tended to be associated with healthiness when the public health definition was used.

In general, the control definitions of nutrition supplements and processed food are located in the middle of the plot and shift towards the reduced waste and public health areas, respectively, when combined with their respective definitions. Looking at the cosmetic products category, the findings indicate that the control definition leads to negative associations linked to disgust. Although it shifts slightly towards the centre of the plot when the public health definition is used, it remains within the area of negative associations. The reduced waste definition seems to have a stronger effect on associations related to cosmetic products, shifting it higher and closer to the area of environmental concern and waste reduction. These results partly confirm the first two hypotheses by showing clear differences in the free associations consumers link to the various product categories with and without additional information.

3.3. Attitudes

The GLM results for the composite attitude towards buying the *products* are presented in Fig. 2. There was a significant main effect of product category, confirming the first hypothesis ($F_{(2,1862)} = 33.84$; $p < 0.001$; Partial eta$^2 = 0.036$). Attitude towards nutrition supplements (mean [M]: 4.77; standard deviation [SD]: 1.36) was significantly more positive ($p = 0.001$) than attitude towards processed food (M: 4.53; SD: 1.22), which in turn was significantly more positive ($p < 0.001$) than for cosmetics (M: 4.18; SD: 1.40). The definition of holistic products also had a significant main effect on attitude, partially confirming the second hypothesis ($F_{(2,1862)} = 78.98$, $p < 0.001$; partial eta$^2 = 0.077$). However, the definition referring to the reduction of food waste (M: 4.82; SD: 1.27) did not lead to a significantly more positive attitude ($p = 0.169$) than the definition referring to public health (M: 4.72; SD: 1.30), but both led to a more positive attitude ($p < 0.001$ and $p < 0.001$, respectively) than the control definition (M: 4.00; SD: 1.35). A significant interaction effect ($F_{(4,1858)} = 3.05$, $p = 0.016$; partial eta$^2 = 0.007$) was also observed between the levels of the experimental factors, indicating a weaker effect of the public health and food waste reduction definitions on processed food.

The results for attitudes towards the *products* by involvement with food waste reduction groups are presented in Figs. 3–5. The GLM model resulted in an adjusted R^2 of 0.42. The results partially confirm the third hypothesis. There was a significant main effect of product category ($F_{(2,1841)} = 24.09$; $p < 0.001$; partial eta$^2 = 0.026$). The product definitions also had a significant main effect on attitude ($F_{(2,1841)} = 22.84$, $p < 0.001$; partial eta$^2 = 0.024$). Although the main effect of involvement with food waste reduction was not significant ($F_{(1,1841)} = 0.78$, $p = 0.377$; Partial eta$^2 = 0$), a significant interaction effect ($F_{(2,1841)} = 3.40$, $p = 0.034$; partial eta$^2 = 0.004$) was also observed between definition and involvement with food waste reduction, indicating lower attitude scores for the high-involvement groups in the control definition condition for all *product* categories.

Three of the covariates included in the GLM had a positive effect in the model: positive moral attitude ($F_{(1,1841)} = 641.95$, $p < 0.001$; partial eta$^2 = 0.259$; $B = 0.47$), trust in producers ($F_{(1,1841)} = 10.76$, $p = 0.001$; partial eta$^2 = 0.006$; $B = 0.12$) and domain-specific innovativeness ($F_{(1,1841)} = 11.63$, $p = 0.001$; partial eta$^2 = 0.006$; $B = 0.07$). Two covariates had a negative effect: social motivation ($F_{(1,1841)} = 16.21$, $p < 0.001$; partial eta$^2 = 0.009$; $B = -0.08$) and need for uniqueness ($F_{(1,1841)} = 14.27$, $p < 0.001$; partial eta$^2 = 0.008$; $B = -0.08$). Finally, three covariates had no significant

Table 2
Social and demographic characteristics of the study participants organised by definition and product type.

	Holistic seafood products by definition											
		Processed food			Nutrition supplements			Cosmetics				
		PH	RW	C	PH	RW	C	PH	RW	C	Total	Sig*
	N	200	200	200	200	200	236	200	200	231	1867	0.692
Characteristic	**Category**											
Age	18–29 years	25	23	17	34	33	48	33	32	41	286	0.338
	30–39 years	39	44	38	47	67	59	45	48	45	432	0.836
	40–49 years	53	48	47	49	45	61	45	48	43	439	0.556
	50–59 years	47	55	56	50	31	37	50	48	60	434	0.199
	60-65+ years	36	30	42	20	24	31	27	24	42	276	0.780
Gender	Female	88	101	85	102	116	143	111	100	134	980	0.103
	Male	112	99	115	98	84	93	89	100	97	887	0.686
Education level	Secondary	58	65	53	23	37	37	32	56	55	416	0.208
	Sixth form/college	65	57	79	72	61	90	73	52	85	634	0.934
	BSc	60	60	52	67	67	76	63	65	64	574	0.821
	MSc	11	17	10	29	23	25	21	21	23	180	0.559
	PhD	6	1	6	9	12	8	11	6	4	63	0.140
Occupation	Manager/senior officials	18	22	16	33	42	32	32	33	25	253	0.971
	Professional occupations	24	29	39	34	24	53	34	30	32	299	0.176
	Associate professional and technical occupations	12	14	11	15	15	15	10	12	16	120	0.830
	Administrative and secretarial occupations	31	40	40	37	35	49	21	37	49	339	0.283
	Skilled trades	30	28	30	27	36	31	28	29	37	276	0.737
	Currently unable to work	21	21	18	14	15	15	29	17	17	167	0.592
	Currently unemployed	48	28	31	29	29	19	26	31	41	282	0.025
	Did not wish to disclose	16	18	15	11	4	22	20	11	14	131	0.013
Weekly household income	<£149	19	18	20	15	7	16	8	8	12	123	0.641
	£150-249	30	20	21	12	11	15	23	17	17	166	0.798
	£250-299	12	21	16	18	16	20	15	18	17	153	0.719
	£300-399	12	15	21	14	16	21	21	19	24	163	0.919
	£400-499	17	21	27	29	21	30	26	14	26	211	0.474
	£500-649	25	22	21	28	36	29	28	29	27	245	0.905
	£650-799	19	13	12	14	19	17	16	17	16	143	0.646
	£800-999	9	6	7	15	13	16	11	13	13	103	0.921
	£1000-1299	6	18	8	14	14	17	14	16	23	130	0.124
	>£1300	12	8	13	18	12	17	8	17	13	118	0.237
	Did not wish to disclose	39	38	34	23	35	38	30	32	43	312	0.329
Household situation	Married	78	82	79	94	94	89	89	86	109	800	0.568
	Living with someone	37	34	33	26	34	51	32	36	38	321	0.204
	Single	66	63	69	62	55	79	64	57	61	576	0.688
	Divorced	16	14	16	16	12	14	13	15	20	136	0.838
	Widow/er	3	7	3	2	5	3	2	6	3	34	0.995

PH: Public health.
RW: Reduced waste.
C: Control.
* p-value based on $\chi 2$ tests across experimental cells.

effect: subjective knowledge ($F_{(1,1841)} = 0.12$, $p = 0.727$), perceived consumer effectiveness ($F_{(1,1841)} = 2.18$, $p = 0.140$) and trust in governmental control ($F_{(1,1841)} = 0.56$, $p = 0.453$). These results partly confirm the fourth and last hypothesis.

4. Discussion

The first two hypotheses were that (a) consumer attitudes towards the product categories (i) processed food, (ii) nutrition supplements and (iii) cosmetics will vary and (b) consumer attitudes towards buying the products will be improved when information about public health or reduced food waste is provided. The results of this study, based on OEQs and attitudes, indicate a clear consumer preference for the two product definitions that included a benefit over the definition without a benefit from products that use ingredients from a sustainable production process that utilises the whole shrimp, crab or mussel, partly confirming the first two hypotheses. The findings of this study support the current literature on consumer perceptions, experiences and attitudes towards healthy and environmentally friendly food behaviours, which indicate a strong tendency towards the appreciation of health benefits from food, especially less processed food (Hoek et al., 2017; Peschel et al., 2019). The results of this study also indicate a strong positive response in terms of attitudes towards food waste reduction, as a benefit for the use of the whole raw material from cleaner seafood production. This may be an indication of intended behaviour, but one would expect it to materialise in the real market with the support of economic incentives that would make consumers feel rewarded (Borrello et al., 2017). Follow-up studies could expand on these results by requesting that consumers make a real purchase to confirm that their reported attitudes and potential intentions can truly predict their actual behaviour in the real market.

It was suspected that the food waste reduction claim in the

Table 3
Contingency table of factors reported by consumers in relation to holistic seafood products* based on frequency.

Holistic seafood products by definition										
	Processed food			Nutrition supplements			Cosmetics			
Coded Category	**PH**	**RW**	**C**	**PH**	**RW**	**C**	**PH**	**RW**	**C**	**Total**
Total	78	65	55	97	87	92	100	92	82	748
Healthy	34	8	6	26	15	12	13	2	1	117
Don't know/No answer	7	14	12	14	12	17	15	9	8	108
Sustainable	7	9	8	6	4	8	2	7	5	56
Smelly	0	0	1	2	2	7	12	12	9	45
Natural	2	0	1	6	6	3	8	8	6	40
Interesting	3	5	3	12	3	3	2	4	3	38
Yuck	3	1	6	1	0	3	5	3	7	29
Weird	1	1	1	1	2	3	8	5	7	29
Different	3	0	1	2	6	5	6	5	1	29
Fishy	1	2	3	2	4	5	3	7	2	29
Good for the environment	0	5	2	1	10	2	1	2	0	23
Strange	1	0	1	0	0	2	7	6	4	21
Disgusting	1	0	0	1	1	3	2	1	11	20
Overpriced expensive	5	2	2	2	0	1	2	2	4	20
Unusual	0	0	3	1	2	2	5	2	3	18
New	0	3	0	3	3	2	0	2	5	18
Seafood	2	1	0	3	2	6	1	3	0	18
What is holistic	2	1	2	2	3	2	3	1	1	17
What is this	4	1	2	3	1	0	0	2	3	16
Good	1	5	0	3	2	3	1	1	0	16
Surprising	1	0	0	2	3	1	2	3	2	14
Nutritious	0	2	0	4	3	2	1	2	0	14
Waste reduction	0	5	1	0	3	0	1	3	0	13

*Evoked situation of being at a shop/supermarket to buy *products* and seeing that they are holistic seafood products; PH: Public health, RW: Reduced waste, C: Control.

definition could lead to less positive attitudes than the public health condition due to the use of the word "waste" and the particular origin of the ingredients (Blichfeldt et al., 2015; Bhatt et al., 2017). However, as the findings of this study indicate, consumers consider food waste reduction so positively that the attitude towards the product was equally positive for both public health and food waste conditions. This result is further supported by recent studies that indicate an increasing acceptance for waste-to-value products, with few early adopter consumers willing to even pay more for them (Coderoni et al., 2020; Grasso et al., 2020; Peschel et al., 2019) and studies that show low consumer egocentrism (McCarthy et al., 2020). The OEQ part of this study supported this finding by indicating how consumers associate food waste reduction with environmental and sustainability issues that go hand in hand with cleaner food production.

The product category of nutrition supplements had more positive consumer attitudes than processed food, followed by cosmetic products, which were rated with the least positive attitudes. The use of the term "ingredients" in the definition may have partly alienated consumers from food products and towards nutraceutical concepts and nutrition supplements. This could be due to a higher acceptance of by-products from plants in their natural form, combined with a higher degree of familiarity with ingredient-based nutrition supplements available in the market (Nitzko, S. and Spiller, A., 2019; Borgogno et al., 2015). However, this potential familiarity effect was not observed in the case of cosmetics, as one would expect, because of the abundance of products including, for example, collagen (Pal and Suresh, 2016). One explanation for the relatively negative reaction towards cosmetic products and, to a lesser extent, processed foods, could be the sourcing of the ingredients from crustaceans, which have potentially triggering associations with odours that could cause disgust (Debucquet et al., 2012). An additional explanation for this result is the potentially weak association consumers draw between cosmetic products and public health. One might expect that motives other than public health are more important for cosmetics choices. The latter was also indicated by fewer words reported in the OEQ part of this study.

The third hypothesis was that consumers involved with food waste reduction would differ in their attitudes towards buying these products than consumers with a lower involvement with food waste reduction. The results of this study showed that high involvement with food waste led to less positive attitude scores in the control condition, despite the expected effect of perceived urgency to act towards protecting the environment (Brown and Stone, 2007). This indicated that consumers with higher familiarity and exposure to the issue of food waste reduction were more sceptical of the control definition, compared with similar consumers who received a definition with the purpose of this production method added to it. One possible explanation for this interaction effect may have been due to the results related to the fourth hypothesis, that is, additional variables such as domain-specific innovativeness, social motivation, the need for uniqueness and innovativeness would influence consumer attitudes towards buying the products. The positive effect of the covariates positive moral attitude, trust in producers and domain-specific innovativeness could support this explanation in terms of how consumers approach this relatively new topic. Innovative consumers who are positive and who trust producers would be less sceptical of such definitions, especially when they are provided with relevant cues to help them evaluate these products (Aschemann-Witzel and Peschel, 2019; Bhatt, 2017). However, those with a high social motivation or a high need for uniqueness are more likely to react to such products less positively. According to the literature, it was expected that these complex decision-making processes would be influenced by subjective knowledge, perceived consumer effectiveness and trust in governmental control and labelling systems (Vittersø and Tangeland, 2015; Moorman et al., 2004). The findings of this study indicated, however, that this was not the case, which could be an indication of the irrelevance of using these variables in studies such as the one reported here. Alternatively, this result may be an indication of other challenging

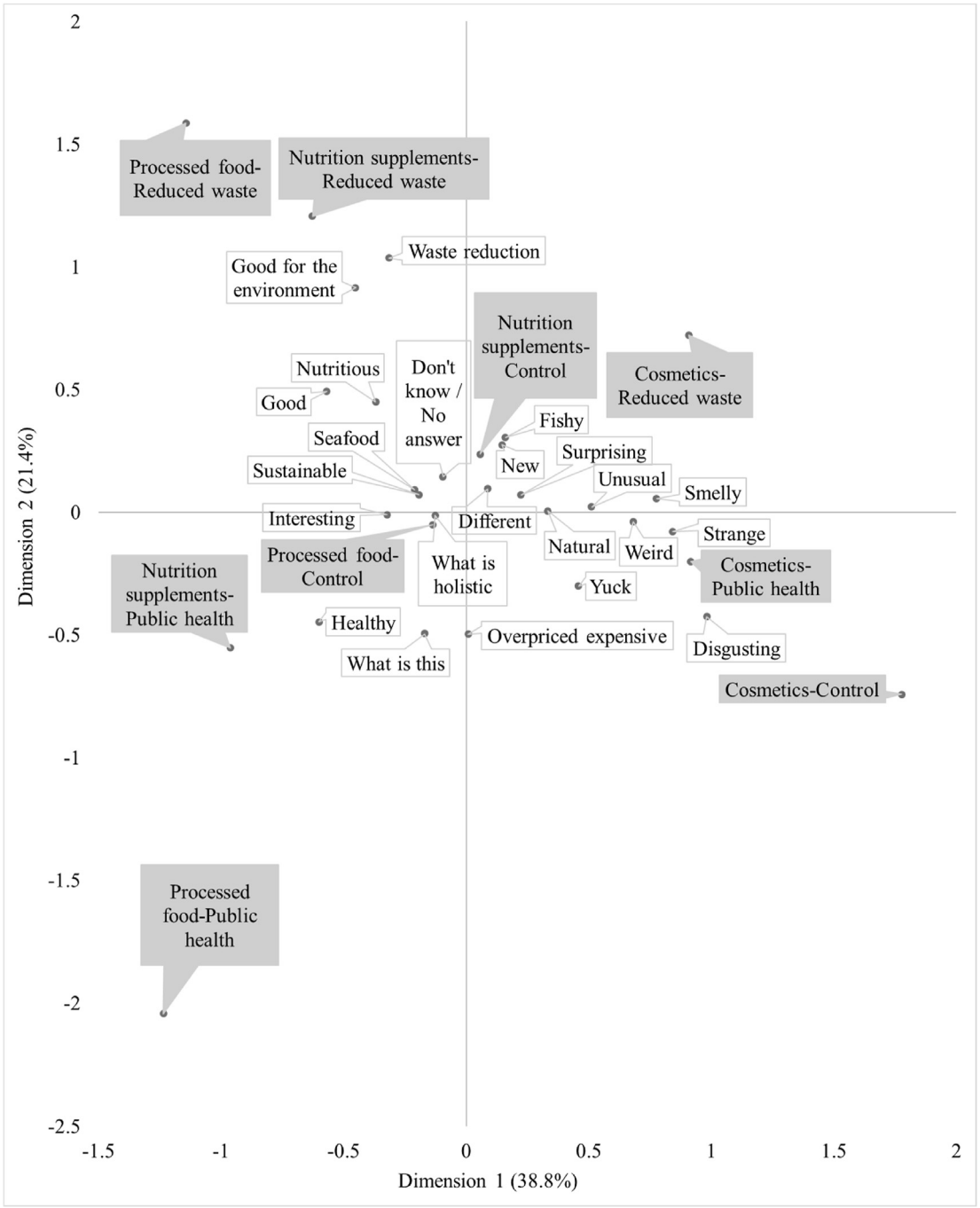

Fig. 1. Correspondence analysis of the frequency of factors reported by consumers in relation to buying holistic seafood products at a shop/supermarket (evoked situation).

elements that are out of our control due to the nature of the study. For example, consumers may believe that food waste is worse at home and may not be informed about the high potential for improvement towards a cleaner food production process that generates less waste (Neff et al., 2015).

The OEQ approach used in this study was based on the first of three OEQ reports that were used in the analysis, representing participants' top-of-mind associations. It was assumed that the participants reported as best they could what they thought about first and that the second OEQ report was less important and potentially a result of more analytical thinking. The third report was not completed by many participants and, based on previous research, it was considered the limit which consumers reached when reporting OEQs (Altintzoglou et al., 2018). It could be argued that asking for only one OEQ report would give the same outcome, that is, one report which can be used in the analysis. However, the risk of pushing participants towards more analytical decisions was considered when selecting participant reports for representative responses. It was thus decided that only the first would be used, as it would indicate appropriate data that reached confirmation by the more conventional attitudinal measurements.

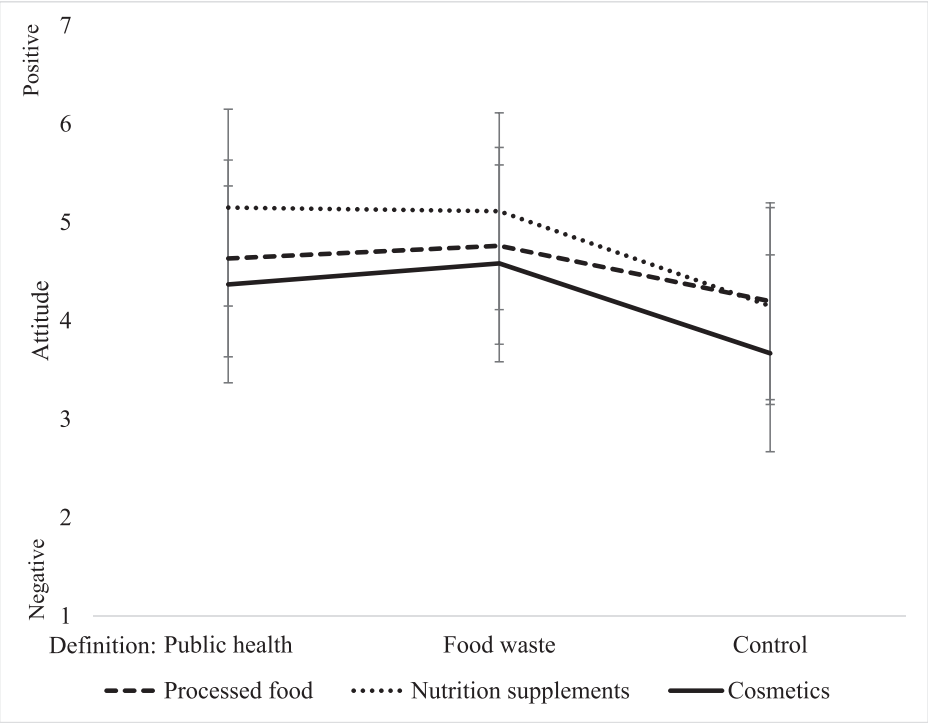

Fig. 2. Mean and standard deviations of attitudes towards holistic *products*.

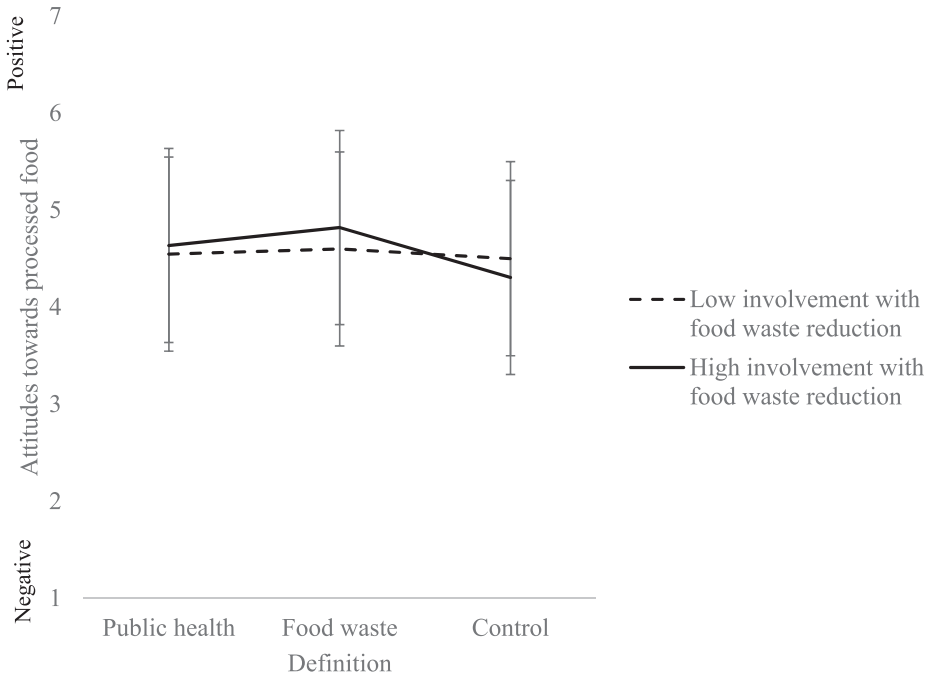

Fig. 3. Mean and standard deviations of attitudes towards processed food products by involvement with food waste reduction groups.

4.1. Study limitations

Referring to whole shrimp, crab or mussel in the definitions used in this study may have led consumers to consider the content of the shells commonly consumed. The definition used in this study may not have been concrete enough to trigger strong associations with the shells as the source of ingredients. Such a clear differentiation could have led to stronger results than those presented in this paper. Food waste reduction and improvement of public health are terms that are direct and familiar. This familiarity with the terms may have been a source of the effects presented in this study, particularly when it comes to seafood and the preservation of resources from the marine environment (Jacobs et al., 2015). Furthermore, the term "holistic" used in the product

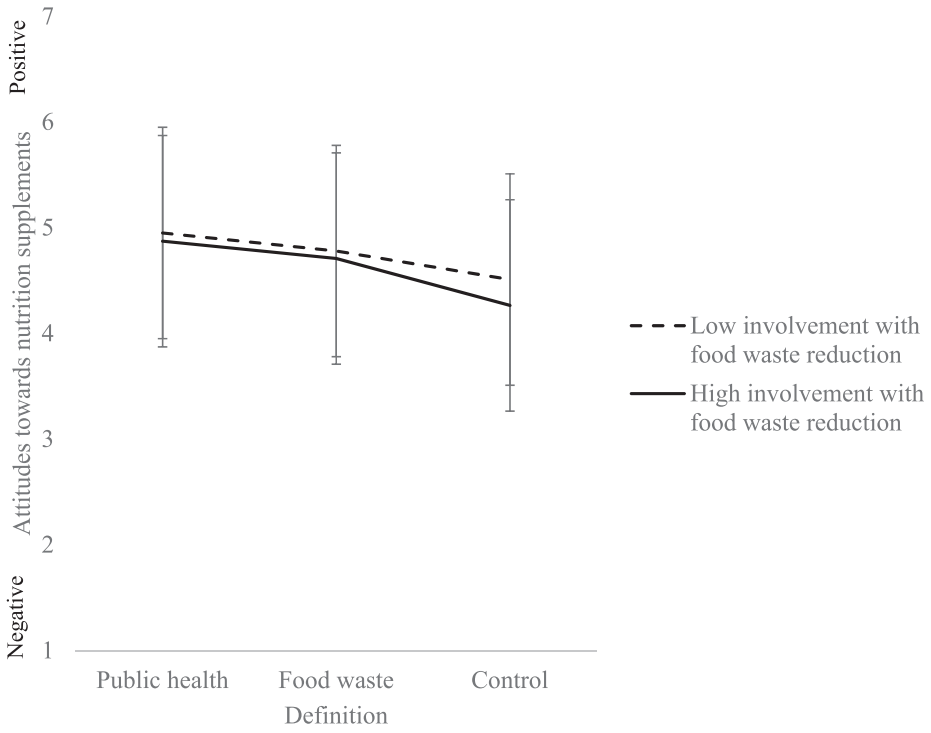

Fig. 4. Mean and standard deviations of attitudes towards nutrition supplements by involvement with food waste reduction groups.

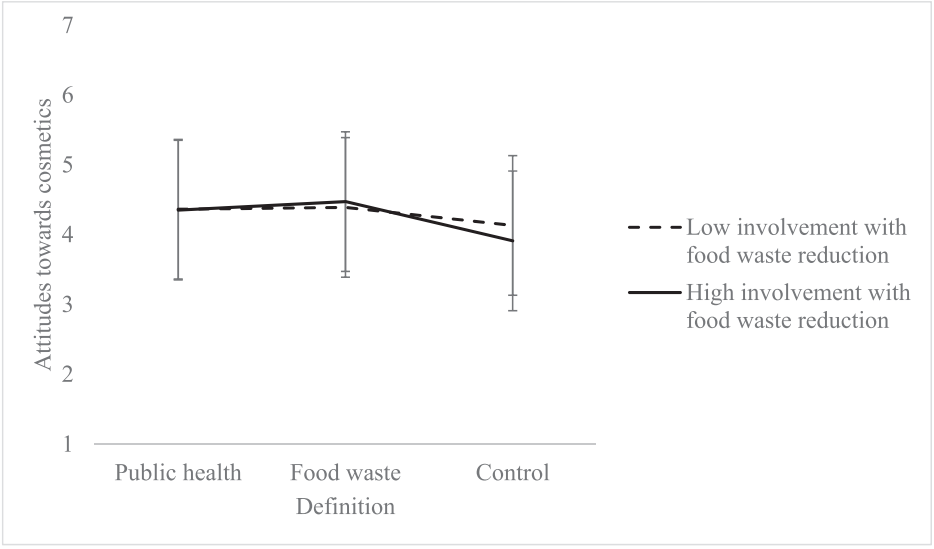

Fig. 5. Mean and standard deviations of attitudes towards cosmetics by involvement with food waste reduction groups.

definitions is uncommon and may have puzzled respondents that are not familiar with this term. Future studies could examine the possibility of using another term and potentially comparing it with the term "holistic" to identify the effect of the term used on the results.

This study presented products with information about public health benefits. This benefit influenced consumer attitudes positively. A much stronger effect could be present if the health benefit was presented as personal. Ideally, a comparison of public and personal health benefits could be tested in future studies, as well as how this effect could differ between generations and age groups (Zhang et al., 2020).

As for all methods, the ones used in this study face challenges related to optimising the validity and reliability of the results. The use of OEQs in this study led to a reduced response rate, reliability and reproducibility for some parts of the results. The qualitative and open nature of this approach led to results that spread broadly on the spectrum of possible information on the topic at hand. However, due to the data being generated by a large enough number of participants, the results have much higher validity than those produced by predetermined approaches. The second part of this study relied on validated survey scales. This led to highly reliable results due to the use of advanced and established statistical analyses and interpretations of the test results. This study

aimed at increasing both its validity and reliability by combining open-ended and predetermined approaches. To some extent, this leads to conclusions with a reduced risk for application and further research, due to triangulation. However, more research needs to be added to the very limited literature on the methods that take this kind of hybrid approach further into more advanced and rapid uses in consumer and marketing research (Altintzoglou et al., 2018).

5. Implications

The practical implications of these results apply to the development of cleaner food production systems that utilise the whole raw material from seafood throughout the supply chain. This study provides only a small insight into the marketing potential of ingredients sourced from raw material that would either be wasted or underutilised in lower-grade functions and, as a result, have much lower profitability. Understanding how consumers respond to information about products that contain such ingredients shows that there is great potential for consumer education about empowered choices of food and nutrition supplements that are environmentally friendly at the ingredient level. Once this education is in place, market demand will attract industrial interest towards increasing investment in cleaner production that makes use of the whole raw material, in this case seafood, but the same approach could be applied to all food production.

The academic implications rest on the use of OEQs to extract information at the top of consumers' minds. Surveys often list variables that are relevant and important but, in doing so, show the study participants that these variables should be considered important to start with, leading to an unrealistic and reaction-based data collection approach, in which consumers only rate how important variables are. Using OEQs allows consumers to state exactly what is it that they consider important, without having to generate opinions that they think about for the first time when they read through a questionnaire. Hybrid approaches such as the one followed in this study contribute valuable triangulated results while at the same time confirming the validity of the OEQ approach with the traditional survey items from the literature.

The policy implications of this study could be summarised and potentially applied to labelling. This study shows that consumers have positive attitudes about reducing food waste and products resulting from cleaner production. A label certifying that products contain ingredients from a cleaner production process could be implemented after further investigation of consumer demands, production method controls and the challenging task of establishing a labelling scheme that could function across various product types and countries. However, the implementation of such a label would be a challenge, considering the need for the establishment of new cross-industry standards and the potential for consumer confusion about the abundance of environmental labelling, which they already have difficulty differentiating.

6. Conclusion

The first and main conclusion of this paper is that consumers report more positive attitudes towards buying processed food and nutritional supplements than cosmetic products that contain ingredients from a cleaner production process that makes use of the whole raw material from shrimp, crab or mussels. The second main conclusion is that information about improved public health and reduced food waste has a positive effect on these attitudes. The third main conclusion was that high involvement with food waste led to less positive attitude scores in the control condition, possibly because they were more sceptical of the control definition, compared with similar consumers that received a definition with the purpose of this production method added to it. The last conclusion was that a positive moral attitude, trust in producers and domain-specific innovativeness could explain the results, because innovative consumers who are positive and those who trust producers would be less sceptical of the products. However, those with a high social motivation or a high need for uniqueness are more likely to react to such products less positively.

The methodological conclusion was that the approach in this study led to useful observations and explanations of the results based on a combination of OEQs in correspondence analysis and survey questions in ANOVA and GLM analyses. These two main results indicate that consumers are sceptical of advances in food production. The challenge in studies that focus on socially desirable behaviour, such as environmental concern and associated issues such as food waste reduction, is to reveal potential barriers for the materialisation of these idealised self-reported attitudes. Hybrid methods can provide such indications, but actual sales in shops are arguably the strongest indication of consumer behaviour. With the increasing relevance of reducing the environmental impact of industrial and private endeavours, future research should seek results that are closer to predicting actual behaviour, of honest consumers, in a real market.

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CRediT authorship contribution statement

Themistoklis Altintzoglou: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing - original draft, Visualization, Project administration, Funding acquisition, Writing - review & editing. **Pirjo Honkanen:** Conceptualization, Methodology, Resources, Writing - review & editing. **Ragnhild Dragøy Whitaker:** Conceptualization, Project administration, Funding acquisition, Writing - review & editing.

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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