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Identifying consumer openness to new ingredients: A conjoint study on consumer segments in the UK

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The aim of this study was to explore consumer acceptance of food products that make use of ingredients from underutilized marine species. As these species are not commonly used as ingredients in food products, a goal of this study was to explore how relevant personality factors influenced the acceptance of such products. This would be achieved by (a) identification of consumer segments based on the personality factors–domain specific innovativeness, food technology neophobia, health involvement, and disgust, (b) description of the main characteristics of these consumer segments, and (c) comparing how these consumer segments responded to information about the potential products, origin species, ingredients, and benefits associated with these ingredients. The method used in this study was a consumer survey (n = 490) that led to a consumer segmentation, followed by a conjoint experiment. The results show that ingredient source was the most important attribute. Yet, as many of the ingredient sources were novel, both for the carrier product and the consumer, the important part was not exposing consumers to the species that functioned as the ingredient source. The younger female consumers of the Safe Player group were most focused on the ingredient source, whereas the older male segment, called Open Minded, found the carrier product more important. The final segment, the Innovator, found all of the attributes of almost equal importance.

KEYWORDS

conjoint, consumer, disgust, marine ingredients, segmentation

1 Introduction

Feeding the world sustainably is one of the biggest challenges of modern society (FAO et al., 2015). To solve the challenge of food security, global calls have been made to transform food systems in order to make healthy diets available and affordable (FAO et al., 2021).

Food loss and waste (FLW) has been identified as a key barrier to global sustainability due to its adverse impacts on food security (FAO, 2017). FLW is also a challenge in fish value chains. In terms of fish, food loss includes fisheries and aquaculture products which are intended for human consumption but are ultimately not eaten, or that have sustained a reduction in quality. One example of loss in fisheries is poor utilization of bycatch, where it is either discarded or left to spoil because of negligence. The latter is the most common bycatch treatment, yet, recent studies indicate that there are improvements, when individual vessels take the potential economic value

of processed bycatch into account (Roberson and Wilcox, 2022). Fisheries' bycatch consists of a variety of species that are caught while fishing for other target species such as cod or shrimp. The challenge is identifying a profitable way to make use of bycatch species in the production of food products or as ingredients that could be included in existing food products. To address this challenge, more knowledge about how consumers respond to buying and consuming products that make use of these species or ingredients that are derived from them. In other words, if the industry develops products or ingredients from underutilized species, will consumers accept them? This is study is the first that looks at how consumers respond to the possibility of buying products with ingredients from these particular underutilised species. The UK market was considered advanced and sophisticated enough to allow for such a challenging study (Altintzoglou et al., 2021). Personal characteristics play an important role in the success or failure of new product introductions (Im et al., 2003). Among the personality factors, innovativeness, food neophobia, and disgust have commonly been used as factors to explain individual differences in new product acceptance (Gielens & Steenkamp, 2007; Siegrist & Hartmann, 2020). An additional personality factor that is especially important for fish consumption is health involvement (Pieniak et al., 2008).

2 Literature background and hypotheses

Innovativeness is a part of consumer personality that describes their attraction to trying new products (Goldsmith and Hofacker, 1991). In the food domain, innovativeness is one of the ways that consumers can express their values and experience in terms of willingness to try new food products that appear in the market (Brunsø et al., 2021). Innovativeness has also been found to be a predictor of novel and alternative protein consumption (Onwezen et al., 2022). The relevance of consumer innovativeness could contribute to the definition of consumer groups that may respond differently to information about the potential products, origin species, ingredients, and benefits associated with these ingredients. This led us to the first hypothesis that domain specific innovativeness is one of the constructs that can differentiate consumer segments for novel products utilizing bycatch species.

In contrast, avoidance of new products or experiences can also influence consumers, especially when it comes to trying new food (Pliner & Pelchat, 1991). Food neophobia has been found to be a barrier in consumption of novel foods such as insects (e.g., Hartmann et al., 2015) or cultured meat (Wilks et al., 2019). In the context of new marine ingredients, food neophobia has been found to be a barrier in the consumption of seaweed (Moons et al., 2018; Birch et al., 2019). The concept of neophobia is multifaceted, and it is often defined by what it is directed towards, for example, food technology neophobia (Cox and Evans, 2008; Çınar et al., 2021). In the context of novel marine ingredients, the fact that the underutilized species need to go through different types of processing in order to become an ingredient in a product could influence consumers acceptance of said product. The second hypothesis in this study was that food technology neophobia is expected to differ among consumer segments in the UK.

Food disgust sensitivity is a personality trait that reflects individual differences in the emotional predisposition to be more or less easily disgusted by certain food-related cues (Hartmann & Siegrist, 2018). Food disgust sensitivity can act as a barrier to food acceptance, especially for foods produced by new technologies (e.g., genetically modified, cultured meat) or new food types (e.g., insects), across countries and cultures (Siegrist and Hartmann, 2020a). For products that are only new to specific cultures, such as eating insects in Western countries, disgust is a strong predictor of aversion and could influence willingness to eat such products (La Barbera et al., 2018). Some underutilized marine species can potentially be perceived as novel and potentially trigger disgust in consumers. However, this effect can vary in a population. This led to the study hypothesis that disgust could be a personality factor that could be different across consumer segments.

Health involvement is classic predictor of food choice behaviour (Kähkönen & Tuorila, 1999). Consumers are influenced by their emotions when it comes to choosing, for example, organic food. This is mostly due to their fear of conventional alternatives and the risks they may introduce to their health (Jose and Kuriakose, 2021). Yet, fish consumption is directly linked to interest in healthy eating, which in turn is influenced by health involvement (Pieniak et al., 2008). The latter chain of interactions leads to a greater satisfaction with life. In this study, the expectation was that health involvement would influence consumer reactions to information about products that include marine ingredients that lead to health benefits. The hypothesis was that health involvement significantly varies among consumer segments in the UK and that this variation would support the explanation of consumer reactions to information about products that include beneficial marine ingredients.

The aim of this study was to explore consumer acceptance of food products that make use of ingredients from underutilized marine species. As these species are not commonly used as ingredients in food products, a goal of this study was to explore how relevant personality factors influenced the acceptance of such products. This would be achieved by (a) identifying consumer segments based on the personality factors–domain specific innovativeness, food technology neophobia, health involvement and disgust, (b) describing the main characteristics of these consumer segments, and (c) comparing how these consumer segments respond to information about the potential products, origin species, ingredients, and benefits associated with these ingredients.

3 Methods

3.1 Recruitment

An online survey service provider recruited 490 participants from the UK. The sample characteristics are shown in Table 1.

The sample was representative of the country's population in terms of age, gender, occupation, income, and location of residence. All participants were at least 50% responsible for buying or preparing seafood products at their household, and they did not have allergies related to seafood. All participants were informed about the aim of the study, the organisations that are responsible for the study, the funding source, and GDPR compliance of data management. Also, they provided their consent before participation. The study received an ethical approval by NSD, the Norwegian centre for research data.

TABLE 1 Social and demographic characteristics of the study sample (n=490) and the part of the sample that participated in the conjoint experiment.

N	490	Highest educational/work-related qualification	Percent
Age	Percent	No formal qualifications	6.3
18-29	15.9	Youth training/skillseekers	0.2
30-39	19	Recognised trade apprenticeship	1.0
40-49	16.1	Clerical and commercial	0.6
50-59	15.5	City & Guilds Cert.	5.3
60+	33.5	City & Guilds certificate - advanced	3.7
Gender	Percent	CSE grades 2-5	1.6
Male	52.2	CSE 1, GCE O, GCSE, School Cert.	11.4
Female	47.8	Scottish Ordinary/Lower Cert.	0.0
Area of residence	Percent	GCE A level or Higher Cert.	14.3
Northeast	4.1	Scottish Higher Cert.	1.6
Northwest	12.2	Nursing qualification	1.0
Yorkshire and the Humber	8.0	Teaching qualification (not degree)	1.4
East Midlands	7.6	University diploma	4.5
West Midlands	8.8	University or CNAA first degree	23.1
East of England	7.6	University or CNAA higher degree	11.4
London	12.7	Other	9.2
Southeast	13.1	Don't know	1.2
Southwest	13.9	Prefer not to say	2.0
Wales	3.5	Gross yearly personal income	Percent
Scotland	7.1	under £5,000	6.9
Northern Ireland	1.6	£5,000 to £9,999	6.9
Residence area type	Percent	£10,000 to £14,999	8.8
Urban	77.6	£15,000 to £19,999	11.0
Town and Fringe	10.8	£20,000 to £24,999	11.0
Rural	9.0	£25,000 to £29,999	13.1
Current marital/relationship status	Percent	£30,000 to £34,999	8.4
Married	45.1	£35,000 to £39,999	6.5
Civil partnership	0.4	£40,000 to £44,999	5.7
Living with a partner	15.3	£45,000 to £49,999	2.7
Single	22.4	£50,000 to £59,999	2.4
Divorced	5.1	£60,000 to £69,999	3.1
Widowed	2.9	£70,000 to £99,999	1.6
Separated	2.0	£100,000 and over	3.3
In a relationship	5.5	Don't know	1.0
Other	0.2	Prefer not to answer	2.7
Prefer not to say	0.8	Gross yearly household income	Percent
Number of household members <18	Percent	under £5,000	3.1
0	75.1	£5,000 to £9,999	4.5
1	11.6	£10,000 to £14,999	5.9

(Continued)

TABLE 1 Continued

N	490	Highest educational/work-related qualification	Percent
2	9.6	£15,000 to £19,999	9.0
3	1.6	£20,000 to £24,999	9.0
4	0.4	£25,000 to £29,999	8.6
5 or more	0.2	£30,000 to £34,999	4.5
Don't know	0.2	£35,000 to £39,999	8.0
Prefer not to say	1.2	£40,000 to £44,999	5.5
Grocery shopping responsibility	Percent	£45,000 to £49,999	4.7
Responsible for all purchases	44	£50,000 to £59,999	5.7
Responsible for most purchases	22.9	£60,000 to £69,999	3.5
Shared equally	33.1	£70,000 to £99,999	8.2
		£100,000 to £149,999	3.9
		£150,000 and over	1.0
		Don't know	3.5
		Prefer not to answer	11.6

3.2 Experimental design

The experimental part of the study was based on a ranking conjoint approach, following the design described in Table 2. Conjoint analysis studies the affinity of consumers towards specific configurations of product attributes. The analysis identifies the relative importance of each attribute that can be compared to other attributes of one or more products. The results of a conjoint analysis can help identify market segments between consumers with similar affinities towards one or more product attributes (Hair et al., 1998). When considering the attributes and levels, these should be carefully chosen to best represent what would be realistic in the market (Gil & Sánchez, 1997). Since this study focuses on underutilized marine species, there are few, if any, products available in the marketplace. When considering attributes and levels, the aim was to test combinations which seemed realistic both in terms of what is possible to combine based on other similar products and what would seem appropriate for the consumer. As an example, marine protein powder with collagen is available in Norwegian drugstores. However, the source of marine collagen is from species like pangasius, tilapia and cod and not from any of the species in this study. In this study, we chose to focus on three attributes for functional foods from underutilized marine species.

The first attribute was the species. Species that are common bycatch in fisheries or by-products in aquaculture were chosen. The second attribute was the carrier product. Various types of products were used as the carrier product, with an emphasis on products that are commonly used as functional food (i.e., yogurt and energy bars) and products that could contain ingredients from marine species (i.e., protein powder and omega-3 capsules). Some of the species chosen should be familiar as food (shrimp and crab) and other more unfamiliar (starfish and jellyfish). The final attribute was benefits. Various potential benefits from the bioactive compounds in the various species were identified and used to formulate health claims. The identification of bioactive compounds was done in consultation with expert scientists in the project. Health claims from commercial products were used to make the health claims realistic. One of the health claims was "Fibre – Good for digestive system" that functioned as a proxy for chitin which is a ubiquitous carbohydrate-like compound found in the exoskeleton of crustaceans. Fibre is a much broader term than chitin and as such less suited but was considered more likely to be recognised by the consumers in the survey.

Before conducting the conjoint task, the consumers were told that the overall aim of the project was to use underutilised marine species to develop new eco-friendly marine ingredients and products.

TABLE 2 Design of the conjoint experiment.

Attribute	Level1	Level2	Level3	Level4	Level5	Control
Species	Shrimp	Fish that cleans salmon	Starfish	Jellyfish	Crab	No Information
Carrier product	Yogurt	Protein powder	Omega-3 capsules	Energy bar		No Information
Benefit	Fibre - Good for digestive system	Collagen - Supports healthy hair, skin, nails, and joints	Antioxidant – Protects cells from oxidative stress			No Information

In each task, the respondent was asked to select the most attractive product (Figure 1).

3.3 Survey items

After the conjoint experiment, the survey introduced the question of domain-specific innovativeness (Goldsmith and Hofacker, 1991; Bartels and Reinders, 2010). Data was collected by using eight items in random order. The items were followed by a scale from 1=Strongly disagree, through 4=Neither agree, nor disagree, to 7=Strongly agree. The scale items were as follows: "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 buys 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". The reliability test for the domain specific innovativeness scale led to a Chronbach's alpha of 0.859. The average of the items was used to calculate the composite variable Domain Specific Innovativeness.

Food technology neophobia (Cox and Evans, 2008) was also rated on a 7-point agreement scale as responses to the randomly presented items: "There are plenty of tasty foods around so we don't need to use new food technologies to produce more"; "The benefits of new food technologies are often grossly overstated"; "New food technologies decrease the natural quality of food"; "There is no sense trying out high-tech food products because the ones I eat are already good enough"; "New foods are not healthier than traditional foods"; "New food technologies are something I am uncertain about"; "Society should not depend heavily on technologies to solve its food problems"; "New food technologies may have long term negative environmental effects"; "It can be risky to switch to new food technologies too quickly"; "New food technologies are unlikely to have long term negative health effects"; "New products produced using new food technologies can help people have a balanced diet"; "New food technologies give people more control over their food choices"; "The media usually provides a balanced and unbiased view of new food technologies". The reversed variables were transposed to positive. The reliability test of the food technology neophobia scale led to a Chronbach's alpha of 0.850. The average of the items was used to calculate the composite variable Food Technology Neophobia.

The survey followed up with questions about health involvement (Pieniak et al., 2010). Health involvement was also rated on 7-point agreement scales. The following items were randomly presented to the consumers: "Health is very important to me"; "I care a lot about health"; "Health means a lot to me"; and "I appreciate healthy food very much". The reliability test of the health involvement scale led to a Chronbach's alpha of 0.938. The average of the items was used to calculate the composite variable Health Involvement.

The measurements items for disgust sensitivity were adapted from the food disgust scale of Hartmann and Siegrist (2018). The items that were specifically created for fish were used because this study focuses on fish or other marine species. The items were rated on a scale from 1=not disgusting at all to 7=totally disgusting. The randomly presented items that captured participants' disgust were as follows: "To have a whole fish with its head on the plate", "To eat raw fish like sushi", "The smell in a fish shop or in fish sections with fresh fish", and "The texture of some kinds of fish in the mouth". The reliability test of the disgust scale led to a Chronbach's alpha of 0.831. The average of the items was used to calculate the composite variable Disgust.

Finally, recent consumption/usage frequency per product type and category (i.e., Energy bars, Protein powder, Omega-3 capsules, and Yoghurt) and social and demographic characteristics were collected and are described in full in the results.

3.4 Statistical analysis

Cronbach's Alpha was used to establish the reliability of construct variables. Cronbach's Alpha for the four personality factors were over 0.8, and thus reliable (Hair et al., 1998). A cluster analysis was performed to identify different groups based on Domain Specific Innovativeness, Food Technology Neophobia, Health Involvement, and Disgust. A hierarchic cluster analysis based on Ward's method was performed first in order to identify the best cluster solution. A

Product 1	Product 2	Product 3	Product 4
Yogurt	Protein powder	Omega-3 capsules	Energy bar
	Ingredients from shrimp	Ingredients from crab	Ingredients from starfish
With fibre - Good for digestive system	With collagen - Supports healthy hair, skin, nails and joints		With antioxidant – Protection of cells from oxidative stress

Which of the following products would you choose?

- Product 1
- Product 2
- Product 3
- Product 4

FIGURE 1
Example of one choice set.

large increase in the agglomeration coefficient indicated a three-cluster solution as being the most appropriate. A hierarchic cluster analysis followed, based on a K-means cluster analysis. Analysis of variance (ANOVA) was conducted to profile the different consumer clusters. One way analysis of variance (ANOVA) was used to compare means of continuous variables between segments. Chi-square tests were used to compare categorial variables between segments. SPSS 23.0 software was used for clustering and conducting the ANOVA.

The composition of the tasks and the concepts shown per respondent were determined by using a fractional factorial design. Choice situations were chosen per respondent by using the random task generation method and implementing complete enumeration in the Sawtooth SSI Web software.

Conjoint analysis was applied in the first step of the data analysis to determine how individual consumers evaluate the different attribute levels in the study. This approach allowed the estimation of individual attribute levels on the overall utility of the specific configuration of attributes in the present study (Green & Krieger, 1991; Lee et al., 2007). This study was designed using Sawtooth SSI Web software, and it consisted of three attributes in a 6 × 5 × 4 design. Table 1 shows the 15 levels of information (choice sets) used in this study.

4 Results

4.1 Segments

The segmentation analysis revealed the existence of three consumer groups (Table 3). The groups were relatively similar in size. The first group reported the highest innovativeness and medium health involvement and disgust, in comparison to the other two groups. This gained the first group the name Innovator. The second group was named Open Minded because of their high health involvement and very low disgust combined with an average innovativeness compared to the other groups. The third and final group reported the highest disgust, low health involvement, and the lowest innovativeness. This group was named Safe Player. The three groups did not differ in food technology neophobia, which was reported to be at the scale's midpoint. Age and gender significantly differed between the three groups. The Innovator segment was relatively split between the youngest and the oldest with a balance between genders. The Open Minded segment was relatively older and more male dominated. The Safe Player segment represented more young and female participants.

No significant differences were found between the segments in terms of area of residence (p=0.329), highest educational or work-related qualification (p=0.357), gross yearly personal income (p=0.677), gross yearly household income (p=0.623), residence area type (p=0.857), current marital or relationship status (p=0.599), and number of household members under the age of 18 years (p=0.333). Finally, no significant differences were found in the consumption frequency of products that could function as carriers of new marine ingredients (Table 4).

4.2 Conjoint

The attribute-level part worth and the relative importance of each attribute were estimated for each consumer. Table 5 shows that the ingredient source was the most important attribute (relative importance of 41.67%) for the consumers, followed by product (34.49), and benefit (23.84%).

The results of this experiment showed that the yogurt and omega-3 capsules were the preferred carrier products. Protein powder was the least

TABLE 3 Mean (standard deviation) values of segmentation variables and significant social and demographic segment characteristics.

Segments	Innovator	Open Minded	Safe Player	Total	P-value*
n	180	177	133	490	
% n	36.7	36.1	27.1	100	
Domain Specific Innovativeness	4.1 (0.88)a	3.7 (1.04)b	2.5 (0.89)c	3.5	<0.001
Food Technology Neophobia	4.1 (0.73)a	4.2 (0.97)a	4.2 (0.89)a	4.2	0.443
Health Involvement	5.6 (1.06)b	5.9 (1.14)a	5.3 (1.16)c	5.6	<0.001
Disgust	4.4 (0.73)b	2.0 (0.71)c	5.8 (0.96)a	3.9	<0.001
Age					0.006**
18-29	36	18	24	78	
30-39	34	30	29	93	
40-49	25	37	17	79	
50-59	20	26	30	76	
60+	65	66	33	164	
Gender					0.015**
Male	90	107	59	256	
Female	90	70	74	234	

*Based on one-way ANOVA tests; **Based on chi-square tests; a-c indicate significant (p<0.05) differences between segments. a-c indicate significant (p<0.05) differences between segments.

TABLE 4 Mean (standard deviation) consumption of product categories per week.

Segments	Innovator	Open Minded	Safe Player	Total	P-value*
Yoghurt	2.49(3.00)	2.47(2.84)	2.01(2.81)	2.35(2.89)	0.294
Energy bars	0.63(1.68)	0.4(1.42)	0.35(1.00)	0.47(1.43)	0.174
Omega-3 capsules	1.46(2.74)	1.32(2.59)	1.32(2.69)	1.38(2.66)	0.87
Protein powder	0.48(1.24)	0.42(1.18)	0.49(1.41)	0.46(1.26)	0.872

*Based on one-way ANOVA tests.

preferred product. For ingredient source, being provided with no information was more attractive than getting information that the ingredient source was crab or shrimp. The ingredient sources (fish that cleans salmon, jellyfish, and starfish) were least important. Finally, the benefit "with fibre - good for digestive system" was most important followed by "with collagen - supports healthy hair, skin, nails and joints", and "with antioxidant – protects cells from oxidative stress". "No information about benefits" was the least important category.

4.3 Segmentation conjoint

Based on the segmentation analysis, the attribute-level part worth and the relative importance of each attribute were estimated for the consumers in each segment (Table 6).

The Innovator and Safe Player segments found information about the ingredient source to be the most important attribute, followed by product and Benefit. In contrast the Open Minded segment found that Product the most important attribute followed by Ingredient source and Benefit.

All segments found that it was important to give no information about the ingredient source. However, this was significantly more important for the Safe Player segment. Crab as an ingredient source received the overall second highest importance rating followed by shrimp. It was significantly more important for the Open Minded and the Innovators to receive information about the ingredient source crab, whereas it was only significantly more important for the Open Minded segment to receive information that the ingredient source was shrimp.

Yogurt and omega-3 capsules was the most preferred products. The Open Minded segment preferred yogurt more than the Safe Player segment. There was no significant difference in preference for omega-3 capsules.

All segments found information about the benefits "with collagen - supports healthy hair, skin, nails and joints" and "with fibre - good for digestive system" important. There was however no significant difference in how important they found information about these benefits.

5 Discussion

The aim of this study was to identify and explore consumer acceptance of food products that make use of ingredients from underutilized marine species. The results show that the ingredient source was the most important attribute. Many of the ingredient sources were novel for the consumers, both as species, but also in terms of being included in the carrier product types used in this study. The latter makes the results comparable with other studies (La Barbera et al., 2018; Siegrist and Hartmann, 2020b). By segmenting the consumers, this study demonstrates that the

TABLE 5 Mean part-worth utilities and mean relative importance of the attributes.

Attributes	Levels	Mean part-worth utility (std.dev.)	Mean relative importance (%)
Product	Yogurt	0.59 (1.74)	34.49
	Protein powder	-0.92 (0.96)	
	Omega-3 capsules	0.43 (1.45)	
	Energy bars	-0.10 (1.11)	
Ingredient source	Shrimp	0.09 (0.57)	41.67
	Fish that cleans salmon	-0.47 (0.85)	
	Starfish	-0.54 (0.63)	
	Jellyfish	-0.52 (0.61)	
	Crab	0.17 (0.60)	
	No information	1.27 (1.62)	
Benefit	With fibre - Good for digestive system	0.51 (0.50)	23.84
	With collagen - Supports healthy hair, skin, nails, and joints	0.42 (0.80)	
	With antioxidant – Protects cells from oxidative stress	0.13 (0.48)	
	No information	-0.62 (0.64)	

TABLE 6 Mean part-worth utilities and importance of the attributes for the three segments.

		Consumer segments				
		Innovator	Open Minded	Safe Player		
Attributes	Levels	36.7%	36.1%	27.1%	F-value	ANOVA P-value
Carrier product	Yogurt	0.52ab	0.95a	0.19b	7.68	0.001
	Protein powder	-0.80a	-1.08b	-0.85ab	4.54	0.011
	Omega-3 capsules	0.42a	0.28a	0.63a	1.89	0.152
	Energy bars	-0.15a	-0.15a	0.03a	1.17	0.311
	Relative importance	32.87	47.65	27.41		
Ingredient source	Shrimp	0.01b	0.25a	-0.02b	11.04	<0.001
	Fish that cleans salmon	-0.39a	-0.40a	-0.66b	4.72	0.009
	Starfish	-0.46a	-0.45a	-0.78b	13.52	<0.001
	Jellyfish	-0.45a	-0.43a	-0.73b	11.24	<0.001
	Crab	0.19a	0.27a	0.02b	6.71	0.001
	No information	1.11b	0.77b	2.17a	33.60	<0.001
	Relative importance	39.02	28.46	54.62		
Benefit	With fibre - Good for digestive system	0.28a	0.37a	0.33a	1.59	0.206
	With collagen - Supports healthy hair, skin, nails, and joints	0.49a	0.35a	0.43a	1.40	0.248
	With antioxidant – Protects cells from oxidative stress	-0.12ab	-0.06a	-0.23b	4.60	0.010
	No information	-0.64a	-0.65a	-0.54a	1.50	0.225
	Relative importance	28.12	23.89	17.97		

a, b indicate significant ($p<0.05$) differences between segments.

attributes investigated are of different importance to different consumer groups. The younger female consumers of the Safe Player group were most focused on ingredient source, whereas the older male segment called Open Minded found the carrier product more important. The final segment, the Innovators, found all of the attributes to be of almost equal importance.

Disgust seems to have a clear discriminating power across our study population, leading to the identification of interesting and relevant consumer segments. These results support previous studies on the universality of disgust as a relevant construct (Siegrist and Hartmann, 2020a). The latter study specifically showed that neophobia and disgust can lead to low willingness to consume products that triggered the disgust reaction. However, in our study, disgust had a more powerful discriminating power than neophobia. Neophobia scores were mostly around the scales' mid-point. However, this may have been due to the distance consumer may feel from "food technology neophobia", the variable used in this study, due to its relevance to the study's focus on ingredients.

Even though the ingredient source in this study is the most important attribute, the consumers prefer not to receive any information about this attribute. In other words, products without information about the origin of the marine ingredient are most attractive. This result can be expected by consumer neophobia (Pliner & Pelchat, 1991). In this case, we observed that consumers responded particularly negative towards the new ingredient sources, by choosing the product alternatives without this information. The consumers also found shrimp and crab to be more attractive than starfish, jellyfish, and cleaner fish. The novelty of the different species could explain this. Even though shrimp and crab are uncommon ingredients in the products used in this experiment, these species are much more familiar to UK consumers than starfish, jellyfish, and cleaner fish. This is supported by UK seafood consumption data. Shrimp and crab can be found as a separate product category, whereas the other species are not mentioned (Seafish, 2021). This study aimed to compare how consumer segments based on personality factors responded to information about the species used as ingredients in food products. The Safe Player segment found the ingredient source to be the most important attribute. This segment was characterised by the consumers with the highest disgust sensitivity and lowest innovativeness. They did not want information about the ingredient source. They also found unfamiliar species to be least attractive compared to the other segments. This is comparable to what previous studies have found; familiarity is important in accepting novel food products such as insects (Wilkinson et al., 2018; Gumussoy et al., 2021). Segmentation studies are commonly used, but they always introduce questions about sample size, sample population, and choice of variables used in the analysis. This study could be repeated with an even larger sample, include more countries, and potentially replace food neophobia with a construct having a stronger discriminative potential. Yet, the results presented here indicate that the study design and analysis performed well in all respects and contributed new theoretical and practical knowledge.

A representative sample was recruited for this study. While this is a strength, it also presents a weakness. Two of the four carrier products in the conjoint study were not very frequently consumed by the participants. Alternatively, the recruitment could have focused on frequent consumers of all four products, which could reveal more information about this target population. This study has therefore been designed on a broader sample, which led to results that can be used in part for targeting segments with more frequent consumption of the carrier products, but also for potential future users of these products. The latter needs to be considered when implementing the results into marketing strategies or future segmentation studies. Additionally, this study focused on consumers in the UK. While the UK is a sophisticated market that allows for challenging experiments with new ingredients and sources, future studies could expand this field by replicating this study in other countries, to ensure that the results can be extrapolated to other populations.

Before conducting the conjoint task, the consumers were told that the overall aim of the project was to use underutilised marine species to develop new eco-friendly marine ingredients and products. This decision may have introduced social desirability bias, leading to results that are more positive than if the consumers were uninformed. Yet, providing information about the study aim is a requirement by the ethical and data privacy authorities to allow participants to make an informed voluntary decision for participating in the study. Future studies could provide more balanced information and measurements related to environmental sustainability, to allow the estimation of potential bias effects.

The design of conjoint experiments is also often under scrutiny. The choice of factors and levels are made under theoretical considerations while keeping the design as simple and clear as possible for the participants. Future studies could expand with more factors and levels that could further complete the picture of what influences consumer choice for products that include ingredients from new marine species. Additionally, a measure could be added to ensure that consumers do not perceive the absence of information as the absence of the ingredients.

This study demonstrates that giving consumers information about marine species as an ingredient in food products is challenging. This is particularly related to species that are unfamiliar as food for the consumer. Previous research has found that consumption of unfamiliar foods (insects) in a processed form increases familiarity with the ingredient. This results in higher ratings of willingness to consume in the future (Hartmann & Siegrist, 2016; Menozzi et al., 2017). Our research indicates that even though unfamiliar food is an ingredient in familiar food products, the consumer does not want information about the unfamiliar food ingredient. To progress toward a more sustainable, more secure, safer food system, FLW from bycatch needs to be addressed. Therefore, general scepticism regarding unfamiliar marine bycatch species will remain a challenge. One way of overcoming the challenge of unfamiliarity is by providing the consumer with information; research on how nuances in wording or topics seems especially promising (Gumussoy et al., 2021). Our study showed how the use of benefits can be applied in the market to gradually increase the focus on marine ingredients as functional ingredients.

6 Conclusions

This study led to implications for future research and practice. It demonstrated that the combination of consumer segmentation and a conjoint experiment can yield useful insights about consumers' responses to new ingredients in products. The results showed that three rather relevant consumer segments could have differences in the ways they respond to information about such products. The Open Minded could be very open to information and products that would have a positive function towards their health goals. This means that they are very open to new products and ingredients, and they could function as early adopters and new ingredient advocates. The Innovators could also function as early adopters because they were the most innovative. With each of these two groups being targeted with a marketing strategy, the Safe Players would potentially follow as a later target group, once they have observed and familiarised themselves with the new ingredients in relevant products.

This study provided one main take-away message: consumers in a sophisticated market like the UK is not ready to be exposed to information about ingredient sources that are not familiar to them. As results show, consumers would not accept food products that make use of ingredients from underutilized marine species if they would be informed about it. Even the most innovative consumers preferred to focus on the benefits that the ingredients provide. Gradual exposure to the ingredient source as a background to the glorious benefits they provide may increase their familiarity in the long run. Yet, for the time being, ingredients are purely sources of benefits.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by NSD, the Norwegian authority for research ethics and privacy. The patients/participants provided their written informed consent to participate in this study.

Author contributions

Both authors contributed in the design of the study and the development and finalization of the paper. The corresponding author contributed additionally to the original idea, the acquisition of the project and the development of the first structure of the paper. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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