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European consumers' intention to buy sustainable aquaculture products: An exploratory study

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ABSTRACT

Given the increasing global importance of low trophic level aquaculture (LTA) products (e.g. seaweed and mussels) for sustainable and healthy seafood supply, this study examined consumer intentions towards LTA products among European consumers. This study performed an extended theory of planned behaviour to focus on the influence of health consciousness, subjective knowledge, food neophobia, and sociodemographic and lifestyle factors on consumers' intentions to buy LTA products. We conducted an online questionnaire survey in Denmark, the United Kingdom and France (~500 respondents per country). Consumer segmentation analysis, based on food-related lifestyles, employing K-means clustering techniques, revealed five distinct segments, namely 'Adventurous', 'Uninvolved', 'Foodies', 'Rational', and 'Conservative', each reflecting unique consumer behavioural patterns. Furthermore, partial least squares structural equation modelling analysis revealed that subjective norms are the main predictor of LTA product buying intention, followed by attitude, food neophobia, subjective knowledge, and health consciousness. Furthermore, food neophobia seems to moderate the influence of subjective norms and subjective knowledge on LTA product buying intention. This dual approach explains the predictive power of the model while identifying targeted segments for sustainable aquaculture product marketing, ensuring that the distinction between the model's test and the subsequent segmentation analysis is clearly articulated. To enhance the adoption of LTA products, marketers should primarily target the 'Foodies' segment, characterised by high involvement and innovation, by emphasizing attitudes, health consciousness, subjective knowledge, and food quality attributes, while mitigating food neophobia and leveraging subjective norms.

1. Introduction

The blue economy, as a cornerstone of sustainable marine and coastal development, is becoming a key contributor to the global economy. Central to this blue economy is the rapidly expanding aquaculture sector, which now leads global seafood production (Food and Agriculture Organization, 2024). However, unlike aquaculture, marine capture fisheries have often failed to achieve efficient harvest levels and economic returns in many countries in Europe (Tunca, 2023) whereas this fact emphasises the essential role of aquaculture production in supporting seafood security and sustainable exploitation of marine resources (Budhathoki et al., 2024). In the search for sustainability within aquaculture production, low trophic aquaculture (LTA) is achieved by culturing species that are inherently efficient in resource use and have a reduced ecological footprint. LTA refers to the farming of species that occupy lower positions in the food web, such as seaweed and filter-feeding shellfish such as mussels and oysters (Chopin et al., 2012).

These species are characterised by their efficient use of resources and minimal environmental impact, as they typically require fewer inputs, such as feed and fertilisers, compared to higher trophic level species such as salmon and trout (Smith et al., 2011). LTA species play a crucial role in sustainable aquaculture due to their ability to enhance water quality and provide ecosystem services (Filgueira et al., 2019). For example, seaweed absorbs excess nutrients from the water, while filter-feeding shellfish helps maintain water clarity and quality (Visch et al., 2020). Despite the expansion of the sector and the emphasis on the potential for nutrition and cultural integration in recent studies (Costello et al., 2020; Jenkins et al., 2021), concerns about the general sustainability of aquaculture practices remain (Jiang and Wu, 2022).

Seaweeds such as wakame and nori have become exemplary for their sustainable cultivation practices, their growing popularity, and their role in diversifying diets with minimal environmental impact

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(Ashkenazi et al., 2018; Wartenberg et al., 2017). In addition, shellfish such as oysters and mussels are increasingly sought after, not just for their culinary appeal, but also for their sustainable production metrics. However, there are critical perspectives on the negative impacts, such as the risk of habitat alteration and the introduction of non-native species, which could disrupt local ecosystems (Smith et al., 2011). Scientific debates on the economic sustainability and profitability of LTA products highlight the balance between ecological benefits and market competitiveness. Some studies show that LTA can be economically viable by reducing feed costs and increasing market appeal through sustainability branding (Cottrell et al., 2021). Others indicated that the high initial investment and operational costs can be prohibitive, limiting the broader adoption of LTA (Diana, 2012).

Furthermore, the incorporation of LTA into the Integrated Multi-Trophic Aquaculture (IMTA) system represents a significant advancement in sustainable aquaculture practices (Chopin et al., 2012). IMTA, a method where various species are farmed together, uses the by-products of one species as resources for another, thus improving the overall resource efficiency of the system (Kleitou et al., 2018; Kerrigan and Suckling, 2018). This is particularly relevant since European aquaculture has successfully adopted IMTA (on a pilot scale), integrating LTA species such as bivalves and macroalgae to create a more sustainable production model, while such practices not only recycle nutrients but also contribute to climate change adaptation strategies by reducing environmental impacts (Wartenberg et al., 2017). The growth benefits observed in species within IMTA systems highlight the crucial role of LTA in sustainable food production systems and the provision of a model to increase food supply that does not exacerbate environmental degradation. The continued advancement of sustainable aquaculture, including the integration of LTA within IMTA, is essential to meet the growing demand for aquatic food sources driven by technological innovations, expanded supply chains, and improved market access (Asche, 2008; Kobayashi et al., 2015; Tveteras et al., 2012).

These benefits are compounded by advances in feed technologies that minimise environmental impact (Cottrell et al., 2021; Neori, 2007). Although broader conventional aquaculture practices often fail to meet sustainability criteria, LTA offers a strategic approach to counteract this trend, providing a model for sustainable expansion that addresses environmental trade-offs while promoting food security and climate resilience (Budhathoki et al., 2024; Diana, 2012). The integration of aquaculture into global food systems has benefited from technological advances and improved practices that extend value chains, but it is not without environmental considerations (Hilborn et al., 2015; Olson et al., 2014). Addressing these concerns is crucial to ensure the socioeconomic and environmental sustainability of the sector, which is essential for the long-term health of the blue economy. Therefore, LTA emerges as a key practice to enhance the sustainability of aquaculture production, aligning ecological stewardship with economic growth.

Consumer acceptance and market diffusion of LTA products are influenced by several factors, including health benefits, sustainability aspects, and food neophobia. Research indicates that consumers with high health consciousness and environmental awareness are more likely to accept and purchase sustainable aquatic food products (Verbeke and Vackier, 2005). However, food neophobia and lack of familiarity with LTA products can significantly hinder their acceptance, particularly in markets where traditional seafood species, such as salmon, dominate consumer preferences (Pliner and Salvy, 2006). Additionally, the integration of LTA products into sustainable and healthy diets, as emphasised by the EAT-Lancet Commission (Troell et al., 2019), underscores its importance in providing nutritious food with a low environmental footprint and aligns with global health and sustainability goals; the EAT-Lancet Commission has highlighted the critical role of such sustainable aquaculture practices in achieving these goals, advocating for increased consumption of plant-based and LTA foods to promote health and environmental sustainability.

In recent decades, increasing attention has been paid to the production and consumption of LTA products to meet the goals of sustainable blue growth and help secure global food demand. Edible LTA products include seaweed (sea grape, nori, and wakame), shellfish (mussels, clams, and oysters), and echinoderms (sea cucumbers, and sea urchins), which could play a key role in global aquaculture production. For example, seaweeds are one of the main LTA products, with billions of dollars in economic value and millions of tonnes of production, most of which are for human consumption, significantly contributing to the global goals of food security and sustainability (Naylor et al., 2021). For example, macroalgae, as nutrients and fertilisers, contribute significantly to global food security and sustainability, although they represent <1 % of the total aquaculture production (Food and Agriculture Organization, 2020).

Asian cultures have used LTA products such as sea cucumbers, nori, and sea urchins in their diets, highlighting a food culture deeply interconnected with taste, texture, and nutritional benefits, reflecting long-term support for marine biodiversity (Hosomi et al., 2012). In sustainable gastronomy, LTA products, such as seaweed and shellfish, offer an innovative connection between traditional practices and modern gastronomic trends. By contrast, European consumers have traditionally exhibited a more conservative position, partially attributed to unfamiliarity and neophobic tendencies (Olsen, 2003; Reinders et al., 2016; Verbeke and Vackier, 2005). However, globalisation and the cross-cultural exchange of culinary traditions are reshaping these patterns, fostering a growing acceptance among Europeans for a wider range of food experiences, including LTA species. Considering the dietary differences between Asian and European consumers, recent research has revealed a shift towards a broader acceptance of diverse foods, including LTA species such as seaweed, in Europe. This transition can be captured by a food-related lifestyle approach that segments consumers based on their values and behaviours towards food, encompassing factors such as convenience, health, and sustainability (Brunsø et al., 2021). By applying a food-related lifestyle approach, previous studies have identified distinct lifestyle segments within European consumer populations with diverse attitudes and behaviours towards food consumption, based on factors such as convenience, health consciousness, and sustainability preferences (Buckley et al., 2007; Budhathoki et al., 2022a; Stancu et al., 2022).

Exploring consumer intentions to purchase LTA products is crucial given their importance in addressing global food demands and sustainability goals. First, attitudes, subjective norms, and perceived behavioural control are fundamental in shaping intentions towards aquatic food products (Budhathoki et al., 2022b; Carlucci et al., 2015). Furthermore, studies highlight the influence of established consumption patterns and the degree of consumer familiarity with these products as critical determinants (Higuchi et al., 2017; Honkanen et al., 2005; Verbeke and Vackier, 2005). The health benefits associated with LTA products, coupled with the level of consumer involvement with food, can significantly influence purchasing decisions (Bell and Marshall, 2003; Brunsø et al., 2021; Cardoso et al., 2015; Olsen, 2003; Tomic et al., 2016). Other factors such as trust, accessibility, and economic factors encompass a broad range of influences on seafood consumption, including risk perception, information availability, market pricing, economic value, perceived value, and alignment with the food-related lifestyle of consumers. These elements collectively affect consumer behaviour towards sustainable aquatic food products (Ding et al., 2013; Pieniak et al., 2007; Richter et al., 2017; Siddique, 2012; Tomic et al., 2016).

The Theory of Planned Behaviour (TPB) (Ajzen, 1991) is a cornerstone framework, and its application extends across a broad range of studies, explaining the decision-making process behind consumer intentions and behaviours and the countless factors that influence these dynamics (Ajzen, 2011; Alam et al., 2020; Aminizadeh et al., 2024; Higuchi et al., 2017). In particular, the utility of the TPB extends beyond the mere categorisation of consumers; it enhances academic rigour and provides predictive insights into consumer purchase behaviour across

various food domains. Additionally, its application in diverse cultural contexts underscores the versatility of the framework, from predicting the well-being of food purchases (Lim and An, 2021) to examining responses to food pricing and in-store displays through a neuroscientific lens (Labban et al., 2021).

As the consumption of most LTA products (e.g. seaweed, and sea cucumber) is a fairly new concept in Europe compared to Asia, it would be interesting to study the various aspects of the intention to buy LTA products. Previous studies have indicated that there is a lack of research addressing the growing importance of new aquaculture products (Banovic, 2019; Stancu et al., 2022). Therefore, our research sheds light on attitudes, consumption patterns, and the food-related lifestyle of both actual and potential consumers. By leveraging the TPB, this study aims to examine the psychological drivers behind consumer intentions, further extending the framework with health consciousness, subjective knowledge, and food neophobia. Therefore, this research integrated the TPB with consumer segmentation to address the multidimensional nature of consumer decision-making. By identifying and analysing distinct consumer segments based on these characteristics, the study aims to refine our understanding of the motivations and barriers that influence consumer choices in the European aquatic food market. This approach not only advances academic discussions on consumer behaviour for sustainable aquaculture products but also contributes to the development of targeted marketing strategies designed to increase the acceptance and market diffusion of LTA products. Ultimately, this concise but comprehensive analysis bridges theoretical insights with practical marketing strategies, highlighting its importance in promoting sustainability and consumer acceptance in the aquaculture sector and supporting the growth of the blue economy.

2. Literature review

Building upon the foundational review of existing literature on consumer behaviour in sustainable aquaculture, this section represents the dynamics that rule consumer choices for LTA products. The literature covers multidimensional approaches towards understanding behaviours, with the TPB providing a robust framework for examining the relationship of attitudes, subjective norms, and perceived behavioural control that influence purchasing decisions. This theoretical foundation not only corresponds to our review but also anticipates the complex interaction of additional psychological socio-demographic and lifestyle factors introduced subsequently. By examining these elements through the TPB, we enhance our understanding of the determinants that shape consumer intentions, thus setting a comprehensive backdrop for the hypotheses formulated in the following subsections.

2.1. Theoretical integration to understand consumer intentions to buy low trophic aquaculture products

Our theoretical framework, strengthened by the TPB, serves as the core for developing research hypotheses centred on the intention to buy LTA products (Fig. 1). Drawing on the TPB, we posit that consumer intention is influenced by factors such as attitudes, subjective norms, and perceived behavioural control of LTA products (Altintzoglou et al., 2011; Birch and Lawley, 2012; Honkanen et al., 2005). Within the TPB, the literature underscores the significant roles of attitude, subjective norms, and perceived behavioural control in shaping consumer intentions. This theoretical foundation is directly relevant to hypotheses concerning consumer intentions to buy LTA products. Tarkiainen and Sundqvist (2005) established that intention serves as a critical mediator influenced by subjective norms, attitudes, and perceived behavioural control, offering a clear theoretical foundation for hypotheses H1, H2, and H3. Specifically, their findings suggest that a positive attitude towards a behaviour (H1), supportive subjective norms (H2), and a high level of perceived behavioural control (H3) are essential to improve consumers' intentions to engage in a specific behaviour, in this case purchasing LTA products. The comprehensive application of the TPB in various sustainable consumption contexts, including the consumption of green products, further endorses these hypotheses (Alam et al., 2020; Paul et al., 2016). These extensions imply that a broader set of attitudes, including those towards sustainability (Honkanen and Young, 2015), could positively influence consumers' intentions H1. Similarly, the significance of subjective norms and perceived behavioural control in predicting consumer behaviour towards green products and environmentally-friendly choices supports H2 and H3, revealing the broad applicability of the TPB in understanding consumer intentions towards environmentally friendly aquatic food products. The literature reinforces these hypotheses and broadens our knowledge of the drivers behind purchasing LTA products.

H1. Attitude positively influences consumers' intentions to buy LTA products.

H2. Subjective norms positively influence consumers' intentions to buy LTA products.

H3. Perceived behavioural control positively influences consumers'

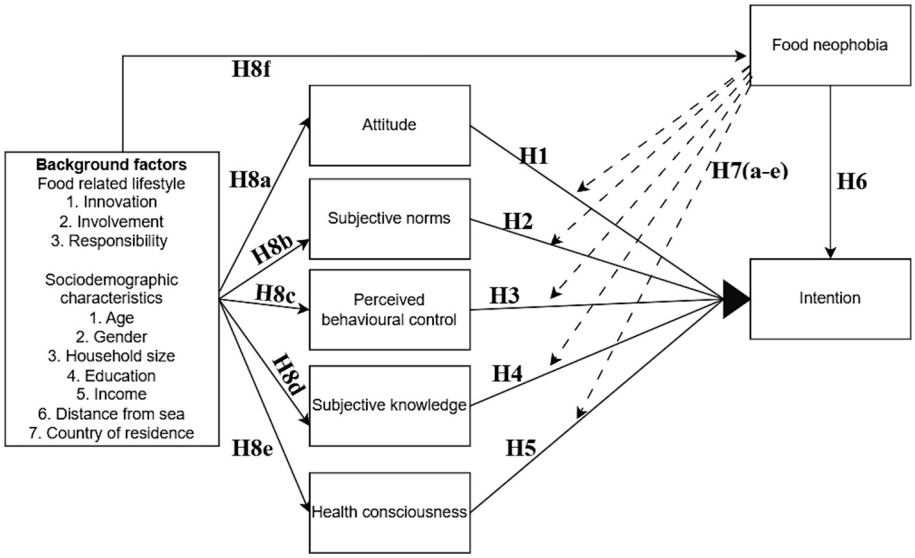

Fig. 1. A proposed extended theory of planned behaviour to understand consumers' intentions to buy low trophic aquaculture products.

intentions to buy LTA products.

2.2. Integrating new constructs into the theory of planned behaviour

Although the TPB captures attitudes, subjective norms, and perceived behavioural control, it may not fully encapsulate the complex interplay of factors driving sustainable food consumption behaviours (Qi and Ploeger, 2021; Ting et al., 2016). The inclusion of other factors such as health consciousness, environmental concerns, subjective knowledge, and food neophobia has been shown to improve the predictability of the model by improving the explanatory power (Armitage and Conner, 2001; D'Souza, 2022). Furthermore, studies have indicated that the incorporation of background factors, such as sociodemographic and lifestyle factors, improves our understanding of complex food choice behaviours (Budhathoki and Pandey, 2021; Menozzi et al., 2015; Pandey et al., 2023a). Thus, we extended the TPB model with additional variables by incorporating subjective knowledge, health consciousness, food neophobia, and background factors (sociodemographic and lifestyle factors) into the original TPB framework. Additionally, we selected these variables based on the extant literature review, and their practical value to policymakers, marketers, business professionals, and practitioners as the findings can easily be combined into their strategies to promote buying intentions towards LTA products in a specific consumer segment.

2.2.1. Subjective knowledge

Subjective knowledge is what a person believes they know about a topic, based on their perceptions and experiences, rather than on factual information or expertise (Aertsens et al., 2011), influences consumer attitudes and purchase intentions towards unfamiliar and new foods (Pieniak et al., 2010a, 2010b). For instance, Chen (2007) found that subjective knowledge affects consumers' perception of control and their intention to buy organic foods. Hartmann et al. (2015) have shown that subjective knowledge affects consumer reactions to unfamiliar foods, such as insects, which often leads to avoidance, while Fernqvist and Ekelund (2014) illustrate how subjective knowledge shapes the perception of food products. Higher subjective knowledge correlates with a greater willingness to consume genetically modified and organic foods, stressing its impact on consumer behaviour (Chen, 2007; Pieniak et al., 2010a, 2010b). Additionally, subjective knowledge influences organic food consumption behaviours and sensory perceptions of food, indicating the broad effects of subjective knowledge on food preferences and risk perceptions (Chryssohoidis and Krystallis, 2005; Hilverda et al., 2017; Lawrence et al., 2009). Subjective knowledge also impacts consumers' purchasing intentions towards alternative food products (Scalco et al., 2017), while highlighting the important role of subjective knowledge in consumer behaviour towards unfamiliar foods such as LTA products.

H4. Subjective knowledge positively influences the intention to buy LTA products.

2.2.2. Health consciousness

Health consciousness significantly influences consumer attitudes and intentions towards LTA products, acting as a catalyst for fostering positive attitudes and enhancing perceived behavioural control, thus encouraging more health-oriented and sustainable consumption patterns (Claret et al., 2012). Health consciousness acts as a facilitator of attitudes and perceived behavioural control (Verbeke, 2005). Its pivotal role is further evidenced by its positive correlation with the intentionality of healthy food consumption, which describes its impact on consumer preferences and decision-making processes (Verbeke et al., 2007a, 2007b). Furthermore, an increased focus on health consciousness is linked to more attentive healthy eating habits, particularly concerning fish consumption, pressing the potential to advance healthier dietary regimes (Huotilainen et al., 2006). Segmentation of consumers based on health-conscious attitudes confirms their importance in sensitive and targeting specific demographics tending towards healthy and sustainable dietary options (Pieniak et al., 2010a, 2010b), while our model accounts for health consciousness as a pivotal construct that is significantly influenced by health-conscious attitudes. Furthermore, the scope of health consciousness extends to influencing the evaluations of packaging attributes and perceptions of food quality, thereby significantly shaping market preferences and consumer choices (Wycherley et al., 2008).

H5. Health consciousness positively influences the intention to buy LTA products.

2.2.3. Food neophobia

Food neophobia is the unwillingness and reluctance to taste new foods and the avoidance of unfamiliar foods, indicating a psychological resistance to new foods (Karaağaç and Bellikci-Koyu, 2023). This reluctance affects food choices, leading to reduced variety, poor nutrient intake, and higher failure rates for new food introductions, as well as negatively impacting the consumption of beneficial foods, such as fish (Damsbo-Svendsen et al., 2017; Pliner and Salvy, 2006). This phenomenon moderates the influence of subjective norms and personal attitudes towards food, suggesting that food neophobia can decrease the willingness of consumers to adopt food products due to unfamiliarity and perceived risks. Research highlights the negative relationship between food neophobia and willingness to try novel foods, indicating that overcoming this barrier is key to enhancing consumer acceptance of LTA products (Choe and Cho, 2011; Cox and Evans, 2008; Reinders et al., 2016; Tuorila et al., 2001). Food neophobia plays a significant role in the development of food products and consumer segmentation, affecting hedonic evaluations of new food products (Henriques et al., 2009; Meiselman et al., 2010).

Integrating food neophobia into behavioural models is essential for identifying and overcoming barriers to the adoption of LTA products. Recognising its impact is fundamental to developing effective strategies that address consumer hesitation, thereby enriching our understanding of the factors influencing consumer intentions and preferences. The literature strongly supports the notion that food neophobia hinders the intention to purchase unfamiliar food products, including LTA product options.

H6. Food neophobia negatively affects the intention to buy LTA products.

H7 (a–e). Food neophobia moderates the effects of attitude, subjective norms, perceived behavioural control, subjective knowledge, and health consciousness on the intention to buy LTA products.

2.2.4. Background factors

Food-related lifestyle, based on the means-end theory of Gutman (1982), was introduced as a segmentation tool with a wider approach to deal with the attributes of product choice, ways of purchasing, food preparation, types of food, and motivations for food (Grunert, 2019). The food-related lifestyle framework identifies food responsibility, food involvement, and food innovation as the core factors influencing sustainable consumption, and their impacts vary by country (Brunsø et al., 2021; Thøgersen, 2017). Food involvement is crucial for shaping consumer attitudes and behaviours, as demonstrated in Taiwan (Fang, 2009); however, food innovation aligns with sustainable development goals despite its complex effects on sustainability (Arcese et al., 2015). Food-related lifestyle instrument is based on the means-end theory of Gutman (1982), which was introduced as a segmentation tool with a wider approach to deal with the attributes of product choice, ways of purchasing, food preparation, types of food, and motivations for food (Grunert, 2019). The food-related lifestyle framework identifies food responsibility, food involvement, and food innovation as the core factors influencing sustainable consumption, and their impacts vary by country

(Brunsø et al., 2021; Thøgersen, 2017). Food involvement is crucial for shaping consumer attitudes and behaviours, as demonstrated in Taiwan (Fang, 2009); however, food innovation aligns with sustainable development goals despite its complex effects on sustainability (Arcese et al., 2015).

Sociodemographic characteristics, such as age, gender, education, and income, significantly affect consumer behaviour towards LTA products (Brough et al., 2016). Furthermore, geographic proximity to the sea influences consumer attitudes and behaviours towards LTA products (Ajzen, 1991; Thøgersen, 2017). Recent studies have expanded on these findings, highlighting that higher income levels are associated with greater acceptance and consumption of aquaculture products and suggesting targeted marketing strategies for different income segments (Budhathoki et al., 2022a; Polymeros et al., 2015; Yi, 2019). Additionally, the social acceptability of aquaculture practices is critical, with consumers in coastal regions showing more favourable attitudes due to their proximity and familiarity with marine environments (Barrington et al., 2010; Martínez-Espiñeira et al., 2015; Risius et al., 2017). Thus, understanding the sociodemographic and geographic factors can help tailor effective marketing and policy strategies to promote sustainable aquaculture practices (Piper et al., 2021).

Therefore, to test the effects of food-related lifestyle and sociodemographic characteristics on consumers' intentions, this study proposed the following hypotheses:

H8 (a–e). Background factors (sociodemographic characteristics and food-related lifestyle components) significantly influence attitudes, subjective norms, perceived behavioural control, subjective knowledge, and health consciousness.

H8 (f). Background factors (sociodemographic characteristics and food-related lifestyle components) significantly influence food neophobia.

3. Methods and materials

This section defines the systematic approach employed to investigate consumer intentions to buy LTA products. The methodology integrates severe data collection, comprehensive questionnaire design, and advanced statistical analysis to ensure robust and reliable findings. The following subsections elaborate on the data collection process, measurement scales, and the analytical techniques used to validate and interpret the theoretical constructs and hypotheses supporting this research.

3.1. Ethical considerations and participant consent

Ethical integrity was ensured through a detailed consent form provided to all participants. The form, outlining the study's purpose, tasks, risks, benefits, confidentiality, time commitment, and contact information, was mandatory reading before participation. Participation was strictly voluntary, with the option to withdraw at any time by closing the survey page. No risks were involved, and data confidentiality was guaranteed for scientific and non-commercial use and reported in aggregated form. Incentives included points redeemable for gift cards or charitable donations. Participants confirmed their consent by selecting "I confirm," ensuring informed and voluntary participation. The ethical approval for the study was reviewed and approved by the Aarhus University ethical committee (BSS-2022-069).

3.2. Data collection

An online questionnaire survey was conducted in three European countries (Denmark, the United Kingdom (UK), and France). These countries are selected based on their production and economic share in the seafood market, consumption of seafood per capita, household income, expenditures for seafood products, and production of LTA products, as well as policies developed to transform aquaculture production with LTA species (European Market Observatory for Fisheries and Aquaculture products, 2021). Denmark is renowned for its trout production and high seafood consumption, supported by strong market growth stemming from a strong tradition in the fish and seafood industries and progressive policies favouring sustainable practices (Andersen et al., 2020; Jacobsen et al., 2016). The UK stands out for its extensive Atlantic salmon production and processing industry, valued at billions, driven by strong seafood demand and a notable preference for fresh fish (Symes and Phillipson, 2019). France is celebrated for its expertise in oysters and mussels, boasting a well-developed seafood market with a high per capita consumption (Gallic, 2013; Andersen et al., 2020; Jacobsen et al., 2016). These countries are also at the forefront of aquaculture innovations, particularly in the cultivation of some LTA species, such as mussels and oysters. These factors collectively provide distinct characteristics for understanding consumer intentions and behaviours towards LTA products in Europe. Thus, data from 1546 consumers (approximately 500 in each country, Denmark, UK, and France) with heterogeneous sociodemographic characteristics were collected through an international market research agency, Norstat.

3.3. Questionnaire and measurement scales

The questionnaire was developed in English and translated into the official languages of two countries (Danish and French). Local seafood experts from each country reviewed the translated surveys. The optimal duration of the questionnaire was set to approximately 15 min, considering the time and capacity of the respondents. The questionnaire consisted of third parts.

In the first part, the respondents were asked to confirm their participation in the survey by asking them to read the purpose of the study, what they would be asked to do, expected risks and discomfort, benefits, confidentiality, time, contact information, and general consent to participate in the survey. The consent section was followed by an overall description of the LTA products.

In the second part, individuals were asked to complete their level of agreement for various statements of the constructs such as the TPB, food-related lifestyles, and food neophobia and their source of adaption (see Supplementary file, Table S1). Brunsø et al. (2021) revised key constructs of food-related lifestyles were used for segmentation: food involvement, food innovativeness, and food responsibility. The TPB variables were measured using a set of statements evaluating attitudes, subjective norms, and perceived behavioural control (Ajzen, 2011), while the Food Neophobia Scale variables were assessed using the Food Neophobia Scale (Pliner and Salvy, 2006) to measure reluctance to try new foods. The statements measuring the food-related lifestyle, the TPB constructs, and the Food Neophobia Scale were measured using a 7-point Likert scale from 'strongly disagree' (1) to 'strongly agree' (7) (Maloney et al., 2014).

The final section of the questionnaire explored participants' prior consumption of LTA products, employing a visual selection method with images to enhance product recognition and a binary response format to identify consumption history (see Supplementary file, Fig. S 1). It assessed consumption frequency using a detailed scale to measure regularity and evaluated the level of agreement with statements about quality perceptions of LTA products through a 7-point Likert scale focusing on sensory, physical, and taste attributes. The survey further explored purchasing behaviours, including locations, preferences for product origin, purchase forms, and consumption methods, alongside sociodemographic queries on household composition, education level, income, employment status, and proximity to the sea.

3.4. Statistical analysis

The collected data were analysed using Statistical Package for the Social Sciences (SPSS) version 28 (IBM Corp, 2021). Initially, descriptive

statistics were used to understand the sociodemographic characteristics and consumption of the overall sample. After conducting descriptive statistics, principal component analysis with eigenvalues >1 was conducted to investigate the variability and interrelationships among the food-related lifestyle constructs: innovation, responsibility, and involvement. The suitability of the data for factor analysis was assessed using Kaiser, Meyer, and Olkin tests. Further, the factor loading of food-related lifestyle constructs was used for K-means clustering to estimate the number of segments. K-means is a widely used and validated method for market segmentation that utilises a machine learning algorithm to associate similar data points and understand the underlying patterns presented (Jain, 2010). Further, to verify the resulting five cluster solutions, "Adventurous", "Uninvolved", "Foodies", "Rational", and "Conservative" we conducted a gap analysis (Malik and Tuckfield, 2019) and cross-validated with previous food-related lifestyle studies (Brunsø et al., 2021). Moreover, a comparison of sociodemographic and lifestyle characteristics between the consumer segments was performed by analysis of variance (ANOVA), Chi-Square test, Fisher's Exact, and Kruskal-Wallis H test.

The structural equation modelling (SEM) approach was used to analyse the proposed extended TPB framework (see Fig. 1). SEM is a powerful multivariate analysis technique appropriate for testing theories with multiple and interrelated dependence relationships (Martínez-López et al., 2013). SEM combines factor and multiple regression analyses, making it an ideal choice for testing complex models. It is also essential to ensure a sufficient sample size, typically 15–20 times the number of measured variables. We used a sample size of 1546 for robustness, which allowed stable and reliable parameter estimates for partial least squares structural equation modelling (PLS-SEM) (Baumgartner and Homburg, 1996; Hair et al., 2014). Before performing the PLS-SEM analyses, factor analysis, reliability, validity (both convergent and discriminant), and multicollinearity of the proposed extended TPB model constructs were determined. This was done in conjunction with partial least squares structural equation modelling (PLS-SEM) using WarpPLS, version 7.0 (Kock, 2022a, 2022b). We applied the Robust Path Analysis algorithm routine with a default inner model analysis (Warp 3 algorithm) and the bootstrapping resampling method (number of data resamples = 999) to test the research hypotheses H1 to H8 (f). The underlying assumption of the model was based on the original TPB model (i.e., a direct path from attitudes, subjective norms, and perceived behavioural control to intention). The model fit was reported using eight goodness-of-fit measures for PLS-SEM: average path coefficient, average R^2 values, average variance inflation factor (AVIF), average full collinearity variance inflation factor (AFVIF), Tenenhaus goodness-of-fit, Simpson's paradox ratio, statistical suppression ratio, and nonlinear bivariate causality direction ratio (Guenther et al., 2023; Kock, 2022b; Pandey et al., 2023b).

4. Results

In this section, we present the research findings. The results include the sociodemographic sample, the segmentation of consumers based on their food-related lifestyle and the path analysis of the proposed extended TPB framework.

4.1. Overall sociodemographic characteristics and consumption

The sociodemographic analysis of respondents from the UK, France, and Denmark shows distinct national profiles that influence consumer behaviour and economic activity (see Supplementary file, Table S2). The gender distribution is nearly equal across all three countries, with a slight male dominance in the UK (51 % of the participants) and a marginally higher percentage of females in Denmark (50.2 %). In terms of age distribution, Denmark has a notably younger population, with 33.7 % of respondents aged 18–34, compared to 29.8 % in the UK, and 29.4 % in France. The education levels of the respondents varied significantly among countries. Denmark shows higher education outside universities, with 40.5 % of respondents achieving this level. In contrast, secondary education is more common in France (25.4 %), while university education, particularly at the undergraduate level, is prevalent in the UK (32.6 %). Income distribution follows a bell-curve pattern in the UK and France, while Denmark shows a more even distribution across income levels, indicating a more equitable income spread. Additionally, a higher percentage of Danish respondents (11.2 %) preferred not to disclose their incomes. Employment status analysis reveals that full-time employment is predominant in the UK (57.8 %) and France (58.5 %), whereas Denmark exhibits a more balanced employment pattern, with a significant portion of the workforce in part-time roles (18.6 %). The UK and France have a slightly higher proportion of self-employed individuals than Denmark.

Considering the respondents' consumption of LTA products, the results revealed a significant preference for certain species across the surveyed countries, including Denmark, France, and the UK, with mussels and oysters being the most consumed species in the three regions. The consumption of sea cucumbers, sea urchins, and seaweeds, such as nori, sea grapes, and wakame, is significantly lower than that of shellfish. The data also indicate a difference in the consumption of abalone, sea cucumbers, and sea urchins, which were less frequently consumed across the surveyed populations (see Fig. 2).

4.2. Segmentation

Exploratory factor analysis confirmed the statistical validity and coherence of the food-related lifestyle components, indicating sample adequacy. The extracted variance was 73.9 %, indicating substantial variability coverage in the dataset. Principal component analysis enhanced factor interpretability, with factor loadings between 0.658 and 0.876 reflecting strong consistency. Components related to food involvement and responsibility showed loadings above 0.65 and 0.7, respectively, suggesting one-dimensionality and strong constructs, with food innovation emerging as a distinct dimension (see Supplementary file Table S3). The results from consumer segmentation (see Fig. 3), characterised by the three food-related lifestyle dimensions (Innovation, Responsibility, and Involvement), yielded five distinct segments: 1) Adventurous, 2) Uninvolved, 3) Foodies, 4) Rational, and 5) Conservative. The 'Adventurous' for high scores in Innovation, the 'Uninvolved' for consistently low scores across factors, the 'Foodies' for their balanced scores with a slight tilt towards Responsibility and Involvement, the 'Rational' for their strong alignment with Responsibility, and the 'Conservative' for their antipathy to Innovation yet a favourable Responsibility score.

4.2.1. Sociodemographic characteristics by consumer segments

The analysis revealed marginal age variation among the groups and moderating age in segment differentiation. The gender distribution was balanced across clusters, with a minor over-representation of females in the conservative segment (56.1 % of the participants). Significant differences appeared in household size, with the rational group favouring smaller households. Educational levels varied significantly, with the Foodies segment having a higher representation of individuals with a master's degree or higher. Employment status differences were modest, with lower full-time employment in the conservative segment. No significant differences were found in monthly household income or distance from the sea. However, the country of residence differed markedly among clusters, with the rational group primarily in Denmark and the conservative group mainly in the UK (see Table 1).

4.2.2. Purchase and consumption habits by consumer segments

Consumers with adventurous eating varied significantly among segments, with the Adventurous and Foodies groups favouring unusual seafood such as wakame and sea urchins, unlike the conservative and rational groups. Sea cucumber consumption was uniformly low across

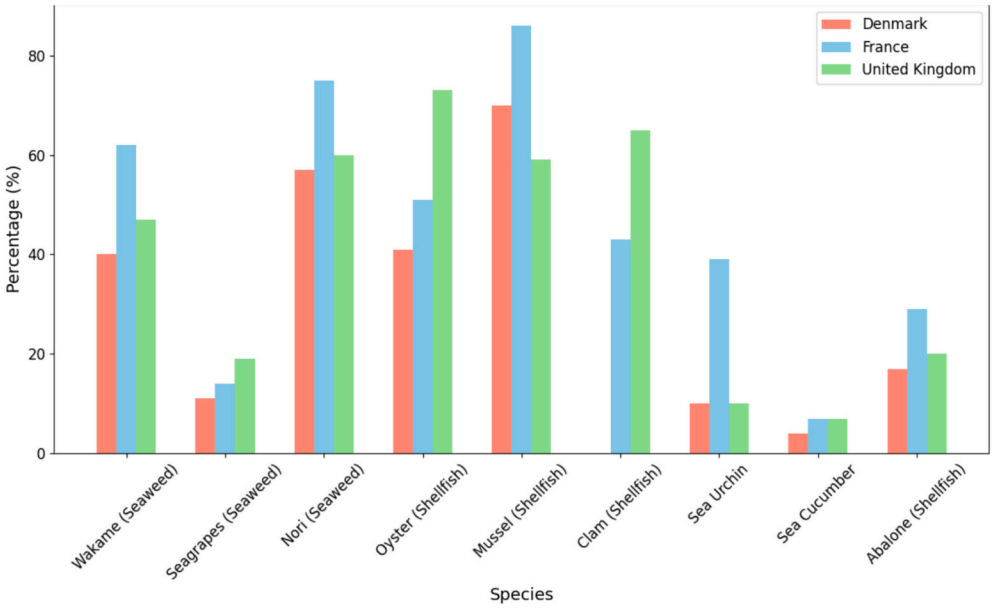

Fig. 2. Distribution of the respondents by previous consumption of low trophic level species.

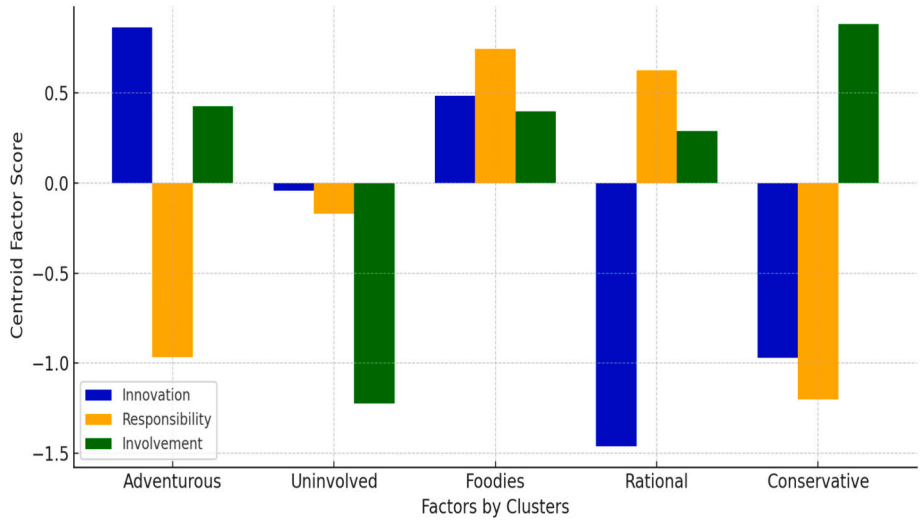

Fig. 3. Cluster factor loadings.

clusters, indicating broader cultural or taste aversion. Significant differences in purchase locations were observed between groups. Foodies, emphasizing quality and variety, frequently shopped at speciality stores (46.7 % of the participants) and engaged in online shopping (9.8 %). In contrast, the rational group, with their functional approach to food, mostly preferred supermarkets (23.7 %).

There was a marked variance in loyalty to products based on geographic origin. The rational segment showed a strong preference for domestic products (34.3 %), reflecting its responsible and sustainability-oriented stance, whereas the conservative segment displayed no predominant preference (43.2 %), indicating less concern about origin as a quality marker. There was a remarkable difference in loyalty to products based on geographic origin. The rational group strongly preferred domestic products (34.3 %) in contrast, the conservative group had no clear preference (43.2 %).

Preferences for the preservation form of seafood also differed significantly, with the Foodies segment predominantly choosing fresh products (80.1 %), in contrast to the conservative and rational segments, which showed a higher tendency towards non-purchase (38.7 % and 33.3 %, respectively), consistent with their conservative and effective positions. Meal context revealed substantial differences, with the Foodies frequently including seafood in warm lunch and dinner dishes, denoting culinary engagement. Conversely, the conservative segment had a higher likelihood of not consuming seafood (34.2 %), reflecting risk-averse food behaviours.

There were significant differences in seafood preservation preferences. The Foodies segment primarily chose fresh products (80.1 %), while the conservative and rational segments were more inclined towards non-purchase (38.7 %, and 33.3 %, respectively). The context of meals also varied notably; Foodies often incorporated seafood into warm lunch and dinner dishes, showcasing their culinary engagement. Conversely, the conservative segment was more likely to avoid seafood consumption (34.2 %), reflecting their risk-averse eating habits (see Table 2).

4.2.3. Quality attributes across consumer segments

Supplementary file, Table S4 presents the median and interquartile range (IQR) values for various quality attributes of LTA products. Safety

Table 1
Distribution of the respondents' sociodemographic characteristics by the segments.

Sociodemographic characteristics	Adventurous	Uninvolved	Foodies	Rational	Conservative	*p*-Value
Age (mean ± SD)	43.13 ± 12.9	43.06 ± 13.4	42.79 ± 12.8	45.71 ± 13.8	43.10 ± 13.7	0.100[a]
Gender, %(n)						0.511[b]
Male	50.6(131)	50.4(210)	52.2(265)	50.7(105)	43.9(68)	
Female	49.4(128)	49.6 (207)	47.8(243)	49.3(102)	56.1(87)	
People in a household, %(n)						0.023[c]
1	19.3(50)	21.5(90)	17.9(91)	26.1(54)	21.3(33)	
2	35.9(93)	33.8(141)	35.4(180)	37.7(78)	36.1(56)	
3	21.2(55)	18(75)	20.9(106)	19.8(41)	15.5(24)	
4 or more	23.6(61)	26.6(111)	25.9(131)	16.4(34)	27.2(42)	
People under 18, %(n)						0.361[c]
0	43.2(112)	43.4(181)	41.7(212)	43(89)	42.6(66)	
1	19.7(51)	15.3(64)	18.7(95)	16.9(35)	12.9(20)	
2	13.1(34)	14.4(60)	15.2(77)	12.6(26)	18.7(29)	
3 or more	4.7(12)	5.3(22)	6.5(33)	1.5(3)	3.4(7)	
Education level, %(n)						<0.001[c]
Primary school	5.8(15)	7.4(31)	1.4(7)	5.3(11)	8.4(13)	
Secondary school	23.6(61)	25.7(107)	17.5(89)	23.2(48)	22.6(35)	
Vocational education	31.3(81)	32.9(137)	30.1(153)	34.8(72)	34.2(53)	
Bachelor's degree	27(70)	18.7(78)	27.6(140)	19.8(41)	20(31)	
Master or above	12.4(32)	15.3(64)	23.4(119)	16.9(35)	14.8(23)	
Employment, %(n)						0.043[c]
Full-time	59.5(154)	53.5(223)	60.4(307)	57(118)	50.3(78)	
Part-time	15.1(39)	14.4(60)	12.4(63)	11.6(24)	15.5(24)	
Self-employment	6.9(18)	6.5(27)	6.5(33)	5.8(12)	2.6(4)	
Seeking a job	3.9(10)	5.8(24)	5.3 (27)	3.9(8)	7.1(11)	
Retired	3.9(10)	6.7(28)	4.5(23)	10.6(22)	7.7(12)	
Others	8.9(23)	10.3(43)	8.7(44)	9.2(19)	13.5(21)	
Prefer not to answer	1.9(5)	2.9(12)	2.2(11)	1.9(4)	3.2(5)	
Monthly household income, %(n)						0.260[c]
£20,000 and under	13.5(35)	19.7(82)	16.3(83)	15(31)	18.7(29)	
£20,000–£39,999	25.9(67)	26.1(109)	26.4(134)	28.5(59)	31(48)	
£40,000–£59,999	15.1(39)	13.9(58)	18.5(94)	17.9(37)	14.8(23)	
£60,000–£79,999	20.1(52)	17(71)	17.3(88)	16.4(34)	14.8(23)	
£80,000 and more	13.9(36)	11.3(47)	13(66)	11.1(23)	12.3(19)	
Prefer not to say/don't know	11.6(30)	12(50)	8.5(43)	11.1(23)	8.4(13)	
Distance from sea, %(n)						0.430[c]
Close (walking distance)	23.2(60)	23(96)	23(117)	23.7(49)	16.1(25)	
Relatively close (by car)	40.2(104)	37.2(155)	38.2(194)	44.4(92)	44.5(69)	
Relatively far	36.7(95)	39.8(166)	38.8(197)	31.9(66)	39.4(61)	
Country, %(n)						<0.001[b]
United Kingdom	33.2(86)	33.1(138)	36.8(187)	27.5(57)	36.1(56)	
France	28.2(73)	38.4(160)	35.2(179)	25.6(53)	20(31)	
Denmark	38.6(100)	28.5(119)	28(142)	46.9(97)	43.9(68)	

SD = Standard Deviation, % = percentage, n = number of participants, £ = Pound Sterling.
[a] ANOVA.
[b] Chi-square.
[c] Kruskal-Wallis H test.

is a significant concern across all segments, with Foodies rating it the highest (median 5, $p < 0.001$). Satisfaction also shows significant differences, with Foodies finding LTA products more satisfying. The taste is rated higher by the Foodies and Adventurous segments, and similarly, pleasant taste ratings are higher among these segments. Pleasant smell ratings are notably higher among Foodies. The Adventurous segment perceives LTA products as less dry, while the Uninvolved segment rates them as fattier (median 3, $p < 0.001$). Firmness is preferred by the Foodies and juiciness is also rated higher by Foodies. Lean texture is rated higher by Foodies, and tenderness is also preferred by them. There are no significant differences in flabbiness ratings among segments ($p = 0.930$), and the fishy taste is consistently rated across all segments (median 4, $p = 0.059$), indicating a common sensory expectation for LTA products.

4.3. Proposed extended Theory of Planned Behaviour Framework

4.3.1. Confirmatory factor analysis, validity, reliability, and multicollinearity tests

The results of the confirmatory factor analysis measuring constructs from the proposed extended TPB framework are shown in Supplementary file, Table S5. The results indicated acceptable convergent validity, as the normalised structure loadings for each construct were reported to be above 0.564 (Cheung and Wang, 2017). Moreover, the value of Cronbach's α and composite reliability was reported to be above 0.75, indicating high reliability and an acceptable index among the construct items (Pallant, 2020). The average variance extracted for each construct was reported to be above 0.563, which is above the minimum threshold of 0.50, signifying convergent validity. The variance inflated factor value was reported to be below 2.8, indicating no multicollinearity (Bowerman and O'Connell, 1990). In addition, the square roots of the average variance extracted from the construct were greater than the correlation coefficients among the constructs (see Supplementary file, Table S6), confirming the discriminant validity of the construct (Hair Jr et al., 2021; Purwanto, 2021).

4.3.2. Goodness-of-fit statistics

The goodness-of-fit statistics are shown in Supplementary file, Table S7 which indicates that the proposed extended TPB framework has a better predictive power for intention than the original TPB framework (adjusted R^2 intention 0.425 versus 0.494). Moreover, predictive power for attitude, subjective norms, and perceived behavioural control was

Table 2
Distribution of purchasing and consumption habits of the respondents by consumer segments.

% (n)	Adventurous	Uninvolved	Foodies	Rational	Conservative	*p*-Value
Past buying/eating						
Wakame (seaweed)	59.8(155)	38.6(161)	64.6(328)	35.7(74)	32.9(51)	<0.001[a]
Sea grapes (seaweed)	15.8(41)	12.9(54)	22(112)	6.8(14)	5.2(8)	<0.001[a]
Nori (seaweed)	78(202)	54.2(226)	75.8(385)	50.7(105)	48.4(75)	<0.001[a]
Oyster (shellfish)	61.8(160)	48.7(203)	66.3(337)	40.6(84)	39.4(61)	<0.001[a]
Mussel (shellfish)	78.8(204)	67.6(282)	80.7(410)	59.9(124)	55.5(86)	<0.001[a]
Clam (shellfish)	40.5(105)	33.6(140)	47.6(242)	15(31)	20(31)	<0.001[a]
Sea urchin	18.1(47)	18.7(78)	27.4(139)	9.7(20)	9(14)	<0.001[a]
Sea cucumber	3.1(8)	7.4(31)	8.7(44)	2.9(6)	2.6(4)	0.756[b]
Abalone	24.3(63)	20.4(85)	28.1(143)	15(31)	10.3(16)	<0.001[a]
Place of purchase[M]						
Supermarket/discount stores	45.6(118)	33.6(140)	49.6(252)	23.7(49)	42.2(39)	<0.001[a]
Online	4.2(11)	5(21)	9.8(50)	2.9(6)		<0.001[b]
Seafood speciality shops	36.7(95)	24.2(101)	46.7(237)	18.4(38)	12.9(20)	<0.001[a]
Straight from farmer	6.9(18)	5.3(22)	9.4(48)	3.9(8)	2.6(4)	0.076[b]
Restaurants	44(114)	29.7(124)	45.5(231)	34.3(71)	27.1(42)	0.011[a]
Asian shops	20.5(53)	12.2(51)	28.5(145)	7.2(15)	9.7(15)	<0.001[a]
Other places	2.3(6)	3.1(13)	2.8(14)	3.4(7)	0.6(1)	0.414[b]
Don't buy (fixed)	13.5(35)	16.1(67)	8.9(45)	17.9(37)	21.9(34)	<0.001[a]
Origin preference						<0.001[a]
Products from my region	12.7(33)	12.2(51)	19.5(99)	15.5(32)	5.8(9)	
Products from my country	20.8(54)	25.4(106)	31.9(162)	34.3(71)	24.5(38)	
Products from EU	10.4(27)	9.8(41)	9.8(50)	7.2(15)	6.5(10)	
Products from non-EU	2.3(6)	3.4(14)	2.4(12)	1(2)	3.2(5)	
Don't know/unsure	15.8(41)	22.3(93)	13.4(68)	19.3(40)	16.8(26)	
No preference	37.8(98)	26.9(112)	23(117)	22.7(47)	43.2(67)	
Consumption form[M]						
Fresh	76.1(197)	59.2(247)	80.1(407)	57(118)	56.1(87)	<0.001[a]
Canned	9.3(24)	10.1(42)	15.4(78)	8.2(17)	3.9(6)	<0.001[a]
Frozen	26.6(69)	19.4(81)	32.1(163)	18.4(38)	11(17)	<0.001[a]
Other processed	6.2(16)	6.5(27)	7.9(40)	3.9(8)	2.6(4)	0.092[b]
Don't buy	17.4(45)	30(125)	11.8(60)	33.3(69)	38.7(60)	<0.001[a]
Meal preference[M]						
Breakfast and cold dish	2.3(6)	3.1(13)	4.5(23)	1.9(4)		
Breakfast and warm dish	2.3(6)	5(21)	5.5(28)	1.9(4)	1.3(2)	
Lunch and cold dish	32.4(84)	19.7(82)	38.2(194)	18.8(39)	12.9(20)	<0.001[a]
Lunch and warm dish	30.5(79)	26.9(112)	38.2(194)	25.1(52)	14.8(23)	<0.001[a]
Dinner and cold dish	49.4(128)	29.5(123)	49.8(253)	31.9(66)	31.6(49)	<0.001[a]
Dinner and warm dish	52.1(135)	46(192)	64.6(328)	47.8(99)	41.3(64)	<0.001[a]
As a snack (anytime)	11.2(29)	9.6(40)	16.9(86)	3.9(8)	5.8(9)	<0.001[a]
Don't eat	17(44)	24(100)	7.5(38)	30(62)	34.2(53)	<0.001[a]

EU = Europe, % = percentage, n = number of participants.
[a] Chi-square test.
[b] Fisher's Exact test.
[M] Multiple choice option.

achieved by including background factors (sociodemographic and lifestyle factors) in the framework. The model determining the moderating effect of food neophobia resulted in similar predictive power for attitudes, subjective norms, and perceived behaviour control, but a slight reduction in intention.

Moreover, the proposed extended TPB framework met all the standard norms requirements (average variance inflation factors = 1.189, average full collinearity = 1.526, Tenenhaus GoF = 0.514, Simpson's paradox ratio = 0.875, R^2 contribution ratio = 0.994, statistical suppression ratio = 0.875, and nonlinear bivariate causality direction ratio = 0.986), thereby representing a good model fit (Kock, 2022a; Tenenhaus et al., 2004). Therefore, the proposed extended TPB framework with subjective knowledge, food neophobia, health consciousness, and background factors (sociodemographic and food-related lifestyle) was retrained to perform PLS-SEM analysis (Kock, 2022a; Tenenhaus et al., 2004).

4.3.3. Partial least square structural equation modelling

The structural analysis of the extended TPB framework gives several critical insights into the determinants of behavioural intention (see Table 3). The results demonstrate that attitude and subjective norms are significant predictors of behavioural intention, each showing medium effects. This finding supports hypotheses H1 and H2, proving the fundamental roles of individuals' positive attitudes towards the behaviour and the perceived social pressure to influence their intentions to buy LTA products. Conversely, perceived behavioural control does not

Table 3
Structural relationships between the constructs and their status.

Paths	Standardised estimates	Standard error	Cohen's f^2	*p*-Value	Hypothesis status
Attitudes to intention	0.278	0.024	0.148	<0.001	H1: Accepted
Subjective norms to intention	0.298	0.030	0.167	<0.001	H2: Accepted
Perceived behavioural control to intention	0.030	0.024	0.011	0.105	H3: Rejected
Subjective knowledge to intention	0.108	0.026	0.047	<0.001	H4: Accepted
Health consciousness to intention	0.069	0.022	0.024	<0.001	H5: Accepted
Food neophobia to intention	−0.228	0.023	0.098	<0.001	H6: Accepted

significantly impact behavioural intention, leading to the rejection of hypothesis H3. This suggests that individuals' perceptions of their ability to perform the behaviour do not substantially contribute to their intention formation in this context. The analysis further revealed the significant influence of additional constructs within the proposed extended TPB framework. Subjective knowledge, health consciousness, and food neophobia significantly affected behavioural intention, supporting hypotheses H4, H5, and H6, respectively. Individuals' self-assessed knowledge about the behaviour, their concern for health, and their dislike of trying new foods were all relevant factors in shaping their behavioural intentions. Moreover, as illustrated in Fig. 4, food neophobia moderated the effects of subjective norms and subjective knowledge on behavioural intention, supporting hypotheses H7b and H7d, while rejecting H7a and H7e. This moderation effect implied that individuals with higher levels of food neophobia are less influenced by social pressures and their subjective knowledge when forming behavioural intentions.

The analysis extended to the relationship between background factors and the constructs of the proposed extended framework, as detailed in Table 4. Food innovation, significantly influenced attitude, subjective norms, health consciousness, and food neophobia. This finding emphasised the importance of individuals' openness to new food experiences in shaping their attitudes and perceptions. Food involvement and food responsibility also appeared as significant predictors across multiple constructs, including attitude, subjective norms, perceived behavioural control, subjective knowledge, health consciousness, and food neophobia. Individuals who were more involved and felt a greater sense of responsibility towards food-related behaviours were more likely to form positive attitudes and perceptions.

Sociodemographic characteristics further explain the multiple relationships between these constructs. Distance from the sea significantly impacts attitude, subjective norms, perceived behavioural control, subjective knowledge, health consciousness, and food neophobia, indicating that geographical proximity to the sea influences individuals' food-related behaviours and perceptions. Age-influenced attitude, subjective norms, perceived behavioural control, subjective knowledge, and food neophobia, but not health consciousness. Gender significantly affected attitude, subjective norms, perceived behavioural control, subjective knowledge, and health consciousness, while household size only significantly affected subjective norms. Education impacted attitude, perceived behavioural control, health consciousness, and food neophobia but not subjective norms or subjective knowledge. Employment affected perceived behavioural control, health consciousness, and food neophobia but not attitude, subjective norms, or subjective knowledge. Income did not significantly influence any constructs of the proposed extended TPB framework. Finally, the country of residence significantly influenced attitude, perceived behavioural control, subjective knowledge, health consciousness, and food neophobia but not subjective norms.

Overall, the broad hypotheses regarding the influence of background factors (H8a to H8e) were not supported, the significant effects observed for specific constructs suggest that background factors play a crucial in influencing consumers' intention to buy LTA products.

5. Discussion

This study extended the TPB with subjective knowledge, health consciousness, food neophobia, and background factors (sociodemographic and lifestyle) to provide a deeper understanding of European consumers' intentions to buy LTA products. The findings from this study identified five segments based on the food-related lifestyle, 1) Adventurous, 2) Uninvolved, 3) Foodies, 4) Rational, and 5) Conservative. Furthermore, this study confirmed the adequacy of the TPB framework for understanding LTA buying intention among European consumers. Furthermore, the extension of the TPB framework to include subjective knowledge, health consciousness, food neophobia, and background factors as additional constructs increased the explained variance of the original TPB framework.

The structural equation modelling analysis results revealed statistically significant relationships among various constructs—attitude, subjective norms, subjective knowledge, health consciousness, and food neophobia—in shaping consumer intentions, consistent with the

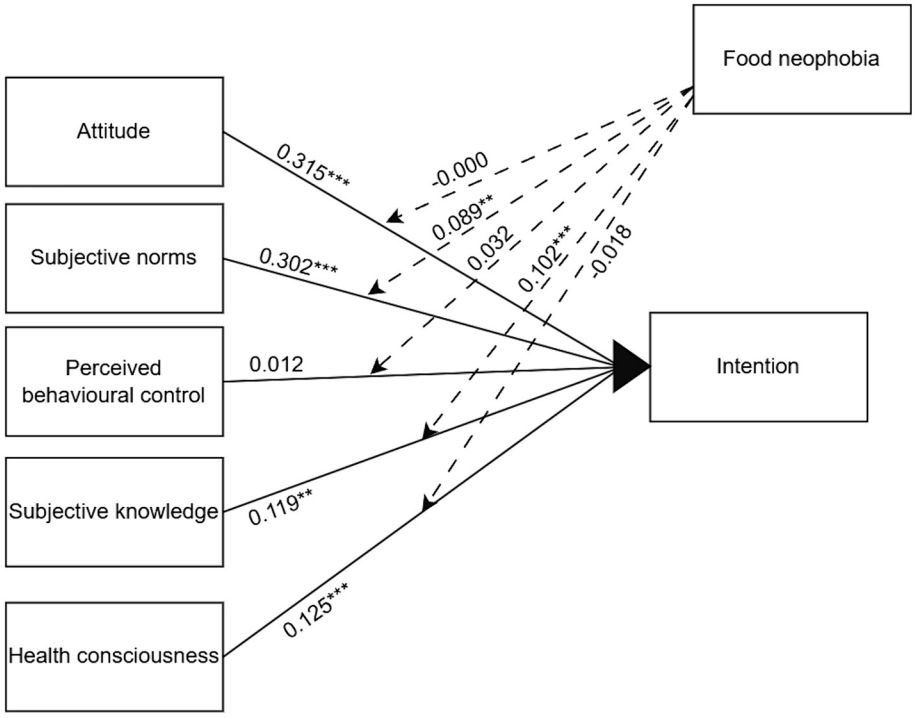

Fig. 4. Moderating effect of food neophobia.
$^{**}p < 0.01$, $^{***}p < 0.001$.

Table 4
Relationship between background factors and constructs.

	Background factors	Attitudes	Subjective norms	Perceived behavioural control	Subjective knowledge	Health consciousness	Food neophobia
Food-related lifestyle	Innovation	0.148***	0.012**	−0.051	0.037	0.204***	−0.021**
	Involvement	0.170***	0.243***	0.108***	0.210***	0.138***	−0.681***
	Responsibility	0.185***	0.223***	0.186***	0.153***	0.420***	−0.050**
Sociodemographic characteristics	Age (40 or less = 1)	0.032*	−0.133***	−0.059***	−0.115*	0.014	0.036**
	Gender (male = 1)	−0.072***	−0.099***	−0.093***	−0.128***	0.058***	0.000
	Household size (2 or less = 1)	−0.078	0.084	0.081	0.101*	0.031	−0.012
	Education (vocational or less = 1)	0.038*	−0.016	−0.036*	0.008	0.044**	−0.048***
	Employment (full time = 1)	−0.008	0.011	−0.041*	−0.003	0.033*	0.069***
	Income (£ 39,999 or less = 1)	−0.025	0.008	−0.013	0.004	0.009	−0.008
	Distance from sea (relatively close = 1)	−0.060***	−0.036*	−0.077***	−0.038*	0.058***	0.032**
	Country (France = 1)	−0.036***	−0.179	−0.183***	−0.183***	−0.068***	−0.145***

£ = Pound Sterling.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

original TPB framework (Ajzen, 1991). Overall, this finding aligns with that reported by Kim et al. (2014). Subjective norms emerged as the strongest predictor of consumer intention, indicating the significant influence of social pressure on purchasing decisions. This was previously shown to be the strongest predictor of certified aquaculture product intention (Yi, 2019), which was further supported by Paul et al. (2016). This finding aligns with prior research that emphasises the role of social influence in consumer behaviour (Ajzen, 1991; Bae and Choi, 2021). Attitude demonstrated a moderate, yet significant influence on intentions, stressing the importance of positive perceptions of LTA products. This result is consistent with previous research that highlights the interaction between consumer attitudes and organic food purchase intentions (Chen, 2007; Wang et al., 2019). The modest impact of subjective knowledge, highlighted by Pieniak et al. (2010a, 2010b), stresses the importance of consumer awareness in decision-making (Jiang et al., 2019). Finally, perceived behavioural control showed an insignificant influence on intentions in this context, suggesting that it may not be a pivotal factor for LTA products. This indicates the need to focus on other constructs, such as attitude and subjective norms, for marketing strategies.

Food neophobia represents a significant psychological barrier that substantially influences consumer behaviour, particularly when trying new and innovative food products, and is emerging as a significant predictor that negatively impacts intention and moderates the influence of subjective norms and subjective knowledge on intention. The challenges raised by consumer knowledge and the focus on familiar species emphasize the impact of food neophobia on consumer behaviour (Aranda et al., 2019). This significant barrier, highlighted in previous studies as a considerable challenge to fear of new foods, poses food-related behavioural intentions (Saba and Messina, 2003; Merlino et al., 2024; Ting et al., 2016). Specifically, food neophobia negatively affects the intention to buy LTA products, which is in line with earlier research on the impact of neophobia on food choices (Henriques et al., 2009; Kallas et al., 2019). This finding underscores the necessity of addressing neophobia to promote LTA product acceptance, especially when encouraging consumers to try new and unfamiliar foods (Meiselman et al., 2010). Overall, the results are consistent with the broader literature on neophobia theory and its application in understanding consumer decision-making processes (Giampietri et al., 2018; Lim and An, 2021; Lobb et al., 2007; Mahon et al., 2006), this barrier's significant role is evident. In parallel with these findings, Henriques et al. (2009) found that neophobia negatively impacts consumer intentions to purchase and consume new food products, particularly those perceived as unfamiliar or unusual while Giampietri et al. (2018) demonstrated that addressing food neophobia is critical in promoting the acceptance of innovative food products. Additionally, food neophobia significantly moderates the impact of health information on consumer choices, which is consistent with our findings (Damsbo-Svendsen et al., 2017). Pliner and Salvy (2006) also noted that neophobia affects sensory evaluations and willingness to try new foods. To overcome the barriers caused by food neophobia, tailored marketing efforts that gradually introduce new products can effectively mitigate adverse effects (Cox and Evans, 2008).

This study found that health consciousness and subjective knowledge had modest impacts on LTA product purchase intentions, which is consistent with prior research. Kumar et al. (2018) have previously suggested the importance of health consciousness in contexts such as luxury seafood and product development. This is supported by Verbeke (2005), who emphasised that health consciousness positively influences attitudes towards healthy eating, which is consistent with our findings. Claret et al. (2012) explored the impact of health-related attributes on consumer preferences for fish products, further supporting our results. Chen (2007) and Pieniak et al. (2010a, 2010b) also noted that consumers with higher health awareness are more likely to adopt health-oriented behaviours, stressing the pivotal role of health consciousness in shaping consumer intentions. Therefore, enhancing health consciousness among consumers has emerged as a strategic priority for promoting LTA products, necessitating targeted marketing and educational initiatives to leverage this pivotal determinant of consumer intention.

The taste of LTA products has emerged as a principal concern across all consumer segments, influencing their quality perceptions. These findings align with Verbeke et al. (2007a, 2007b), who highlighted the crucial role of food quality evaluation in shaping consumption levels and beliefs regarding the benefits and risks associated with fish consumption. This study's results show that sensory attributes, such as taste, satisfaction, and sensory pleasure, are central to defining consumer segments, with the Foodies segment demonstrating the highest concern for these attributes. This underscores the importance of sensory appeal as a key determinant, alongside safety, in influencing consumer preferences for LTA products (Imtiyaz et al., 2021). Building on the general concern for safety, it is evident that enhancing the sensory qualities of LTA products could play a vital role in increasing their acceptance and consumption among different consumer segments.

Adding food-related lifestyle dimensions enriches the application of the TPB framework to explain European consumers' attitudes, subjective norms, health consciousness, subjective knowledge, and food neophobia in influencing the purchase intention of LTA products. The food-related lifestyle's three core dimensions (innovation, responsibility, and

involvement) have a significant influence on attitude, subjective norms, health consciousness, subjective knowledge, and food neophobia. Furthermore, the findings from this study also indicate that the Foodies consumer segment had mostly bought LTA products in the past. The strong interest of Foodies in fresh products can be seen as a search for quality, aligning findings on consumer-oriented product differentiation (Mueller Loose et al., 2013). Considering the place of purchase, Foodies' preference for speciality stores and online shopping would be indicative of their increased concern for quality, aligning with previous findings that good taste and perceived health benefits drive frequent seafood consumption (Cantillo et al., 2021). Huotilainen et al.'s (2006) findings on the Foodies and Adventurous segment's tendency towards innovation and involvement support the value of lifestyle-based segmentation. The importance of product quality evaluation is also highlighted in our study, drawing parallels with Thøgersen's (2017) and Verbeke et al.'s (2007a, 2007b) research on consumer perceptions of fish quality and sustainable food consumption. These perspectives jointly support tailoring LTA product innovations to meet the specific lifestyles and preferences of the different consumer segments.

Sociodemographic characteristics significantly influence consumer intentions through their indirect effects on attitudes, subjective norms, subjective knowledge, and health consciousness. Specifically, factors such as distance from the sea, age, gender, country of residence, employment, and education indirectly shaped intention. For example, older consumers living near the sea are more likely to exhibit food neophilia, whereas those who are older, less educated, and less aware of the health benefits of eating fish tend to be more neophobic towards new fish products, such as Asian carp (Varble and Secchi, 2013). This geographical divide is evident as older consumers close to coastal areas show greater neophilia towards new seafood, while younger inland consumers demonstrate higher food neophobia, consistent with previous studies (Huotilainen et al., 2006). Additionally, women generally display higher health consciousness and a greater intention to purchase LTA products than men, a pattern supported by research on gender-based differences in health-related food choices (Brough et al., 2016; Verbeke and Vackier, 2005). Furthermore, higher education level correlates with greater awareness and acceptance of sustainable food products, indicating that targeted educational campaigns could reduce neophobic tendencies and increase the adoption of LTA products among diverse demographic groups (Budhathoki et al., 2022b; Pieniak et al., 2010a, 2010b).

5.1. Practical implications

The findings of this study provide significant practical implications for marketing strategies and policy formulations targeted at promoting LTA products. First, the strong influence of subjective norms suggests that marketing campaigns should leverage social influences, such as endorsements by popular influencers and community leaders, to shift consumer perceptions and behaviours towards buying LTA products. Given the moderate impact of attitude and the substantial negative effect of food neophobia, educational initiatives that emphasize the benefits of LTA products while addressing fears of unfamiliar LTA products could enhance consumer acceptance. Particularly, increasing familiarity towards LTA products is essential and adding meal descriptions, and hosting tasting events to gradually introduce new LTA products could be effective in promoting LTA products. Furthermore, facilitating consumers to try new innovative LTA products, such as seaweed snacks, may promote LTA products. Such strategies could be effective when targeted to the ‘Foodies’, ‘Adventurous’, and ‘Uninvolved’ consumer segments. Tailored interventions for the ‘Foodies’ consumer segment might have a larger effect on behaviour while targeting ‘Adventurous’, and ‘Uninvolved’ consumer segments might have a larger effect on attitudes and intention. Additionally, targeting younger female consumers, those residing far away from the sea with marketing strategies to influence subjective norms may have a larger effect on intention to buy LTA products. Collectively, these strategies can drive the adoption of LTA products, contributing to sustainable food consumption and broader goals of the blue economy.

5.2. Limitations and future research

Despite these contributions, this study has several limitations that open avenues for future research. The primary quantitative design could be complemented with qualitative methods, such as interviews or focus groups, to gain deeper insights into the motivations and barriers to LTA product consumption. Such approaches could reveal the core psychological, cultural, and background factors that quantitative methods may not capture. The geographical focus on European consumers does not capture the full spectrum of cultural and socioeconomic diversity that influences global seafood consumption. For example, the 18–34 age group represents only 19 % of the French population. This over-representation can be explained by the online survey process, which has a potential influence on consumption patterns. Expanding the scope to include more diverse regions would enable a more comprehensive comparison of consumer attitudes and behaviours towards LTA products. The TPB model may not encompass all factors influencing consumer behaviour towards LTA products. Integrating additional theoretical frameworks, such as the Value-Belief-Norm Theory or the Technology Acceptance Model, could provide a broader understanding of consumer decision-making. Furthermore, we have only investigated the moderating effect of food neophobia, while future studies might also investigate the moderating effect of other factors such as health consciousness. Longitudinal studies are needed to track changes in consumer preferences over time, particularly in response to global sustainability challenges and innovations in aquaculture. Additionally, reliance on self-reported data may introduce biases; therefore, future research could use experimental designs or observational methods to obtain more accurate measurements. Exploring the impact of emerging trends, such as digital marketing, online shopping, and social media, on consumer intentions towards LTA products is crucial. Understanding how these factors influence consumer behaviour can help to develop effective marketing strategies and reduce food neophobia. In conclusion, addressing these limitations through diverse methodological approaches, a broader geographical focus, additional theoretical integration, and consideration of emerging trends will enhance the robustness and applicability of future research.

6. Conclusion

This study advances the literature on consumer behaviour in sustainable aquaculture by applying and extending the TPB framework, addressing a gap in understanding consumer intentions for buying LTA products. By applying consumer segmentation based on the food-related lifestyle, we identified five distinct consumer segments: the ‘Adventurous’, the ‘Uninvolved’, the ‘Foodies’, the ‘Rational’, and the ‘Conservative’. The key findings revealed that subjective norms significantly influenced consumer intentions, followed by attitudes, food neophobia, subjective knowledge, and health consciousness. Perceived behavioural control had an insignificant effect on the intentions to buy LTA products. The substantial negative impact of food neophobia highlights the importance of addressing consumers' fear of unfamiliar foods, particularly seaweed and sea cucumbers. This segmentation of European consumers provides information on the sociodemographic and lifestyle characteristics that influence the intentions for buying LTA products as a sustainable aquaculture product. Targeted strategies are recommended such as educational campaigns for the ‘Uninvolved’ consumers, quality certification for the ‘Conservatives’, novelty promotion for the ‘Adventurous’ and ‘Foodies’, and practical messaging for the ‘Rational’ consumers. These insights are valuable for the aquaculture industry in developing targeted marketing strategies and product differentiation tailored to different European contexts. Despite its geographic and

design limitations, this study lays a foundational framework for future research on sustainable consumer behaviour. Future research should expand the geographical scope, employ qualitative methods to uncover deeper consumer motivations and explore the impact of emerging trends such as digital marketing and social media. Integrating additional theoretical frameworks can provide a more comprehensive understanding of consumer decision-making in the context of sustainable food consumption, enhancing both theoretical and practical contributions to the field.

CRediT authorship contribution statement

Sezgin Tunca: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mausam Budhathoki:** Writing – review & editing, Visualization, Validation, Software, Methodology, Formal analysis. **Karen Brunsø:** Supervision, Funding acquisition.

Declaration of competing interest

The authors declare that they have no conflicts of interest.

Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Appendix A. Supplementary data

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