Nudging the acceptance of insects-fed farmed fish among mature consumers

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The increased demand for aquaculture products is raising concerns over the impact it has on the environment. As a result, policymakers and companies increasingly search for a replacement to fish-based feed, which causes pressures on the stock of wild fish. Insect-based feed is a widely considered as viable solution, due to their positive impact on fish nutrition, and from a circular economy perspective. Yet, consumer acceptance might be limited especially among mature consumers, typically more reluctant to accept novel foods.

This article uses a Structural Equation Model to investigate how information and visual priming influence the acceptability of insect-farmed fish among Italian consumers aged 55 and over. We show that informing or priming consumers with images of the environment and nature can change consumers' beliefs alternative feeds, favouring in turn their attitude towards insect-farmed fish and their consumption intentions.

Our findings support the development of more sustainable aquaculture systems, particularly among conservative consumers.

Keywords: insect-based feed; aquaculture; nudges; information; ageing consumers; Structural Equation Modelling.

Introduction

Aquaculture is a sector that has rapidly expanded over the past few decades, with production of fish and shellfish increasing from 10 million tonnes (Mt) in 1987 to 80 Mt in 2017 (Naylor et al., 2021). According to FAO (2020), currently 52% of per capita fish consumed comes from aquaculture. This percentage is expected to increase in the future as global population increases. The increase in demand for products from aquaculture is particularly important from a nutritional perspective: fish is nutritionally a very important source of protein, rich in essential fatty acids (e.g., omega 3) (de Boer et al., 2020; Sargent & Tacon, 1999), and also lower in environmental impact compared to land-based animals (Leach et al., 2016). Aquaculture has made fish available in areas that would otherwise have had limited or no access to farmed species, often at lower prices, leading to improved nutrition and food security (Asche & Smith, 2018; Belton & Thilsted, 2014; Béné et al., 2016). At the same time, aquaculture reduced the dependence of consumer demand on wild fish, limiting the occurrence of overfishing and supporting the repopulation of species that have been overfished (Davidson et al., 2012; FAO, 2020; Naylor et al., 2021).

Yet, the increased demand for products from aquaculture generates non-negligible environmental challenges. The key challenge is about feeding farmed fish. Fish farming relies heavily on fish-based feeds (Boyd et al., 2022; Naylor et al., 2021), the most widely used alternative, which puts pressure on the (already depleted) stocks of wild fish, and reduces the profitability of farmers, who struggle to pass the higher costs of fish feed in the final price (Arru et al., 2019). Plant-based meals have been widely used as a replacement for fish meal, despite a sub-optimal nutritional profile (Gai et al., 2012; Gasco et al., 2018). Being so dependent on terrestrial crops and wild fish, aquaculture is also reducing resources that could support food security (Troell et al., 2014). More recently, the literature has proposed the use of insect-based feed as a more sustainable alternative to fish meals on several grounds: it has a favourable nutritional composition, which leads to healthier animals (Gasco et al., 2021; Govorushko, 2019); it has a lower environmental impact than its alternatives (Mulazzani et al., 2021); and it better fulfils the task of a circular economy, as insects can feed on waste generated by other food sectors (Gasco, Acuti, et al., 2020).

While regulation and science support the use of insect feeds in aquaculture, there remain questions on consumer acceptance. Consumers generally dislike eating insects (Hartmann et al., 2015; Hartmann & Siegrist, 2016; Onwezen et al., 2021; Verbeke, 2015; Verneau et al., 2016), and the use of insects as feed may face less opposition (Gasco, Acuti, et al., 2020; Sogari et al., 2019). For instance, Verbeke, Spranghers, et al. (2015)

show that consumers are more favourable than farmers on the adoption of insects in animal feed. Similarly, Italian (Mancuso et al., 2016) and British consumers (Popoff et al., 2017) also show a generally positive attitude to insect meal as feed, although differences exist across socioeconomic characteristics and knowledge, while German consumers are indifferent to the use of insect meals as feed in trout production. In Brazil, consumer's acceptance for insect-based feed is higher for fish than for poultry, cattle, and pigs (Domingues et al., 2020). Younger consumer also view favourably the use of insect feeds in aquaculture (Baldi et al., 2022; Naranjo-Guevara et al., 2021); however, a study on Italian consumers aged less than 45 indicate that acceptance decreases with age (Baldi et al., 2022). Problematically, data from Italian consumers shows they are not always ready to purchase the final product, despite strong environmental concerns and positive attitudes towards insect feeds (Laureati et al., 2016; Mancuso et al., 2016), findings that indicate the existence of an attitude-behaviour gap. The literature also suggests that acceptance can increase when information on product safety and taste is available to consumers (Ankamah-Yeboah et al., 2018; Bazoche & Poret, 2021).

In this article, we study acceptance of fish meal in Italian mature consumers, defined as consumers over the age of 55 (Laukkanen et al., 2007; Moschis & Nguyen, 2008). This age group is an important segment of the Italian market: in Italy, 65% of consumers aged 55 and over consume fish at least once a week (ISTAT, 2022, p. 20). Moreover, in developed economies, mature consumers account for a large – and increasing – share of the population (Lutz et al., 2008; United Nations, 2022), with a high purchasing power (Cherry & Asebedo, 2022; Uncles & Lee, 2006). This segment of the population is at a relatively high risk of malnutrition, and recent years have seen a steady increase in research on their nutritional needs, which requires low-fat and nutritious diets, inclusive of regular fish consumption (Alhassan et al., 2017; Bakre et al., 2018; Fotuhi et al., 2009; Jayedi & Shab-Bidar, 2020; Mozaffarian et al., 2005; van Gelder et al., 2007). However, older consumers tend to be less willing to accept novel foods in their everyday life (Stratton et al., 2015), potentially limiting their interest in more sustainable farmed fish fed with insects.

The aim of this study is to explore how we can “nudge” (Thaler & Sunstein, 2008) – that is, increase – acceptance of farmed fish fed with insects in mature consumers by providing information on environmental benefits, as well as priming pro-environmental behaviour. As mentioned above, the literature has shown that information on the environmental benefits of insect feeds can motivate acceptance of fish that was fed with those feeds (Bazoche & Poret, 2021). The second nudge we propose uses a priming task (Friis et al., 2017; Mazar & Zhong, 2010; Papies, 2016; Wilson et al., 2016) to motivate acceptance of fish fed with insects by activating preferences for nature and the environment, which have been shown to be relevant for the consumption of insects-fed farmed fish in previous research (Baldi et al., 2022). Methodologically, we innovate by estimating the impact of these two nudges using a structural equation model (Costa-Font & Gil, 2009; MacCallum & Austin, 2000) that models the relationship between beliefs over fish feeds (Bazoche & Poret, 2021), attitudes towards insects-fed fish (Bazoche & Poret, 2021), and intentions to purchase or consume an innovative product (Albertsen et al., 2020). The focus on intention is dictated by the nature of the product under consideration – insects-fed farmed fish – which is not available on the market.

The reminder of this article is structured as follows. Section 2 presents the background knowledge on the use of insects as feed. The literature on this topic is rapidly expanding (Alfiko et al., 2022; Gasco et al., 2023), and understanding acceptability – particularly in mature consumers, who have set and less malleable preferences within a market – is a key research question. Section 3 presents the Theoretical Framework, which builds on the Theory of Planned Behaviour (Ajzen, 1991), adapting this framework to focus more specifically on the relationship between beliefs, attitudes and intentions. Section 4 describes the data collection process. Section 5 presents the results, which shows that information and priming can increase acceptance of insects-fed farmed fish, and operate by activating beliefs over the naturality of alternative feeds, which in turn changes intentions by activating attitudes towards insects-fed farmed fish. Section 6 discusses and concludes.

Background

The environmental benefits of insects feeds in aquaculture management

Globally, fish and seafood are an important component of diets. According to FAO (FAO, 2020), human consumption of fish and seafood increased from 9.0kg (live weight) in 1961 to 20.3kg in 2017, with an average annual growth rate of 3.1%. FAOSTAT data indicates that yearly per-capita consumption in Italy is around 28.8 kg (+11% in 10 years) (*FAOSTAT*, n.d.). Traditionally, the demand for marine products was satisfied through wild fish; however, the fisheries sector caused significant overfishing, which reduced wild fish stocks and damaged marine ecosystems (Sadovy de Mitcheson et al., 2020). In recent years, supply has steadily shifted towards farmed fish, which can supply fish and seafood with lower levels of harm (Jiang et al., 2022). While more sustainable, aquaculture consumes significant amounts of energy and water, emitting sizeable quantities of greenhouse gases (Jiang et al., 2022), and polluting water (Huang, 1997). An important source of environmental damage in aquaculture is associated to fish feed: fish are often fed with wild fish, the supply of which reduces the existing stocks. Fishmeal are been gradually replaced with plant-based proteins (primarily soya) (Arru et al., 2019; Hua et al., 2019); however, plant feeds have a sub-optimal nutritional profile that hinders fish growth and health, being poor in essential amino acids (Gai et al., 2012; Gasco et al., 2018). Moreover, these feeds are based on extensive crops, whose production exert unsustainable pressure on land (Hua et al., 2019).

Insects, and product obtained by insect processing, are considered one of the most promising ingredients for aquafeed (Tran et al., 2022). Insects are easy to rear, and supply large quantities of high-quality proteins (Veldkamp et al., 2022), and represent a more natural feed for carnivorous species (Henry, Gai, et al., 2018; Henry, Gasco, et al., 2018). The nutritional profile of insect feeds is also superior to plant-based feds (Gasco, Acuti, et al., 2020; Govorushko, 2019), preserving fish health (Gasco et al., 2021; Henry, Gai, et al., 2018), due to bioactive compounds that have antimicrobial, antioxidant and immunostimulant properties (Peng et al., 2022). Insect-based feeds also have a lower environmental impact than plant-based feed (Oonincx & Boer, 2012; Tran et al., 2022). For instance, insects production is based on the bio-conversion of low value substrates, such as food waste, into high value feed (Gasco, Biancarosa, et al., 2020; Smetana et al., 2019), providing a viable, circular economy solution to the aquaculture sector. Overall, life-cycle assessment (LCA) studies indicate that the environmental impact of meat and whey proteins is 2–5 times higher than insect proteins (Smetana et al., 2016). While the use of insect feed in aquaculture is authorised by European law (EU Regulations 2017/893), its use is limited, and a reduction in production costs requires a large-scale adoption (International Platform of Insects for Food and Feed (IPIFF), 2019; Mancuso et al., 2019).

Mature consumers and acceptance of novel food products

Part of the problem of adoption of insect feeds in the production process is driven by concerns aquafarmers have over the quality of the products marketed (Mulazzani et al., 2021; Verbeke, Spranghers, et al., 2015) , particularly as consumers may be unwilling to accept these products (Bazoche & Poret, 2021; Mancuso et al., 2016). A particularly resistant group of consumers are “mature consumers”, defined as those between 55 and 74 years old – a group also known in the literature as aging “baby-boomers” (Moody, 2017). This is a large segment of the population in developed economies (accounting for 38% of the Italian population, and expected to reach 43% in 2030, *OECD Statistics*, n.d.), with strong purchasing power (Uncles & Lee, 2006), and significant assets ownership (Asebedo et al., 2019; Cherry & Asebedo, 2022). The key characteristic of this segment of relevance to this study is that older consumers are generally more conservative in their eating habits (Delaney & McCarthy, 2011; Moschis, 2022), and possess food preferences that are less malleable than younger consumers (D’Antuono & Bignami, 2012; Jezewska-Zychowicz et al., 2021). At the same time, older consumers are characterised by high level of food neophobia, which inhibits the willingness to taste or eat new or different products (Meiselman et al., 2010; Ritchey et al., 2003; Torri et al., 2020). Finally, when choosing new foods older consumers are more safety-conscious than younger people (Bäckström et al., 2003), and show higher levels of food-related risk perception (Siegrist et al., 2020) as well as greater propensity for food disgust (Egolf et al., 2018).

Importantly, the acceptance of insect-fed farmed fish hinges on holding an interest in environmental preservation. Baby boomers are often depicted as a generation greedy in their use and appropriation of natural resources (Willetts, 2011), individualistic and competitive, who view work as an essential element of their lives because it leads to economic security and career success (Jackson et al., 2011). At the same time, research has shown that environmental attitudes and concerns are weaker in older consumers (Diamantopoulos et al., 2003; Liere & Dunlap, 1980; Panzone et al., 2016). Moreover, when having a personal desire to protect the environment, most mature consumers do not get involved in actions supporting environmental protection, despite reporting high levels of social concerns (Jansson et al., 2010; Wright et al., 2003). Finally, when making consumption decisions, for instance when purchasing goods, mature consumers tend to spend more effort searching for information, and process this information intensively (Valkeneers & Vanhoomissen, 2012), and manifest preferences for products that are reliable, fairly priced, and economical (Williams & Page, 2011), rather than environmentally-friendly (Panzone et al., 2016) .

Nudging the acceptance of fish fed with insects in older consumers

As indicated above, mature consumers tend to be more reluctant in the acceptance of novel foods, due to a low utility from new alternatives, and high opportunity costs of trying new products. Part of this problem is psychological: older consumers may give unnecessarily higher value to the status quo (Beenstock et al., 1998), and may be faced with loss aversion when assessing the risk of not liking the new product (Beenstock et al., 1998; D'Antuono & Bignami, 2012; Jezewska-Zychowicz et al., 2021; Johns et al., 2011; Mrkva et al., 2020; Parment, 2013). A way to increase acceptance of novel products is the use of behavioural methods, such as nudges (Cadario & Chandon, 2020; Carlsson et al., 2021; Wensing et al., 2020). Specifically, research indicates that consumers attitudes and preferences are not stable, but malleable, and can be modified by the context in which they operate (Bettman et al., 1998; Bohner & Dickel, 2011; Ropret Homar & Knežević Cvelbar, 2021), or changing the framing of the information (Carlsson et al., 2021; Ropret Homar & Knežević Cvelbar, 2021). More generally, nudging refers to any type of intervention that changes the costs and benefits of an action – that is, it alters the incentives (Kamenica, 2012) – other than the price of the goods in the market, and the structure of the choice set.

Acceptance can be nudged by presenting useful information about the impact of the target behaviour (Wensing et al., 2020) On the specific case of this exercise, the literature seems to converge on the idea that several concerns prevent consumers from fully accepting insects-fed fish: acceptance of farmed fish fed with insects increased in young Italian consumers informed about its nutritional and environmental benefits (Baldi et al., 2022), also increasing in French consumers when informed on the negative effects of overfishing (Bazoche & Poret, 2021). Previous research has also indicated that awareness of the environmental quality of food can encourage consumption of more sustainable seafood species (Carlucci et al., 2015; Giacomarra et al., 2021; Jaffry et al., 2004), as well as farmed fish (Bronnmann & Asche, 2017). As a result, acceptance could be nudged by making relevant information on the sustainability of insects-fed farmed fish available to consumers.

A second barrier to the acceptance of insects-fed fish is the presence of an attitude-behaviour gap, whereby environmental attitudes and beliefs are not active when consumers make decisions involving insects-fed farmed fish (Mancuso et al., 2016). In this case, a nudge could alter behaviour by priming relevant constructs (e.g., beliefs and concerns) that influence consumer choices (Fazio et al., 1986; Mazar & Zhong, 2010; Papies, 2016), with a consequent impact on the choice itself. A nudge based on priming may be effective if it activates attitudes and beliefs on the importance of insects-fed farmed fish; crucially, consumers are expected to hold these attitudes, who are inactive if not primed. As a result, a priming nudge reveals whether consumers hold these attitudes, but are inactive, or not.

Theoretical Framework

Conceptual Model

We model the acceptance of fish products fed with insects using the theory of planned behaviour (Ajzen, 1991), a modelling framework already used to model fish consumption (Higuchi et al., 2017; Verbeke & Vackier, 2005). This theory provides a conceptual relationship between attitudes, subjective norms, and behavioural control, and behaviour as the dependent variable, with intentions playing a mediating role between these variables. Of interest to our study is a better understanding of the role of constructs that can influence attitudes, particularly behavioural beliefs and behavioural concerns (which we refer to as simply "beliefs" and "concerns" in the remainder of the article). Specifically, consumers may not have fully formed attitudes towards farm fish fed with insects, as typical for novel products they have not yet encountered (Brunner et al., 2018; Kempf, 1999; Verbeke, Marcu, et al., 2015). As a result, the response assigned to the attitudinal questions may depend on the beliefs and concerns they may hold (Ahmed et al., 2021; Bamberg et al., 2015; de Groot & Steg, 2007). The structural model used in this research is depicted in Figure 1. The main aim of the model is to determine the pathway through which nudges (information and priming) operate, after adjusting for relevant socio-demographic variables – that is, whether they have a direct or a indirect effect on intentions, or both.

In the empirical exercise, we could not measure actual behaviour, as the products under consideration are not supplied in the market. However, previous research identified that intentions are significantly correlated with subsequent behaviour, although the strength of this correlation is generally moderate (Arts et al., 2011; Chandon et al., 2005; Schwenk & Möser, 2009; Sheppard et al., 1988); notably, this correlation is weaker for novel products, but it increases significantly when consumers are asked about specific – as opposed to generic or abstract – products (Morwitz et al., 2007).

Structural Equation Model (SEM)

To estimate the parameters of the model in Figure 1, we use a Structural Equation Model (SEM), a methodology that merges the feature of a regression with those of a factor analysis (Dilalla, 2000; Ullman & Bentler, 2012). To this extent, imagine a consumer *i*. For this consumer, we observe a set of endogenous variables: their intention to eat fish fed with insects, Y_i; their attitudes towards over insect-feeding in aquaculture A_i; their beliefs over the benefits and naturalness of insect-feeding in aquaculture, B_i; and their concerns over the practice of insect-feeding in aquaculture C_i. Consumers also differ on a set of exogenous demographic characteristics X_i. The structural model corresponds to the system of equations:

$$Y_i = \beta_0 + \beta_1 A_i + \beta_2 X_i + e_i \qquad (1)$$

$$A_i = \alpha_0 + \alpha_1 B_i + \alpha_2 C_i + \alpha_3 X_i + u_i \qquad (2)$$

$$B_i = \gamma_0 + \gamma_1 X_i + \varepsilon_i \qquad (3)$$

$$C_i = \delta_0 + \delta_1 X_i + \nu_i \qquad (4)$$

this system, the variance-covariance matrix is defined as $\Sigma = \begin{bmatrix} \sigma_e^2 & 0 & 0 & 0 \\ 0 & \sigma_u^2 & 0 & 0 \\ 0 & 0 & \sigma_\varepsilon^2 & \sigma_{\varepsilon,\nu} \\ 0 & 0 & \sigma_{\varepsilon,\nu} & \sigma_\nu^2 \end{bmatrix}$,

allowing for non-zero correlation between beliefs and concerns. Notably, all the exogenous constructs are observed into multiple variables that reflect a single latent endogenous variable. The confirmatory factor analysis uses these latent endogenous variables in the regression, and it is done simultaneously with the final regression.

Data

Procedure and participants

Respondents were recruited using an external data provided (Qualtrics) and responded to an online survey link to complete an online questionnaire. Only respondents aged 55 or older were included in the study. The data collection took place from January to March 2022 in Italy. In total, 437 valid responses have been collected.

Structure of the survey

After providing informed consent, respondents had to report their socio-demographic information (age, gender, education, geographic area, household size, income level, whether responsible for household food expenditure). Respondents were then randomized into a treatment, as discussed in Section 4.4. Finally, consumers had to fill a survey, reporting their attitudes, beliefs, concerns, as well as their acceptance to fish products fed with insects. The complete questionnaire can be found in the Online Appendix, and the descriptive statistics of the survey items are reported in Table 1.

Measures

Beliefs on alternative feeds and fish as feed

Two measures of behavioural beliefs were based on Bazoche & Poret (2021). The first measured beliefs towards insects as feed, based on the following questions: (1) I find natural for fish to feed on insects; (2) I find normal for farmed fish to be fed on insect-based feed; (3) I find normal for farmed fish to be fed on plant-based feed (grain and pulses). The second measure of behavioural beliefs regarded fish-based feed and was measured using the following questions: (1) I find natural for fish to feed on other fish; (2) I find normal for farmed fish to be fed on fish-based feed. All questions used a five-point Likert scale, where 1 = “Strongly Disagree” and 5 = “Strongly Agree”.

Concerns

Concerns regarding aquaculture reflected the following questions (Bazoche & Poret, 2021): (1) Fish farming can have negative knock-on effects on the environment; (2) I am concerned about how farmed fish are fed. All questions used a five-point Likert scale, where 1 = "Strongly Disagree" and 5 = "Strongly Agree".

Attitude toward the product

Attitude toward the product was measured using the following items (Bazoche & Poret, 2021): For me, eating fish fed on insect-based feed … (1) is reasonable in the scheme of things; (2) … is just disgusting; (3) …. is good for my health; (4) … is good for the environment; (5) … is a novel experience. All questions used a five-point Likert scale, where 1 = "Strongly Disagree" and 5 = "Strongly Agree".

Intentions to purchase

Intention to purchase was measured using four questions from Albertsen et al. (2020): (1) I intend to buy the product in the future; (2) I am very faithful to the product; (3) The product is worth a higher price than other products; (4) I would recommend the products to my friends. All questions used a five-point Likert scale, where 1 = "Strongly Disagree" and 5 = "Strongly Agree".

Intentions to consume

Intention to consume was based on three questions, adapted from Albertsen et al. (2020): (1) How willing would you be to use the product?; (2) How likely is it that you will integrate the product into your everyday life?; (3) I would be ready to eat farmed fish fed on insect based feed. All questions used a five-point Likert scale where 1 is the lowest score and 5 the highest.

Conditional intentions to consume

A key limitation of the use of statements measuring intentions is the use of terminology that refers to the adoption of a behaviour “no matter what”, that is without considering the context within which a behavioural decision is made (Ajzen, 1991). To better capture the reality of a decision, we also asked conditional intention, defined as “*a commitment to a contingency plan, a commitment about what to do upon (learning of) a certain contingency relevant to one’s interests obtaining”* (Ludwig, 2015, p. 32). In our survey, conditional intentions can account for the behavioural element (e.g., "I would eat farmed fish fed with insects”), as well as the conditions under which this response holds true (e.g., “as long as it is safe to eat”). Conditional intentions were retrieved form the questions of Bazoche & Poret (2021): I would eat farmed fish fed with insects … (1) as long as the foods were safe and fit to eat; (2) as long as the foods did not taste like insects; (3) as long as the food label clearly flags the fact; (4) as long as all insect farming related risks are controlled; (5) as long as the food is not more expensive than another product in the same category. All questions used a five-point Likert scale, where 1 = “Strongly Disagree” and 5 = “Strongly Agree”.

Experimental design

Our experiment consists of a 3 (environmental priming, nature priming, no priming) x 2 (information vs no information) orthogonal design, which interacts information with the 2 nudges. The design leads to six different treatment groups, as explained next.

Control treatment

In this group, participants completed the survey without any stimuli.

Information treatment

In this group, respondents were asked to read a short, informative text that explained the environmental and economic issues related to fish or vegetable-based feed for farmed fish, and introduced the advantages (naturalness, safety, healthiness, and environmental friendliness) of insect-based feed. The full text can be found Appendix A1. Following the literature, the presence of useful information is expected to encourage the acceptance (White et al., 2019): knowledge of the damages caused by aquaculture, and the benefits provided by insect feeds can motivate the choice of insect-fed fish by providing consumers with relevant knowledge that they might not have otherwise had (Baldi et al., 2022; Bazoche & Poret, 2021).

Environmental priming nudge treatment

In this group, respondents were shown pictures related to environmental protection activities (e.g., recycling, bike sharing), extracted from the Affective Climate Images Database (Lehman et al., 2019), and that were meaningful for Italians. A pilot test with 55 respondents was conducted to select the imagines to be included in the final analysis. The six pictures with the highest score that were selected for the final survey are reported in Table 2.

The priming task asked participants to score how much they liked each image, on a scale going from 1 to 10. This rating mechanism was meant to draw their attention to the images (as in Mazar & Zhong, 2010). The priming task is expected to activate pro-environmental attitudes (Fazio et al., 1986) and beliefs (Forwood et al., 2015), in turn affecting consumers intention to purchase and consume.

Nature priming nudge treatment

In this group, respondents were shown a selection of six picture displaying bonding situations with nature (e.g., hiking, waterfalls). All pictures were extracted from the Geneva Affective Picture Database (Dan-Glauser & Scherer, 2011), a database of 730 pictures for emotion induction. No pilot test was conducted since only the six pictures containing nature sceneries with the highest relevance, in terms of arousal and valence, were selected. Two pictures were replaced with images more closely related to the Italian culture. The list of pictures with the corresponding score is reported in Table 3. As in Mazar and Zhong (2010), in order to draw respondents' attention to these pictures, the priming task asked participants to score how much they liked each image, on a scale going from 1 to 10. As before, the priming task is expected to activate attitudes towards nature (Fazio et al. 1986) and related beliefs (Forwood et al., 2015), in turn affecting consumers intention to purchase and consume.

Interactions between Environmental priming nudges and information / Nature priming nudges and information

In the last two groups interacting priming and information, participants read the information page prior to starting the priming task. In this case, priming would be at least *a priori* expected to increase in intensity (Ensaff, 2021): consumers have a clear understanding that insect-feeding can improve the environmental performance of fish from aquaculture being at the same time a natural solution; priming will additionally reinforce the effect of this information, as consumers will engage in the priming task with more precise knowledge of the environmental implications of their intentions.

Empirical results

Characteristics of the sample

The socio-demographic profile of the sample is reported in Table 4. In terms of gender, participants are close to a 50-50 split (with slightly more female participants). Almost half of the respondents are responsible for household food expenditure, therefore more informed about the marketplace. The age distribution shows that the data well captures the generation of baby-boomers. Most respondents (51.72%) have a secondary education, while just less than a third (~30%) attended university. Most of the respondents (53%) lives in families with 3 to 5 members, with one third of the sample living in a 2-member household; only around 11% of the sample lives in single-person dwellings. Finally, 48% of participants are either satisfied or very satisfied with their income, with an additional 40% almost satisfied. A series of Pearson χ^2 tests of independence show that the demographic profile of consumers does not differ significantly across treatment group.

Further results (Table 1) shows that the sample reports an overall low level of concern for the effect of fish farming on the environment (2.88 out of 5), showing more concerns on farmed fish are fed. In particular, mature consumers find most natural for fish to feed on other fish (mean: 4.00 out of 5), slightly less so for farmed fish (3.43 out of 5). Most respondents also found natural for fish to feed on insects (3.88 out of 5), slightly decreasing for farmed fish (3.57 out of 5). The least natural feed for this sample appears to be plant-based feeds (3.20 out of 5). In terms of attitudes, consumers find eating insects-fed farmed fish disgusting (3.75 out of 5), although also good for the environment (3.31 out of 5), reasonable (3.30 out of 5), and a novel experience (3.23 out of 5). Participants are less clear on the link between insects-fed farmed fish and health, scoring on average on the middle of the scale (2.97 out of 5).

Intentions to purchase or to consume are generally close to the middle "neither agree nor disagree" point. Participants report in general an intention to buy (3.33 out of 5), eat (3.32 out of 5), and use (3.20 out of 5) insects-fed farmed fish, also reporting they would buy it often (3.10 out of 5) and integrate it in their own life (3.04 out of 5). Respondents tend to believe this product is not worth more than other products (2.70 out of 5), and are unlikely to recommend the product to friends (2.92 out of 5). An analysis of conditional intention indicates that the purchase of insects-fed farmed fish would be more likely to occur if all insect farming-related risks are controlled (4.03 out of 5), if the information is on labels (3.83 out of 5), if safe to eat (3.72 out of 5), if it is not more expensive that an equivalent product (3.71 out of 5), and if the final product did not taste like insects (3.69 out of 5).

Internal consistency of the scales

SEM performs a confirmatory factor analysis, and is unable to determine how many factors can be derived from the variables in the model, and to what factor these variables are allocated to, a task left to the investigator (Acock, 2013; Costa-Font & Gil, 2009; MacCallum & Austin, 2000). As a result, we conduct an exploratory factor analysis prior to the SEM analysis. To explore the internal consistency of the constructs collected in this survey, we calculate the Cronbach α scores, and perform a factor analysis to determine the number of factors in each scale, and the share of variance explained by the latent variable. In line with our expectations, Table 5 shows that Attitude and Intentions loaded into a single factor, in all cases with $\alpha > 0.8$ (strong internal consistency), and more than 60% of variance explained. Concerns also loaded into a single factor, while beliefs loaded into two factors; in all instances, $\alpha \sim 0.6$ (moderate internal consistency), although the share of variance explained is comparable to the other constructs. Lastly, the correlation coefficients for the three intention variables obtained from the factor analysis using the Regression Method[1] are as follows: Conditional intentions to consume and Intentions to purchase = 0.6406 ($p<0.001$); Conditional intentions to consume and Intentions to consume = 0.6547 ($p<0.001$); Intentions to purchase and Intentions to consume = 0.8703 ($p<0.001$).

SEM Results

Tables 6-8 presents the results of the SEM analysis[2], based on the model of Figure 1. These tables use three different dependent variables: Conditional intentions to consume (Table 6), Intentions to purchase (Table 7), Intentions to consume (Table 8). In all cases, the system includes equations for consumption, attitudes, beliefs and concerns, which are regressed over experimental stimuli – individually and interacted – and demographics. The system of equation allows for correlation between the residuals of the equations of beliefs and concern. The same results are presented in Figures 2-4, which focus on the effects that the experimental stimuli had on beliefs, concerns, attitudes, and intentions.

Figure 5 shows that beliefs on alternative feeds and attitude toward the product (the two factors from the factor analysis), on average, correlate positively, and the relation observed in the control group changes, although with no clear pattern, in the presence of nudges. This correlation is particularly evident when nature priming is used.

Tables 6-8 indicate that stronger beliefs on the value of alternative feeds increases attitudes towards insects-fed farmed fish, while concerns over the environmental and

[1] A method for estimating factor score coefficients. The scores that are produced have a mean of 0 and a variance equal to the squared multiple correlation between the estimated factor scores and the true factor values.

[2] We report three different tables, one for each dependent variable, since a unique estimation of the SEM model failed to reach convergence.

nutritional impact of farmed fish is inversely related to attitudes. As expected, attitudes are positively and significantly related to all intentions and consumption factors, as predicted by the TPB. Results appear to be stable and consistent across models.

Information appears to have the stronger standardised effect on belief of alternative feeds, highlighting the relevance of information as shown in previous research on elderly people (Sherman et al., 2001; Valkeneers & Vanhoomissen, 2012). Moreover, environmental priming appearing slightly more effective in motivating intentions than nature priming, both showing a significant impact on beliefs on alternative feeds. Importantly, we find no evidence of a significant interaction between information and environmental priming; while information interacts negatively with nature priming, weakening the beliefs on alternative feeds compared to the treatments alone.

Results present a very important understanding of the pathway through which the nudges we propose operate. Specifically, information, environmental priming and nature priming impacted intentions by positively increasing the beliefs on alternative feeds, with no impact on beliefs on fish as feed and concerns. The increase in beliefs on alternative feeds in turn increases attitudes towards insects-based farmed fish, which becomes more attractive to eat. Finally, the stronger attitudes towards the product motivate intentions, and remove barriers to adoption; notably, the standardised effect of attitudes on intentions is lowest for conditional intentions, due the better ability to incorporate the "costs" associated to intentions. The results show no residual effect of information and priming on attitudes and no direct effect on intentions. The similar results using conditional and unconditional intentions, probably caused by the hypothetical nature of the behavioural questions, give confidence of the robustness of the structural model, as results replicate using different dependent variables.

In terms of socio-demographic variables, results indicate that age, income satisfaction, and gender do not explain differences in beliefs on fish as feed, concerns, and attitudes. However, respondents who reported more satisfaction with their income held stronger beliefs on insects as feed; while males report stronger intentions to purchase and to consume insects-fed farmed fish. The literature generally finds contrasting results on the significant effects of gender on food neophobia (Meiselman et al., 2010); yet, a gender effect similar to the one observed in this analysis has been observed in other aquaculture related analyses (Baldi et al., 2022; Bazoche & Poret, 2021; Torri et al., 2020).

Discussion

This article investigates how information and visual priming influence the acceptability of insect-farmed fish by mature consumers (those aged 55 and over). We show that providing information, or priming consumers with images of the natural environment and nature can significantly change the intention to consume insects-fed farmed fish. This change in intentions is driven by a change in the beliefs over the use of alternative feeds, a change that is then mediated by more favourable attitudes towards this product. In this section, we contextualise this research by highlighting the relevance of the results to the development of more sustainable aquaculture systems (Naylor et al., 2021; Troell et al., 2014). Albeit focusing on a specific segment of the population, our article also contributes to the debate on how policy can make consumption more sustainable (De Bauw et al., 2022; Taufik et al., 2022), by observing behaviour change in very conservative consumers.

Insect feeds can improve the sustainability of aquaculture system – and consumers will not stand on the way of the market

The steady increase in the production of fish from aquaculture systems has been widely seen as important way to increase fish and seafood with lower environmental damage (Jiang et al., 2022). Aquaculture, however, causes significant environmental and ecological damage in the surroundings of aquaculture farms (Naylor et al., 2021), and can be made more sustainable by shifting to alternative and more sustainable fishmeal, particularly those made of insects, which provide better nutrition (Gasco, Acuti, et al., 2020; Gasco et al., 2021; Govorushko, 2019; Henry, Gai, et al., 2018; Henry, Gasco, et al., 2018; Tran et al., 2022; Veldkamp et al., 2022) and a smaller environmental footprint (Gasco, Biancarosa, et al., 2020; Oonincx & Boer, 2012; Smetana et al., 2016, 2019; Tran et al., 2022). The use of insect feeds is therefore a clear example of instances where innovation brings both economic and environmental benefits. This point is in fertile grounds, as European laws already authorise the use of insect for feed in aquaculture (EU Regulations 2017/893).

A key challenge is the adoption of these products in the marketplace (Arru et al., 2019; Mulazzani et al., 2021). In this study, we interviewed a very conservative and wealthy segment of the population – baby-boomers – who tends to be less attracted to innovation in the food sector (Meiselman et al., 2010; Ritchey et al., 2003; Torri et al., 2020) and is less sensitive to environmental problems than younger segments of the society (Diamantopoulos et al., 2003; Liere & Dunlap, 1980; Panzone et al., 2016). However, this segment also has greater need for a healthy diet, including fish-based meals, and would benefit from the consumption of healthier, leaner fish produced with more sustainable protein sources. The success in changing – even if indirectly – attitudes and intentions in this segment of the population suggests that the barriers to adoption of insects-fed farmed fish can be removed, obtaining significant improvements with relatively little effort. Results in this article also suggest that for this segment of the population barriers are mostly caused by uncertainty over the performance of the product upon consumption, rather than being a total opposition of the product. In fact, consumers highlight potential disgust and concerns over taste; however, these concerns appear easy to overcome when products where consumers have familiarity (fish) are fed with insects (Onwezen et al., 2019; Popoff et al., 2017), as opposed to more complex tasting decisions concerning the consumption of insects, where disgust has more rooted concerns (Hartmann et al., 2015; Hartmann & Siegrist, 2016).

A more prominent problem for the adoption of insects feeds for fish farms, not analysed in this piece, is acceptance from aquafarmers themselves. Mulazzani et al. (2021) observed that the type of business model (small vs. large) as well as the type of product (niche vs. mass) can affect farmers' willingness to switch, partially or fully, to insect meals. For instance, trout farmers, who produce a niche product, may be ready to invest more on this type of feed, but the small scale of the average trout farm limits the ability to conduct all the necessary trials before adoption. In order to increase farmers' acceptance, two urgent challenges need to be addressed. Firstly, the literature indicates that insect-based flours is not as competitive as other feeds: adoption requires economy of scale, that is not easy to achieve in current aquaculture systems (Arru et al., 2019; Mulazzani et al., 2021). This problem may be addressed by an increase in demand for products fed with insects, which can increase the liquidity needed to make such an investment. Secondly, there is still limited evidence on the performance of insect-based feed on fish growth, with mixed and sometimes contrasting results, also with conversion ratios that can vary substantially depending on the type of insect used (see Arru et al., 2019, and references therein). Future research should investigate ways to motivate farmers to replace fish feed with insect feed (Brugere et al., 2021; Chia et al., 2020), in a bid to make aquaculture systems more sustainable and resilient.

What communication is more effective to remove barriers to insects-fed farmed fish?

A key finding of this research is that consumer intention to buy and consume insects-fed farmed fish increases when consumers hold stronger beliefs over the value of alternative fish feeds. As a result, large-scale behaviour change could be driven by information delivered to consumers (Ropret Homar & Knežević Cvelbar, 2021; White et al., 2019). Specifically, our results, in accordance with other studies on the consumer of insect-farmed fish (Bazoche & Poret, 2021; Baldi et al., 2022) indicates that information that clearly highlights the benefit and the naturality of insects feed in fish farming is central to the design of informational campaigns and marketing. Interestingly, concerns over the possible negative knock-on effects of aquaculture on the local environment does not seem to be a (indirect) determinant of the intention to consume insects-fed farmed fish. Rather, what drives this sample of customers is the belief that the feed used for fish is natural. Information can provide this knowledge, with a subsequent positive impact on attitudes toward insects-fed farmed fish, which in the scale used in this research includes disgust, a significant barrier for the adoption of novel foods (Egolf et al., 2018; Siegrist et al., 2020). Information may also help reduce neophobia (Torri et al., 2020). Consequently, marketing and policy efforts to encourage the consumption of fish fed with insects requires removing these barriers and increasing the belief that it is natural for fish to feed on insects.

At the same time, the priming task suggest that the use of relevant images, related to nature and the environment, on labels and advertising can motivate consumers to buy and consume insects-fed farmed fish. The priming nudges instead influence the emotional and affective sphere of consumers (Bargh et al., 1992; Fazio et al., 1986; Mazar & Zhong, 2010), with limited need for cognition. This type of communication effort is effective for mature consumers, and potentially to the broader market. The effectiveness of priming reveals that mature consumers hold relevant values on the preservation of the natural environment. Rather, results suggest these values are not active when consumers make decisions in the marketplace. This problem may be caused by consumers not associating environmental damage to food consumption (Bronnmann & Asche, 2017; Siegrist et al., 2015) – aquaculture in this particular case – or due to attentional problems caused by the complexity of the marketplace (Gregoire, 2003; Moschis et al., 2011). The use of effective images may be able to ensure environmental values are used by intervening precisely when consumers are considering their choices in the marketplace.

Crucially, our results show that when information and priming appear jointly, they have a negative effect on beliefs. More precisely, the net joint effect remains positive – the joint presence strengthens beliefs – but it is lower than the sum of the individual effects. The result is somewhat unexpected, as information would be expected to resound more prominently when priming activates beliefs over the naturality of alternative feeds. However, there appears to be some reactance, where the cognitive sphere – activated by information – conflicts with the affective and emotional sphere of the consumer. Notably, the information provided to consumers was fairly factual, and did not contain information expected to change the emotional state of the consumer, and this might have weakened its effectiveness. Indeed, it is known from the literature that different types of information influence consumers' attitudes towards products differently, as in the case of insects-based food (Lombardi et al., 2019) or fish (Marette et al., 2008).

Future research should explore this result, to understand under what conditions nudges and information can lead to positive – as opposed to negative – synergistic effects.

Concluding remarks

Understanding consumer acceptance of new products that consumers are reluctant to accept is key to ensure the successful new product development. This is particularly important for the introduction of insects within the supply chain, which is considered a key step for the development of sustainable food systems, including aquaculture systems, for their low production costs and high protein content. While consumers may not yet be ready to eat insects, their use in aquaculture as feed could be a viable alternative pathway to gradually bring them into the supply chain, with important benefits for producers and consumers. We hope this piece of research will inspire academics and producers to find innovative ways to remove barriers for marketing insects-fed farmed fish, with the overall aim of reorienting the current aquaculture system towards a more sustainable future.

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Appendix A1. Information treatment – textual stimulus

To meet the increased demand for fishery products as a result of the expected increase in world population, current fish production would have to be tripled.

Globally, 50 percent of fish production comes from farms.

Currently, farmed fish are mostly fed with vegetable meals (e.g., soy-based) or fishmeal. However:

- Plant meals are a popular food, but, in nature, carnivorous fish do not eat plant protein sources;
- Fishmeal would represent an ideal food for carnivorous fish (salmon, sea bream, sea bass, trout), but the amounts that can be produced have now reached a sustainable maximum;
- It is important to remember that in nature many fish feed on insects.

Insect meal in animal feed is currently a booming sector. Such meals represent a sustainable food since they are obtained from insects that are specially raised and fed from resources that would find no better use, such as, for example, food waste. Insect farms also have low land and water consumption and reduced greenhouse gas emissions.

Flours obtained from insects have a high protein content (even over 60 percent), and are therefore particularly good for fish, whose diet requires high protein requirements.

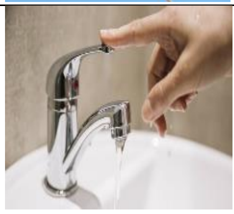
Finally, several studies have shown how the use of insect meal can have a positive effect on the health of fish, and consequently on humans.

Table 1. Items used in the questionnaire and their characteristics (N = 437)

Group	Item	Mean	S.D.
Beliefs – alternative feed	I find natural for fish to feed on insects	3.88	1.27
	I find normal for farmed fish to be fed on insect-based feed	3.57	1.27
	I find normal for farmed fish to be fed on plant-based feed (grains and pulses)	3.20	1.29
Beliefs – fish	I find natural for fish to feed on other fish	4.00	1.09
	I find normal for farmed fish to be fed on fish-based feed	3.43	1.25
Behaviorual concerns	Fish farming can have negative knock-on effects on the environment	2.88	1.14
	I am concerned about how farmed fish are fed	3.43	1.22
Attitude	For me, eating fish fed on insect-based feed is reasonable in the scheme of things	3.30	1.30
	For me…...is just disgusting*	3.75	1.27
	For me….is good for my health	2.97	1.16
	For me….is good for the environment	3.31	1.23
	For me….is a novel experience	3.23	1.27
Conditional intentions to consume	I would…as long as the foods were safe and fit to eat	3.72	1.37
	I would….as long as the foods did not taste like insect	3.69	1.44
	I would ….as long as the food label clearly flags the fact	3.83	1.35
	I would….as long as all insect farming-related risks are controlled	4.03	1.34
	I would….as long as the food is not more expensive than another product in the same category	3.71	1.35
Intentions to purchase	I intend to buy the product in the future	3.33	1.31
	I would buy this product often	3.10	1.24
	The product is worth a higher price than other products	2.70	1.19
	I would recommend the product to my friends	2.92	1.24
Intentions to consume	How willing would you be to use the product?	3.20	1.29
	How likely is it that you will integrate the product into your everyday life?	3.04	1.27
	I would be ready to eat farmed fish fed on insect-based feed	3.32	1.42

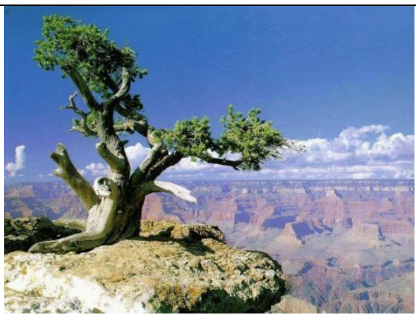
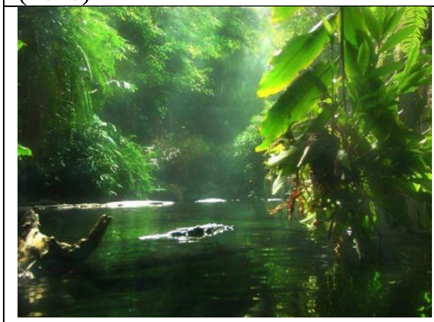
Note: All scales were ordinal, going from 1 to 5.

Table 2. Pictures included in the pilot test and then selected for the environmental priming

Picture	Pilot test average score	Picture	Pilot test average score
	7.78		6.61
	7.78		7.24
	7.41		7.15

Source: Affective Climate Image Database (Lehman et al., 2019). The score reported in the Table is the average score, on a scale from 1 to 10, obtained by pictures in our pilot study.

Table 3. Pictures included in the nature priming

Picture	Score	Picture	Score
 (P050)	148.90	 (P088)	132.03
 (P070)	133.53	 (P114)	124.71
 (P065)	132.92	 (P072)	112.11

Note: the score is given by the picture Valence and Arousal as reported by the authors in the original database. The picture id is reported in parentheses.
Source: Geneva Affective Picture Database (Dan-Glauser & Scherer, 2011)

Table 4. Socio-demographic characteristics of the sample

Variable	Category	N.	%	Pearson χ^2	p-value
Age	55-59	207	47.37	19.98 $^{n.s.}$	0.173
	60-64	133	30.43		
	65-69	55	12.59		
	>=70	42	9.61		
Gender	Male	215	49.20	4.49 $^{n.s.}$	0.482
	Female	222	50.80		
Education	Primary school	12	2.75	11.48 $^{n.s.}$	0.718
	Middle school	68	15.56		
	Secondary school	226	51.72		
	University	131	29.98		
Household size	1 member	50	11.44	12.76 $^{n.s.}$	0.620
	2 members	146	33.41		
	3-5 members	235	53.78		
	6+ members	6	1.37		
Income level satisfaction	Very dissatisfied	50	11.44	20.55 $^{n.s.}$	0.152
	Almost satisfied	173	39.59		
	Satisfied	147	33.64		
	Very satisfied	67	15.33		
Responsible of household food expenditure	Always	217	49.66	15.41 $^{n.s.}$	0.422
	Often	155	35.47		
	Sometimes	61	13.96		
	Never	4	0.92		

Note: the chi2 statistic refers to a Pearson test of independence across different treatment groups. Statistical significance is as follows: *, 10%; **, 5%; ***, 1%, n.s. Not Statistically Significant

Table 5: Internal consistency analysis for the scales used in the SEM.

Factor	Items	Cromb ach's alpha	% of varianc e
Beliefs – alternative feed	I find natural for fish to feed on insects I find normal for farmed fish to be fed on insect-based feed I find normal for farmed fish to be fed on plant-based feed (grains and pulses)	0.604*	64.9%
Beliefs – fish	I find natural for fish to feed on other fish I find normal for farmed fish to be fed on fish-based feed	0.614*	
Concerns	Fish farming can have negative knock-on effects on the environment I am concerned about how farmed fish are fed	0.614	72.2%
Attitude	For me, eating fish fed on insect-based feed is reasonable in the scheme of things For me…...is just disgusting For me….is good for my health For me….is good for the environment For me….is a novel experience	0.821	61.1%
Intentions to purchase	I intend to buy the product in the future I am very faithful to the product The product is worth a higher price than other products I would recommend the product to my friends	0.873	72.9%
Intentions to consume	How willing would you be to use the product? How likely is it that you will integrate the product into your everyday life? I would be ready to eat farmed fish fed on insect-based feed	0.927	87.6%
Conditional intentions to consume	I would…as long as the foods were safe and fit to eat I would….as long as the foods did not taste like insect I would ….as long as the food label clearly flags the fact I would….as long as all insect farming-related risks are controlled I would….as long as the food is not more expensive than another product in the same category	0.906	72.9%

* Since the same Factor Analysis returned two different factors for the Beliefs, also a joint Cronbach's alpha for Beliefs on alternative feed and Beliefs on fish feed was also computed and was equal to 0.612.

Table 6: SEM results: Conditional intentions to consume

	Conditional intentions to consume	Attitude toward the product	Beliefs on alternative feeds	Beliefs on fish as feed	Concerns
Attitude toward the product	0.703***				
S.E.	(0.031)				
Beliefs on alternative feeds		0.752***			
S.E.		(0.039)			
Beliefs on fish as feed		0.041			
S.E.		(0.051)			
Concerns		-0.085*			
S.E.		(0.044)			
Gender	-0.044	0.013	0.078	0.036	-0.089
S.E.	(0.039)	(0.036)	(0.049)	(0.063)	(0.063)
Age	-0.023	0.02	0.029	0.068	-0.086
S.E.	(0.039)	(0.036)	(0.030)	(0.062)	(0.061)
Income	0.023	-0.014	0.104**	0.011	-0.03
S.E.	(0.039)	(0.036)	(0.049)	(0.061)	(0.057)
Information	-0.078	0.077	0.254***	0.024	0.078
S.E.	(0.067)	(0.062)	(0.082)	(0.104)	(0.102)
Environmental priming	0.072	0.035	0.171**	0.08	0.145
S.E.	(0.064)	(0.060)	(0.080)	(0.101)	(0.102)
Nature priming	0.105	-0.008	0.165**	-0.087	-0.03
S.E.	(0.063)	(0.059)	(0.080)	(0.099)	(0.096)
Information + environmental priming	-0.037	-0.024	-0.147	-0.062	-0.016
S.E.	(0.071)	(0.065)	(0.089)	(0.113)	(0.114)
Information + nature priming	0.002	-0.03	-0.194**	0.083	0.046
S.E.	(0.071)	(0.066)	(0.089)	(0.110)	(0.107)
Covariances					
Beliefs insects, Beliefs fish	0.384***				
S.E.	(0.058)				
Beliefs insects, Concerns	-0.159***				
S.E.	(0.064)				
Beliefs fish, Concerns	-0.026				
S.E.	(0.077)				
LL	-12147.303				
LR test of model vs. saturated:	553.31***				
N	437				

Note: Statistical significance is as follows: *, 10%; **, 5%; ***, 1%,. The table reports the model standardized coefficients and the standard errors (in parentheses). The non-standardized coefficients are available upon request, Gender is a dummy equal to 1 for men, and 0 otherwise; Age is a dummy equal to 1 for respondents aged 65 and older; Income is a dummy equal to 1 for respondents with an at least satisfactory income level. Each stimulus variable (information, environmental priming, nature priming, interaction between information and priming) is a dummy equal to 1 when the respondent was treated with the corresponding stimuli.

Table 7: SEM results: Intentions to purchase

	Intentions to purchase	Attitude toward the product	Beliefs on alternative feed	Beliefs on fish as feed	Concerns
Attitude toward the product	0.843***				
S.E.	(0.020)				
Beliefs on alternative feeds		0.795***			
S.E.		(0.036)			
Beliefs on fish as feed		0.023			
S.E.		(0.048)			
Concerns		-0.082*			
S.E.		(0.042)			
Gender	0.108***	0.017	0.079	0.037	-0.092
S.E.	(0.031)	(0.035)	(0.049)	(0.063)	(0.062)
Age	-0.031	0.020	0.030	0.069	-0.088
S.E.	(0.032)	(0.035)	(0.50)	(0.062)	(0.061)
Income	0.023	-0.015	0.104**	0.010	-0.030
S.E.	(0.032)	(0.035)	(0.49)	(0.061)	(0.058)
Information	-0.019	0.055	0.254***	0.025	0.081
S.E.	(0.054)	(0.060)	(0.082)	(0.104)	(0.102)
Environmental priming	0.018	0.025	0.172**	0.081	0.149
S.E.	(0.051)	(0.057)	(0.081)	(0.101)	(0.101)
Nature priming	0.032	-0.021	0.165**	-0.087	-0.028
S.E.	(0.051)	(0.057)	(0.080)	(0.099)	(0.097)
Information + environmental priming	0.011	-0.015	-0.148	-0.064	-0.021
S.E.	(0.057)	(0.063)	(0.089)	(0.113)	(0.114)
Information + nature priming	-0.012	-0.016	-0.194**	0.082	0.043
S.E.	(0057.)	(0.063)	(0.089)	(0.110)	(0.108)
Covariances					
Beliefs insects - Beliefs fish	0.384***				
S.E.	(0.058)				
Beliefs insects, Concerns	-0.162***				
S.E.	(0.063)				
Beliefs fish, Concerns	-0.022				
S.E.	(0.079)				
LL	-11272.182				
LR test of model vs. saturated:	424.34***				
N	437				

Note: Statistical significance is as follows: *, 10%; **, 5%; ***, 1%. The table reports the model standardized coefficients and the standard errors (in parentheses). The non-standardized coefficients are available upon request, Gender is a dummy equal to 1 for men, and 0 otherwise; Age is a dummy equal to 1 for respondents aged 65 and older; Income is a dummy equal to 1 for respondents with an at least satisfactory income level. Each stimulus variable (information, environmental priming, nature priming, interaction between information and priming) is a dummy equal to 1 when the respondent was treated with the corresponding stimuli.

Table 8: SEM results: Intentions to consume

	Intentions to consume	Attitude toward the product	Beliefs on alternative feed	Beliefs on fish as feed	Concerns
Attitude toward the product	0.831***				
S.E.	(0.021)				
Beliefs on alternative feeds		0.796***			
S.E.		(0.036)			
Beliefs on fish as feed		0.025			
S.E.		(0.050)			
Concerns		-0.076*			
S.E.		(0.043)			
Gender	0.130***	0.016	0.080	0.037	-0.094
S.E.	(0.031)	(0.035)	(0.050)	(0.063)	(0. 062)
Age	-0.054*	0.019	0.031	0.069	-0.091
S.E.	(0.031)	(0.035)	(0.050)	(0.062)	(0. 061)
Income	0.042	-0.015	0.104**	0.010	-0.030
S.E.	(0.031)	(0.035)	(0.50)	(0.061)	(0. 058)
Information	-0.028	0.053	0.257***	0.025	0.085
S.E.	(0.053)	(0.060)	(0.083)	(0.105)	(0. 103)
Environmental priming	0.000	0.022	0.176**	0.081	0.154
S.E.	(0.051)	(0.058)	(0.081)	(0.101)	(0. 102)
Nature priming	0.020	-0.020	0.165**	-0.087	-0.025
S.E.	(0.051)	(0.057)	(0.080)	(0.099)	(0. 098)
Information + environmental priming	0.037	-0.012	-0.151*	-0.064	-0.027
S.E.	(0.056)	(0.063)	(0.089)	(0.113)	(0. 116)
Information + nature priming	0.015	-0.015	-0.196**	0.082	0.040
S.E.	(0.057)	(0.064)	(0.089)	(0.110)	(0. 110)
Covariances					
Beliefs insects, Beliefs fish	0.386***				
S.E.	(0.058)				
Beliefs insects, Concerns	-0.165***				
S.E.	(0.064)				
Beliefs fish, Concerns	-0.018				
S.E.	(0.080)				
LL	-10614.862				
LR test of model vs. saturated:	386.1***				
N	437				

Note: Statistical significance is as follows: *, 10%; **, 5%; ***, 1%,. The table reports the model standardized coefficients and the standard errors (in parentheses). The non-standardized coefficients are available upon request, Gender is a dummy equal to 1 for men, and 0 otherwise; Age is a dummy equal to 1 for respondents aged 65 and older; Income is a dummy equal to 1 for respondents with an at least satisfactory income level. Each stimulus variable (information, environmental priming, nature priming, interaction between information and priming) is a dummy equal to 1 when the respondent was treated with the corresponding stimuli.

Figure 1

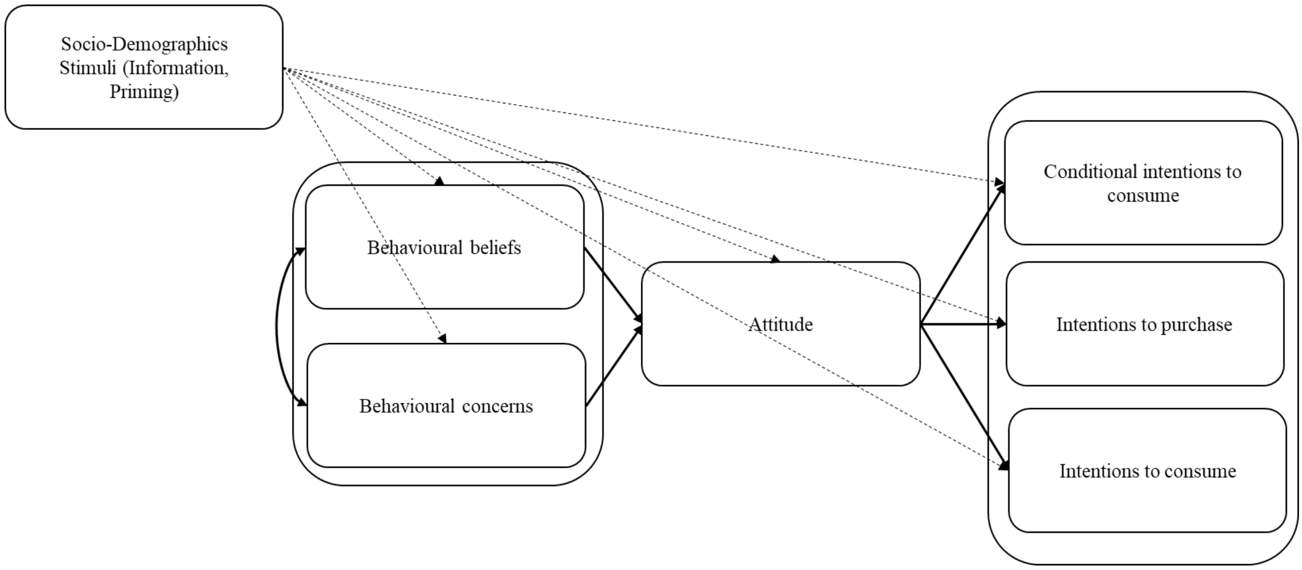
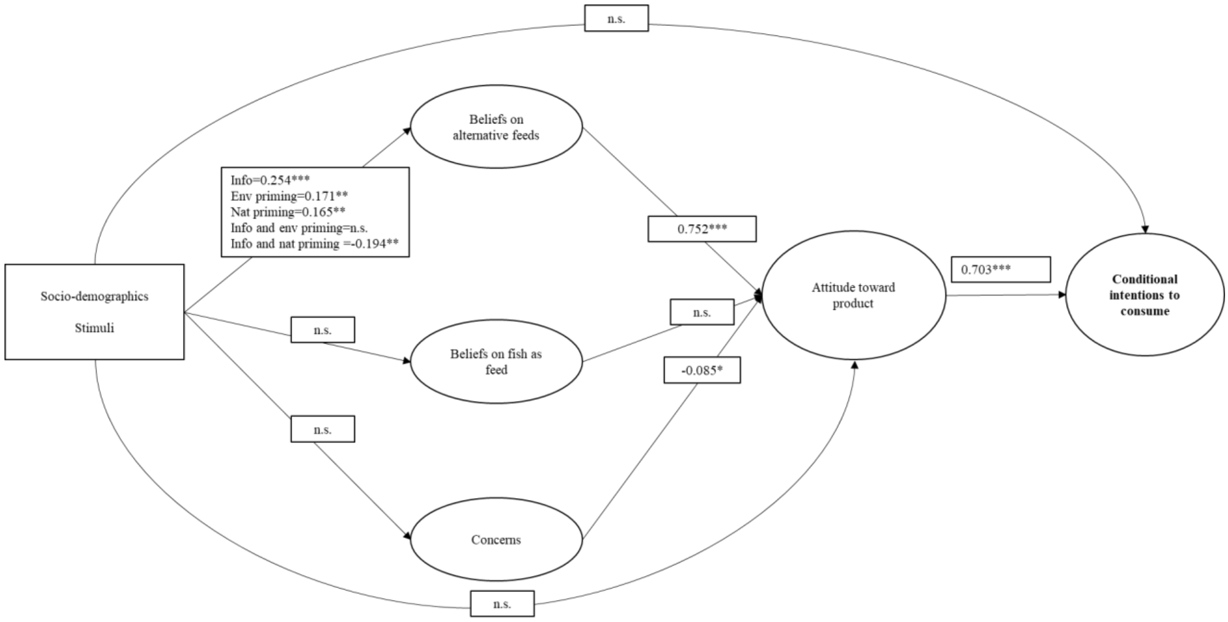
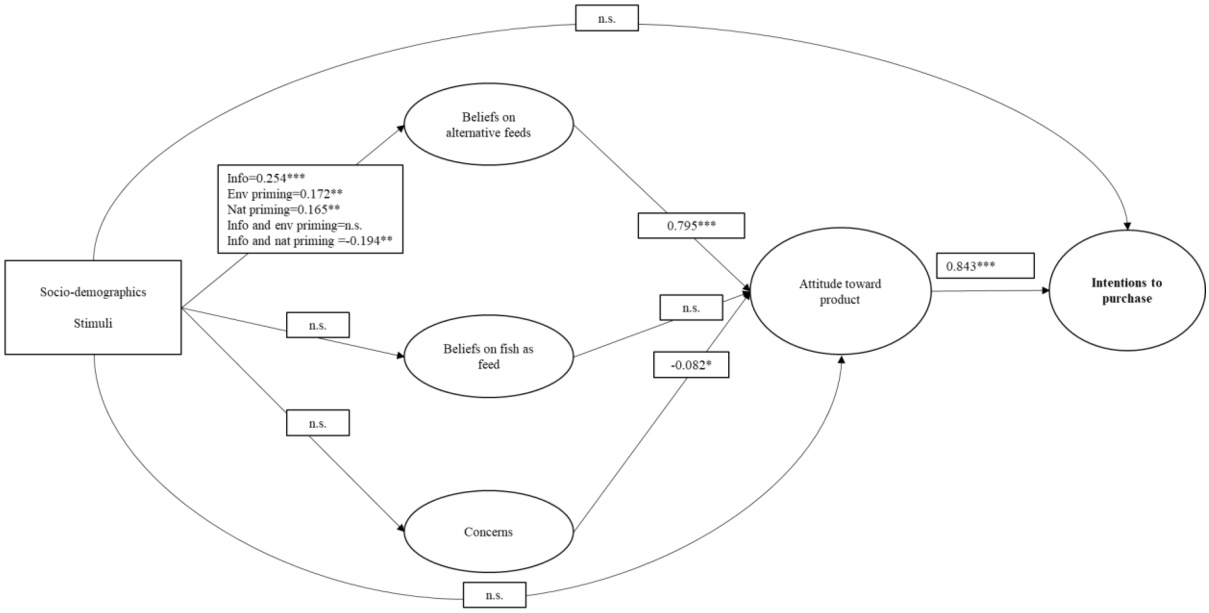

Socio-Demographics
Stimuli (Information,
Priming)
Behavioural beliefs
Behavioural concerns
Attitude
Conditional intentions to consume
Intentions to purchase
Intentions to consume

Figure 2



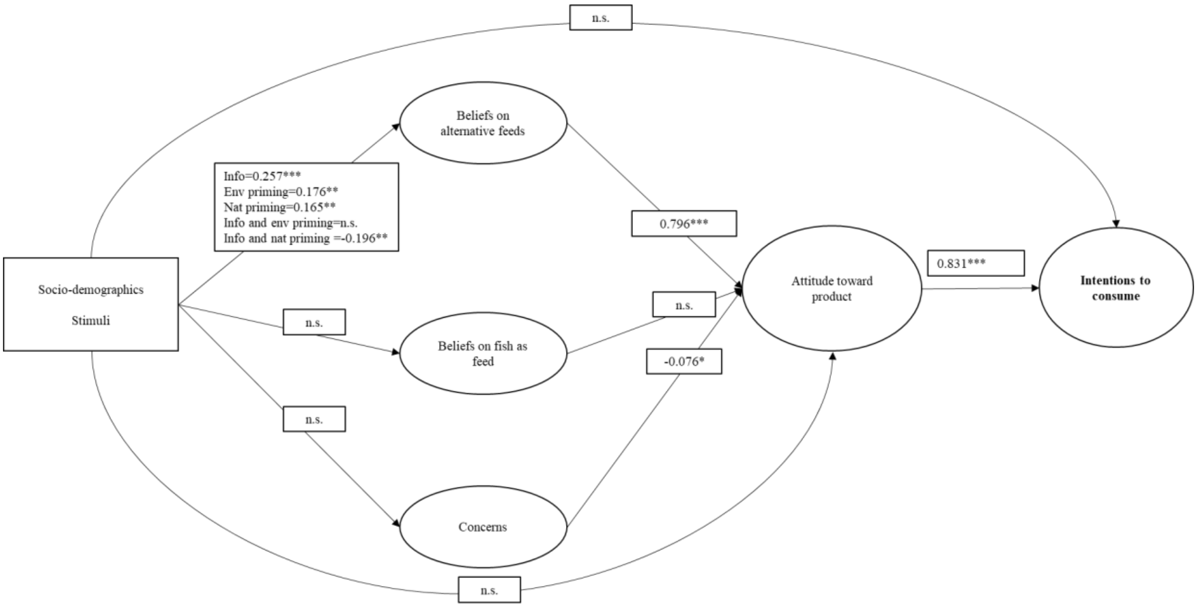
Statistical significance is as follows: *, 10%; **, 5%; ***, 1%; n.s. means Not Statistically Significant

Figure 3



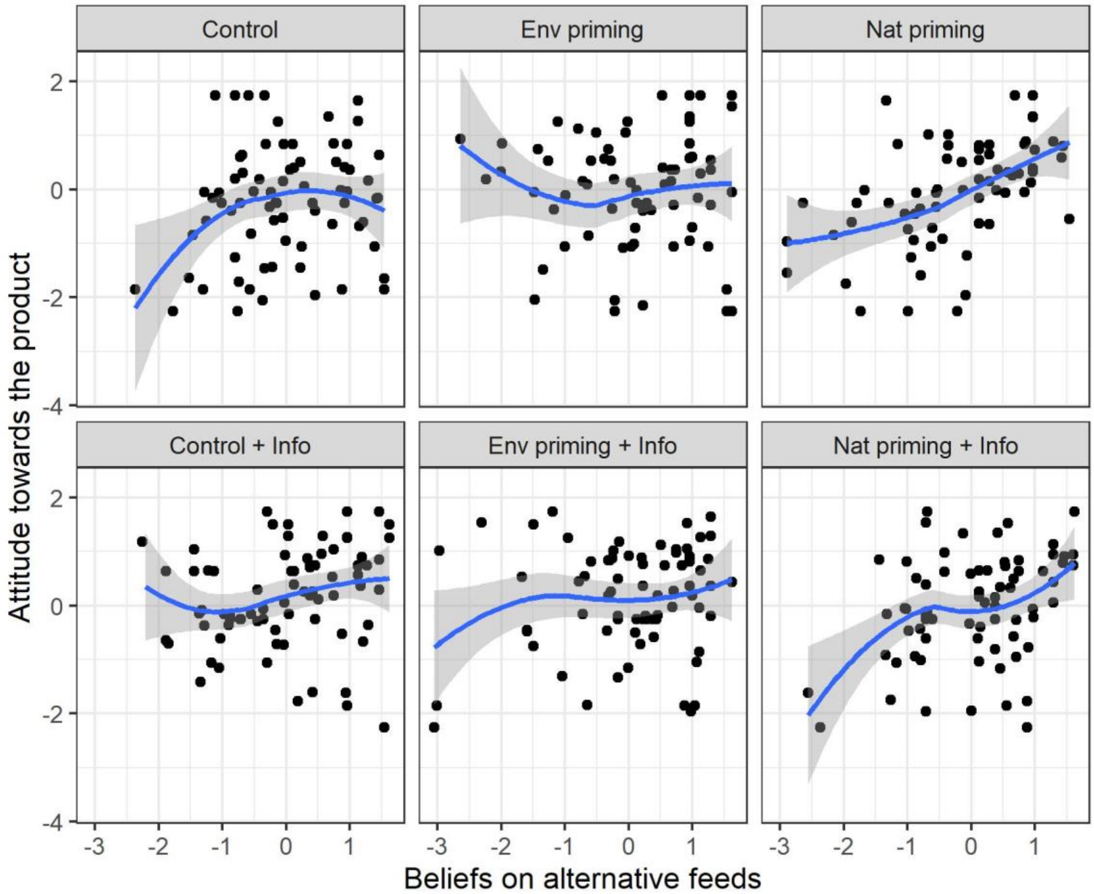
Statistical significance is as follows: *, 10%; **, 5%; ***, 1%, n.s. means Not Statistically Significant

Figure 4



Statistical significance is as follows: *, 10%; **, 5%; ***, 1%, n.s. means Not Statistically Significant

Figure 5



The Figure above displays the Local Polynomial Regression Fit between Beliefs on alternative feed and Attitude toward the product (obtained from a Factor Analysis with the Regression Method, see footnote 1), and estimated with span and degree both equal to 1.

Figure captions

Figure 1. Theoretical model

Figure 2. SEM results – Conditional intentions to consume

Figure 3. SEM results – Intentions to purchase

Figure 4. SEM results – Intentions to consume

Figure 5. SEM results – Relationship between Beliefs on alternative feed and Attitude toward the product