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How Information Influences Consumers' Perception and Purchasing Intention for Farmed and Wild Fish

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ABSTRACT

Aquaculture has increased significantly in recent decades and, if managed sustainably, it could contribute to food security and safety. However, several studies have found the evidence that European consumers prefer wild fish relative to farmed fish. Hence, it becomes crucial to provide accurate information on aquaculture products. This study aims to examine the influence of consumers' perceptions and knowledge on their intention to purchase farmed and wild fish. A sample of 804 Italian consumers participated in a survey which included an information treatment. Participants perceived that wild fish tastes better and is more nutritious than farmed fish; further, they considered farmed fish to be cheaper, safer, and more ethical than wild fish. A logit regression was conducted whose results show that several factors, such as fish preference,

attitude, and subjective knowledge, affect consumers' intention to purchase. In addition, participants in the treatment group were found to have higher intentions to purchase farmed fish than those in the control group. Therefore, information strategy is crucial to promote the consumption of farmed fish.

Key words: Aquaculture, Attitude, Italy, Knowledge, Sustainability

1. Introduction

The world population is expected to increase to 9 billion by 2050 with a consequent growth in the demand for food, including fish consumption (Food and Agriculture Organization, FAO, 2020). Fish products could play an important role in providing high quality nutrients both in the developed and developing countries. In 2018, the world average annual fish consumption per capita was 20.5 kg with a global fish supply of approximately 179 million tonnes (FAO, 2020). Fish products are supplied from two main sources, namely, natural stocks (54%) and aquaculture practices (46%), as per the data observed in 2018 (FAO, 2020). The global aquaculture production was 114.5 million tonnes in live weight in 2018 with an estimated value of 263.6 USD billion (FAO, 2020).

Despite this increasing shift in world trend of fish production from aquaculture (from 25.7% in 2000 to 46% in 2018), the growth rate of the European aquaculture sector has remained constant (FAO, 2020). In the 27-European countries and the UK, aquaculture production including that of fish, crustaceans, and mollusks was estimated to be 1,372,012 tonnes of live weight in 2017, representing only the 1.2% of the total world aquaculture production (European Commission, 2020a). In 2017, the EU citizen consumed an average of 24.4 kg of seafood (European Commission, 2020a).

In Italy, according to estimation by European Market Observatory for Fisheries and Aquaculture (EUMOFA), the consumption of fishery and aquaculture products reached

approximately 31 kg of live weight per capita in 2018. Due to this value, which is higher than the EU average, Italy ranks seventh among the EU member states (EUMOFA, 2021). The estimation of Italian aquaculture production including fish and shellfish was 142,726 tonnes, generating a business value of around 439 million euro in 2018. Farmed fish with a volume of 50,154 tonnes represented 27% of the total Italian fish production. Farmed trout, sea bass, and seabream are the most commercialized fish species with mean price values of 3.0, 8.0 and 7.6 euro/kg, respectively (EUMOFA, 2021).

Farmed fish is perceived by consumers to have less positive image as compared to wild fish (Claret et al., 2014; Reig et al., 2019; Vanhonacker et al., 2013). This is considered as one of the possible reasons for production stagnation and the consequent low consumption rate of farmed fish in Europe. For instance, farmed fish is considered to be of a lower quality than wild fish (Claret et al., 2014; Verbeke et al., 2007b, 2005), especially in terms of taste and health aspects (Cardoso et al., 2013; Claret et al., 2016, 2014; Rickertsen et al., 2017). This might be due to the limited and often incorrect information made available on this sector, especially by the media (Amberg and Hall, 2010, 2008; Govaerts, 2021; Olsen and Osmundsen, 2017; Phuc, 2016). For instance, studies in Italy (e.g., Carlucci et al. 2015; Pulcini et al. 2020) show the limited and often incorrect information regarding aquaculture in the media and among consumers. Thus, it becomes crucial to create awareness and provide reliable information regarding aquaculture products to consumers (Feucht and Zander, 2017; Polymeros et al., 2015).

Existing literature suggests that there exists a relationship between knowledge and consumer purchasing decision (Aertsens et al., 2011; Brucks, 1985; Demartini et al., 2021; Flynn and Goldsmith, 1999; Hoque and Alam, 2020; Pieniak et al., 2010a). Subjective knowledge is the individual's perception of how much they knows or is familiar with a product or choice (Brucks, 1985; Park et al., 1994). Objective knowledge refers to what a consumer actually knows about (Brucks, 1985). However, these two components tend to be unrelated as Kruger and Dunning (1999) found that people with limited objective knowledge tend to overestimate their knowledge,

while expert individuals tend to underestimate their competencies. Therefore, in this study, objective and subjective knowledge and their effects on purchasing intention were investigated.

Several studies have investigated individual's perception (opinion) of fish using belief statements about safety, quality, and healthiness (Altintzoglou et al., 2011; Claret et al., 2016, 2014; Jacobs et al., 2015; Pieniak et al., 2010c; Verbeke et al., 2005). However, there are some studies that have focused on their perception toward sustainability, ethical concerns in the fish sector, and their impact on consumer decision-making (Banovic et al., 2019; Bronnmann and Asche, 2017; Maesano et al., 2020; Uchida et al., 2014; Verbeke et al., 2007b; Yi, 2019). Today, it is crucial to investigate how the public perceives the fish sector, considering the increasing consumer demand for more sustainable food (Cerroni et al., 2019) and concerns about animal welfare (Pulcini et al., 2020). While conducting a study on Belgian consumers, Verbeke et al. (2007b) found that sustainability and ethics with respect to fish were considered to be important by them. However, future studies need to investigate how beliefs toward sustainability and ethical concerns can directly influence the purchase intent of both wild and farmed fish.

The objective of this study is to investigate the potential gap between consumer perception and scientific evidence related to wild and farmed fish, and the impact of information on attitude and purchase intent in Italy. Specifically, the research questions are as follows. 1) What are the main issues that are related to knowledge, uncertainty, and misconceptions in consumer perception of fish products? 2) Can information improve the understanding of the aquaculture sector and thus contribute to a positive attitude toward farmed fish? 3) What are the main factors which shape the purchase intention of wild and farmed fish? By addressing these questions, we explored the underlying consumers purchasing intention and role of knowledge, such that any related policy communication strategy is properly targeted and helps to undertake informed choices.

The structure of this paper is as follows. Section 2 describes how the study was conducted. Section 3 presents the results of the study on fish perception. Section 4 discusses the results

comparing with literatures. Finally, in Section 5, we provide recommendations to help the industry and authorities in the domain of public health and focus on formulating future fish consumption information to reduce uncertainty about aquaculture products and farming practices.

2. Material and Methods

2.1 Data Collection and Sample

Cross-sectional data were collected through an online survey conducted in Italy from July to September 2020. The survey instrument was uploaded on Qualtrics®, an online survey platform, and distributed among a convenient sample of Italian food primary shoppers. The online survey link was distributed through advertisement on social media platforms and food websites. In total, 1493 individuals participated in the survey. Participants were excluded from the survey if they reported that they were minors, were not primary food shoppers, did not purchase fish in the last 12 months, or did not complete the questionnaire. The final sample comprised 804 valid respondents.

2.2 Measures

The questionnaire comprised several sections, including purchase habits, consumer fish involvement, preferences for wild fish, perceived importance of sustainability, ethics of fish production and consumption, subjective knowledge, objective knowledge, misconception of the fish sector, and attitude and purchase intent toward farmed and wild fish. Finally, socio-demographic questions were presented.

The first section consisted of general questions about consumer habits (Menozzi et al., 2020; Perez Cueto Eulert et al., 2011). Consumption frequency of fish with respect to fresh, frozen, canned, smoked, and ready to eat fish was asked (Almost every day, 3 to 4 times a week, 1 or 2 times a week, 2 to 3 times a month, once a month or lesser, few times a year, never). Consequently, the responses were coded to “Less than once a week” and “More than once a

week." We also collected information regarding different points of purchase (fish shops or fishmongers, supermarket, discount, online channel, direct from fish catchers, and others). These questions specifically considered consumers' habits before the COVID-19 crisis. Moreover, it was specified in the questionnaire that the word "fish" was referring to finfish of saltwater and freshwater origin, and did not include mollusks, cephalopods, and crustaceans.

In the perception section of the questionnaire, a number of well-established scales was used to measure "Consumer involvement" (Banovic et al., 2019; Perez Cueto Eulert et al., 2011), "Preferences for wild fish" (Tomić et al., 2017), "Perceived importance of sustainability and ethics related to fish" (Verbeke et al., 2007b), "Subjective knowledge" (Claret et al., 2014; Perez Cueto Eulert et al., 2011; Pieniak et al., 2007; Verbeke et al., 2007b), "Attitude toward farmed and wild fish" (Perez Cueto Eulert et al., 2011; Verbeke et al., 2007b), and "Purchase intention" (Banovic et al., 2019; Boase et al., 2019). Details of the items on each scale are presented in the Appendix (Table A1).

All the items were measured on 7-point Likert scales with endpoints of "strongly disagree" (1) and "strongly agree" (7), excepting in the case of the attitude items. Six 7-point semantic differential scales were used to measure attitudes in response to the following statements: "Eating wild fish is…" and "Eating farmed fish is…." The six attitudes use the following endpoints: unhealthy/healthy; not nutritious/nutritious; unfavorable/favorable; unethical/ethical; unsafe/safe; and expensive/cheap.

In the objective knowledge section, participants' objective knowledge was measured using nine statements originally developed by the authors and based on scientific evidence (see Table 1 in Information Treatment section). Five-item scales (false, maybe false, do not know, maybe true, and true) were used to measure objective knowledge (adapted from Boase et al. 2019). First, "Maybe false" was recoded as "False" and "Maybe true" was recoded as "True," such that it could be considered whether the responses were correct, false, or the consumers did not know the answers. If a participant said True when it was True, or False when it was False, their response

was rated as “Correct” (1). If the participants said True when it was False, or False when it was True, their response was rated as “Incorrect” (0). The response “Don't know” was rated as “0”. An aggregated scale of consumers’ objective knowledge about fish was computed for each participant by summing the number of correct answers.

Finally, we asked about various demographic and socio-economic characteristics to the consumers: gender, age, education, employment status, household income, and area of residence (*that is*, living near coastline).

A pilot test (*n* = 30) was conducted for clarity of content, language or wording, and overall understanding. Further, the questionnaire was revised prior to the administration.

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Research Ethics and Integrity Committee of the Italian National Research Council (Protocol Number: 0029841). At the beginning of the survey participants were asked to provide consent that they were willing to participate in it.

2.3 Information Treatment

Since information provision can affect consumers’ decision to purchase fish (Hoque and Alam, 2020), we decided to test the impact, randomizing our sample into two groups: (1) control group without information provision and (2) treatment group with information provision. Respondents were asked nine questions related to the most common misconceptions about wild and farmed fish. In the treatment group, participants received correct information about farmed and wild fish every time after they responded to the question in the objective knowledge section.

Figure 1 shows an example of a question in the objective knowledge section. Participants in the control group would only see a question, respond to it, and then move to the next question without receiving any feedback on whether the response was correct or not. However, the participants in the treatment group would receive feedback to their answer on every question,

regardless of whether the response was correct or not and the explanation of it. The questions' order was the same for all participants for technical reasons.

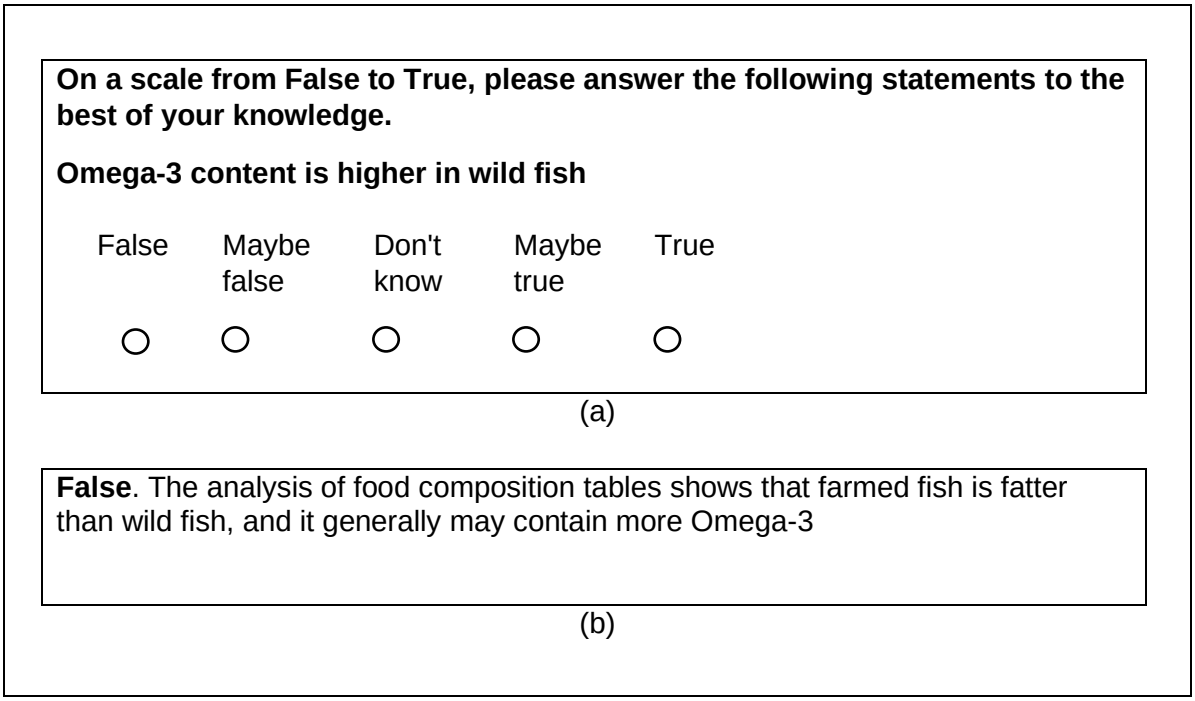

Figure 1. Example of a question in the objective knowledge section. (a) Participants both in control and treatment groups saw a question and responded to it. (b) The answers in the form of a pop-up box-after responding to the question; only the participants in treatment group received a pop-up box feedback, including explanation, regardless of whether the response was correct or not. The pop-up box appeared after every question for the treatment group.

The explanatory text, based on the current scientific evidence, was developed by the authors after conducting a critical review of the current literature in the aquaculture sector and a discussion with two technical experts in the field of fish farming. Three topic categories of scientific evidence related to wild and farmed fish were included: Healthiness (nutrition) and Quality, Safeness and Quality, and Animal Welfare. Each one has three statements for a total of nine questions (see Table 1).

[Insert **Table 1** here]

2.4 Analyses and Model Specification

The descriptive statistics obtained from the 804 questionnaires were calculated using Statistical Package for the Social Sciences, SPSS 27.0. The Pearson Chi-square and Mann–Whitney U tests for independent samples were performed in order to determine the existence of significant differences between the control and treatment groups regarding socio-demographic data, fish consumption, knowledge, and beliefs on farmed *versus* wild fish. A logistic regression model was employed to analyze the influence of the different factors on the intention to purchase farmed or wild fish.

A logistic regression was used to predict the outcome of a binary categorical dependent variable based on predictor variables. This method can be used to analyze consumers' intention to purchase healthy food and sustainable products (Güney, 2019; Klein et al., 2019; Wongprawmas et al., 2021). In this study, consumers were asked whether they intended to purchase (1) farmed fish and (2) wild fish.

The dependent variable "purchase intention" was related to the responses to the questions: "I intend to purchase farmed fish in the near future" and "I intend to purchase wild fish in the near future," using a 7-point semantic scale. Further, the responses of the question were recoded to binary responses. Answers from 1 to 4 were coded as 0, which was ''no purchase intention'' and answers from 5 to 7 were coded as 1, which was ''purchase intention''. The first group ''no purchase intention'' included also the "neutral" value (that is, value 4), since the participants did not express an intention to purchase fish. In addition, 5 being the median value for all the items and thus the cutting point, allowed us to divide the sample into two different groups with a balanced number of participants for both farmed and wild fish. Therefore, each consumer's choice is represented by a dummy variable:

$$y_i = \begin{cases} 1, & \text{if the consumer intended to purchase farmed or wild fish} \\ 0, & \text{if the consumer did not intend to purchase farmed or wild fish} \end{cases}$$

The independent variables for both the models (farmed fish and wild fish) comprised the same variables: age, if the respondent purchases fish at a fish shop or fishmonger; consumer involvement in purchasing fish; preference for wild fish; sustainability and ethics of fish products; subjective knowledge about fish; attitude toward farmed fish; attitude toward wild fish; perceived price of farmed fish; and perceived price of wild fish. Factor analysis (Principal Component Analysis, PCA) was performed to derive the perception variables (*i.e.*, consumer involvement in purchasing fish, preference for wild fish, sustainability and ethics of fish products, subjective knowledge about fish, attitude toward farmed fish, and attitude toward wild fish) into factors (the PCA results are shown in Appendix, Table A2). The multicollinearity of the derived predictors was tested. The mean of variance inflation factors (VIF) of the 10 variables is 1.3, whereas the minimum VIF-value is 1.1 and the maximum 1.8, which indicates that there is no problem of multicollinearity. The reliability of the variables was measured through Cronbach's Alpha and all the item scales showed acceptable values (See Appendix, Table A1). Other demographics, habits, perception variables, and objective knowledge scores were also introduced in the models to simultaneously control for their influence on the intention to purchase farmed or wild fish. However, due to lack of significance and poor fit, they were not included in the final models.

The general logistic model for consumers' intention to purchase farmed or wild fish is expressed as follows:

$$y_i = \log\left(\frac{\mathrm{P}_i}{1\text{-}P_i}\right) = \alpha + \sum_{n=1}^{n} \beta_n \mathrm{x}_{ni,} \quad (1)$$

where y_i, the dependent variable, represents the ith consumer's purchasing intention for farmed or wild fish; P_i is the likelihood of the ith consumer to purchase farmed or wild fish; x_i is a vector of independent variables; α is a constant; and β is the coefficient to be estimated.

The model specification for farmed or wild fish purchasing intention is as follows:

$$y_i = \alpha + \beta_1 \text{Age} + \beta_2 \text{Purchase fishmonger}_i + \beta_3 \text{Consumer involvement}_i + \beta_4 \text{Preference for wild fish}_i + \beta_5 \text{Sustainability and ethics}_i + \beta_6 \text{Subjective knowledge}_i + \beta_7 \text{Attitude farmed fish} + \beta_8 \text{Attitude wild fish}_i + \beta_9 \text{Perceived price farmed fish}_i + \beta_{10} \text{Perceived price wild fish}_i, \quad (2)$$

where $i = 1, ..., n$ is the number of the participants; y_i is the individual intention to purchase farmed or wild fish (dummy: 0 to 1); α is an intercept; *Age* is a continuous variable; *Purchase fishmonger*$_i$ is whether individual *i* purchases fish mainly at a fish shop or fishmonger (dummy: 0 to 1); *Consumer involvement*$_i$ is a factor variable of consumer involvement in purchasing fish (continuous variable); *Preference for wild fish*$_i$ is a factor variable of preference for wild fish (continuous variable); *Sustainability and ethics*$_i$ is a factor variable of concern regarding sustainability and ethics (continuous variable); *Subjective knowledge*$_i$ is a factor variable of subjective knowledge toward fish (continuous variable); *Attitude farmed fish*$_i$ is a factor variable of attitude toward farmed fish (continuous variable); *Attitude wild fish*$_i$ is a factor variable of attitude toward wild fish (continuous variable); *Perceived price farmed fish*$_i$ is a standardized variable of farmed fish's perceived price (continuous variable); and *Perceived price wild fish*$_i$ is a standardized variable of wild fish's perceived price (continuous variable).

The logistic models were employed to observe the intentions to purchase farmed and wild fish in the total sample, control group, and treatment group. A maximum likelihood method was used for estimating the model (Hair et al., 2010). Instead of minimizing the squared deviations (least squares), a logistic regression maximizes the likelihood of the occurrence of an event. The likelihood value is then used when calculating a measure of the overall model fit. Hence, the estimated parameters are not directly tied to the actual magnitude of change, but they provide only the direction of the effect of the independent variables in the model (Zhang et al., 2018).

3. Results

3.1 Participants' Characteristics

Fifty-one percent of the sample were male. The average age was 49.7 ± 15.1 years old. The majority of participants were higher educated and held a university degree (62.7%), were employed (66%), had a household income of 2,500 – 3,499 euro/month (21%), and did not live near coastline (65%). The participants' average age, gender proportion, and average net household income were similar to the Italian census. The sample comprised higher educated individuals, a proportion that exceeded the average higher education in Italy in 2019 (28%).

Sixty-eight percent of participants purchased fish at least 1-2 times a week (slightly higher than 59%, as reported in a survey conducted by IPSOS marketing company in 2019 (Statista, 2021) so they were our target group. Note that, in the question, fish included fresh, frozen, canned, smoked, and ready to eat ones. Around 77% of participants purchased fish at supermarkets and 47% at fish shops and fishmongers (at wet markets).

Socio-demographic and fish purchasing habits are equivalent between control and treatment groups, except for living near the coastline and purchasing fish directly from fish catchers. A lower percentage of participants in the treatment group (62%) live near coastline than those of the control group (68%). In the treatment group more participants (7%) bought fish directly from fish catchers than those in the control group (3%). Details of sample characteristics are presented in Appendix (Table A2).

3.2 Objective and Subjective Knowledge

3.2.1 Objective Knowledge and Misconceptions

The most commonly held knowledge (Table 2) were that ''K9: Living conditions of farmed fish have been improved thanks to the use of technological innovations (True)'' (92.9% correct answers in the total sample), ''K6: Wild fish is always safer than farmed fish because it doesn't contain harmful substances for human health (False)'' (87.1% correct answers in the total

sample), and “K2: Farmed fish tends to accumulate more fat than wild fish (True)” (83.5% correct answers in the total sample). Whereas most of the participants failed to provide a correct answer to the statement that ‘‘K5: Farmed fish grow faster thanks to antibiotics and hormones (False)’’ (32.3% correct responses in the total sample) and ‘‘K1: Omega-3 content is higher in wild fish (False)’’ (33.0% correct responses in the total sample). Highlighting information regarding these two issues is missing with respect to the Italian market.

Participants appeared to hold an uncertainty about ‘‘K1: Omega-3 content is higher in wild fish (False)’’ (28.5% don’t know responses in the total sample) and “K7: Farmed fish are treated in an unethical way in the near-death phases of their life and they suffer more than wild fish (False)” (25.1% don’t know responses in the total sample).

It is worth noting here that, in general, the level of objective knowledge was not very high (median score 6 out of 9). The aggregated score for objective knowledge about fish showed that participants in the treatment group exhibited significantly higher scores than those in the control group (z = -9.48, p < 0.001). This means that information provision affects participants’ objective knowledge. When we compared knowledge scores for each item of participants between groups, participants in the treatment group scored significantly higher than those in the control group in all items, except for the statement “Omega-3 content is higher in wild fish” (z = -1.020, p = 0.306).

[Insert **Table 2** here]

3.2.2 Subjective Knowledge

Generally, the participants showed a medium subjective knowledge about fish (average 4.2 - 4.8 out of 7.0). Then, PCA was performed to derive a factor representing subjective knowledge to be an independent variable in the purchasing intention models. The reliability was verified on the basis of Cronbach’s alpha (0.905) and its total variance explained was 78.1%. Details of average subjective knowledge items and PCA results are presented in Appendix (Table A2).

3.3 Attitude Toward Farmed and Wild Fish

Figure 2 shows participants' attitudes toward farmed and wild fish. Participants perceived that farmed fish is cheap, nutritious, safe, and healthy. While wild fish is perceived as nutritious, healthy, and favorable. Participants of the treatment group scored significantly higher for farmed fish than those of the control group in the following aspects– nutritious ($z = -5.353$, $p < 0.001$), safe ($z = -6.772$, $p < 0.001$), healthy ($z = -6.055$, $p < 0.001$), ethical ($z = -6.347$, $p < 0.001$), and favorable ($z = -4.378$, $p < 0.001$). In contrast, participants in the control group scored significantly higher for wild fish than those of the treatment group in the following aspects– nutritious ($z = -4.783$, $p < 0.001$), healthy ($z = -4.179$, $p < 0.001$), favorable ($z = -5.443$, $p < 0.001$), safe ($z = -2.553$, $p = 0.011$), and ethical ($z = -3.945$, $p < 0.001$). Both groups agreed that wild fish is expensive.

Since questions in this section followed the section with information provision (only for the treatment group), the provided information significantly affected participants' attitudes in the treatment group as they clearly have a more positive attitude toward farmed fish than those in the control group.

[Insert **Figure 2** here]

Comparing between attitudes toward farmed and wild fish (Figure 3), participants assigned scores that were significantly higher for farmed fish than wild fish for the following aspects: price (cheaper) ($z = -24.826$, $p < 0.001$), safe ($z = -8.174$, $p < 0.001$), and ethical ($z = -3.206$, $p = 0.001$), whereas wild fish is significantly more favorable ($z = -7.895$, $p <0.001$) and nutritious ($z = -2.732$, $p = 0.006$) than farmed fish.

Participants in the control group assigned scores that were significantly higher for wild fish than for farmed fish in the following aspects- healthy ($z = -5.171$, $p < 0.001$), nutritious ($z = -6.898$, $p < 0.001$), favorable ($z = -9.784$, $p < 0.001$), and ethical ($z = -3.024$, $p = 0.002$), whereas they

perceived that farmed fish is significantly cheaper than wild fish ($z = -16.926$, $p < 0.001$). In contrast, participants in the treatment group assigned scores that were significantly higher for farmed fish than wild fish in all aspects- healthy ($z = -5.351$, $p < 0.001$), nutritious ($z= -3.252$, $p = 0.001$), ethical ($z = -7.562$, $p < 0.001$), safe ($z = -10.488$, $p < 0.001$), and cheap ($z = -18.172$, $p < 0.001$), except for favorable ($z = -1.028$, $p = 304$). The results demonstrated that information provision had an effect on the attitudes of participants as the treatment group had more positive attitudes toward farmed fish than the control group.

[Insert **Figure 3** here]

3.4 Determinants of Farmed and Wild Fish Purchasing Intention

We use a logistic regression model to analyze determinants of farmed and wild fish purchasing intention of control and treatment groups (see Table 3 for the presentation of the coefficient and standard error). For farmed fish, the results outline that having a positive attitude toward farmed fish, perceiving that farmed fish is cheap, and having a negative preference and negative attitude toward wild fish increases the possibility of purchasing intention. The same is true for the control group. For participants in the treatment group, high perceived subjective knowledge increases the possibility of purchasing intention of farmed fish, while the perceived price of farmed fish did not significantly affect their intention.

In contrast, participants that are younger and purchase fish at fish shop or fishmonger, have a positive preference and attitude toward wild fish, and perceive that they have high knowledge about fish (high subjective knowledge) have a higher intention to purchase wild fish. In addition, having a negative attitude toward farmed fish, and perceiving that farmed fish is cheap also increase the possibility of purchasing intention. While in the control group, age did not significantly affect purchasing intention. Furthermore, perceiving that farmed fish is cheap

significantly increases the possibility of purchasing intention among the control group. However, it does not influence participants in the treatment group.

Note that after participants received information (treatment group), the perceived price of the fish does not have influence on their purchasing intention. In addition, attitude toward and perceived price of farmed and wild fish are after the information section. Hence, these variables could be affected by the information provided.

[Insert **Table 3** here]

4. Discussion

Our results show that, on average, the level of objective knowledge of participants was slightly higher than half of total knowledge scores. The main known facts are that living conditions of farmed fish have been improved due to technological innovations, that wild fish are not always safer than farmed fish, and that farmed fish tend to accumulate more fat than wild fish. This reflects that these facts have been settled (communicated) in the Italian market.

The main misconceptions are that farmed fish grow faster because of antibiotics and hormones, and that omega-3 fatty acid content is higher in wild fish, though these are incorrect. The fear of use of antibiotics and hormones in farmed fish had been identified in previous studies (Claret et al., 2014; Pulcini et al., 2020) and the fact that this misconception still persists here means there is a lack of correct information regarding this misbelief. Regarding omega-3 content, we can compare to previous studies (e.g., Verbeke et al. 2005) where participants seemed to know that fish contains this nutrients, however, they misunderstood that wild fish has higher content of these fatty acids than farmed fish. Thought wild fish have a higher percentage of omega-3 content, the absolute quantity of Omega-3 is higher in farmed fish because of their higher content of fat. In addition, in wild fish, the chemical and nutritional characteristics are not consistent, depending on seasons (Cahu et al., 2004; Huss, 1995; Nettleton and Exler, 1992).

The results clearly demonstrate that the treatment group which received information scored higher than those in the control group both in total median score (6 *vs* 5, respectively) and individual items (except omega-3 content which is the first question). Participants also reported that they have medium subjective knowledge (neutral to slightly agree on subjective knowledge items). Hence, our results indicated that participants, on average, did not overestimate or underestimate their knowledge. There is no difference in this regard between treatment and control groups.

Participants perceived that eating fish is healthy no matter whether it is farmed or wild. However, they perceived that farmed fish is more ethical and safer than wild fish (in line with Verbeke and Brunsø, 2005; López-Mas et al., 2021). Since healthiness is a crucial factor in food decision-making, especially in the case of fish, communication of the healthy properties should be stressed. As suggested by previous literature (Pulcini et al., 2020), the positive perception of farmed fish could be improved if consumers were aware about the presence of anti-oxidants and omega-3 fatty acids. Other studies have suggested the positive impact on consumers' surplus of the use of one label signaling omega-3 (Marette, 2017).

Participants perceived that wild fish is nutritious and preferred over farmed fish. These results are in line with previous studies that wild fish is always preferred over farmed fish due to perceived higher quality (Claret et al., 2014; López-Mas et al., 2021; Pulcini et al., 2020; Reig et al., 2019; Rickertsen et al., 2017; Vanhonacker et al., 2013; Verbeke et al., 2007b, 2005) and better taste (Maesano et al., 2020; O'Dierno et al., 2006). While some previous studies found that consumers also prefer wild-caught fish for its better safety and health aspects (Maesano et al., 2020), including the absence of negative environmental impacts, which characterize the aquaculture practice (Tidwell and Allan, 2001). Nevertheless, farmed fish is more consistent in terms of physico-chemical parameters, size and availability than wild fish, which depend on the season (Fuentes et al., 2010; Saavedra et al., 2017).

Safety, health, and ethics aspects, however, are arguable issues because they are complex, and individuals might think of these issues differently. For instance, regarding the ethics issue, high demand of wild-caught fish could lead to overfishing and result in damage or stagnation of fish stock (Ertör and Ortega-Cerdà, 2015). In contrast, aquaculture can generate a negative impact on environmental resources due to the factors relating to intensive fish farming practices, such as the escape of genetically modified farmed fish, contamination of wild fish stocks (in the case of cage culture), and release of effluents causing pollution and disrupting the natural performance of marine and freshwater ecosystems (FAO, 2020; Read and Fernandes, 2003; Uchida et al., 2014; Wagner and Young, 2009). Considering safety and health, wild fish could be exposed to marine pollution and to contaminants such as mercury, unsafe levels of cobalt, copper and cadmium, while farmed fish contain less contamination because they were raised with controlled conditions (Claret et al., 2014). The microplastics contamination (López-Mas et al., 2021; Suaria et al., 2016) and other anthropogenic threats (FAO, 2018; López-Mas et al., 2021) could be critical issues for wild fish as well. Even though slaughter methods for farmed fish are normally less cruel than methods used in wild fish (Bovenkerk and Meijboom, 2020), participants seemed to be quite uncertain about it.

Regarding price aspect, in line with previous studies (e.g., López-Mas et al. 2021), wild fish was perceived as more expensive as it suffers significant price fluctuations due to the seasonality and the limited availability of supply. While the price of farmed fish is low in supermarkets, this might be partly because of the price interaction among export countries. For instance, imported fish from developing countries has a cheaper price due to the lower production cost (Bjørndal and Guillen, 2016). Therefore, the low price is not a real measure of farmed fish's quality. The price of farmed and wild fish should be set as to reflect their quality.

Since attitude questions were placed after information provision, we clearly observed the impact of information on them. In the control group, the participants assigned scores significantly higher for wild fish in nutritious, healthy, and favorable issues than for farmed fish, whereas their

scores reflected indifference for the safety issue. Participants who received objective information (treatment group) appreciated farmed fish more than wild fish in nutrition, health, ethics, and safety issues while they were indifferent about the favorability issue. Price remained the same as farmed fish is cheaper than wild fish of the same species on the Italian market.

Considering factors that influenced purchasing intention, preference and attitude significantly affected purchasing intention for both farmed and wild fish (Hoque and Alam, 2020; Nauman et al., 1995).

Subjective knowledge has a strong positive influence on purchasing intention of wild fish in both the control and treatment groups whereas it has a weak positive effect on purchasing intention of farmed fish in the treatment group. This meant that more the participants believed that they possess knowledge about quality of fish and how to choose it, the more they tended to choose wild fish. We tested the direct effect of objective information on purchasing intention as well, but it did not have a significant effect. These results are consistent with (Hoque and Alam, 2020; Pieniak et al., 2010b) who reported that subjective knowledge had a positive and significant impact on fish consumption frequency while objective knowledge had a positive but comparatively weaker impact.

Price has both positive (for farmed fish) and negative (for wild fish) effects on purchasing intention. Perceived low price of farmed fish influenced consumers' intention to purchase it since, for consumers, a convenient price is one of the main factors affecting the decision to purchase fish (Claret et al., 2012; Conte et al., 2014; López-Mas et al., 2021; Pieniak et al., 2010c). However, a perceived low price of farmed fish increased the possibility of intention to purchase wild fish. An explanation could be that consumers tend to distrust the use of new technologies in food production and aquaculture is considered a relatively new production method compared to traditional wild-caught fish (Fernandez-Polanco and Luna, 2012; López-Mas et al., 2021; Yeung and Morris, 2001). Another reason could be that consumers might consider a product's price as

an indicator of its quality (Claret et al., 2012; Kole et al., 2009). As a result, people may assume that farmed fish is of lower quality because it is usually cheaper than the wild fish counterpart.

Nevertheless, price did not have an effect on the participants in treatment group. This implies that if consumers received adequate objective information, price would be unlikely to affect their decision. The possible reason could be that the more knowledge people have, the less likely they have the confusion and thus, presumably, their decision would be based on their knowledge and beliefs (Claret et al., 2014; Gaviglio and Demartini, 2009; Hoque and Alam, 2020; Matzler et al., 2011; Verbeke et al., 2007a).

Considering socio-demographic and habit variables, only age and purchasing place had influences on purchasing intention of wild fish. Participants who were younger intended to purchase wild fish more. This is in contrast to the results of previous literature (Güney, 2019; López-Mas et al., 2021; Pulcini et al., 2020; Verbeke et al., 2007a) as they reported the preference for wild fish among older consumers and suggested that this may be because they are more habituated to wild fish and because aquaculture is a relatively new food source. However, our result is in line with results from Gaviglio and Demartini (2009) where an Italian consumer segment ("trend-influenced consumer") who reported their preference for wild fish comprised young consumers with medium to high purchasing power (they are not affected by low product price), and buy fish at fish shops and the local market. They also found that this consumer group is vulnerable to messages coming from mass media. Hence, the possible reason that young participants reported their intention to purchase wild fish might be that they received incorrect information about sustainability and ethics issues regarding farmed fish from the mass media, e.g., farm-raising activity risks for the environment and abuses of animal welfare in fish farms (Forthomme, 2021; Sousa, 2021; Urch, 2017). Furthermore, the younger generation tends to be more sensitive to sustainability and animal welfare issues (Bollani et al., 2019; Estévez-Moreno et al., 2021; Gaviglio and Demartini, 2009; Kymäläinen et al., 2021; Pulcini et al., 2020). Since they tend to receive information from their social networks rather than more formal sources (*i.e.*,

newspapers), they may have a higher probability of receiving fake news or scandals from their social networks (Ahmed, 2020; Konstantinos Demestichas et al., 2020; Leeder, 2019).

Purchase at fishmongers or fish shops increased the likelihood of purchasing intention of wild fish. This might be because fishmongers or fish shops are more specialized, so they have more availability of wild fish. Also, people who go there might have higher budgets and trust the vendor more than supermarket (EUMOFA, 2017).

In this study, information does have an effect on objective knowledge and attitudes toward farmed or wild fish, but it does not have a direct impact on purchasing intention. Further research might consider using a Structural Equation Model (SEM) to test the role of information on objective knowledge, attitude, and intention.

Some limitations should be acknowledged when interpreting our findings, which identify some opportunities for further research. The sample comprised a high proportion of higher educated individuals which might be because of the mode of the survey (online). Hence, the interpretation should be done with care and further research should try to reach individuals with an education level representative of the Italian population level. Further research should consider the randomization of the objective knowledge questions in order to avoid the order effect. In this study, we did not measure the discrepancy between objective and subjective knowledges which could have an impact on consumers' attitudes and intentions to purchase fish (Hoque and Alam, 2020). Further research should consider this issue as well.

Questions about purchasing frequency of farmed and wild fish, including risk and benefit of eating or preparing fish should be asked in further research. Questions about sustainability and ethics should be asked after information provision to identify whether consumers' perceptions toward these issues change. We also suggest research on more extended stakeholders including distributors (retailers, food services in school and hospital, etc.), to explore what could be the main drivers to choose the type of fish.

For policy implications, information provision is crucial to improving consumers' objective knowledge. Our results indicate that consumers have moderate knowledge about aquaculture, suggesting that an information-based strategy should be framed through effective means of communication (e.g., labeling) in order to assist consumers to make a conscious decision based on objective and scientific facts rather than unfounded beliefs. Consumers with higher objective knowledge about fish could be more open to scientific evidence and make better and more reasoned fish choices. Hence, information strategies about farmed fish (e.g., production systems, slaughtering method, environmental and sustainability aspects, quality, nutritional properties, safety, healthiness, and ethics) might help to increase farmed fish acceptance and add value to the sector. For instance, highlighting the fact that farmed fish suffers less than wild fish in the slaughtering process could reduce uncertainty of consumers and improve their perceived image of aquaculture products. Since consumers nowadays are concerned about ethical and sustainability issues, a key recommendation is to encourage the aquaculture industry to implement animal welfare, sustainability, and quality standards (Banovic et al., 2019). For example, aquaculture manufactures could consider applying for the Aquaculture Stewardship Council (ASC) standard and label which could improve their image and position in the market. On one side we found that scientific information could have an impact on consumers' attitudes. However, the simple label about ethics could be effective to influence buying intention at the point of purchase (Banovic et al., 2019).

For business implications, the market could point to a new marketing strategy in which the consumer is informed of the production methods, such as the non-use of antibiotics, hormones and the animal welfare in farmed fish, and sustainability of the product. The scientific community and business actors should work together on practical strategies and information provision. Research on price margins and market power of distributors should be conducted so that a fair price for fish farmers could be set and the price could be a better-quality parameter for consumers. However, price should also allow a wider population to have access to this protein and exclusive

omega-3 fatty acid source such as Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA).

One implication of our findings is that consumers are relying, in part, on erroneous information about aquaculture products when making a decision to purchasing fish. Hence, encouraging the open platform between experts and the public to discuss and debate about ethical and environmental issues of aquaculture might raise consciousness and provide scientific information and facts for consumers to make informed decisions.

5. Conclusion

This study shows that providing information on aquaculture production could be a promising strategy for further expansion of the aquaculture market, as its effects may increase the positive attitude toward farmed fish. This communication exchange can be accomplished by providing specific messages. For instance, farmed fish should be presented as nutritious food because it is rich in EPA and DHA omega-3; it is more ethically produced because its slaughtering standard is more controlled than the case of wild fish and more sustainable because it reduces the pressure on wild fish stocks, thereby safeguarding biodiversity. Moreover, its traceability and safety (*i.e.*, the limited usage of antibiotics, less probability of microplastic, and heavy metals contamination) should be communicated via clear labels and QR codes. Policymakers, public authorities, and private sector stakeholders should address the need for information to reduce misconceptions regarding the aquaculture sector.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDIX

A.1 Socio-Demographic and Other Characters of the Sample

[Insert **Table A1**]

A.2 Factor Analysis of Independent Variables of Logistic Regression

Principal component analysis (PCA) with varimax rotation were performed on six consumers' perceptions: consumer involvement in purchasing fish, preference for wild fish, sustainability and ethics for fish products, subjective knowledge about fish, attitude toward farmed fish, and attitude toward wild fish. Prior to performing PCA, the suitability of the data for factor analysis was assessed using the Kaiser–Meyer–Olkin (KMO) statistics and the statistical significance of the Bartlett's test of sphericity were used as the criteria. Further, Cronbach's alpha was used to check the reliability of the factors. The results of the factor analysis are shown in Table A2.

For consumer involvement, the result of PCA indicated one factor with KMO 0.640 and a significant Bartlett's test. The factor was call "consumer involvement" and its total variance explained was 76.6%.

For preference for wild fish, the first result of PCA indicated 1 factor with KMO 0.560 and significant Bartlett's test with Cronbach's alpha = 0.16. Therefore, item 2 ("When I consume fresh fish, I do not detect differences in wild and farmed fish") was excluded and PCA was performed with items 1 and 3 (KMO 0.500 with Bartlett's test significant with Cronbach's alpha = 0.850). The final result indicated one factor, "preference for wild fish"; its total variance explained was 87.1%.

For sustainability and ethical aspects, the result of PCA indicated one factor with KMO 0.707 with a significant Bartlett's test. The factor was called "sustainability and ethical" and its total variance explained was 62.7%.

For subjective knowledge, the result of PCA indicated one factor with KMO 0.776 with Bartlett's test significant. The factor was called "subjective knowledge" and its total variance explained was 78.1%.

For attitude toward farmed fish, the first result of PCA indicated 1 factor with KMO 0.844 and significant Bartlett's test with Cronbach's alpha = 0.853. However, when the item price ("Expensive - Cheap") was excluded, the Cronbach's alpha improved. Further, the PCA analysis was performed with items 1 to 5 (KMO 0.892 with a significant Bartlett's test and Cronbach's alpha = 0.892). The final result indicated one factor, that is, "attitude farmed fish"; its total variance explained was 70.1%. The scores of the item "price of farmed fish" were standardized and later used in the logistic regression.

For attitude toward wild fish, the first result of PCA indicated 2 factors with KMO 0.780 and the Bartlett's test significant with Cronbach's alpha = 0.751. However, when item price ("Expensive - Cheap") was excluded, the Cronbach's alpha improved. Then, the PCA was performed with items 1 to 5 (KMO 0.793 with significant Bartlett's test and Cronbach's alpha = 0.825). The final result indicated one factor, that is "attitude wild fish"; its total variance explained was 59.1%. The scores of item "price of wild fish" were standardized and later used in the logistic regression.

[Insert **Table A2**]

Table 1. Objective knowledge statements, scientific explanation, and references.

Code	Category	Statement	Response	Explanation and reference sources
K1	Healthiness (nutrition) & Quality	Omega-3 content is higher in wild fish	**False**	The analysis of food composition tables shows that farmed fish is fatter than wild fish and it generally may contain more omega-3 (Cahu et al., 2004; Saavedra et al., 2017; Sprague et al., 2016)
K2	Healthiness (nutrition) & Quality	Farmed fish tends to accumulate more fat than wild fish	**True**	Farmed fish tend to accumulate more fat than wild fish because they are regularly fed (Cahu et al., 2004; Saavedra et al., 2017)
K3	Healthiness (nutrition) & Quality	Wild fish has a more constant nutritional composition than farmed fish	**False**	Wild fish has a less constant nutritional composition because in its natural habitat, food access and food composition could vary during the year. Instead in farms, animal feeding is more controlled (Cahu et al., 2004)
K4	Safeness & Quality	In farmed fish the risk of the presence of microplastics is lower than in wild fish	**True**	The risk is lower in farmed fish because their feeding is more controlled so you can select raw materials with a higher level of safety (Barboza et al., 2020; Lusher et al., 2017; Smith et al., 2018)
K5	Safeness & Control & Quality	Farmed fish grow faster thanks to antibiotics and hormones	**False**	In aquaculture, growth promoters are not used. Antibiotics are only used therapeutically, respecting precise laws. The use of growth promoters' hormones is forbidden. Additionally, they are also pointless (Hoga et al., 2018; Kümmerer, 2009; Santos and Ramos, 2018)

Table 1. (Continued)

Code	Category	Statement	Response	Explanation and reference sources
K6	Safeness & Control & Quality	Wild fish is always safer than farmed fish because it doesn't contain harmful substances for human health	**False**	Wild fish may ingest harmful substances in relation to the environment where they live. While in farmed fish the risk is lower (Costa, 2007; Girolametti et al., 2021; Hassell et al., 2020)
K7	Animal Welfare	Farmed fish are treated in an unethical way in the near-death phases of their life and they suffer more than wild fish	**False**	The slaughter takes place with the use of techniques which have the purpose to reduce stress. This is important for both ethical and qualitative reasons. In fact, the suffering damages the quality of the product (Council of Europe, 2005; Hassell et al., 2020; Metcalfe, 2009)
K8	Animal Welfare	Farms are unhealthy places for fish because the majority of them get sick	**False**	Italian farms are particularly controlled in order to respect strict rules. These rules guarantee the optimal conditions (ex. chemical-physical and biological characteristics of water) and health and hygiene safety of the final product (European Commission, 2020b)
K9	Animal Welfare	Living conditions of farmed fish have been improved thanks to the use of technological innovations	**True**	For example, with the development of biotechnologies which reduce disease and the use of drugs. In addition, with the reduction of the impact of the environment, thanks to a more precise control of farm management (e.g., precision livestock feeding) (Cahu et al., 2004; Saavedra et al., 2017; Sprague et al., 2016)

Table 2. Knowledge and Misconception about Farmed and Wild Fish in the Total Sample, Control and Information Treatment groups (in %).

Code	Statement	Response	Total (*n* = 804)	Control (*n* = 403)	Treatment (*n* = 401)
K1	Omega-3 content is higher in wild fish (F)	Correct	33.0	31.3	34.7
		Incorrect	38.6	37.5	39.7
		Don't know	28.5	31.3	25.7
K2	Farmed fish tends to accumulate more fat than wild fish (T)	Correct	83.5	79.2	87.8
		Incorrect	8.1	9.7	6.5
		Don't know	8.5	11.2	5.7
K3	Wild fish has a more constant nutritional composition than farmed fish (F)	Correct	58.8	51.1	66.6
		Incorrect	25.1	25.1	25.2
		Don't know	16.0	23.8	8.2
K4	In farmed fish the risk of the presence of microplastics is lower than wild fish (T)	Correct	60.0	54.6	65.3
		Incorrect	25.4	25.3	25.4
		Don't know	14.7	20.1	9.2
K5	Farmed fish grow faster thanks to antibiotics and hormones (F)	Correct	32.3	26.3	38.4
		Incorrect	57.0	60.3	53.6
		Don't know	10.7	13.4	8.0
K6	Wild fish is always safer than farmed fish because it does not contain harmful substances for human health (F)	Correct	87.1	80.9	93.3
		Incorrect	4.7	6.2	3.2
		Don't know	8.2	12.9	3.5
K7	Farmed fish are treated in an unethical way in the near-death phases of their life and they suffer more than wild fish (F)	Correct	53.7	37.5	70.1
		Incorrect	21.1	27.3	15.0
		Don't know	25.1	35.2	15.0

Table 2. (Continued)

Code	Statement	Response	Total (*n* = 804)	Control (*n* = 403)	Treatment (*n* = 401)
K8	Farms are unhealthy places for fish because the majority of them get sick (F)	Correct	51.9	35.0	68.8
		Incorrect	34.0	44.4	23.4
		Don't know	14.2	20.6	7.7
K9	Living conditions of farmed fish have been improved thanks to the use of technological innovations (T)	Correct	92.9	89.8	96.0
		Incorrect	1.0	1.7	0.2
		Don't know	6.1	8.4	3.7
	Aggregated objective knowledge [1]		6.0	5.0[a]	6.0[b]

Note: (T) Indicates the statement is true; (F) indicates the statement is false. [1] Median of correct answers out of 9, where correct answer = 1; don't know and incorrect = 0. [a,b] Values with a different letter as superscript indicate statistically significant differences between the groups (columns) based on Mann–Whitney U test ($p < 0.001$).

Table 3. Logistic Regression Estimation Results of Intention to Purchase Farmed and Wild Fish.

	Farmed Fish			Wild Fish		
	Total	**Control**	**Treatment**	**Total**	**Control**	**Treatment**
Variable	**Coeff. (SE)**	**Coeff. (SE)**	**Coeff. (SE)**	**Coeff. (SE)**	**Coeff. (SE)**	**Coeff. (SE)**
Age	-0.002	0.001	-0.006	-0.013**	-0.009	-0.018**
	(0.007)	(0.009)	(0.010)	(0.006)	(0.009)	(0.009)
Purchase at fishmonger or fish shop	-0.039	-0.137	0.093	0.379**	0.576**	0.181
	(0.198)	(0.282)	(0.285)	(0.182)	(0.263)	(0.261)
Consumer Involvement	-0.012	0.018	-0.050	0.085	-0.025	0.191
	(0.110)	(0.150)	(0.162)	(0.099)	(0.139)	(0.152)
Preference for Wild Fish	-0.668***	-0.622***	-0.830***	0.491***	0.459**	0.546**
	(0.134)	(0.192)	(0.203)	(0.115)	(0.165)	(0.172)
Sustainability and ethics	0.066	-0.109	0.217	-0.094	-0.019	-0.151
	(0.101)	(0.154)	(0.137)	(0.090)	(0.136)	(0.126)
Subjective knowledge	0.168	0.017	0.299*	0.353***	0.349**	0.341**
	(0.110)	(0.151)	(0.164)	(0.098)	(0.134)	(0.146)
Attitude farmed fish	1.550***	1.612***	1.478***	-0.692***	-0.495**	-0.902***
	(0.143)	(0.213)	(0.216)	(0.129)	(0.175)	(0.212)
Attitude wild fish	-0.388***	-0.462**	-0.306*	0.794***	0.763***	0.846***
	(0.122)	(0.177)	(0.177)	(0.104)	(0.146)	(0.158)
Perceived price farmed fish (cheap)[a]	0.228**	0.375**	0.085	0.177*	0.317**	0.098
	(0.108)	(0.154)	(0.161)	(0.099)	(0.135)	(0.152)
Perceived price wild fish (cheap)[b]	-0.028	-0.078	0.021	-0.081	0.044	-0.181
	(0.099)	(0.141)	(0.147)	(0.093)	(0.130)	(0.141)
Constant	0.494	0.276	0.758	1.311***	0.998**	1.729***
	(0.359)	(0.505)	(0.527)	(0.341)	(0.485)	(0.506)
Number of participants	804	403	401	804	403	401
Log Likelihood	-342.05	-170.11	-167.29	-389.38	-193.44	-191.18
McFadden's pseudo R2	0.38	0.39	0.36	0.26	0.23	0.30

Note: ***, **, and * indicate significance at the 1, 5, and 10% levels, respectively, SE = Standard Error. [a] Standardized value of variable "Attitude – Cheap for Farm Fish," [b] Standardized value of variable "Attitude – Cheap for Wild Fish"

Table A1. Principle component analysis (PCA) results for the factor variables: consumer involvement, preference of wild fish, sustainability and ethics, subjective knowledge, and attitude toward farmed and wild fish.

Factor	Variable	Mean[1]	SD	Factor loading	Cronbach's alpha	KMO	Explained variance
Consumer involvement					**0.840**	**0.640**	**76.6%**
	I am very concerned about what fish I purchase	6.1	1.2	0.927			
	I care a lot about what fish I consume	6.2	1.2	0.927			
	Generally, choosing the right fish is important to me	6.0	1.2	0.761			
Preference for wild fish					**0.852**	**0.500**	**87.1%**
	When buying fresh fish, I prefer species that are not farmed	4.9	1.8	0.933			
	When buying fresh fish, I tend to choose wild species	4.8	1.9	0.933			
Sustainability and ethics					**0.789**	**0.707**	**62.7%**
	I believe it is important to apply environmental - friendly catch and production methods	6.6	0.9	0.761			
	I believe it is important to adopt non-polluting production processes	6.8	0.7	0.759			
	I believe it is important to respect the rights and welfare of fish during catch and fish farming	6.4	1.2	0.824			
	I believe it is important to reduce animal suffering	6.5	1.1	0.820			

Table A1. (Continued)

Factor	Variable	Mean[1]	SD	Factor loading	Cronbach's alpha	KMO	Explained variance
Subjective knowledge					**0.905**	**0.776**	**78.1%**
	I feel I know about fish in general more than an average person	4.8	1.5	0.894			
	I feel I know about fish in general more than my friends	4.9	1.5	0.865			
	I have a lot of knowledge about how to purchase fish	4.5	1.6	0.911			
	I have a lot of knowledge about how to evaluate the quality of wild and farmed fish	4.2	1.7	0.863			
Attitude farmed fish					**0.892**	**0.852**	**70.1%**
	Healthy	5.0	1.8	0.897			
	Nutritious	5.3	1.6	0.847			
	Favorable	4.2	2.0	0.854			
	Ethical	4.7	1.9	0.818			
	Safe	5.1	1.7	0.765			
Attitude wild fish					**0.825**	**0.793**	**59.1%**
	Healthy	5.1	1.6	0.815			
	Nutritious	5.5	1.4	0.743			
	Favorable	4.9	1.7	0.815			
	Ethical	4.5	1.7	0.703			
	Safe	4.5	1.5	0.763			

Note: [1] participants were asked to respond on a 7-point semantic scale (1 = “totally disagree”, 4 = “neutral,” and 7 = “totally agree”). SD = Standard deviation.

Table A2. Socio-Demographic and Other Characters of the Sample

Item		Total	Control	Treatment	*p*-value
	n	804	403	401	
	%	100	50.1	49.9	
Gender	Male	50.5	49.1	51.9	0.103
	Female	48.6	50.6	46.6	
	Other/Don't want to response	0.9	0.2	1.5	
Age	Mean (SD)	49.7 (15.14)	49.4 (15.08)	49.9 (15.21)	0.683
Education	Middle school	3.1	3.2	3.0	0.594
	High school	34.2	35.0	33.4	
	University degree	62.7	61.8	63.6	
Employment	Full-time	58.1	56.8	59.4	0.503
status	Part-time/Other	7.8	7.9	7.7	
	Unemployed	3.7	4.2	3.2	
	Retired	16.7	15.4	18.0	
	Student	7.0	8.4	5.5	
	Other	6.7	7.2	6.2	
Household	1: < 900 euro	1.7	1.7	1.7	0.663
monthly income	2: 900 – 1,499 euro	9.8	9.4	10.2	
	3: 1,500 – 2,499 euro	28.4	27.5	29.2	
	4: 2,500 – 3,499 euro	21.0	21.3	20.7	
	5: 3,500 – 4,499 euro	10.2	10.4	10.0	
	6: ≥ 4,500 euro	9.7	11.4	8.0	
	Don't know/don't want to response	19.2	18.1	20.2	
Near Coastline	Yes	35.1	31.8	38.4	0.05**
	No	64.9	68.2	61.6	
Fish purchasing	Less than once a week	32.2	32.0	32.4	0.901
frequency	More than once a week	67.8	68.0	67.6	

Table A2. (Continued)

Item		Total	Control	Treatment	*p*-value
Point of purchase[2]	Fish shops/Fishmongers	47.3	47.4	47.1	0.941
	Supermarket	77.2	77.2	77.3	0.963
	Discount	5.8	5.7	6.0	0.867
	Online channel	1.9	2.0	1.7	0.802
	Direct from fish catchers	5.2	3.2	7.2	0.011**
	Others	2.0	2.5	1.5	0.317

Note: Student T-test: age. Pearson chi-square: gender, employment status, near coastline, and point of purchase. Mann–Whitney U Test: education, household monthly income, and fish purchasing frequency. ** indicates significance at the 5% level. [1] Flexitarian is a plant-based diet with the occasional inclusion of animal products, [2] Participants could choose multiple purchasing points. SD = Standard deviation

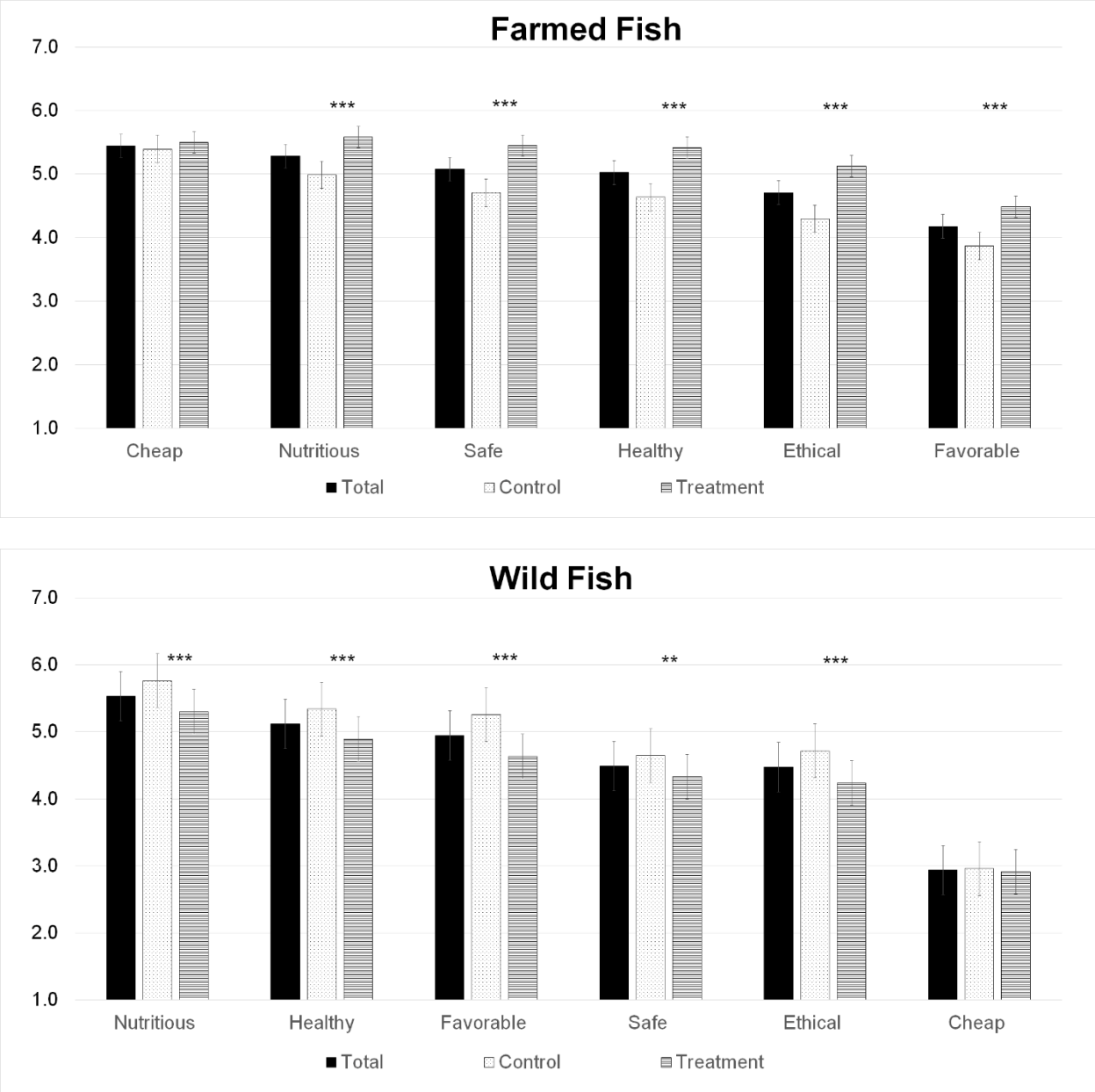

Figure 2. Average Scores of Attitude toward Farmed and Wild Fish of the Total Sample, Control and Information Treatment groups. Note: Participants were asked to indicate their attitude about eating farmed and wild fish based on 7-point semantic differential scale (1-7). The six attitudes use the following endpoints: unhealthy/healthy; not nutritious/nutritious; unfavorable/favorable; unethical/ethical; unsafe/safe; and expensive/cheap. Results from Mann–Whitney U Test between control and treatment, *** significant at the 0.01 level.

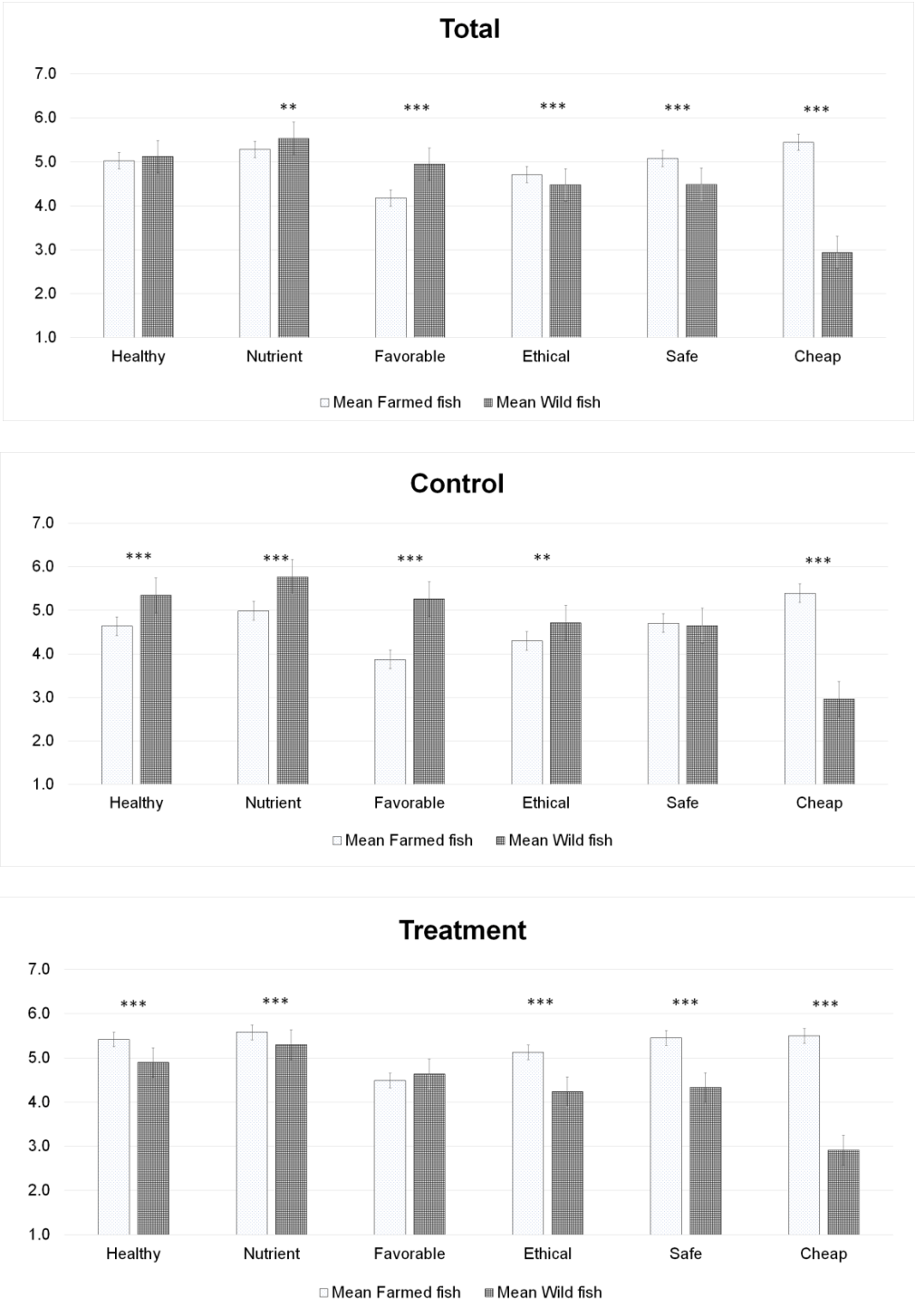

Figure 3. Average Scores of Attitude toward Farmed and Wild Fish of the Total Sample, Control and Information Treatment groups. Note: Participants were asked to indicate their attitude about eating farmed and wild fish based on 7-point semantic differential scale (1-7). The six attitudes use the following endpoints: unhealthy/healthy; not nutritious/nutritious; unfavorable/favorable; unethical/ethical; unsafe/safe; and

expensive/cheap. Results from Mann–Whitney U Test between farmed and wild fish, *** significant at the 0.01 level, ** significant at the 0.05 level.

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