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

3

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15

16 **ABSTRACT**

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

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

30

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

32

### 33 **1. Introduction**

34 The world population is expected to increase to 9 billion by 2050 with a consequent growth  
35 in the demand for food, including fish consumption (Food and Agriculture Organization, FAO,  
36 2020). Fish products could play an important role in providing high quality nutrients both in the  
37 developed and developing countries. In 2018, the world average annual fish consumption per  
38 capita was 20.5 kg with a global fish supply of approximately 179 million tonnes (FAO, 2020).  
39 Fish products are supplied from two main sources, namely, natural stocks (54%) and aquaculture  
40 practices (46%), as per the data observed in 2018 (FAO, 2020). The global aquaculture  
41 production was 114.5 million tonnes in live weight in 2018 with an estimated value of 263.6 USD  
42 billion (FAO, 2020).

43 Despite this increasing shift in world trend of fish production from aquaculture (from 25.7%  
44 in 2000 to 46% in 2018), the growth rate of the European aquaculture sector has remained  
45 constant (FAO, 2020). In the 27-European countries and the UK, aquaculture production including  
46 that of fish, crustaceans, and mollusks was estimated to be 1,372,012 tonnes of live weight in  
47 2017, representing only the 1.2% of the total world aquaculture production (European  
48 Commission, 2020a). In 2017, the EU citizen consumed an average of 24.4 kg of seafood  
49 (European Commission, 2020a).

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

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

59 Farmed fish is perceived by consumers to have less positive image as compared to wild  
60 fish (Claret et al., 2014; Reig et al., 2019; Vanhonacker et al., 2013). This is considered as one of  
61 the possible reasons for production stagnation and the consequent low consumption rate of  
62 farmed fish in Europe. For instance, farmed fish is considered to be of a lower quality than wild  
63 fish (Claret et al., 2014; Verbeke et al., 2007b, 2005), especially in terms of taste and health  
64 aspects (Cardoso et al., 2013; Claret et al., 2016, 2014; Rickertsen et al., 2017). This might be  
65 due to the limited and often incorrect information made available on this sector, especially by the  
66 media (Amberg and Hall, 2010, 2008; Govaerts, 2021; Olsen and Osmundsen, 2017; Phuc,  
67 2016). For instance, studies in Italy (e.g., Carlucci et al. 2015; Pulcini et al. 2020) show the limited  
68 and often incorrect information regarding aquaculture in the media and among consumers. Thus,  
69 it becomes crucial to create awareness and provide reliable information regarding aquaculture  
70 products to consumers (Feucht and Zander, 2017; Polymeros et al., 2015).

71 Existing literature suggests that there exists a relationship between knowledge and  
72 consumer purchasing decision (Aertsens et al., 2011; Brucks, 1985; Demartini et al., 2021; Flynn  
73 and Goldsmith, 1999; Hoque and Alam, 2020; Pieniak et al., 2010a). Subjective knowledge is the  
74 individual's perception of how much they know or is familiar with a product or choice (Brucks,  
75 1985; Park et al., 1994). Objective knowledge refers to what a consumer actually knows about  
76 (Brucks, 1985). However, these two components tend to be unrelated as Kruger and Dunning  
77 (1999) found that people with limited objective knowledge tend to overestimate their knowledge,

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

80 Several studies have investigated individual's perception (opinion) of fish using belief  
81 statements about safety, quality, and healthiness (Altintzoglou et al., 2011; Claret et al., 2016,  
82 2014; Jacobs et al., 2015; Pieniak et al., 2010c; Verbeke et al., 2005). However, there are some  
83 studies that have focused on their perception toward sustainability, ethical concerns in the fish  
84 sector, and their impact on consumer decision-making (Banovic et al., 2019; Bronnmann and  
85 Asche, 2017; Maesano et al., 2020; Uchida et al., 2014; Verbeke et al., 2007b; Yi, 2019). Today,  
86 it is crucial to investigate how the public perceives the fish sector, considering the increasing  
87 consumer demand for more sustainable food (Cerroni et al., 2019) and concerns about animal  
88 welfare (Pulcini et al., 2020). While conducting a study on Belgian consumers, Verbeke et al.  
89 (2007b) found that sustainability and ethics with respect to fish were considered to be important  
90 by them. However, future studies need to investigate how beliefs toward sustainability and ethical  
91 concerns can directly influence the purchase intent of both wild and farmed fish.

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

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

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

107

## 108 **2. Material and Methods**

### 109 *2.1 Data Collection and Sample*

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

118

### 119 *2.2 Measures*

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

125 The first section consisted of general questions about consumer habits (Menozzi et al.,  
126 2020; Perez Cueto Eulert et al., 2011). Consumption frequency of fish with respect to fresh,  
127 frozen, canned, smoked, and ready to eat fish was asked (Almost every day, 3 to 4 times a week,  
128 1 or 2 times a week, 2 to 3 times a month, once a month or lesser, few times a year, never).  
129 Consequently, the responses were coded to “Less than once a week” and “More than once a

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

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

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

149 In the objective knowledge section, participants’ objective knowledge was measured using  
150 nine statements originally developed by the authors and based on scientific evidence (see Table  
151 1 in Information Treatment section). Five-item scales (false, maybe false, do not know, maybe  
152 true, and true) were used to measure objective knowledge (adapted from Boase et al. 2019). First,  
153 “Maybe false” was recoded as “False” and “Maybe true” was recoded as “True,” such that it could  
154 be considered whether the responses were correct, false, or the consumers did not know the  
155 answers. If a participant said True when it was True, or False when it was False, their response

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

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

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

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

169

### 170 *2.3 Information Treatment*

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

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



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

**On a scale from False to True, please answer the following statements to the best of your knowledge.**

**Omega-3 content is higher in wild fish**

False	Maybe false	Don't know	Maybe true	True
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(a)

**False.** The analysis of food composition tables shows that farmed fish is fatter than wild fish, and it generally may contain more Omega-3

(b)

183

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

189

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

196 [Insert **Table 1** here]

197 *2.4 Analyses and Model Specification*

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

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

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

220           
$$y_i = \begin{cases} 1, & \text{if the consumer intended to purchase farmed or wild fish} \\ 0, & \text{if the consumer did not intend to purchase farmed or wild fish} \end{cases}$$

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

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

$$239 \quad y_i = \log \left( \frac{P_i}{1-P_i} \right) = \alpha + \sum_{n=1}^n \beta_n x_{ni}, \quad (1)$$

240 where  $y_i$ , the dependent variable, represents the  $i^{\text{th}}$  consumer's purchasing intention for farmed or  
 241 wild fish;  $P_i$  is the likelihood of the  $i^{\text{th}}$  consumer to purchase farmed or wild fish;  $x_i$  is a vector of  
 242 independent variables;  $\alpha$  is a constant; and  $\beta$  is the coefficient to be estimated.

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

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

249 where  $i = 1, \dots, n$  is the number of the participants;  $y_i$  is the individual intention to purchase farmed  
250 or wild fish (dummy: 0 to 1);  $\alpha$  is an intercept; *Age* is a continuous variable; *Purchase fishmonger<sub>i</sub>*  
251 is whether individual  $i$  purchases fish mainly at a fish shop or fishmonger (dummy: 0 to 1);  
252 *Consumer involvement<sub>i</sub>* is a factor variable of consumer involvement in purchasing fish  
253 (continuous variable); *Preference for wild fish<sub>i</sub>* is a factor variable of preference for wild fish  
254 (continuous variable); *Sustainability and ethics<sub>i</sub>* is a factor variable of concern regarding  
255 sustainability and ethics (continuous variable); *Subjective knowledge<sub>i</sub>* is a factor variable of  
256 subjective knowledge toward fish (continuous variable); *Attitude farmed fish<sub>i</sub>* is a factor variable  
257 of attitude toward farmed fish (continuous variable); *Attitude wild fish<sub>i</sub>* is a factor variable of attitude  
258 toward wild fish (continuous variable); *Perceived price farmed fish<sub>i</sub>* is a standardized variable of  
259 farmed fish's perceived price (continuous variable); and *Perceived price wild fish<sub>i</sub>* is a  
260 standardized variable of wild fish's perceived price (continuous variable).

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

## 268 **3. Results**

### 269 *3.1 Participants' Characteristics*

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

276 Sixty-eight percent of participants purchased fish at least 1-2 times a week (slightly higher  
277 than 59%, as reported in a survey conducted by IPSOS marketing company in 2019 (Statista,  
278 2021) so they were our target group. Note that, in the question, fish included fresh, frozen, canned,  
279 smoked, and ready to eat ones. Around 77% of participants purchased fish at supermarkets and  
280 47% at fish shops and fishmongers (at wet markets).

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

287

### 288 *3.2 Objective and Subjective Knowledge*

#### 289 *3.2.1 Objective Knowledge and Misconceptions*

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

294 sample), and “K2: Farmed fish tends to accumulate more fat than wild fish (True)” (83.5% correct  
 295 answers in the total sample). Whereas most of the participants failed to provide a correct answer  
 296 to the statement that “K5: Farmed fish grow faster thanks to antibiotics and hormones (False)”  
 297 (32.3% correct responses in the total sample) and “K1: Omega-3 content is higher in wild fish  
 298 (False)” (33.0% correct responses in the total sample). Highlighting information regarding these  
 299 two issues is missing with respect to the Italian market.

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

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

311

312 [Insert **Table 2** here]

313

### 314 *3.2.2 Subjective Knowledge*

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

### 320 3.3 Attitude Toward Farmed and Wild Fish

321 Figure 2 shows participants' attitudes toward farmed and wild fish. Participants perceived that  
 322 farmed fish is cheap, nutritious, safe, and healthy. While wild fish is perceived as nutritious,  
 323 healthy, and favorable. Participants of the treatment group scored significantly higher for farmed  
 324 fish than those of the control group in the following aspects– nutritious ( $z = -5.353$ ,  $p < 0.001$ ),  
 325 safe ( $z = -6.772$ ,  $p < 0.001$ ), healthy ( $z = -6.055$ ,  $p < 0.001$ ), ethical ( $z = -6.347$ ,  $p < 0.001$ ), and  
 326 favorable ( $z = -4.378$ ,  $p < 0.001$ ). In contrast, participants in the control group scored significantly  
 327 higher for wild fish than those of the treatment group in the following aspects– nutritious ( $z = -$   
 328  $4.783$ ,  $p < 0.001$ ), healthy ( $z = -4.179$ ,  $p < 0.001$ ), favorable ( $z = -5.443$ ,  $p < 0.001$ ), safe ( $z = -$   
 329  $2.553$ ,  $p = 0.011$ ), and ethical ( $z = -3.945$ ,  $p < 0.001$ ). Both groups agreed that wild fish is  
 330 expensive.

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

335

336 [Insert **Figure 2** here]

337

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

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

346 perceived that farmed fish is significantly cheaper than wild fish ( $z = -16.926$ ,  $p < 0.001$ ). In  
347 contrast, participants in the treatment group assigned scores that were significantly higher for  
348 farmed fish than wild fish in all aspects- healthy ( $z = -5.351$ ,  $p < 0.001$ ), nutritious ( $z = -3.252$ ,  $p =$   
349  $0.001$ ), ethical ( $z = -7.562$ ,  $p < 0.001$ ), safe ( $z = -10.488$ ,  $p < 0.001$ ), and cheap ( $z = -18.172$ ,  $p <$   
350  $0.001$ ), except for favorable ( $z = -1.028$ ,  $p = 0.304$ ). The results demonstrated that information  
351 provision had an effect on the attitudes of participants as the treatment group had more positive  
352 attitudes toward farmed fish than the control group.

353

354 [Insert **Figure 3** here]

355

356 *3.4 Determinants of Farmed and Wild Fish Purchasing Intention*

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

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



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

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

377

378 [Insert **Table 3** here]

379

#### 380 **4. Discussion**

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

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

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

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

412           Participants perceived that wild fish is nutritious and preferred over farmed fish. These  
413 results are in line with previous studies that wild fish is always preferred over farmed fish due to  
414 perceived higher quality (Claret et al., 2014; López-Mas et al., 2021; Pulcini et al., 2020; Reig et  
415 al., 2019; Rickertsen et al., 2017; Vanhonacker et al., 2013; Verbeke et al., 2007b, 2005) and  
416 better taste (Maesano et al., 2020; O'Dierno et al., 2006). While some previous studies found that  
417 consumers also prefer wild-caught fish for its better safety and health aspects (Maesano et al.,  
418 2020), including the absence of negative environmental impacts, which characterize the  
419 aquaculture practice (Tidwell and Allan, 2001). Nevertheless, farmed fish is more consistent in  
420 terms of physico-chemical parameters, size and availability than wild fish, which depend on the  
421 season (Fuentes et al., 2010; Saavedra et al., 2017).

422 Safety, health, and ethics aspects, however, are arguable issues because they are  
423 complex, and individuals might think of these issues differently. For instance, regarding the ethics  
424 issue, high demand of wild-caught fish could lead to overfishing and result in damage or  
425 stagnation of fish stock (Ertör and Ortega-Cerdà, 2015). In contrast, aquaculture can generate a  
426 negative impact on environmental resources due to the factors relating to intensive fish farming  
427 practices, such as the escape of genetically modified farmed fish, contamination of wild fish stocks  
428 (in the case of cage culture), and release of effluents causing pollution and disrupting the natural  
429 performance of marine and freshwater ecosystems (FAO, 2020; Read and Fernandes, 2003;  
430 Uchida et al., 2014; Wagner and Young, 2009). Considering safety and health, wild fish could be  
431 exposed to marine pollution and to contaminants such as mercury, unsafe levels of cobalt, copper  
432 and cadmium, while farmed fish contain less contamination because they were raised with  
433 controlled conditions (Claret et al., 2014). The microplastics contamination (López-Mas et al.,  
434 2021; Suaria et al., 2016) and other anthropogenic threats (FAO, 2018; López-Mas et al., 2021)  
435 could be critical issues for wild fish as well. Even though slaughter methods for farmed fish are  
436 normally less cruel than methods used in wild fish (Bovenkerk and Meijboom, 2020), participants  
437 seemed to be quite uncertain about it.

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

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

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

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

455         Subjective knowledge has a strong positive influence on purchasing intention of wild fish  
456 in both the control and treatment groups whereas it has a weak positive effect on purchasing  
457 intention of farmed fish in the treatment group. This meant that more the participants believed that  
458 they possess knowledge about quality of fish and how to choose it, the more they tended to  
459 choose wild fish. We tested the direct effect of objective information on purchasing intention as  
460 well, but it did not have a significant effect. These results are consistent with (Hoque and Alam,  
461 2020; Pieniak et al., 2010b) who reported that subjective knowledge had a positive and significant  
462 impact on fish consumption frequency while objective knowledge had a positive but comparatively  
463 weaker impact.

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

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

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

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

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

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

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

509 Some limitations should be acknowledged when interpreting our findings, which identify  
510 some opportunities for further research. The sample comprised a high proportion of higher  
511 educated individuals which might be because of the mode of the survey (online). Hence, the  
512 interpretation should be done with care and further research should try to reach individuals with  
513 an education level representative of the Italian population level. Further research should consider  
514 the randomization of the objective knowledge questions in order to avoid the order effect. In this  
515 study, we did not measure the discrepancy between objective and subjective knowledges which  
516 could have an impact on consumers' attitudes and intentions to purchase fish (Hoque and Alam,  
517 2020). Further research should consider this issue as well.

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

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

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

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

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

557

## 558 **5. Conclusion**

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

570

## 571 **Declaration of Competing Interest**

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



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579

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583

## 584 **APPENDIX**

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

586

587   [Insert **Table A1**]

588

### 589 **A.2 Factor Analysis of Independent Variables of Logistic Regression**

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

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

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

605 For sustainability and ethical aspects, the result of PCA indicated one factor with KMO  
606 0.707 with a significant Bartlett's test. The factor was called "sustainability and ethical" and its  
607 total variance explained was 62.7%.

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

611 For attitude toward farmed fish, the first result of PCA indicated 1 factor with KMO 0.844  
612 and significant Bartlett's test with Cronbach's alpha = 0.853. However, when the item price  
613 ("Expensive - Cheap") was excluded, the Cronbach's alpha improved. Further, the PCA analysis  
614 was performed with items 1 to 5 (KMO 0.892 with a significant Bartlett's test and Cronbach's alpha  
615 = 0.892). The final result indicated one factor, that is, "attitude farmed fish"; its total variance  
616 explained was 70.1%. The scores of the item "price of farmed fish" were standardized and later  
617 used in the logistic regression.

618 For attitude toward wild fish, the first result of PCA indicated 2 factors with KMO 0.780 and  
619 the Bartlett's test significant with Cronbach's alpha = 0.751. However, when item price  
620 ("Expensive - Cheap") was excluded, the Cronbach's alpha improved. Then, the PCA was  
621 performed with items 1 to 5 (KMO 0.793 with significant Bartlett's test and Cronbach's alpha =  
622 0.825). The final result indicated one factor, that is "attitude wild fish"; its total variance explained  
623 was 59.1%. The scores of item "price of wild fish" were standardized and later used in the logistic  
624 regression.

625

[Insert **Table A2**]

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

<b>Code</b>	<b>Category</b>	<b>Statement</b>	<b>Response</b>	<b>Explanation and reference sources</b>
<b>K1</b>	Healthiness (nutrition) & Quality	Omega-3 content is higher in wild fish	<b>False</b>	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)
<b>K2</b>	Healthiness (nutrition) & Quality	Farmed fish tends to accumulate more fat than wild fish	<b>True</b>	Farmed fish tend to accumulate more fat than wild fish because they are regularly fed (Cahu et al., 2004; Saavedra et al., 2017)
<b>K3</b>	Healthiness (nutrition) & Quality	Wild fish has a more constant nutritional composition than farmed fish	<b>False</b>	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)
<b>K4</b>	Safeness & Quality	In farmed fish the risk of the presence of microplastics is lower than in wild fish	<b>True</b>	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)
<b>K5</b>	Safeness & Control & Quality	Farmed fish grow faster thanks to antibiotics and hormones	<b>False</b>	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)

628 **Table 1.** (Continued)

<b>Code</b>	<b>Category</b>	<b>Statement</b>	<b>Response</b>	<b>Explanation and reference sources</b>
<b>K6</b>	Safeness & Control & Quality	Wild fish is always safer than farmed fish because it doesn't contain harmful substances for human health	<b>False</b>	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)
<b>K7</b>	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	<b>False</b>	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)
<b>K8</b>	Animal Welfare	Farms are unhealthy places for fish because the majority of them get sick	<b>False</b>	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)
<b>K9</b>	Animal Welfare	Living conditions of farmed fish have been improved thanks to the use of technological innovations	<b>True</b>	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)

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

Code	Statement	Response	Total ( <i>n</i> = 804)	Control ( <i>n</i> = 403)	Treatment ( <i>n</i> = 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

633 **Table 2.** (Continued)

Code	Statement	Response	Total ( <i>n</i> = 804)	Control ( <i>n</i> = 403)	Treatment ( <i>n</i> = 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
<b>Aggregated objective knowledge</b> <sup>1</sup>			6.0	5.0 <sup>a</sup>	6.0 <sup>b</sup>

634

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

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

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

640

641 Note: \*\*\*, \*\*, and \* indicate significance at the 1, 5, and 10% levels, respectively, SE = Standard Error.

642 <sup>a</sup> Standardized value of variable "Attitude – Cheap for Farm Fish," <sup>b</sup> Standardized value of variable "Attitude

643 – 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 <sup>1</sup>	SD	Factor loading	Cronbach's alpha	KMO	Explained variance
<b>Consumer involvement</b>					<b>0.840</b>	<b>0.640</b>	<b>76.6%</b>
	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			
<b>Preference for wild fish</b>					<b>0.852</b>	<b>0.500</b>	<b>87.1%</b>
	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			
<b>Sustainability and ethics</b>					<b>0.789</b>	<b>0.707</b>	<b>62.7%</b>
	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 <sup>1</sup>	SD	Factor loading	Cronbach's alpha	KMO	Explained variance
<b>Subjective knowledge</b>					<b>0.905</b>	<b>0.776</b>	<b>78.1%</b>
	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			
<b>Attitude farmed fish</b>					<b>0.892</b>	<b>0.852</b>	<b>70.1%</b>
	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			
<b>Attitude wild fish</b>					<b>0.825</b>	<b>0.793</b>	<b>59.1%</b>
	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: <sup>1</sup> 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

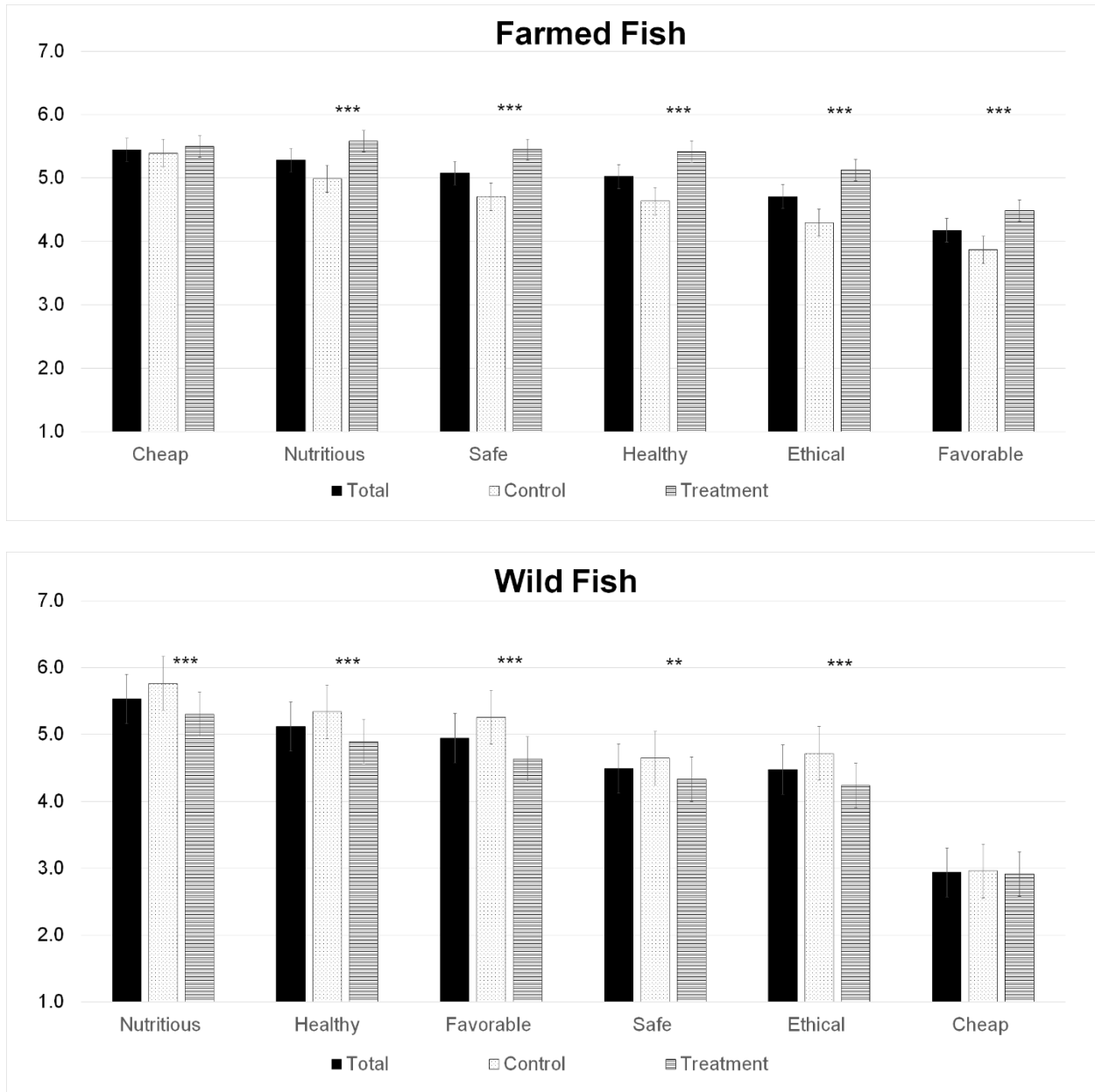
Item		Total	Control	Treatment	p-value
	n	804	403	401	
	%	100	50.1	49.9	
Gender	Male	50.5	49.1	51.9	0.103
	Female	48.6	50.6	46.6	
	Other/Don't want to response	0.9	0.2	1.5	
Age	Mean (SD)	49.7 (15.14)	49.4 (15.08)	49.9 (15.21)	0.683
Education	Middle school	3.1	3.2	3.0	0.594
	High school	34.2	35.0	33.4	
	University degree	62.7	61.8	63.6	
Employment status	Full-time	58.1	56.8	59.4	0.503
	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 monthly income	1: < 900 euro	1.7	1.7	1.7	0.663
	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 frequency	Less than once a week	32.2	32.0	32.4	0.901
	More than once a week	67.8	68.0	67.6	

**Table A2.** (Continued)

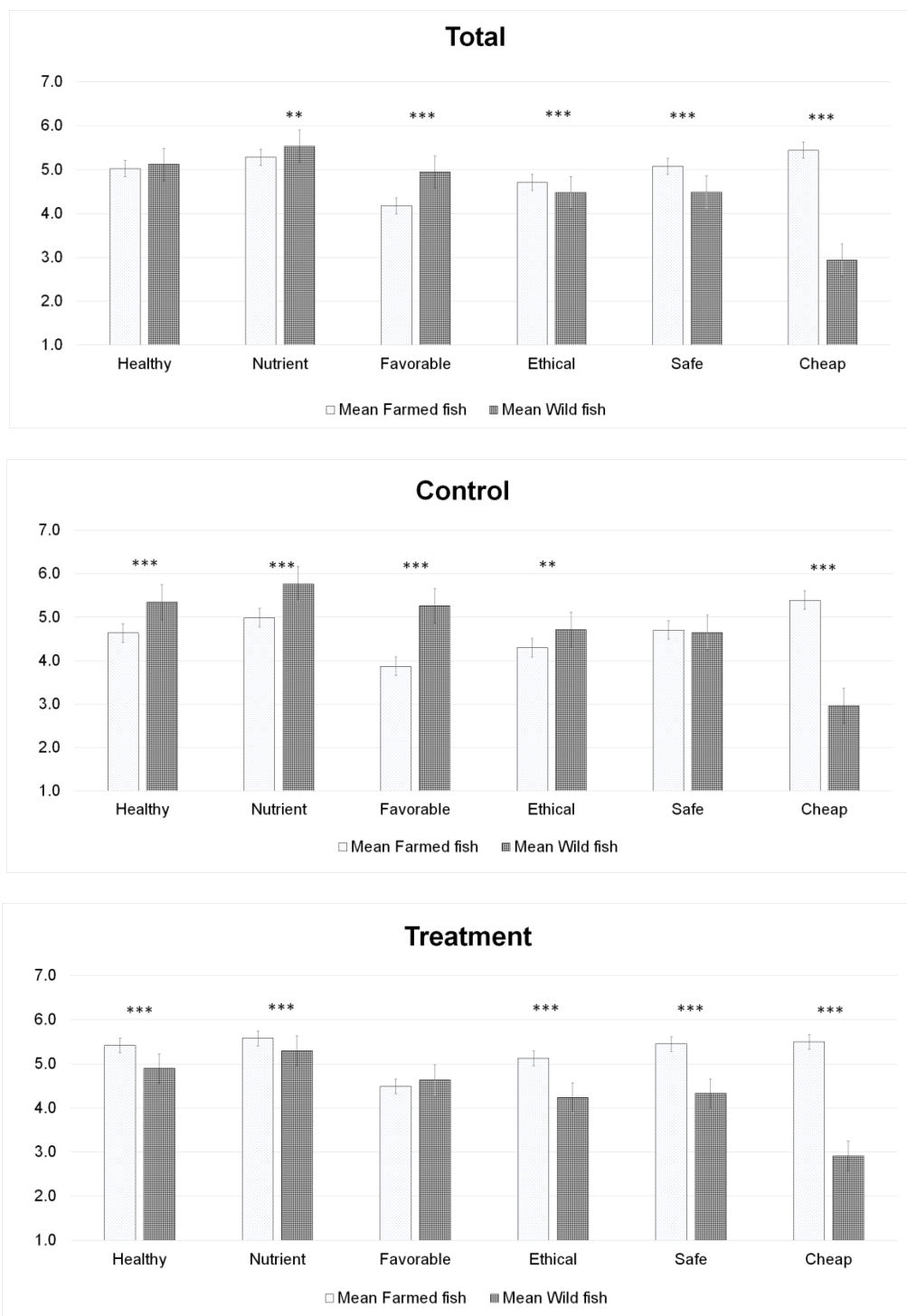
<b>Item</b>		<b>Total</b>	<b>Control</b>	<b>Treatment</b>	<b>p-value</b>
Point of purchase <sup>2</sup>	Fish shops/Fishmongers	47.3	47.4	47.1	0.941
	Supermarket	77.2	77.2	77.3	0.963
	Discount	5.8	5.7	6.0	0.867
	Online channel	1.9	2.0	1.7	0.802
	Direct from fish catchers	5.2	3.2	7.2	0.011**
	Others	2.0	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. <sup>1</sup> Flexitarian is a plant-based diet with the occasional inclusion of animal products, <sup>2</sup> 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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