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European consumers' beliefs about the main pillars of the sustainability: a comparison between wild and farmed fish

Laura López-Mas^{1,2} · Anna Claret¹ · Gaëlle Arvisenet³ · Roser Romero del Castillo² · Zein Kallas² · Massimo Zuccaro⁴ · Luis Guerrero¹

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Abstract

Aquaculture can represent an alternative means of economic yield and food security. Despite this fact, consumers still have a more negative perception of farmed fish when compared with wild fish, including its sustainability. Understanding how consumers perceive sustainability is essential in building an effective strategy to encourage sustainable fish consumption. A survey with 2145 consumers was conducted in five European countries (France, Germany, Italy, Poland, and Spain) to inquire into consumers' beliefs about the main pillars of the sustainability (environmental, social, and economic) when farmed and wild fish are compared, as well as to identify segments of consumers with similar beliefs about fish sustainability. Overall, results showed that European consumers perceived farmed fish as being more sustainable, locally obtained, providing environmental benefits, generating employment, improving human living conditions, generating rural development, and ensuring more fair fish prices than wild fish. Conversely, wild fish was perceived as ensuring animal welfare and being more organic but causing more environmental damage than farmed fish. Additionally, it seems that to effectively communicate aquaculture sustainability, it would be better to focus on single aspects of sustainability (beliefs) rather than focusing on the whole concept of sustainability. Finally, four segments of consumers were identified according to consumers' beliefs, which were labelled accordingly: ambivalent, pro aquaculture, pro wild fish, and impartial. Results obtained may be helpful to provide each segment with tailored marketing strategies to stimulate farmed fish consumption and improve the overall image of the aquaculture sector to foster its full development in Europe.

Keywords Aquaculture · Environmental · Social · Economic · Segmentation · Europe

Handling Editor: Gavin Burnell

Highlights

- There are differences in the perception of the three pillars of sustainability.
- Communication campaigns should be focused on specific sustainability beliefs.
- Welfare and organic nature are better perceived in wild fish than in farmed fish.
- Four segments of consumers were identified based on their sustainability beliefs.
- “Pro aquaculture” segment is likely to adopt sustainable farmed fish consumption.

Extended author information available on the last page of the article

Introduction

The world's population is expected to reach 9.7 billion inhabitants by 2050 (UN 2022a). Such an increase in the global population requires a proportional increase in food production, including fish and fish products. To face the expected growing fish demand, farmed fish from aquaculture offers the most suitable alternative to wild fish from fisheries (Hoque and Alam 2020; Risius et al. 2019), mainly due to the depletion of marine stocks. Accordingly, 57.3% of fisheries are exploited, and 35.4% are overexploited (FAO 2022). Regulate harvesting, end overfishing, and destructive fishing are some of the challenges addressed by the “Life below water” sustainable development goal (SDG) (UN 2022b). The World Commission on Environment and Development (1987) defined sustainable development as “*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*”. The concept of “sustainable development” is composed by three main pillars: environmental, economic, and social (UN 2012).

As defined by Goodland (1995), the environmental sustainability means “*the natural capital that must be maintained, both as a provider of inputs (‘sources’) and as a ‘sink’ for wastes*”. Renewable sources must be kept within regeneration rates, while non-renewables must keep their depletion rates equal to the rate at which renewable substitutes are created. The sink waste should hold emissions within its assimilative capacity without damaging the environment (Goodland 1995). From a customer-centric perspective of the sustainability, the economic pillar is described by Sheth et al. (2011) as related “*to impact of consumption on economic well-being of consumers associated with financial aspects such as debt burden, earning pressures, and work-life balance*”. Finally, the social sustainability pillar is founded on the promotion of well-being among the members of a community, comprising aspects such as assuring fair labour practices, providing social equality, eradicating poverty, improving life quality, avoiding unethical practices, and defending human rights (Boyd et al. 2020). The three-dimension conception of the sustainability (i.e., environmental, economic, and social aspects) has become ubiquitous (Purvis et al. 2019), for this reason may be considered its three main pillars. Even so, other authors reported the existence of additional sustainability dimensions. Some examples are FAO (2014) who described a fourth pillar (governance), whereas Hanss and Böhm (2012) added two additional pillars (temporal and developmental ones).

Despite the relevant role that aquaculture may play in global sustainability, as a valuable production method for obtaining food and feed (European Commission 2021a) and preservation of fish stocks by reducing the need to catch wild fish (European Commission 2021b), most consumers still have a more negative perception of farmed fish compared with their wild counterparts. This less positive image of farmed fish can be a barrier to the acceptance of the whole aquaculture sector (Altintzoglou et al. 2010), which may be translated into lower consumption. Proof of this fact is that, in the European Union (EU), only 25% of fish consumed comes from aquaculture (European Commission 2021b), a lower proportion than average global consumption of farmed fish (56%) (FAO 2022). Previous studies on consumers' perceptions already reported that wild fish outperformed farmed fish in terms of better quality, fewer antibiotics, fresher, healthier, natural, nutritious, and better taste, among others (Claret et al. 2014; López-Mas et al. 2021a, b; Reig et al. 2019; Rickertsen et al. 2017; Schlag and Ystgaard 2013; Stubbe and Yang 2011; Vanhonacker et al. 2013; Verbeke et al. 2007a; Wongprawmas et al. 2022).

Still, few studies have focused on consumers' perceptions of overall fish sustainability (Feucht and Zander 2015; Risius et al. 2019; Verbeke et al. 2007b). Even though, except for Whitmarsh and Giovanna (2009), most of those studies only focused on the general

concept of sustainability, rather than specific aspects belonging to any of the three main pillars of the sustainability, while others use sustainability as a synonym for the environmental pillar. Claret et al. (2014), López-Mas et al. (2021b), and Wongprawmas et al. (2022) already pointed out the necessity of inquiring into consumers' beliefs regarding sustainability, environment, animal welfare, as well as ethical issues due to the increasing concern and awareness among consumers.

Consumers' beliefs are able to influence their food choices and quality perception (Ares and Varela 2018; Frewer et al. 2001; Sobal et al. 2006). According to the Theory of Planned Behaviour, one of the most popular social-psychological models for understanding and predicting human behaviour (Ajzen 2015), beliefs, along with attitudes, are core determinants of human behaviour (Fishbein and Ajzen 2011). Beliefs, which may be true or false, rational or irrational (Perloff 2017), are persistently being adjusted (Bar-Tal 1990). Depending on how beliefs are shaped, three categories can be established: (a) observational beliefs as a result of the individual's direct observation; (b) informational beliefs based on information received from outside sources (e.g., media); and (c) inferential beliefs self-generated through inference processes (Fishbein and Ajzen 2011).

Understanding consumers' beliefs, perceptions, and insights are the first steps to effectively communicating aquaculture fish benefits and breaking down their associated myths (Reig et al. 2019; Stancu et al. 2022). In the same vein, understanding how consumers perceive sustainability is essential to encourage sustainable fish consumption (Hanss and Böhm 2012). Considering that beliefs are strongly dependent on individuals' cultural traditions and culinary habits (Caporale et al. 2005; Issanchou 1996), idiosyncrasies of European participants should be taken into account as they may play a key role in fish perception (Verbeke and Brunsø 2005), as well as in its perceived sustainability. In addition, it is worth exploring the existence of consumer segments across EU countries with similar beliefs about sustainability to provide each segment with tailored marketing strategies to stimulate farmed fish consumption and improve the overall image of the aquaculture sector to foster its full development.

The present work has a two-fold aim: (1) to assess European consumer beliefs of farmed fish compared with wild fish regarding the main pillars of the sustainability, and (2) to identify and profile segments of consumers with similar beliefs about fish sustainability.

Methodology

Participants

A stratified sample of 2145 participants was recruited to answer a questionnaire in five European countries, namely France ($n=471$), Germany ($n=414$), Italy ($n=404$), Poland ($n=423$), and Spain ($n=433$). The country selection was based on different fish consumption per capita (Spain > France > Italy > Poland > Germany) (European Commission 2020) and distinct aquaculture production methods, coastal or mariculture (higher in Spain, France, and Italy), and inland (higher in Poland and Germany) (FAO 2020). An eligibility questionnaire to participate was applied to select participants according to certain sociodemographic characteristics, including quotas on country, gender (evenly split), and age (evenly distributed in each age range: 18–35/36–55/56–75). Participants were also at least partially responsible for food purchase and preparation within their household, as well as fish consumers (at least twice a week). Table 1 shows the sociodemographic characteristics of the participants in each country.

Questionnaire

The questionnaire was developed in English, translated into national languages, and checked by native speakers not involved in the original translation. Additionally, it was tested and validated by a small sample of participants to identify incoherencies or comprehension issues.

The questionnaire was structured into several topics. Among other questions, the survey gathered participants' beliefs regarding sustainability of wild and farmed fish, overall sustainability perception, as well as participants' sociodemographic and economic characteristics (Table 1).

Participants' beliefs were assessed through 19 items comparing sustainability of wild fish with that of farmed fish. Beliefs statements were selected based on a previous qualitative research phase (López-Mas et al. 2021a) and a literature search (Alexander et al. 2016; Altintzoglou and Honkanen 2020; Balderjahn et al. 2013; Fernández-Polanco and Luna 2012; Honkanen and Olsen 2009; Ruiz-Chico et al. 2020; Whitmarsh and Giovanna 2009; Whitmarsh and Wattage 2006). From the selected beliefs, four items were related to general aspects of sustainability, while five items referred to each of the three main pillars of the sustainability (i.e., environmental, social, and economic). All the beliefs statements were presented in random order and in the format "wild/farmed fish _____ than farmed/wild fish" (Claret et al. 2014; López-Mas et al. 2021b). To reduce "yea-saying" and "nay-saying" response bias, some items were reversed in the original questionnaire. Participants' beliefs were measured on a 7-point Likert scale which ranged from 1 (strongly disagree) to 7 (strongly agree).

The two additional questions about overall fish sustainability perception were (1) do you believe that aquaculture is sustainable? and (2) do you believe that wild fishing is sustainable?. Both were measured on a 7-point scale from 1 (not sustainable at all) to 7 (very sustainable).

Participants' self-reported sociodemographic and economic characteristics included country of residence, gender, age, education level, perceived economic situation, presence of children or teenagers at home (under 18 years old), and place of living (rural–urban and inland-coastal). Quantitative variables, except for age, which used a continuous scale, were gathered through a 7-point scale: perceived economic situation (1 = difficult, 7 = well-off) and place of living (1 = rural, 7 = urban; 1 = inland, 7 = coastal).

Data analysis

All the statistical analyses were conducted with XLSTAT statistical software, version 2020.1 (2020) (Addinsoft, France).

A two-way analysis of variance (ANOVA) with Tukey's honestly significant difference (HSD) post hoc test was performed on participants' beliefs data, including country as a fixed factor and participants as a random effect. Later, a two-step clustering analysis was performed to identify segments of consumers with similar beliefs about fish sustainability. First, an agglomerative hierarchical clustering (AHC) using Ward's method and the Euclidean distance (Chung et al. 2011; Claret et al. 2014) was performed to determine the number of segments to retain according to the dendrogram, considering the homogeneity within and among the segments (Hair et al. 2010), and the parsimony rule (Vandekerckhove et al. 2015). Previously, the dataset was standardised per participant to block the idiosyncratic use of the scale (Reinders et al. 2016). Second, a *k*-means clustering analysis, using the determinant (*W*) clustering criterion, was performed by means of the centroids identified in the AHC to group participants in segments based on their beliefs scores. Finally, a discriminant analysis (DA) was performed to

Table 1 Sociodemographic and economic characteristics of the participants from the five selected countries (N=2145)

	Overall	FR	DE	IT	PL	ES
Quantitative (mean values)*						
Age**	40.7	42.2	41.8	43.6	36.4	39.6
Economic situation	4.3	4.2	4.4	4.1	4.9	3.9
Rural–urban	5.1	4.6	4.5	5.1	6.0	5.1
Inland-coastal	3.8	3.4	4.1	3.5	3.8	4.1
Is farmed fish sustainable?	4.6	3.9	4.8	4.7	4.5	4.9
Is wild fish sustainable?	4.8	4.8	4.6	4.7	5.3	4.5
Qualitative (relative frequencies [%])						
Country	100.0	22.0	19.3	18.8	19.7	20.2
Gender	54.5	63.7	44.2	54.0	52.0	57.0
	45.5	36.3	55.8	46.0	48.0	43.0
Education level	1.8	1.3	2.4	1.5	1.2	2.5
	9.2	4.7	16.2	13.1	2.8	10.2
	42.6	38.9	43.2	45.3	43.5	42.5
	46.4	55.2	38.2	40.1	52.5	44.8
Children at home	50.2	54.4	54.6	62.6	32.9	46.9
	49.8	45.6	45.4	37.4	67.1	53.1

FR, France; DE, Germany; IT, Italy; PL, Poland; ES, Spain. *Quantitative variable mean values in a 7-point scale; economic situation ranges from 1 (difficult) to 7 (well-off); place of living: rural–urban ranges from 1 (rural) to 7 (urban); place of living: inland-coastal ranges from 1 (inland) to 7 (coastal); Is farmed/wild fish sustainable? ranges from 1 (not sustainable at all) to 7 (very sustainable). **age (continuous variable)

validate the number of clusters retained by checking how many individuals were properly classified in their corresponding cluster (confusion matrix).

A subsequent cluster profiling allowed for the identification of statistical differences among the selected segments for the participants' sociodemographic and economic characteristics, as well as the two questions about the overall sustainability perception. To carry it out, an additional two-way ANOVA with Tukey's HSD post hoc test was applied for quantitative variables, whereas a k proportion test after a pairwise comparison with the Marascuilo procedure (Marascuilo and Serlin 1988) was used for qualitative variables.

Finally, a paired sample t -test was conducted to assess statistical differences between overall fish sustainability perception.

Results

European consumers' sustainability beliefs

European participants' beliefs comparing sustainability of wild fish with farmed fish are shown in Table 2. All beliefs are presented in the format "Wild fish _____ than farmed fish" to facilitate the subsequent interpretation. The mid-point of the 7-point Likert scale indicates neither agreement nor disagreement (4), values lower than 4 indicate disagreement, while values higher than 4 indicate agreement with the beliefs statement presented.

Table 2 Mean values of the selected beliefs comparing wild versus farmed fish per country

Pillar	Item Wild fish _____ than farmed fish	Mean values					
		Overall	FR	DE	IT	PL	ES
General	is more sustainable	3.4	3.9 ^a	3.2 ^b	3.5 ^b	3.4 ^b	3.2 ^b
	has more animal welfare	4.9	5.1 ^a	5.1 ^a	5.0 ^a	4.4 ^b	5.1 ^a
	is more ethical	3.7	4.0 ^a	3.6 ^b	3.7 ^{ab}	3.5 ^b	3.6 ^b
	is more organic	4.8	4.5 ^c	5.1 ^a	4.7 ^{bc}	4.8 ^{ab}	4.8 ^{ab}
Environmental	catching causes more environmental damage	4.5	4.1 ^d	4.4 ^{cd}	4.7 ^{ab}	4.5 ^{bc}	4.9 ^a
	is more locally obtained (closer origin)	3.4	3.6 ^a	3.2 ^c	3.6 ^{ab}	3.2 ^c	3.3 ^{bc}
	catching is more polluting	4.3	4.0 ^c	4.2 ^{bc}	4.4 ^{ab}	4.4 ^{ab}	4.6 ^a
	practices preserve more the marine ecosystem	4.1	4.0 ^b	4.4 ^a	3.9 ^b	4.4 ^a	3.9 ^b
	provides more environmental benefits	3.5	3.9 ^a	3.4 ^b	3.5 ^b	3.5 ^b	3.4 ^b
Social	generates more employment	3.4	3.5 ^a	3.2 ^b	3.4 ^{ab}	3.2 ^b	3.7 ^a
	generates better employment	4.2	4.2 ^{ab}	4.3 ^a	4.1 ^b	4.4 ^a	4.2 ^{ab}
	industry favours more the gender equality	3.6	3.8 ^a	3.6 ^{ab}	3.8 ^a	3.6 ^{ab}	3.5 ^b
	improves more the human living conditions	3.5	3.8 ^a	3.3 ^b	3.5 ^b	3.3 ^b	3.4 ^b
	provides more social benefits	4.3	4.2	4.4	4.2	4.2	4.4
Economic	improves more the local economy	4.4	4.3	4.4	4.3	4.4	4.5
	generates more rural development	3.4	3.6 ^a	3.2 ^b	3.6 ^a	3.2 ^b	3.6 ^a
	limits more the expansion of tourism	4.1	4.0 ^{bc}	4.4 ^a	3.8 ^c	4.2 ^{ab}	4.1 ^{ab}
	ensures more fair fish prices	3.2	3.4	3.2	3.2	3.3	3.1
	provides more economic benefits	4.3	4.2 ^b	4.3 ^{ab}	4.1 ^b	4.3 ^{ab}	4.5 ^a

Mean values in a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). Superscript a–d: different letters in the same row indicate statistically significant differences ($p \leq 0.05$); the absence of letters within a row indicates no statistical differences

Overall, when both production systems were compared, European consumers considered farmed fish as being more sustainable, more locally obtained, providing more environmental benefits, generating more employment, improving more the human living conditions, generating more rural development, and ensuring more fair fish prices than wild fish. Conversely, wild fish was perceived as ensuring better animal welfare, being more organic, and causing more environmental damage than farmed fish.

When focusing on participants' beliefs from different countries, there were significant differences in 16 out of 19 beliefs. If general sustainability is targeted, farmed fish was perceived as more sustainable in all countries, even though French respondents exhibited scores more neutral (3.9), closer to the scale's mid-point. Regarding animal welfare, participants from all countries believed that wild fish has higher welfare, even though this belief was lower for Polish. Higher ethics of farmed fish was recognised by respondents from all countries, but this belief was less salient for Italian and, specially, for French participants whose punctuations were in the mid-point of the scale. The belief that wild fish is more organic was shared by respondents from all countries, even though it was significantly stronger for German than for French and Italian participants.

Concerning the environmental pillar, the belief that wild fish catching causes more environmental damage was widespread across all countries, although French held it weaker when compared with Spanish respondents. In the same line, French participants perceived significantly less prominent than the rest of the countries the belief that farmed fish provides more environmental benefits. In general terms, participants perceived farmed fish as more locally obtained. In particular, German and Polish respondents were the ones that significantly perceived farmed fish as being of closer origin when they were compared with French participants. Spanish respondents believed that wild fish catching is more polluting than French did. Finally, significant differences were found in the preservation of the marine ecosystem beliefs. German and Polish participants stressed that wild fish practices preserve more the marine ecosystem, while the remaining countries did not have a clear trend against one or another production system.

If the spotlight is on the social pillar of the sustainability, participants from all countries agreed that farmed fish improves more the human living conditions, although this belief was held less strongly by French. German and Polish respondents perceived significantly more prominent than Spanish and French the belief that farmed fish generates more employment. Conversely, also participants from Germany and Poland were the ones who believed that employment generated by aquaculture fish industry is worse when compared with the same belief held by Italian participants. Respondents from all countries stressed that farmed fish provides more gender equality, although Italian and French held it weaker than Spanish participants did.

Concerning the economic pillar, the belief that farmed fish generates more rural development was more salient among German and Polish participants when compared with the other countries. Regarding the expansion of tourism, Italian respondents believed that farmed fish limits the expansion of tourism while the rest of the countries, in particular Germany, believed otherwise. Finally, participants from Spain believed that wild fish provides more economic benefits than Italian and French did.

Segments of consumers

The two-step clustering analysis suggested the existence of four segments of consumers with similar sustainability beliefs regarding wild fish when compared with farmed fish

Table 3 Mean values of the four segments of participants identified according to their beliefs comparing sustainability of wild versus farmed fish

Pillar	Item Wild fish _____ than farmed fish	Segment (mean values)			
		1 (n=420)	2 (n=472)	3 (n=653)	4 (n=600)
General	is more sustainable	2.4 ^c	2.4 ^c	4.4 ^a	4.0 ^b
	has more animal welfare	5.7 ^a	4.4 ^b	5.7 ^a	4.0 ^c
	is more ethical	2.5 ^d	2.9 ^c	4.6 ^a	4.1 ^b
	is more organic	5.6 ^a	4.3 ^b	5.5 ^a	3.8 ^c
Environmental	catching causes more environmental damage	5.5 ^a	5.6 ^a	3.6 ^c	3.9 ^b
	is more locally obtained (closer origin)	2.5 ^c	2.7 ^b	3.9 ^a	4.0 ^a
	catching is more polluting	5.5 ^a	5.2 ^b	3.5 ^d	3.7 ^c
	practices preserve more the marine ecosystem	5.6 ^a	3.0 ^d	4.5 ^b	3.5 ^c
Social	provides more environmental benefits	2.4 ^d	2.6 ^c	4.4 ^a	4.1 ^b
	generates more employment	2.3 ^d	3.2 ^c	3.7 ^b	4.0 ^a
	generates better employment	5.6 ^a	3.6 ^c	4.3 ^b	3.7 ^c
	industry favours more the gender equality	2.5 ^d	3.3 ^c	4.0 ^b	4.3 ^a
Economic	improves more the human living conditions	2.4 ^c	2.9 ^b	4.0 ^a	4.1 ^a
	provides more social benefits	5.6 ^a	3.6 ^c	4.6 ^b	3.6 ^c
	improves more the local economy	5.7 ^a	3.7 ^d	4.5 ^b	3.9 ^c
	generates more rural development	2.4 ^d	3.0 ^c	3.8 ^b	4.0 ^a
	limits more the expansion of tourism	5.5 ^a	4.0 ^b	3.8 ^c	3.6 ^c
	ensures more fair fish prices	2.3 ^d	2.6 ^c	3.6 ^b	4.0 ^a
	provides more economic benefits	5.5 ^a	3.7 ^c	4.4 ^b	3.8 ^c

Mean values in a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). Superscript a–d: different letters in the same row indicate statistically significant differences ($p \leq 0.05$); the absence of letters within a row indicates no statistical differences. Segment 1, ambivalent; segment 2, pro aquaculture; segment 3, pro wild fish; segment 4, impartial

(Table 3). The DA allowed to classify each individual in their expected cluster for 87.9% of the participants, confirming the optimal four-segment solution.

Participants from segment 1 ($n=420$ respondents; 19.6% of the total sample) were labelled as “ambivalent” as their scores showed positive opinions towards both production systems. On the one hand, some of their beliefs were in favour of wild fish as it was perceived as having better animal welfare, being more organic, preserving more the marine ecosystem, generating better employment, providing more social benefits, improving more the local economy, and providing more economic benefits. On the other hand, some of their beliefs were in favour of farmed fish as it was perceived as being more sustainable, being more ethical, causing less environmental damage, being more locally obtained, being less polluting, providing more environmental benefits, generating more employment, favouring more the gender equality, improving more the human living conditions, generating more rural development, and ensuring more fair fish prices. Regarding the belief about the limitation of tourism expansion, it is difficult to predict whether it favours farmed or wild fish as it is more ambiguous when compared with the other beliefs (see the “[European consumers’ sustainability beliefs](#)” section).

Segment 2 ($n = 472$; 22.0%) grouped the participants whose beliefs favoured farmed fish and, consequently, it was labelled as “pro aquaculture”. Only two exceptions disturbed their unanimity on a better perception of farmed fish, as wild fish was perceived as having higher animal welfare (4.4) and being more organic (4.3).

Segment 3 ($n = 653$; 30.4%) was labelled as “pro wild fish” as their participants’ beliefs had the tendency to favour wild fish. Respondents from this segment held the strongest beliefs, along with the participants belonging to segment 1, that wild fish has higher animal welfare (5.7) and is more organic (5.5) than farmed fish. Other beliefs in favour of wild fish were related to its more ethical character, its lower pollution, its higher preservation of the marine ecosystem, and its higher improvement of the local economy. Almost all remaining beliefs also were in favour of wild fish, although they were not held with the same strong convictions as its mean values were around the mid-point of the scale (4 ± 0.5).

Finally, segment 4 ($n = 600$; 28.0%) was labelled as “impartial” as consumers’ punctuations were in the neighbourhood of the mid-point of the scale (4 ± 0.5). Their beliefs did not show a clear trend in favour or against the sustainability of one or another production system.

Segment’s profiling

The four segments of consumers were profiled according to participants’ sociodemographic and economic characteristics, as well as their overall perception of farmed and wild fish sustainability (Table 4). Differences between segments were found in all variables except for education.

The segment “ambivalent” grouped the younger participants, with a higher perceived economic situation, from urban and coastal areas, which considered sustainable both farmed and wild fish. More German and Polish, followed by Spanish, took part in this segment.

The “pro aquaculture” segment grouped older respondents, together with the “pro wild fish” segment. Participants from the “pro aquaculture” segment, along with the “impartial” segment, perceived the sustainability of wild fish as lower when compared to the other two segments. More Italian and Spanish participants took part in this segment, but also more males.

Participants belonging to the “pro wild fish” segment were the ones that perceived the sustainability of farmed fish as lower when compared with the other segments. More French participants than Polish ones belonged to this segment, as well as more females.

Lastly, “impartial” segment grouped more French and Polish participants, but it did not stand out for any other sociodemographic or economic characteristic.

Discussion

European consumers’ sustainability beliefs

The first aim of this study was to assess European consumer beliefs regarding sustainability of farmed fish when compared with wild fish. As expected, when examining the overall mean values, there was not a general cognitive consensus; i.e., some of the

Table 4 Sociodemographic and other characteristics of the participants grouped within the segments identified

		Segment				Number of individuals
		1 (n=420)	2 (n=472)	3 (n=653)	4 (n=600)	
Quantitative (mean values)*						
Age**		38.9 ^c	43.0 ^a	41.2 ^{ab}	39.7 ^{bc}	2145
Economic situation		4.9 ^a	4.2 ^b	4.2 ^b	4.1 ^b	
Rural–urban		5.5 ^a	5.2 ^{ab}	5.0 ^{bc}	4.8 ^c	
Inland–coastal		4.5 ^a	3.5 ^b	3.8 ^b	3.5 ^b	
Is farmed fish sustainable?		5.4 ^a	5.1 ^b	3.9 ^d	4.2 ^c	
Is wild fish sustainable?		5.4 ^a	4.3 ^c	5.0 ^b	4.5 ^c	
Qualitative (observed frequencies)						
Country	FR	52 ^{Cb}	70 ^{Cb}	173 ^{Aa}	176 ^{Aa}	471
	DE	111 ^{Aa}	80 ^{BCb}	126 ^{ABab}	97 ^{Bb}	414
	IT	60 ^{BCb}	119 ^{Aa}	119 ^{ABab}	106 ^{Bb}	404
	PL	108 ^{Aa}	91 ^{ABCab}	102 ^{Bb}	122 ^{ABab}	423
	ES	89 ^{ABab}	112 ^{ABa}	133 ^{ABab}	99 ^{Bb}	433
Gender	Female	211 ^b	227 ^{Bb}	395 ^{Aa}	335 ^{ab}	1168
	Male	209 ^a	245 ^{Aa}	258 ^{Bb}	265 ^{ab}	977
Education	Basic	11	5	12	10	38
	Secondary	45	35	55	63	198
	High school/ technical training	177	196	273	267	913
	University	187	236	313	260	996
Children	No	137 ^{Bb}	265 ^{Aa}	353 ^{Aa}	322 ^{Aa}	1077
	Yes	283 ^{Aa}	207 ^{Bb}	300 ^{Bb}	278 ^{Bb}	1068

FR France, DE Germany, IT Italy, PL Poland, ES Spain. *Quantitative variable mean values in a 7-point scale: economic situation ranges from 1 (difficult) to 7 (well-off); place of living: rural–urban ranges from 1 (rural) to 7 (urban); place of living: inland–coastal ranges from 1 (inland) to 7 (coastal); Is farmed/wild fish sustainable? ranges from 1 (not sustainable at all) to 7 (very sustainable); **age (continuous variable). Superscript a–d: different letters in the same row indicate statistically significant differences ($p \leq 0.05$); superscript A–C: different letters in the same column indicate statistically significant differences ($p \leq 0.05$); the absence of letters within a row or a column indicates no statistical differences. The segment size or the number of individuals must be considered to compare the data between columns and rows, respectively. Segment 1, ambivalent; segment 2, pro aquaculture; segment 3, pro wild fish; segment 4, impartial

beliefs favoured farmed fish while others favoured the wild option. These mean values ranged between 3.4 and 4.9, close to the scale's mid-point, which normally is an indicator of high variability in the responses as frequently observed in overall acceptability scores (Font-i-Furnols and Guerrero 2014). Results showed that there were statistical differences between countries, but in most cases, consumers' beliefs from all countries were in unison, i.e., different mean values but indicating agreement (higher than 4) or disagreement (lower than 4) in all countries. The only two beliefs with a slight disagreement between countries were related to the preservation of the marine ecosystem and the limitation of tourism expansion, probably because those are more ambiguous when compared with the other beliefs. Particularly, some participants believed that farmed fish limits the expansion of tourism (e.g., Italian), whereas other respondents believed

that is wild fish (e.g., the rest of the countries) that hampers tourism. Those results raise a question of whether the expansion of tourism seems to be beneficial or harmful for the overall sustainability. On the one hand, the limitation of tourism in coastal areas allows the preservation of the ecosystems (Nitivattananon and Srinonil 2019) (environmental pillar). On the other hand, the livelihoods of many coastal communities are dependent on tourism as a source of employment (European Commission 2021a) (economic and social pillars). This ambiguity may hinder consumers' comprehension of the real meaning of this belief and, therefore, results obtained should be interpreted with caution.

If a closer look is given at other beliefs, it could be seen that European respondents perceived farmed fish as more sustainable but with worst animal welfare. Similar results were reported by Hoerterer et al. (2022) for German consumers, who found that 40% of the general public agreed with the statement that "aquaculture is not good for fish welfare, but the only way to ensure seafood availability". Farmed fish welfare has been criticised for a long time (Feucht and Zander 2015). Indeed, during the qualitative research phase of this study (López-Mas et al. 2021a), and as it was found in previous literature (Claret et al. 2014; López-Mas et al. 2021c), some consumers questioned farmed fish welfare and stated that wild fishes are "happier" because they can freely swim. However, this analogy was not applied to terrestrial animals, whose freedom is rarely questioned. What consumers probably do not know is that swimming freely is only one of the "five freedoms" defined by the Farm Animal Welfare Council. Those guidelines were widely adopted as a practical checklist for animal welfare assurance, which include freedom from (1) hunger and thirst; (2) discomfort; (3) pain, injury, and disease; (4) express normal behaviour; and (5) fear and distress (FAWC 2009; Stien et al. 2020). Therefore, it is important to transmit to consumers that fish welfare does not only depend on one single aspect but is a conjunction of different ones. In this line, it is worth informing consumers that despite farmed fish cannot swim in the open ocean, they gain in other aspects of animal welfare such as feed availability, absence of predators, control of diseases and parasites, among others. This information provision may help consumers to form an informational belief in favour of farmed fish welfare.

As reported by Feucht and Zander (2015), aquaculture is sometimes criticised for its negative environmental impacts. However, results obtained within this study tend to indicate the opposite. Overall, European consumers believed that farmed fish causes less environmental damage, is less pollutant, and provides more environmental benefits. Considering the growing importance of environmental issues among consumers, this better perception should wisely be exploited in favour of aquaculture when communicating its benefits to citizens.

Also related to environmental issues is the fish origin, as consumers associated longer distances between the fishing zone and the selling point with higher environmental impact (Feucht and Zander 2015). In line with those findings, participants from this study perceived farmed fish as more locally obtained (closer origin). In Europe, consumers increasingly demand products with short supply chains (European Commission 2021c), acquiring prominence initiatives such as Km 0 products. Besides, origin has gained relevance over the last years in fish purchase as, behind appearance and cost, it is the third most important aspect for Europeans when buying fish, increasing from 41% in 2018 (European Commission 2018) to 49% in 2021 (European Commission 2021d). Even so, considering that aquaculture facilities could be located closer to the consumption place, especially in landlocked regions, and that consumers already have a good perception, marketers should emphasise the closer origin of the farmed fish products to increase its demand (Petereit et al. 2022). The same reasoning may explain why German and Polish respondents are the ones that perceived farmed fish as of closer origin, probably because their inland aquaculture and

inland fishery catching (e.g., rivers and lakes) production are higher (FAO 2020), as a result of their shorter coastline, when compared with the one from France, Italy, and Spain. Interestingly, the higher inland aquaculture production and inland fishery catching in Germany and Poland may also have influenced their perception of rural development, as inland aquaculture is particularly suitable for providing jobs in landlocked regions (European Commission 2021e). Indeed, the belief that farmed fish promote the rural development was more salient among German and Polish consumers than in other countries.

Altogether, participants perceived that farmed fish generates more employment than wild fish; however, this belief was only supported by factual data in France and Poland (European Commission 2020). What is noteworthy is that participants slightly believed that farmed fish generates more employment but of lower quality than the one generated by wild fisheries. Results were contrary to what was expected considering that fishery workers are likely to stand long working hours, often far from home, in challenging work conditions, and often with the dangers associated with navigating on the high seas. Indeed, according to the International Labour Organization (ILO), fishing is among the most hazardous occupations in the world (FAO 2022; ILO 2007). Therefore, transforming this belief in favour of farmed fish is crucial for improving consumers' perception of the aquaculture sector and its potential social benefits for the community.

Respondents from all countries agreed that farmed fish provide more gender equality than wild fish, which is consistent with actual European figures (FAO 2020). Even so, the representativeness of females in the primary fish sector is minimal, around 3% for capture fisheries and 22% for aquaculture, although it increases in the processing sector.

If differences between countries are targeted, 16 out of 19 items presented significant differences. Various studies reported that French participants have a worst perception of aquaculture production when compared with wild fishing (European Commission 2018; López-Mas et al. 2021b; Rickertsen et al. 2017). Those findings were corroborated in the present study as French participants showed a generally worst perception of aquaculture sustainability for all the explored pillars. Therefore, the general worst perception of farmed fish may have distorted French consumers' perception of its sustainability. Indeed, French respondents were the ones who significantly scored lower on the question about overall farmed fish sustainability.

If a closer look is given at both questions about overall sustainability of wild and farmed fish, European consumers perceived wild fish as being significantly more sustainable. In other words, if participants were directly asked about which production method is more sustainable, their answer was wild fish. However, if they were asked about different aspects (beliefs) of sustainability and its main pillars when wild and farmed fish are compared, farmed fish was favoured in many beliefs. This fact suggests that to effectively communicate aquaculture sustainability, it is better to focus on single aspects of the sustainability rather than encompassing the whole concept. Similar results were reported by López-Mas et al. (2022), who found that consumers placed higher importance on a single aspect of the environmental pillar (i.e., recyclability) rather than the whole concept of sustainability. A plausible reason for this fact may be the use and abuse of the term sustainability and its derivatives, which might have caused some indifference among consumers (Luttenberger 2021).

Segments of consumers and their profile

The second aim of the study was to identify and profile segments of consumers with similar perceptions about fish sustainability. The findings showed that sustainability beliefs

were useful for identifying segments of consumers and profiling them according to participants' sociodemographic and economic characteristics. As pointed out by Stancu et al. (2022), one of the main advantages of identifying international segments of consumers is the possibility of uniting the communication efforts in favour of aquaculture rather than conducting country-specific strategies.

As defined by Gardner (1987, p. 241), “*ambivalence is a psychological state in which a person holds mixed feelings (positive and negative) towards some psychological object*”. In the present study, segment 1 was labelled as “ambivalent” as participants showed mixed feelings, sometimes favouring sustainability of farmed fish while others wild fish. Honkanen and Olsen (2009) already reported the existence of a similar segment among Spanish consumers when it comes to aquaculture fish welfare and environmental issues. To target participants from “ambivalent” group, those worst perceived aspects regarding aquaculture fish should be addressed through communication and marketing campaigns. In this sense, fact-based communication campaigns may play a relevant role in enhancing the societal perception of aquaculture and adding value to the sector (Carrassón et al. 2021; Wongprawmas et al. 2022). However, caution is required when consumers are approached in any form. To improve the overall farmed fish image is probably better to highlight the positive aspects of aquaculture rather than pointing out the negative aspects of wild fish. Communicating negative facts to consumers could provoke a collateral effect and dull the general positive image that fish products enjoy, independent of the production method (Vanhonacker et al. 2013). Various studies reported that younger generations consume less fish (Pieniak et al. 2010; Pulcini et al. 2020; Skuland 2015; Verbeke and Vackier 2005). Considering that participants belonging to this segment, a part of being younger, are mainly from urban areas and have a higher perceived economic situation, strategies such as online shopping or delivery of ready-to-eat or ready-to-cook may increase their fish consumption (Cantillo et al. 2021). Indeed, as reported by Pulcini et al. (2020), younger generations have the highest rate of fish consumption out of home, but also the highest takeaway and street-food consumption.

It is highly relevant that participants from the “pro aquaculture” segment, who are mostly in favour of aquaculture fish and that perceived the overall sustainability of wild fish as lower than other segments, believed that wild fish outperforms it in two aspects (i.e., animal welfare and organic character). This fact underlines the need to emphasise these two attributes when communicating aquaculture benefits to the public. Indeed, numerous studies reported the importance of fish welfare for consumers (Altintzoglou et al. 2010; European Commission 2021e; Risius et al. 2019; Saidi et al. 2022; Wongprawmas et al. 2022; Zander and Feucht 2018). As mentioned before, animal welfare may be addressed in several ways, including targeting the “five freedoms” defined by the Farm Animal Welfare Council. Therefore, when promoting farmed fish welfare, special emphasis should be placed on its freedom from hunger, discomfort, pain, injury, diseases, express normal behaviour, fear, and distress. In the same vein, considering the relevance of the organic character for consumers, it is important to inform them that fishing of wild animals could not be considered organic production (Council Regulation (EC) No 834/2007). Therefore, providing information to consumers on organic farmed fish existence may offer aquaculture producers a marketing advantage over their wild counterpart (Engle et al. 2017). Certainly, there exists a positive correlation between knowledge and general fish consumption (Hoque and Alam 2020; Krešić et al. 2022), and more in particular, the consumption of organic aquatic foods (Pulcini et al. 2020). Consequently, more information should be given to consumers on the distinction between organic and sustainable, as the difference is sometimes not fully aware (Sánchez-Bravo et al. 2021).

Despite the fact that older consumers tend to have a better perception of wild fish for various attributes (e.g., taste, health, and nutritious value) (Verbeke et al. 2007a), aged respondents of the present study were mainly split into two segments, the “pro wild fish” and the “pro aquaculture”, suggesting that there is no relationship between age and a better wild fish perception regarding sustainability beliefs. At a time, this lack of correlation may be caused by the lower concern of aged consumers about environmental, social, or ethical issues when compared with younger generations (European Commission 2021d), as the latter tend to be more sensitive regarding sustainability and animal welfare issues (Wongprawmas et al. 2022). Additionally, although more males took part in this segment, there are relatively few differences between males and females when it comes to attitudes towards aquaculture and fishery products (European Commission 2021d). Therefore, to target this segment, is probably better to focus on the country (Italy and Spain), which yields opportunities for conducting country-specific marketing campaigns and communication efforts, as are the nationalities most prevalent in this segment.

Similarly, although strongly held, participants from the “pro wild fish” believed that wild fish has higher animal welfare and is more organic than farmed fish, while the remaining beliefs also favoured wild fish. Consequently, participants from this segment seem less likely to buy and adopt sustainable aquaculture fish products, as beliefs are prime determinants of human behaviour (Fishbein and Ajzen 2011), including food intake and food choices (Ares and Varela 2018). Even so, it is worth providing consumers with objective and truthful information coming from credible sources (Krešić et al. 2022) to transform inferential beliefs, sometimes based on prejudices against intensive terrestrial livestock and agricultural production (Engle et al. 2017; Feucht and Zander 2015; Verbeke et al. 2007a), into informational ones. Actually, Carrassón et al. (2021) demonstrated that providing consumers with scientifically based information can improve the perception of aquaculture. Bearing that participants in this segment perceived the sustainability of farmed fish as lower than the other segments, the information provision should focus on the crucial role that aquaculture may play in global sustainability. Indeed, the European Green Deal plan that Europe will become a climate-neutral continent by 2050 (European Commission 2020). Within this context, aquaculture is deemed crucial in creating a sustainable food system as a valuable method for obtaining food that can reduce the pressure on fisheries (FAO 2022). Considering that more French participants belonged to this segment, specific campaigns highlighting those aspects should be carried out in this country.

Consumers of segment “impartial” had no clear belief against the sustainability of one or another production system. Previous studies also identified segments of consumers which were not involved with the product when different segmentation criteria were used. For example, Risius et al. (2019) identified five consumer segments based on sustainability attributes and country of origin of aquaculture products. One of the clusters identified was referred to as “average consumers” as their preference structure resembled the mean preferences of the overall sample. In the same line, Reinders et al. (2016) also identified a segment of consumers labelled as “ambiguous indifferent”, as they did not show any specific interest in the psychographic moderators studied regarding farmed fish. Similarly, Stancu et al. (2022) also reported the existence of a segment of consumers which was uninvolved or indifferent.

In the present study, although it is not within its scope, it would be interesting to inquire whether consumers of the impartial segment are unaware or indifferent regarding fish sustainability. In the former case, as already reported by Risius et al. (2019), certified sustainable aquaculture is a relatively new market segment, which may have caused consumers’ unawareness. Therefore, providing consumers with information about sustainability could transform inferential beliefs into informational ones and, thus, raising consumers’

awareness and acceptance in favour of farmed fish production system. In this line, Honkanen and Olsen (2009) found that 40% of Spanish respondents neither agree nor disagree with various statements related to farmed fish, which may be a sign of a low knowledge level on fish farming at a time that may lower fish consumption. On the contrary, considering that predisposition is essential to gain knowledge and influence individuals' behaviour, consumers' indifference to fish sustainability is a rougher task to address. In any case, participants from the impartial segment seem less likely to buy sustainable fish products. Therefore, communication campaigns to promote sustainable fish consumption should not emphasise its sustainable character if the impartial segment is targeted. Instead, other strategies may be used, for example, as suggested by Reinders et al. (2016), to target other salient fish attributes (e.g., healthiness), although those are beyond the scope of this study.

Conclusions

Aquaculture is an alternative method to wild fish that may contribute environmentally, economically, and socially to the sustainability of food production systems. Encouraging the consumption of farmed fish is vital to address the "Life below water" sustainable development goal (SDG) to end overfishing and destructive fishing. In this line, promoting sustainable aquaculture consumption is essential to meet the food needs of the present without compromising the ability of future generations to meet their own needs.

The less positive perception of aquaculture fish in Europe can negatively affect its consumption. Considering the role that consumers' beliefs play in food choices and behaviour, it is crucial to understand consumer beliefs when the sustainability of farmed and wild caught fish is compared in a cross-cultural context. The results obtained may be useful for providing guidelines to different stakeholders (e.g., producers, marketers, food industry, and policymakers) to shift consumers' habits into more sustainable ones with the final aim of increasing the aquaculture fish consumption to feed the increasing global population. Specifically, the identification of those aspects of aquaculture fish sustainability that are negatively perceived among European consumers (e.g., animal welfare and organic character) can be used by stakeholders during communication campaigns to improve or, at least, mitigate the less positive perception of farmed fish.

The results obtained showed that to build an effective strategy to communicate sustainable aquaculture to citizens, it is crucial to know which particular aspects are negatively perceived to target them during promotion campaigns rather than focusing on the whole concept of sustainability. In this line, it may be better to highlight aquaculture's positive aspects rather than pointing out the negative aspects of wild fish as communicating adverse facts to consumers could dull the general positive image that fish products enjoy, independent of the production method.

The identification of four consumer segments as well as their sociodemographic and economic profile can be useful to focus promotion campaigns for sustainable aquaculture fish. One of the segments identified, the "pro aquaculture", seemed to be the most likely to adopt sustainably farmed fish. Conversely, the strategy to persuade the "pro wild fish" and "ambivalent" segments should be focused on providing consumers with objective and truthful information to transform inferential beliefs into informational ones. Finally, consumers belonging to the "uninvolved" segment may be the most difficult ones to convince to increase their farmed fish consumption due to their unawareness or indifference about fish sustainability.

Limitations of the study and further research

This study is focused on fish, but other aquatic animals also deserve attention (i.e., crustaceans, molluscs, and algae). In particular, aquatic plants are gaining special relevance in recent times as they could be an important source of alternative protein for a sustainable food system (European Commission 2021e) to meet the increasing trend of reducing animal product intake (i.e., vegan and vegetarian).

Besides the three main pillars of the sustainability, some studies and reports also include additional dimensions (e.g., FAO 2014). In this sense, future studies may benefit from including some additional dimensions when inquiring into consumers' perceptions of sustainability.

Considering the relevant role that beliefs may play in consumers' behaviour, additional research is required, both in obtaining updated data and exploring new areas of study. In this line, considering that farmed fish welfare is generally not well perceived among European consumers, further research should be conducted on specific aspects of fish welfare, including fish slaughtering, diseases management, and technological innovations (Wongprawmas et al. 2022).

Finally, some authors have noticed a gap between consumers' concerns and actual purchasing behaviour regarding fish welfare and environment (Honkanen and Olsen 2009). Therefore, it would be worth studying how consumers will behave in a real setting environment, like the one they encounter when shopping.

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Data availability The datasets generated during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval The study protocol was assessed and approved by the Ethical Committee of the Institute of Agrifood Research and Technology (IRTA), registration number CCSC 14/2022, in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

Informed consent Informed consent was obtained from all subjects involved in the study.

Competing interests The authors declare no competing interests.

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