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Information impact on consumers' perceptions towards aquaculture: Dismantling the myth about feeds for farmed fish

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ABSTRACT

Aquaculture products are commonplace in markets around the world. However, despite efforts to minimize the negative perceptions towards aquaculture, several misbeliefs or myths still persist, and thus globally consumers tend to value wild fish more highly than farmed fish . The lack of information has been shown to be one of the most important causes of this preference, driving buying decisions to be more emotional than rational. The aim of this study was to determine whether scientific-supported information contrasting one myth could contribute to a better perception of farmed products. To that end, consensus on a series of aquaculture-related issues among different scientists, external experts, and aquaculture societies was used to build up the scientific information. This information was provided to 300 Spanish consumers using two different communication tools (150 consumers each tool): an interactive web documentary and a written and printed document, to detect possible differences in the change of consumers' perception. Consumers were asked for their degree of agreement on a set of 14 statements before and after providing the scientific information. A variable collecting the assessment of each of the statements was calculated as the Overall-perception. Possible significant differences between the scores before and after providing the information and for the 'overall perception' were analysed separately for each communication tool as well as for the combined sample. Possible relationship between the consumers' perception with the sociodemographic factors, the consumers' knowledge and the fish consumption habits were also assessed. Results show that consumer's perception of aquaculture before the query were moderate (5.6 average in a 0 to 10 scale) but that it increased slightly but significantly and regardless of the communication tool used. Among sociodemographic factors, age and gender were the ones that most influenced consumer's perceptions, being older people those who exhibited a generally more positive opinion towards aquaculture. The effects of consumption habits and knowledge about aquaculture were also the two most explicative factors for change in perception. Importantly, the opinion of consumers with less knowledge about seafood products in general and production methods or consuming only wild fish products, improved after being exposed to the information. These results demonstrate the utility of science- and fact-based communication campaigns to improve the societal perception of aquaculture practices and products, regardless of the tool used to transmit this information.

1. Introduction

Worldwide demand for fish products is continuously increasing. Over the last decade, fish from capture fisheries has remained constant while aquaculture production has increased significantly (FAO, 2020; Pauly et al., 2003; Pauly et al., 2002). These factors allow consumers to have access to aquaculture products in the marketplace at reasonable prices. Thus, globally, from 1990 to 2018, there was a rise in

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aquaculture production of 527%, and currently aquaculture provides about half of the total fish supply (FAO, 2020). Aquaculture products are now routinely consumed in Spain and many other countries around the world (about the 20% of the aquatic consumption products in the European Union come from aquaculture, MAPAMA, 2018) with different species and formats. In fact Spain is an important seafood trader, the first European Union country producer of aquaculture in terms of biomass, and the third country in terms of value income, mainly thanks to the production of bivalves (APROMAR, 2020). However, despite the positive changes in environmental and welfare aspects of aquaculture, which is a consequence of the sector evolution and its increasing awareness for sustainability issues, a lack of favourable perception still remains among many consumers (Reig et al., 2019). Indeed, there is an overall lack of awareness regarding aquaculture products and their potential safety and quality characteristics (Kaimakoudi et al., 2013).

When farmed products are evaluated, they are rarely considered on their own since comparison with wild specimens is very often unavoidable. In this scenario, there is a clear preference for the wild fish, which is more valued, as evidenced for example by their higher price in the markets. When comparing wild and farmed fish prices from different species at the Central Fish Market in Barcelona (MERCABARNA, 2019) the differences are very important. Aspects such as fish size or supply volume, among others, might partially explain market price differences between wild and farmed fish. Thus, for example, Regnier and Bayramoglu (2017) found that for wild and farmed European seabass in France there was not a homogeneous or integrated market, suggesting that consumers are more sensitive to aquaculture processes in high valued species, while wild and farmed sea bream markets were partially integrated. In the same sense, in Spain, the production method (capture vs. aquaculture) was an important factor for consumers when choosing sea fish (Claret et al., 2014).

The difference in perception by wild and farm fish has been described by different authors, who demonstrate that consumers tend to value more the wild than the farmed fish (Bacher, 2015; Claret et al., 2014; López-Mas et al., 2021; Reig et al., 2019; Vanhonacker et al., 2013; Verbeke et al., 2007) even if in a blind tasting panel they cannot differentiate between both origins (Claret et al., 2016). In general, European consumers weight scientific concerns about environment or human health related to farmed and wild fish, but they consider the latter more natural and thus they have a preference for it (Schlag and Ystgaard, 2013). Several studies have attempted to determine the attributes that consumers tend to value in farmed fish. These aspects are related to the environmental impact of the production, as well as concern for fish welfare (Aarset et al., 2004; Feucht and Zander, 2016), a lower level of pollution, heavy metals, and parasites (Claret et al., 2014; López-Mas et al., 2021), better control of the entire production process and better price and availability (López-Mas et al., 2021), and more stable quality (Reig et al., 2019), among others. According to market statistics (MERCABARNA, 2019) even though consumers prefer wild fish, the consumption of farmed fish is higher. Therefore, increasing the knowledge of consumers about aquaculture in several aspects such as safety, health or sustainability, could maintain and increase the positive image and consumption of farmed fish itself (Altintzoglou et al., 2010).

Moreover, a set of negative attributes are also assigned to farmed fish (e.g., attributes related to animal welfare, quality and environment impact; see Reig et al. (2019)), but one common element that frequently arises is a demand for more information about aquaculture processes and products. In Reig et al. (2019), the highest concordance in negative aspects included the lack of sufficient information about aquaculture and the quality of farmed products. Therefore, there is not only a distorted and frequently negative idea about several aspects of aquaculture but also a perception of needing more information. According to Pieniak et al. (2007), one of the consequences of this lack of information is that buying decisions can be made more emotionally than rationally. This makes these decisions more voluble and fragile, as they do not consider other objective aspects, like the knowledge of the product or the quality of the process.

Aquaculture is constantly changing, so when consumers try to find information about its products and processes, it can be quite difficult both to find up-to-date, friendly, and scientifically sound material and, at the same time, to avoid an excess of information, not always well focused or with the appropriate scientific rigor. One interesting remark is that, after receiving information, the perceptions and opinions of consumers can change very quickly depending on the trust in the source and, therefore, it is not surprising that opinion changes can arise even after a simple discussion between pairs lasting only several minutes (Reig et al., 2019).

In aquaculture, the emergence of widely held but false beliefs or ideas (referred to as “myths” in the rest of this paper) has been described concerning various topics such as feed (Ayvaz, 2017; Hardy, 2005), genetic manipulation, or the use of therapeutic products (Bergh, 2007). Some of these myths condition consumer's perception of aquaculture and its products (Claret et al., 2014; Fernandez-Polanco and Luna, 2012; Reig et al., 2019). In the work of Reig et al. (2019), positive aspects detected included market issues and the stable quality of farmed products. On the other hand, negative perceptions included the lack of sufficient information about aquaculture and quality. Animal welfare and environmental impact issues were not of much concern, although they included some minor positive and negative perceptions. Some of these negative aspects were identified as erroneous, matching several of the so-called myths about aquaculture. The need for communication campaigns addressing these issues was a relevant conclusion of that study.

For the present paper, the hypothesis is that providing scientifically sound but accessible information might be key to clarify several myths or wrong beliefs about aquaculture. This means taking a step forward towards start providing solutions for a problem that has already been very well described: the different valuation of the aquaculture products by the consumer.

The myth chosen to dispel by providing information was one of those identified as being relevant in the study of Reig et al. (2019) and was related to the feeding of the farmed fish. It was formulated as follows: the feeding that the fish receive in the fish farms can have detrimental consequences for the quality of the product, the fish and the consumers' health, and the environment. As can be seen, fish feeding encompasses many different elements about aquaculture production, so dispelling this myth through scientific-based information (e.g., Kok et al., 2020) can provide positive guidance on several aspects of aquaculture (health, environment, sustainability, among others that are at the base of other myths).

These myths can be dismantled by providing valid objective arguments through documentation. The importance of information is a determinant factor of individual behavior. Rather than simply memorizing the content and answering the questions, the consumers read and understand the relevance of the information and in turn the relevance of their decisions on fish consumption. Thus, providing certain scientific based information focused on the main benefits of aquaculture or the minimisation of the negative effects is crucial to tackle those myths. Moreover, besides providing the right information, it is important to make it available to all consumers utilizing a friendly language. When considering how this information should be provided, two aspects have to be taken into account. First, the possible influence of the socio-economic profile of respondents and, secondly, the influence of the communication tool used to provide the information. Factors like age (Verbeke et al., 2005), gender, and education (Pieniak et al., 2010; Verbeke and Vackier, 2005) can influence fish consumption and perception and even affect buying decisions (Kraus et al., 2017). So, it is important to consider such socio-economic features in any consumer perception research. Considering the tool used to provide the information, when comparing web-based and paper-based questionnaires in previous surveys, the first produced information of similar or superior quality than the traditional paper version (Vergnaud et al., 2011). In another research investigating three methods, paper-based, computer-

based, and web-based (Touvier et al., 2010) few differences were observed despite some evidence in favor of paper-based questionnaire administration.

Based on what has been discussed above, the main objective of this study was to determine whether consumer's perceptions of aquaculture and, specifically, on the myth that the feed fish receive can have detrimental consequences for the animal, the consumers, and the environment could be dispelled by providing correct information. To this, we developed and launched a questionnaire in which we assessed consumers' perceptions towards aquaculture processes and products. This was done in two stages: before and after providing them with scientific information about the selected myth, i.e. the feeding of farmed fish. Additionally, two communication tools were implemented to test if there was a difference depending on the format in which information was provided.

Providing a powerful information tool could add value to the sector, contributing to improving its image among consumers (and increasing the value of its products). This is, furthermore, a key element that can contribute to the sustainable development of aquaculture.

2. Materials and methods

The whole process included different steps, from selecting and analysing the myth to the final output (Fig. 1).

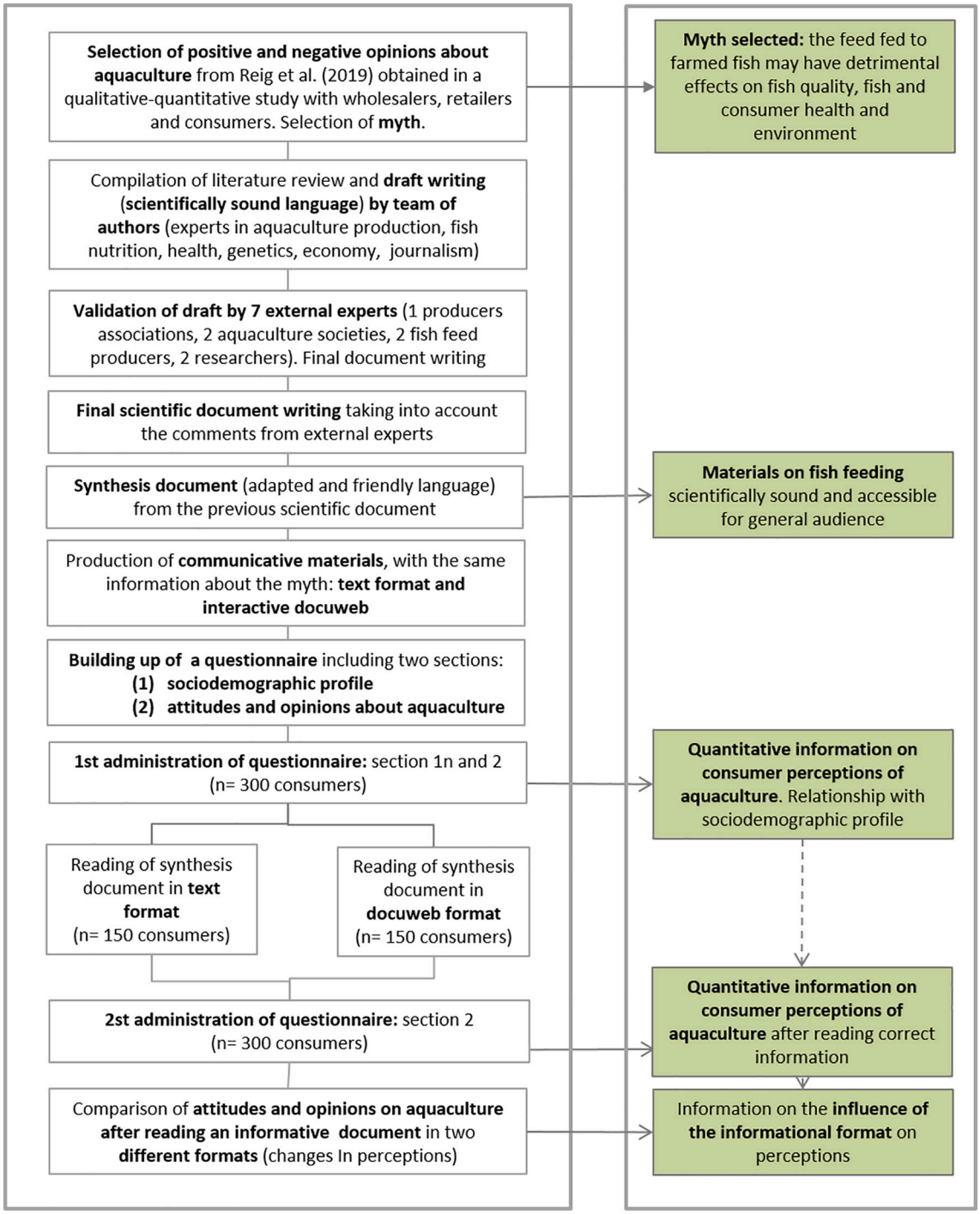

Fig. 1. A flow diagram that summarizes the process of the survey during the different steps and outputs obtained in each step.

2.1. Generating the information to dispel the myth: a consensus among researchers

The information to be provided to consumers focused on feed for farmed fish, although it also contained other aspects related to aquaculture, such as animal welfare and traceability. First, an extended literature review was compiled and written in a scientifically comprehensive language, including all the scientific references (to justify its contents). The building up of a first draft included several rounds of discussion within the authors of this study, covering different expertise: aquaculture production, fish nutrition, and health, genetics, economy, and communication. Each expert wrote a first draft of one section of the document, including all scientific references, and was later circulated and discussed in face-to-face meetings where suggestions were debated at large. The draft was then rewritten and a consensus was reached when all members of the team approved it. This document was then sent to one expert of each of the following fields and organizations: Aquaculture Spanish society, European Aquaculture Society, Spanish producers association, university scientist, aquaculture research center scientist, feed company, food safety). Their knowledge and opinions were taken into account and helped to improve the final document's content.

On a second step, the team wrote a synthesis of the previous document choosing proper but easy-to-understand words and eliminating scientific references as well as footnotes, to simplify the reading. Special care was taken to not change the conceptual content of the message. Again, a consensus was reached within the authors' team by approval of the document. A list of questions was then decided and the answers written with contents of the synthesis document, maintaining the facts, but using a language adapted keeping in mind that the target population was the consumers. The aim was to communicate true, science-based, and clear messages that could be conveyed to society.

From the final document, two formats were produced, by the communications expert, each adapted to a different type of communication tool: (1) a written and printed document; and (2) an interactive web documentary. Both tools shared the same information and phrasing. However, the web documentary allowed the readers to play a more active role, by including photographic material in a way that made it more amiable to read (Supplementary Material S1B). Also, the written document accounted for the whole information, all in once. Instead, the web documentary provided a first highlighted information and the reader could ask for further detailed information. The photographic material to be included was agreed upon after discussion among the authors of this study. Both documents included the identity of the authors' affiliation (universities and research centers) to provide context to respondents when receiving the questionnaire.

2.2. Empirical application

The questionnaire was tested first a total of three times using a pilot sample of 14 different consumers each time and subsequently revised to improve readability and understanding. From our pilot survey, adjustments were made to the vocabulary and the structure of some of the sentences. Besides, some technical issues from the online questionnaire also needed to be rearranged. For example, the speed in which the screen would jump from page to page, a clarification of how to return to the questionnaire after the information was read, among others of the kind. Once it was deemed suitable and polished, it was presented to 300 Spanish consumers ("the sample") qualified by having purchased and consumed seafood products at least once in the last 2 months. The fieldwork was subcontracted to a company specialized in marketing research and the sample was stratified by gender and place of residence. The 300 participants were randomly assigned to one of the two communication tools (150 each) while assuring the stratification within each group. Each group visualized one of the designs (written document or web documentary). Table 1 shows a summary of the technical sheet of the survey.

Table 1
Survey technical sheet.

Universe frame	Usual consumers of fish within 20–70 years old
Scope	Spain
Sample size	300 consumers
Sample error	± 5.66%
Confidence level	95% (k = 1.96)
Sample design	Stratified by gender and place of residence
Control measures	Pilot survey (14 consumers), repeated three times
Field work dates	July and August 2017

The procedure was structured in several blocks, in the following order: (A) gathering and recording consumers' knowledge and fish consumption habits, (B) gathering and recording consumers' beliefs and opinions towards aquaculture, (C) display of the communication tool to consumers, (D) repetition of bloc B, and (E) gathering and recording information on consumers' sociodemographic characteristics. It is important to note, that once consumers had read the information, they were not allowed to go back to the questionnaire to check their first set of answers (before displaying the information).

Items from blocks A and E are displayed on Table 2. They collect sociodemographic, consumption and knowledge data which are generally gathered in consumer studies. Blocks B and D are shown on Supplementary Material S2. The 14-items set collect the most relevant myths identified from Reig et al. (2019), among others. The 14 statements were classified according to their character: personal opinions (O) about aquaculture and, respondents' opinions about what society (S) knows or feels about aquaculture practices and products (Table 3, factor "type"). Participants' were asked about their agreement with each statement measured by an 11-point Likert scale, where 0 and 10 mean null and full agreement, respectively, with the statement related to the selected myth (the feeding for farmed fish). Block C provided the communication tool. A fraction of its contents are shown in the Supplementary Material S1 of this manuscript.

The sociodemographic factors (block E of the questionnaire) included gender, age, area of residence, yearly gross household income, and family structure. For the statistical analysis, gender was divided into (0) male and (1) female. Age was categorized into three groups: (1) 22 to 33 years old, (2) 34 to 53 years old and, (3) 54 to 72 years old. Age groups were based on current demographic trends in Spain and were chosen to represent individuals of three different generations. The area of residence was divided into inland (0) and coastal (1) provinces (territorial divisions in Spain), depending whether the province has a sea coast or not. At the time when the survey was carried out, in Spain the average household income per capita was ~14,000 euro and average household size was ~2,5 (INE, 2020). This is why we took 35 k euro as the middle average class in total household income and thus household income was categorized into three groups: (1) low (< 35.000 €), (2) medium (~35.000 €) and, (3) high (> 35.000 €). Family structure was segmented into three groups: (1) independent youngsters and adults, (2) single-parent families and couples with children and, (3) couples without children (Table 2).

Fish consumption habits and consumers' knowledge factors (block A of the questionnaire) included: weekly consumption of seafood products (number of times per week that seafood is consumed) *[wconsump]*; weekly expenditure on seafood products (euros spent per week on seafood) *[wexpend]*; diversity of species consumed (number of different seafood species usually consumed) *[divers]*; consumption of wild or farmed fish or both *[aqconsump]*; consumers' knowledge about the definition of aquaculture *[def]*; consumers' knowledge about the production method of the seafood that they consume *[knowofmethod]*, and; consumers' knowledge about seafood products in general *[consknow]*. For the statistical analysis, *wconsump* was divided into (1) once a week, (2) 2 times a week, (3) 3 times a week, (4) 4 times a week, and (5) 5 or more times a week. *Wexpend* was segmented in (1) ≤ 10 €, (2) from 11 to 20 € and (3) from 21 to 30 € and (4) > 30 €. *Divers* was classified as (1)

Table 2
Sociodemographic and Consumption and knowledge characteristics of the consumers participating in the present study (corresponding to the blocks E and A from the procedure survey). Data as percent. Consumers were grouped into two communication tools: information provided on a written document and information provided on an interactive web documentary. * indicates statistically significant differences Chi-squared test between the two tool.

Factors	Written document (n = 152)	Web documentary (n = 148)	Combined (n = 300)
SOCIODEMOGRAPHIC (BLOCK E)			
Gender			
Male	46.1	50.7	48.3
Female	53.9	49.3	51.7
Age			
22 to 33 years old	10.5	20.3	15.3
34 to 53 years old	78.3	68.9	73.7
54 to 72 years old	11.2	10.8	11.0
Yearly gross Household Income*			
Above 35,000€	40.1	27.0	33.7
Around 35,000€	32.9	34.5	33.7
Below 35,000€	27.0	38.5	32.7
Family structure			
Couples or single parent with children	68.0	59.9	64.0
Couples with no children	24.7	29.6	27.1
Independent adults/ youngsters	7.3	10.6	8.9
Area of residence			
Mainland	49.3	48.6	49.0
Coastal	50.7	51.4	51.0
CONSUMPTION AND KNOWLEDGE (BLOCK A)			
Weekly consumption of seafood products *[wconsump]*			
Once a week	9.7	9.9	9.8
2 times a week	29.2	37.6	33.3
3 times a week	23.6	27.7	25.6
4 times a week	22.2	12.8	17.5
5 or more times a week	15.3	12.1	13.7
Weekly expenditure on seafood products *[wexpend]**			
$\leq$ 10 €	18.5	27.4	22.9
from 11 to 20 €	39.7	42.5	41.1
from 21 to 30 €	18.5	19.2	18.8
$>$ 30 €	23.3	11.0	17.1
Diversity of species consumed *[divers]*			
Low (1 to 3 species)	21.1	29.1	25.0
Medium (4 to 7 species)	67.8	60.8	64.3
High (8 to 10 species)	11.2	10.1	10.7
Consumption of wild or farmed fish or both *[aqconsump]*			
Only wild	1.3	2.7	2.0
Both	92.10	87.8	90.0
Only aquaculture	6.6	9.5	8.0
Consumers' definition of aquaculture *[def]*			
Right response	87.5	85.1	86.3
Wrong response	12.5	14.9	13.7
Consumers' knowledge about the production method *[knowofmethod]*			
Low (from 0 to 3 points)	23.7	30.4	27.0
Medium (from 4 to 6 points)	34.2	30.4	32.3
High (form 7 to 10 points)	42.1	39.2	40.7
Consumers' knowledge about seafood products in general *[consknow]*			
Low (from 0 to 3 points)	18.4	17.6	18.0
Medium (from 4 to 6 points)	42.8	40.5	41.7
High (form 7 to 10 points)	38.8	41.9	40.3

low (1 to 3 species from a list of 10 species including the most consumed in Spain - based on sales statistics from (MERCABARNA, 2019) (2) medium (4 to 7 species), and (3) high (8 to 10 species). *Aqconsump* was divided into (1) only wild, (2) wild and aquaculture, and (3) only aquaculture. *Def* classified participants into two groups: (0) wrong response and (1) right response (this information was derived from a multiple-choice question concerning aquaculture's definition with one correct definition and three incorrect ones). *Knowofmethod* and *consknow* were both elicited from a self-assessment 11-point Likert scale where 0 indicated no knowledge whatsoever and 11 deep knowledge. Then we classified participants in three discrete classes depending on grades: (1) low (from 0 to 3 points), (2) medium (from 4 to 6 points), and (3) high (from 7 to 10 points) (Table 2).

2.3. Data analysis

Chi-square tests were applied to determine possible differences in sociodemographic and the consumption and knowledge factors between the consumers presented with the two communication tools - (1) information provided on a written document and, (2) information provided on an interactive web documentary. A non-parametric multidimensional scaling (MDS) was applied on square-root transformed first response (before being exposed to information) data of 14 statements set using the factor "type" (O, S, see Table 3) to visualize the ordination of 14 statements concerning the similarity of the character.

The consumer's responses obtained for the 14 statements before and after providing the information are the core of our statistical analysis. For the analysis, to make proper comparisons between the 14 different statements, some of them needed to be positivized (particularly, statements #1, 4, 5, 6, 7, and 9, shown in Table 3) since these were in fact reverse-worded sentences.

Data obtained from the 14 statements sets were tested for normality and homoscedasticity. A variable named 'Overall-perception' was calculated as the mean of the responses obtained for the 14 statements sets, before and after providing the information, and provides consumer's overall perception towards aquaculture. Mean and standard deviation were calculated for each statement and for the Overall perception (both before and after reading the information provided). Possible significant differences between the scores before and after reading the 14 statements and for the Overall perception were analysed by the paired t-test, for each one of the two communication tools as well as for the combined sample. Furthermore, the change (c) in each one of the 14 statements for both the two tools as well as the combined sample was calculated as the difference between the response before and after being presented with information (Change-variables: from c1 to c14, Table 4). An Overall-change variable was also calculated as the mean of the values obtained for the 14 Change-variables. Possible significant differences for c1 to c14 and the overall-change variable separately in two sets according to the communication tool provided (web documentary or written document) were analysed by respective t-tests.

To analyze the main drives for change of opinion and taking into account the structure of the survey, we considered sociodemographic factors and consumers' consumption habits and knowledge factors. Redundancy analysis (RDA) (van den Wollenberg, 1977) was applied to test the relation between sociodemographic factors, as multiple explicative variables, and the 14 statements set before reading the information, as multiple response variables. The analysis was also applied to the 14 Change-variables. The statistical significance of each of the axes derived by each analysis was tested with a Monte Carlo permutation test (Hope, 1968). The number of permutations was set at 500. Pearson correlations were used to explore the relationship among these variables. Possible effects of the two important explicative factors in the RDA (which turned out to be age and gender) were tested for the Overall perception and the Overall-change variable, each of the 14 statements (before reading the information), and; the 14 Change-variables (c1 to c14) using General Linear Models (GLM), with post-hoc pairwise

Table 3
Influence of information provision on aquaculture perceptions. Mean (X) and standard deviation (SD) of the 14 statements (11-point Likart scale, 0–10) and the Overall perception (mean of the responses obtained for the 14-item sets), before and after reading the provided information. (R) refers to the reverse-worded statements that required to be positivized. Changes were analysed separately for those who read the written document, those who read the web documentary and the combined sample. Statement type indicates whether it concerns about the respondent's own opinion (O) or what they think society (S) knows or feels about aquaculture. Different superscript letters show significant differences ($p < 0.05$) among before and after reading information (paired T-test).

		Written document (n = 152)				Web documentary (n = 148)				Combined (n = 300)			
		Before		After		Before		After		Before		After	
	Type	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
1. There are no chemical products in fish feeds that can be harmful to our health (R)	O	5.09 a	2.52	5.96 b	2.95	5.03 a	2.35	6.01 b	2.85	5.06 a	2.44	5.99 b	2.90
2. Aquaculture products are healthy	O	6.87 a	1.85	7.32 b	1.91	6.86 a	1.92	7.50 b	1.74	6.87 a	1.88	7.41 b	1.83
3. Feeds for farmed fish are healthy for the fish	O	6.19 a	2.05	7.11 b	1.97	6.18 a	1.88	7.40 b	1.89	6.18 a	1.97	7.25 b	1.94
4. The quality of farmed fish is unaffected by the feeds that they receive (R)	O	4.63 a	2.35	5.55 b	2.86	4.78 a	2.61	5.91 b	2.85	4.70 a	2.48	5.73 b	2.86
5. Resources are not wasted by the use of wild fish in farmed fish feeds (R)	O	5.19 a	2.24	6.06 b	2.66	5.05 a	2.23	5.78 b	2.67	5.12 a	2.23	5.92 b	2.67
6. Society trusts aquaculture processes (feeding, medication, treatments…) (R)	S	3.47 a	1.97	3.45 a	1.81	3.38 a	1.96	3.64 a	1.94	3.43 a	1.96	3.54 a	1.88
7. Society is informed about aquaculture processes (feeding, medication, treatments…) (R)	S	2.36 a	2.02	2.59 a	1.71	2.51 a	1.97	2.61 a	1.90	2.43 a	2.00	2.60 a	1.80
8. There are more sanitary controls for farmed fish than for wild fish	O	6.78 a	2.15	7.91 b	1.70	6.47 a	2.11	7.52 b	1.86	6.62 a	2.13	7.72 b	1.79
9. Society tends to accept aquaculture products (R)	S	4.28 a	2.25	3.95 a	2.29	4.41 a	2.29	3.76 b	2.14	4.34 a	2.27	3.86 b	2.22
10. Fish farming is more environmentally friendly than other livestock sectors	O	6.01 a	2.38	7.28 b	2.07	6.01 a	2.05	7.24 b	1.82	6.01 a	2.22	7.26 b	1.95
11. Aquaculture products taste good	O	6.47 a	2.11	7.32 b	1.85	6.72 a	1.75	7.41 b	1.67	6.59 a	1.94	7.36 b	1.76
12. Aquaculture products have affordable prices	O	7.01 a	1.73	7.70 b	1.48	6.98 a	1.83	7.28 b	1.67	7.00 a	1.78	7.49 b	1.59
13. Aquaculture products are quality products	O	6.62 a	1.94	7.48 b	1.82	6.72 a	1.87	7.62 b	1.59	6.67 a	1.90	7.55 b	1.71
14. Aquaculture products provide essential nutrients for our health	O	7.05 a	1.89	7.49 b	2.05	7.19 a	1.85	7.89 b	1.65	7.12 a	1.87	7.69 b	1.87
Overall perception	–	5.57 a	1.03	6.22 b	1.12	5.59 a	0.95	6.25 b	1.05	5.58 a	0.99	6.24 b	1.09

comparisons. The analyses using the change of opinion were repeated separately depending on the type of communication tool provided.

Redundancy analysis (RDA) was also applied to test the relation among the 14 Change-variables (c1 to c14 from Table 4) and the consumption and knowledge factors. Then, using individuals as replicate samples, differences in 14 Change-variables (c1 to c14) and the Overall-change variable were tested using GLM, followed by post-hoc Student-Newman-Keuls test. This was done for the three factors that after the RDA turned out to be the most important: *aqconsump*, *knowofmethod* and *consknow*, plus the factor "type of communication tool".

Relative importance of the 14- statements sets (before the information) and the 14-Change variables were explored separately with Random Forests (Strobl et al., 2008) using R Studio 1.1.463. The *cforest ()* function was used to apply the method with subsampling without replacement to account for variables with varied scales of measurement and number of categories. Mean decrease in accuracy was used to order variables by their importance. The analysis included all the factors used in both RDA.

3. Results

Possible differences in the characterization of consumers from the two samples were tested. Only significant differences between the two tools (written document and web documentary) were found for the factors Yearly Gross Household Income ($X^2 = 6.936$, $p = 0.031$) and *wexpend* ($X^2 = 9.154$, $p = 0.027$) (Table 2). No differences were found for the remaining 10 factors considered.

3.1. Effect of the information provided for the aggregated sample

Before providing the information, the obtained value for the Overall perception was 5.58, which shows that the values of consumers' agreement with the statements were moderate (Table 3). Responses by statements show that the three most positive considerations about aquaculture products are: providing essential nutrients, being healthy, and having affordable prices (statements #14, 2, and 12, respectively). Assessments showing the three lowest scores are those related to respondents' opinions about what society knows or feels about aquaculture: trusting aquaculture processes, being informed about aquaculture processes and tending to accept aquaculture products (statements #6, 7, and 9, respectively).

Fig. 2 shows a two-dimensional non-metric Multidimensional Scaling (MDS) plot of the 14 statements with superimposed clusters resulting from group average clustering, at similarity levels of 85%. It shows a clear separation between respondents' personal opinions about aquaculture (O), and those about what society knows or feels in the field of aquaculture (S). Combined sample scores before reading the information significantly differed (*t*-test: $t = 49{,}162$, $p < 0.001$) between personal opinions and society knowledge statements (6.18 ± 0.84 vs 3.40 ± 0.95, respectively; mean $\pm$ SD).

The combined respondents' assessments for the 14 statements (Table 3) showed a moderate but significant increase in agreement scores after reading the information for the Overall perception and for 11 of the statements (1, 2, 3, 4, 5, 8, 10, 11, 12, 13 and 14 from Table 3) (paired t-test, $p < 0.05$ in all cases). However, the assessment to statement # 9 got significantly lower scores after reading the information while statements 6 and 7 did not change ($p > 0.05$). The three latter statements, nevertheless, do not relate to the consumer him/herself, but

Table 4
Mean (X) and standard deviation (SD) of the change produced between the responses of 14 statements before and after reading the provided information and the Overall change variable. Changes were analysed separately for those who read the written document, those who read the web documentary and the combined sample.

	Written document (n = 152)	Web documentary (n = 148)		Combined sample (n = 300)	
	X	SD	X	SD	X	SD
c1. There are no chemical products in fish feeds that can be harmful to our health	0.88	3.04	0.98	3.20	0.93	3.11
c2. Aquaculture products are healthy	0.45	2.16	0.64	2.04	0.54	2.10
c3. Feeds for farmed fish are healthy for the fish	0.92	2.33	1.22	2.14	1.07	2.24
c4. The quality of farmed fish is unaffected by the feeds that they receive	0.91	3.34	1.14	3.15	1.03	3.24
c5. Resources are not wasted by the use of wild fish in farmed fish feeds	0.87	2.91	0.73	2.85	0.80	2.88
c6. Society trusts aquaculture processes (feeding, medication, treatments…)	−0.03	2.09	0.26	2.48	0.11	2.29
c7. Society is informed about aquaculture processes (feeding, medication, treatments…)	0.23	2.17	0.11	2.39	0.17	2.28
c8. There are more sanitary controls for farmed fish than for wild fish	1.13	2.25	1.05	2.15	1.09	2.20
c9. Society tends to accept aquaculture products	−0.33	2.53	−0.64	2.30	−0.48	2.42
c10. Fish farming is more environmentally friendly than other livestock sectors	1.26	2.74	1.24	2.42	1.25	2.58
c11. Aquaculture products taste good	0.85	1.94	0.69	1.91	0.77	1.92
c12. Aquaculture products have affordable prices	0.68	1.59	0.30	1.97	0.50	1.79
c13. Aquaculture products are quality products	0.86	1.79	0.90	1.97	0.88	1.88
c14. Aquaculture products provide essential nutrients for our health	0.44	2.06	0.70	1.72	0.57	1.90
Overall perception	0.65	1.00	0.67	1.00	0.66	1.00

to what the consumer thinks about how society thinks or feels.

For the group that read the written document, statement #9 also did not change significantly (Table 3). These were the only differences detected between the groups exposed to the two different communication tools. Furthermore, the Overall-change variable and the 14 Change-variables (c1 to c14) were not dependent on the type of communication tool received (t-test, $p > 0.05$ in all cases) (Table 4).

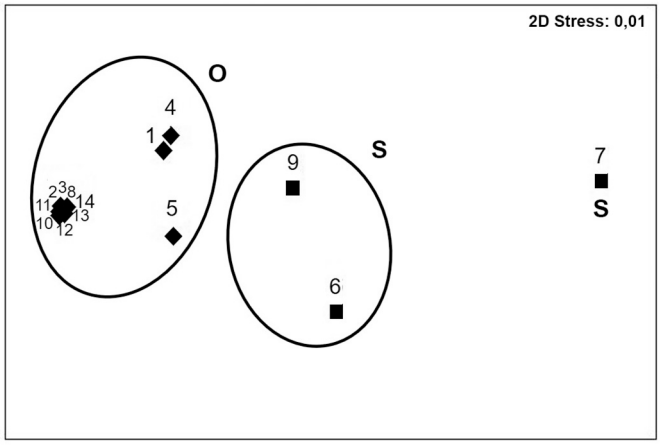

Fig. 2. Multidimensional scaling (MDS) showing ordination of the first response of 14 statements depending of the character or type of the statement. S: statements related to the opinion of what respondents think society knows or feels; O: personal opinion of the respondents over the aquaculture product.

3.2. Effect of the sociodemographic factors

Unless otherwise stated, no interaction was found between factors tested (sociodemographic or consumption habits and knowledge) in any of the above-described analyses (respective GLMs).

The RDA showed that 79.10% of the variability in consumer's responses to the 14 statements before being provided with the information was explained by age, gender, family structure, yearly gross household income, and area of residence as explanatory variables ($p < 0.05$) (not shown). The standardized canonical coefficients of age and gender were the two more important for the two first axes.

There was a significant relationship between the Overall perception before reading the information and age (GLM, $p = 0.027$), being the oldest adult group (range: 54–72 years) those which showed a more positive opinion towards aquaculture. However, only answers to two of the 14 statements were significantly influenced by age (GLM, $p < 0.05$ in both cases): statements #3 and 13 (feed safety in farmed fish and the quality of aquaculture products), with a more positive agreement again from the oldest adult group. Regarding gender, men's scores were higher before reading the information in statements # 8 and 14 (more sanitary controls for farmed vs wild fish and the essential nutrient provided by aquaculture products) (GLM, $p < 0.05$ in both cases).

Regarding the change in perception after reading the scientific information, the RDA performed with the 14 Change-variables produced similar results (70.56%, $p = 0.05$), being again age and gender the two more explicative factors in the analysis (Fig. 3). However, the GLMs indicate that there was a significant change produced after the information only for the gender factor in the overall change and in one statement (c1: no chemical products in fish feeds harming our health), being women consumers the ones who improve more their opinion (GLM, $p < 0.05$ in both cases) (Fig. 4A, Gender).

3.3. Effect of consumption habits and knowledge factors

The RDA showed that 65.70% of the variability of the changes produced after the information (Change-variables; c1-c14) was explained by the participants' consumption habits and knowledge about seafood and aquaculture as explicative factors ($p < 0.05$). Particularly, *knowofmethod* and *consknow* were the two most explicative factors, together with *aqconsump* (Fig. 5).

Interactions between *aqconsump* and *consknow* were found for the Overall-change variable and for the statements c1 and c2 (no chemical products in fish feeds harming our health and the healthy of aquaculture

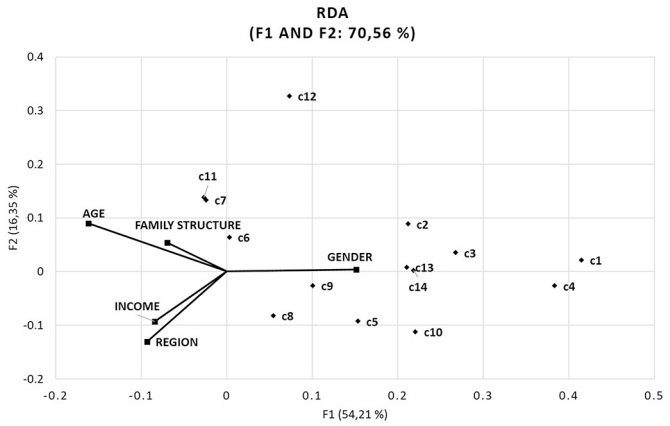

Fig. 3. Redundancy Analysis (RDA) among the change of opinion in responses of survey after reading the materials provided (c1-c14) and the sociodemographic factors (age, gender, family structure, income, region) as the explicative variables.

products) (from the 14 Change variables). An interaction between *knowofmethod* and *consknow* for the statement c12 (the affordable prices of aquaculture products) also was detected. In general, the change in each response (14 Change variables) did not differ for the factors *aqconsump*, *knowofmethod*, *consknow,* and type of document read. Differences were only found for the statements c4 (feed does not affect the quality of farmed fish) and c12, pointing out that consumers with less knowledge about the production method *[knowofmethod]* change more their opinion when reading the information document (Fig. 4B, C). Besides, people with less knowledge about seafood products in general *[consknow]* changed more their responses in Overall-change, c1, c2, and c12 (Fig. 4D, E, F, G). Similarly, people who consume only wild fish products *[aqconsump]* improved more their opinion in c1 and c5 (no chemical products in fish feeds harming our health and feed farmed fish does not waste wild fish resources) than those who consume aquaculture products (GLM, $p < 0.05$ in all cases) (Fig. 4H, I). In any case, there were no differences in the change of the response by the type of communication tool (GLM, $p > 0.05$ in all cases).

In general terms, *knowofmethod* and *consknow* were also the factors that contributed more to explaining the variation in the responses before reading the provided information and on the change produced between the responses before and after reading the information (Random Forests). Both variables were the most listed in the top 1st and 2nd positions at both analyses.

4. Discussion

The goal of this study was to test whether providing consumers with scientifically-based information yet in a friendly manner could contribute to an overall better perception of aquaculture. Additionally, we also tested whether the medium by which the information was

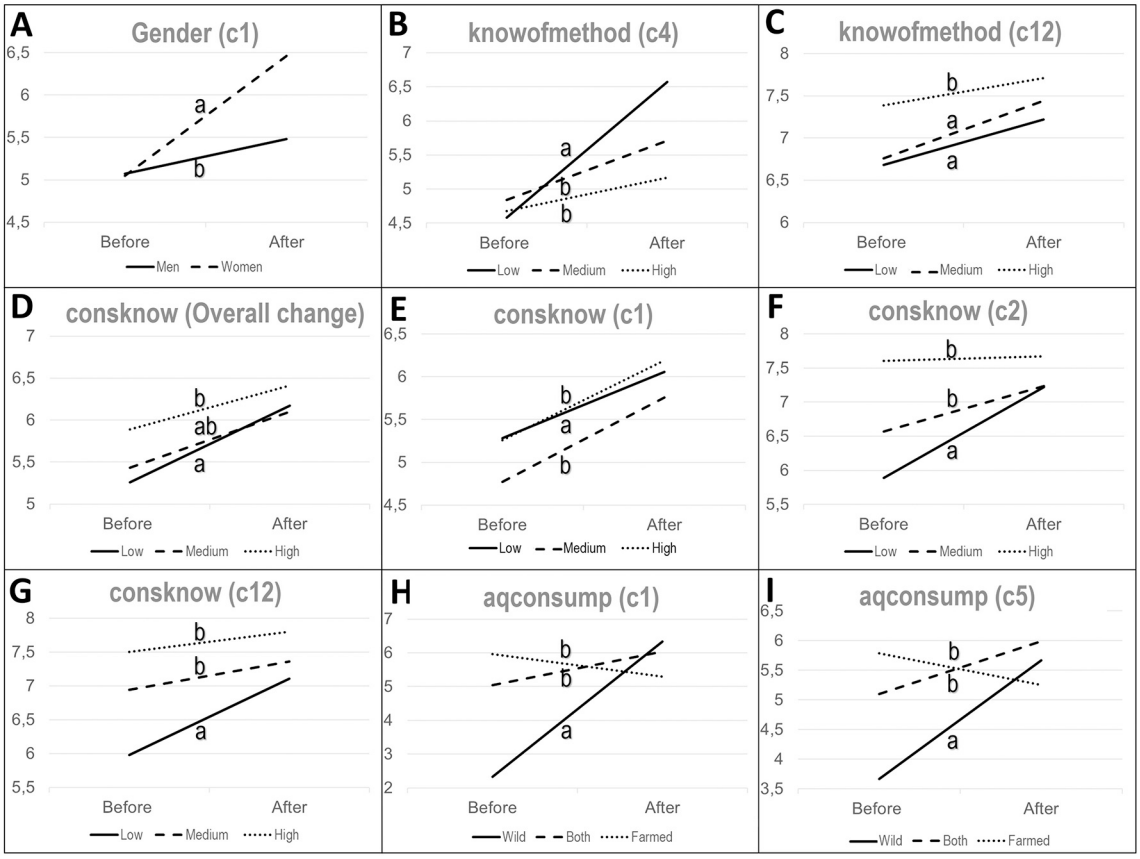

Fig. 4. Significant change in the level of consumer's agreement (0−10) after being exposed to the information to specific statements according to different factors. Significant differences in the change of response for the statement c1 (A) between men and women; differences in the change of response for the statement c4 (B) and c12 (C) between consumers with low, medium or high knowledge about the production method [knowofmethod]; differences in the change of response for the Overall change (D), and the statements c1 (E), c2 (F) and c12 (G) between people with low, medium or high knowledge about seafood products [consknow]; differences in the change of response for the statements c1 (H) and c5 (I) between people who consume wild, mix or farmed fish products [aqconsump]. Different letters show significant differences in the change-variables among groups. Among the GLM tested, only the ones that have significant relationships with the factors are shown.

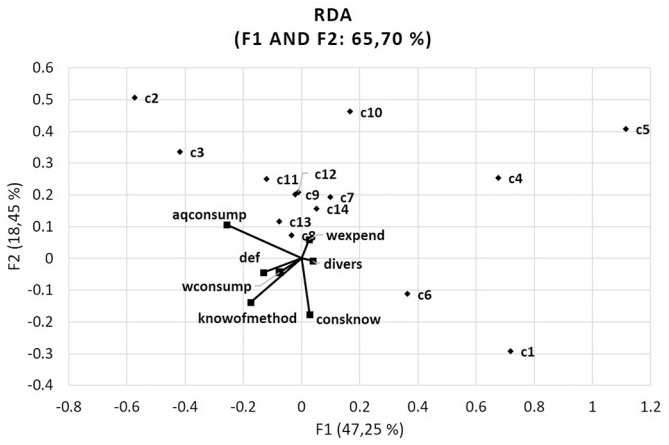

Fig. 5. Redundancy Analysis (RDA) of seven factors of knowledge and consumption of aquaculture species related to the change produced between the responses before and after reading the provided information (c1-c14). Abbreviations for the factors: *wconsump*: weekly consumption of seafood products; *wexpend*: weekly expenditure on seafood products; *divers*: diversity of species consumed; *aqconsump:* consumption of wild or farmed fish or both; *def*: consumers' definition of aquaculture; *knowofmethod*: consumers' knowledge about the production method of the seafood that they consume; *consknow*: consumers' knowledge about seafood products in general.

presented (written document or web-based tool) could influence consumer's possible changes in perception. As expected, our results clearly show a moderate but significant more positive opinion of consumers towards aquaculture and aquaculture products after being presented with proper information, independently to the tool provided. Some interesting insights provided by this study are discussed below. The performance of a pilot survey, as was done in this paper, is highly advisable to avoid misinterpretations of the questions and adjust the language and the semantics, prior the final survey is launched. It also ensures that the order and the flow of the questionnaire is correct. These can be taken as the recommendations to researchers or institutions that aim to contribute to debunking these myths.

First, in general, there were no differences in any but two of the sociodemographic and consumption and knowledge variables between the participants who used the text document and those that used the web-based tool. The only significant difference was in the Yearly gross household income and weekly expenditure on seafood products. Thus, about two-thirds of the consumers who read the written document had an income around or above 35,000 € while around two-thirds of those who used the web documentary had an income around or below that figure. This was related to the weekly expenditure on seafood products since consumers who read the written document tended to spend more on seafood than those that were exposed to the web documentary. However, based on the results of the 14 statements, in which there is an overall concordance, it seems that this difference in these two factors did not bear any influence on the overall results of our study.

The lower mean score of societal vs. personal statements (mean, SD: 3.40, 0.95 vs 6.18, 0.84, respectively) when assessing somebody else's behavior concerning our own can be explained by consumers' social desirability. This phenomenon occurs because consumers tend to reply to personal opinions in the way they believe that it is correct or more agreeable to the researcher, providing their own responses with a certain bias (Bonsall and Shires, 2009; Hufnagel and Conca, 1994). It is also possible that greater knowledge of a subject, with a more critically informed position on it, can increase one's acceptance of the subject while projecting lower expectations of acceptance by others or that the opinion on one's knowledge is lower than what they think. This resembles the Dunning-Kruger effect (Kruger and Dunning, 1999) a cognitive bias in psychology that explains the success of content marketing, and that has been previously observed when exploring consumer's answers to survey statements (Graeff, 2003) or to the opinion on food issues (Fernbach et al., 2019). Such an effect could explain the observation that, regardless of the tool used, statement #9 ("Society tends to accept aquaculture products"), the most generalist and straightforward of the societal type of statements, was the only for which consumers reduced their agreement scores.

Many factors influence the public perception of aquaculture processes and products that do not only include objective knowledge but also preconceived ideas, attitudes, and beliefs (Bacher, 2015). In our study, among the sociodemographic factors, age and gender were the ones that had more influence on consumer's perceptions. Indeed, age is known to be one of the major factors affecting consumers' perceptions (Verbeke et al., 2005). However, the influence of that factor can vary among studies. Verbeke et al. (2007) noticed that the oldest respondents hold a stronger belief that wild fish are healthier than farmed fish. Instead, we found that Spanish consumers belonging to the oldest age class (54–72 years) had an initial higher acceptance of aquaculture when compared to younger age classes. This does not mean that wild seafood is less values compared to farmed fish, but at least elucidates a quite good initial perception from elderns regarding aquaculture. Gender influences on consumer perceptions are widely reported, e.g., on Portuguese seafood preferences (Cardoso et al., 2013). However, in our study this influence was not conclusive, as men exhibited more positive beliefs than women only for the statements #3 and #14, while women consumers improved more their opinion after reading the scientific information.

The results showing lack of major differences depending on the tool used to present the information are in line with results of studies that also tested the influence of the tool when retrieving consumer perceptions, sometimes showing a slight advantage of the web-based approaches (Touvier et al., 2010; Vergnaud et al., 2011). In any case, the lack of differences can be regarded as positive because this allows in future informative campaigns the possibility to exploit a diversity of communication tools. It is important to note that the message was the same for the two communication tools used in the study. The lack of significant differences between the two tools and a moderate but significant improvement for the Overall perception of aquaculture after reading the information was observed, allowed us to validate the message used, since it was the same for both communication tools. The fact that the information provided comes from a group of experts and has been validated by different reputables organization in the aquaculture sector may be a key factor responsible for that improvement in consumers' opinion, regardless the tool.

Average scores before providing information to consumers (ranging 6.87–7.12 in the Combined sample) indicate a medium-to-high positive opinion to the statements. This is quite comparable to what was observed in an study carried out in the West Coast of Sweden. Swedish respondents tended to be favourable though a majority chose neutral responses to the query "how would you rate your general opinion toward aquaculture?" (Thomas et al., 2018). Given that Sweden is a country of great and ancient national heritage in aquaculture, the dominance of neutral responses (60% versus the 40% of positive responses) is still surprising. However, it is worth noting that very few respondents expressed a bad or very bad opinion. So, accouting that in Spain consumers had a similar neutral-to-positive opinion as in Sweden, aquaculture perception rates occupy a good position. Furthermore, other authors have reported a non negative opinion about aquaculture, occurring simultaneously with a more favourable opinion towards the wild product, among Spanish consumers (Claret et al., 2016). In fact Fernández-Polanco and Luna (2010) suggested that in Spain both wild and cultured seabream share a common image, more related to the species than to the origin, in such a way that both products become complementary rather than substitutes. The country's great potential for aquaculture reflected to the notable supply of farming marine species may point out that consumers have learned to check for the seafood

origin and its traceability (Garza-Gil et al., 2016). Thus they may tend to associate some regions origin with a certain quality and food safety.

Still considering that there was not a notable previous prejudice towards aquaculture, and the limitation of the memory effect of the participant when conducting the survey, information given to consumers did improve their opinion. Regardless of whether the information was presented as a text document or was web-based, the results of this study showed an increase in the agreement scores in all but two of the 14 statements posed in the combined sample. The correlation between increased awareness with change in perceptions has been also assessed in salmon farming (Wrigley, 2017). These results demonstrate the utility of science-and-fact-based communication campaigns to increase consumers' awareness and information about food products. Moreover, potential social changes such as the incentivation of the sustainable development goals including the Blue Growth Economy goals may accelerate consumer's opinion changes and gaining more adepts for aquaculture products. So, these results could be taken as an experimental indicators of policy-process learning to measure change in perception of aquaculture. The more we know the better we choose.

It is interesting to note that we found a significant and inverse relationship between the initial score and the change in score. Among consumption and knowledge factors, *knowofmethod* and *consknow* were the two most explicative factors, together with *aqconsump*. These results could somehow be anticipated and confirm the link between knowledge on a particular food production method and the consequent acceptance of the resulting product irrespective of its actual nature. Claret et al. (2016) found that people tend to value wild products more when they know their precedence of origin, but perhaps without adequate knowledge. Therefore, providing adequate information on aquaculture improves its image and therefore the acceptance of aquaculture products. Thus, for example, Bastian et al. (2015) in a survey of Australian wine consumers found that the use of winemaking additives, even commonly used and legally permitted additives such as tartaric acid, preservatives, and tannins were considered far less acceptable by less knowledgeable consumers. This is thus relevant for the differences we found in the change of statement #4 ("The quality of the farmed fish in unaffected by the feeds that they receive"), pointing out that consumers with less knowledge about the production method [*knowofmethod*] change more their opinion when reading the information document. Another interesting insight is that consumers with the lowest knowledge on seafood products, in general, were the ones that clearly more benefited from being provided with information, as shown in two particularly interesting aspects for such type of consumers: informing them about the healthiness and affordable prices of aquaculture products, an aspect that has been deemed of crucial importance in previous studies on consumer perceptions on aquaculture (Dey et al., 2005). This indicates that the lower the initial score the higher the increase in agreement after being exposed to information. In that regard, therefore, it could be said that the present study already fulfilled the mission of promotional campaigns by at least contributing to the education of consumers with the lowest knowledge of seafood products. Finally, a particularly illustrative insight is that consumers that usually opt for wild fish improved most their agreement with statement #1 ("There are no chemical products in fish feeds that…") and #5 ("Resources are not wasted by the use of wild fish in farmed fish feeds") which, again, indicates the usefulness of information campaigns to increase consumer's acceptance and thus consumer's choice of new food products and in this particular case educating them on the fact that aquaculture is tending towards sustainability and concern for the environment. These results are in line with those of an study on the perception of salmon farming in Scotland, where it was shown the priority that people attach to the environmental performance of the salmon aquaculture industry, relative to other objectives (Whitmarsh and Wattage, 2006).

In summary, we conclude that consumers significantly improve their perceptions towards aquaculture processes and products when exposed to scientifically-based information. These results are consistent across two different tools for providing the information, indicating that educational campaigns can exploit to their benefit printed documents and web-based formats as complementary communication channels to reach potentially larger audiences. We have identified the most important sociodemographic factors to be taken into account. This information will be particularly useful in the design of future campaigns tailored at, for example, particular gender, age- or income-class groups. We have determined that consumers with the lowest knowledge of seafood products and aquaculture improve more their opinion when the information is provided. Results are also consistent regardless of whether they concern specific questions or when gauged globally. Thus, in this regard the results of this study are robust. This study has provided insights into the usefulness of information campaigns to enhance the societal acceptance of aquaculture practices and products, on the medium to convey such information and also has provided a sort of baseline as a reference point for further studies.

Author Contributions

Maite Carrassón: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing. Anna Soler-Membrives: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing. Maria Constenla: Conceptualization, Data curation, Formal analysis, Methodology, Validation, Visualization, Writing - review & editing. Cristina Escobar: Conceptualization, Data curation, Methodology, Validation, Visualization, Writing - review & editing. Rosa Flos: Conceptualization, Project administration, Supervision, Data curation, Visualization, Writing - original draft, Writing - review & editing. Jose M Gil: Conceptualization, Data curation, Methodology, Validation, Visualization, Writing - review & editing. Virginia Luzon: Conceptualization, Validation, Visualization, Writing - review & editing. Francesc Piferrer: Conceptualization, Investigation, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing. Lourdes Reig: Conceptualization, Project administration, Supervision, Data curation, Visualization, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

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

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.aquaculture.2021.737137.

References

Aarset, B., Beckmann, S., Bigne, E., Beveridge, M., Bjorndal, T., Bunting, J., McDonagh, P., Mariojouls, C., Muir, J., Prothero, A., Reisch, L., Smith, A., Tveteras, R., Young, J., 2004. The European consumers' understanding and

perceptions of the "organic" food regime: the case of aquaculture. Br. Food J. 106 https://doi.org/10.1108/00070700410516784.
Altintzoglou, T., Verbeke, W., Vanhonacker, F., Luten, J., 2010. The image of fish from aquaculture among Europeans: impact of exposure to balanced information. J. Aquat. Food Prod. Technol. 19, 103–119. https://doi.org/10.1080/10498850.2010.492093.
APROMAR, 2020. Aquaculture in Spain 2020. Annual Report, 95 pp.
Ayvaz, Z., 2017. Consumer preference for seafood: the myths and realities, in: fifth international conference sustainable postharvest and food technologies - INOPTEP, April 23-28th 2017, Vrsac, Serbia, 4.
Bacher, K., 2015. Perceptions and misconceptions of aquaculture. Globefish Res. Program. FAO 120, 35pp.
Bastian, S., Saltman, Y., Johnson, T., Wilkinson, K., 2015. Australian wine consumers’ acceptance of and attitudes toward the use of additives in wine and food production. Int. J. Wine Res. 7, 83. https://doi.org/10.2147/IJWR.S90802.
Bergh, Ø., 2007. The dual myths of the healthy wild fish and the unhealthy farmed fish. Dis. Aquat. Org. https://doi.org/10.3354/dao075159.
Bonsall, P., Shires, J., 2009. Estimating the robustness of questionnaire results: lessons from a mixed-mode survey of expectations for tele-working and road-based business travel. Transportation (Amst). 36, 47–64. https://doi.org/10.1007/s11116-008-9185-5.
Cardoso, C., Lourenço, H., Costa, S., Gonçalves, S., Nunes, M.L., 2013. Survey into the seafood consumption preferences and patterns in the portuguese population. Gender and regional variability. Appetite 64, 20–31. https://doi.org/10.1016/j.appet.2012.12.022.
Claret, A., Guerrero, L., Ginés, R., Grau, A., Hernández, M.D., Aguirre, E., Peleteiro, J.B., Fernández-Pato, C., Rodríguez-Rodríguez, C., 2014. Consumer beliefs regarding farmed versus wild fish. Appetite 79, 25–31. https://doi.org/10.1016/j.appet.2014.03.031.
Claret, A., Guerrero, L., Gartzia, I., Garcia-Quiroga, M., Ginés, R., 2016. Does information affect consumer liking of farmed and wild fish? Aquaculture 454, 157–162. https://doi.org/10.1016/j.aquaculture.2015.12.024.
Dey, M.M., Rab, M.A., Paraguas, F.J., Piumsombun, S., Bhatta, R., Alam, M.F., Ahmed, M., 2005. Fish consumption and food security: a disaggregated analysis by types of fish and classes of consumers in selected Asian countries. Aquac. Econ. Manag. 9 https://doi.org/10.1080/13657300590961537.
FAO, 2020. The state of the world fisheries and aquaculture. Sustainability in action. Nat. Res. https://doi.org/10.4060/ca9229en.
Fernández-Polanco, J., Luna, L., 2010. Analysis of perceptions of quality of wild and cultured seabream in Spain. Aquac. Econ. Manag. 14, 43–62. https://doi.org/10.1080/13657300903566878.
Fernandez-Polanco, J., Luna, L., 2012. FACTORS AFFECTING CONSUMERS' BELIEFS ABOUT AQUACULTURE. Aquac. Econ. Manag. 16, 22–39. https://doi.org/10.1080/13657305.2012.649047.
Fernbach, P.M., Light, N., Scott, S.E., Inbar, Y., Rozin, P., 2019. Extreme opponents of genetically modified foods know the least but think they know the most. Nat. Hum. Behav. https://doi.org/10.1038/s41562-018-0520-3.
Feucht, Y., Zander, K., 2016. Aquaculture in the German print media. Aquac. Int. https://doi.org/10.1007/s10499-016-0021-1.
Garza-Gil, M.D., Vázquez-Rodríguez, M.X., Varela-Lafuente, M.M., 2016. Marine aquaculture and environment quality as perceived by Spanish consumers. The case of shellfish demand. Mar. Policy 74, 1–5. https://doi.org/10.1016/j.marpol.2016.09.011.
Graeff, T.R., 2003. Exploring Consumers' answers to survey questions: are uninformed responses truly uninformed? Psychol. Mark. https://doi.org/10.1002/mar.10090.
Hardy, R.W., 2005. Fish meal myths concerning omnivorous farmed fish. Aquac. Mag. 31, 53–58.
Hope, A.C.A., 1968. A Simplified Monte Carlo Significance Test Procedure. J. R. Stat. Soc. Ser. B 30. https://doi.org/10.1111/j.2517-6161.1968.tb00759.x.
Hufnagel, E.M., Conca, C., 1994. User response data: the potential for errors and biases. Inf. Syst. Res. 5 https://doi.org/10.1287/isre.5.1.48.
INE, 2020. Continuous Household Survey (CHS). Year 2019. Instituto Nacional de Estadística. www.ine.es/en/.
Kaimakoudi, E., Polymeros, K., Schinaraki, M.-G., Batzios, C., 2013. Consumers' attitudes towards fisheries products. Procedia Technol. 8, 90–96. https://doi.org/10.1016/j.protcy.2013.11.013.
Kok, B., Malcorps, W., Tlusty, M.F., Eltholth, M.M., Auchterlonie, N.A., Little, D.C., Harmsen, R., Newton, R.W., Davies, S.J., 2020. Fish as feed: Using economic allocation to quantify the Fish In : Fish Out ratio of major fed aquaculture species. Aquaculture 528, 735474. https://doi.org/10.1016/j.aquaculture.2020.735474.
Kraus, A., Annunziata, A., Vecchio, R., 2017. Sociodemographic factors differentiating the consumer and the motivations for functional food consumption. J. Am. Coll. Nutr. 36 https://doi.org/10.1080/07315724.2016.1228489.
Kruger, J., Dunning, D., 1999. Unskilled and unaware of it: how difficulties in recognizing one's own incompetence lead to inflated self-assessments. J. Pers. Soc. Psychol. 77 https://doi.org/10.1037/0022-3514.77.6.1121.
López-Mas, L., Claret, A., Reinders, M.J., Banovic, M., Krystallis, A., Guerrero, L., 2021. Farmed or wild fish? Segmenting European consumers based on their beliefs. Aquaculture 532, 735992. https://doi.org/10.1016/j.aquaculture.2020.735992.
MAPAMA, 2018. Estadísticas Pesqueras, p. 302.
MERCABARNA, 2019. Mercabarna Central Fish Market Statistics [WWW Document]. URL. https://www.mercabarna.es/sala-de-premsa/publicacions/llibres-estadistics/.
Pauly, D., Christensen, V., Guénette, S., Pitcher, T.J., Sumaila, U.R., Walters, C.J., Watson, R., Zeller, D., 2002. Towards sustainability in world fisheries. Nature 418, 689–695.
Pauly, D., Alder, J., Bennett, E., Christensen, V., Tyedmers, P., Watson, R., 2003. The future for fisheries. Science (80-.). https://doi.org/10.1126/science.1088667.
Pieniak, Z., Verbeke, W., Scholderer, J., Brunsø, K., Olsen, S.O., 2007. European consumers' use of and trust in information sources about fish. Food Qual. Prefer. 18, 1050–1063. https://doi.org/10.1016/j.foodqual.2007.05.001.
Pieniak, Z., Verbeke, W., Scholderer, J., 2010. Health-related beliefs and consumer knowledge as determinants of fish consumption. J. Hum. Nutr. Diet. 23 https://doi.org/10.1111/j.1365-277X.2010.01045.x.
Regnier, E., Bayramoglu, B., 2017. Competition between farmed and wild fish: the French sea bass and sea bream markets. Aquac. Econ. Manag. 21, 355–375. https://doi.org/10.1080/13657305.2016.1189012.
Reig, L., Escobar, C., Carrassón, M., Constenla, M., Gil, J.M., Padrós, F., Piferrer, F., Flos, R., 2019. Aquaculture perceptions in the Barcelona metropolitan area from fish and seafood wholesalers, fishmongers, and consumers. Aquaculture 510. https://doi.org/10.1016/j.aquaculture.2019.05.066.
Schlag, A.K., Ystgaard, K., 2013. Europeans and aquaculture: perceived differences between wild and farmed fish. Br. Food J. 115, 209–222. https://doi.org/10.1108/00070701311302195.
Strobl, C., Boulesteix, A.-L., Kneib, T., Augustin, T., Zeileis, A., 2008. Conditional variable importance for random forests. BMC Bioinformatics 9, 307. https://doi.org/10.1186/1471-2105-9-307.
Thomas, J.B.E., Nordström, J., Risén, E., Malmström, M.E., Gröndahl, F., 2018. The perception of aquaculture on the Swedish west coast. Ambio 47, 398–409. https://doi.org/10.1007/s13280-017-0945-3.
Touvier, M., Méjean, C., Kesse-Guyot, E., Pollet, C., Malon, A., Castetbon, K., Hercberg, S., 2010. Comparison between web-based and paper versions of a self-administered anthropometric questionnaire. Eur. J. Epidemiol. 25 https://doi.org/10.1007/s10654-010-9433-9.
van den Wollenberg, A.L., 1977. Redundancy analysis an alternative for canonical correlation analysis. Psychometrika 42. https://doi.org/10.1007/BF02294050.
Vanhonacker, F., Pieniak, Z., Verbeke, W., 2013. European consumer image of farmed fish, wild fish, seabass and seabream. Aquac. Int. 21, 1017–1033. https://doi.org/10.1007/s10499-012-9609-2.
Verbeke, W., Vackier, I., 2005. Individual determinants of fish consumption: application of the theory of planned behaviour. Appetite 44, 67–82. https://doi.org/10.1016/j.appet.2004.08.006.
Verbeke, W., Sioen, I., Pieniak, Z., Van Camp, J., De Henauw, S., 2005. Consumer perception versus scientific evidence about health benefits and safety risks from fish consumption. Public Health Nutr. 8, 422–429. https://doi.org/10.1079/PHN2004697.
Verbeke, W., Sioen, I., Brunsø, K., Henauw, S., Camp, J., 2007. Consumer perception versus scientific evidence of farmed and wild fish: exploratory insights from Belgium. Aquac. Int. 15, 121–136. https://doi.org/10.1007/s10499-007-9072-7.
Vergnaud, A.C., Touvier, M., Méjean, C., Kesse-Guyot, E., Pollet, C., Malon, A., Castetbon, K., Hercberg, S., 2011. Agreement between web-based and paper versions of a socio-demographic questionnaire in the NutriNet-Santé study. Int. J. Public health 56. https://doi.org/10.1007/s00038-011-0257-5.
Whitmarsh, D., Wattage, P., 2006. Public attitudes towards the environmental impact of salmon aquaculture in Scotland. Eur. Environ. 16, 108–121. https://doi.org/10.1002/eet.406.
Wrigley, J., 2017. The "F-word": awareness and perceptions in fin-fish farming and the "F-word": awareness and perceptions in fin-fish farming and aquaculture policies aquaculture policies, WWU graduate school collection. Western Washington University. doi:10.25710/m9d4-cj68.