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Source / Izvornik: **Croatian journal of food science and technology, 2020, 12, 287 - 295**

Journal article, Published version
Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

https://doi.org/10.17508/CJFST.2020.12.2.17

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:191:950994

Croatian Journal of Food Science and Technology
journal homepage: www.ptfos.unios.hr/cjfst/

Review paper
DOI: 10.17508/CJFST.2020.12.2.17

Factors affecting consumers´ preferences for products from aquaculture

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ARTICLE INFO
Article history:
Received: July 3, 2020
Accepted: August 10, 2020

Keywords:
aquaculture
consumer
farmed fish
preference
wild fish

ABSTRACT
Fish is an essential component of a balanced and healthy diet and the present demand for fish cannot be sustained by capture fisheries. Consequently, aquaculture is currently the fastest growing food production industry in the world, contributing to more than half of the global fish production intended for human consumption. Although the image of aquaculture is not necessarily negative *per se*, consumers around the world still have a greater preference for wild fish. Therefore, the aim of this review is to critically evaluate some of the factors which may affect consumer preferences: socio-demographic characteristics of consumers, quality and safety perception of products from aquaculture, price of aquaculture products and socio-economic aspects of aquaculture, and concerns about the negative impact of aquaculture on the environment and about the sustainability of the production method. A literature review confirmed that age is the most influential sociodemographic variable. Being younger, female or having higher income and a higher education level can result in greater preference for aquaculture products. The image of farmed fish suffers from a perception of lower quality in terms of taste, health and nutritional value and, in some cases, even from low safety perceptions. On the other hand, farmed fish is believed to have lower prices and greater availability. Additionally, economic benefits are one of the main advantages of aquaculture. Mixed results emerge, however, with regard to the environmental impact of aquaculture, but sustainable production may compensate for possible environmental concerns and drive preference for farmed fish. Depending on how consumers weigh up the advantages and disadvantages of both aquaculture and its products, this will result in a preference for wild or farmed fish.

Introduction

Today consumers are advised to eat fish as an essential component of a balanced and healthy diet because it has a low fat content and provides high quality proteins as well as many micronutrients such as vitamins and minerals (Tørris et al., 2018). Regular fish intake is an integral part of several healthy dietary patterns such as the Mediterranean diet (Gil and Gil, 2015), Nordic diet (Mithril et al., 2013) and the Dietary Approach to Stop Hypertension (Sacks et al., 1995). Due to its high nutritional value and anti-inflammatory effect, thanks to the presence of n-3 long chain polyunsaturated fatty acids, fish is linked with positive benefits in many pathological conditions such as cardiovascular diseases, obesity, metabolic syndrome, cancer and mental health (Bork et al., 2020; Jayedi and Shab-Bidar, 2020; Natto et al., 2019).

World fish consumption has more than doubled since the 1960s and in 2018 it reached 20.5 kg *per capita* per year, with farmed fish contributing to more than a half of global fish production intended for human consumption. Aquaculture is currently the fastest

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growing food production industry in the world, with an average annual growth of 5.3% since the 2000s (FAO, 2020). Given the fact that capture fisheries have remained relatively stable since the late 1980s, aquaculture is the only way to ensure the current levels of *per capita* fish consumption and will continue to be a key industry to meet the increasing demand for food, paralleled by population growth (FAO, 2018).

The production method (wild *vs* farmed) is an important attribute affecting consumers' choice of fish (Carlucci et al., 2015). Although the image of aquaculture is not necessarily negative *per se*, consumers around the world still have greater preferences for wild fishery products (Bronnmann and Hoffmann, 2018; Cardoso et al., 2013; Claret et al., 2012; Davidson et al., 2012; Hall and Amberg, 2013; Jaffry et al., 2004; Kaimakoudi et al., 2013; Rickertsen et al., 2017; Roheim et al., 2012; Schlag and Ystgaard, 2013; Vanhonacker et al., 2013). A less positive image of farmed fish relative to the image of wild fish could be a barrier for the development and acceptance of products coming from aquaculture (Altintzoglou et al., 2010). Even though the practice of aquaculture dates back thousands of years, most consumers still perceive it as a novel production method in comparison with traditional fishing, which is romanticized as the ideal, "natural" way of obtaining fish (Schlag and Ystgaard, 2013). Moreover, farmed fish may have suffered from negative image transfers from past processes and from intensive terrestrial livestock production (Vanhonacker et al., 2011).

Since consumers' knowledge about aquaculture is generally low (Pieniak et al., 2013), preconceived ideas such as attitudes and beliefs are important in detecting what influences consumer preferences. Attitudes towards aquaculture are the function of perceived benefits (e.g. job creation) and risks (e.g. negative environmental impact). The perception that aquaculture's benefits are outweighing its risks reflects positively on support for aquaculture (Rickard et al., 2020). Attitudes towards aquaculture products are the function of perceived differences between wild and farmed fish (e.g. quality). Beliefs in the superiority of wild fish (e.g. more flavourful, more taste, of higher quality) are negatively associated with the consumption of farmed fish, while positive beliefs of aquaculture are positively associated with its consumption (Hall and Amberg, 2013).

Since consumer preferences regarding aquaculture are multi-dimensional, the aim of this review is to critically evaluate some of the factors which may affect consumer preferences, namely: socio-demographic characteristics of consumers, quality and safety perception of aquaculture products, price of aquaculture products and socio-economic aspects of aquaculture, concerns about the negative impact of aquaculture on the environment and about the sustainability of production.

1. Socio-demographic characteristics of consumers

Socio-demographic characteristics (age, gender, educational level, income, place of residence etc.) are among the most studied factors influencing consumers' preferences and behaviour.

Of the various socio-demographic variables, Güney (2019) found age to have the greatest effect on the consumption of farmed fish. The youngest consumers (≤34 years) are 51% more likely to consume farmed fish than consumers who are 70 years or older, and the likelihood of farmed fish preference decreases as age increases. Vanhonacker and co-authors (2011) also confirmed that consumers with a higher preference for farmed fish are usually younger in age. Other studies also show that older consumers have a greater preference for wild fish and are much more unwilling to consume farmed fish (Arvanitoyannis et al., 2004; Cardoso et al., 2013; Rickertsen et al., 2017; Tomić et al., 2017; Verbeke et al., 2007a), indicating they are more reluctant to change their opinions about innovative, non-traditional seafood harvest methods (Fernández-Polanco and Luna, 2012).

Claret et al. (2014) identified females to be more open to aquaculture products, which can be explained by the fact that women are still the main meal preparers and food shoppers within the household and, therefore, they are more accustomed to such products. When investigating the group of predominantly farmed fish consumers, Vanhonacker et al. (2011) found that the group comprised slightly more females than the group of consumers of predominantly wild fish and consumers who equally consume both products. Additionally, men are found to prefer wild fish to a greater extent than women (Cardoso et al., 2013).

Consumers with a higher educational level have a greater capacity to understand information related to aquaculture, i.e. they are more likely to agree with scientific evidence and, thus, make better and more reasoned fish choices (Claret et al., 2014; Fernández-Polanco and Luna, 2012). Kaimakoudi et al. (2013) identified Greek consumers, belonging to a high-potential aquaculture cluster, as having higher income and a higher educational level, as well as greater preference for farmed fish in comparison with the other, low-potential cluster (37% *vs* 22%). Güney et al. (2019) also confirmed a relationship between income level and the consumption of wild or farmed fish, although results were inconsistent.

Place of residence also plays an important role influencing consumer consumption preference and

perceptions of aquaculture. People living or raised in coastal areas have stronger preferences for wild fish, and farmed fish is less present in their diet compared to the diet of the continental population, probably due to greater availability of caught fish on the coast (Cardoso et al., 2013; Tomić et al., 2017). Living in the vicinity of fish farms may result in negative attitudes towards aquaculture development, expressing a "not in my backyard" attitude (Froehlich et al., 2017; Katranidis et al., 2003; Shafer et al., 2010).

2. *Quality and safety perception of aquaculture products*

Consumers pay much attention to the quality of fish (Bronnmann and Hoffmann, 2018), so it is not surprising that many studies have examined the perceived quality differences between farmed and wild fish in terms of overall quality or in taste, health, nutritional value and safety (Altintzoglou et al., 2011; Bronnmann and Hoffmann, 2018; Claret et al., 2014; Reig et al., 2019; Verbeke et al., 2007a).

Sensory characteristics of fish (i.e. taste, smell and texture) are one of the strongest drivers of overall consumption, but in the case of aquaculture it can be one of the main barriers (Claret et al., 2014), since consumers often highlight the superiority of wild fish in terms of taste (Davidson et al., 2012; Musa et al., 2012; Verbeke et al., 2007a). However, when information is provided about a particular production method, it can have a significant effect on the sensory perception of fish. Several studies assessing the hedonic values of wild and farmed fish, when conducted as a blind experiment, found a greater preference for farmed fish. Conversely, in the informed condition, results were in favour of wild fish (Claret et al., 2016; Kole et al., 2009; Rickertsen et al., 2017).

Claret et al. (2014) found in a sample of Spanish consumers that 60% of the participants assessed the better overall quality of wild fish in comparison with 26% who assessed farmed fish as having better quality. On top of that, all items dealing with quality (sensory characteristics, nutritional value, health, freshness) were in favour of wild fish. The strongest held belief was the one concerning the artificiality of farmed fish. Similar results were found in a study by Verbeke et al. (2007a) conducted in Belgium, where in spite of the fact that the majority of consumers perceived no differences between farmed and wild fish, wild fish scored higher on the attributes of taste, health and nutritional value. These preferences seem to come from the belief that wild fish has less medicinal and growth promoter residues than farmed fish (Verbeke et al., 2007a). Indeed, more consumers would consider eating more fish if they knew that it had not been treated with antibiotics (Solgaard and Yang, 2011). In addition, uncertainty about fish feed promotes the idea that farmed fish is less tasty and less healthy than wild fish (Reig et al., 2019).

An interesting conclusion emerged from a study in Spain, where Fernández-Polanco and Luna (2010) concluded that the quality assessments of the farm-raised seabream can benefit from the established positive image of the wild seabream in the market. Hence, when deciding to farm a new species it is worth considering the quality image of its wild counterpart in the market. Taking this into account, one of the aims of promotional activities could be raising awareness of the quality and benefits of consumption of particular fish *per se*, which could, in turn, lead to developing positive attitudes towards the consumption of the same species, originating from aquaculture, among consumers who have ambivalent attitudes towards aquaculture.

Although consumers perceive wild fish as having better quality, such beliefs are not based on actual scientific facts. Actually, the current scientific consensus is that farmed and wild fish cannot be differentiated in terms of healthiness and nutritional value (EFSA, 2005). Furthermore, Cahu et al. (2004) concluded that farmed fish can be at least as beneficial as wild fish if raised under appropriate conditions, particularly in terms of potential to prevent cardiovascular diseases. Although EPA and DHA levels in farmed fish are generally lower, the total lipid content is higher in comparison with wild fish, meaning that the amounts of EPA and DHA provided *per* portion may even be higher than those in the same quantity of wild fish. Moreover, the fatty acid composition of farmed fish is more constant and can be influenced by the lipid composition of the feed (Cahu et al., 2004; EFSA, 2005; Krešić et al., 2017; Krešić et al., 2019; Petrović et al., 2015; Pleadin et al., 2017).

Farmed fish is considered to be safe food (Altintzoglou et al., 2010; Verbeke and Brunsø, 2005) but beliefs of its higher safety in comparison with wild fish do not seem to have consensus. European consumers seem to perceive the safety of wild and farmed fish differently: being lower in farmed fish (Arvanitoyannis et al., 2004; Rickertsen et al., 2017; Verbeke and Brunsø, 2005), equivalent in fish from both production methods (Claret et al., 2014; Verbeke and Brunsø, 2005; Verbeke et al., 2007a), or in some cases even higher in aquaculture products (Verbeke and Brunsø, 2005; Reig et al., 2019). Opposing views also emerge with specific issues of food safety. In their study, Claret et al. (2014) found that consumers

believe farmed fish is less affected by marine pollution, heavy metals and parasites, whereas Verbeke and Brunsø (2005) found the perception of wild fish being more resistant to chemical and microbial contamination due to the idea of better wild fish well-being.

3. Price of aquaculture products and socio-economic aspects of aquaculture

Although price is generally one of the main barriers of fish consumption, with fish being perceived as an expensive product compared to meat (Carlucci et al., 2015), in the case of aquaculture, its affordable price can be an advantage in the market and an important competitive tool in guiding the preference towards farmed fish (Fernández-Polanco and Luna, 2010). Indeed, farmed fish is believed to be cheaper and this aspect of aquaculture is frequently reported as the most positive one (Bronnmann and Hoffmann, 2018; Claret et al., 2014; Reig et al., 2019; Vanhonacker et al., 2013). However, Hall and Amberg (2013) found price did not predict an overall preference for wild *vs* farmed fish. Price is also used as an indicator of the expected quality, which can contribute to consumer perception of farmed fish being of a lower quality than its wild counterparts (Claret et al., 2014), resulting in consumers' willingness to pay more for high quality wild-caught fishery products (Davidson et al., 2012). On the other hand, although wild fish have a superior quality image, farmed fish scored better on the quality/price relationship compared with wild fish (Vanhonacker et al., 2013). Another, often highlighted advantage of aquaculture is that it is easily accessible and more available all year around, enabling regular consumption of fish (Claret et al., 2014; Reig et al., 2019; Schlag and Ystgaard, 2013; Vanhonacker et al., 2013; Verbeke et al., 2007a).

The main positive idea emerging from the relationship of aquaculture and society is the creation of jobs. Low-income groups and rural communities are the ones who benefit significantly from the employment created through aquaculture, making job creation one of the reasons for governments to promote aquaculture (Bhari and Visvanathan, 2018). Indeed, it seems that the socio-economic benefits of aquaculture can overcome the environmental concerns of consumers in the most deprived areas (Whitmarsh and Palmieri, 2009). Also, in highly developed countries like Canada and Norway, a high percentage of consumers recognise aquaculture as an opportunity for employability increase in coastal areas (Flaherty et al., 2019; Hynes et al., 2018). On the other hand, consumers may also perceive aquaculture as a contributing factor to the destruction of traditional lifestyle and fishing methods, which is a particularly prevalent view among Spanish consumers since the fish farming sector in Spain is run by big industries and conglomerations (Schlag and Ystgaard, 2013).

4. Concerns about the negative impact of aquaculture on the environment

Environmental concerns may also act either as a driver or a barrier of preference for aquaculture products. According to Davidson et al. (2012), concern about the use of natural resources was detected as the main reason for the preference for mariculture, while in the case of farmed salmon, environmental concerns resulted in the lower likelihood of purchasing this product (Whitmarsh and Palmieri, 2011).

A multinational study of seven European countries (UK, France, Germany, Portugal, Spain, Poland and Italy), concerning public attitudes towards aquaculture, found aquaculture to be a relatively minor threat to the marine environment while the most severe threats were industrial pollution and litter (Potts et al., 2016). Similar results were obtained among Irish and Norwegian consumers (Hynes et al., 2018). The difference is that the Irish and Norwegians perceive fisheries as less of a threat than aquaculture, whereas other European consumers consider fishing as a moderate threat, greater than aquaculture (Hynes et al., 2018; Potts et al., 2016).

Currently, more than one third of the world's marine fish stocks are overexploited, and the trend is increasing every year, while at the same time the percentage of stocks that are within sustainable levels are declining (FAO, 2020). Consumers seem to be well aware of this fact since they believe that aquaculture offers the possibility to protect wild fish stocks and satisfy future global seafood demand, while traditional fisheries will continue to decline in importance because of the pressures of overfishing (Bronnmann and Hoffmann, 2018; Claret et al., 2014; Freeman et al., 2012; Hall and Amberg, 2013; Honkanen and Olsen, 2009; Mazur and Curtis, 2006). Consumers tend to perceive aquaculture as causing the same environmental damages as agriculture (Hall and Amberg, 2013). Fully half of the consumers, however, were not aware that aquaculture can be environmentally more sustainable than the production of meat, since it is well known that aquaculture emits less phosphorous, nitrogen and greenhouse gases than livestock breeding (Hynes et al., 2018).

Although consumers are strongly concerned about the environmental impacts of both aquaculture and fisheries, in various countries they put different emphasis on this topic. Germans see over-fishing as a greater cause of environmental damage than fish

farms, posing a threat to wild fish species and, thus, sustainability concerns have increased among these consumers (Schlag and Ystgaard, 2013). Indeed, Freeman et al. (2012) also found that Germans are concerned about the depletion of wild fish stocks, with the majority of respondents indicating that the advantage of mariculture is, in fact, that it does not lead to overfishing. Further, more than half of them indicated that mariculture is not associated with damage to the natural habitat. Israelis, on the other hand, perceive waste water from fish farms and pollution of marine environments as a major concern, which consequently results in disapproval of aquaculture (Freeman et al., 2012). Norwegians are most concerned about the impact of farmed fish escapees on biodiversity, while Spanish, British and French consumers are highly uncertain of the environmental impacts of aquaculture and fishing, as a result of their lower awareness of and knowledge in these topics (Schlag and Ystgaard, 2013). Indeed, Reig et al. (2019) also confirmed that the Spanish do not identify the environment as an important concern in the value chain.

Besides differences between countries, regional settings as well as conditions of the local environment may influence different perceptions of the aquaculture industry. In Canada, respondents on the Atlantic coast tended to hold more favourable beliefs on aquaculture as being a sustainable way of producing food and relieving pressure on wild stocks in comparison with respondents on the Pacific coast. There are more environmental non-governmental organizations in the west, operating public campaigns against salmon farming industry, and more media attention is given to this issue (Flaherty et al., 2019).

5. Sustainability of production methods

As reviewed above, consumers have different opinions on the environmental impacts of aquaculture. Even though aquaculture is, generally speaking, a sustainable way of food production and an alternative to capture fisheries, not all practices can be put under the same umbrella of sustainability. In fact, if aquaculture is not managed responsibly, it can have negative consequences not only on the environment but also on social and economic aspects (FAO, 2010). Therefore, it is essential for the aquaculture sector to ensure its further development in a sustainable manner and to communicate this effectively to consumers. Consumers, on the other hand, can support and contribute to the implementation of sustainable aquaculture by purchasing and consuming these products.

Recently, several studies carried out on the topic of sustainable aquaculture have shown that there are consumers who are willing to pay price premium for sustainably farmed fish (Banovic et al., 2019; Bronnmann and Asche, 2017; van Osch et al., 2017, 2019; Zander et al., 2018) or, even more specifically, for organically produced fish (Mauracher et al., 2013; Pulcini et al., 2020; Stefani et al., 2012). Bronnmann and Asche (2017) found sustainability related issues to be more important than quality in driving the preference for wild or farmed fish. Sustainable production not only makes up for the negative association of farmed salmon but it also gives similar prices for sustainably labelled farmed salmon as for sustainably labelled wild salmon (Bronnmann and Asche, 2017). However, earlier research by Verbeke et al. (2007b) found that sustainability and ethics, although regarded as important, did not significantly correlate with fish consumption behaviour. While the rejection of wild fish products was partly motivated by sustainability and ethical concerns, the main reason why consumers did not purchase farmed fish was based on expected lower intrinsic value.

European consumers identified the minimal use of hormones and drugs, protection of endangered species, and no pollution of the environment as the three most important aspects of sustainability in aquaculture. Social criteria seemed to be a less important aspect (Zander and Feucht, 2018). In a focus study, Germans identified organic aquaculture as the ideal practice, mostly because they are familiar with other forms of organic food production, whereas sustainability is still a vague term with an unclear definition for most of them. Earth ponds were the most desirable production method because of their visual appearance, whereas closed recirculating systems were associated with "mass animal husbandry" systems, indicating a lack of naturalness even though their higher degree of control was acknowledged (Feucht and Zander, 2015). Italians, however, seem to prefer fish farmed in marine cages over the production of fish in ponds, as they associate mariculture with a lower environmental impact (Stefani et al., 2012).

The sustainability of the production method is mainly communicated to consumers through claims or labels. A qualitative study carried out among German consumers implies that even though consumers support sustainable production, certification schemes do not seem to be of the greatest importance in buying decisions (Zander et al., 2018). In choice experiments, however, labels and claims had a positive influence on the probability that a given product would be chosen (Bronnmann and Asche, 2017; Zander et al., 2018). It is worth noting that there is a segment of consumers who base their

choice primarily on sustainability attributes (Banovic et al., 2019; Risius et al., 2019; van Osch et al., 2019). Since labels alone will be effective only for this segment of sustainability-oriented consumers, aquaculture products should be accompanied with claims in order to provide a better understanding and reach a broader segment of consumers (Risius et al., 2019).

For example, Risius et al. (2017) confirmed that even though consumers are supporting sustainable production practices, certification schemes for sustainable aquaculture products are not of high importance for purchase decisions.

For example, Risius et al. (2017) confirmed that even though consumers are supporting sustainable production practices, certification schemes for sustainable aquaculture products are not of high importance for purchase decisions. Among the most important attributes affecting consumers when choosing and buying fish is certainly country of origin (COO). As reviewed by Carlucci et al. (2015), there is a clear preference for domestic products. Even though COO is often examined as a separate factor influencing consumer behaviour, apart from the obtaining method (farmed *vs* wild), it can be considered as an important contribution asset not only in the quality assessment of farmed fish but also in the sustainability perception of aquaculture practices. Local and European aquaculture products are recognized as being more environmentally friendly, having a lower carbon footprint because of shorter transportation distances and less usage of natural resources, as well as a means to support local economies (Feucht and Zander, 2015). While sustainability claims and labels have a positive influence on consumers, they have a much weaker importance compared with geographical origin (Risius et al., 2019). Thus, the aquaculture sector could benefit from consumers' interest in COO by emphasizing its role in building a sustainable image. In fact, Banovic et al. (2019) concluded that the COO label, "Produced in own country", together with an eco-label, functions the best as a driver of choice.

Conclusion

Depending on how consumers weigh up the advantages and disadvantages of aquaculture as well as its products, this will result in a preference for either wild or farmed fish. Although consumer beliefs and attitudes vary from person to person and from market to market, they are susceptible to change. Therefore, it is important to understand what consumers believe in order to avoid misconceptions, increase the public knowledge and successfully target promotional campaigns. Socio-demographic characteristics cannot be changed, but they are important to understand. The future success of aquaculture depends on diminishing perceived differences between methods of fish production (farmed *vs* wild), together with putting focus on sustainable production methods. However, it still remains a challenge for the aquaculture sector to develop an efficient strategy so that people, who are currently discouraged to buy and consume farmed fish because of the aforementioned beliefs, are persuaded otherwise. Future research could be undertaken on this topic to determine the strength of particular factors in driving the overall preference towards aquaculture products as well as consumption habits, with special emphasis on the sustainable aquaculture niche. It is expected that results would vary across countries and regions, given the reviewed different beliefs and attitudes prevalent in each. Conclusions obtained in this review could contribute to the efficient selection of various approaches to promote the purchasing of products from sustainable aquaculture in different markets.

Source of funding: The work was conducted within the frame of the EU-funded AdriAquaNet (Enhancing Innovation and Sustainability in Adriatic Aquaculture) project.

References

Altintzoglou, T., Vanhonacker, F., Verbeke, W., Luten, J. (2011): Association of health involvement and attitudes towards eating fish on farmed and wild fish consumption in Belgium, Norway and Spain. *Aquac. Int.* 19 (3), 475-488. https://doi.org/10.1007/s10499-010-9363-2.

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 (2), 103-119. https://doi.org/10.1080/10498850.2010.492093.

Arvanitoyannis, I. S., Krystallis, A., Panagiotaki, P., Theodorou, A. J. (2004): A marketing survey on Greek consumers' attitudes towards fish. *Aquac. Int.* 12 (3), 259-279. https://doi.org/10.1023/B:AQUI.0000036137.29397.12.

Banovic, M., Reinders, M. J., Claret, A., Guerrero, L., Krystallis, A. (2019): A cross-cultural perspective on impact of health and nutrition claims, country-of-origin and eco-label on consumer choice of new aquaculture products. *Food Res. Int.* 123, 36-47. https://doi.org/10.1016/j.foodres.2019.04.031.

Bhari, B., Visvanathan, C. (2018): Sustainable Aquaculture: Socio-Economic and Environmental Assessment. In: Sustainable Aquaculture. Applied Environmental Science and Engineering for a Sustainable Future, Hai, F. I., Visvanathan, C. and Boopathy, R. (eds.), Cham,

Switzerland: Springer, pp. 63-93. https://doi.org/10.1007/978-3-319-73257-2_2.

Bork, C. S., Mortensen, L. T., Hjelmgaard, K., Schmidt, E. B. (2020): Marine n -3 fatty acids and CVD: New insights from recent follow-up studies and clinical supplementation trials. *Proc. Nutr. Soc.* 1-7. https://doi.org/10.1017/S0029665120006886.

Bronnmann, J., Asche, F. (2017): Sustainable Seafood From Aquaculture and Wild Fisheries: Insights From a Discrete Choice Experiment in Germany. *Ecol. Econ.* 142, 113-119. https://doi.org/10.1016/j.ecolecon.2017.06.005.

Bronnmann, J., Hoffmann, J. (2018): Consumer preferences for farmed and ecolabeled turbot: A North German perspective. *Aquac. Econ. Manag.* 22 (3), 342-361. https://doi.org/10.1080/13657305.2018.1398788.

Cahu, C., Salen, P., De Lorgeril, M. (2004): Farmed and wild fish in the prevention of cardiovascular diseases: Assessing possible differences in lipid nutritional values. *Nutr. Metab. Cardiovasc. Dis.* 14 (1), 34-41. https://doi.org/10.1016/S0939-4753(04)80045-0.

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.

Carlucci, D., Nocella, G., De Devitiis, B., Viscecchia, R., Bimbo, F., Nardone, G. (2015): Consumer purchasing behaviour towards fish and seafood products. Patterns and insights from a sample of international studies. *Appetite* 84, 212-227. https://doi.org/10.1016/j.appet.2014.10.008.

Claret, A., Guerrero, L., Aguirre, E., Rincón, L., Hernández, M. D., Martínez, I., Benito Peleteiro, J., Grau, A., Rodríguez-Rodríguez, C. (2012): Consumer preferences for sea fish using conjoint analysis: Exploratory study of the importance of country of origin, obtaining method, storage conditions and purchasing price. *Food Qual. Prefer.* 26 (2), 259-266. https://doi.org/10.1016/j.foodqual.2012.05.006.

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.

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.

Davidson, K., Pan, M., Hu, W., Poerwanto, D. (2012): Consumers' Willingness To Pay for Aquaculture Fish Products Vs. Wild-Caught Seafood - a Case Study in Hawaii. *Aquac. Econ. Manag.* 16 (2), 136-154. https://doi.org/10.1080/13657305.2012.678554.

EFSA (2005): Opinion of the scientific panel on contaminants in the food chain on a request from the European Parliament related to the safety assessment of wild and farmed fish. *EFSA J.* 236, 1-118.

FAO (2010): Aquaculture development. 4. Ecosystem approach to aquaculture. *FAO Technical Guidelines for Responsible Fisheries, 5* (Suppl. 4). Food and Agriculture Organization of the United Nations, Rome.

FAO (2018): The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. Food and Agriculture Organization of the United Nations, Rome.

FAO (2020): The State of World Fisheries and Aquaculture 2020 - Sustainability in action. Food and Agriculture Organization of the United Nations, Rome.

Fernández-Polanco, J., Luna, L. (2012): Factors affecting consumers' beliefs about aquaculture. *Aquac. Econ. Manag.* 16 (1), 22-39. https://doi.org/10.1080/13657305.2012.649047.

Fernández-Polanco, J., Luna, L. (2010): Analysis of perceptions of quality of wild and cultured seabream in Spain. *Aquac. Econ. Manag.* 14 (1), 43-62. https://doi.org/10.1080/13657300903566878.

Feucht, Y., Zander, K. (2015): Of earth ponds, flow-through and closed recirculation systems - German consumers' understanding of sustainable aquaculture and its communication. *Aquaculture* 438, 151-158. https://doi.org/10.1016/j.aquaculture.2015.01.005.

Flaherty, M., Reid, G., Chopin, T., Latham, E. (2019): Public attitudes towards marine aquaculture in Canada: insights from the Pacific and Atlantic coasts. *Aquac. Int.* 27 (1), 9-32. https://doi.org/10.1007/s10499-018-0312-9.

Freeman, S., Vigoda-Gadot, E., Sterr, H., Schultz, M., Korchenkov, I., Krost, P., Angel, D. (2012): Public attitudes towards marine aquaculture: A comparative analysis of Germany and Israel. *Environ. Sci. Policy* 22, 60-72. https://doi.org/10.1016/j.envsci.2012.05.004.

Froehlich, H. E., Gentry, R. R., Rust, M. B., Grimm, D., Halpern, B. S. (2017): Public perceptions of aquaculture: Evaluating spatiotemporal patterns of sentiment around the world. *PLoS One* 12 (1), 1-18. https://doi.org/10.1371/journal.pone.0169281.

Gil, A., Gil, F. (2015): Fish, a Mediterranean source of n-3 PUFA: Benefits do not justify limiting consumption. *Br. J. Nutr.* 113 (S2), S58-S67. https://doi.org/10.1017/S0007114514003742.

Güney, O. I. (2019): Consumers' Perceived Differences between Wild and Farmed Fish: A Survey Study in Turkey. *J. Aquat. Food Prod. Technol.* 28 (2), 210-220. https://doi.org/10.1080/10498850.2019.1572684.

Hall, T. E., Amberg, S. M. (2013): Factors influencing consumption of farmed seafood products in the Pacific northwest. *Appetite* 66, 1-9. https://doi.org/10.1016/j.appet.2013.02.012.

Honkanen, P., Olsen, S. O. (2009): Environmental and animal welfare issues in food choice: The case of farmed fish. *Br. Food J.* 111 (3), 293-309. https://doi.org/10.1108/00070700910941480.

Hynes, S., Skoland, K., Ravagnan, E., Gjerstad, B., Krøvel, A. V. (2018): Public attitudes toward aquaculture: An Irish and Norwegian comparative study. *Mar. Policy* 96, 1-8. https://doi.org/10.1016/j.marpol.2018.07.011.

Jaffry, S., Pickering, H., Ghulam, Y., Whitmarsh, D., Wattage, P. (2004): Consumer choices for quality and sustainability labelled seafood products in the UK.

Food Policy 29 (3), 215-228. https://doi.org/10.1016/j.foodpol.2004.04.001.

Jayedi, A., Shab-Bidar, S. (2020): Fish Consumption and the Risk of Chronic Disease: An Umbrella Review of Meta-Analyses of Prospective Cohort Studies. *Adv. Nutr.* 0, 1-11. https://doi.org/10.1093/advances/nmaa029.

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.

Katranidis, S., Nitsi, E., Vakrou, A. (2003): Social acceptability of aquaculture development in coastal areas: The case of two Greek Islands. *Coast. Manag.* 31 (1), 37-53. https://doi.org/10.1080/08920750390168291.

Kole, A. P. W., Altintzoglou, T., Schelvis-Smit, R. A. A. M., Luten, J. B. (2009): The effects of different types of product information on the consumer product evaluation for fresh cod in real life settings. *Food Qual. Prefer.* 20 (3), 187-194. https://doi.org/10.1016/j.foodqual.2008.09.003.

Krešić, G., Koprivnjak, O., Lešić, T., Jurković, M., Sokolić, D., Gross-Bošković, A., Branežec, K., Pleadin, J. (2017): Consumption of canned oily fish as a source of fatty acids. *Riv. Ital. Sostanze Gr.* 94 (4), 239-249.

Krešić, G., Vulić, A., Dergestin Bačun, L., Lešić, T., Želježić, D., Pleadin, J. (2019): Nutritive composition and lipid quality indices of commercially available filleted fish. *Food Health Dis.* 8 (1), 67-73.

Mauracher, C., Tempesta, T., Vecchiato, D. (2013): Consumer preferences regarding the introduction of new organic products. The case of the Mediterranean sea bass (Dicentrarchus labrax) in Italy. *Appetite* 63, 84-91. https://doi.org/10.1016/j.appet.2012.12.009.

Mazur, N. A., Curtis, A. L. (2006): Risk perceptions, aquaculture, and issues of trust: Lessons from Australia. *Soc. Nat. Resour.* 19 (9), 791-808. https://doi.org/10.1080/08941920600835551.

Mithril, C., Dragsted, L. O., Meyer, C., Tetens, I., Biltoft-Jensen, A., Astrup, A. (2013): Dietary composition and nutrient content of the New Nordic Diet. *Public Health Nutr.* 16 (5), 777-785. https://doi.org/10.1017/S1368980012004521.

Musa, S. M., Aura, C. M., Kundu, R. (2012): Wild-Caught Fish versus Aquaculture Fish Products: A Fish Marketing Concept for Aquaculture Quality Improvement, A Case Study of Nyanza Region, Kenya. *Int. J. Sci. Res.* 3 (9), 1972-1978.

Natto, Z. S., Yaghmoor, W., Alshaeri, H. K., Van Dyke, T. E. (2019): Omega-3 Fatty Acids Effects on Inflammatory Biomarkers and Lipid Profiles among Diabetic and Cardiovascular Disease Patients: A Systematic Review and Meta-Analysis. *Sci. Rep.* 9 (1), 1-10. https://doi.org/10.1038/s41598-019-54535-x.

Pieniak, Z., Vanhonacker, F., Verbeke, W. (2013): Consumer knowledge and use of information about fish and aquaculture. *Food Policy* 40, 25-30. https://doi.org/10.1016/j.foodpol.2013.01.005.

Petrović, M., Krešić, G., Zrnčić, S., Oraić, D., Džafić, N., Pleadin, J. (2015): Influence of season and farming location on the quality parameters of sea bass (*Dicentrarchus labrax*) and sea bream (*Sparus aurata*). *Ital. J. Food Sci.* 27 (2), 151-159. https://doi.org/10.14674/1120-1770/ijfs.v181.

Pleadin, J., Lešić, T., Krešić, G., Barić, R., Bogdanović, T., Oraić, D., Vulić, A., Legac, A., Zrnčić, S. (2017): Nutritional quality of different fish species farmed in Adriatic Sea. *Ital. J. Food Sci.* 29 (3), 537-549. https://doi.org/10.14674/IJFS-706.

Potts, T., Pita, C., O'Higgins, T., Mee, L. (2016): Who cares? European attitudes towards marine and coastal environments. *Mar. Policy* 72, 59-66. https://doi.org/10.1016/j.marpol.2016.06.012.

Pulcini, D., Franceschini, S., Buttazzoni, L., Giannetti, C., Capoccioni, F. (2020): Consumer Preferences for Farmed Seafood: An Italian Case Study. *J. Aquat. Food Prod. Technol.* 29 (5), 1-16. https://doi.org/10.1080/10498850.2020.1749201.

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, 256-266. https://doi.org/10.1016/j.aquaculture.2019.05.066.

Rickard, L. N., Britwum, K., Noblet, C. L., Evans, K. S. (2020). Factory-made or farm fresh? Measuring U.S. support for aquaculture as a food technology. *Mar. Policy* 115. https://doi.org/10.1016/j.marpol.2020.103858.

Rickertsen, K., Alfnes, F., Combris, P., Enderli, G., Issanchou, S., Shogren, J. F. (2017): French Consumers' Attitudes and Preferences Toward Wild and Farmed Fish. *Mar. Resour. Econ.* 32 (1), 59-81. https://doi.org/10.1086/689202.

Risius, A., Hamm, U., Janssen, M. (2019): Target groups for fish from aquaculture: Consumer segmentation based on sustainability attributes and country of origin. *Aquaculture* 499, 341-347. https://doi.org/10.1016/j.aquaculture.2018.09.044.

Roheim, C. A., Sudhakaran, P. O., Durham, C. A. (2012): Certification of Shrimp and Salmon for Best Aquaculture Practices: Assessing Consumer Preferences in Rhode Island. *Aquac. Econ. Manag.* 16 (3), 266-286. https://doi.org/10.1080/13657305.2012.713075.

Sacks, F. M., Obarzanek, E., Windhauser, M. M., Svetkey, L. P., Vollmer, W. M., McCullough, M., Karanja, N., Lin, P. H., Steele, P., Proschan, M. A., Evans, M. A., Appel, L. J., Bray, G. A., Vogt, T. M., Moore, T. J., DASH Investigators (1995): Rationale and design of the Dietary Approaches to Stop Hypertension trial (DASH). A multicenter controlled-feeding study of dietary patterns to lower blood pressure. *Ann. Epidemiol.* 5 (2), 108-118. https://doi.org/10.1016/1047-2797(94)00055-X.

Schlag, A. K., Ystgaard, K. (2013): Europeans and aquaculture: Perceived differences between wild and farmed fish. *Br. Food J.* 115 (2), 209-222. https://doi.org/10.1108/00070701311302195.

Shafer, C. S., Inglis, G. J., Martin, V. (2010): Examining residents' proximity, recreational use, and perceptions regarding proposed aquaculture development. *Coast. Manag.* 38 (5), 559-574. https://doi.org/10.1080/08920753.2010.511700.

Solgaard, H. S., Yang, Y. (2011): Consumers' perception of farmed fish and willingness to pay for fish welfare. *Br. Food J.* 113 (8), 997-1010. https://doi.org/10.1108/00070701111153751.

Stefani, G., Scarpa, R., Cavicchi, A. (2012): Exploring consumer's preferences for farmed sea bream. *Aquac. Int.* 20 (4), 673-691. https://doi.org/10.1007/s10499-011-9495-z.

Tomić, M., Lucević, Z., Tomljanović, T., Matulić, D. (2017): Wild-caught versus farmed fish – consumer perception. *Croat. J. Fish.* 75 (2), 41-50. https://doi.org/10.1515/cjf-2017-0007.

Tørris, C., Småstuen, M. C., Molin, M. (2018): Nutrients in fish and possible associations with cardiovascular disease risk factors in metabolic syndrome. *Nutrients* 10 (7), 1-17. https://doi.org/10.3390/nu10070952.

Van Osch, S., Hynes, S., Freeman, S., O'Higgins, T. (2019): Estimating the public's preferences for sustainable aquaculture: A country comparison. *Sustain.* 11 (3), 1-24. https://doi.org/10.3390/su11030569.

Van Osch, S., Hynes, S., O'Higgins, T., Hanley, N., Campbell, D., Freeman, S. (2017): Estimating the Irish public's willingness to pay for more sustainable salmon produced by integrated multi-trophic aquaculture. *Mar. Policy* 84, 220-227. https://doi.org/10.1016/j.marpol.2017.07.005.

Vanhonacker, F., Altintzoglou, T., Luten, J., Verbeke, W. (2011): Does fish origin matter to European consumers?: Insights from a consumer survey in Belgium, Norway and Spain. *Br. Food J.* 113 (4), 535-549. https://doi.org/10.1108/00070701111124005.

Vanhonacker, F., Pieniak, Z., Verbeke, W. (2013): European consumer image of farmed fish, wild fish, seabass and seabream. *Aquac. Int.* 21 (5), 1017-1033. https://doi.org/10.1007/s10499-012-9609-2.

Verbeke, W., Brunso, K. (2005): Consumer awareness, perceptions and behaviour towards farmed versus wild fish. In: The economics of aquaculture with respect to fisheries, 95th EAAE Seminar European Association of Agricultural Economists, Thomson, K. J. and Venzi, L. (eds.), Civitavecchia (Rome), Italy, pp. 237-251. https://doi.org/10.22004/ag.econ.56075.

Verbeke, W., Sioen, I., Brunsø, K., Henauw, S., Camp, J. (2007a): Consumer perception versus scientific evidence of farmed and wild fish: Exploratory insights from Belgium. *Aquac. Int.* 15 (2), 121-136. https://doi.org/10.1007/s10499-007-9072-7.

Verbeke, W., Vanhonacker, F., Sioen, I., Van Camp, J., De Henauw, S. (2007b): Perceived importance of sustainability and ethics related to fish: A consumer behavior perspective. *Ambio* 36 (7), 580-585. https://doi.org/10.1579/0044-7447(2007)36[580:PIOSAE]2.0.CO;2.

Whitmarsh, D., Palmieri, M. G. (2009): Social acceptability of marine aquaculture: The use of survey-based methods for eliciting public and stakeholder preferences. *Mar. Policy* 33 (3), 452-457. https://doi.org/10.1016/j.marpol.2008.10.003.

Whitmarsh, D., Palmieri, M. G. (2011): Consumer behaviour and environmental preferences: A case study of Scottish salmon aquaculture. *Aquac. Res.* 42 (S1), 142-147. https://doi.org/10.1111/j.1365-2109.2010.02672.x.

Zander, K., Feucht, Y. (2018): Who is Prepared to Pay For Sustainable Fish? Evidence from a Transnational Consumer Survey in Europe. In: Proceedings in System Dynamics and Innovation in Food Networks 2018, Deiters, J., Rickert, U. and Schiefer, G. (eds.), Innsbruck, Austria, pp. 99-112. https://doi.org/10.18461/pfsd.2018.1806.

Zander, K., Risius, A., Feucht, Y., Janssen, M., Hamm, U. (2018): Sustainable Aquaculture Products: Implications of Consumer Awareness and of Consumer Preferences for Promising Market Communication in Germany. *J. Aquat. Food Prod. Technol.* 27 (1), 5-20. https://doi.org/10.1080/10498850.2017.1390028.