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Sustainable aquaculture from students' perspectives

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ABSTRACT

Due to its nutritional value and health benefits, regular consumption of fish should be encouraged at all stages of life. Considering the fact that the majority of the world's marine fish stocks are being exploited, aquaculture is the only way to ensure an adequate supply. Aquaculture production should be sustainable and it should integrate environmental, social, and economic dimensions. Students, as a valuable segment of consumers, are future decision-makers in society and can contribute to sustainable development as agents of change. In this study, 224 students from the University of Rijeka (68 males and 156 females) with an average age of 21.5±1.4 years were included. The aim of this study was to obtain information about the most important aspects of sustainable aquaculture from their point of view. Descriptive statistics was used to analyse the sample characteristics, while statistical significance difference between males and females was computed using an independent t-test and Pearson's chi-square test. The obtained results confirmed that the most important features of sustainable aquaculture were: minimal use of hormones and drugs, no environmental pollution, and production close to nature. Female participants consider more important protection of endangered species ($p=0.04$) and respect for fish welfare ($p=0.01$), while male participants are much more aware of supporting rural areas ($p=0.04$) and low technical level in production ($p=0.04$). Quality also emerged as an important component in an open-ended question, together with environmental factors. Furthermore, there is an opportunity to enhance students' interest in eco-labels, since it did not receive very high importance among this student group (3.60 ± 1.20 and 3.82 ± 0.90). In the future, nutrition education provided by institutions could be an important tool in preparing future generations for sustainable society.

KEYWORDS
aquaculture; seafood; sustainability; students

KEY CONTRIBUTION

Students mostly associate environmental aspects with sustainable aquaculture. Minimal use of hormones and drugs, as well as quality also emerged as important components. Female participants consider more important protection of endangered species and respect of fish welfare, while male participants are much more aware of supporting rural areas and low technical level in production.

Introduction

In the last decade, there has been a growing global emphasis on sustainability which is evident through initiatives such as the United Nations' 2030 Agenda (UN, 2015). In addition to its important role in promoting human well-being, aquaculture is also increasingly recognized for its contribution to achieving the Sustainable Development Goals (SDGs) set by the UN 2030 Agenda (Mair et al., 2023; Troell et al., 2023). Even though aquaculture is specifically mentioned only in SDG Goal 14 – "Conserve and Sustainably use the oceans, seas and marine resources for sustainable development" under indicator 14.7, the impact of aquaculture as a part of sustainable food production and consumption extends across all 17 SDGs (Troell et al., 2023). Furthermore, in line with the EU Blue Growth Strategy, and the more recent strategy for a Sustainable Blue Economy, sustainable aquaculture is promoted for the growth of the European seafood sector (European Commission, 2012; European Commission, 2021). At an amount of 20.2 kg per capita in 2020, global fish consumption is expected to rise in the years ahead due to urbanization, rising incomes, shifting dietary preferences toward healthy food choices, and an overall increase in the world's population (FAO, 2022). Besides, regular consumption of fish is continuously encouraged by nutritionists due to its nutritional value and numerous health benefits (EFSA, 2014). In this view, coupled with the fact that natural fish resources are limited, aquaculture production has grown rapidly and currently, it is the fastest-growing food production segment (FAO, 2022; Naylor, 2021). As a result, more than half of the seafood available for consumption today is produced in aquaculture (FAO, 2022). Therefore, it has been recognized that aquaculture development must be carried out in a sustainable manner, and sustainability has become the focus of attention among academic, political, and industry stakeholders (Boyd et al., 2020).

Sustainable aquaculture should consider not only frequently mentioned environmental aspects, but also social, and economic ones, commonly known as the three pillars of sustainability (Boyd et al., 2020, Mair et al., 2023). Despite increased pressure on the aquaculture industry to adopt sustainable measures and the fact that progress is being achieved (Naylor, 2021), the concept of sustainability linked to aquaculture is still not well-defined and comprehensive (Boyd et al., 2020). In many countries, fish from certified sustainable aquaculture is a relatively new market segment, and consumers do not know how to recognize and evaluate such a method of food production. Consumers and their consumption behaviour play a key role in the sustainability of all food systems, including aquaculture (Boyd et al., 2020; Peano et al., 2019; van Bussel et al., 2022). Thus, it is important to understand how consumers view sustainability in relation to seafood and to what extent it is an important attribute when buying seafood. In a recent review on this topic, it was found that younger consumers are more likely to consume farmed fish compared to older consumers (Krešić et al., 2020). In addition, consumers with higher level of education are more likely to understand information about aquaculture and are more likely to agree with scientific findings (Krešić et al., 2020).

It has been shown that Generation Z (namely, individuals born between 1995 and 2012), due to their early exposure to healthy lifestyle choices, are environmentally conscious and they value sustainability in their consumption choices (Gibson et al., 2023; Su et al., 2019). With the rise of the global market and digitalization, Generation Z has more alternatives in the marketplace than prior generations, which may impact how they perceive and purchase seafood (Gibson et al., 2023). Students, as a valuable consumer segment, representing Generation Z-cohort, are future decision-makers in society and can contribute to sustainable development as agents of change (Su et al., 2019). Given their values, students may have distinct perspectives on sustainable aquaculture.

To date, several researchers have studied fish consumption behaviour in Croatia. Their primary focus has been on investigating the factors that influence the consumption of various types of fish—ranging from fresh fish to both white and fatty varieties, as well as a broader category of fish and seafood in general (Krešić et al., 2022a; Krešić et al., 2023; Marinac Pupavac et al., 2022; Tomić et al., 2016b). Additionally, they aimed to identify consumers' attitudes, barriers, and preferences related to fish consumption (Krešić et al., 2023; Marinac Pupavac et al., 2022; Tomić et al., 2016a). Somewhat less research has specifically targeted farmed fish, exploring the determinants affecting preferences for wild-caught versus farmed fish, as well as describing different consumer segments based on their intention to consume farmed fish (Krešić et al., 2022b; Tomić et al., 2017). However, only one study dealt with the topic of organic aquaculture, as one of the particular segments of sustainable aquaculture (Ferfolja et al., 2022). The findings of this study revealed that consumers have limited knowledge about fish from organic aquaculture. Nevertheless, they hold a positive perception of it. Hence, there is a lack of research on this emerging and significant subject matter in Croatia, creating a gap that awaits further exploration and investigation.

In view of the above, the aim of this study is to obtain information about the most important aspects of sustainable aquaculture from students' perspective since this consumer group will soon play a significant role in the marketplace.

Materials and methods

This research is part of an extensive study on university students´ knowledge, attitudes, and intentions to consume fish from aquaculture. A self-administered survey was used to collect data among the student population of the Faculty of Tourism and Hospitality Management, University of Rijeka, in April 2023. The questionnaire was published online via Google form on the student learning platform and students were asked to fill out the questionnaire voluntarily. In addition, informed consent was obtained prior to filling out the questionnaire. A total sample of 224 respondents was obtained, 68 males and 156 females with an average age of 21.5±1.4 years. Based on their weight and height, students' body mass indices were computed. Fish consumption frequency was measured on an 8-point scale as follows: never, less than once a month, once a month, 2-3 times a month, once a week, twice a week, 3-4 times a week, almost every day (Stancu et al., 2022). The obtained results were calculated and expressed on a weekly basis (Table 1).

Table 1. Characteristics of the study sample (mean ± SD)

	Total (n=224)	Male (n=68)	Female (n=156)	p
Age (yrs)	21.46 ±1.40	21.72±1.51	21.34±1.34	0.075
Weight (kg)	68.48±14.63	82.58±14.05	62.33±9.87	<0.001
Height (cm)	172.35±9.13	182.46±6.07	167.95±6.30	<0.001
BMI (kg/m^2)*	22.87±3.36	24.71±3.32	22.07±3.06	<0.001
Fish consumption (*per* week)	0.88±0.75	0.84±0.59	0.90±0.81	0.539

**BMI (Body Mass Index)*

Firstly, to get information about the understanding of the sustainability concept, study participants were asked to describe in their own words what sustainable aquaculture means to them (Lawley et al., 2019).

From the responses they gave to this open-ended question, keywords were extracted and ranked by frequency. Several responses were discarded due to the inability to categorize them, as well as those that only appeared among a few students (n=12). Secondly, participants were offered a list of eleven possible aspects of sustainability in aquaculture according to Zander and Feucht (2018). From the list, they were asked to select three aspects that they considered the most relevant. In addition, they were asked to rate the importance of several product information when purchasing fish: shelf life, country of origin, fish species (commercial designation and scientific names), production method (wild *vs*. farmed), eco-label, product brand (European Commission, 2014) on a Likert scale from 1 to 5 (1 = not at all important, 5 = extremely important).

Descriptive statistics was used to describe the sample characteristics. Statistically significant difference between males and females was computed using an independent t-test and Pearson's chi-square test. The obtained data were analysed using the statistical software IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). The statistical significance level was set at $p < 0.05$.

Results and discussion

When trying to improve communication with consumers about sustainability, it is important to know what they think and expect, but also what they know and assume. Research addressing consumer behaviour related to sustainable seafood could measure their knowledge or understanding. In this study, the self-reported definition complexity of sustainable aquaculture established through an open-ended question varied from “quality” as the most mentioned keyword to “transparency”. If students mentioned or explained more than one term, each one would be recorded separately, thus giving the total number of responses greater than the number of students (Figure 1).

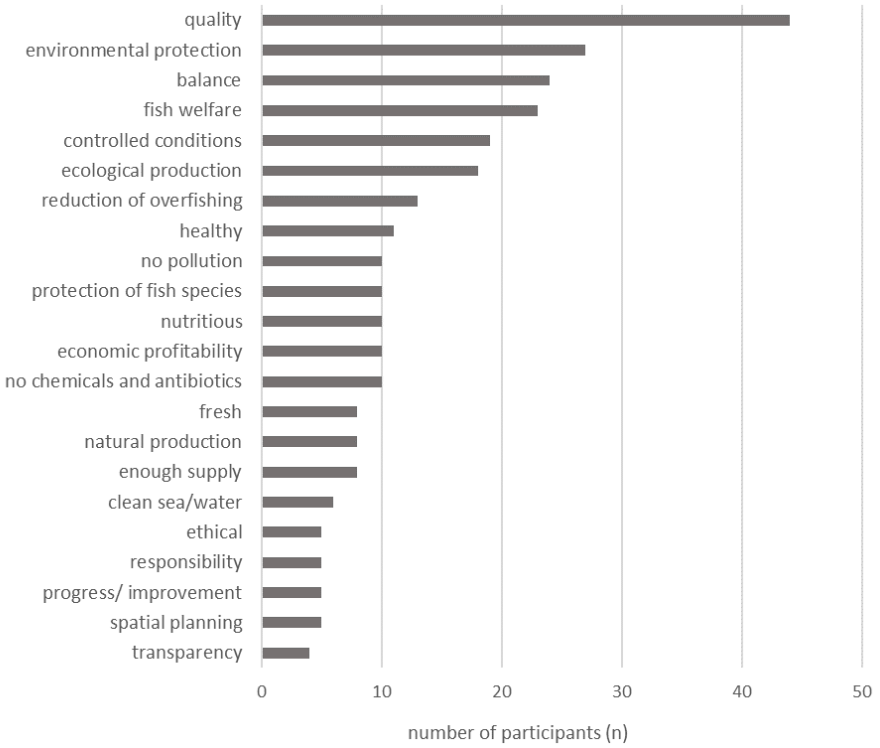

Figure 1. Keywords describing sustainable aquaculture from students’ perspective (n=224)

Interestingly, many students associated quality and quality attributes such as control, nutritional value, healthiness, and freshness with sustainability (n=92). Consumers, indeed, place a high value on the quality of fish, however, farmed fish is often considered of lower quality than captured fish, resulting in consumers having stronger preferences for wild fishery products (Cantillo et al., 2020; Krešić et al., 2020; López-Mas et al., 2021). Furthermore, wild fish is often considered superior in terms of healthiness and nutritional value compared to its wild counterparts (Cantillo et al, 2020; López-Mas et al., 2021). This notion often comes from the belief that wild fish has a higher content of omega-3 fatty acids (Wongprawmas et al., 2022). However, the absolute amount of omega-3 is larger in farmed fish because of its increased fat content and its fatty acid profile is more stable and not variable depending on seasons as it is in wild fish (Krešić et al., 2020). Interestingly, when comparing organically farmed fish with conventional one, consumers perceive organic fish as tastier, healthier, and lower in fat content (Ferfolja et al., 2022). On the other hand, recent work by López-Mas and co-workers (2021) showed that farmed fish is preferred among consumers in terms of control. Nonetheless, there are opposing beliefs in terms of general or specific issues on safety (Krešić et al., 2020). In a study by Bronnmann and Asche (2017), when the preferences of wild *vs*. farmed fish were compared, issues associated with sustainability were found to be more important than quality. In fact, because of the indication of sustainable production, consumers were ready to pay similar prices for aquaculture and wild fishery products. The results of our study further deepen the knowledge that the sustainability aspect could make up for the negative image of farmed fish, as well as it could give an indication to aquaculture producers to highlight the quality of their products when promoting them as sustainable. In the second place, students evaluated “environmental protection“ “protection of fish species“, “no pollution“, and “ecological and natural production“ as essential components of sustainable aquaculture (n=73). Indeed, when talking about the sustainability of aquaculture or food systems in general, the most recognition and attention among consumers are given to the environmental pillar of sustainability, while social and economic ones are often overlooked (Peano et al., 2019; van Bussel et al., 2022; Zander and Feucht, 2018). Consumers might perceive a closer relationship between sustainability and the environment as a result of current communication and advertising activities, as well as certifications that promote sustainable products connected to environmental protection and natural resource preservation, while only making sporadic attempts to address cultural and economic concerns (Osmundsen et al., 2020; Peano et al., 2019).

After expressing their opinion on sustainable aquaculture, students were asked to indicate the three most important elements of sustainability in aquaculture through a closed-ended question. The students consider the most important aspect of sustainability in aquaculture to be “minimal use of hormones and drugs“ (62.9%), followed by “no pollution of the environment“ (62.5%) and “production close to nature“ (46.4%) (Figure 2).

The results of the study by Zander and Feucht (2018) also confirmed that minimal use of hormones and drugs was the most important issue for consumers. This fact could be explained by a strong selfish component, as people do not want to consume fish that contains residues of one or both substances due to potential risks to their health (Zander and Feucht, 2018). A common misconception that persists among consumers is that farmed fish contains high levels of antibiotics and hormones which causes them to grow faster (López-Mas et al., 2021; Wongprawmas et al., 2022). However, the use of hormonal substances in all food production systems, including aquaculture, has been prohibited for a long time in the European Union (European Commission, 2003), while antibiotics could be used only for prophylactic and therapeutic purposes, abiding by strict laws. New EU legislation that came into the force in 2022 goes further and prohibits all forms of routine antibiotic use in farming, including preventative group treatments (European Commission, 2019). Overall, there is a strong indication of the need for consumers

to be properly informed on this issue (Wongprawmas et al., 2022). Interestingly, in an open-ended question, “no use of chemicals and antibiotics“ was not in the top answers (n=10).

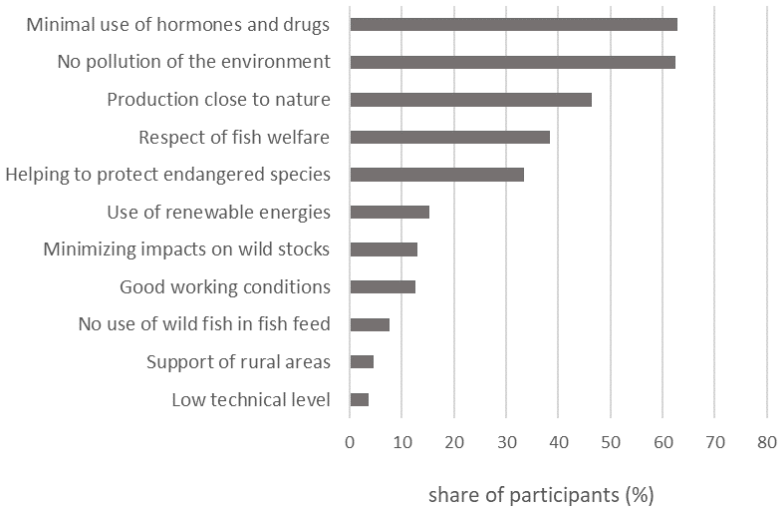

Figure 2. Important aspects of sustainable aquaculture from students´ perspective (n=224)

In alignment with answers to the open-ended question, in closed-ended questions, “no pollution of the environment“ was among the most important aspects of sustainable aquaculture. Although there was no statistical difference between genders, this aspect was the most important for men, given that it was in first place for them (69.1%). Similarly, in the study of Ferfolja et al. (2022) conducted in Croatia, fish farmed according to environmental standards was the most frequently mentioned definition of organic fish. Aquaculture in the literature has been perceived to be less of a threat to the environment in comparison to industrial pollution and litter (Potts et al., 2016), yet it is considered to do the same environmental harm as agriculture (Hall and Amberg, 2013). Consumers are truly worried about the environmental impact of aquaculture products, which can influence their preferences and consumption habits (Krešić et al., 2020). In addition, conventionally farmed fish is believed to have a negative impact on the environment (Ferfolja et al., 2022). Hence, the perceived environmental impact may influence the social acceptability of aquaculture and therefore restrain its growth and development. For this reason, ensuring environmental sustainability has emerged as a top priority among EU aquaculture strategies (Cavallo et al., 2021). In addition, consumers with high environmental awareness are more likely to actively support sustainable aquaculture (Yi, 2019). A recent study by López-Mas et al. (2023) found that farmed fish is perceived as less pollutant, causing less environmental damage, and providing more environmental benefits than its wild counterparts.

Female participants consider endangered species protection ($p=0.037$) and respect for fish welfare ($p=0.007$) significantly more important in comparison to males. On the other hand, men are much more aware of supporting rural areas ($p=0.037$) and low technical levels in production ($p=0.044$) (Table 2). Many previous research confirm that girls and women have stronger pro-animal welfare attitudes than boys and men (Clark et al., 2016; Randler et al., 2021a; Randler et al., 2021b). Even though a great number of consumers are worried about the well-being of animals in food production systems, the welfare of farmed fish does not seem to have reached the same level of sensibility (Alfnes et al., 2018). When compared to wild fish, farmed fish is perceived as having worse animal welfare which may stem

from the idea that wild fish is “happier” because of the possibility to swim freely (López-Mas et al., 2023). However, several studies identified that there is a segment of consumers who are interested in fish welfare issues and are willing to pay more for products with welfare labels and claims (Maesano et al., 2020; Solgaard and Yang, 2011; Zander and Feucht, 2018). This market segment consists primarily of women (Solgaard and Yang, 2011).

Studies suggest that women are more likely to buy seafood since they are in most cases in charge of procuring and preparing food for the household (Richter et al., 2017), hence it would be expected that they are more likely to use food labels (Campos et al., 2011; Christoph et al., 2016). There were no gender specific differences in the level of importance that students in this research put on product information when purchasing fishery and aquaculture products.

Table 2. Gender-specific importance of aspects of sustainable aquaculture

	Male n (%)	**Female** n (%)	**p**
Minimal use of hormones and drugs	46 (67.6)	95 (60.9)	0.336
Helping to protect endangered species	16 (23.5)	59 (37.8)	0.037
No pollution of the environment	47 (69.1)	93 (59.6)	0.177
Respect of fish welfare	17 (25.0)	69 (44.2)	0.007
Minimizing impacts on wild stocks	12 (17.6)	17 (10.9)	0.166
Production close to nature	30 (44.1)	74 (47.4)	0.647
No use of wild fish in fish feed	4 (5.9)	13 (8.3)	0.524
Use of renewable energies	15 (22.1)	19 (12.2)	0.058
Support of rural areas	6 (8.8)	4 (2.6)	0.037
Good working conditions	6 (8.8)	22 (14.1)	0.272
Low technical level	5 (7.4)	3 (1.9)	0.044

The lack of disparity between men and women could be explained by consumers' young age, absence of household members to take care of, and similar purchasing habits in this period of life. Students consider shelf life (4.41 and 4.57) as the most important information on fishery and aquaculture products, followed by fish species (3.84 and 3.86) and country of origin (3.76 and 3.74) (Table 3). Similar results were obtained in the study of Cantillo et al. (2021) where “the name of the product and the species” and the “use by” or “best before” date were the most important criteria for European consumers. Many studies have found the country of origin as the most important attribute in the decision-making process of fish purchasing, with local products being preferred over imported ones (Alfnes et al., 2018; Cantillo et al., 2020; Maesano et al., 2020). Eco-label did not receive very high importance among this student population (3.60 and 3.82). This aligns with a recent survey among Croatian consumers, which showed that only slightly more than half of them attach importance to this label (Krešić et al., 2022a). Moreover, earlier research confirms that despite the fact consumers favour sustainable aquaculture, certification schemes do not play an important role in purchasing decisions (Risius et al., 2017), while in choice experiments consumers showed a higher willingness to pay for such products (Maesano et al., 2020; Cantillo et al., 2020).

The strength of the present study is the quality data on students' opinions regarding sustainable aquaculture, thus deepening the literature knowledge about Generation Z students' beliefs, preferences, and behaviour towards sustainable food and its systems. However, there are several limitations to this study. First, it should be mentioned that the collected data are based on an online questionnaire, filled out voluntarily. Further limitations are the relatively small study sample, limited to the specific area, faculty, and country. Therefore, the results of this study cannot be generalized to a broader audience.

Table 3. Gender-specific importance of product information (mean ± SD)

	Male	Female	p
Shelf life	4.41 ± 0.92	4.57 ± 0.73	0.209
Country of origin	3.76 ± 1.12	3.74 ± 1.00	0.856
Fish species (commercial designation and scientific names)	3.84 ± 1.10	3.86 ± 0.93	0.885
Production method (wild *vs*. farmed)	3.49 ± 1.15	3.60 ± 0.93	0.461
Eco-label	3.60 ± 1.20	3.82 ± 0.90	0.183
Product brand	3.47 ± 1.15	3.60 ± 1.03	0.421

Future research is advised to be conducted on a nationally representative sample of university students, as well as to explore the effects of different cultural settings. Given the fact students do not place high importance on eco-labels, researchers are encouraged to determine the factors that influence this. In addition, choice experiments are proposed in order to better understand which claims and labels would be successful in marketing sustainable aquaculture products in the Croatian market.

Conclusions

In the past, the paradigm of aquaculture was to produce seafood at a lower cost; today and in the future, the paradigm will be to produce seafood sustainably, taking into account social, economic, and environmental factors. According to the presented findings, from both open-ended and closed-ended questions, students mostly associate environmental aspects with sustainable aquaculture, which is not surprising given the current situation in the market where those are emphasized more by producers. However, minimal use of hormones and drugs, as well as quality also emerged as important components, which can be useful information for marketing managers to design strategies in order to attract more young consumers to buy their products. Fish welfare is another aspect that is expected to gain more and more attention in the future, although results show that currently, women value it significantly more than men. Furthermore, there is an opportunity to enhance students' interest in eco-labels, which are the main methods of communicating the sustainability of aquaculture practices. It also indicates the need for greater education and raising awareness of young population as an important group of consumers. In the future, nutrition education provided by institutions could be an important tool in preparing future generations for sustainable society.

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References

Alfnes, F., Chen, X., Rickertsen, K. (2018): Labeling farmed seafood: A review. *Aquaculture Economics & Management* 22 (1), 1-26. https://doi.org/10.1080/13657305.2017.1356398

Boyd, C.E., D'Abramo, L.R., Glencross, B.D., Huyben, D.C., Juarez, L.M., Lockwood, G.S., McNevin, A.A., Tacon, A.G.J., Teletchea, F., Tomasso, J.R., Tucker, C.S., Valenti, W.C. (2020): Achieving sustainable aquaculture: Historical and current perspectives and future needs and challenges. *Journal of the World Aquaculture Society* 51 (3), 578-633. https://doi.org/10.1111/jwas.12714

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

Campos, S., Doxey, J., Hammond, D. (2011): Nutrition labels on pre-packaged foods: A systematic review. *Public Health Nutrition* 14 (8), 1496-1506. https://doi.org/10.1017/S1368980010003290

Cantillo, J., Martín, J., Román, C. (2020): Discrete choice experiments in the analysis of consumers' preferences for finfish products: A systematic literature review. *Food Quality and Preference* 84, 103952. https://doi.org/10.1016/j.foodqual.2020.103952

Cantillo, J., Martín, J.C., Román, C. (2021): Assessing the label's mandatory information for fishery and aquaculture products in the EU28. A consumer approach based on a consistent fuzzy preference relation with geometric Bonferroni mean. *Marine Policy* 128, 104515. https://doi.org/10.1016/j.marpol.2021.104515

Cavallo, M., Pérez Agúndez, J.A., Raux, P., Frangoudes, K. (2021): Is existing legislation supporting socially acceptable aquaculture in the European Union? A transversal analysis of France, Italy and Spain. *Reviews in Aquaculture* 13 (3), 1683-1694. https://doi.org/10.1111/raq.12540

Christoph, M., An, R., Ellison, B. (2016): Correlates of nutrition label use among college students and young adults: A review. *Public Health Nutrition* 19 (12), 2135-2148. https://doi.org/10.1017/S1368980015003183

Clark, B., Stewart, G.B., Panzone, L.A., Kyriazakis, I., Frewer, L.J. (2016): A systematic review of public attitudes, perceptions and behaviours towards production diseases associated with farm animal welfare. *Journal of Agricultural and Environmental Ethics* 29, 455-478. https://doi.org/10.1007/s10806-016-9615-x

EFSA (2014): Scientific Opinion on health benefits of seafood (fish and shellfish) consumption in relation to health risks associated with exposure to methylmercury. *EFSA Journal* 12 (7), 3761. https://doi.org/10.2903/j.efsa.2014.3761

European Commission (2003): Directive 2003/74/EC of the European Parliament and of the Council of 22 September 2003 amending Council Directive 96/22/EC concerning the prohibition on the use in stockfarming of certain substances having a hormonal or thyrostatic action and of beta-agonists, *Official Journal of the European Union* L 262, 17-21.

European Commission (2012): Blue Growth: Opportunities for Marine and Maritime Sustainable Growth – Communication, 494.

European Commission, Directorate-General for Maritime Affairs and Fisheries (2014): A pocket guide to the EU's new fish and aquaculture consumer labels, Luxembourg: Publications Office of the European Union.

European Commission (2019): Regulation (EU) 2019/6 of the European Parliament and of the Council of 11 December 2018 on veterinary medicinal products and repealing Directive 2001/82/EC, *Official Journal of the European Union* L 4, 43-167.

European Commission (2021): A new approach for a sustainable blue economy in the EU: Transforming the EU's Blue Economy for a Sustainable Future – Communication, 240.

FAO (2022): The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, Italy: FAO. https://doi.org/10.4060/cc0461en

Ferfolja, M., Cerjak, M., Matulić, D., Tomić Maksan, M. (2022): Consumer knowledge and perception about fresh fish from organic farming in Croatia. *Croatian Journal of Fisheries* 80 (1), 7-16. https://doi.org/10.2478/cjf-2022-0002

Gibson, K.E., Sanders, C.E., Byrd, A.R., Lamm, K.W., Lamm, A.J. (2023): The Influence of Sustainability on Identities and Seafood Consumption: Implications for Food Systems Education for Generation Z. *Foods* 12 (10), 1933. https://doi.org/10.3390/foods12101933

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

Krešić, G., Dujmić, E., Lončarić, D., Buneta, A., Liović, N., Zrnčić, S., Pleadin, J. (2020): Factors affecting consumers´ preferences for products from aquaculture. *Croatian Journal of Food Science and Technology* 12 (2), 287-295. https://doi.org/10.17508/CJFST.2020.12.2.17

Krešić, G., Dujmić, E., Lončarić, D., Zrnčić, S., Liović, N., Pleadin, J. (2022a): Fish Consumption: Influence of Knowledge, Product Information, and Satisfaction with Product Attributes. *Nutrients* 14 (13), 2691. https://doi.org/10.3390/nu14132691

Krešić, G., Dujmić, E., Lončarić, D., Zrnčić, S., Liović, N., Pleadin, J. (2022b): Profiling of Croatian Consumers Based on Their Intention to Consume Farmed Fish. *Foods* 11 (14), 2158. https://doi.org/10.3390/foods11142158

Krešić, G., Dujmić, E., Lončarić, D., Zrnčić, S., Liović, N., Pleadin, J. (2023): Determinants of white and fatty fish consumption by Croatian and Italian consumers. *British Food Journal* 125 (6), 2157-2175. https://doi.org/10.1108/BFJ-01-2022-0088

Lawley, M., Craig, J.F., Dean, D., Birch, D. (2019): The role of seafood sustainability knowledge in seafood purchase decisions. *British Food Journal* 121 (10), 2337-2350. https://doi.org/10.1108/BFJ-08-2018-0513

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

López-Mas, L., Claret, A., Arvisenet, G., del Castillo, R.R., Kallas, Z., Zuccaro, M., Guerrero, L. (2023): European consumers' beliefs about the main pillars of the sustainability: a comparison between wild and farmed fsh. *Aquaculture International* 31 (4), 2035-2055. https://doi.org/10.1007/s10499-023-01070-2

Maesano, G., Di Vita, G., Chinnici, G., Pappalardo, G., D'Amico, M. (2020): The Role of Credence Attributes in Consumer Choices of Sustainable Fish Products: A Review. *Sustainability* 12 (23), 10008. https://doi.org/10.3390/su122310008

Mair, G.C., Halwart, M., Derun, Y., Costa-Pierce B.A. (2023): A decadal outlook for global aquaculture. *Journal of the World Aquaculture Society* 54 (2), 196-205. https://doi.org/10.1111/jwas.12977

Marinac Pupavac, S., Kenđel Jovanović, G., Linšak, Ž., Glad, M., Traven, L., Pavičić Žeželj, S. (2022): The influence on fish and seafood consumption, and the attitudes and reasons for its consumption in the Croatian population. *Frontiers in Sustainable Food Systems* 6, 945186. https://doi.org/10.3389/fsufs.2022.945186

Naylor, R. L. (2021): A 20-year retrospective review of global aquaculture. *Nature* 591, 551-563. https://doi.org/10.1038/s41586-021-03308-6

Osmundsen, T.C., Amundsen, V.S., Alexander, K.A., Asche, F., Bailey, J., Finstad, B., Olsen, M.S., Hernández, K., Salgado, H. (2020): The operationalisation of sustainability: Sustainable aquaculture production as defined by certification schemes. *Global Environmental Change* 60, 102025. https://doi.org/10.1016/j.gloenvcha.2019.102025

Peano C., Merlino, V.M., Sottile, F., Borra, D., Massaglia, S. (2019): Sustainability for Food Consumers: Which Perception? *Sustainability* 11 (21), 5955. https://doi.org/10.3390/su11215955

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

Randler, C., Adan, A., Antofie, M.-M., Arrona-Palacios, A., Candido, M., Boeve-de Pauw, J., Chandrakar, P., Demirhan, E., Detsis, V., Di Milia, L., et al. (2021a): Animal Welfare Attitudes: Effects of Gender and Diet in University Samples from 22 Countries. *Animals* 11 (7), 1893. https://doi.org/10.3390/ani11071893

Randler, C., Ballouard, J.M., Bonnet, X., Chandrakar, P., Pati, A.K, Medina-Jerez, W., Pande, B., Sahu, S. (2021b): Attitudes Toward Animal Welfare Among Adolescents from Colombia, France, Germany, and India. *Anthrozoös* 34 (3), 359–374. https://doi.org/10.1080/08927936.2021.1898212

Richter, I.G., Klöckner, C.A. (2017): The Psychology of Sustainable Seafood Consumption: A Comprehensive Approach. *Foods* 6 (10), 86. https://doi.org/10.3390/foods6100086

Risius, A., Janssen, M., Hamm, U. (2017): Consumer preferences for sustainable aquaculture products: Evidence from in-depth interviews, think aloud protocols and choice experiments. *Apettite* 113, 246-254. https://doi.org/10.1016/j.appet.2017.02.021

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

Stancu, V., Brunsø, K., Krystallis, A., Guerrero, L., Cruz, E.S., Peral, I. (2022): European consumer segments with a high potential for accepting new innovative fish products based on their food-related lifestyle. *Food Quality and Preference* 99, 104560. https://doi.org/10.1016/j.foodqual.2022.104560

Su, C.-H., Tsai, C.-H., Chen, M.-H., Lv, W.Q. (2019): U.S. Sustainable Food Market Generation Z Consumer Segments. *Sustainability* 11 (13), 3607. https://doi.org/10.3390/su11133607

Tomić, M., Kovačićek, T., Matulić, D. (2016a): Attitudes as basis for segmenting Croatian fresh fish consumers. *New Medit* 15 (4), 63-71.

Tomić, M., Matulić, D., Jelić, M. (2016b): What determines fresh fish consumption in Croatia? *Appetite* 106, 13-22. https://doi.org/10.1016/j.appet.2015.12.019

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

Troell, M., Costa-Pierce, B., Stead, S., Cottrell, R.S., Brugere, C., Farmery, A.K., Little, D.C., Strand, Å., Pullin, R., Soto, D., et al. (2023): Perspectives on aquaculture's contribution to the Sustainable Development Goals for improved human and planetary health. *Journal of the World Aquaculture Society* 54 (2), 251-342. https://doi.org/10.1111/jwas.12946

UN (2015): Transforming our world: the 2030 Agenda for sustainable development. https://sdgs.un.org/2030agenda

van Bussel, L.M., Kuijsten, A., Mars, M., van 't Veer, P. (2022): Consumers' perceptions on food-related sustainability: A systematic review. *Journal of Cleaner Production* 341, 130904. https://doi.org/10.1016/j.jclepro.2022.130904

Wongprawmas, R., Sogaria, G., Gai, F., Parisi, G., Menozzi, D., Mora, C. (2022): How information influences consumers' perception and purchasing intention for farmed and wild fish. *Aquaculture* 547, 737504. https://doi.org/10.1016/j.aquaculture.2021.737504

Yi, S. (2019): Determinants of consumers´ purchasing behaviour for certified aquaculture products in South Korea. *Sustainability* 11 (14), 3840. https://doi.org/10.3390/su11143840

Zander, K., Feucht, Y. (2018): Consumers' Willingness to Pay for Sustainable Seafood Made in Europe. *Journal of International Food & Agribusiness Marketing* 30 (3), 251-275. https://doi.org/10.1080/08974438.2017.1413611