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Fish consumption and *Anisakis* risk: An exploratory study of Sicilian consumer awareness

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ABSTRACT

The presence of *Anisakis* parasites in fish products represents a critical challenge for both public health and the aquaculture sector, with significant implications for market dynamics and consumer trust. This paper investigates the influence of *Anisakis*-related risks on consumer behavior, particularly in relation to food safety perceptions, nutritional quality, and economic factors such as willingness to pay for parasite-free products. Using a mixed methods approach, the study highlights gaps in knowledge regarding food safety measures and their implications for consumer confidence and purchase decisions. The findings demonstrate an increasing demand for high-quality, convenient fish products with transparent labelling that address both safety and sustainability. The findings highlight the importance of improving education and marketing strategies to promote informed choices, thereby supporting both public health and economic sustainability in the seafood industry. This study provides actionable insights to support sustainable growth in the seafood industry by aligning public health priorities with market demands

1. Introduction

The presence of parasites in fish products, particularly nematodes from the Anisakidae family, poses a serious threat to consumer health, leading to diseases such as anisakidosis (Shamsi, 2019; Garcia-Sanchez et al., 2024). According to a recent global review, over 762 cases of anisakidosis were documented between 1965 and 2022 across 34 countries, demonstrating that this is not only a Japanese or Mediterranean concern, but a widespread, emerging zoonotic threat (Shamsi & Barton, 2023).

This issue is further amplified by the importance of international fish trade and the growing global demand for fish products, a trend already noted by Chai et al. (2005) and further supported by recent analyses highlighting the role of aquaculture, demographic shifts, and global food security concerns (Boyd et al., 2022; Campanati et al., 2022; Falcon et al., 2022; Cooney et al., 2023). In this context, Williams et al. (2020a, 2020b, 2020c) have also emphasized how fish trade dynamics, including illegal and unregulated practices, may amplify the risks associated with zoonotic parasites, particularly in under-monitored supply chains (Williams et al., 2020a; 2020b; 2020c).

More recently, Williams et al. (2022) identified zoonotic parasites in imported freshwater fish, pointing to recurring non-compliance with inspection standards, which further illustrates the public health risks arising from insufficient regulatory control in global seafood trade.

Anisakiasis, a parasitic disease contracted by consuming fish contaminated with third-stage larvae of *Anisakis* spp., has become an increasing concern. Humans, as incidental hosts, can develop the infection by ingesting raw or undercooked fish containing live larvae. In addition to gastrointestinal symptoms, there is growing evidence of allergic reactions, particularly linked to elevated immunoglobulin E (IgE) levels (Audicana & Kennedy, 2008; Fruscione et al., 2024; Adroher et al., 2024; Dinas et al., 2024; Nonković et al., 2025). Prior to 2010, over 20,000 cases of anisakiasis have been reported globally, with over 90 % originating from Japan, where it is predicted that approximately 2000 cases are recognized annually (EFSA and Biohaz, 2010). Recently, the yearly incidence of anisakiasis patients in Spain has been calculated

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to be around 8000 (Bao et al., 2017). The European Food Safety Authority (EFSA) has identified *Anisakis simplex* as the main fish parasite responsible for allergic reactions, requiring live larvae to trigger these responses (EFSA and Biohaz, 2010). Recent studies, however, suggest that even non-viable larvae may pose a food safety risk by acting as potent allergens, contributing to Type I hypersensitivity reactions (Daschner et al., 2012; Baird et al., 2014; Heffler et al., 2016). These reactions have been reported not only from consuming cooked or frozen fish but also through contact or inhalation. *Anisakis* nematodes are thread-like parasites with a circular cross-section, their length varying from a few millimeters to several centimeters (Marty, 2008; Klimpel et al., 2019). The clinical symptoms of anisakiasis, or anisakidosis, include severe abdominal pain, nausea, vomiting, and diarrhea, often mistaken for other gastrointestinal disorders such as gastric ulcers or appendicitis (Pozio, 2005; Cong & Elsheikha, 2021; Cavallero et al., 2022). Recent studies have expanded this clinical picture, highlighting variability depending on the larval location and host immune response, and have reported both typical gastrointestinal symptoms and allergic reactions, including anaphylaxis (Baron et al., 2014; Cong & Elsheikha, 2021; Lam et al., 2024; Nonković et al., 2025)

Moreover, *Anisakis* larvae have been found not only in the gastrointestinal tract but also in atypical sites such as the lungs, tonsils, or peritoneum, underlining the complexity and systemic nature of the infection in certain patients (Shamsi & Barton, 2023).

Although nematode larvae in fish had been observed historically, the first well-documented association between gastrointestinal symptoms in humans and *Anisakis* spp. was made in the Netherlands in the 1950s by Dr. Straub, who observed acute abdominal colics in patients after consuming lightly salted herring. This association was later confirmed in the 1960s by Van Thiel, who identified third-stage larvae in the patients' digestive tract. (Van Thiel, 1962; Kołodziejczyk et al., 2020; Adroher et al., 2024).

The highest incidence of anisakiasis is reported in Japan, with 2000 to 3000 cases annually, mostly due to the consumption of contaminated sushi and sashimi (Yorimitsu et al., 2013). To prevent anisakiasis, effective preventive measures and consumer education about the risks of consuming raw fish are essential (Pravettoni et al., 2012). Eliminating or inactivating *Anisakis* larvae can be achieved through immediate evisceration of freshly caught fish, freezing, or cooking the fish before consumption (Acha & Szyfres, 1987; Abollo et al., 2001; Valero et al., 2006; Buchmann & Mehrdana, 2016). Immediate evisceration is critical, as *Anisakis* larvae primarily inhabit the viscera of fish and can migrate into muscle tissue after the fish's death (Acha & Szyfres, 1987; Abollo et al., 2001; Bao et al., 2017). Freezing seafood products is a key step to ensure food safety. Raw fish or fish subjected to marinating, salting, or smoking must be frozen at −20°C for at least 24 h, or alternatively, at −35°C for at least 15 h (Sakanari & Mckerrow, 1989; Audicana et al., 2002). Studies indicate that treatments like marinating and salting alone are not sufficient to kill the larvae, making freezing a crucial complementary measure (Buchmann & Mehrdana, 2016). Finally, thermal treatment at a core temperature of at least 60°C for one minute, or preferably 70°C, is effective in killing *Anisakis* larvae, further reducing the risk of infection when consuming cooked fish (Buchmann & Mehrdana, 2016). In this context, *Anisakis* parasites in fisheries products can substantially reduce their marketability and economic value owing to food safety and quality issues. The losing of trust may result in decreased demand, thus impacting sales and profitability in the fishing and fish processing businesses. Research demonstrates that the economic impact on fish processors and the wider fishing sector is considerable (Llarena-Reino et al., 2015). These economic losses, resulting from declined customer demand and amplified processing costs, will probably reach several million dollars (Llarena-Reino et al., 2015). This financial burden highlights the necessity of mitigating *Anisakis* contamination in order to protect the economic stability of the fishing industry, preserve consumer trust, and guarantee food safety. Regarding the preferences of today's consumers, it has been seen in some studies (Liu & Grunert, 2020; López-Mas et al., 2021; Kovács et al., 2022; Modica et al., 2023) that they are constantly looking for food characteristics related to safety, quality and freshness. In fact, as far as food safety is concerned, they look for fish that does not cause any health risk. Another fundamental aspect is the provenance of the raw material, certainly clear labels on the origin and with accurate information on the various steps the fish has taken increase consumer confidence by counteracting information asymmetry phenomena that generally occur between producers and consumers (Akerlof, 1978; Bacarella et al., 2015).To contextualize consumer attitudes, Bao et al. (2018) found that 77 % of respondents were willing to pay around 10 % more for fish free from *Anisakis* and its allergens. In this study, we further explore Sicilian consumers' awareness, perceptions, and socio-economic factors influencing their willingness to pay for *Anisakis*-free products.

2. European and Italian framework on fish consumption and regulations

According to the Council for Agricultural Research and Agricultural Economy Analysis - Policies and Bioeconomy (CREA - PB, 2020), the COVID-19 pandemic significantly disrupted lifestyles and consumption patterns, particularly in Europe and low-income countries. Quarantine measures, mobility restrictions, and economic hardship reshaped the demand for fish products, which are a vital protein source in many diets. During the early phase of the pandemic, retail data indicated a 30 % surge in demand for non-perishable fish products such as canned and frozen items, while demand for fresh fish dropped by 20 % (CREA - PB, 2020). These shifts were largely driven by stockpiling behavior and a preference for long-shelf-life products amid uncertainty.

Between March and April 2020, the overall demand for fish and seafood declined by 40 %, primarily due to the shutdown of the Ho.Re.Ca. sector (Hotels, Restaurants, Catering), which plays a major role in fish consumption. This contraction led to price drops of up to 25 % for several species (ISMEA, 2020a). However, demand and prices began to stabilize as restrictions eased from May onwards. Social distancing requirements at fish markets further reduced foot traffic and income, particularly affecting small-scale vendors. Meanwhile, household consumption of frozen fish increased by 25 %, and alternative sales methods—such as home delivery and online purchases—rose by 35 %, indicating a shift in consumer behavior that may persist and positively influence traceability and support for local seafood products (ISMEA, 2020b, 2023).

In Italy, although the closure of restaurants, the decline in tourism, and reduced local markets posed challenges, the agri-food sector demonstrated relative resilience. In the first quarter of 2020, household food expenditure rose by 7 %, with a notable increase in the purchase of durable goods including pasta, rice, canned fish (+11.9 %), and frozen fish (+20.8 %), while the demand for fresh fish declined by 6.1 % (ISMEA, 2020a). These trends underscored a widespread consumer shift toward convenience and food security during crisis periods.

Recent data from the EU Fish Market Report – 2023 further supports these patterns. According to the European Market Observatory for Fisheries and Aquaculture Products (EUMOFA), Italy ranked second in the EU in 2022 in total consumption of frozen fish and seafood, with over 130,000 tonnes sold and a per capita intake of more than 2 kg. For refrigerated fish products, Italy held third place with 36,000 tonnes, representing 9 % of the EU total. This reflects a continuing preference for processed and long-lasting seafood products among Italian consumers, consolidating a trend first observed during the pandemic period (EUMOFA, 2023).

By the way, to better understand fish consumption trends and their underlying drivers, it is essential to analyze them within broader socio-economic and cultural contexts, which can significantly influence consumer behavior across different regions.

These consumption behaviors occur in a regulatory environment that ensures high food safety standards. Italy's Circular No. 10/1992

recommends the prompt evisceration of fish over 18 cm in length. Legislative Decree No. 531/1992 mandates visual inspections and freezing of raw fish at −20°C for at least 24 h to prevent parasitic infections. At the EU level, Regulation (EC) No. 853/2004 strengthens the responsibilities of Food Business Operators (FBOs) by enforcing strict hygiene requirements and mandatory freezing protocols. Regulation (EC) No. 2074/2005 extends visual inspections to retail outlets, while Regulation (EC) No. 882/2004 establishes risk-based official controls, periodic inspections, and sampling procedures. Products that fail to comply with these regulations are deemed unfit for human consumption.

2.1. Literature review on fish consumption and risk perception with a focus on Europe and the Mediterranean region

This section examines existing studies on fish consumption patterns, consumer perceptions of food safety, and awareness of parasitic risks—particularly *Anisakis*—within a European and Mediterranean context. The focus is on understanding how socio-economic, environmental, and health-related factors shape consumer behavior, with particular attention to regional variations in knowledge and attitudes that may influence purchasing decisions and risk mitigation practices. The Mediterranean region, including Italy, plays a significant role in seafood trade, acting both as an importer and re-exporter. This trade dynamic may influence the risk of zoonotic parasites, as suggested in broader reviews on seafood substitution and traceability issues (Williams et al., 2020b).

The analysis of fish consumption increasingly considers its socio-economic and environmental implications. While increased fish consumption is beneficial for public health, it also raises concerns about the overexploitation of fish stocks and the damage to marine ecosystems (Golden et al., 2022). In response, consumers have become more attentive to the environmental impact of production processes, leading to the growth of certified and branded fish products emphasizing sustainability and traceability (Maesano et al., 2020; Cancellieri et al., 2023). The rise in demand for sustainable fish products has been fueled by growing consumer awareness of the environmental consequences of intensive fishing. Labels certifying sustainability and product quality are now essential tools in reducing information asymmetry between producers and consumers, providing transparency about not only the intrinsic qualities of the fish but also extrinsic factors such as origin and capture methods (Asioli et al., 2020; Mercken et al., 2020). These labels help consumers make more informed decisions about the fish they purchase (Bao et al., 2018; Maesano et al., 2020; Rodríguez-Salvador, 2021; Saidi et al., 2022). Local consumption patterns also play a significant role in shaping consumer behavior. Local fish products are often perceived as fresher, safer, and more sustainable compared to imported options, a perception linked to the typicity of fish and its geographical origin (Hoque et al., 2022; Onozaka et al., 2023). Consumers also tend to associate local fish with lower environmental impact due to the use of sustainable fishing practices (Autzen & Hegland, 2021; Cancellieri et al., 2023). However, the fishery sector faces challenges related to consumer perception. While some consumers demand more information about sustainability and origin, others struggle to evaluate these factors due to the complexity of the fish market. In addition, recent reviews have warned that vulnerabilities in the seafood supply chain, such as species substitution and insufficient traceability, may lead to underestimated exposure to parasitic risks (Williams et al., 2020a; 2020b; 2020c).

Perceived difficulties in preparing fish and its cost further limit purchase intentions, especially among lower-income consumers (Trondsen et al., 2004; Verbeke & Vackier, 2005; Afaishat et al., 2023). Fish is widely regarded as a healthy food choice, with health-conscious consumers more likely to include it in their diet (Pieniak et al., 2010; Thorsdottir et al., 2012; Smith et al., 2017). Nonetheless, concerns over parasites like *Anisakis* have introduced new doubts about the safety of fish products, particularly raw or undercooked fish (Bao et al., 2019; Golden et al., 2022).

Although extensive research has been conducted on the biological and zoonotic risks posed by *Anisakis*, there remains a lack of studies focusing on consumer perceptions of this parasite and how such perceptions influence their buying and consumption habits (Cancellieri et al., 2023; Golden et al., 2023). For example, demographic factors like age, education, and regional consumption habits may affect risk perceptions, but these aspects are underexplored (Bao et al., 2018). Moreover, there is a gap in research on how well public health campaigns inform consumers about effective preventive measures, such as freezing fish to mitigate the risk of anisakiasis. Allergic reactions caused by *Anisakis* are well-documented (Gay & Verrez-Bagnis, 2023), but few studies explore how consumer awareness of these risks impacts their purchasing decisions. For instance, as demonstrated by Verbeke et al. (2005), there are some risks that impact on consumer purchasing decisions on fish consumption such as contamination concerns, the balance of health risks versus nutritional benefits, the psychological effects of information presentation, trust in information sources, demographic differences, and cultural and economic influences. First of all, contamination concerns in fish, such as heavy metals, PCBs, and dioxins, can lead to consumers avoiding or limit their consumption. The perception that harmful substances in fish outweigh the health benefits of nutrients like omega-3 fatty acids creates a conflict in consumer decision-making. Second, the psychological impact of information on food safety can significantly influence consumer perceptions, with adverse news having a stronger impact on decisions than positive news. Especially, trust in information sources is important, as consumers may be more likely to consider the health benefits of fish if they perceive it as credible and reliable. Third, different demographic groups may respond differently to risk perceptions, with younger consumers being more influenced by safety concerns and conflicting information. Additionally, the influence of psychosocial factors, such as trust in food safety authorities and media, on consumer behavior remains insufficiently studied (Bao et al., 2019). Finally, further research is needed to evaluate the effectiveness of legislation and safety measures aimed at controlling *Anisakis* in fish products, especially in terms of improving risk communication without eroding consumer trust in seafood (Cancellieri et al., 2023).

3. Methodology

In this study, a quantitative method was used to examine Sicilian consumers' awareness and opinions regarding the risks associated with *Anisakis* in fish consumption. Variables related to fish consumption habits, risk perception, socio-demographic characteristics, and knowledge of parasitic contamination prevention methods were all included in the research instrument, which was a structured questionnaire.

Between January and March 2023, a convenience sample of people living in Sicily was distributed the questionnaire. In total, 676 valid responses were collected. Together with Likert-scale formats and closed-ended multiple-choice questions, the application allowed the collection of standardized responses suitable for statistical analysis. The data were analyzed using descriptive statistics to summarize the demographic characteristics and consumption behaviors of the sample. Frequencies and percentages were used for categorical variables, while means and standard deviations were reported for continuous variables and Likert scale items. In addition, a reliability analysis was conducted using Cronbach's alpha to assess the internal consistency of the items related to factors that influence fish purchasing decisions.

Additionally, Pearson correlation analysis was used to examine the interrelationships between key variables such as fish origin, traceability, nutritional values and perceived freshness. This allowed us to identify significant patterns in consumer perceptions, providing insights into the factors that most influence purchasing behavior.

All statistical analyses were conducted using standard statistical software, ensuring the robustness and replicability of the results. The research was completed in compliance with ethical standards and

participants provided informed consent before completing the survey.

3.1. Data description and summary statistics

The sample consisted of 676 participants,[1] providing insights into socio-demographics features (Table 1), fish consumption behaviors, and *Anisakis* awareness levels.

In terms of gender, participants were almost evenly split, with males comprising 51.04 % and females 48.96 %. The age distribution indicated that the largest group was between 21 and 30 years old (32.69 %), followed by those aged 51–70 years (22.49 %), and the smallest representation was from participants over 70 years (3.40 %). This spread provided a well-rounded age representation within the sample. City size showed that half of the participants (50.00 %) lived in medium-sized cities (5001-250,000 inhabitants), with smaller percentages in large cities (35.06 %) and small towns (14.94 %), suggesting that fish consumption perspectives may be influenced by both urban and rural backgrounds.

Regarding education level, the majority had a high school diploma (41.12 %), followed by individuals with a Master's (22.49 %) or Bachelor's degree (19.23 %). This distribution suggests that a well-educated population participated, possibly influencing awareness of nutrition and sustainability. Family status indicated that most participants were single or unmarried (55.77 %), with a significant portion married (36.24 %). Household size varied, with four-member households being most common (39.50 %), which could correlate with larger consumption patterns. Turning to fish consumption behaviors (Table 2), 97.78 % of respondents reported eating fish. The majority preferred purchasing fish from fishmongers (63.46 %), with fewer opting for supermarkets (19.38 %) or street vendors (17.16 %). When asked about the proportion of fresh fish in their diet, 29.73 % of participants reported consuming more than 60 % fresh fish, while 10.95 % consumed less than 10 %, suggesting diverse access and preferences for fresh seafood.

Frequency of fish consumption varied, with 38.61 % eating fish once per week, and 30.62 % eating it more than once per week, indicating a generally high consumption rate. However, processed fish products were consumed less frequently, with 51.18 % of respondents consuming these once per month. Most participants reported consuming fish portions between 100 and 200 g (59.62 %), while only 6.21 % consumed portions over 300 g, suggesting moderate portion sizes on average. Monthly spending on fish indicated that 32.25 % of respondents spent between 25 and 49 euros, with smaller proportions spending either above or below this range. In terms of source preference, 70.71 % of participants reported checking if seafood products were locally sourced, indicating significant awareness or preference for local products.

Influential factors in purchasing varied. The origin of the fish was rated influential by 53.46 % of respondents, with other key factors including traceability (55.99 %), farming methods (46.94 %), nutritional values (41.42 %), and environmental impact (36.83 %). Raw vs. well-cooked consumption preferences revealed that most participants preferred cooked fish due to concerns about parasites, reflecting a strong

Table 1
Socio-demographic features of the sample (n = 676, %)".

Variable	Levels	N	%
Gender	Female	331	48.96
	Male	345	51.04
Age	16–20	92	13.61
	21–30	221	32.69
	31–40	99	14.64
	41–50	89	13.17
	51–70	152	22.49
	Over 70	23	3.40
City Size	Large (>250,000 inhabitants)	237	35.06
	Medium (5001 to 250,000 inhabitants)	338	50.00
	Small (up to 5000 inhabitants)	101	14.94
Education level	High School Diploma	278	41.12
	Master's Degree	152	22.49
	Master's or Doctorate	84	12.43
	Secondary School Diploma	32	4.73
	Bachelor's Degree	130	19.23
Family status	Married	245	36.24
	Separated	36	5.33
	Single/Unmarried	377	55.77
	Widower	18	2.66
Number of family members	1	68	10.06
	2	81	11.98
	3	147	21.75
	4	267	39.50
	More than 4	113	16.72
Occupation	Housewife	4	0.59
	Employee	237	35.06
	Freelancer	104	15.38
	Retired	38	5.62
	Student	272	40.24
	Unemployed, looking for work	21	3.11

Table 2
Consumption habits and purchasing patterns of fish of the sample (n°=676, %).

Variable	Level	N	%
Do you eat fish?	No	15	2.22
	Yes	661	97.78
Where do you buy fish?	Fishmonger	429	63.46
	Street vendor (mobile stall)	116	17.16
	Supermarket	131	19.38
What percentage of fresh fish?	10 %−20 %	115	17.01
	21 %−40 %	128	18.93
	41 %−60 %	158	23.37
	Less than 10 %	74	10.95
	More than 60 %	201	29.73
How often do you eat fish?	1 time a month	62	9.17
	1 time a week	261	38.61
	1 time every two weeks	146	21.60
	More than 1 time a week	207	30.62
How often do you eat processed fish products?	1 time a month	346	51.18
	1 time a week	119	17.60
	1 time every two weeks	160	23.67
	More than 1 time a week	51	7.54
What is the usual weight of the fish portion you consume?	100–200 g	403	59.62
	200–300 g	153	22.63
	less than 100 g	78	11.54
	More than 300 g	42	6.21
Among the different categories, which one do you consume most frequently?	Bivalve molluscs (mussels, clams, etc.)	71	10.50
	Cephalopod molluscs (octopus, cuttlefish, etc.)	88	13.02
	Fish slices	166	24.56
	Prepared/processed (canned goods, marinated, etc.)	107	15.83
	Whole fish with bone	244	36.09
How much do you spend on average monthly for fish purchases?	0–24 €	139	20.56
	25–49 €	218	32.25
	50–74 €	146	21.60
	75–99 €	105	15.53
	Greater than or equal to 100 €	68	10.06
When purchasing seafood products, do you check if they are locally sourced?	Yes	478	70.71
	No	198	29.29

[1] This study was conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments. Ethical approval was not required according to the guidelines of the University of Palermo, as the survey involved anonymous responses, posed no risk to participants, and did not collect any sensitive personal data. Participation was entirely voluntary, and informed consent was obtained from all respondents prior to data collection. No identifying information was recorded or stored.

awareness of food safety.

Finally, awareness of *Anisakis* larvae showed some knowledge gaps (Table 3). Despite a high percentage of consumers understand the importance of eating cooked fish instead of raw to prevent the main biological hazards (Variable 1; 69.97 %), there is a significant percentage of interviewees (37 %) that erroneously consider also the freezing of raw fish able to inactivate parasite, bacteria and virus. Furthermore, the 29.73 % of respondents don't know the importance of freezing in prevention of parasitological hazards. Some knowledge gaps concern the morphology of parasites and its localization in fish: more than 50 % of respondents don't know the aspect of *Anisakis* larvae as well as the precise localisations. Finally, high percentages of respondents are not able to identify fishery products more dangerous for *Anisakis*. Particularly, concerning fresh fish, despite Sword fish or Tuna could be infected with *Anisakis* larvae, its presence in muscle it is very unlikely since the migration of larvae from gut to muscle after the harvest is very slow in these species while the presence of *Anisakis* larvae in Mackerel muscle and serosae of celomatic cavity is often observed. Moreover, only the 30.03 % of interviewees recognize "marinated anchovies (never frozen)" as most dangerous for *Anisakis* risk.

Table 3
Awareness and behavior towards risks associated with raw fish and *anisakis* larvae.

Variable	Levels	N	%
Consuming raw fish instead of well-cooked fish can cause gastroenteric diseases in humans	Yes, but only due to the potential presence of *Anisakis* larvae	86	12.72
	Yes, but only if the fish is not fresh	117	17.31
	Yes, due to the potential presence of Anisakis larvae, pathogen bacteria and virus	473	69.97
If you want to order a Tuna Tartare at the restaurant and notice an asterisk (indicating "defrosted product") next to the specific item on the menu, do you think that:	I am safer because freezing can inactivate the *Anisakis* larvae	219	32.40
	I am safer because freezing can inactivate the *Anisakis* larvae as well as pathogen bacteria and virus	256	37.87
	I think the product is of lower quality and no longer safe	201	29.73
***Anisakis* larvae are**	I don't know how to give an answer to this	133	19.67
	Nodular parasites the size of a hazelnut	82	12.13
	Parasites measuring between 10 and 20 millimeters	316	46.75
	Parasites not visible to the naked eye	145	21.45
***Anisakis* larvae are found**	Exclusively in fish muscles	92	13.61
	Exclusively located inside and outside the fish's gut	94	13.91
	I don't know how to give an answer to this	174	25.74
	Mainly located inside and outside the fish's gut	316	46.75
Concerning the potential ingestion of live *Anisakis* larvae, which of the following fish could be the most dangerous	I don't know how to give an answer to this	156	23.08
	Mackerel (never frozen and eaten raw)	136	20.12
	Swordfish (never frozen and eaten raw)	86	12.72
	Tuna (never frozen and eaten raw)	298	44.08
Concerning the potential ingestion of live *Anisakis* larvae, which of the following seafood product could be the most dangerous	Canned tuna	36	5.33
	I don't know how to give an answer to this	157	23.22
	Marinated anchovies (never frozen)	203	30.03
	Salted anchovies (never frozen)	56	8.28
	Smoked salmon (never frozen) obtained by reared fish	102	15.09
	Surimi	122	18.05

4. Results

An overview of consumer items regarding factors influencing fish purchase decisions (Table 4). It summarizes the data by displaying the distribution of responses across predefined categories (Strongly Disagree/Disagree, Neutral, Agree/Strongly Agree) and includes central tendency measures (mean) and variability measures (standard deviation, SD) for each factor.

- Mean Score: Indicates the average level of agreement with each factor's importance on a 4-point scale, reflecting the general trend in consumer opinions.
- Standard Deviation: Reflects the variability or dispersion of responses, showing how consistently participants rated each factor.

The highest mean score was observed for Freshness Requirements (Mean = 2.82, SD = 1.14), indicating that consumers consider freshness the most important factor. This was followed by Traceability (Mean = 2.41, SD = 1.13) and Fish Origin (Mean = 2.32, SD = 1.18), suggesting that these attributes are also significant in shaping purchasing decisions. Lower mean scores were recorded for Nutritional Values (Mean = 2.23, SD = 1.14), Farming or Slaughtering Method (Mean = 2.15, SD = 1.19), and Environmental Issues (Mean = 2.13, SD = 1.16), indicating that these factors are comparatively less influential.

A reliability test was performed on the six variables to assess internal consistency. The Cronbach's alpha for the scale was **0.9035**, demonstrating excellent reliability. This high value indicates that the variables are strongly related and measure a consistent construct regarding consumer attitudes toward fish purchases.

4.1. Correlation analysis

The correlation matrix (Table 5) highlights significant positive relationships between the variables:

The strongest correlation was observed between Fish Origin and Traceability (r = 0.76), highlighting that consumers associate these two factors closely. Moderate correlations were found between Environmental Aspects and variables like Nutritional Values (r = 0.63) and Farming Method (r = 0.61), indicating that sustainability concerns are

Table 4
Consumer items about fish (n = 676, %), mean score and standard deviation (SD) on 5-point scale[a]".

How much does the knowledge of the following information influence your fish purchase?	Strong Dis/ Disagree	Neutral	Agree/ Strongly Agree	Mean	SD
Fish Origin	167	222	287	2.32	1.811
	24,7	32,8	42,5		
Traceability	142	231	303	2.40	1.129
	21,0	34,2	44,8		
Farming Method	210	212	254	2.14	1.186
	31,07	31,36	37,57		
Refrigerated Fish	85	181	410	2.81	1.139
	12,57	26,78	60,65		
Nutritional Values	181	215	280	2.23	1.140
	26,78	31,80	41,42		
Enviromental aspects (sustanaibility etc)	205	222	249	2.12	1.160
	30,33	32,84	36,83		

[a] Categories 'strongly disagree' and 'disagree', and 'agree' and 'strongly agree', from the initial 5-point scale have been merged for clarity of presentation; The Likert scale used ranges from 0 to 4, where 0 indicates "Strongly disagree," 1 indicates "Disagree," 2 indicates "Neutral," 3 indicates "Agree," and 4 indicates "Strongly agree." Statistical analyses (Mean and Standard Deviation) as reported in the text have been performed with the original 5-point scale data.

Table 5
Correlation matrix of key items related to fish consumption[a]".

Variable	Fishorigin	Traceability	Farming method	Freshness	Nutritional values	Environmental aspects
Fishorigin	**1**	0.7577	0.6866	0.6138	0.5242	0.5467
Traceability	0.7577	**1**	0.6965	0.6768	0.5331	0.6031
Farming method	0.6866	0.6965	**1**	0.5845	0.5384	0.6064
Freshness	0.6138	0.6768	0.5845	**1**	0.5555	0.5922
Nutritional values	0.5242	0.5331	0.5384	0.5555	**1**	0.6275
Environmental aspects	0.5467	0.6031	0.6064	0.5922	0.6275	**1**

[a] The internal consistency of the items was evaluated using **Cronbach's alpha (α)**, which yielded a value of **0.9035**, indicating "excellent reliability".

moderately related to health and production methods. Freshness "Requirements" showed moderate correlations with all other variables, particularly Traceability (r = 0.68). These results suggest a significant interplay among the factors, with Freshness Requirements and Traceability standing out as the most influential aspects of consumer decision-making.

5. Discussion

The findings of this study offer significant insights into consumer behavior regarding fish consumption and the perception of *Anisakis*-related risks, particularly in a regional context such as Sicily, where fish represents a culturally and nutritionally important component of the diet. The results reveal both a high frequency of fish consumption and a substantial preference for fresh, locally sourced products, which reflects broader Mediterranean dietary patterns. These consumption trends are consistent with those observed in previous studies highlighting the value placed by consumers on freshness, origin, and traceability (Ingrassia et al., 2017; López-Mas et al., 2021; Modica et al., 2023).

One of the most noteworthy contributions of this study lies in its detailed exploration of consumer knowledge gaps related to *Anisakis*. Despite general awareness of the need to cook fish to prevent parasitic infections, misconceptions persist—particularly regarding the role of freezing in eliminating biological hazards. For instance, a significant proportion of respondents erroneously believed that freezing can inactivate not only *Anisakis* larvae but also bacteria and viruses, or alternatively, questioned the safety of frozen products altogether. These findings underscore the need for more effective public health communication strategies, as well as clearer and more accessible labelling practices, a point also raised by Cancellieri et al. (2023) and Bao et al. (2019).

Moreover, the study identifies freshness and refrigeration as the most influential factors in purchasing decisions, surpassing even sustainability concerns or farming methods. This suggests a hierarchy of consumer priorities where immediate food safety cues take precedence over longer-term environmental attributes. Such preferences align with the risk-averse behavior seen in contexts where foodborne illnesses are perceived as plausible threats (Verbeke & Vackier, 2005). The strong correlation between traceability and origin further supports the notion that consumers interpret these attributes as intertwined indicators of product reliability.

Importantly, the statistical analysis conducted—including a high Cronbach's alpha (0.9035) and consistent correlation patterns—confirms the internal coherence of the attitudinal constructs measured. This methodological robustness allows the study to contribute not only descriptive insights but also analytical value to the literature on seafood consumption and zoonotic risk perception.

This study also adds to the limited empirical research focusing on the Italian consumer context, particularly in southern regions where dietary customs and seafood availability differ from northern or international patterns. While previous work has largely concentrated on northern European markets (e.g., Bao et al., 2018; Golden et al., 2022), this paper fills a gap by documenting awareness levels and behavioral intentions in a Mediterranean population that is both highly exposed to fish products and at potential risk for anisakiasis.

Finally, by identifying the disconnect between actual risk factors and perceived safety measures, this research highlights the critical need for integrated interventions that combine education, regulation, and transparent labelling to mitigate zoonotic risks without undermining consumer trust in fish products. In this sense, the findings support recent calls for interdisciplinary approaches to food safety that balance public health imperatives with economic and cultural dimensions of consumption (Gay & Verrez-Bagnis, 2023).

The results invite further reflection on the level of awareness among healthcare professionals, in particularly general practitioners and emergency physicians, regarding the diagnosis and clinical management of anisakiasis. The infection remains underdiagnosed in non-endemic areas because medical personnel receive limited training and show low clinical suspicion. Seal et al. (2020) reported widespread unawareness of seafood-borne parasitic diseases among Australian doctors, while Shamsi (2020) pointed out that medical and veterinary training lacks formal diagnostic protocols and insufficient integration of parasitology during medical and veterinary education. More broadly, Bradbury et al. (2022) highlighted the global decline in morphological diagnostic skills, warning of its implications for accurate surveillance and response to parasitic infections. This demonstrates the immediate need for One Health programmes that strengthen parasitology and food safety education in medical, veterinary and public health education (Shamsi, 2019).

6. Conclusions

Analyzing the complex link between fish consumption patterns and consumer purchasing behavior offers vital insight into the determinants of dietary choices and market dynamics. There is a strong preference for fresh fish purchased from local fishmongers, suggesting that consumers value quality and freshness. Fish represents a fundamental component of the daily diet, especially among younger generations who prefer 200–300 g portions suitable for a balanced diet. Additionally, from most of the samples examined, there is an indication of the emergence of consumer segments willing to invest higher amounts for the purchase of fish, likely in relation to the search for superior quality or premium products. The preference for fish fillets over mollusks, cephalopods, and processed products highlights the inclination towards practical and quick-to-prepare foods, the so-called time-saving products. For example, in the case of pre-marinated and portioned fish fillets, it represents an excellent compromise for consumers who need to reduce the time spent on meal preparation without compromising on quality and freshness. From an economic perspective, they increasingly meet the growing demand for practical solutions and can be sold at a premium price, generating higher margins compared to traditional products. This would enhance food safety and boost consumer trust in seafood eating. Regarding the factors that influence consumers' purchasing decisions, such as the origin of the fish, traceability, and nutritional values, they emerge as elements of moderate relevance, reflecting an increasingly growing trend towards quality and food safety. However, the most impactful aspect for purchasing choices seems to be the refrigeration of the product, indicative of a preference for fresh and well-preserved fish, an aspect associated with trust in the distribution chain. Moreover, aspects such as environmental sustainability and production methods show a

less pronounced influence compared to other factors. This highlights that these latter aspects have a lower priority for the consumer compared to more immediate factors, such as freshness, origin, and traceability. In addition, the correlation matrix and Cronbach's alpha value provide significant information on the economic importance and consistency of the key aspects related to fish consumption. The strong correlations between variables such as traceability, fish origin, and farming methods indicate that consumers perceive these factors as closely interconnected. This suggests that improvements in one of these aspects can potentially positively influence the overall perception of consumers, with positive economic repercussions for the fish supply chains that invest in transparency and quality.

Finally, this paper has provided interesting insights into fish consumption habits, highlighting the key items that customers take into consideration related to the process of purchasing behavior.

CRediT authorship contribution statement

Caterina Sciortino: Visualization, Validation, Supervision, Software, Methodology, Investigation, Conceptualization. **Giusi Giamporcaro:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Data curation, Conceptualization. **Filippo Sgroi:** Visualization, Validation, Supervision. **Salvatore Costantino:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation. **Alessandro Giuffrida:** Visualization, Validation. **Antonino Nazareno Virga:** Visualization, Validation. **Simona Bacarella:** Visualization, Validation. **Salvatore Forgia:** Validation, Visualization. **Alessandra Di Natale:** Visualization, Validation. **Federico Modica:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Methodology, Investigation, Formal analysis.

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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