

Parasites of fish and risks to public health

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Summary

A multitude of parasites have been reported in fish, but only a few species are capable of infecting humans. The most important of the helminths acquired by humans from fish are the anisakid nematodes (particularly *Anisakis simplex* and *Pseudoterranova decipiens*), cestodes of the genus *Diphyllobothrium* and digenetic trematodes of the families Heterophyidae, Opisthorchiidae and Nanophyetidae. Seafood-associated infections by acanthocephalans are rarely reported in humans. All of the helminths mentioned above are associated with social-cultural and behavioural factors, in particular the consumption of raw or undercooked seafood.

Measures can be taken during harvesting, processing or post-processing (e.g., by the consumer) to mitigate the risks of infection. The seafood industry and government authorities can apply various programmes to reduce these risks, including good manufacturing practices (GMPs) and hazard analysis and critical control point (HACCP) systems. Such measures may include avoiding particular harvest areas, sizes of fish, or even particular species of fish. The method of capture, handling and storage of the catch can directly affect the quality of the seafood with regard to the presence and numbers of parasites. The extent of processing – including heading and gutting, candling and trimming – and the type of product derived (fresh, frozen, salted or pickled) can all contribute to the control of the risks posed by helminths. The most effective means of killing the parasites are either freezing or heat inactivation.

Keywords

Acanthocephalans – Cestodes – Fish – Freezing – Good manufacturing practices – Hazard analysis and critical control points – Nematodes – Parasites – Public health – Seafood – Trematodes.

Introduction

While there is an extensive range of helminthic parasites of marine fish, only a few species are capable of infecting humans. There are a moderate number of nematodes, trematodes, cestodes and acanthocephalans which have been reported in humans, but only a few cause serious disease. All of the worms, however, are associated with social-cultural and behavioural factors which enhance infection, especially the habit of eating raw fish.

Seafood parasites

Nematodes

The most important of the nematode diseases of humans acquired from marine fish is anisakiasis or anisakidosis. *Anisakis simplex* is the species most frequently associated with human disease, followed by *Pseudoterranova decipiens*. *Contracaecum osculatum* has rarely been reported to cause disease. The diseases are caused by the larval stages of the worms; human infection with adult worms has not been

documented. The worms are natural parasites of marine mammals such as whales, dolphins and porpoises (order: Cetacea), which are definitive hosts for *A. simplex*, and seals and sea lions (families Oteridae and Phocidae), which are definitive hosts for *P. decipiens*. Humans acquire larval *A. simplex* by eating raw, inadequately cooked, poorly salted, pickled or smoked herring (*Clupea harengus*), cod (*Gadus* spp.), mackerel (*Scomber* spp.), salmon (*Oncorhynchus* spp.) or squid (*Todarodes* spp.), and *P. decipiens* is acquired from cod, halibut (*Hippoglossus hippoglossus*), flatfish (family Pleuronectidae) or Pacific red snapper (*Sebastes* spp.). Major sources of infection are traditional preparations such as raw herring, lomi lomi salmon (a preparation of raw, marinated salmon), ceviche, sushi and sashimi.

Adult anisakids are present in the stomachs of the marine mammalian definitive hosts. Eggs produced by female worms pass in the faeces and embryonate in the ocean waters. Larvae hatch from the eggs, enter small marine micro-invertebrates (such as crustaceans of the family Euphausiidae) and develop into third-stage larvae. When the crustacean is eaten by a fish or squid paratenic host, the larvae are released and pass through the gastrointestinal tract, then enter the mesenteries, viscera or muscle. If the infected fish or squid is eaten by a marine mammal, the larvae are released and become established in the stomach. When humans eat the paratenic hosts (the infected fish), the larvae may enter the tissue of the gastrointestinal tract and cause disease.

In humans, *A. simplex* larvae enter the gastric or intestinal mucosa and cause an abscess or eosinophilic granuloma. The worms may enter the peritoneal cavity and may also enter other organs. Some worms may not invade tissue but instead may pass out with faeces, vomit or pass up the oesophagus. *P. decipiens* larvae may also invade tissue, but these rarely attempt to lodge in the oesophagus: the larvae may, however, cause 'tickling throat syndrome' in which a tickling sensation occurs and the patient may cough up the larvae.

The symptoms of anisakiasis resemble an acute abdomen, gastric ulcer or neoplasm. Parasitological diagnosis is made by finding the worms or demonstrating sections of the parasite in biopsied tissue. Serological tests are not conclusive. The treatment for most infections is removal of the parasites surgically or by the use of forceps through fiberoptic endoscopy. The prognosis is good once the parasite has been removed.

Anisakiasis was first recognised in Holland in the 1960s (31) where people frequently ate lightly pickled or raw herring. The disease was initially associated with the use of refrigerated or iced fish, which had been caught in the ocean and subsequently kept cold on the fishing boats for several days prior to reaching port. Prior to the use of refrigeration or ice, the boats did not stay out for such long periods and the fish were eviscerated shortly after being caught, either on the boat or on shore. The introduction of refrigeration and the ensuing

longer chilling period meant that after the fish had died in the cold, anisakids migrated to the fish muscle. On reaching port and the market, the fish were eviscerated but the larvae had moved on by this time. Furthermore, smoking or pickling the fish was inadequate to kill the worms which had already reached the muscle.

Otsuru *et al.* (23) compiled the first report of a worm as the cause of ileitis in Japan. Since then, anisakid larvae have been shown repeatedly to be responsible for severe gastrointestinal disease. In a 1993 study, Ishikura *et al.* (16) reported 11,629 cases of gastric, 567 cases of intestinal and 45 cases of extra-gastrointestinal anisakiasis, as well as 355 cases of gastric pseudo-terranoviasis. Over 500 cases of ileitis have been reported from other countries, although few of these have been reported from other Asian countries. This could be due to the fact that, in Asia, marine fish are usually eviscerated shortly after being caught, are not iced or refrigerated, and reach the market in a matter of hours. Furthermore, other populations in Asia do not relish raw marine fish as the Japanese do. A total of 107 cases of anisakiasis were reported in Korea between 1989 and 1992 (15). Human infections in Japan continue to be reported and seem to be increasing: the increase may be attributable to the growing use of endoscopy (14) and physician awareness. The increase in the number of cases of pseudo-terranoviasis or codworm anisakiasis is caused by the growth of seal populations, especially along the west coast of the United States of America (USA). In northern Japan, as many as 4,500 *P. decipiens* larvae were found in the stomach of a male sea lion from the Japanese Sea area (16). In southern Japan, anisakiasis is more common than pseudo-terranoviasis. More cod is eaten in the north, while chub mackerel (*Scomber japonicus*) is more frequently consumed in the south. Many species of fish world-wide have been found to be infected with anisakid larvae (18, 25, 30).

Cestodes

Cestodes which may be transmitted to man from marine fish are limited, for the most part, to members of the genus *Diphyllobothrium*. Records of fish-associated human infection with cestodes are generally confined to countries where fish are eaten raw, marinated or undercooked (e.g., Alaska, the USA, Canada, Scandinavia, Japan, Chile, Peru and Russia) (32). Rausch and Hilliard recorded six species of *Diphyllobothrium* from humans in Alaska, of which *D. latum* was the most common (24). World-wide, at least 13 species of *Diphyllobothrium* have been reported from humans, with infections by *D. latum* and *D. dendriticum* being the most prevalent (1). *D. latum* has been of interest for many years because the cestode causes pernicious anaemia, probably due to competition between the worms and the host for vitamin B₁₂. In Japan, diphyllobothriasis (primarily caused by *D. latum*) has increased in incidence since the 1970s: about 100 patients are recorded annually (22). The salmonid genus *Oncorhynchus* is the most important potential intermediate host. Of the 52 cases of diphyllobothriasis which occurred in

the west coast States of the USA in 1980, salmon was implicated in 82% (32). Over 60 cases have been reported from Peru, most of which were considered to be caused by *D. pacificum*. The systematics of this genus are unsettled and identification is difficult, particularly for the larval stage encountered in fish (the plerocercoid).

Knowledge of the life-cycles of these species is also incomplete, although the cycles occur in either marine or freshwater ecosystems, depending on the species of cestode. In general, the adult tapeworm resides in the intestine of a definitive host (either marine or terrestrial mammals) and releases eggs which pass in the host faeces. If the eggs reach water, they hatch and release a free-swimming stage (coracidium) which may be ingested by a copepod. Within this crustacean intermediate host, the larval tapeworm (proceroid) develops. If the copepod is ingested by a suitable fish, the larva migrates to the body cavity of the host and develops to the plerocercoid stage, which is infective to the definitive host (including man).

The important risk factor for this zoonosis is the consumption of raw or undercooked fish. Related factors are the intrusion of man into the wild habitat of the host fish and contamination of water with human waste. Greater control of the latter, however, will not eliminate the risk of diphyllbothriasis in marine systems because of the existence of alternative mammalian hosts for species of *Diphyllbothrium*. Therefore, post-harvest controls such as proper fish processing and preparation of food are the most effective measures to prevent diphyllbothriasis.

Trematodes

Although 33 species of digenetic trematodes have been listed as transmissible to man through the consumption of fish, crustacea or molluscs, only a few represent notable zoonotic threats (28). Among these, the members of the Heterophyidae family are significant. This group comprises very small trematodes which inhabit the intestine of birds and mammals. The infective stage (metacercaria) can be found in a wide variety of fresh and marine fish.

Williams and Jones have described the taxonomy, life-cycles and epidemiology of those species considered to have the most importance as zoonoses (32). Perhaps the most important are *Heterophyes heterophyes* and *Metagonimus yokogawai*. These parasites, acquired by eating raw, marinated or improperly cooked fish, are frequently reported from human infections in the Middle East and Asia, especially the Philippines, Indonesia, Thailand, the People's Republic of China, Japan and the Republic of Korea. The accumulation of large numbers of these parasites in the small intestine may cause inflammation, ulceration and necrosis.

Although not marine fish parasites, *Clonorchis sinensis* and *Opisthorchis* spp. are important fishborne and parasitic

diseases of humans (33). Fish belonging to the family Cyprinidae (carp) are the major intermediate hosts of *C. sinensis* and *Opisthorchis* spp. More than 100 species of freshwater fish have been shown to be naturally infected with *C. sinensis* and more than 35 with *Opisthorchis* spp. However, more than one fish species in any particular aquatic environment can become infected. Therefore, in areas where transmission of the parasites is known to occur, the absence of infection of any one fish species is no guarantee that other fish cannot harbour the infective stages of the trematodes. *Clonorchis sinensis* is endemic in the People's Republic of China, the Republic of Korea, Japan, Taipei China and Vietnam. The infections are acquired by eating freshwater fish which is raw, poorly cooked or inadequately preserved. When mature, the parasites inhabit the smaller biliary passages of humans or other fish-eating mammals. *Opisthorchis viverrini* is found in humans and fish-eating mammals in South-East Asia, particularly Thailand and Laos. Similar hosts are infected by *O. felineus* in eastern Europe and Russia. The pathology caused by all species is similar and the risk of cholangiocarcinoma may be high in chronic cases.

A member of another family, Nanophyetidae, is characterised by a unique pathology called 'salmon poisoning'. This trematode, *Nanophyetes salmincola*, is an intestinal parasite of dogs and many wild piscivorous mammals. The disease, however, does not arise directly from the trematode, but instead is due to a rickettsial 'hyperparasite', *Neorickettsia helminthoeca*, which is pathogenic for dogs. Although humans infected with the fluke do not develop salmon poisoning, the presence of large numbers of the parasite can cause gastroenteritis (3, 6, 11).

As with cestodes, the eating of raw or partially cooked fish is the main risk factor for these trematodes. If fish consumption increases globally as is predicted (32), the importance of these zoonoses may increase. The need for more extensive efforts to ensure adequate handling and preparation of fish and fish products for human consumption is obvious.

Acanthocephalans

Another group of worms found in marine animals (in particular sea lions) are acanthocephalans or spiny-headed worms. Three species of these parasites have been reported from humans on rare occasions. Adults of *Corynosoma strumosum* are found in the stomachs of pinnipeds. Tiny crustacean intermediate hosts and fish which eat the crustaceans are sources for human infection. *C. strumosum* has been reported in an Eskimo and *Acanthocephalus butonis* was found at autopsy in a case in Indonesia (26). *Bolbosoma* sp. has also been reported in Japan in two cases with intestinal symptoms (5).

The eating of raw or inadequately cooked, pickled or fermented fish is a cultural practice instilled in populations throughout the world. It is difficult to change eating habits

which have been practised for generations. However, without a change in dietary habits, marine helminthic parasites will continue to infect humans.

Risk mitigation and prevention measures

Parasites are a natural component of the environment and may be viewed as an indicator of the relative health of an ecosystem. The majority of species of parasites present on and within fish are not hazardous to human health. Those which are hazardous tend to have complex life-cycles which involve more than one type of host for development. With the ensuing protection of the various hosts involved, particularly marine mammals, the complete elimination of parasites from seafood products is not possible; however, measures can be taken to mitigate the risks of infection. These steps involve either physically removing (completely or in part) or negating the infectivity of the parasites present. Such measures may be applied during harvesting, processing or post-processing treatment (e.g., by the consumer).

The seafood industry and governmental authorities have many programmes to provide a commercially viable product to the consumer (2), of which two in particular may be applied to parasites. Good manufacturing practices (GMPs) pertain to conditions and procedures undertaken by a company to avoid producing an adulterated product. GMPs are not directly connected to the elimination of health hazards, although implementation of these practices may contribute to this goal. The second programme, which concerns a hazard analysis and critical control point (HACCP) system, relies in part on GMPs, but is designed specifically to address food safety hazards and to eliminate or reduce these to an acceptable level, from reception of a raw material through to production and delivery to the consumer. Within an HACCP programme, the first step is to identify a food safety hazard; the processing step best suited for control of the hazard is then determined, and finally the actual control measure is implemented. In recent years, HACCP programmes have received considerable emphasis, both domestically and internationally. On 18 December 1995, the Final Rule for seafood HACCP for processors and importers of fish and fishery products in the USA was published by the Food and Drug Administration (10). These regulations are focused primarily on processing of seafood intended for consumption in a raw or undercooked product, but also address the public health hazards of seafood parasites.

Harvesting

Measures to reduce the likelihood or abundance of parasites within a seafood product can be applied prior to harvesting. The type and size of fish (e.g., groundfish, pelagic or anadromous fish) intended for capture should be considered.

The feeding habits and immediate environments of groundfish, such as arrowtooth flounder (*Atheresthes stomias*) and many species of sole (family Pleuronectidae) tend to result in the acquisition of large numbers of larval anisakid nematodes. Additionally, many parasites of concern (e.g., anisakids and diphyllbothriids) accumulate within the host during the lifetime of the fish, with the number of worms generally increasing in accordance with the age and size of the fish. Therefore, the selective harvesting of younger fish of such species will reduce the likelihood of large numbers of parasites. Young found that at one study-site, 83% of the cod were harvested before they attained 60 cm in length, by which time the fish had not lived long enough to acquire heavy infections of anisakids (34). Certain fish stocks or geographic locations develop reputations for having excessive numbers of parasites, and are either avoided by fishing vessels or the harvested fish are heavily processed into minced products or analogue as used for surimi (a processed fish product made into a paste to which cryoprotectants and flavour are added to produce imitation seafood products such as crab legs and flakes). To reduce the need for extensive processing, some firms will specifically purchase only smaller fish of a species known to have parasite problems.

Marine fish are the intermediate hosts for parasites of marine mammals, most notably the anisakid nematodes. Fish occupying inland waters which are also frequented by marine mammals (including rookeries and haul-out areas) often demonstrate appreciably larger numbers of parasites in the edible flesh. For example, populations of the grey seal (*Halichoerus grypus*) have been markedly increasing during the past 35 years in the North Atlantic (19) and this expansion has apparently resulted in the greater incidence of *P. decipiens* in the flesh of cod and other bottom-dwelling fish from the same locations (13, 21). Harvesting of these types of fish should be avoided, or the fish should be thoroughly processed. To avoid the additional cost incurred by extensive processing to ensure that the anisakids are removed, a processor may prefer to pay a premium for fish caught outside marine mammal areas.

During harvesting, the method of capture may contribute indirectly to the necessity to remove parasites during processing. Fish which are caught with long-lines rather than with nets tend to be fresher because they are bled immediately after death and are then chilled or frozen. The resulting product has a whiter flesh and is easier to candle (view over a strong, bright light) for physical removal of parasites. The actual capture, whether by long-lines or nets, and the resulting handling, may also cause the loss of many of the parasites present on the body and fins, although these are generally not infectious to humans.

After capture, the fish may be stored frozen or chilled, or may undergo some preliminary processing (e.g., heading and gutting). The larval helminths accumulate primarily in the viscera and secondarily in the edible flesh. If the worms are

prevented from migrating into the flesh after the death of the piscine host by rapid chilling or gutting, the overall numbers of parasites in the flesh will be lower. Some fish, such as salmon, herring and arrowtooth flounder, appear to be more susceptible to post-mortem migration than other species, and particular care should be taken with these species. Gutting consists of the physical removal of the viscera and any attendant parasites; chilling or freezing may be carried out with the viscera intact. In addition to preventing the migration of parasites, rapid chilling or freezing also extends the shelf-life and freshness of the seafood. Freezing the fish at appropriate temperatures and durations will kill the parasites and eliminate the possibility of infection. None of these methods will eliminate the presence of parasites which migrated into the flesh prior to harvesting.

For those fish known to host parasites, processors may place further restrictions on the harvesters. Vessels may remain at sea for extended periods of time, capturing several different species of fish. For fish such as arrowtooth flounder, the processor may request that the time at sea be reduced or that the fish be caught and held during the last few days of fishing, to decrease the period of post-mortem anisakid migration. The processor may also 'test' a sample of the catch to determine the extent of parasite migration. A failing grade occurs when nematodes are found above the lateral line of the fillets, and the catch may be refused by the processor.

For a few commercially valuable species, particularly the salmonids, aquaculture can produce stock in which the presence of those parasites of public health concern is decreased or eliminated. In aquaculture, the fish can be indoctrinated into accepting only pelleted feed. Such fish do not appear to recognise crustaceans and smaller fish as possible prey. In these conditions, the life-cycles of anisakid nematodes and tapeworms are interrupted and the fish remain free of these parasites. However, if the fish are acquired from a hatchery which is inhabited by *Juga plicifera*, the snail intermediate host needed for the *Nanophyetus* life-cycle, the salmon may arrive at the net pens already infected with the trematode. Hatcheries which use only well-water and which are free of the snails can produce salmon free of this trematode. In a study involving two net-pen sites and 237 Atlantic salmon (*Salmo salar*), the viscera and edible flesh of all fish were free of anisakids, diphyllbothriids and *N. salmincola* (4). For those culinary dishes which incorporate raw or undercooked seafood, the use of salmon raised in aquaculture conditions is a reasonable alternative to wild-caught salmon with regard to parasites of public health concern.

Processing

Depending on the final product and market, a processor may perform several steps in the handling of a catch, including heading and gutting, filleting, skinning, candling and trimming. Candling is the process by which a fish fillet is

placed on a light table to enable the detection of parasites, although this process does not necessarily reveal the presence of all parasites. Factors which may interfere with detection are as follows:

- thickness of the fillet
- presence of skin on the fillet
- oil content
- pigmentation
- the level of experience of the operator.

In a comparison of four types of white-fleshed fish – rockfish (*Sebastes* spp.), arrowtooth flounder (*Atheresthes stomias*), sole (family Pleuronectidae) and true cod (*Gadus macrocephalus*) – candling detected 53% to 79% of the infected fillets and from 43% to 76% of the anisakids present (A.M. Adams, unpublished data).

Parasites observed by candling may be removed either with a probe or forceps or by trimming the portion of fillet affected. The area of the fillet which generally has the most parasites is the belly flap region surrounding the viscera (the first area into which the parasite can migrate). Some processors automatically cut away the belly flap without candling, while others may candle the fillets and trim only those containing visible parasites.

Much seafood is released onto the market immediately after filleting. Irradiation has been proposed as an additional step prior to marketing to increase food safety for many agricultural products (29). However, several issues need to be considered prior to implementation. Many consumers do not understand how irradiation works (e.g., expecting food to become radioactive or to 'glow in the dark'), and are reluctant to purchase food which has been treated in this manner. Of primary importance is the fact that the amount of irradiation necessary to eliminate a hazard varies according to the organism. Irradiation of pork to eliminate the possibility of trichinellosis is highly effective at 0.15 to 0.30 kGy (7), in that the larvae do not need to be killed, but simply rendered sexually sterile. Unfortunately, irradiation is inappropriate for the anisakid nematodes: the larvae which are present within the fishery product directly cause anisakiasis, thus the level of irradiation must be high enough actually to kill the nematodes (0.5 MegaRads or 10 kGy) rather than render the parasite sexually sterile (reproduction does not occur within the human host regardless of the sexual status of the anisakid larvae) (8). At these levels of irradiation, the fish acquires an unpalatable texture and taste.

In addition to fresh and frozen seafood on the market, products which have been prepared in brine, salt, pickle or marinade are available, and consumers may also utilise these steps to prepare a seafood dish at home. In general, two components are present in pickling solutions and marinades: salt and acid. The acid level present in brining solutions has

no appreciable effect on anisakid nematodes, which is not surprising since anisakids live primarily in the stomach of marine mammals. Therefore, attention should be focused on the salt level of any brining or pickling solution. Of the helminths mentioned above, the nematodes are the most resistant to brining solutions. Dry salt is lethal to anisakids within 10 minutes of direct contact (17). In a 22% salt solution (a saturated solution), the worms will be dead in 10 days. As the concentration of salt drops, the time required to kill the nematodes increases. In a 15% salt and 7% acid solution, 97% of the worms are killed after 30 days; with a 6% salt and 4% acid solution – similar to most pickling solutions – more than 70 days are required for the nematodes to be killed (27). For many pickled fish products (e.g., pickled herring, ceviche), freezing the fish prior to pickling or marinating is recommended.

Within the framework of seafood HACCPs, freezing provides the most reasonable control measure for parasites. In the Final Rule for seafood HACCPs (10), processors are required to institute a control plan for parasites when there is a likelihood that the product will be consumed without adequate means of removing the hazard, or where the product is labelled or marketed to be consumed in that fashion. Essentially, a control step is required for fishery products which are known to have a parasite problem and which are generally sold to be consumed raw or undercooked. Freezing, carried out at any one of several production steps, fulfils the HACCP requirement for these products. Fish frozen at the harvesting stage, for example, need not be refrozen by the processor as a parasite control measure. During the production of Nova Scotia-type smoked salmon, the salmon is frozen after smoking to enable the thin-slicing of the fish which is characteristic of the final product. Freezing as a means of killing parasites is time/temperature dependent. Generally, for parasitic worms, 15 hours in a blast freezer at -35°C (-31°F) or 7 days at -20°C (-4°F) will be effective (9). Home freezers should be checked for temperature and sufficient air-flow to ensure effective freezing.

Heat inactivation of parasites is the single, most effective method for eliminating the risk of parasitic infections and can be achieved during processing or by the consumer. However, macroscopic parasites, such as worms, will still be present within the product and will be visible to the consumer. At this point, the presence of parasites becomes an aesthetic issue and not a health problem. Heat inactivation of parasites is also

time/temperature dependent after a minimum temperature is attained. For conventional cooking (including baking), the internal temperature of the thickest part of the product should reach a minimum of 63°C (145°F) for 15 seconds or longer (9). Cooking with a microwave oven requires a higher temperature to kill all the parasites due to the uneven heating which occurs: a temperature of 77°C (170°F) in the thickest part of the product is recommended (20). Turning the food during cooking, covering the food, and adding liquid while cooking all help to stabilise the uneven heating of the meal.

Control of parasites in smoked products is dependent on the type of smoking performed. Hot smoking of products, particularly fishery products, can effectively inactivate parasites because the product is essentially cooked during the smoking process. However, care should be taken to ensure that the product reaches an appropriate temperature for a long enough period during the smoking process. Unlike bacteria, helminth parasites are not affected by the seasonings and flavourings (liquid smoke) which are used on a raw product to impart a smoked flavour. In cold-smoking operations which use real smoke, the product is contained within a chamber in which the temperature does not increase sufficiently to kill parasites. Cold-smoking itself is not a control measure for parasites (12). Brining or salting performed prior to cold-smoking may have a limited effect. Furthermore, many operations use fish which has been frozen previously, or the product may be frozen after smoking for storage, transportation, or to enable thin slices of product to be cut. In these situations, the freezing of the product could fulfil the control function if proper temperatures and durations are met.

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Risques pour la santé publique liés aux parasites des poissons

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Résumé

Parmi la multitude de parasites connus des poissons, seules quelques espèces peuvent infester l'homme. Les helminthes transmis à l'homme par des poissons sont essentiellement des nématodes anisakidés (en particulier, *Anisakis simplex* et *Pseudoterranova decipiens*), des cestodes du genre *Diphyllobothrium* et des trématodes digénétiques appartenant aux familles des Hétérophidés, des Opisthorchiidés et à l'espèce *Nanophyetus*. Les acantocéphales présents dans le poisson n'infestent que rarement l'homme. Les infestations par les helminthes mentionnés ci-dessus sont liées à des facteurs socio-culturels et comportementaux, en particulier la consommation de poisson cru ou mal cuit. Des mesures visant à atténuer les risques d'infestation peuvent être prises au moment de la pêche ou de la capture, lors de la transformation ou lors de la préparation (par exemple, en cuisine). Les producteurs de poisson, ainsi que les pouvoirs publics, peuvent mettre en œuvre divers programmes en vue de réduire ces risques, notamment à travers de bonnes pratiques de fabrication et l'application de l'analyse des risques, points critiques pour leur maîtrise. Parmi ces mesures, il convient de citer la possibilité d'interdire certaines zones de pêche, certaines tailles de poisson voire certaines espèces. Les méthodes de pêche, de manipulation et de stockage ont une incidence directe sur la présence et le nombre de parasites dans les produits. Les risques liés aux helminthes dépendent du degré de préparation du poisson (étêtage, éviscération, mirage et élimination des parties suspectes) et du type de produit obtenu (frais, congelé, salé ou mariné). Les méthodes les plus efficaces pour tuer les parasites sont la congélation et l'inactivation par la chaleur.

Mots-clés

Acantocéphales – Analyse des risques, points critiques pour leur maîtrise – Bonnes pratiques de fabrication – Cestodes – Congélation – Nématodes – Parasites – Poisson – Produits de la mer – Santé publique – Trématodes.

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Parásitos de los peces y riesgos para la salud pública

A.M. Adams, K.D. Murrell & J.H. Cross

Resumen

Se han descrito multitud de parásitos que afectan a los peces, pero sólo unas pocas de esas especies son capaces de infectar al ser humano. Los más importantes helmintos que los peces pueden transmitir a los humanos son los nematodos del género *Anisakis* (en particular *Anisakis simplex* y *Pseudoterranova decipiens*), los cestodos del género *Diphyllobothrium* y los trematodos digenéticos de las familias Heterophyidae, Opisthorchiidae y Nanophyetidae. Los casos de toxi-infección alimentaria por acantocéfalos son raros en el ser humano. Todos los helmintos antes mencionados están de algún modo relacionados con factores socioculturales o hábitos personales, en especial el consumo de pescado crudo o insuficientemente cocinado.

Es posible adoptar medidas que reduzcan el riesgo de infección durante las fases de captura, tratamiento o preparación (por ejemplo por parte del consumidor). Los productores de pescado y las autoridades públicas disponen en este sentido

de varias posibilidades, entre otras aplicar programas de buenas prácticas de fabricación o sistemas de análisis de riesgos y control de puntos críticos. Las medidas inscritas en tales programas pueden consistir en evitar determinadas zonas de captura y en excluir peces de determinado tamaño o incluso algunas especies piscícolas concretas. El método de captura, manipulación o almacenamiento del producto de la pesca puede influir directamente sobre la calidad de los alimentos y sobre la eventual presencia y abundancia de parásitos. La intensidad del tratamiento –descabezado y vaciado, miraje de los filetes y eliminación de las partes sospechosas–, así como el tipo de producto a que da lugar (fresco, congelado, salado o adobado) son sendas variables que pueden contribuir a controlar los riesgos asociados a los helmintos. Los medios más eficaces para matar a los parásitos son la congelación y la inactivación por calor.

Palabras clave

Análisis de riesgos y control de puntos críticos – Buenas prácticas de fabricación – Cestodos – Congelación – Nematodos – Parásitos – Pescado – Productos de origen marino – Salud pública – Trematodos.

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