



# **Food Safety aspects of fish farming systems**

## ***a review of EFSA opinions on welfare***

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1. AHAW - Animal Health and Welfare Panel

2. BIOHAZ – Panel on Biological Hazards

European Food Safety Authority

- **Background**

- **Directive 98/58/EC** on animal welfare includes farmed fish
- **EFSA (2004)** scientific opinion on stunning and killing including farmed fish called for a species specific approach.
- The **Commission** requested EFSA to issue species-specific scientific opinions on the welfare of farmed fish (husbandry systems, stunning and killing)
  - **AHAW** on animal welfare aspects
  - **BIOHAZ** on Food Safety considerations

# Welfare and food safety ?



*"You can see by its smile that this halibut was humanely killed."*

# Guiding principles

- The BIOHAZ assessments have focused on the food safety relevance of pre-harvest and harvest factors relating to fish welfare
- There is limited or unavailable evidence of a quantifiable and directly applicable relationship between animal welfare-relevant factor (on-farm) and safety hazard (at slaughter)
- Based on general principles of hygiene, various factors (e.g. microbial contamination of water, irresponsible use of antimicrobials, increased handling, invasive stunning, etc.) could lead to increasing the risk of microbial contamination of fish
- The closer the biological risks occur to the time of slaughter, the higher is their importance in food safety
- Post-slaughtering and processing stages have not been considered

- Bacteria are usually considered as
  - indigenous to the aquatic environment, where fish is farmed
  - a contamination, or introduced during post-harvest /processing
- Some indigenous pathogenic bacteria
  - *Vibrio, Aeromonas, Plesiomonas, non-proteolytic Clostridium botulinum,...*
- Generally non-indigenous bacteria
  - *Salmonella, Shigella, pathogenic E. coli, Campylobacter, Yersinia*

- Non proteolytic psychrotrophic *Clostridium botulinum* type E has been frequently implicated in fishborne intoxications
  - raw smoked salmon and trout
  - toxinogenesis may precede organoleptic spoilage
- *C. botulinum* type E, an authentic aquatic organism
  - sediments of lakes, ponds and sea (anoxic conditions)
  - gills, skin and intestines (fish is a transient carrier of spores)
  - marked geographic distribution with low/high occurrence
- Its occurrence in farms is associated with un-hygienically managed or mud-bottomed farms where fish have access to sediments
- Other *C. botulinum* types such as type A, B and C have also been isolated from fish

- Prevalence in waters depends on environmental factors
  - temperature, salinity, and phytoplankton
  - In Europe, levels are generally low except in bivalves
- Principal species linked to seafood-borne infections are
  - *Vibrio parahaemolyticus*, *V. cholerae*, and *V. vulnificus*
  - at least 12 different human pathogenic species described
- Non pathogenic clones also exist for some species
- Some species are also pathogenic for fish
  - *V. parahaemolyticus*, *vulnificus*, *damsela*, *anguillarum*, *alginolyticus*
- Most cases reported in Europe are
  - wound infections become systemic in susceptible people
  - foodborne *V. parahaemolyticus* infections are almost exclusively associated with the consumption of raw/undercooked fish/shellfish

# Listeria monocytogenes

- Seafood (incl. smoked salmon) has caused outbreaks of listeriosis
- Agriculture run-off waters can be a source of contamination
  - Unpolluted seawater and ground waters used in aquaculture are generally free from *Listeria*, and fish from these environments are not contaminated
- It is assumed that fish can be contaminated at any point between pre-harvest and consumption
  - Raw fish materials are a source of contamination for final products
  - Final product mainly contaminated during processing due to pathogen persisting in food-processing environments
- Control of this hazard should be performed at pre- as well as post-harvest stage

- ***Aeromonas hydrophila*** is a fish pathogen (haemorrhagic septicemia). It causes wound infections in exposed persons handling fish or in contact with water (WHO low risk)
- ***Plesiomonas shigelloides*** has its primary habitat in aquatic environment (isolated from fish and oysters). Its role in gastroenteritis disease is still unclear (WHO low risk)
- ***Salmonella*** and other enteric pathogens are not aquatic microorganisms and their presence in water or fish is due to contamination, as a result of poor hygiene standards (including contaminated feed) or run-off waters from human sewage, livestock farming, or industry.
- Idem for pathogenic ***E. coli***, ***Shigella*** spp., ***Yersinia enterocolitica***, and ***Campylobacter*** spp.
  - However some *Salmonella* serotypes can persist in the marine environment for months, even years

- Some zoonotic bacterial agents occurring in fish can cause systemic infections and threaten life in humans as a result of fish handling (aquaculture or recreational fish, wounds caused by fins and spines), or after exposure to waters
- ***Mycobacterium marinum***, *M. fortuitum*, *M. chelonae*, *M. shottsii* can cause chronic disease in fish
  - *M. marinum* causes “fish tank granuloma” in workers handling infected fish
- ***Erysipelothrix rhusiopathiae*** and ***Streptococcus iniae*** are considered occupational hazards in people handling fish
  - mainly immunocompromised people with present wounds, abrasions
  - risk of healthy people contracting the disease is very low
- ***Edwardsiella tarda*** (another fish pathogen) can cause gastroenteritis and generalized infection (usually through skin lesions) in immuno-compromised people

- Farmed fish has limited access to intermediate hosts
  - aquaculture based on wild caught fish (eels)
  - interaction between farmed and wild animals
  - introduction of a species into a new area
- Helminths (trematodes, nematodes & cestodes) occurring in farmed fish are very rarely reported.
- *Anisakis simplex* prevalence in wild fish is high
  - *A. simplex* has never been detected in a large number of aquaculture salmon
  - Other nematodes causing disease in humans are *Capilaria*, *Gnathostoma*, and *Pseudoterranova* spp.
- Trematodes commonly infesting fish are: *Clonorchis*, *Ophisthorchis*, *Paragonimus*, and to a lesser extent *Heterophyes*
- Cestode: *Dibothriocephalus (Diphyllobotrium) latus*
  - recent outbreak in Chile

- Finfish are not usually involved in foodborne diseases caused by viruses
  - most reports associate molluscan bivalves with caliciviruses (such as noroviruses) and hepatitis A virus
  - occurs in areas polluted with faecal effluents where bio-filtration leads to concentration of virus particles in molluscs
- It has not been demonstrated that viruses causing disease in fish be pathogenic to humans, and human viral diseases caused by the consumption of finfish and crustaceans appear to present a low risk
- Infectious salmon anaemia (ISA) has been pointed out as a possible zoonosis, but there is no evidence for risk to humans

- **Prions**

- According to the BIOHAZ Panel, “currently there are no indications that natural TSEs occur in farmed or wild fish
- However, this is based on very limited examination data both in terms of fish species examined, number of samples and detection methods applied

- **Antimicrobial resistance**

- In European aquaculture antimicrobial usage has been traditionally restricted (vaccines and strict legislation)
- Intensive use of chemotherapeutic agents to treat infectious diseases in aquaculture has led to an increased frequency of drug-resistant microorganisms, as well as bacteria showing multiple-antibiotic resistance
- A FAO/OIE/WHO workshop has emphasized the risk of spread of antibiotic resistance genes from aquatic and fish bacteria to human pathogens

- Food safety hazards associated with aquaculture products vary greatly according to methods of production, farm management and location
  - mud-bottomed farms have increased probabilities of occurrence of *Clostridium botulinum* type E spores in fish end-products
- Although most of the biosecurity and hygiene measures are specifically intended to reduce fish diseases, they will influence also the safety of the fish product
- Good aquaculture practices (GAP) can reduce spore prevalence in fish and some of the pre-harvest risk reduction measures implemented are
  - removing bottom sludge, proper cleaning and disinfection of ponds, good hygienic condition of feed (trash fish) used in fish feeding, and the daily removal of weak, damaged or dead individuals

- The location of the farm and possible contamination with faecal pollutants (run-off waters, human sewage and farm effluents, wild animals) should be addressed, as sources of faecal contamination (animal/human) can occur accidentally in the vicinity of the farm
  - This will increase the prevalence of pathogens (*Salmonella*, *Shigella*, pathogenic *Escherichia coli*, enteric viruses, hepatitis viruses, parasites)
- Introduction of aquatic species in new habitats for recreation or aquaculture can change parasite and bacteria prevalence

- Changes in the **water quality** and **environmental conditions** may act as stressors, **making fish more susceptible** to infection and pathogen carriage
- Environmental conditions (water temperature, salinity, oxygen levels, phytoplankton concentration, pH, light, nutrient conc. i.e., phosphorous, nitrogen) can **modify the occurrence and concentration** of indigenous aquatic pathogenic bacteria in water (*Vibrio*, *Aeromonas*, etc.)
- Development of **blooms** (red tides), which could eventually lead to the presence of toxic microalgae in fish, has also a strong dependence on environmental conditions.

- Climate change as a possible future challenge.
  - Changes in temperature, current, pH, nutrient inflow will definitely contribute to a modification in the distribution and concentration of harmful algae, contaminants, invasive species in coastal and marine habitats
  - Climate change may exacerbate risks re aquatic pathogens
  - Increased prevalence for some pathogens (*Vibrio* spp.) as a result of extremely warm seasons has been detected in Europe
- An evaluation of emerging risks should be performed to elucidate the scope of these issues
  - e.g. how heavy rains, storms, floods may impact food safety(ex. run-off waters and *Listeria monocytogenes* in salmon, trout farms)
  - Environmental conditions influencing water parameters (e.g. salinity) and pathogen occurrence (e.g. *V. parahaemolyticus*)

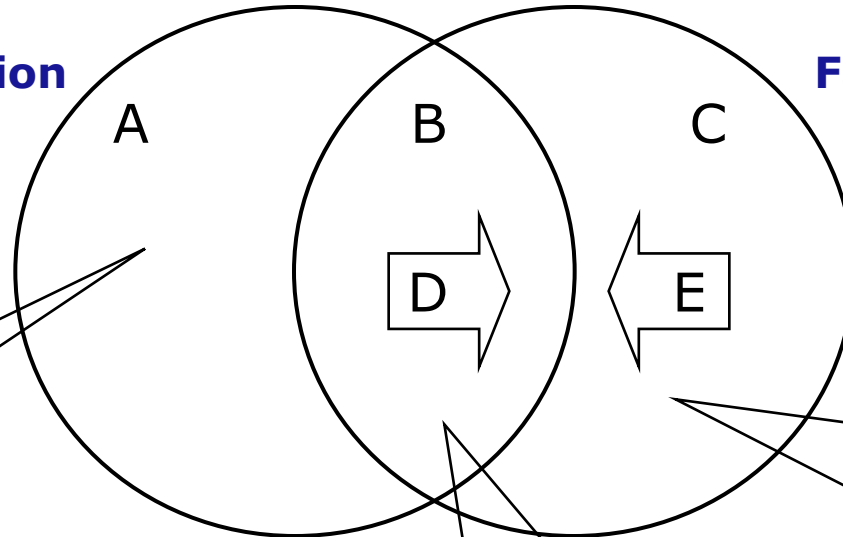
- All farmed species are susceptible to stress factors such as stocking density, grading, mixing of species, presence of predators, handling, transport, removal of fish from water, temperature changes or inadequate light regimes
- Response to stress is hormone dis-balance, osmoregulation disruption, suppression of the inflammatory response (immuno-suppression), and as a result the fish is more susceptible to disease and possibly prone to bacterial carriage and this may have an effect in the safety of fish products
- This may have particular importance for safety when occurring close to slaughter

- Food safety biological hazards may include *Salmonella* and other *Enterobacteriaceae*, and possibly prions
  - GMPs to minimize the associated risk
- Use of animal/human excreta as fertilizers to stimulate the natural production of food organisms
  - increased prevalence of enteric bacterial pathogens and parasites in the final product (grown under stressful conditions)
- Raw (infested/contaminated) trash fish is used for fish feeding
  - parasitic infestations and bacterial infections of farmed fish
  - if feed is not properly handled, proliferation of pathogens (e.g. *C. botulinum*) can take place.
- Research is needed on plant proteins as a viable alternative and the influence on fish health and welfare

# Venn diagram for fish welfare

**Fish's adaptation**

**Farm system**

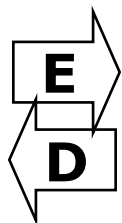


Adaptations not used in farm system

Adaptation used in farm system and evidence of normal function and behaviour

Challenges from farm system for which fish is not adapted and evidence of abnormal function and behaviour

From Turnbull & Kadri, 2007



Factors increasing risk of exposing fish to challenges for which it is not adapted

Factors reducing the risk of exposing fish to challenges for which it is not adapted

- Farmed fish in Europe have a good record of safety with respect to biological hazards
- The risk associated with aquaculture products is very low:
  - low occurrence of pathogens in the production systems and practices in place,
  - the implementation of risk management measures not only at pre-harvest stages but also during harvesting and processing,
  - the hygienic preparation of foods before consumption
- Good Aquaculture Practices result in optimal animal health and welfare, increase fish resistance to infections and therefore can lead to a reduction of the food safety risks
- Some aquaculture practices and conditions inherent to specific production systems may influence the safety of the product
- Pre-harvest and harvest measures are to be complemented by the post-harvest best practices

- Further research on the quantitative relationship between on-farm factors consequentially affecting fish health and welfare, on one hand, and any food safety hazards associated with the resulting food product, on the other, should be encouraged in order to facilitate and improve quantitative risk assessment in the context of the food chain
- Extension of coordinated animal health and welfare / food safety research programs, should be encouraged and supported so as to improve the desired synergism between the two approaches
- Most factors that positively affect fish welfare also contribute to food safety. Where factors promote animal welfare but increase food safety risks, additional risk reduction measures should be implemented

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