This project is financed by the
EUROPEAN UNION

HACCP Case study
Aquaculture-Trout

1. Product description and intended use

1.1. Introduction

There are a variety of potential hazards for most foods, many of which can occur during the processing stage. Since most fish processing plants are capable of processing high volumes of products, foodborne outbreaks can potentially affect large sectors of the population. A hazard may be an unacceptable level of disease-causing micro-organisms or products of microbial activity (i.e. toxins). Hazards may also be caused by chemical substances that reach food inadvertently through various environmental sources, or during food processing, preparation or storage. Hazards can result from food additives that are used in excess of functional or culinary needs; or from materials that leach into highly acidic food from containers, pipes or their toxic coatings. Physical hazards may also occur, for example, glass, metal fragments and insects.

1.2. Terms of reference

The HACCP study covers all types of food safety hazards, biological, chemical and physical. It does not include any cleaning and sanitation operations which are covered by the plant Good Manufacturing Practice procedures and Good Hygiene practice.

1.3. Product description

1.3.1 General

Aquaculture or aquafarming, is the farming of aquatic organisms such as fish, crustaceans, molluscs and aquatic plants. Aquaculture involves cultivating freshwater and saltwater populations under controlled conditions, and can be contrasted with commercial fishing, which is the harvesting of wild fish. Mariculture refers to aquaculture practised in marine environments. The science, art, and business of cultivating marine or freshwater food fish or shellfish, such as oysters, clams, salmon, and trout, under controlled conditions is very advanced in some modern developed processes and very practical and primitive on other side. This case is ilustrated with trout.

1.3.2. Trout

TROUT, aquacultured, *Oncorhynchus mykiss aguabonita, Oncorhynchus clarkii, Oncorhynchus gilae, Oncorhynchus mykiss, Salmo trutta. Salvelinus fontinalis, Salvelinus malma, Salvelinus namaycush, Stenodus leucichthys, Salvelinus alpinus*

1.3.3 Process

See Figure 1 – Process Flow Diagram

1.3.4 Product specifications

Portion size trout (see Bally 2006)

1.3.6 Shelf life

7 days at 4^0C

One (1) year at -18^0C

1.3.5 Package

In containers in fresh water

Or cooled with ice in crates h: 95 mm, W: 320 mm, l: 500 mm

1.3.7 Nutritional values

Trout has in average Water 76.3(%), Proteins 19-20 (%), Fats0.8 (%), Ash1.2 (%), Energy value 351 (kJ/100g) (*Vranić et al 2011*). Trout is reach with PUFA. What is good for nutrition.

1.3.8 Intended use

Consumers: General public all ages.

1.3.9 Uses

Fish can be considered as universal food.

1.3.10 Consumer instructions are as follows

Keep refrigerated ≤ 4 ºC

Consumers should be aware of following hazards

MICROBIOLOGICAL	CHEMICAL	PHYSICAL
• pathogenic (disease causing) micro-organisms • cross-contamination • spoilage micro-organisms (a concern when histamine producing fish) • parasites	• toxins • chemical cleaners/ sanitizers • food additives • undeclared allergens	• foreign bodies • packaging

NOTE: The determination of microbiological hazards requires an understanding of the dangerous organism's profile, in particular, those factors that influence its survival in food. Growth temperature range, water activity requirements, and pH requirements are the main determining factors for the survival and growth of micro-organisms. Much of this information can be found in the Appendix.

2. Key process technologies

2.1. Prepare and sanitize hatchery and management equipment.
ENVIRONMENTAL HYGIENE is essential and hier we refer to the *Recommended International Code of Practice - General Principles of Food Hygiene (CAC/RCP 1-1969, Rev 4 (2003)*

2.2 Fill distribution tank with well water
Mechanical filtration is used to remove particulate contaminants. Daily cleaning and visual inspection of the integrity of the filter is necessary.

2.3 Set up pumps, holding tanks, staging equipment near boat landing and fish collection site
Occasional microbiological test of the final rinse water for the presence of coliforms.

2.4 Capture striped trout broodstock and place in boat holding tank.
Frequent micro-biological test of trout broodstock and relevant equipment is needed.

2.5 Transfer fish by net from boat to staging holding tank that has been filled with river water via portable pump

2.6 Feed fish by feeding regime until mature for market
During the feeding process Good Manufacturing Practice must be applied, mainly respecting, quality of water, hygiene of all activities and good feeding practice keeping optimal temperature for growth and respecting basic principles of feeding practice like specified in Regulation (EC) No 183/2005 laying down requirements for feed hygiene. Microbial and biological and chemical cross contamination must be controlled.(2011 Statement on oral toxicity of endosulfan in fish) and respecting nutritional requremnts to fed identical daily feed rations using spcified **portion sizes.**

2.7 Stage and tag fish, transfer by net to distribution tank after rising fish with well water from truck.
To enable traceability fish should be tagged before going to the market place. If fish is exposed to air or water temperatures above 28.3°C should be placed in ice, or in refrigerated seawater, ice slurry, or brine of 4.4°C) or less, as soon as possible after harvest, but not more than 6 hours from the time of death;

2.8 Transport fish to fish market, unload fish from hauling tanks and transfer to fish house tanks by net.
Good transport Practice must be applied, respecting water quality and safety, aeration and temperature control during the transport .

2.9 Drain water from distribution tank on ground away from ponds and waterways.
Regarding WASTE MANAGEMENT refer to the *Recommended International Code of Practice - General Principles of Food Hygiene (CAC/RCP 1-1969, Rev 4 (2003)*. Water is possibly contaminated with bacteria and virus particles should be discarded in a manner that contact between next production cycle is prevented.

2.10 Clean and sterilize hatchery and management equipment prior to next use.
Regarding MONITORING EFFECTIVENESS refer to the *Recommended International Code of Practice - General Principles of Food Hygiene (CAC/RCP 1-1969, Rev 4 (2003)*.
During preparing facility for next batch one should be aware of potential contaminant as indicated in appendix in table form. 4.1. Identification of CCPs.

3. Process Flow chart

Task
1
Prepare and sterilize hatchery and management equipment.
⇓
Task
2
Fill distribution tank with well water.
⇓
Task
3
Set up pumps, holding tanks, staging equipment near boat landing and fish collection site.
⇓
Task
4
Capture striped trout broodstock and place in boat holding tank.
⇓
Task
5
Transfer fish by net from boat to staging holding tank that has been filled with river water via portable pump.
⇓
Task
6
Feed fish by feeding regime until mature for market
⇓
Task
7
Stage and tag fish, transfer by net to distribution tank after rising fish with well water from truck.
⇓
Task
8
Transport fish to fish market, unload fish from hauling tanks and transfer to fish house tanks by net.
⇓
Task
9
Drain water from distribution tank on ground away from ponds and waterways.
⇓
Task
10
Clean and sterilize hatchery and management equipment prior to next use.
⇓

Figure 1. Flow diagram of trout production

4. A HACCP control chart

4.1. Identification of CCPs

Tasks (from HACCP Step 3 - Flow Diagram)	2 Potential hazards identified in HACCP Step 2	3 Are any potential hazards probable? (yes/no)	4 Justify evaluation for column 3	5 What control measures can be applied to prevent undesirable results?	6 Is this task a critical control point? (yes
Task 1 Prepare and sterilize hatchery and management equipment.	Vertebrates	No	No hazard		No
	Invertebrates Zebra Mussels	Yes	Can be within equipment.	Follow set protocol for sterilization sanitation procedures.	
	All Aquatic Plant Material	Yes	Can be attached to equipment	Visually inspect and remove	
	Microorganisms Ie.: Virus	Yes		Sterilization protocol.	
	Chemical	Yes	Residua of sanitizers	Rinse with additional water	
	Physical	Yes	Stone,	Rinse with additional water	
Task 2: Fill distribution tank with well water.	Vertebrates	No	No hazard		No
	Invertebrates	No	No		
	Plant Material	No	No		
	Microorganisms	No	No		
	Chemical	No	No		
	Physical	No	No		
Task 3:Set up pumps, holding tanks, staging equipment near boat landing and fish collection site.	Vertebrates	No	No hazard		No
	Invertebrates	No	No		
	Plant Material	No	No		
	Microorganisms	No	No		
	Chemical	No	No		
	Physical	No	No		

Task 4: Capture striped trout broodstock and place in boat holding tank.	Vertebrates Other fishes	Yes	Captured fish can be misidentified.	Identify and remove hazards.	No
	Invertebrates Zebra Mussels, Clams	Yes	Can be in water in net.	Drain water from net prior to placing fish in holding tank.	
	Plant Material All aquatic plant material	Yes	Can be dipped with fish.	Remove seen plant material.	
	Microorganisms Pathogens and viruses	Yes	Can be if fish is sick	Check health status	
	Chemical	No			
	Physical	No			

Task 5:Transfer fish by net from boat to staging holding tank that has been filled with river water via portable pump.	Vertebrates other fish	yes	Captured fish can be misidentified.	Identify and remove hazards.	No
	Invertebrates Zebra Mussels, Clams	Yes	Can be in water in net.	Drain water from net prior to placing fish in holding tank.	
	Plant Material All aquatic plant material	Yes	Can be dipped with fish.	Remove seen plant material.	
	Microorganisms	Yes	Can be if fish is sick	Check health status	
	Chemical	Yes	Can be if step 10 vas nod done properly	Rinse once more	
	Physical	Yes	Stone and sand	Filter water	

Task 6: Feed fish by feeding regime until mature for market	Vertebrates	No			Yes
	Invertebrates	No			
	Plant Material	No			
	Microorganisms Different fish and human pathogens	Yes	Can be present if feed is not thermally processed	Regular testing of feed	
	Chemical Mycotoxins Drug residua	Yes	Depends on row materials quality	Regular testing of feed	
	Physical	Yes	Sand,	Regular testing of feed	

Task 7: Stage and tag fish, transfer by net to distribution tank after rising fish with well water from truck.	Vertebrates Other fishes	Yes	Captured fish can be misidentified.	Identify and remove hazards.	Yes
	Invertebrates Zebra Mussels, Clams	Yes	Can be in water in net.	Drain water from net.	
	Plant Material All aquatic plant material	Yes	Can be dipped with fish.	Remove seen plant material.	
	Microorganisms Pathogens and viruses	Yes	Can be if fish is sick	Check health status and remove	
	Chemical	No			
	Physical	No			

Task 8:Transport fish to fish market, unload fish from hauling tanks and transfer to fish house tanks by net.	Vertebrates Other fishes	No			Yes
	Invertebrates Zebra Mussels, Clams	Yes	Can be in water in net.	Drain water from net	
	Plant Material All aquatic plant material	Yes	Can be dipped with fish.	Remove seen plant material.	
	Microorganisms Pathogens and viruses	No			
	Chemical	No			
	Physical	No			

Task 9: Drain water from distribution tank on ground away from ponds and waterways.	Vertebrates	No			No
	Invertebrates	No	Cane be some	Drain water away from ponds and waterway.	
	Plant Material	Yes			
	Microorganisms	Yes	Can be some	Drain water away from ponds and waterway.	
	Chemical	No			
	Physical	No			

Task10: Clean and sterilize hatchery and management equipment prior to next use	Vertebrates	No		Drain water away from ponds and waterway after clening and disinfection is done.	Yes
	Invertebrates	Yes			
	Plant Material	Yes			
	Microorganisms	Yes			
	Chemical, sanitisers, Heavy metals	Yes			
	Physical sand,	Yes			

* Questions of the Decision Tree
Q1 Is there a hazard associated with this raw material?
Yes: Go to Q2 / *No*: Proceed to next raw material
Q2 Are you or the consumer going to process this hazard out of the product in a subsequent step?
Yes: Go to Q3 / *No*: CCP. Sensitive raw material, high level of control required
Q3 Is there a cross-contamination risk to the facility or to other products which will no be controlled?
Yes: CCP. Sensitive raw material, high level of control required. / *No*: Proceed to next raw material

5. Critical Control Points (CCP)

5.2 Controlling of CCPs

Critical Control Point (CCP)	Significant Hazard(s)	Limits for each Control Measure	What	How	Frequency	Who	Evaluation &Corrective Action(s) (if needed)	Supporting Documentation (if any)
Task 6	Foreign fishes ie:White Perch, Asian Carp, Hybrid Striped Bass, Zebra	Zero Tolerance	Fish and water	Visually inspect with eye and microscope	Once during task and sample hatchery	Staff	Follow established protocol	

	Mussels, Asian Clams, All Aquatic Plant Material, Virus bacteria				Biannually for patogens and viruses			
Task 7	Zebra Mussels, Clams, All Aquatic Plant Material, Virus mycotoxins	Zero Tolerance	Fish and water	Visually inspect with eye and microscope	during task and sample hatchery Biannually for patogens and viruses And safety of feed	Staff	Follow established protocol	
Task 10	Mussels, Clams, Virus bacetria Residua of sanitisers and drugs and heavy metals	Zero Tolerance	Equipment and water	Visually inspect with eye and sampling	Each batch	Staff	Follow established protocol	

5. Key control measures, Critical limits, Monitoring Systems and Corrective actions

The close confinement of aquaculture provides circumstances under which stress is a common phenomenon, and the transmission of diseases relatively easy. Therefore, fish culturists rely on approved chemicals to overcome unavoidable problems. For example, certain chemicals are used as anesthetics that reduce trauma to animals; disinfectants are used to remove pathogens, and antiseptics, antibacterial, virucides, fungicides and antiparasitics are used to control specific disease organisms.
Additionally, chemicals are often used to improve water quality, to remove or to control algal blooms or vegetations, or to remove nuisance aquatic organisms. However, the use of these chemicals must not contaminate human food supply and the natural ecosystems. To ensure safety of the food supply, national agencies and international organizations must regulate the aquaculture industry (Fong 81 Brooks, 1989).
If an aquaculture pond is to be constructed on agricultural land, soil must be tested for pesticide residues, particularly for persistent pesticides. Transfer of pesticide residues from soil to animals, through water, must be avoided. Chemicals introduced via construction materials, such as stabilizers, pigments, antioxidants, and antifouling compounds, also could be harmful. A potential health hazard introduced by pesticides and construction chemicals into the human food supply has to be carefully evaluated (Fong & Brooks, 1989).
The lack of approved drugs for disease control has been cited as a primary obstacle to develop aquaculture production. Many drugs currently used in aquaculture do not have established withdrawal times for cultured species and lack proper government approval and/or international recognition. Concern ranges from consumption of any drug residuals in cultured products to potential generation of antibiotic-resistant bacteria. Likewise, food ingredients that are used intentionally such as color additives, flavorings, and medication, or those which occur unintentionally, such as heavy metals, mycotoxins, toxic chemicals, and potential microbial

pathogens must be legal to the intended use and comply with national and international guidelines (Otwell, 1989). Worldwide, regulatory response for drug and feed use lags behind aquaculture development. At the international level, these chemicals are classified within the group of food additives and contaminants by the joint FAO/WAO Expert Committee on Food Additives (JESFA). (Srisomboon, Pooimchatra, 1995).

References

1. Bartley, D. M. & Subasinghe, R. . (1995)Historical aspects of international movement of living aquatic species. OIE International Conference, Paris, June 1995.
2. Carlton, J.T. (1995) The what?: The ICES/EIFAC Codeos f Practices, and their rolien reducing the spread of aquatic animal diseases. OIE International Conference, Paris, June 1995.
3. Doulman, W. (1 995)Animal Health Rules governing trade in aquatic animals within and to the European Community. OIE International Conference, Paris, June, 1995. EEC (1990)
4. Proposition de réglement (CEE) du conseil relatif aux conditions de police sanitaire régissant la mise sur le marchi! d'animauext de produits d'aquaculture. CLM (896) 55 final, CEE, Bruxelles, le 2 février 1990.
5. Fong, W. G. & Brooks, G. M. (1989)Regulations of chemicals for aquaculture use. Fd. Technology, Nov 1989: 88-93
6. Garrett, E. S. & Jahncke, M. (1994)HACCP in Aquaculture. Paper presented at International Association of Milk, Food, and Environmental Sanitarians (IAMFES) Meeting, San AntonioT, X, USA, August 3, 1994:14 PP
7. Håstein, T. (1 995)OIE International Aquatic Animal Health Code. OIE International Conference, Paris, June 1995.
8. *Vranić D., Đinović-Stojanović J., Spirić A.,* Rainbow trout (*Oncorhynchus Mykiss*) from aquaculture, – meat quality and importance in the diet , Tehnologija mesa 52 (2011) 1, 122–133
9. Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes
10. Species-specific welfare aspects of the main systems of stunning and killing of farmed fish: Rainbow Trout, doi:10.2903/j.efsa.2009.1012 http://www.efsa.europa.eu/en/efsajournal/pub/1012.htm
11. *International Code of Practice - General Principles of Food Hygiene (CAC/RCP 1-1969, Rev 4 (2003).*
12. Statement on oral toxicity of endosulfan in fish , EFSA Journal 2011;9(4):2131 [22 pp.]. doi:10.2903/j.efsa.2011.2131
13. Regulation (EC) No 183/2005 laying down requirements for feed hygiene
14. Aquatic Animal Health Code 2011, http://www.oie.int/en/international-standard-setting/aquatic-code/access-online/
15. Bailey J., Alanärä A,: Effect of feed portion size on growth of rainbow trout, Oncorhynchus mykiss (Walbaum), reared at different temperatures, Aquaculture 253 (2006) 728–730

APENDIX
1. Biological contaminates

Table 1 Potential contaminants

Trout, aquaculture/ latin names	Parasites *Anisakis simplex*	Natural toxins	Scombrotoxin	Environmental see apendix	Aquaculture drugs see apendix
Oncorhynchus mykiss aguabonita				✓	✓
Oncorhynchus clarkii				✓	✓
Oncorhynchus gilae				✓	✓
Oncorhynchus mykiss				✓	✓
Salmo trutta				✓	✓
Salvelinus fontinalis				✓	✓
Salvelinus malma				✓	✓
Salvelinus namaycush				✓	✓
Stenodus leucichthys				✓	

Table 2: Bacteria Pathogens

PATHOGEN	SENSITIVE SEAFOOD
Viral infections: norovirus, hepatitis	a. Raw or undercooked shellfish from contaminated waters
Vibrio parahaemolyticus	b. Fermented salmon roe a. Raw oysters b. Cooked and picked crabmeat c. Frozen cooked shrimp, prawns, and lobster tail d. Fish eaten raw e. Frozen raw shrimp, prawns, and lobster tail f. Frozen raw breaded shrimp and prawns
Vibrio vulnificus	a. Raw oysters
Clostridium botulinum	a. Smoked fish, including kippered and cold smoked, eaten uncooked
Listeria monocytogenes	a. Cooked crab and shrimp eaten without further cooking b. Cold smoked fish eaten without further cooking
Salmonella	a. Freshwater fish from warm waters b. Contaminated shellfish
Staphylococcus aureus	a. Smoked fish eaten uncooked b. Frozen cooked shrimp, prawns, and lobster tails
Anisakis simplex	a. Smoked / dried fish eaten uncooked

Table 3: Growth and Heat Inactivation Characteristics of Food Poisoning Bacteria Important in Seafood Processing

Bacteria	Growth Temperature (°C)			Lowest Ph for Growth	Maximum NaCl (%) Tol.
	Minimum (a)	Optimum (a)	Maximum (a)		
C. botulinum types A & B	10°	35°	50°	4.7	10.0
C. botulinum type E	3°	15°	30°	4.7	6.0
Vibrio spp.	5°	37°	43°	4.8	9-10
Salmonella	5°	37°	46°	3.8	8.0
Shigella	6°	-	47°	4.9	-
S. *aureus*	7°	37°	48°	4.0	17.0
C. *perfringens*	4°	45°	50°	5.0	5.0
Listeria monocytogenes	-0.4°	45°	50°	5.5	30.0

ICMSF (1996) Micro-organisms in Food 5: Characteristics of Microbial Pathogens, Roberts, T.A., Baird-Parker, A.C. and Tompkin, R.B. (eds) Blackie Academic & Professional London [ISBN 0412 47350X]

1. Chemical Contaminants and Pesticides

For detals see
http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/Seafood/FishandFisheriesProductsHazardsandControlsGuide/ucm256690.htm

Table "Environmental Chemical Contaminants and Pesticides Tolerance and Action Levels," lists the tolerance and action levels that have been established for environmental chemical contaminants and pesticides in the edible portion of fish (wet weight).

Deleterious Substance	**Level in Edible Tissue**
PCBs	2 ppm
Diquat	2 ppm
Endothall and its monomethyl ester	0.1 ppm
Glyphosate	0.25 ppm
2,4-D	0.1 ppm
Aldrin and dieldrin1	0.3 ppm
Chlordane	0.3 ppm
Chlordecone2	0.3 ppm
DDT, TDE, and DDE3	5 ppm

For details see http://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/Aquaculture/default.htm

Approved aquaculture drugs

For details see
(http://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/Aquaculture/ucm132954.htm).

Chorionic gonadotropin
Formalin solution
Florfenicol
Tricaine methanesulfonate (MS-222)
Oxytetracycline
Hydrogen peroxide
Sulfamerazine

FDA low regulatory priority aquaculture drugs
Acetic acid
Calcium chloride
Calcium oxide
Carbon dioxide gas
Fullers earth
Garlic (whole form)
Ice
Magnesium sulfate
Onion (whole form)
Papain
Potassium chloride
Povidone iodine
Sodium bicarbonate
Sodium chloride
Sodium sulfite
Thiamine hydrochloride
Urea and tannic acid