Code of practice for fresh and frozen salmon and trout

National code for export to the Russian Federation

The Norwegian Seafood Research Fund

Norwegian Seafood Federation (FHL)

Norwegian Seafood Association (NSL)

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Emphasis: Control of operation for *Listeria monocytogenes*

Contents

Introduction

International food trade is increasing, bringing important social and economic benefits. Effective hygiene control is vital to avoid the adverse human health and economic consequences of foodborne illness, foodborne injury and food spoilage. Everyone in the food chain has a responsibility to assure that food is safe and suitable for consumption to protect the health of consumers and ensure fair practice in food trade (Codex Alimentarius Recommended International Code of Practice General Principles of Food Hygiene, CAC/RCP 1 - 1969).

This Code of practice has been developed by the The Norwegian Seafood Research Fund, in co-operation with the Norwegian Seafood Federation (FHL) and the Norwegian Seafood Association (NSL) to attain safe and wholesome salmon and trout products that can be sold on the Russian market. The Code applies to the approved Norwegian companies exporting dressed (whole fish, gutted and washed) fresh and frozen salmon and trout to the Russian Federation.

This Code of practice is developed in accordance with the Codex Alimentarius Standards, as a collection of internationally adopted food standards. Good Hygiene Practice as specified in the Recommended International Code of Practice – General Principles of Food Hygiene (CAC/RCP 1-1969) is an essential part of the general strategy for control of foodborne pathogens including Hazard Analysis and Critical Control Points (HACCP).

The main focus throughout this Code of practice is on the control of *Listeria monocytogenes.* The basis of the Code is the Codex Alimentarius Guidelines on the Application of General Principles of Food Hygiene to the Control of *Listeria monocytogenes* in Foods (CAC/GL 61 – 2007). While this Code of practice is intended for the production of dressed salmon and trout in frozen or chilled state, the Codex CAC/GL 61-2007 is intended for ready-to-eat foods. The focus on *Listeria monocytogenes* in ready-to-eat foods in the Codex CAC/GL 61 – 2007 is based on the result of the FAO/WHO risk assessment, other available risk assessments and epidemiological evaluations. Codex Alimentarius General Guidelines on Sampling (CAC/GL 50 – 2004) is used to facilitate the selection of sampling plans.

The Norwegian food hygiene legislation complies with the legislation of the European Economic Area, which is the basis for the Norwegian exporting companies. The European food hygiene legislation complies with the Codex Alimentarius concerning microbiological criteria for *Listeria monocytogenes,* focusing on certain ready-to-eat foods and not seafood in general. This is in line with a risk based approach as international governmental risk assessments have identified ready-to-eat products with the ability to support the growth of *Listeria monocytogenes,* to represent a significant risk (FAO/WHO, 2004).

However, this Code of practice for fresh and frozen salmon and trout contains selected elements to meet requirements from the national legislation of the Russian Federation regarding microbiological criteria for *Listeria monocytogenes* in fish and fishery products (SanPiN 2.3.21078-01).

The different elements in this Code of practice will be implemented in the quality systems and HACCP plans in Norwegian salmon and trout companies approved for export to the Russian Federation.

Section 1. Objective and Scope

The Code of practice for fresh and frozen salmon and trout applies to the approved Norwegian companies exporting to the Russian Federation. The Code identifies some hygiene specific requirements to assure that the food is safe and suitable for consumption. The overall objective of this document is to protect the health of consumers and ensure fair practice in food trade.

This Code of practice lays down some specific criteria to reduce the risk of hazards that may be associated with salmon and trout production. The Code is limited to the production of dressed salmon and trout covering the steps from receiving live salmon and trout to dispatching of the final fresh or frozen fish for distribution.

To meet requirements from the national legislation of the Russian Federation regarding microbiological criteria for *Listeria monocytogenes* in fish and fishery products requiring absence in 25 g (San PiN 2.3.2 1078-01), this code of practice focuses on prevention of *Listeria monocytogenes* at the production steps covered by the flow diagram in Figure 1. section 5. The code will assist the companies to control the occurrence of *Listeria monocytogenes* in salmon and trout production.

Section 2. Definitions

- **Batch -** a group or set of identifiable products obtained from a given process under practically identical circumstances and produced in a given place within a defined production period
- **Cleaning** – the removal of soil, food residue, dirt, grease or other objectionable matter.
- **Contaminant** – any biological or chemical agent, foreign matter, or other substances not intentionally added to food which may compromise food safety or suitability.
- **Contamination** – the introduction or occurrence of a contaminant in food or environment. This also includes cross contamination, i.e. indirect contamination caused by contact with previously infected raw food or non-food sources
- **Critical Control Point (CCP)** – a step which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.
- **Disinfection** – the reduction, by means of chemical agents and/or physical methods, of the number of micro-organisms in the environment, to a level that does not compromise food safety or suitability.
- **Flow diagram** – a systematic representation of the sequence of steps or operations used in the production or manufacture of a particular food item.
- **Food hygiene** - all conditions and measures necessary to ensure the safe and suitability of food at all stages of the food chain.
- **Food safety** – assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use.
- **Food suitability** – assurance that food is acceptable for human consumption according to its intended use.
- **Hazard** - a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.
- **HACCP** - a system which identifies, evaluates, and controls hazards which are significant for food safety.
- **Ready-to-eat-food** - any food which is normally eaten in its raw state or any food handled, processed, mixed, cooked, or otherwise prepared into a form which is normally eaten without further listericidal steps.

Section 3. General considerations for prerequisite programs, Hazard analysis and Critical Control Point (HACCP) and Defect Action Point Analysis (DAP)

Each salmon and trout processing company shall ensure that the products covered by this Code of practice are prepared and handled in accordance with a prerequisite program, a HACCP system and a DAP analysis. Specifications to the prerequisite program and HACCP refers to Codex Alimentarius Recommended International Code of Practice – General Principles of Food Hygiene and the Hazard Analysis and Critical ControlPoint (CAC/RCP 1-1969) and other relevant Codex texts such as Code of practice for Fish and Fishery products (CAC/RCP 52 – 2003) and Guidelines on the application of general principles of food hygiene to the control of *Listeria monocytogenes* in foods (CAC/GL 61 – 2007). A prerequisite program together with HACCP provides a successful framework for the control of *Listeria monocytogenes.*

Well established and operational prerequisite programs and HACCP systems are the basis for this Code of practice for fresh and frozen salmon and trout.

Prior to the application of a HACCP based approach, a solid foundation of good hygienic practices must exist. This is covered in the prerequisite program and ensures that the facility is operating according to the Codex Principles of Food Hygiene, the Code of practice and appropriate food safety legislation. In this Code of practice, prerequisite issues have been limited to those related to microbial food safety and especially to the control of *L. monocytogenes.* (Section 6. Control of operations)

The purpose of the hazard analysis in HACCP is to identify all food safety hazards at each step, to determine their significance and to assess whether control measures for those hazards are available at each step. Defect Action Point Analysis (DAP) serves the same purpose for other aspects of production including the potential quality and labeling defects. It is important to identify potential hazards and defects in the operation from the point of view of plant construction, equipment used and hygiene practices. This is covered by the prerequisite program and is used to denote hazards and defects that are common to almost any point in the process. (Ref CAC/RCP 52 – 2003)

Food business operators shall control food hazards through the use of HACCP to:

- Identify any steps in their operations which are critical to the safety of food
- Implement effective control procedures at those steps
- Monitor control procedures to ensure their continuing effectiveness
- Review control procedures periodically, and whenever the operations change.

(Codex CAC/RCP 1 – 1969)

See section 5., with a HACCP based review through a flow diagram for salmon and trout.

Section 4. Potential hazards associated with the products

It is important to consider naturally occurring food safety hazards in the environment from which the fish are harvested. In general, risks to consumer health from seafood captured in unpolluted marine environments are low provided that these products are handled in line with principles of good manufacturing practice (GMP).

The two primary factors that determine whether a hazard or defect is significant are probability of occurrence of an adverse health effect and the severity of the effect.

The type of processing the fish will undergo, and its subsequent storage, will determine their risk to human health and inclusion in a food safety management plan. (CAC/RCP 52 – 2003)

4.1. Microbiological hazards

Listeria monocytogenes is considered to be an important human pathogenic bacterium in seafood. This is based on the fact that *L. monocytogenes* can cause severe illness in humans, and that it is able to survive and grow at refrigerating temperatures. Hence, the main focus in this document lies on *Listeria monocytogenes.* The main risk for spreading *L. monocytogenes* is due to contamination during processing (CAC/GL 61-2007, Guidelines on the application of general principles of food hygiene to the control of *Listeria monocytogenes* in foods). As the Russian hygiene legislation has specific requirements for *L. monocytogenes* in all fish and fishery products, requiring absence in 25 g (San PiN 2.3.2 1078-01), the main focus lies on *L. monocytogenes*.

Listeria monocytogenes is a bacterium that is commonly present in the environment and in food. Most people who are otherwise healthy and not pregnant may tolerate exposure to quite high levels of the bacterium in their food. The organism is important because infection during pregnancy is associated with a risk of severe infection of the mother and the foetus or new-born infant that may result in death. Listeriosis is an infection that most often affects individuals experiencing immunosuppression, including individuals with chronic diseases, elderly, foetus or new-borns, and individuals being treated with immunosuppressive drugs.

The foods associated with listeriosis have mainly been ready-to-eat products that are typically held for extended periods at refrigeration or chill temperatures. Smoked fish is one of the specific foods implicated in outbreaks and sporadic cases of listeriosis.

Vibrio cholera, Vibrio parahaemolyticus, Vibrio vulnificus, Staphylococcus aureus and staphylococcus enterotoxin, which may be a problem in fish from warmer waters, is today not considered a risk in Norwegian salmon and trout, and is therefore not addressed in this code.

Both for Norovirus and Hepatitis A virus fresh produce, bivalve mollusks and prepared (ready to eat) foods are identified as the commodity of concern where special attention is needed. For slaughtering and packing of degutted salmon, personal cleanliness and personal hygiene of the staff in line with Codex principles and the FHL guidelines are appropriate and adequate measures to control the risk.

4.2. Biological hazards

The EFSA opinion on risk assessment of parasites in fishery products (EFSA Journal 2010; 8(4):1543) concludes that where farmed Atlantic salmon is reared in floating cages or onshore tanks, and fed compound feedstuffs, which are unlikely to contain live parasites, the risk of infection with larval anisakis is negligible. The same applies on other salmonids reared in the same conditions. This is reflected in the new EU hygiene legislation. In Norway all Atlantic salmon and rainbow trout farmed in seawater are reared under those conditions, and the risk of infection is negligible. Further control of hazards is therefore redundant.

Biotoxins and scombrotoxin are not considered as risks in salmon and trout.

4.3. Chemical hazards

In Norway the use of veterinary drugs in fish farming is strictly regulated. Only authorized veterinarians and fish health personnel may prescribe veterinary drugs and every prescription has to be reported to the Norwegian Food Safety Authority (NFSA). Before slaughtering fish, NFSA has to be notified, this includes information on the use of veterinary drugs, and it is cross checked with information on withdrawal time. For many years NFSA has monitored farmed fish for residues of veterinary drugs and illegal substances, documenting that everything is in line with food safety regulations.

4.4. Russian product requirements

The following product requirements for fresh and frozen are extracted from the national legislation of the Russian Federation with regard to hygiene in fresh fish (SanPiN 2.3.2.1078-01, Annex 1)

Product category	Mesophile and facultative anaerob bacteria CFU/g, less then	[3]coliform bacteria	*S. aureus*	Pathogen bacteria including *Salmonella* and *Listeria monocytogenes*	*V. para-haemolyticus* in salt water fish[2] CFU/g, less then
Raw material and fresh fish	Less then 50 000 cfu[1]/g	Not detected in 0,01 g	Not detected in 0,01 g	Not detected in 25 g	Less then 100 cfu/g
Fresh , chilled and frozen fishery product: Fish fillet	100 000 cfu/g	Not detected in 0,001 g	Not detected in 0,01 g	Not detected in 25 g	Less then 100 cfu/g

[1]Cfu= Colony forming units

[2]Salmon and trout are considered salt water fish in this regulation

Section 5. Processing of fresh and frozen salmon and trout

This section is a HACCP based approach focusing on *Listeria monocytogenes* to meet specific requirements in the Russian sanitary legislation for production of fresh and frozen salmon and trout for export to the Russian market, requiring absence of *Listeria monocytogenes* in 25 g in all fish and fishery products regardless whether it is a ready-to eat product or not. (San PiN 2.3.2 1078-01)

In the context of recognizing controls at individual processing steps, this section provides examples of potential hazards and defects and describes technological guidelines that can be used to develop control measures and corrective actions. At a particular step, only the hazards that are likely to be introduced or controlled at the step are listed. Particular attention has been given to the risk of contamination by *Listeria monocytogenes*. It should be recognized that in preparing a HACCP plan it is essential to consult the Codex guidance for the application of the HACCP principles. (CAC/RCP 52 – 2003)

As this Code focuses on the export of fish to the Russian market, the described steps are limited to the production of dressed salmon and trout in frozen or chilled state. Regardless of the complexity of a particular process, the production of the desired product relies on the consecutive execution of individual steps. As stressed in this Code, the application of appropriate elements of the prerequisite program and HACCP principles (Section 3) at these steps will provide the producer (business operator) with reasonable assurance that the essential quality, composition and labeling provisions of the appropriate Codex Standard will be maintained and food safety issues controlled. (CAC/RCP 52 – 2003)

The application of additional control measures with regard to *L. monocytogenes* as described in this code of practice will provide the producer with reasonable assurance that the specific Russian sanitary requirements will be met.

The example of the flow diagram (Figure 1.) will provide guidance to the common steps involved in the preparation of dressed salmon and trout from fresh, live fish in Norway.

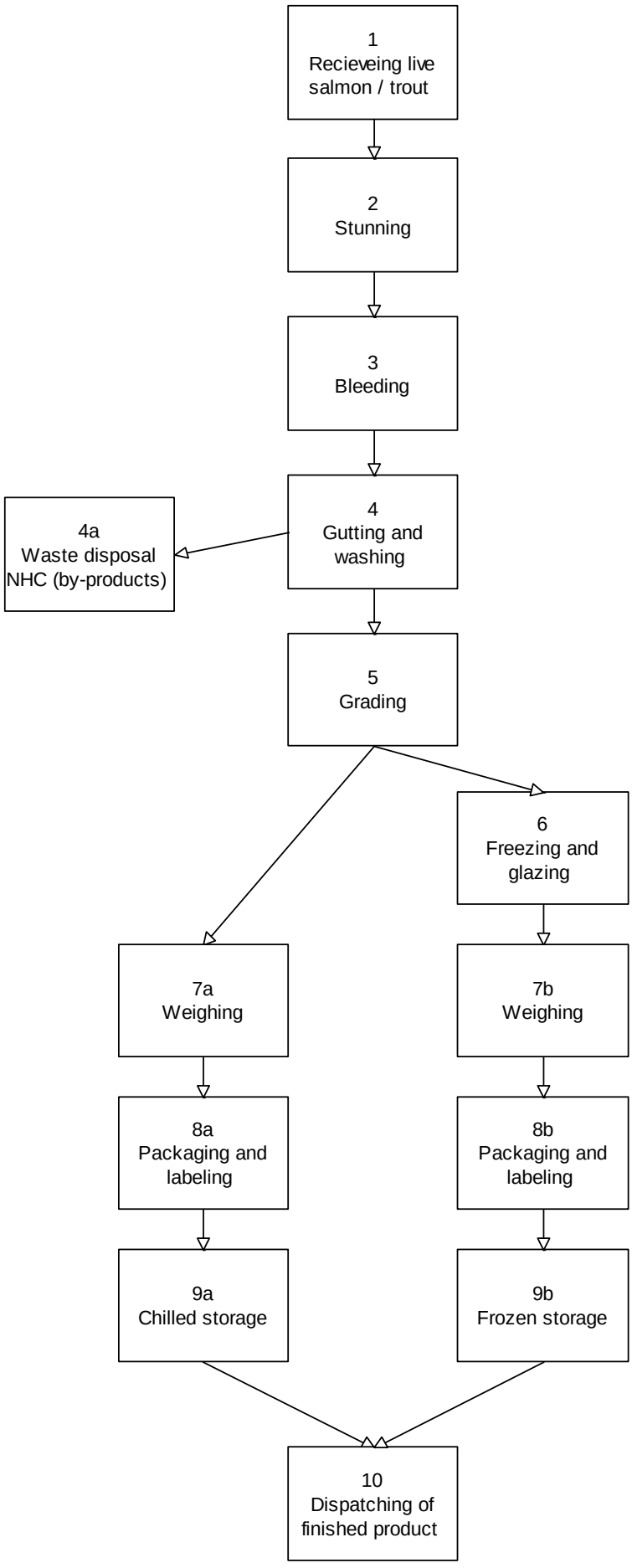
1
Recieveing live salmon / trout
2
Stunning
3
Bleeding
4
Gutting and washing
4a
Waste disposal NHC (by-products)
5
Grading
6
Freezing and glazing
7a
Weighing
7b
Weighing
8a
Packaging and labeling
8b
Packaging and labeling
9a
Chilled storage
9b
Frozen storage
10
Dispatching of finished product

Figure 1: Flow diagram of the common steps in the production of dressed salmon and trout from fresh live fish in Norway.

This section is a HACCP based approach to focus on *Listeria monocytogenes* to meet requirements in the Russian legislation for seafood.

5.1. Receiving live salmon and trout

It is important to monitor the microbial quality of the raw material, as contaminations will be carried on to subsequent processing steps and may lead to contamination throughout the production line.

Where appropriate, the monitoring of the raw material with regard acceptance according to product specification and the sampling may be performed at a later stage, after stunning and bleeding but before grading.

5.1.1. Potential hazards

Microbial contamination *(Listeria monocytogenes)* from seawater (sewage, fecal contamination etc.) especially on skin and gills

Potential defects: Decomposition, physical contamination

5.1.2. Technical guidance

Fish should be handled in such a way to avoid unnecessary stress.

Fish should be rejected if it is known to contain harmful, decomposed or extraneous substances.

Only healthy and undamaged fish should be chosen, damaged, sick and dead fish should be removed before introduction to holding or conditioning tanks.

Water should not be contaminated with either human sewage or industrial pollution. Holding tanks and transportation systems should be designed and operated in a hygienic way to prevent contamination of water and equipment. Fish should be transported to chilling or freezing facilities immediately after reception and be protected from the sun or other heat sources at all times.

Where appropriate (see 5.1 and 5.3.2):

Sampling plan for *Listeria monocytogenes*

Product specifications for fish raw material including:

Organoleptic characteristics, such as appearance, odor and texture

5.2. Stunning

5.2.1. Potential hazards

Microbial contamination from other fish, surroundings and fish handling personnel

5.2.2. Technical guidance

Refer to guidelines for personal hygiene in section 6.4.

5.3. Bleeding

5.3.1. Potential hazards

Microbial contamination by equipment, handling personnel and between fish

5.3.2. Technical guidance

Refer to guidelines for sanitation and personal hygiene in section 6.3 and 6.4.

Where appropriate (see 5.1 and 5.1.2):

Sampling plan for *Listeria monocytogenes*

Product specifications for fish raw material including:

Organoleptic characteristics, such as appearance, odor and texture

5.4a. Gutting and washing

5.4a.1. Potential hazards

Microbial contamination by gutting equipment and handling personnel as well as contamination with pathogens from fish viscera

5.4a.2. Technical guidance

Product specifications for fish raw material including:

- Organoleptic characteristics, such as appearance, odor and texture

Fish should be gutted efficiently, without undue delay and with care to avoid contamination.

Gutting is considered complete when the intestinal tract and internal organs have been removed.

An adequate supply of clean seawater or potable water should be available for washing of whole fish, to remove foreign debris and reduce bacterial load prior to gutting.

Refer to guidelines for sanitation and personal hygiene in section 6.3 and 6.4.

5.4b. Waste disposal NHC (by-products)

5.4b.1. Potential hazards

Microbial growth in waste and by-products

Microbial contamination of fish being processed by viscera and handling personnel

5.4b.2. Technical guidance

Any type of production waste should be discarded in separate, clean containers. Waste should not be kept in the same container for more than 1.5 hours (SanPiN 2.3.21078-01) without chilling or other proper preservation method

Separate and adequate storage facilities should be provided for fish viscera, if they are saved for later utilization.

Refer to guidelines for sanitation and personal hygiene in section 6.3 and 6.4.

5.5. Grading

5.5.1. Potential hazards

Microbial contamination by grading machines and handling personnel

5.5.2. Technical guidance

Refer to guidelines for sanitation, maintenance and personal hygiene in section 6.3 and 6.4.

5.6. Freezing and glazing (Processing steps 6 and 7)

5.6.1. Potential hazards

Contamination by contact surfaces and between fish

5.6.2. Technical guidance

The fish product should be subjected to a freezing process as quickly as possible.

A time and temperature regime should be established and should take into consideration the freezing equipment and capacity, the nature of the fish product including thermal conductivity, thickness, shape and temperature and the volume of production to ensure that the range of temperature of maximum crystallization is passed through as quickly as possible.

The thickness, shape and temperature of fish entering the freezing process should be as uniform as possible.

Ice should be prepared from clean or potable water.

Processing facility production should be geared to the capacity of freezers.

The core temperature of the frozen fish should be monitored regularly for the completeness of the freezing process.

Frequent checks should be made to ensure correct operation of freezing.

Accurate records of all freezing operations should be kept.

The facility should be capable of maintain the temperature of the fish at or colder than - 18 °C, and with minimal temperature fluctuations.

A systematic stock rotation plan should be developed and maintained.

The store should be equipped with a calibrated indicating thermometer - preferably a recording thermometer.

A systematic stock rotation plan should be developed and maintained.

Products should be glazed and / or wrapped to protect it from dehydration.

Glazing is considered complete when the entire surface of the frozen fish should be covered with a suitable protective coating of ice.

Where dips are used for glazing, the glazing solution should be replaced periodically to minimize the bacterial load and buildup of fish protein.

5.7. Weighing

5.7.1. Potential hazards

Contamination by contact surfaces and handling personnel

Incorrect weight and calibration

5.7.2. Technical guidance

Weight should be calibrated and weighing surroundings should be inspected regularly for parts that are cracked, worn or have developed spaces where food and moisture can accumulate. Weights should be cleaned and disinfected according to a plan.

The products should meet appropriate standards for net weight.

Refer to guidelines for sanitation and personal hygiene in section 6.3 and 6.4.

5.8. Packaging and labeling

5.8.1. Potential hazards

Microbiological contamination by packaging materials, packaging equipment or personnel

Package damaging can lead to subsequent growth of microbial pathogens

Too long expiration dates facilitate the growth of pathogenic bacteria to unacceptable levels

5.8.2. Technical guidance

Refer to guidelines for sanitation and personal hygiene in section 6.3 and 6.4.

Ice should be prepared from clean or potable water. Enough ice should be used to ensure proper temperature during storage and transport.

Packaging material should be clean, sound and durable and of food-grade material

Packaging material should be stored appropriately in terms of temperature and humidity.

Packaging materials should be properly protected and segregated to prevent contamination.

Defective packaging material should not be used.

Packaging machines and work surroundings should be inspected regularly for parts that are cracked, worn or have developed spaces where food and moisture can accumulate.

Packaging material integrity should be examined by trained personnel before and after packaging to avoid leakage.

Labels should be verified to ensure that all information declared meets, where applicable, the General Standard for the labeling of prepackaged foods (CODEX STAN 1-1985), labeling provisions of the appropriate Codex Standard for products and / or other relevant national legislative requirements.

Plans should be in place for regularly validation of expiration dates.

Products should be transported to chilled storage immediately after packaging.

5.9. Chilled and frozen storage

5.9.1. Potential hazards

Growth of microbial pathogens during chilled storage or contamination from fish, contact surfaces or handling personnel

5.9.2. Technical guidance

Fish should be moved to the chilled storage facility without undue delay.

The facility should maintain the temperature of the chilled storage room between 0 and + 4 °C.

The chill room should be equipped with a calibrated thermometer, preferably a recording thermometer.

Stock rotation plans should ensure proper utilization of the fish.

The fish should be stored in shallow layers and surrounded by sufficient finely divided ice.

Fish should be stored such that damage from overstacking or overfilling of boxes will be prevented.

Ice should be prepared from clean or potable water.

Where appropriate, the ice supply on the fish should be replenished or the room temperature should be controlled and adjusted.

Refer also to section 5.6.

5.10. Dispatching of finished product

5.10.1. Potential hazards

Package damaging and thereby microbial contamination of the product

5.10.2. Technical guidance

Careful handling of products to avoid damage

Section 6. Control of operations

This Code of practice focuses on control measures of processing operations to reduce the frequency and level of microbial contamination in dressed salmon and trout in frozen or chilled state. The Codex Alimentarius Recommended International Code of Practice – General Principles of Food Hygiene and the Hazard Analysis and Critical Control Point (CAC/RCP 1-1969) reflects what is considered the best scientific practice to ensure the safety and suitability of food for consumption in general. The Codex Alimentarius Guidelines on the Application of General Principles of Food Hygiene to the Control of *Listeria monocytogenes* in Foods" (CAC/GL 61 – 2007) describes additional measures for risk-based control of *L. monocytogenes* in ready-to-eat foods. Well established and operational prerequisite programs and HACCP systems are basis for these guidelines (Section 3). The control strategies in this code of practice have a basis in the above guidelines and are focused and specified on control of *L. monocytogenes* within the range of the schematic production process in **Fig. 1**. For guidelines reflecting design and facilities of establishment, we refer to the two codes of practice CAC/RCP 1-1969 and CAC/GL 61 – 2007. Specified measures described in this Code are in accordance with Codex Alimentarius guidelines and should be consulted and implemented, as necessary to control *L. monocytogenes* in the production process of salmon and trout for export to the Russian market. Individual manufacturers must adapt and refine their own control measures according to their specific process using a risk-based HACCP approach.

Key elements in the control of *L. monocytogenes* in the fish production process include

1) Raw materials control

2) Environmental monitoring and control

3) Finished product control

4) Sanitation and maintenance

5) Personal hygiene and management

6) Temperature control

6.1 Microbial criteria

Where microbiological specifications are used in a food control system, such specifications should be based on sound scientific principles and state, where appropriate, monitoring procedures, analytical methods and action limit. (Codex Alimentarius CAC/RCP 1 – 1969)

Microbial criteria provide guidance on the acceptability of foods and the processing environments in terms of microbial safety. Current knowledge has not identified fresh and frozen salmon and trout to be involved in listeriosis outbreaks and significant growth of *L. monocytogenes* is unlikely to occur within the shelf-life of these products. *Listeria monocytogenes* is a bacterium that is commonly present in the environment and in food. The risk of listeria contamination can be reduced, but cannot always be eliminated from the production environment or the finished product.

At international level a microbiological criterion for *Listeria monocytogenes* has only been established for ready-to-eat foods, as these have been identified as the food category that represents a significant risk. Microbiological criteria for *Listeria monocytogenes* have not been set for other food categories or for processing hygiene at international level. The hygiene legislation of the Russian Federation has however specific requirements for *L. monocytogenes*, in all fish and fishery products, requiring absence in 25 g (San PiN 2.3.2 1078-01). This includes products covered by this Code of Practice.

6.2 Guidelines for sampling and analyses

Producers of fresh and frozen salmon/trout should have an environmental monitoring program *for L. monocytogenes* in processing areas in accordance with Codex Guidelines for control of *Listeria monocytogenes* (CAC/GL 61 – 2007 Annex 1). An appropriate action plan should be designed and established to adequately respond to positive findings. A review of hygiene procedures and controls should be considered. Producers should react to each positive results; the nature of reaction should be risk-based and depend upon the likelihood of contaminating the product and the expected use of the product. The plan should define the specific action to be taken and the rationale. This could range from no action (no risk of recontamination), to intensified cleaning, to source tracing (increased environmental testing), to review of hygienic practices.

A written plan for the periodic collection and testing of samples for the presence of *L. monocytogenes* should be implemented. The plan should involve testing of different types of samples including raw materials, non-food contact surfaces in the processing plant environment, food-contact surfaces and finished products. Sampling plans should be selected in accordance with specifications laid down by Codex General Guidelines on Sampling (CAC/GL 50-2004). The plan should be flexible and allow for increasing or decreasing sampling frequency as a response to sampling results. In general, the amount of sampling should be related to the production volume and the risk profile of the product (ref. Luber et al. 2011). Sampling procedures should be performed in accordance with appropriate standards, for example ISO 18593 for sampling from surfaces. Sampling from process surfaces and environmental surfaces should be performed using wipes (sponge, cloth, gauze pads) or with swabs for hard-to-reach small areas. Each sample area should be as large as possible with a maximum of 2500 cm^2. In addition to surface sampling the sampling scheme should also include water and ice. Aseptic sampling techniques should be used to avoid contamination of sample, raw materials, environments or product. Sample analyses should be performed in accordance with approved methods related to the commodity of concern, for example ISO 11290 or validated alternative methods for the detection of *L. monocytogenes*. It is preferable that laboratories should be accredited before conducting *Listeria* tests for companies. If alternative rapid test methods are used, they should be validated for the specific microorganism and sample type to guarantee high specificity and sensitivity.

Trend analyses of sampling results should be recorded. This may help evaluating the risk of contamination in various locations and thereby help implementing more targeted and cost-effective control measures and sampling plans. Total elimination of *L. monocytogenes* in production facilities of fresh and frozen salmon and trout cannot be expected.

A sampling plan for *Listeria monocytogenes* describing the sampling frequency, number of samples, sampling points or sampling material, sampling method, sample size, analytical method, limit for corrective action, corrective actions within the processing facility and corrective actions with regard to customers and competent authority has to be developed.

6.2.1 Raw materials control

Typically, *L. monocytogenes* will not be found on fish harvested from open waters, but contamination may occur prior to the fish enter processing or in the receiving of the fish to the facility. *L. monocytogenes* may therefore be present on the surface of unprocessed raw salmon and trout. Control and monitoring of *L. monocytogenes* in raw, unprocessed fish should be performed to determine *L. monocytogenes* in the raw fish material. Relevant sampling points of whole unprocessed fish are gills and surfaces of fish. Where appropriate, the monitoring of the raw material with regard acceptance according to product specification and the sampling may be performed at a later stage, after stunning and bleeding but before grading.

Control of *L. monocytogenes* in raw materials could limit the introduction of *L. monocytogenes* in the processing plant, and salmon and trout processors should select suppliers of raw materials with documented low frequencies of *L. monocytogenes.*

6.2.2 Environmental monitoring and control

The control *of L. monocytogenes* in the production of fresh or frozen salmon and trout relies on sanitation and good manufacturing practice (GMP) to prevent the product from being contaminated. Control and verification of the environment is the most suitable approach to control *L. monocytogenes*. Microbial testing of finished products is an imprecise science and may not portray the true microbial status. Sampling sites should include sites with previous occurrence of *Listeria* and sites that are most likely to be the cause of contamination of the products. Samples from food contact surfaces are more important for detecting and controlling *L. monocytogenes* in processed salmon/trout than finished product testing. Non-food contact surfaces including floors, walls and drains do not necessarily present a high risk of contaminating the product, but may be an indicator of the presence of *Listeria* in the facility.

6.2.3 Finished product control

Sampling of finished products can never assure that *L. monocytogenes* is not present in the products. In processed salmon/trout, microorganisms (e.g. *L. monocytogenes*) may be unevenly distributed within the batch and within the entities of each batch. The purpose of the periodic sample collection and testing is therefore to provide a historical reference for the production facility and to verify the functionality of the control strategies.

Routine sampling of finished product lots for the detection of *L. monocytogenes* must be performed. Each establishment must define what constitutes a batch. Production on different days separated by sanitation is one distinction, separate processing lines or different raw suppliers may be another distinction. Representative samples should be taken from each batch. Over a time period, samples taken must include sampling of products made from raw material salmon/trout of all the raw material suppliers to the establishment.

6.3. Sanitation and maintenance

Preventive maintenance and sanitation procedures can reduce contamination of food with *Listeria monocytogenes*. Well-structured cleaning and disinfection procedures should be targeted against *Listeria monocytogenes*. To ensure that the facilities and equipment are clean, sanitized and suitable for the intended use, management of the food business must draw up and operate a written sanitation program in accordance with HACCP procedures and GMP. Companies should implement an effective, scheduled preventive maintenance program to prevent equipment failures during operation. The preventive maintenance program shall be written. A person of the staff should have the primary responsibility that the plant has been sanitized according to the sanitation program. The sanitation program should specify:

- areas, items of equipment and utensils to be cleaned
- responsibility for particular tasks
- method and frequency of cleaning
- monitoring arrangements for suitability and effectiveness of the program

The sanitation program should include specific information for different zones within a facility, utensils or equipment. Cleaning and disinfection should be performed at the end of each production day. There shall be no production during cleaning and disinfection. Disinfection chemicals should be changed regularly to prevent the development of bacterial resistance to the disinfectant. All areas of the plant and equipment should be visually inspected and documented before production to ensure that sanitation is satisfactory. Monitoring tools using ATP can be useful for monitoring the overall sanitation in the plant.

Strict attention to the methods and frequency of cleaning is important. The sanitation procedure in the fish processing area should, where appropriate, follow the steps: 1) Dry clean, 2) pre-rinse of equipment 3) visual inspection of the equipment 4) foam and scrub the equipment 5) rinse the equipment 6) visual inspection of the equipment 7) floor cleaning and rinsing followed by disinfection and rinsing. Apply low pressure hose 8) apply disinfection agent 9) rinse the equipment 10) verify effect of disinfection 11) remove water pooling, particularly on floors. All detergents and disinfectants used should have documented effects and be used according to the manufacturer's instructions as contact times and concentrations vary with sanitizer.

Cleaning of floor drains should be performed daily and be performed in a manner to avoid contamination through aerosols from the drain during cleaning. Utensils used for cleaning drains should be dedicated to that purpose and designed to avoid splashing and aerosol generation. High pressure hoses should not be used to clean a drain. It is also important to avoid unnecessary accumulation of fish waste and clogging of drains. Even though removal of fish waste during production is necessary, hosing and use of high pressure water should be avoided during production as this increases the risk of contamination between environmental sites and products. Special attention should be paid to sites of increased risk, including sites of previous *Listeria* presence. If a drain backup occurs in finished product areas, production should stop until the water has been removed and the areas have been cleaned and disinfected. For cleaning purposes, availability of sufficient amounts of hot water is necessary.

Refrigerators should be sanitized monthly. Freezers should be cleaned at a minimum once per year. All products should be removed prior to sanitation to avoid contamination of raw materials or products.

Cleaning utensils should be zone specific. After use cleaning utensils should be disinfected and stored in a dry place or in strong disinfectant solution (600-1000 ppm quaternary ammonium compound recommended). The disinfectant should be changed regularly according to the manufacturer's instructions.

Disinfectants based on quaternary ammonium compounds, peracetic acid, or chlorine are commonly used to control L. monocytogenes. Rotation between disinfectants with different mechanisms of bactericidal action may provide for greater effectiveness. Rotation should be considered in agreement with suppliers with competence on industrial sanitation systems.

The facility should have proper ventilation for removal of humid air during production and after sanitation.

Equipment should be designed to facilitate cleaning, and maintenance performed to reduce the possibility of microbial multiplication in the processing facility (equipments, environments). Special care should be taken during and after extraordinary situations, i.e. moving of production lines, implementation of new or used equipment, reparation and maintenance during production, use of untrained personnel (temporary employees) or clogged drains.

All equipment and work surroundings should be inspected regularly for parts that are cracked, worn or have developed spaces where food and moisture can accumulate.

All tools used for maintenance should be washed and disinfected prior to use and food contact surfaces or equipment should be cleaned and disinfected after maintenance work and prior to production use. Routine maintenance and repair should not be performed during production.

Traffic flow patterns of employees, food products, and equipment should be controlled between raw processing, storage area(s) and finished area(s) to minimize the transfer of *L. monocytogenes*. (Codex Guidelines for control of *Listeria monocytogenes* CAC/GL 61 – 2007). Strict separation between clean and unclean zones should be enforced. It is recommended to employ locks between different zones as well as obligatory cleaning and disinfection of hands and changing of shoes and clothes. It is important that these rules are applied to all persons entering the clean zones, including process personnel, cleaning personnel, maintenance personnel and guests.

6.4 Personal hygiene and management

Staff hygienic practices play an important role in preventing contamination of foods with *L. monocytogenes*. For example, staff who handle trash, floor sweepings, drains, packaging waste or scrap product, should not touch the food, touch food contact surfaces or food packaging material, unless they change their smock or outer clothing, wash and disinfects hands, and wear clean new gloves for tasks requiring gloves. Adequate training and supervision should be provided to assure hygienic practices are accomplished.

Those engaged in food operation that come directly or indirectly in contact with foods should be trained and/or instructed in the control of *L. monocytogenes* to a level appropriate to the operations they are to perform.

Employees who have been cleaning drains should not contact or clean food contact surfaces without changing clothes, and washing and disinfecting hands.

(Codex Guidelines for control of *Listeria monocytogenes* CAC/GL 61 – 2007).

For health status, illness, injuries and personal cleanliness, routines should be established in accordance with the Recommended International Code of Practice – General principles of food hygiene (Codex CAC/RCP 1-1969). The FHL Guide: Personal Hygiene in Seafood Businesses (Guide March 2012) may be used as a direction.

Inadequate training is a major cause of food safety failure. Educational plans for workers in fish processing plants should be standardized. The management shall organize training of staff involved in the production process on a regular basis according to a written plan and training on personal hygiene and management with emphasis on *L. monocytogenes* should be repeated and updated at least once a year. Training shall include information of main risk factors and why they are important and address issues in order to make managers and workers aware of the risks. Training programs should be designed to facilitate positive behavior and practices that seek to prevent microbial contamination and growth of *L. monocytogenes* during production and handling along the production process. The training of the staff shall be documented.

Managers and supervisors shall have enough knowledge to be able to judge potential food safety risks, take appropriate preventive and corrective action and ensure that effective monitoring and supervisions takes place.

6.5 Temperature control

Temperature is the single most important factor affecting the rate of fish deterioration and multiplication of microorganisms. Systems shall be in place to ensure that temperature is controlled effectively. It is essential that fresh fish and its products that are to be chilled should be held at a temperature as close as possible to 0 °C. The product temperature should not exceed 6 °C (preferably 0 °C - 4 °C) (Codex Control of *Listeria monocytogenes* CAC/GL 61 – 2007).

Chilling should commence as soon as possible and fresh fish should be processed and distributed with care and minimum delay. Monitoring and controlling the time and temperature and homogeneity of chilling should be performed regularly. (Codex Code of practice for fish and fishery products CAC/RCP 52 – 2003)

The chilling and freezing rooms should be equipped with a calibrated recording thermometer with alarms and checked at regular intervals at least twice a day (SanPiN 2.3.21078-01).

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