GUIDE TO SMALL SCALE TROUT PROCESSING METHODS

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Budapest, 2012

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PREFACE

This book intends to provide advice on trout preservation methods, lists the steps of fish processing and also describes different packaging technologies that could be utilized by small scale processing companies as well. As small scale trout farming represents a notable part of aquaculture, information about processing provides a mean to improve the level of services and so to increase the income of producers.

ACKNOWLEDGEMENT

Authors wish to express their gratitude to Ms. ZSUZSA POLYÁK *for translation and* Ms. ÉVA KOVÁCS*, Junior Aquaculture Officer (FAO-REU) for participation in the elaboration of this document.*

We would like to thank to Mr. JANNE TURUNEN*, Coldfin (Finland) offering his photos to illustrate this publication out of which we used those, presented in Figure 4.*

Thanks are also due to Mr. ISTVÁN FÁBIÁN *(www.ajel.hu and kopfbt@t-online.hu) for the typographical design and work of this publication.*

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1 INTRODUCTION

Global fish production has continued to increase in the past 10 years. Processed and canned fish represent a large share within this growth. These facts also underline the importance and progress of the processing industry.

No matter what culture or continent, food preservation traces back to many thousand years of tradition. Warm, sunny regions have been the cradle of sun-drying and curing, while improved fire-drying methods developed to smoking. In ancient times salting was used as an attempt to preserve meat. Pickling of vegetables and fish has originated in the Orient, whereas freezing stems from the Eskimos as a natural result of their geographical environment.

Housewives and current lifestyle show a continuous demand for easy-to-cook fish products, the easier the better. This is in harmony with the requirements of longer shelf life, easy transportability of fish products and global driving forces for value addition of fish food, including the maintenance of product quality.

To satisfy the interest for specific details a glossary has been compiled. Furthermore, tables and annexes have been attached. For the sake of easier identification and finding additional information, italics and asterisk symbols (*) are used at words clarified in the glossary.

In order to supply the reader with more information the book also contains a list of those FAO publications which deal with fish processing.

2 FISH PRESERVATION METHODS

Fish meat has a high nutritive value. In addition to protein, fat and carbohydrates, it is also rich in minerals and vitamins. The composition of fish proteins is more valuable than that of mammals because it includes a favourable portion of essential amino acids indispensable for humans. Carbohydrate content of freshwater fish is negligible.

Fish species	Water (%)	Protein (%)	Fat (%)
Carp	78.9	16.0	4.0
Trout	76.3	19.5	0.8
Catfish	80.5	17.5	0.8
Pikeperch	78.9	19.0	0.8

Table 1: Contents of fish meat

The protein content of fish meat varies widely, depending on the species and, within that, on the feeding, more precisely the type of *natural fish food** or the feed consumed.

The mineral compound content of fish meet slightly exceeds that of warm-blooded animals. From among fat-soluble vitamins A and D occur in fish in relatively large quantities. From among water-soluble vitamins B1 and B2 are the most significant ones. Fish is also an excellent source of omega-3 and omega-6 fatty acids that are essential for human health.

As a consequence of the high water and protein contents fish meat is easily perishable. Spoilage causes loss of quality and value and is primarily induced by microorganisms, enzymes and, after some time, the oxidation of fish fat. In the course of processing efforts are taken to counteract these factors to ensure a longer shelf life for fish meat. In short, preservation is the practice of preventing spoilage while retaining physical and chemical characteristics of raw material along with its biological value and taste.

Several methods are applied to curb the spread of microbes. These are cooling, freezing, drying, smoking, heat treatment, salting and applying antimicrobial agents and antioxidants (see Box 1).The best way of preserving freshness of a fish, is to keep it alive (Welcomme, 2001)

Fish are covered with micro-organisms that can cause spoilage if mishandled or processed improperly afterwards.

Therefore, it is essential to ensure a hygienic handling of fresh or processed fish products in each and every phase of production, storage and transportation. Qualities which make fish suitable for processing (or not) are specified in Table 2.

Preventing microbiological damage

Cooling
Cooling takes place at a temperature between 0 and 8 oC which slows down the process of spoilage but does not prevent it. The method is primarily suitable only for short-term storage.

Freezing
The purpose of freezing is to prevent or reduce to the minimum processes which spoil the quality of fish meat.

Drying
The oldest of physical fish preservation methods which is intended to extract water from fish in the shortest possible time to avoid bacterial proliferation.

Smoking
An ancient mode of fish preservation. Components of smoke exercise a germicidal impact on fish meat.

Heat treatment
Heat treatment is aimed to inhibit processes which lead to fish decay by preventing enzyme activity and destroying microorganisms.

Salting
The method is based on the preserving effect of table salt which is hygroscopic* hence it absorbs water from microbes and the environment.

Applying antimicrobial agents
Antimicrobial agents (preservatives) retain food quality and ensure longer shelf life by protecting fish from spoilage caused by microorganisms. Adding such agents in proper dosage to fish lengthens their shelf life.

Applying antioxidants
This method is applied to prevent chemical spoilage. It means the inhibition of tissue enzyme activity by adding spoilage preventives and/or microorganism destroyers to the raw material. Such organic or inorganic antimicrobial agents are preservatives which inhibit metabolism by modifying enzyme proteins. In terms of cellular impact location preservatives may target the cell wall, the cell membrane and the cytoplasm. Even small dosages are sufficient. Nevertheless, preservatives may exercise an unwelcome impact on the quality (taste, color, substance, valuable nutritive compounds) of preserved material.

Additionally, chemical substances inhibiting or destroying microbial cells may influence human body as well. It is a professional conviction that being cytotoxins by nature and accumulating in the body which is followed by a slow leeching out, such agents may have a detrimental effect on human body which is also made up of cells.

Box 1

3 PREPARING FISH FOR PROCESSING

When processing fish it is important to remember the following principles:
- maintain the cold-chain,
- maintain hygiene,
- avoid damaging or crushing fish,
- work rapidly.

Usually the first step of preparing fish for processing is fishing. Fishing methods have an effect on quality. It is advisable to keep nets and lines in water for as short a time as possible. In addition, seining and trawling times should be made as short as possible. It is recommended that fish are handled gently and care taken to pick fish by holding the head in order to avoid bruising and gaping of the flesh.

When harvesting it is important to avoid causing damage to fish because damaged or injured skin reduces marketability of the product. In addition, it paves a path for micro-organism transfer from skin to flesh, which may accelerate spoilage.

In case of fishing fish can be stored in clean containers on board the fishing vessel. It is also important to maintain hygiene on board and provide a clean fishing environment.

It is important to ensure optimum conditions and cause the least possible stress to live fish during transportation. Observing and adhering to animal welfare regulations and avoiding bruising of fish in transit is a precondition for maintaining the quality of fish meat.

If there are no live fish transport facilities caught and stunned fish should be chilled to 0-5 °C. Fish should be placed between 3-5 cm thick layers of ice chips. Insulated boxes help to maintain the cold-chain by preventing ice from melting too quickly. The rule of thumb is to use 1 kg of ice for each kg of fish. One should avoid making too many layers of iced fish in boxes as the fish placed on lower-levels are subject to pressure from higher-level layers, which may then result in bruised flesh. If there is a choice in ice, the best is small crushed ice, while the worst is crudely crushed block ice (Welcomme, 2001).

A fish processing plant should construct

and use a storage pond or tank. Fish should be starved for two days here in order to empty their guts. It will reduce chances of product contamination. In trout stored in 12 °C water food will pass through the gut within about 20-24 hours. If water temperature is lower the starvation period should be longer than 2 days. Considering storage facilities harvested quantities should not exceed daily processing capacities.

Table 2: Quality aspects of live fish to be processed

	Healthy or fresh fish	Spoiled fish
Movement	Vivid	Slow, not reacting, scratching
Location	Within the water	On the surface, at the edges or on the bottom of water
Colour	Genus-specific	Dark, black
Eyes	Genus-specific, healthy looking, bright with clear lens and cornea	Opaque and abnormally bulging or sunken
Integument	Intact, healthy	Damaged, blistery, covered with parasites
Skin	Bright, shiny, genus-specific colour, difficult to remove	Faded, dull with whitish slime
Gills	Bright red	White or grey, offensive smell
Odour	Genus-specific, pleasant fishy odour, characteristic to the species	Unpleasant, offensive smell
Muscles	Firm, elastic, vigorous adherence to bones, does not spring back when pressed upon	Soft, stiff
Scales	Firmly attached	Easy to pick
Mucus	Genus-specific, transparent	Abundant in quantity, opaque
Belly volume	Normal, fish submerges when placed into water	Strongly swollen, fish does not submerge when placed into water
Fish steak	Genus-specific, pleasant fishy odour characteristic to the species	Offensive smell, ribs often pierce the meat
Fins	Intact	Damaged, broken, ruptured

4 STEPS OF FISH PROCESSING

Steps of processing are as summarised below.

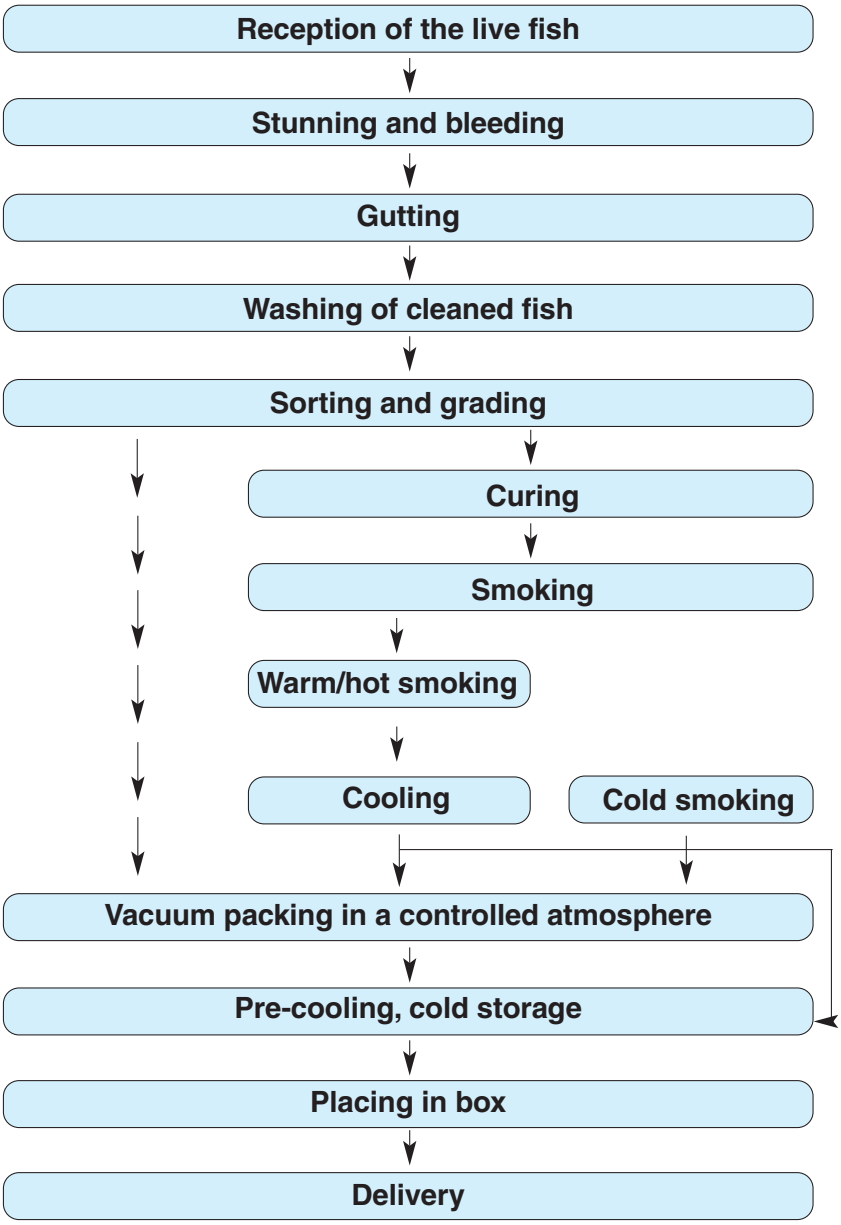

Figure 1: Flow chart of steps of fresh and smoked fish production

4.1 STUNNING

The fresh bath of captured fish should be transferred to the preparatory room where fish are stunned in a container equipped for this purpose. The process of stunning is completed with a battery operated equipment at 12–24 Volts and 0.2–2 Amperes.

4.2 GUTTING

Washing of stunned fish should precede gutting. Following stunning fish are bled and then cutting and gutting shall begin immediately. This should take place on a corrosion-resistant table fitted with a pipe for sacking fish viscera into a collecting tank. Care should be taken not to hurt the intestinal canal during gutting otherwise it may soil the fish meat. The table should also feature a fish washer to remove blood from inside and outside the fish. The drainage of the fish washing sink should be equipped with a fat trap.

Gutting is followed by the removal of scales, fins, head and tail depending on the species of fish and the final objective of processing.

Scaling can be done by rubbing a rough surface on the fish or using automated or hand-held scales. Heading can be done in two ways: a straight cut perpendicular to the backbone or using a v-cut behind the gills. Heading can be done manually or using heading machines.

4.3 CLEANING

It is important to clean fish as it carries micro-organisms on its skin, which easily causes spoilage at later stages during processing. It is essential to use clean, running water and avoid re-using water several times.

4.4 SORTING AND GRADING

Sorting is the practice of separating fish into groups with different physical properties while grading is the practice of separating fish by quality according to certain pre-determined criteria. Containers such as tumblers are needed in this phase of the processing chain. In addition, sizing devices and scales may also be essential.

Figure 2:
A simple but highly sufficient place to clean fish (above left).
Knife to cut the belly and vacuum gutting device fixed together near to the wheel brush to clean the fish from inside (above right and left below)

4.5 ◗ SLICING TO STEAKS

Depending on species, fish size and the degree of processing, fish are cut, sliced to steaks, filleted and deboned. These steps may be performed manually or with machines. When filleting by hand, meat is carefully detached from big fish bones with a sharp knife, starting at the back. With proper routine, 60–65 percent of live fish can be gained. Filleting machines can also be used, though machines are species and sizespecific.

4.6 ◗ FISH PRESERVATION

4.6.1 ◗ Salting

The method is based on the preserving effect of table salt (NaCl) which is hygroscopic i.e. it absorbs water from the microbes and the environment. To prevent bacterial food spoilage, it is sufficient to apply table salt in a quantity of 15 percent of product weight. The entire fish surface shall be covered with salt which then permeates into meat tissue. Uncoloured salt, free of additives should be applied both in case of dry or wet salting or their combination. Salting should be done in cool temperatures to reduce the possibilities of bacterial growth.

Dry salting is used in case of fish with 6 percent or less fat content. Smaller fish are able to take up more salt than bigger ones. In this process, salt is either rubbed into fish or sprinkled onto its surface.

Wet salting means that fish are soaked in ready-made concentrated *brine** for a period of time. Salting equipment features various kegs, tubs and containers. Kegs are suitable for smaller fish. Fresh fish rolled in dry table salt is layered in the keg, left to stand there for a while. Then the keg is capped with an airtight sealing and after curing for a period of time supplied to the consumer.

When tubs are used, their bottom is covered with a 1-2 cm layer of salt, the fish are placed on it and each fish layer is covered with salt again. This can take place in a warm, cooled or chilled environment.

Salted fish should be stored at the same temperature as the salting process had. The lower the salt concentration of the fish meat, and the longer the storage time, the lower the temperature should be. Minimum storage temperature of light salted fish shall be -5 °C, medium salted ones should be -1 °C and even heavily salted ones cannot be stored at temperatures exceeding +5 °C.

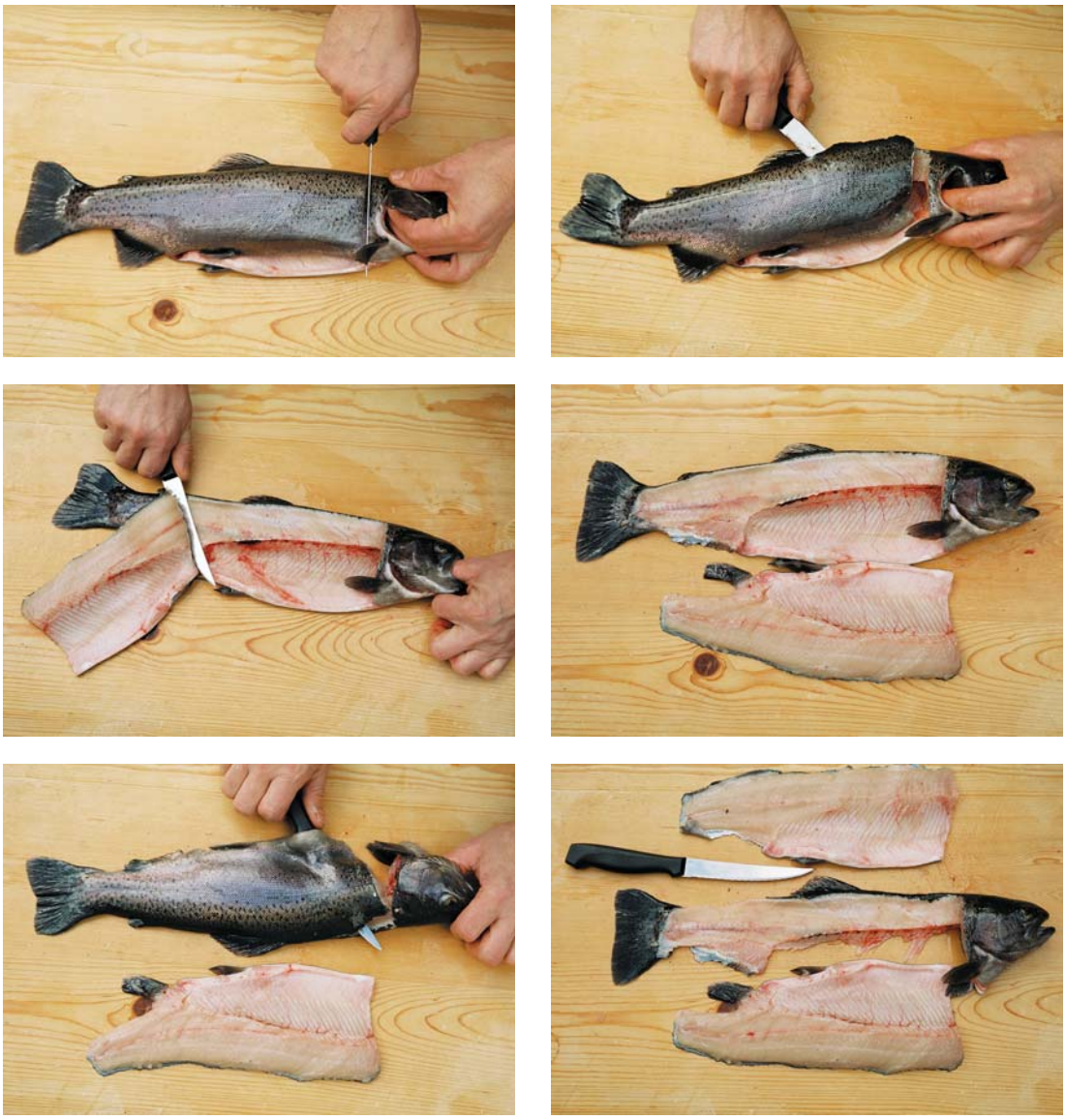

Figure 3: Steps of cutting filet of trout

Figure 4: Cutting the ribs out of a large trout

4.6.2 Smoking

Smoking techniques can vary widely from one region to another and are highly dependent on taste preferences. It is one of the oldest processing methods of fish and is highly suitable for producing products with a long shelf-life especially as it makes fish dry out. In addition, smoke components (phenols, acids, formaldehydes, creosotes) have antigermic and antioxidative impacts on the product.

Climatic conditions have a major impact on smoking. The process is different in cool, moist or hilly regions from that in drier lowlands. Depending on smoking temperature there are cold, warm and hot smoking techniques.

Fish should be cured in brine prior to smoking, either in strong brine or in a traditionally milder one. The first is a 25–30 percent brine and the latter is a 10–12 percent salt solution. Fish should be cured in it for about 12–16 hours and carefully turned two or three times during this period.

Cleaned, washed fish should be transferred in a covered plastic or corrosion-proof dish to the curing room. When water has dripped off them, fish are placed into plastic kegs or corrosion-proof, acid-resistant tubs and brine is poured on them. Fish is cured in the brine for a while and carefully turned two to three times. Then they are removed from the brine, hooked one by one and hanged on a rod which is placed on a rolling stand. After dripping fish are pre-dried before the stand is rolled into a smoking cabinet or room.

Figure 5: Small scale cold smoking apparatus

Figure 6: Cold smoked trout

Cold smoking

Cold smoking is done below 30 °C. Cold smoking takes place at a temperature of 12–24 °C. Relative humidity shall remain in the range of 75–85 percent. Removed from the brine, fish should be drip dried before placing them into the smoking facility. Smoking time is about 12–24 hours, depending on fish size.

Warm smoking

Warm smoking is at temperatures between 30 and 80 °C but it is typically done at temperatures between 30 and 60 °C. Depending on fish size and smoke quality, fish should remain 2–6 hours in the smoke. These products have a shelf life of about 20–50 days when stored at 0–5 °C.

Hot smoking

Hot smoking needs even less time. However, shelf life of the product is reduced accordingly. Smoking is performed at a temperature between 90 and 120 °C from ½ to 2 hours.

In addition to wood smoke, liquid smoke can also be used. In liquid smoking, fish is dipped into a concentrate of a liquid that has been used to absorb smoke (Wheaton

Figure 7: Trout smoked on wood

and Lawson, 1985). The liquid concentrate transfers the aroma and flavor of smoke onto the product. In some developing countries grass, coconut husks, saw dust and even cow dung have been used to generate smoke.

Storage of smoked fish

Warm and hot smoked fish should be cooled before packaging and relocating to storage.

Daily produced and packed smoked fish should be transferred in a closed container to storage facilities where they should be kept in separate fridges on melting ice temperature until delivery. Fresh and smoked fish should be stored in separate fridges.

Box 2

Wood used for smoking trout

Mostly hardwood shavings or sawdust are used like beech (Fagus silvatica), oak (Quercus sp.), robinia, (Robinia pseudo-acacia), alder and birch though in Southern countries mahogany and cedar are attained as well.

It is not advisable to use trees of the pine family, grasses and peatmoss for fish smoking.

4.6.3 Deep freezing

Deep freezing is an up-to-date method of preservation by heat-extraction when the raw material is cooled in a fairly short time (3 to 5 hours) to a very low temperature (-35, -45 ºC). As a result of rapid refrigeration free water content of raw materials is frozen to tiny ice crystals which are smaller than the cell wall, therefore, though they strain the cell wall they do not split it. The process strongly limits microorganic activity while raw materials remain able to retain their biological value and taste. However, it requires the storage and transportation of deep frozen products at a constant, low temperature of -18 to -20 ºC. Temperature fluctuation would explicitly lead to recrystallization, the growth of tiny ice crystals. Around -18 to -20 ºC the activity of microorganisms causing spoilage slows down, some of them are even destroyed though the germicidal effect is still not complete. At temperatures higher than -12 ºC microorganisms may restart proliferation while at 10-40 ºC it reaches a pace which turns food to a health hazard. This is the reason behind the discouragement of refrigerating thawed but unused raw materials.

4.6.4 Drying or desiccation

Drying or desiccation is aimed ~~for~~ at removing water present in the food in various forms of bonds. While earlier fish were dried with the heat of the sun, today's desiccating equipments are capable of absolute drying, as well. The process requires careful attention to lead to the least possible loss of nutrients.

Quality of dried products varies with temperature and length of drying. Optimum temperature ranges are between 25 and 45 ºC while a heat of 60 ºC or over may burn raw material. Average drying time is 5-8 hours which also depends on the thickness and water content of the fish. Too quick drying will form a hard crust on the outer surface of the product though it remains wet inside and may start spoiling. Too slow drying may develop a taint. Drying is completed when the product becomes flexible and can be bent without breaking,



Figure 8: Air conditioner, refrigerator and hygienic means of transporting fish are important devices of a fish processing plant

when cut up no moisture can be seen. Dried fish is relatively cheap to produce, easy to store and does not take up much storage space. About 10 kg raw material yields 1.5–2 kg dried product on average which is easy to pack and to transport.

Drying is widespread in Asia and Africa and, lately, increasingly popular in Europe. There is a fish specialty made of dried smaller fish and served with drinks. Drying is a cheap, does not require expensive equipment and investments and requires little skill. It is recommended to dry fish on racks rather than on the ground due to the shorter drying time achieved. In addition, fish can be kept cleaner.

4.6.5 ◗ Marinating

Increasing acid content in food and thereby decreasing pH will inhibit vital functions of microorganisms causing spoilage. The most frequently applied table acid which is also considered to be the most efficient is acetic acid. It does not destroy the micro flora in food, however, it is a strong inhibitor to their proliferation. *Acetic acid** also inhibits most enzymatic activities but some enzymes still remain active. Thus, protease activity slows down in marinated fish which assists in "curing" the fish product. Marinating is a widespread mode of fish preservation. Marinating is the preservation of fish meat with table salt and acetic acid: fish are prepared with pickling, cooking or frying then kept in spicy, salty, acidic pickling solution containing onion. Acetic acid makes fish meat whiter and also shrinks it.

The salty-acidic pickling solution cures the fish, develops specific tastes and odours and changes meat texture. Acetic acid should reach a 2–5 percent concentration in the solution, while curing is the best with 3–9 percent table salt content. Temperature should be kept at 0 °C for optimum results. The process takes 10–30 days to complete, depending on the salt and acetic acid concentration. Marinating solutions feature cold, cooked, fried and specially spiced sauces.

Cold marinating starts with curing in a proper solution of vinegar and table salt then the cured fish is put into glass jars with spices and poured over with a salty vinegar solution. The best known product of this type is sprat.

Cooked marinating means that fish are cooked or braised in salty vinegar water. Then they are filled into boxes with liquid gelatin containing the cooking water, vinegar, table salt and spices.

Fried marinating begins with merging the cleaned fish in brine and flour and then frying it. When cooled down, fish are

placed into a solution containing spices, table salt and acetic acid.

Special spiced marinating requires cold, cooked or fried marinated fish topped up with piquant mayonnaise, paprika, curry or mushroom sauces.

All marinated products are considered semi-preserved because vinegar and salt are not sufficient for killing microorganisms. Therefore, they should be store on 0-10 °C.

4.6.6 Roe processing

Roe products are a high value product made by separating individual eggs from each other and from skein material (screening), followed by brining in a saturated solution and curing (Bledsoe and Rasco, 2006). Screening can be done manually or using enzyme preparations rich in collagenase. After curing, roe is graded for instance according to flavor and colour, or even size. Roe is usually packed into plastic containers and frozen.

Figure 9: High tech small scale packing machine before loading and with the product ready to weigh and label

5 PACKAGING

The purpose of packaging is to protect the quantity and quality of the product from production through the supply chain to the intended consumer.

Using quality raw materials and ingredients, modern machinery, skilled, conscientious and well organized workers and production technology will result in quality products. This very product should then be transferred in its unchanged, original condition to the user or consumer. The original product condition can only be retained with proper packaging. In cases when packaging becomes an element of the supply chain – e.g. takes place in the trading location, – it becomes impossible to fully complete its protective mission because the product may be exposed to a series of hazards from production to packaging. Unpacked product may loose weight (in a natural way as well, e.g. by desiccation), get soiled or contaminated with insects or mould. It is also an easy subject to pilferage.

Therefore, it is practical to perform packaging operations at the manufacturing location of the product. As an added benefit, packaging should feature elements whereby it is easy to detect if it has been opened. If the original sealing has a visible and unrepairable damage when opened the fact of opening can easily be seen.

Gas-tight packing foils prevent oxygen infiltration and the escape of added gases. Oxygen would be vital for life functions of microorganisms while gaseous additives destroy them preventing the product to decay in quality.

Freshly cleaned or smoked fish should be packed in a designated packaging room. Freshly cleaned fish are transferred to the packaging room in dishes after washing and drip drying. They are prepared and portioned on a corrosion-proof table then shrink wrapped into foil on trays or vacuum packed in sleeve pouches with protective gases (N_2CO_2). Similarly to preparation and curing, care should be taken during packaging to prevent damages, soiling or contamination of the product and to ensure that it is protected with the packaging material.

The packaging room should provide storage for not more than the daily quantities of packaging material. Additional stocks of packing materials should be stored in a separate dust-free room not exposed to insect or rodent hazards or other ways of contamination or spoilage.

Packaged products should be labelled. The most important characteristics of the product such as product name, name and address of the manufacturer, date of production, shelf life date, recommended storage temperature and net weight should appear on the label of the retail packaging.

Retail packages should then be wrapped in wholesale boxes and placed in cold storage at required temperature.

There is a wide range of different types and brands of fish packaging machines which can be purchased worldwide. Fresh or smoked fish can be packed with vacuum packaging or gas flushing machinery. Gas flush packaging is rapidly gaining popularity in recent years. Such machines require a special, impermeable foil which does not let the molecules of the protective gas to pass through.

Deep frozen finished products are packed in PE (polyethylene) pouches and sealed. Pouches may bear colored graphic design. Retail packages are collected in large cardboard wholesale boxes then tied around with plastic bands. The boxes bear self-adhesive labels on their side with basic product characteristics and storage temperature on them.

Marinated fish products are mainly marketed in small plastic boxes, buckets or glass jars while most of the fully preserved fish products are packed traditionally into tins (lacquered, tin-coated steel or aluminium sheet). It is appealing both in terms of appearance (non-exposure of fat precipitation) and quality (light protection). The multi-colored graphic design of the tin surface is an added marketing value and advertising possibility. Fish products fully shielded from consumer eyes do recruit customers through brand trust alone. Tinned products are able to find a steady market if the manufacturer continues to be trustworthy, supposing that there are no fluctuations in the quality of the packaged product.

6 PRODUCTION OFFAL

Fish processing yields offal. Its quantity varies with the size of the fish, processing and preparation methods and ranges between 15-60 percent.

Certain by-products of fish processing may be converted to products suitable for human consumption e.g. filleting residues like fish head and backbone yield 3-8 percent meat pulp after meat-bone separation or they may be simmered to fish stock with various ingredients.

Materials unsuitable for human consumption and pieces that have fallen on the floor or soiled in any other way during processing should be treated as offal.

Offal should be collected in a way not to cause contamination. Products unsuitable for human consumption shall be clearly marked as such (with a red stripe or labelling).

Offal should be collected in dedicated storage containers in the plant. Depending on quantities, offal should be transferred to storage containers whenever it is accumulated during a shift but at least at the end of each shift. Storage containers should be located in the cold storage of the service building.

Temporary storage should be designed in a way not to allow the contamination of food or drinking water. Access by insects, rodents, birds and domestic animals to storage containers should be prevented.

Both storage location and containers should be cleansed and disinfected after emptying. Offal storage should be removed from the plant each day with a dedicated vehicle.

6.1 ◗ OFFAL QUANTITY AND TREATMENT

Blood, intestines and gills as well as scales and skin should be stored in a dedicated, closed plastic container in the preparatory room. This offal container should be emptied whenever filled up and also at the end of each shift. Intestines have to be stored open-air in closed containers in a washable area paved with concrete. They should be removed from the plant each day with a dedicated vehicle or placed into cold storage until disposal from the plant. It is recommended that a waste management plan is enacted throughout the processing facility.

6.2 ◗ OFFAL PROCESSING INTO FISH SILAGE

Large quantities of offal unsuitable for human consumption can be utilized after processing into animal feed.

Table 3: Treatment of fish offal with sulphuric acid

Minced fish offal:	98.1 kg
80% sulphuric acid solution:	1.3 kg
Potassium pyrosulphate (K2S2O5):	0.6 kg

Offal remaining after cleaning fresh fish has to be minced. This may be completed with a hammer grinder and then the product should be passed through a sieve of 5–8 mm mesh size. Following heat treatment the pulp should be mixed with traditional feed (wheat, cornmeal) then it becomes suitable for feeding fish.

The ground, minced pulp may also be treated with an 80 percent sulphuric acid solution to yield a product of 1 percent acid concentration.

Fish offal pulp treated with preservatives should be stored in closed containers (barrels).

Cooked and dried fish offal may be ground into fish meal. Its nutritive value varies with the quality of the offal. As a rule, 4 units of offal yield 1 unit of fish meal.

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[1] Norwegian Institute for Nature Research
[2] European Sustainable Use Specialist Group

GLOSSARY

Acetic acid
The acid which gives vinegar its characteristic taste.

Brine
Water containing dissolved salt.

Hygroscopic
A substance which absorbs moist from its environment.

Natural fish food
The collective name of all those dead or living organisms and organic materials which grow/develop in natural and man made water bodies and is consumed by fish. In case of trout *zooplankton** aquatic insects and their larvae, fish and fish larvae and any smaller aquatic and terrestrial animals which can be grabbed and consumed by trout.

Zooplankton
It is the collective name of tiny worms and insects swimming passively or actively in the water. In other words it means the animal members of the plankton (Thain and Hickman, 1980).

ANNEX 1

CRITERIONS OF A MODERN FISH PROCESSING PLANT

1 General hygiene requirements

Providing safe food, free from contamination for human consumption, is important to ensure effective food control (Huss et al., 2005). Good Hygiene Practices (GHP) are all the practices regarding the conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain (CAC, 2001). In fish processing, it is important to maintain hygiene in order to maintain quality of fish. This is not only limited to the fish itself, but also covers the processing facility, processing equipment and the workers in the facility.

Figure 10: Personal hygiene of workers starts at the proper storing of their clothes

There are general hygiene requirements applicable in most countries which should be known and observed. When designing a processing plant it is essential to allocate sufficient work space to allow proper completion of work processes in accordance with hygiene requirements. Work phases

should be planned in a way to prevent products being soiled. Therefore a clear separation of clean and dirty zones is required. Material flow within the facility should be so designed that cross-contamination is prevented as much as possible. For instance, cleaned fish should be kept away from non-cleaned fish, just as cooked fish should be kept away from raw fish.

The design of a food manufacturing facility should permit proper cleansing and disinfection. For this reason flooring should be covered with impermeable, easy to clean and disinfect materials (concrete > waterproof > anti-slip floor tiles/ slabs). The floor should be properly drainable into the sewage system in order to keep it clean and completely dry.

Walls should have smooth, easy to clean, waterproof surfaces (tile cover) up to the ceiling in technological rooms and up to a height of 2 m in all other rooms. Doors and windows should also be easy to clean. Inner window sills should have a slope of 45 degrees. Windows should be covered with mosquito net on the outside. Proper lighting is essential as well. In addition to natural light work tables in the gutting room should be illuminated with 540 lux, in other rooms with 310 lux. Lamps are to be placed and arranged in a way to prevent shading at work processes.

Proper aeration of a food production facility should be ensured partly by natural aeration, partly by artificial ventilation. The latter should include air conditioning in rooms where fish cleaning, cutting, curing and packaging take place. These working processes require a temperature below 12 °C. Ventilation of the lavatory and shower rooms should be done with an air sacking fan for discharging used air to the outside of the building.

The entrance should be equipped with boots and an apron washer. A fish processing plant should include changing rooms dimensioned and equipped in accordance with standards and regulations. Sanitary requirements of places where hot and cold running water is available should also be observed and maintained.

Technological rooms should feature foot-pedal operated hand washing facilities. Disposable paper towels available from wall-mounted containers should be used for drying hand.

Staff rooms and toilets should not have direct access to processing rooms. Cleaning materials and disinfectants used for cleansing should be stored outside the production rooms in a well ventilated cupboard in a separate place.

A separate water discharge facility should be installed for cleansing purposes equipped with special valves which prevent the backflow of water in the pipes.

Utensils, such as knives and cleavers used for fish processing should be regularly cleaned and disinfected at least once after each work shifts. For this purpose a disinfecting facility with hot water of minimum 82 °C should be provided. It is recommended that a written cleaning plan is drawn up and included in the processing facilities in-house control plan, where for instance, the chemicals and disinfectants to be used are determined, as are the amounts, mode and frequency of cleaning and the persons responsible.

2 Rodent and insect control

Regular, planned and timely executed pest control is essential which should include preventive, control and at infected places eliminating measures as well as their preset timing. Pest preventive, control and protective actions should be accurately documented.

Rodent elimination should possibly be coordinated with neighboring sites and repeated if and when necessary. Nevertheless, the placing of poisonous baits cannot interfere with or jeopardize food production, processing or trade and their location where poisonous substances are not permitted. Accordingly, bait spots should be carefully identified. Positioning of the numbered rodent box traps within the buildings and throughout the entire plant should be marked in a map. Box traps should bear Arabic numbers starting with 1 and up, as well as a warning sign. They must be lockable and made of weatherproof material. They should feature entry and exit openings as well as a dividing partition. The floor of the box should be covered with fine sand to allow detection of eventual in-

vaders. Poisoned baits should be placed in a way to prevent scattering and also to permit the precise follow-up of their consumption.

To track pest/rodent presence operators should complete weekly visual checks of numbered box traps and keep records of bait and poison consumption. Should there be no consumption still a chemical treatment of the space is required twice a year whether the area is pest contaminated or not.

Where insects are a threat their elimination should be carried out at least twice a year or whenever necessary. The application of poison must not interfere with or jeopardize food production, processing or trade nor their location. Unpacked food must be removed and placed in safe place during the application of insecticides. They should be properly protected. Following insect destruction surfaces which may contact with food must be checked for residues of poisonous substances.

3 Personal hygiene

It is essential to maintain worker hygiene in the processing plant. Staff in contact with food must keep personal hygiene in every respect, wear clean work clothes and protective gears where required such as hair and beard net, mask, etc to prevent hair, microbes etc. from falling into the fish products. Protective clothing is essential when working, and clothing and footwear should also be regularly washed. Visitors to the processing facility should also be required to wear protective clothing.

Equipment for cleaning and disinfecting hands should be located nearest to work places. No manually operated taps are permitted. Hot and cold running water should be provided. Staff engaged in cutting fish or handling and preparing raw materials and products should start each work shift in clean protective clothing. If necessary it should be changed to a clean one even before the end of a shift. Staff must wash and disinfect hands at the start of each work shift and should repeat it several times during working hours.

ANNEX 2

PRODUCT SHEETS OF FRESH AND SMOKED TROUT

NAME OF PRODUCT Processed fish: Fresh trout	
Quality requirements	Appearance: Skin is intact and its colour is characteristic to the species. It may vary from silver-white to dark-gray. It is well cleaned, free of dirt and any possible contamination. Colour of flesh varies from light-pink to reddish. Taste: Free of any strange flavour, clear light flavour of fish. Smell: Free of any strange odour, clear light odour of fish. Consistency: Elastic touch of flesh, crispy if cooked or fried.
Mode of preservation	Packing with gas: 30% CO_2 and 70% N_2
Expiry date	7 day from packing
Packing	Single packing: Fish placed on polystyrene tray and covered with gas retaining folia. Parameters of packing materials: Number of trading permission and name of producer Whole packing: Identification of the type of a cartoon box
Indication of packing unit	Single packing with label
Storage	Storing between 0–5 °C (It should not be longer than 1/3 of the entire lifespan of product).
Costumers' target groups	For the entire population directly from retailers.
Possible improper use	Interruption of cool-chain anywhere between production and consumption. Consumption beyond date of expiration. Improper preparation in the kitchen including the lack of cooking or frying.
Transporting condition	In special vehicle equipped with cooler which guaranties required temperature 0–5°C.
Recommendations for wholesalers and retailers	Store between 0–5°C (no longer than 1/3 of the entire lifespan of the product). Instruction on label
Recommendations for costumers	Consumption before: Recommended ways of preparation:
Contents of label	Produced by: Name, location and EU number Packed by: Name, location and phone number Type of product: State of preparedness: Way of packing: Date of production: dd/mm/yy, Date of expiration: dd/mm/yy Recommended temperature to store: Net weight: Unit price: Price:
Particulars of producer	Name and location

NAME OF PRODUCT Processed fish: Smoked trout	
Quality requirements	Appearance: Skin is intact, well cleaned and free of dirt. Due to smoking its colour varies from light golden-yellow to bronze brown. Colour of flesh varies from light-pink to reddish. Taste: Free of any strange flavour, clear light flavour of smoked fish. Smell: Free of any strange odour, clear light odour of smoked fish. Consistency: Elastic touch of flesh and crispy.
Mode of preservation	10% brine, smoking and packing with gas (30% CO_2 and 70% N_2)
Expiry date	30 days
Packing	Single packing: Fish placed on polystyrene tray and covered with gas retaining folia. Parameters of packing materials: Number of trading permission and name of producer Whole packing: Identification of the type of cartoon box
Indication of packing unit	Single packing with label
Storage	Storing between 0–5 ºC (This period should not be longer than 1/3 of the entire lifespan of product).
Costumers' target groups	For the entire population directly from retailers.
Possible improper use	Interruption of cool-chain anywhere between production and consumption. Consumption beyond date of expiration. Improper preparation in the kitchen including the lack of cooking or frying.
Transporting condition	In special vehicle equipped with cooler which guaranties the required temperature 0–5ºC.
Recommendations for wholesalers and retailers	Storing between 0–5 ºC (This period should not be longer than 1/3 of the entire lifespan of the product).
Recommendations for costumers	Consumption before: Recommended ways of preparation:
Contents of label	Produced by: Name, location and EU number Packed by: Name, location and phone Type of product: State of preparedness: Way of packing: Date of production: dd/mm/yy, Date of expiration: dd/mm/yy Recommended temperature to store: Net weight: Unit price: Price:
Particulars of producer	Name and location

ANNEX 3

LIST OF RECOMMENDED FURTHER READINGS OF RELATED LITERATURE PUBLISHED BY FAO

Bykowski, P.; Dutkiewicz, D. 1996. Freshwater fish processing and equipment in small plants. *FAO Fisheries Circular*. No. 905. Rome, FAO. 1996. 59p (http://www.fao.org/docrep/w0495e/w0495E00.htm)

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Lamendour, P.M.; 1983. Improvement of Fisheries and Aquaculture Production Project, Syrian Arab Republic. Handling, processing and marketing of fish. Field document, FAO, Rome (Italy), 1983 , 19 p. http://www.fao.org/docrep/field/003/Q3832E/Q3832E00.htm

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