

FISHERY AND AQUACULTURE

Level – III

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Standard**



Module Title: - Performing fish postharvest handling

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Introduction to the Module

This module covers the knowledge, skills and attitude required to perform fish postharvest handling that requires the ability to prepare for fish postharvest handling, perform fish postharvest handling on boat and Handle during landing and transportation.

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LG #25	LO#1- prepare for fish postharvest handling
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Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Preparing plan for post-harvest handling
- Post-harvest handling techniques
- Confirming suitable storage and facilities
- Selecting and calibrating tools, materials, equipment and machines
- Identifying risk factors affecting quality of harvested fish
- Occupational health and safety(OHS) procedures
- Maintaining hygienic condition of working area

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Prepare plan for post-harvest handling
- Post-harvest handling techniques
- Confirm suitable storage and facilities
- Select and calibrate tools, materials, equipment and machines
- Identify risk factors affecting quality of harvested fish
- Occupational health and safety(OHS) procedures
- Maintain hygienic condition of working area

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks

5. Perform Operation Sheets

6. Do the “LAP test”

Information Sheet1

1.1.Preparing plan for post-harvest handing

Keeping your fish production operation running efficiently requires a lot of planning and preparation. Therefore prepare a plan based on post-harvest handling techniques should include:

- Resources needed
- Most or all actions necessary to reach the goal
- Efficiencies can be built in to the work, and into the chronological order of the tasks
- Opportunities to reach the goal faster and better
- Risks and dangers visible, and ways to be managed better
- Ways of completing tasks the right way the first time, without the need to go back and heavily modify work to make it all fit together well

1.2.Post-harvest handling techniques

As a fish producer, it's important to know the best post-harvest handling practices to ensure quality and safe products are delivered to the end consumer. Not following the proper post-harvest techniques can lead to decreased shelf life and even spoilage of your produce. The steps you take are critical to ensuring your produce is ready for sale or storage. Some of optimal post-harvest processes that will help you maximize the shelf life of your fish products.

I. Sort and Clean Your Product to Minimize Microbial Contamination

The first post-harvest handling step is sorting and cleaning the product. This will help remove any debris or microorganisms that may be on the fish. Sorting helps to identify any defects so they can be removed before packing. It also helps remove any product or portions of products that may be unusable or unsellable. Sorting is mostly done by hand and can be a tedious task, but it is crucial for maintaining the quality of the product before packaging and storage.

Sorting products mostly involves checking for:

- **Contaminated products** – Remove any products that are visibly contaminated with dirt, mud, or pests.

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- **Unusable product** – Remove any product that is damaged or has a defect that would make it unsellable. This includes products with bruises, cuts, etc.
- **Senescing product** – Remove any product that is beginning to senesce or show signs of deterioration and will not last for an extended period.
- **Insect damaged product** – Remove any product that is infested with insects.
- **Products with broken skin** – Remove any product that has broken or open skin.
- **Products that are out of grade** – Remove any product that does not meet the grade requirements for the variety.

All of these conditions can lead to problems with storage and transport as they may cause additional deterioration during this process. Once the sorting is complete, clean the fish to remove any surface microorganisms. Do this using a gentle stream of water or brush them with a soft brush. Don't use too much force as this could damage the product, making it susceptible to microbial contamination.

Cleaning helps to remove any dirt, dust, or microorganisms that may have contaminated your product while in the field or during post-harvest handling processes. It's vital to use a sanitizing agent if there is any concern about microbial contamination. Proper sorting and cleaning post-harvest techniques ensure you provide customers with attractive and clean products with minimal contamination risk.

II. Ensure Safe Product Packaging to Protect the Integrity of the Product

Improper packaging can lead to damaged fish product, resulting in decreased market access, reduced demand for the product, and lower prices for growers. When selecting your packaging, you must take into account:

- The type of fish being packaged
- Packaging material required by markets
- The weight and dimensions of the product
- Packing method (case packing, single layer packing)
- Labeling requirements

Product packaging is a critical post-harvest handling process that must protect the product from physical damage, and prevent contamination. Careful selection of packaging materials is critical to ensure safe and high-quality products reach the consumer. The ultimate goal is to ensure the integrity of the product is maintained from the farm to the table.

The packaging containers used must be food-grade quality and clean. Plastic containers should be smooth with no sharp edges that could damage the agricultural product. If using corrugated cardboard, ensure the flaps are glued or taped shut to prevent moisture infiltration. As part of the post-harvest handling process, the produce must be handled with care to prevent bruising and damage.

Consider packing produce in single-layer boxes, as less handling is required and, therefore, there is reduced risk of damage to produce during post-harvest processing. Over-packing can lead to excessive bruising and more rapid water loss. Additionally, be sure to follow any specific packing instructions provided by buyers or shippers.

III. Ensure Proper Pre-Cooling to Prolong Product Shelf Life

Proper pre-cooling is also a vital post-harvest technique to prolong a product's shelf life. Pre-cooling helps to reduce the internal temperature of products and extend shelf life. Including various pre-cooling methods in your post-harvest handling process is a crucial step to take. The most effective pre-cooling methods include:

- **Forced air cooling (within the storage room)** – This method uses a fan to blow cold air over the product, but it requires post-harvest facilities that can properly maintain the type of temperature and humidity required for the process. This solution may not be practical or economical for small growers.
- **Hydro cooling** – This involves submerging the agricultural products in a large tub of chilled water for 30 minutes to an hour. After cooling, the product is placed on racks and allowed to drain before being transferred into bins or crates ready for storage.

- **Icing** – This is a very simple technique that can be used to cool agricultural products. All you need is ice and water. Icing can help reduce the internal temperature of fish.

Keep in mind that wet products are more likely to allow the rapid growth of bacterial if not cooled properly. The storage temperature also matters and is often dependent upon the type of agricultural product you're pre-cooling. The most critical temperature ranges to keep in mind for post-harvest handling include:

- Below 41°F to minimize any bacterial growth
- Bacteria grow most rapidly from 70 – 135°F.

Deciding on the optimum storage temperature for your products will also vary depending on the product's respiration rate and whether or not the products are chill-sensitive. Choose the right pre-cooling technique for your specific product and storage conditions to get the most shelf life possible.

IV. Ensure Proper Storage with Appropriate Temperature and Humidity

Improper storage and handling of produce can result in significant loss of product quality and quantity due to microbial growth. As you plan for the post-harvest handling of your produce, ensure that you have a clean storage area with the appropriate temperature and humidity.

- **Temperature** – The ideal storage temperature for most produce is below 0°C. However, this depends on the type of produce.
- **Humidity** – Maintaining an appropriate level of humidity in your storage area is critical for preventing produce from shriveling or wilting.
- **Storage Length** – Different types of produce have different storage lifespans. Be sure to research the appropriate storage time for your produce or consult a post-harvest handling expert.

There are many important factors that should also be considered when storing your produce as part of your post-harvest technique.

- Ensure that your storage area is separated from the processing area to avoid contamination

- Maintain clean and sanitary storage using good housekeeping practices
- Ensure that storage racks are away from walls to allow proper air circulation and easy cleaning
- Practice the tried and true “First-In,” “First-Out” approach for efficient inventory control
- Ensure that no product or packaging materials are stored on the floor
- Maintain a strict rodent control program and monitor your produce regularly for signs of spoilage or pests
- Monitor and maintain a record of storage temperature and humidity
- Ensure that the produce is properly packaged to avoid bruising and moisture loss
- Label all packages with the name of the product, the date it was harvested, and any other important information (e.g. “Refrigerate after Opening”). These records are critical for your post-harvest handling program and will help you to determine the best storage practices for your specific produce.

V. Choose Proper Transportation and Distribution to Avoid Damage and Risk of Contamination

To ensure that your products reach their destination safely and in the best condition possible, it is important to select an appropriate transportation method. When selecting a carrier, keep in mind the following: the weight of your product, the size of your product, the distance to be traveled, and the time of year.

To avoid product damage during this post-harvest handling step, products that are temperature sensitive should not be transported on open trucks for extended periods during the summer months, especially if they will be traveling long distances. You may choose to use your own truck or trailer for local transport, depending on how much product you need to move.

If your products are sensitive to temperature changes, consider a refrigerated vehicle for transporting them safely and efficiently. A good rule of thumb for this post-harvest handling step

is to pack products so that there is a consistent temperature throughout the vehicle. This will help avoid damage and minimize the risk of contamination.

During product distribution, you'll want to keep these post-harvest techniques in mind:

- Take precautions to help minimize the risk of microbial contamination during transit
- Pay attention to all food contact surfaces and keep them clean to avoid cross-contamination
- Use a temperature recorder to monitor temperatures during transport so you know exactly how cold or hot they get while being transported from one place to another
- Make sure you have enough cold storage for your products – this post-harvest handling step will help you determine how much storage capacity is needed

Avoid using transport vehicles that were used to move livestock, poultry, or other animals, as this can pose a risk to the quality and safety of your products. In order to ensure that you're following all the necessary safety protocols, consult your local food regulatory agency for more information on transporting and distributing your products.

VI. Follow Good Manufacturing Practices (GMPs)

Standardized GMPs ensure that your company or farm is following appropriate procedures for handling and storing food. This post-harvest handling step helps to reduce the risk of contamination by pathogens, chemicals, or allergens. GMPs are guidelines established by the Food and Drug Administration (FDA) for food producers to help prevent illness from contaminated products and protect consumers from mislabeling on food products.

Here are some good practices to keep in mind:

- Any building where post-harvest activities take place should be designed, constructed, and maintained to protect food from contamination.
- Equipment and utensils used in post-harvest must be cleaned and sanitized before and after use.

- Food contact surfaces (cutting boards, countertops, etc.) must be clean and sanitized after each use.
- A supply of potable water should be available on the farm for washing hands, as required by GMPs.
- Water quality in your post-harvest handling facility should be regularly monitored.
- Employees must practice proper personal hygiene and wear clean clothing when working in post-harvest facilities.

By following these best practices, you can help ensure the safety of your food products. Of course, post-harvest techniques vary from facility to facility depending on the type of product you're handling, the climate, and other factors. So be sure to consult with your local agricultural extension office or food safety specialist for specific recommendations.

VII. Ensure Proper Preservation to Prolong Product Shelf Life

Fish, however, is more susceptible to spoilage than certain other animal protein foods, such as meat and eggs. To prevent spoilage of fish, some form of preservation is necessary. Preservation means keeping the fish, after it has landed, in a condition wholesome and fit for human consumption for a short period to few days or for longer periods of over few months. During the period of preservation the fish is kept as fresh as possible, with minimum losses in flavour, taste, odor, form, nutritive value, weight and digestibility of flesh. This preservation should cover the entire period from the time of capture of fish to its sale at the retailers counter.

Methods of Preservation- Preservation can be done, both for short and long duration

A. Preservation for short duration

Chilling:-This is obtained by covering the fish with layers of ice. Ice is effective for short term preservation such as is needed to transport landed fish to nearby markets or to canning factories, etc. Here autolytic enzyme activities are checked by lowering the temperature.

B. Preservation for long time

When the preservation is required for a long period of time, the fishes are passed through the cleaning, gutting and conservation and storage.

Cleaning and gutting:-During cleaning, the caught first are fish washed thoroughly in cold,

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clean water to remove bacteria, slime, blood, faeces, and mud, etc. from the body surface of the fish. It is being done under proper sanitary conditions. Large fishes are gutted (i.e. all the internal organs or viscera are removed) and the body cavity is washed.

C. Conservation and Storage

Conservation is necessary to keep the dead fish in fresh condition for quite a long time. This is achieved by employing any one of the methods like freezing, drying, salting, smoking and canning.

Freezing:-Freezing means removal of heat from the body. To check the enzymal, bacterial action and putrefaction it is preferred to store the fish under lower temperatures. When fish is intended to be stored for a long period, quick freezing is preferred which inhibits bacterial action. During quick freezing every part of the product comes within the range of 0 to -5°C . Properly frozen fish at -20°C retains its physical properties and nutritive values for a year or more and is almost as good as fresh fish. There are three ways effecting quick freezing:

- Direct immersion of fish in the refrigerating medium,
- Indirect contact with the refrigerant through plates
- Forced convection of refrigerated air directed at heat transfer surfaces.

In general different methods of freezing are adapted through sharp freezer, air blast freezer, contact plate freezer, immersion freezing, liquid freon freezing, liquid nitrogen freezing, fluidized bed freezer, cryogenic freezing, etc. Among the various types of quick freezing plants installed in India the carrier air blast type is widely used. The air blast freezer is in the form of a tunnel and heat transfer is affected rapidly by the circulation of air. The temperature used ranges from 0 to -30°C and air velocity varies from 30 to 1050 meters/min.

Freeze drying- This is modified deep freezing, completely eliminating all chances of denaturation. The deep frozen fish at -20°C is then dried by direct sublimation of ice to water vapour with any melting into liquid water. This is achieved by exposing the frozen fish to 140°C in a vacuum chamber. The fish is then packed or canned in dried condition. The product is quite fresh looking in appearance, flavour, colour and quality.

Salting:-Salting is a process where the common salt, sodium chloride, is used as a preservative

which penetrates the tissues, thus checks the bacterial growth and inactivates the enzymes. Some of the factors involved in salting of fish which play an important role are purity of salt, quantify of salt used, method of salting and weather conditions like temperature, etc.

During the process the small fishes are directly salted without being cleaned. In the medium and large sized fish the head and viscera are removed and longitudinal cuts are made with the help of knives in the fleshy area of the body. Then the fish is washed and filled with salt for uniform penetration through flesh. Large fishes like sharks are cut into convenient sized pieces. Generally, sardines, mackerels, seer fishes, cat fishes, sharks and prawns are used for salting. Dry salting and wet salting and are the methods employed in salting of fish.

- Dry salting

In this process the fish is first rubbed in salt and packed in layers in the tubs and cemented tanks. The salt is applied in between the layers of fishes in the proportion of 1:3 to 1:8 salts to fish. The proportion of salt to fish varies with the fish since the oily fish require more salt. At the end of 10 - 24 hours the fishes are removed from the tubs and washed in salt brine and dried in the sun for 2 or 3 days.

- Wet salting

The cleaned fish are put in the previously prepared concentrated salt solution. It is stirred daily till it is properly pickled. With large sized fishes, longitudinal slits are made in the flesh to allow penetration of salt. After pickling for 7-10days, the salty water that oozes out from the fish is allowed to drain off. This can be stored upto 3-4months.

Smoking:-In this method, landed fish is cleaned and brined. It is then exposed to cold or hot smoke treatment. In cold smoking, first a temperature of 38⁰C is raised from a smokeless fire. After this heating, cold smoke at a temperature below 28⁰C is allowed to circulate past the fish. In case of hot smoking, first a strong fire produces a temperature around 130⁰C. This is followed by smoking at a temperature of 40⁰C. The smoke has to be wet and dense. Good controls are necessary over density, temperature, humidity, speed of circulation, pattern of circulation and time of contact with fish of the smoke. The phenol content of the smoke acts as an antiseptic and it also imparts a characteristic colour and flavour. For making fire and smoke, only hard wood

(Conifer wood, Saw dust etc.) are used.

Canning:-Canning is a method of preservation in which spoilage can be averted by killing micro-organisms through heat. Oily fish are the most suitable for canning. Salmon, tuna, sardine, herring, lobster, shrimp, etc. are canned. The raw material should be processed properly since it contains most dangerous *Clostridium botulinum* which should be destroyed. There are some other heat resistant bacteria like *Clostridium sporogenes* which can be eliminated at a temperature of 5 - 6 times more than *Clostridium botulinum*. It needs a temperature of 120⁰C for 4 minutes or at 115⁰C for 10 minutes to kill them in large numbers.

Canning is done by putting cleaned dressed and cut fish into a saline solution. The cans holding the fish and the saline are then double seamed under vacuum. Thereafter, sterilization of cans takes place at 121⁰C for 90min under steam pressure. Sterilization is followed by cooling of the cans under room temperature by running water.

Drying:-Drying involves dehydration i.e. the removal of moisture contents of fish, so that the bacterial decomposition or enzymic autolysis does not occur. When moisture contents reduce upto 10%, the fishes are not spoiled provided they are stored in dry conditions. Fish drying is achieved either naturally or by artificial means. In natural drying the fishes after being caught are washed and dried in the sunshine. In artificial drying the killed fishes are cleaned, gutted and have their heads removed. They are then cut lengthwise to remove large parts of their spinal column, followed by washing and drying them mechanically.

1.3.Confirming suitable storage and facilities

Harvested fish storage and facilities should be confirmed their availability as well as suitability to keep the products. The capacity of storage and facilities, quoted in terms of the quantity of produce it can hold, can only be a nominal value which may differ widely from the actual capacity achieved in practice.

Some of the factors which affect storage and facilities capacity and suitability are:




- Loading density of the products,
- Proportions of different products stored





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- Stacking method used,
- Stacking arrangement to meet access requirement,
- Separation of products required to suit customer or product requirements,
- Mixture of pallet sizes,
- Handling system used and space required,
- Stacking height,
- Space required for coolers and air-flow distribution




1.4. Selecting and calibrating tools, materials, equipment and machines





Table. 1.1 Tools and Equipment's used in fish post-harvest handling





No	Name of items	Image/Figures	Functions
1	Fish cleaning/ gutting machine		Used to remove gut accurately and cleanly without damaging the fish gallbladder.
2	Fish filleting machine		Designed for Cut the fish with fast speed; The sharp blade cuts the fish with accuracy; Fillet the head-off fish into three pieces (the left piece, the right piece and the pin bone)
3	Band saw		Band saws are used to cut large volumes of frozen fish and fish products.


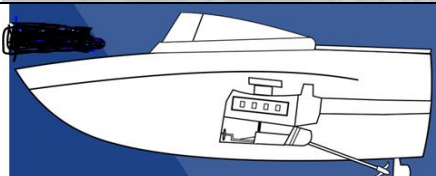
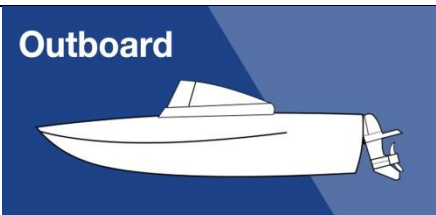
4	Fish scaler		This kitchen tool is made to easily remove the scales attached to the skin of a fish that will be prepared and cooked whole.
5	Fish filleting troughs		fish filleting troughs for washing and icing
6	Filleting knives		Fillet knives are specifically designed for cutting fish and removing bones.
7	Cleaning/gutting knives		Handy blades allow you to easily and delicately prepare fish for removing internal parts.

8	Deboning knives		The main purpose of deboning knives is to separate meat from the bone. They make boning easier and save time. They are strong enough to withstand the toughest meat cutting jobs. Solid blades and handles make boning knives more powerful than other pieces of cutlery.
9	Cleaning/gutting and filleting table		A Table designed to make the process of filleting and trimming fish more efficient with a central dispenser trough for waste disposal or alternatively graded goods ready for packaging.
10	Fish boxes and tubs/ Plastic fish handling boxes		Used for storage of catches on board the vessels. Today, fish boxes already consist of mono-material, namely HDPE, which is a hard and durable plastic. The material can thus be recycled.
11	Trays		Used to protect the fish from contamination and keeps them fresh. These trays are manufactured so that they do not support the growth of micro-bacteria. There is no compromise

			on quality these days, so maintain a hygienic environment to keep your customers alive and kick and stick with you.
12	Weighing balance		Used to determine the weight of fish
13	Deboning machines		Used for collecting and extracting the fish flesh with stainless steel rotary drum which is designed with screening holes in it. By extracting the fish flesh from the screening hole, fish deboner can separate the flesh from the fishbone, thus saving labor and time.
14	Fish tubs and bins		Used for storing fish, for the transport of live fish, during maturation of fish products, and as bins for collecting fish waste.

15	Scaling knife		Used to remove scales. Knives can handle small fish such as sardines and mackerels or fish with only few scales or thin scales, but they can't handle fish with solid scales.
16	Scaling machine		used to remove the fish scale in an automatic and sanitary way. The whole descaling process has no damage to fish with soft brush type rolling.
17	Packaging material		Protect fishery products from dehydration, oxidation and contamination. A good package has: Moisture proofness. Loss of water during frozen storage results in a condition often referred to as freezer burn.
18	Chiller		Reduce the temperature at which the fish is kept lowers the rate of deterioration. During chilling the temperature is reduced to that of melting ice, 0 °C/32 °F.

19	Ice box		An icebox is a container which is kept cool so that the fish and fish product inside stays fresh.
	Ice		Ice is an extremely efficient cooling agent for fish. It is capable of reducing fish temperatures to 0 °C very rapidly. This type of ice is mostly used to stow fish in closed containers such as boxes or insulated tubs. Its use for stowage of fish on shelving depends on the texture (liquidity) of the ice.
20	Ice machine		Dedicated to making a large amount of ice in the comfort of your own home. This prevents you from having to stock up on ice.
21	Hand cart/Poly outdoor fish cart	 <p>FOLDABLE BAIT TRAY WITH LURE & TOOL SLOTS</p> <p>8 REMOVABLE FISHING ROD HOLDERS</p> <p>13-INCH TIRES Solid-all-terrain tires</p> <p>TOUGH POLY BED</p>	The use of hand carts to transport loads instead of carrying them saves workers a lot of effort. It decreases the risk of overexertion injury in jobs that include manual materials handling. However, pushing, pulling, and maneuvering hand carts still involve some

			common hazards (overexertion).
	Electric generators		Used to provide a good backup for power needs.
	Inboard boats/ Direct Drive		Boats using a direct drive inboard have their engine positioned in the center of the boat with a drive shaft running straight to the propeller positioned underneath the boat in the rear.
	Outboard boats/V-Drive		Places the engine in the rear of the boat behind the transom. The engine is placed backward when compared to the direct drive, with the driveshaft first exiting toward the front of the boat then quickly turning and angling down and back toward the stern.

1.5. Identifying risk factors affecting quality of harvested fish

Maintaining the quality of fish begins with harvest and transport of the fish products. It is advisable for the fisher-folk to carefully handle their fish products on canoe/boat during transport. This will allow the fisher-folk to maintain high quality of the fish product. There are several factors affecting fish handling on canoe/boat, mostly the biological, chemical and

physical factors that cause degradation of fish products. The surfaces of dead fish are ideal growth habitats for bacteria contributing to the spoilage process. Hence, it is important for the fisher-folk to control the temperature of fish. Bacteria growth implicates chemical breakdown due to oxidative and enzymatic reactions leading to off odour; flavor and rancidity. The following factors discussed below can affect the quality of fish after harvest when not properly managed.

I. Temperature

Proper temperature management between the period of harvesting and consumption has been found to be the most effective way to maintain quality. Keeping harvested fish cool at low temperatures will slow down many metabolic activities which lead to spoilage, hence allowing more time for all the postharvest handling of the produce. It is therefore important to determine the optimum temperature needed when handling tomato fruits during storage.

It is well known that high temperatures increase the rate of fish spoilage and low temperatures slow it down. Therefore, if the temperature of fresh fish is low, then quality is lost slowly. The faster a lower temperature is attained during fish chilling, the more effectively the spoilage activity is inhibited. Temperature influences the ability/desire of the fish to obtain food, and how they process food through digestion, absorb nutrients within the gastrointestinal tract, and store excess energy.

II. Road

Fresh fish are highly perishable, and microbiological spoilage is one of the important factors that limit their shelf life and safety. Fresh can be cross-contamination at any point of transportation or creates delays to reach landing centers due to inappropriate roads.

III. Transport

Transportation of live fish from the farm to the processing unit is known to cause stress to the fish and leads to a number of physiological responses. In the industry, the arrival of live fish is important so that processing can occur during the period of pre-rigor mortis; fish processed during rigor mortis have impaired flesh quality and lower fillet yield. Therefore, the pre-slaughter stress during the transportation of live fish to the processing unit is important to the provision of strategies to the aquaculture industry for improving fish handling techniques.

IV. Market

Due to the physical hazards, biological hazards, and chemicals contained within the land, contamination may present a risk to users of the site, neighbouring site occupants, and workers on the market site carrying out activities as well as the environment lead quality deterioration.

V. Storage system

Fish spoilage is frequently caused by bacteria from fish that have been incorrectly stored, prepared, handled. Fish contaminated with fish spoilage bacteria may look, smell and taste normal. If food is not stored properly, the bacteria in it can multiply to dangerous levels. If fish isn't handled, prepared or stored properly, it can become spoiled with germs. You won't always be able to tell from the taste or smell. These germs can cause stomach aches, diarrhea or vomiting, or fever. Some germs can cause more serious problems such as kidney failure, blood infection or even paralysis.

VI. Infrastructure

There are a number of challenges that relate to accessibility, Lack of Infrastructure, no electrical power, no running water, bad roads, etc. that are risky for keeping the quality of harvested fish. Insufficiencies in infrastructure (e.g., transportation/roads, telecommunication, and energy) translate into poorly functioning markets, thus affecting fish supplies and, consequently, harvested fish quality.

1.6. Occupational health and safety(OHS) procedures

Occupational health and safety is the discipline concerned with preserving and protecting human resources in the workplace. Occupational health is the adaptation of work to man and of each man to his job. It has the following components:

- Promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations;
- Prevention among workers of departures from health caused by their working conditions;
- Protection of workers in their employment from risks resulting from factors adverse to health; and

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- Placing and maintenance of a worker in an occupational environment adapted to his physiological and psychological equipment.

<https://www.youtube.com/watch?v=mSKxcVZAXjw> (accesses date May, 03, 2023)

1.6.1. Conducting checks on all Tools, materials, equipment and machines

Checking materials, tools and equipment's refers to the process of examining their parts to ensure their normal functioning.

- **Checking before use**
 - ✓ To identify the problems (defects, damages) of the Machinery, Tools and Equipment's and take actions to correct or change them before using them.
 - ✓ To identify any hazards and risks that can be raised from miss-use of the Machinery, Tools and Equipment's and take minimization action timely.
- **A guideline to conduct pre-operational checks on equipment's and tools**

You should make sure that the equipment's and tools used for work are safe to use. Here is list of actions that should be taken to ensure this is so.

- ✓ Perform a risk assessment to identify the hazards and the control measures you should use
- ✓ Check that the equipment/tool is suitable for work and way in which it is going to be used
- ✓ Check that the equipment/tool is in good condition
- ✓ Make sure that the user knows which personal equipment to use and how to use it
- ✓ Think about who will use the equipment/tool including experienced workers, workers with language difficulties, new starter
- ✓ Speaking with team members or team leaders who has used the equipment before will help you identify any potential issues or problems.

1.6.2. Manual handling techniques for loading and unloading materials

Loading: refers to putting of the load (anything) on to the ship, truck or pack Fish

Unloading: removing cargo from carrier or taking the load off a ship, truck, or pack Fish

- **A guideline to load and unload equipment's and tools**

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- ✓ Load/unload the material in required order taking care to avoid damage
- ✓ Use manual handling techniques of loading /unloading throughout the process to avoid injury or damage
- ✓ Install the material in appropriate work or storage area in accordance with direction
- ✓ Identify any hazardous items and load /unload these in a manner that minimizes health and safety risks.
- ✓ Inspect load prior to transportation to ensure that all items are loaded appropriately and make adjustments as required
- ✓ Secure package against shifting within a vehicle during transportation though tying, blocking and bracing the load
- ✓ Load packages with orientation marks (up arrow) so that the marks remain pointed up
- ✓ Do not allow any smoking or any source of ignition on or near the vehicle when loading flammable
- ✓ Always load materials having high weight at the bottom
- ✓ Always load similar materials in one side during loading of different types of items

1.6.3. Selecting and checking Suitable Personal Protective Equipment (PPE)

Personal protective Equipment's (PPE): -Personal Protective Equipment's are those equipment's that used to protect the body from external hazardous matters or conditions during work activities in the workplace.

1.6.3.1. Choosing the appropriate Personal Protective Equipment

What protective clothing and equipment is necessary? This depends on the duty being undertaken and chemical being used but the work place instruction and manufacturer's directions should be used as a guide. The degree of protection required will be relative to the degree of hazard presented by a particular product or/and work.

1.6.3.2. Common PPE items

There are many PPE items however, we will mention some of the ones that you are most likely to come across in most animal care workplaces.

- A. Plastic boot:** Helps your foot against possible exposure within a contaminated environment.



Figure 1.1 Plastic boot

- B. Uniforms, overalls or protective clothing:** used as protective clothing when working.



Figure 1.2. Uniforms

- C. Aprons:** Description usually made of rubber; aprons protect the body and clothing from splashes and spills when handling large quantities of corrosive chemicals. They are also

useful to keep you dry when handling fish. Aprons should cover the body from the shoulder to below the tops of boots.



Figure 1.3 Aprons

D. Gloves, mitts or gauntlets, and protective hand and arm covering: help protect you when directly handling potentially infectious materials or contaminated surfaces.



Figure 1.4. Gloves

E. Protective hair, beard and boot covers: help protect only your head from sun rays.



Figure 1.5. Protective hair, beard and boot covers

F. Insulated protective clothing: for freezers or chillers and refrigeration unit.



Figure 1.6. Insulated protective clothing

G. Face mask: protect against food contamination.



Figure 1.7. Face mask

1.6.4. Identifying and responding OHS hazards

Hazard is the term that refers to dangerous conditions that can results risks in the working place. This can be physical, mechanical, chemical, and biological factors which affect or harm the health and safety of all people in the working place. Hazardous issues that occur during the operational phase of fish post-harvest handling primarily include the following:

a) Physical hazards

Causes of accidents in fish processing operations include falls caused by slippery floors and stairs; equipment safety issues associated with filleting knives and other sharp tools; and cuts from sharp edges on process equipment (e.g. stainless steel basins). In addition to general recommendations included in the General EHS Guidelines, the following are sector-specific recommendations for accident prevention: Provide workers with training in the proper use and maintenance of cutting equipment (including the use of machine safety devices, handling /

storage and upkeep of knives, and emergency shutoff procedures) and personal protective equipment (e.g. metallic gloves and leather aprons for cutting activities, and protective footwear with rubber soles);

- Design the plant so that different activities and the flow of processes do not cross. In addition, clearly demarcate transport corridors and working areas; ensure that handrails are provided on platforms, ladders, and stairs; and use non-slip floor surfacing;
- Use completely enclosed conveyer belts to protect hands and fingers.

b) Biological hazards

Workers involved in manual gutting, skinning, and general handling of fish and shellfish may develop infections and or allergic reactions resulting from exposure to the fish itself, or bacteria on the fish. Water spraying processes may result in the formation of aerosols with bacteria that can be inhaled. In addition to general recommendations included in the General EHS Guidelines, the following are sector-specific recommendations to prevent exposure to bacteria:

- Consider work rotation strategies to reduce occupational exposure to allergens;
- Wear gloves to protect hands from exposure to products, especially when working with that is known to create allergic reactions (e.g. scallops and shrimp).
- Provide food-approved shielding hand creams;
- Avoid aerosol-generating activities (e.g. use of compressed air or high-pressure water for cleaning). Where these activities cannot be avoided, provide proper ventilation of enclosed or semi-enclosed areas to reduce or eliminate exposure to aerosols, in addition to adequate distances between workers and aerosol-generating activities;
- Ensure physical segregation of work and personal facilities to maintain worker personal hygiene.

c) Lifting, Carrying, and Repetitive Work

Fish processing activities may include a variety of situations in which workers can be exposed to lifting, carrying, and repetitive work, and work posture injuries. Many of the manual operations in less mechanized fish processing plants include lifting heavy boxes of raw materials. Repetitive strain injuries may result from manual filleting and trimming operations. Poor working postures

may result from the design of the workspace, furniture, machinery, and tools. Recommended prevention and control measures for these activities are discussed in the General EHS Guidelines.

d) Chemicals

Exposure to chemicals (including gases and vapors) includes handling chemicals such as chlorine, lye, and acids that are related to cleaning operations and disinfection in process areas. In fish smoking facilities, workers could be exposed to smoke a particle that contains potential or confirmed carcinogens such as polycyclic aromatic hydrocarbons (PAHs). Recommendations to prevent and control exposure to chemicals are presented in the General EHS Guidelines. Additional, industry-specific recommendations include:

- Avoid locating smoking kilns in the same rooms as processing workers. Chimney exhaust systems should ensure that smoke is not entering the processing factory. Respiratory protection should be used when cleaning smoke ovens;
- Ensure that employees handling concentrated lye, acid, and chlorine wear protective clothing and eyewear.

e) Heat and Cold

Exposure to extreme heat and cold is common because fish processing is often conducted in air-conditioned plants under low temperature, even in tropical locations. Improper work clothes in combination with stationary work locations can result, or be an additional factor, in respiratory and musculoskeletal ailments. Recommendations for the management of exposure to heat and cold include the following:

- Set the temperature in air-conditioned processing facilities, where stationary manual work is conducted, at a level that is appropriate according to temperature stress management procedures as noted in the General EHS Guidelines. Products awaiting the next processing step can be kept chilled without lowering the ambient temperature through proper use of ice, slush-ice, or waterice mixtures;
- Equip cold stores and chill stores with strip curtains to avoid extensive drafts when doors are open. Ensure freezers can be opened from the inside;

- Design air-conditioning systems for processing facilities in conjunction with strip curtain placement to minimize drafts;
- Provide protective clothing in cold environments (e.g. refrigerated storage rooms). Process workers should always be equipped with proper working garments, including dry boots;
- Reduce movement of processing workers between different temperature zones (e.g. when packing frozen products). Confined Space

f) Occupational health and safety impacts

Confined spaces in fish processing operations (e.g. storage areas, boat holds) are common to most industries, and their prevention and control are discussed in the General EHS (Environmental, Health, and Safety Guidelines) Guidelines.

g) Noise and Vibrations

Noise and vibration exposure may result from proximity to noisy machinery (e.g. compressors, automatic packing machinery, condensers, ventilation units, and pressurized air). Recommendations for noise management are discussed in the General EHS Guidelines.

Preventive measures

- Wear safety shoes with non-slip soles
- Erect fences and post warning signs round open pits in the farm.
- call a qualified electrician to examine and repair faulty or suspect electric equipment
- Wear protective goggles and respiratory protection during work
- Do not ever enter a confined space when you are alone
- Seek medical attention if skin rashes develop; consult an allergy specialist
- Keep a high level of personal hygiene; change clothes at the beginning and end of shift; do not take work-soiled clothes home
- Learn correct lifting techniques and work postures, to avoid low back pain use mechanical aids for the lifting and transport of heavy loads how to deal with sensitivity to solvents and adhesives.

- Install effective exhaust ventilation to remove hazardous gases and vapors, and eliminate obnoxious odors from the farm.

1.7. Maintaining hygienic condition of working area

Whatever the work, the working environment should be free of hazards that make problems both on workers and the products getting from the farms. Fish handling area should be free from dry and wet wastes, rusted metals, rusted and damaged equipment, unwanted bushes, wild fire, suspected flood, dangerous reptiles (snakes, crocodiles, etc.) and other enemies of both workers and fishes.

The major waste that makes difficulty in and around fish processing area is the cut of harvested fish and feed remaining. Therefore, fish producers give great concentration for waste management program by thinking over the workers as well as the dwellers surrounding the fish and fish product handling area.

A good workplace housekeeping system will provide for proper inspection, maintenance, upkeep and repair of tools, equipment, machines and processes. Tasks and the equipment required to carry them out should also be set up in a fashion that minimizes the number of times items have to be handled.

Poor workplace housekeeping can often lead to workplace injuries from:

- being hit by falling objects
- tripping over objects on the floor, stairs and platforms
- slipping on wet, greasy, dirty or icy surfaces
- hitting projecting items and stacked materials
- Cutting, puncturing or tearing the skin on projecting nails, wire, etc.

General guidelines in maintaining the work area;

- All dead stock must be removed and buried as soon as possible.
- Fuel must be stored away from other chemicals, food and holding tanks.
- Always tighten the caps and tops of chemical containers after use.
- Mop up all spills immediately.
- Check baits and traps regularly and dispose of any kills properly.

- Waste water is transported to the settling pond.
- Waste must be handled properly; otherwise the environment may be damaged.

Self-check 1	Written test
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Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test 1 matching

- | | |
|--|--------------------|
| A | B |
| _____ 1. Used to open the belly of fish. | A. Fish scaler |
| _____ 2. Used to removing meat from bones. | B. Filleting knife |
| _____ 3. Remove the scales attached to the skin. | C. Fish tubs |
| _____ 4. Used for storing fish. | D. Gutting knife |
| _____ 5. Essential tool that easily breaks down and precisely portions fish. | E. Deboning knife |

Test 1: Give short answer for the following questions.

1. List at list five tools and equipment's used for fish post-harvest work?
2. Write down at least three fish post-harvest techniques?
3. What are the major risk factors that affect the quality of harvested fish?

LG #26	LO#2- : Perform fish postharvest handling on boat
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Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying signs of spoilage, defects, parasites and defective fish
- Causes of fish spoilage
- Removing gill and gut of large fish
- Caring fish from mechanical injuries
- Keeping fish in appropriate container and position
- Washing and cleaning postharvest handling tools
- Handling fish with ice box
- Monitoring temperature of fish
- Protecting fish from contamination
- Understanding post mortem change of fish

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Identify signs of spoilage, defects, parasites and defective fish
- Causes of fish spoilage
- Remove gill and gut of large fish
- Care fish from mechanical injuries
- Keep fish in appropriate container and position
- Wash and clean postharvest handling tools
- Handle fish with ice box
- Monitor temperature of fish

- Protect fish from contamination
- Understand post mortem change of fish

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 2

2.1. Identifying signs of spoilage, defects, parasites and defective fish

2.1.1 Signs Use to Determine Spoilt Fish

There are signs on a fish that can help you determine if the fish is spoilt. These include can:

- Sunken eyes.
- Dark gills
- Presence of flies
- Burst stomach
- Bad smell



Figure 2.1. Sunken eyes fish



Figure 2.2. Good - Bright red gills and Bad - Dark gills



Figure 2.3. Fish with flies








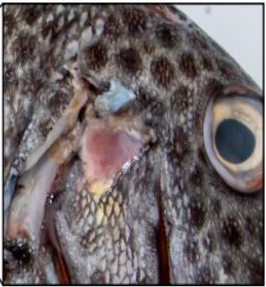



Figure 2.4. Burst stomach

2.1.2. Determining freshness of fish

Fresh fish will have bright coloured, glossy and clear skin, transparent flesh and undamaged body.

Table. 2.1 Spoiled and fish fresh

A. Check the eyes	
A bad/spoiled fish eye will look:	A fresh fish eye will be:
<p>► Cloudy and dull</p> 	<p>► Shiny and clear</p> 
<p>► Sunken</p> 	<p>► Bulging out</p> 
B. Look for abrasions on the fish body	

<p>Injured fish deteriorate faster.</p>  	
C. Check the gills	
<p>Bad/spoiled/old fish will have discolouration on the gills and it will also be slimy.</p> 	<p>Fresh fish will have bright pink or red gills. They should also be slightly wet and not slimy or dry.</p> 
D. Notice the smell	
<p>If the fish has a strong foul 'fishy' smell, the fish is decomposing. Fresh fish in good condition has a clean slightly fishy smell, not unpleasant, and not strong.</p> 	

Spoilage, defects, parasites and defective fish includes:

- Consistency of muscle flesh
- Scale consistency and skin colour
- Appearance of eye
- Gill color
- Consistency of belly
- Mechanical injuries
- Parasite infestation on the external and internal

2.2.Causes of fish spoilage

What comes into your mind when you hear “spoilage”? Let us try to discuss it and see what it means. In our daily handling of fish, we touch the fish frequently, which may cause the fish to deteriorate. Fish spoilage can be defined as any change in your fish which causes a loss in its quality and commercial value. Note that a spoilt fish cannot be good for human beings to eat, they can only be thrown away or be used to feed animals. Spoilt fish causes loss to your fisheries business when they are thrown away. The various changes that take place in the handling of fish that cause losses, are influenced by several factors. Some of these factors are:

- i. **Time:** The time between the death of the fish to its final use or consumption. Delay in the process will cause the fish to spoil. Naturally, quality processed fish also deteriorates over a period of time.
- ii. **Temperature:** It is the degree of hotness or coldness the fish is exposed to. High ambient temperatures, such as 20°C and above, easily create favorable conditions for fish spoilage while temperatures below 5°C help slow down the action of bacteria and the rate of spoilage, thereby helping to reduce losses.
- iii. **Contamination /Bad Handling Practices/:** Poor handling practices lead to sustained and increased microbial contamination, speeding up the spoilage rate of fish. Such practices include:
 - Using dirty canoes, equipment, fish boxes and baskets
 - Not washing fish
 - Washing fish in dirty water
 - Placing fish on dirty surfaces
 - Physically damaging fish by throwing or standing on them
 - Throwing away catch fish at sea because fish is too small or not good enough to land for sale.
 - Poor processing techniques damages fish
 - Animal predation and insect infestation

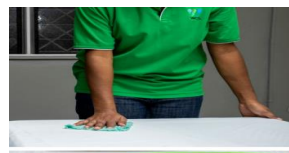
- Poor packaging and storage practices lead to damage the fish
- iv. **Enzymatic:** Enzymatic spoilage is caused by the autolytic fish enzymes. Fishes are highly perishable than meat because of more rapid autolysis by fish enzymes, and favorable conditions for microbial growth due to less acid reactions.
- v. **Chemical:** The most common chemical action which causes spoilage is the oxidative rancidity in fatty fishes. The levels of peroxide value and free fatty acid content both a measure of oxidative rancidity are considered an index of quality of fat fishes. The spoilage in fish is accompanied by the change in physical characteristic. Oxygen in the air can attack unsaturated oils in seafood causing rancidity, off-odors and off- flavors.
- vi. **Bacterial:** Whilst the spoilage of fresh and highly salted fish is well understood, much less is known about spoilage of lightly preserved fish products. It is concluded that the spoilage is probably caused by lactic acid bacteria, certain psychotrophic Enterobacteriaceae and/or Photobacterium phosphoreum.

2.3. Removing gill and gut of large fish

Gills and viscera of fish harbour several spoilage bacteria in large numbers. These are potential areas where bacteria multiply and infiltrate into other areas. Partially digested food in the viscera may become sour or putrid due to bacterial action. Viscera are also the seat of very powerful digestive enzymes. They can bring about accelerated spoilage of fish. Therefore, the gills and viscera of the fish are removed before they are preserved and stored. While gills and viscera are removed, the general practice is to retain the head intact. Evisceration should be complete with no portion of it left out. During evisceration no cut or bruise should be inflicted on the exposed belly portion. Retention of visceral parts can easily contaminate the soft belly, whereas bruises can cause accelerated spoilage by permitting easy penetration of bacteria. Removal of viscera and gills and bleeding should be done separately without contaminating other fishes. After each operation the fish should be thoroughly washed.

Table. 2.2 Steps of cleaning and gutting:

Step 1. Thoroughly clean chopping board or flat surface, and knife you will be using to gut your fish.



Step 2. Wash your hands, remove fish from brine solution or ice box and place the fish with the belly facing you on a clean chopping board or flat clean surface.



Step 3. Make a slit from the anus, along the belly of the fish to the gills (or just under the pelvic fins), taking care not to puncture the internal organs or gut. Purpose: To reduce and remove bacteria present in the fish stomach and intestines thus slowing the spoilage process.



Step 4. Lift gill cover and carefully cut gill attachments for easy removal.



Step 5. Carefully grab hold of the gills and remove fish gills pulling the entire gut along. The gut and gills should come out as one complete piece making sure the stomach does not burst open. Take care, as some gills can be sharp and may pierce your gloves and cause cuts.



Step 6. Note that the fish gut has been removed with the gills intact, without puncturing any internal organs such as the stomach and intestines. Clean fish thoroughly in fresh running water before icing or cooking.



2.4. Caring fish from mechanical injuries

To minimize damage to the fish

- In handling areas, surfaces should have a minimum of sharp corners and projections.
- In boxing and shelving storage areas, the design should preclude excessive pressure being exerted on the fish and shellfish.
- Chutes and conveyors should be designed to prevent physical damage caused by long drops or crushing.
- Fishing gear and its usage should minimize damage to and deterioration of fish
- Seines, nets and traps should be carefully selected to ensure minimum damage during harvesting.
- Harvesting areas and all equipment for harvesting, catching, sorting, grading, conveying and transporting of live products should be designed for their rapid and efficient handling without causing mechanical damage. These should be easy to clean and free from contamination.
- Conveying equipment for live and slaughtered products should be constructed of suitable corrosion-resistant material that does not transmit toxic substances and should not cause mechanical injuries to them.
- Where fish are transported live, care should be taken to avoid overcrowding and to minimize bruising.
- Where fish are held or transported live, care should be taken to maintain factors that affect fish health (e.g. CO₂, O₂, temperature and nitrogenous wastes)

2.5. Keeping fish in appropriate container and position

Many types of containers, constructed from a variety of materials, are used for the transport of ice and fish - from simple baskets of woven reeds, bamboo, cane or grasses, to containers made from wood, metals and plastics. In order to reduce the melting of ice, insulation materials such as those may be used in the construction of containers. Use of any particular type depends very much on the economic situation of the locale and fishery being pursued.

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Although estimates vary, in some situations a high proportion of fresh fish caught in tropical and subtropical areas may be wasted, with the major loss in quality and value occurring between harvesting operations and first sale in landing areas. It is envisaged that with the increased availability and wider use of properly designed containers for use on canoes and small fishing vessels, there will be scope for reducing wastage of fresh fish in small-scale fisheries.

However, there are a number of factors that limit the achievement of this goal. These include the relatively high cost of insulated containers and the fact that ready-made containers are generally manufactured in industrialized countries and need to be imported. The extra costs involved in the purchase of metal or plastic boxes are sometimes sufficient to deter fishermen from using them. They opt instead for the traditional locally made containers or baskets with their lower investment cost. As a fishery becomes more developed and product quality becomes an issue, the trend to purchase plastic or metal boxes increases.

In some tropical areas, the cost and availability of ice are limiting factors, rather than the cost of insulated containers. Besides the existing technological limitations in some tropical areas, there is scope for developments in the design and construction of locally made insulated containers, which should eventually make them more easily available and inexpensive enough for small-scale fishermen.

Insulated fish containers the main functions of an insulated fish container on board canoes and small fishing vessels are:

- to make handling easier (by reducing the handling frequency of individual fish) and protect the fish from the risk of physical damage;
- to maintain fish quality, by ensuring adequate chilling and low ice-meltage rates as a result of reduced heat infiltration through container walls;
- to improve fish-handling practices and so lead to better quality fish being landed, making longer fishing trips and better fish prices possible for fishermen.

The effectiveness of insulated containers in reducing ice melting is an important criterion in the evaluation and selection of such containers. It is more likely that the advantages that insulated containers offer will be fully appreciated by small scale fishermen in tropical climates where ice melting rates are much higher than in cold or temperate climates.

2.6.Washing and cleaning postharvest handling tools

Washing and cleaning refers to removal of dirt, filth or unwanted substances matter from the materials, tools and equipment. Work site have to be clean and safe for efficient work of employee. So, any farmer or employee in livestock farm has to keep sanitation of his work site; which mean that he has to clean his work area after completing his task by doing these he can keep healthy himself and his staff members.

After completion of the work all materials, tools and equipment they has to be cleaned, sanitized, disinfected, maintained, and stored properly. The materials tools and equipment should be Stored in a safe, dry place/ ventilated and away from animals reach, and placed on wooden racks or shelve in order to prevent direct contact with soil.

2.7.Handling fish with ice box

Icing fish the use of ice to store fish immediately after they are caught can improve the quality of the catch and increase its value. During trials in India, the crew and owners of fishing boats earned about 20% more money when they used ice and insulated fish boxes because their fish was high quality and sold at better prices in local and urban markets. Ice is used to remove heat from the fish. Without ice, or another way of preserving the catch, fish will spoil and become inedible after 7-8 hours storage at tropical temperatures. However, icing fish ensures that top prices are received even after long fishing trips. Fatty fish keep for about one week and fish with little fat last for two weeks or longer if correctly iced. Fishing trips can be lengthened and fuel costs reduced, as less time is spent traveling between fishing grounds and markets. Fish can also be stored for a few days before selling to overcome price reductions at market during glut landings.

2.7.1. Methods of using ice to preserve fish

Two methods are used to store fish with ice. Bulking is the layering of fish and ice, usually in a fish hold, though it can be done in a large, permanently fixed, insulated ice box.

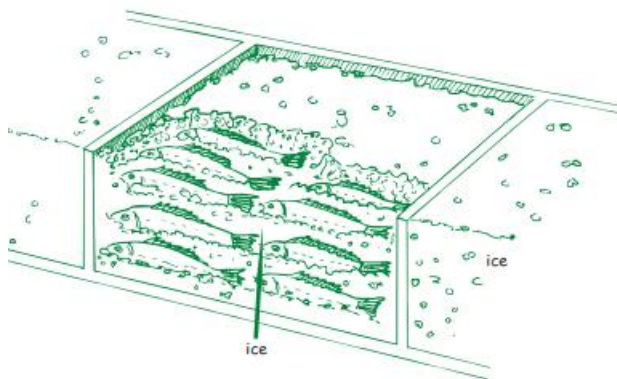


Figure 2.5. Bulking Methods of using ice to preserve fish

Boxing is the layering of fish and ice in specially made boxes. These boxes can be removable for transport to market, or permanently fixed on board the boat.

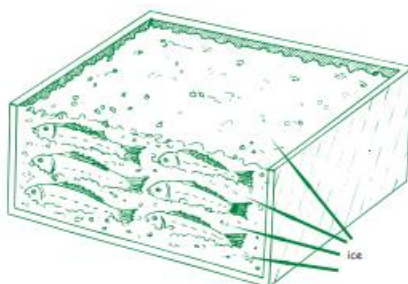


Figure 2.6. Bulking Methods of using ice to preserve fish

The method chosen depends on the size and type of boat. Boxing is recommended for all types of boats, as it produces the best quality fish. Insulation must be provided in either an insulated hold or insulated fish boxes. It is not necessary to use both together. Bulking is more common in boats which have a hold or permanent fish boxes. However, in open boats, fish and ice can be layered using the same technique as bulking.

2.7.2. Procedure for using ice to preserve fish

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Ice and whole fish must be in close contact. Whole fish should not be wrapped in plastic or paper, as a layer of air is trapped between the fish and ice, which slows cooling. Also melting ice cannot wash the fish. However, prepared fish, such as fillets, are leached when ice and flesh come into contact and wrapping is often necessary.

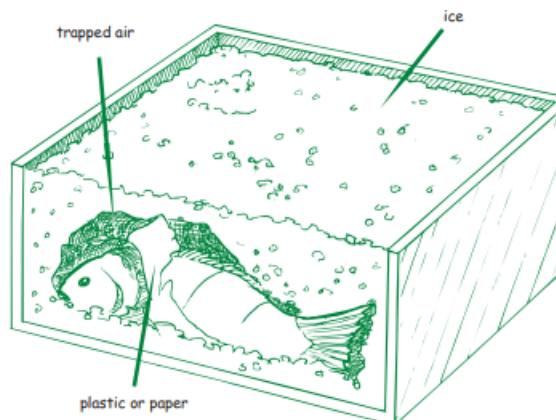


Figure 2.7. Place some ice at the bottom of the ice box

It may be necessary to repack ice around the fish after cooling. As the ice melts, air pockets form above the fish and this slows cooling.

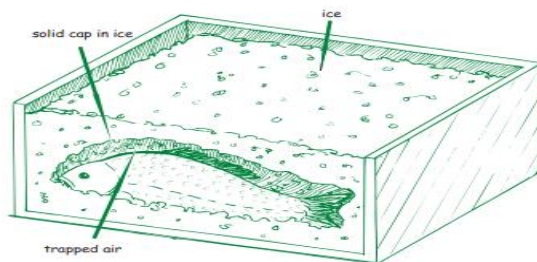


Figure 2.8. Place fish belly side down

Ice must be layered between and thoroughly mixed with the fish, with a thick layer (5 cm) around the sides, top and bottom of the container. Ice cannot cool the fish properly if it is only put on the top, sides or bottom of the container.

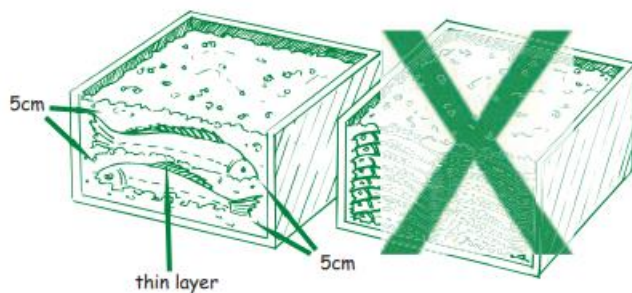


Figure 2.9. Fish with flies

A lot of ice is needed to cool the fish immediately after capture, but once chilled the fish can be repacked for storage using less ice. Everything must be kept clean. All equipment must be cleaned with detergent and disinfectant after each trip.

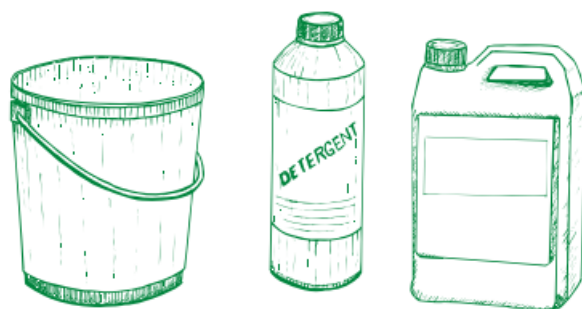


Figure 2.10. Detergent for cleaning ice box

Clean ice must be kept separate from used ice and from the ice/fish mixture - clean divider boards can be used if there is not enough space for individual boxes.

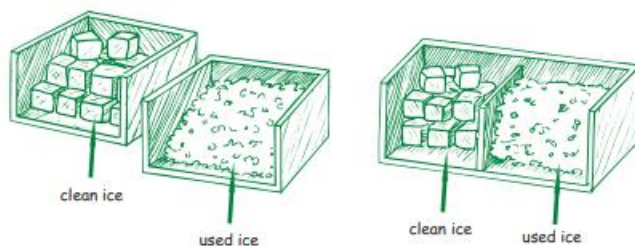


Figure 2.11. Cleaning ice

Any used ice left at the end of the trip must be thrown away as it will be dirty. Clean, unused ice may be kept.

There must be drainage for melting ice. Melt water carries blood, slime and bacteria. It must be able to drain away, from the bottom of the box or container without coming into contact with the fish. This can be done by installing a false bottom in the boat or box; in its simplest form this can be several planks at the bottom of the boat to raise the fish. Fish boxes should have holes in the sides to allow melted water to drain out.

2.7.3. Determine amount of ice to use

The amount of ice needed will vary depending on conditions. For overnight fishing trips, the same weight of ice as the expected weight of the catch is usually enough. For longer trips more ice than fish is needed. If the hold or boxes are insulated, or there is shade, less ice is needed. If the temperature is high, ice melts faster and therefore more is needed. If there is still ice surrounding the fish when it is landed, then enough ice has been used. If there is no ice left, then more needs to be taken on the next trip.

2.7.4. Ways to slow down the melting of ice

Shading can reduce the rate that ice melts, by protecting it from direct sunlight.

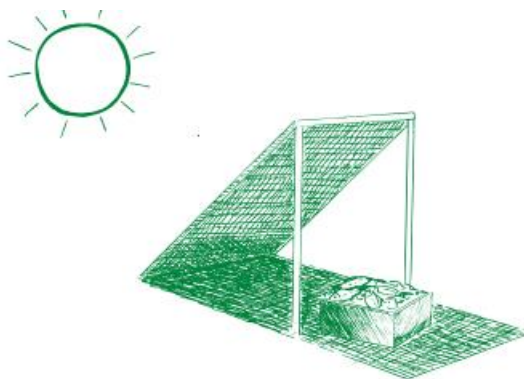


Figure 2.12. Ways to slow down the melting of ice

Evaporation of the water cools the fish. If a wet material, such as gunny sack, is placed over the fish it will cool slightly when no ice is available. The effect is improved if the surrounding air is moving.

Preventing the movement of air by keeping hold hatches closed and lids on fish boxes means that cold air remains around the fish and ice, and is not replaced by warm air. Insulation is used to keep warm air out and cold air in. It can take a variety of forms, many of which are expensive. The simplest method is to cover iced fish with clean material, for example, cloth, net or leaves, to prevent air movement through the fish and ice mixture.

2.7.5. Identify type of ice to use

There are various forms of ice crushed, block, broken tube, flake and others. It is best to use crushed ice with pieces of different sizes to allow rapid chilling at first and then continued cooling, though none of the pieces should be larger than 6 cm.

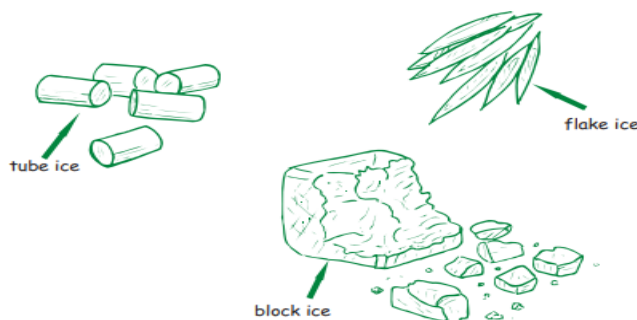


Figure 2.13. type of ice to use

Ice should be made from clean water. The pieces must not have sharp edges as they may damage the fish. Though it is usually more convenient to take broken ice to sea, block ice melts more slowly and so it may be more economical to take blocks and thoroughly crush them while at sea.

2.8. Monitoring temperature of fish

- Internal fish temperatures should be measured at reception to ensure reception temperature limits are met, and to help provide confidence that fish were properly stored onboard the fishing and transfer vessel.
- For fish stored in ice, the adequacy of ice surrounding the fish should be observed and recorded at the time of offloading the fishing vessel, along with internal temperature measurements. More fish should be monitored when the quantity or distribution of ice

appears inadequate. Temperatures near the surface of exposed un-iced portions should be measured, as well as deep core temperatures of the fish, to ensure all edible portions of the fish are taken into consideration in the assessment.

- Sampling should be done randomly throughout the fishing vessel delivery lot. The number of fish temperatures monitored and results recorded should be sufficient to provide reasonable assurance that the temperatures appeared to be controlled by the vessel crew. Variations in species, morphologies, and sizes of fish should be taken into account when taking samples.
- Fish on the vessel should have been stored at a temperature as close as possible to 0°C (4°C or below). If an internal temperature in a sample fish exceeds 4°C (or the established temperature limit based on elapsed time from death) then this indicates a lapse in histamine control. The cause of the deviation should be determined and corrected, and histamine testing of the entire vessel delivery lot performed, or the delivery rejected. For fish used for producing fish sauce.
- Higher temperatures usually correspond to higher histamine risk; however, higher deep core temperatures may need to be allowed for in larger fish that have been delivered soon after harvest and have not yet chilled to 4°C or below, despite implementation of appropriate chilling procedures. Cooling curves based on studies applicable to the specific fishing sector are useful to establish proper fish reception temperatures in these circumstances.

2.9. Protecting fish from contamination

To minimize contamination:

- All surfaces in handling areas should be non-toxic, smooth, impervious and in sound condition in order to minimize the build-up of fish slime, blood, scales and guts and to reduce the risk of physical and microbial contamination.

- Where appropriate, adequate facilities should be provided for the handling and washing of fish and shellfish and should have an adequate supply of cold potable water or clean water for that purpose.
- Adequate facilities should be provided for washing and disinfecting equipment, where appropriate.
- The intake for clean water should be so located as to avoid contamination.
- All plumbing and waste lines should be capable of coping with peak demand.
- Non-potable water lines should be clearly identified and separated from potable water to avoid contamination.
- Objectionable substances, which could include bilge water, smoke, fuel oil, grease, drainage and other solid or semi-solid wastes, should not contaminate the fish and shellfish.
- Where appropriate, containers for offal and waste material should be clearly identified, suitably constructed with a fitted lid and made of impervious material.
- Separate and adequate facilities should be provided to prevent the contamination of fish and shellfish and dry materials, such as packaging, by:
 - ✓ poisonous or harmful substances;
 - ✓ dry storage of materials, packaging, etc.; and
 - ✓ Offal and waste materials.
- Adequate hand washing and toilet facilities, isolated from the fish and shellfish handling areas, should be available where appropriate.
- The entry of birds, insects or other pests, animals and vermin, where appropriate.

2.10. Understanding post mortem change of fish

Postmortem changes include a variety of bodily changes that occur following death. Such changes can be important in estimating or confirming a time-of-death, providing a clue as to the cause or circumstances of death, or suggesting that a body may have been moved following death.

2.10.1. Sensory changes

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Sensory changes are those perceived with the senses, i.e., appearance, odour, texture and taste. The first sensory changes of fish during storage are concerned with appearance and texture. The characteristic taste of the species is normally developed the first couple of days during storage in ice.

The most dramatic change is onset of rigor mortis. Immediately after death the muscle is totally relaxed and the limp elastic texture usually persists for some hours, where after the muscle will contract. When it becomes hard and stiff the whole body becomes inflexible and the fish is in rigor mortis this condition usually lasts for a day or more and then rigor resolves. The resolution of rigor mortis makes the muscle relax again and it becomes limp, but no longer as elastic as before rigor. The rate in onset and resolution of rigor varies from species to species and is affected by temperature, handling, size and physical condition of the fish.

The effect of temperature on rigor is not uniform. In the case of cod, high temperatures give a fast onset and a very strong rigor mortis. This should be avoided as strong rigor tensions may cause gaping, i.e., weakening of the connective tissue and rupture of the fillet.

It has generally been accepted that the onset and duration of rigor mortis are more rapid at high temperatures, but observations, especially on tropical fish show the opposite effect of temperature with regard to the onset of rigor. It is evident that in these species the onset of rigor is accelerated at 0°C compared to 10°C, which is in good correlation with a stimulation of biochemical changes at 0°C. Onset of rigor mortis in carp depends on the difference in sea temperature and storage temperature. When the difference is large the time from death to onset of rigor is short and *vice versa*.

Rigor mortis starts immediately or shortly after death if the fish is starved and the glycogen reserves are depleted, or if the fish is stressed. The method used for stunning and killing the fish also influences the onset of rigor. Stunning and killing by hypothermia (the fish is killed in iced water) give the fastest onset of rigor, while a blow on the head gives a delay of up to 18 hours.

The technological significance of rigor mortis is of major importance when the fish is filleted before or in rigor. In rigor the fish body will be completely stiff; the filleting yield will be very poor, and rough handling can cause gaping. If the fillets are removed from the bone pre-rigor the muscle can contract freely and the fillets will shorten following the onset of rigor. Dark muscle may shrink up to 52 % and white muscle up to 15 % of the original length. If the fish is cooked pre-rigor the texture will be very soft and pasty. In contrast, the texture is tough but not dry when the fish is cooked in rigor. Post-rigor the flesh will become firm, succulent and elastic.

Whole fish and fillets frozen pre-rigor can give good products if they are carefully thawed at a low temperature in order to give *rigor mortis* time to pass while the muscle is still frozen.

The sensory evaluation of raw fish in markets and landing sites is done by assessing the appearance, texture and odour. Most scoring systems are based upon changes taking place during storage in melting ice. It should be remembered that the characteristic changes vary depending on the storage method. The appearance of fish stored under chilled condition without ice does not change as much as for iced fish, but the fish spoil more rapidly and an evaluation of cooked flavour will be necessary. Knowledge of the time /temperature history of the fish should therefore be essential at landing.

The characteristic sensory changes in fish post mortem vary considerably depending on fish species and storage method.

2.10.2. Autolytic Changes

Autolysis means "self-digestion". It has been known for many years that there are at least two types of fish spoilage: bacterial and enzymatic. enzymatic changes related to fish freshness preceded and were unrelated to changes in the microbiological quality. In some species (squid, herring), the enzymatic changes precede and therefore predominate the spoilage of chilled fish. In others, autolysis contributes to varying degrees to the overall quality loss in addition to microbially - mediated processes.

2.10.3. Bacteriological changes

Microorganisms are found on all the outer surfaces (skin and gills) and in the intestines of live and newly caught fish. The total number of organisms vary enormously and a normal range of 10^2 - 10^7 cfu (colony forming units)/cm² on the skin surface. The gills and the intestines both contain between 10^3 and 10^9 cfu/g.

The bacterial flora on newly-caught fish depends on the environment in which it is caught rather than on the fish species. Fish caught in very cold, clean waters carry the lower numbers whereas fish caught in warm waters have slightly higher counts. Very high numbers, i.e. 10^7 cfu/cm² are found on fish from polluted warm waters. Many different bacterial species can be found on the fish surfaces. The bacteria on temperate water fish are all classified according to their growth temperature range as either psychrotrophs or psychrophiles. Psychrotrophs (cold-tolerant) are bacteria capable of growth at 0°C but with optimum around 25°C. Psychrophiles (cold-loving) are bacteria with maximum growth temperature around 20°C and optimum temperature at 15°C. In warmer waters, higher numbers of mesophiles can be isolated. The microflora on temperate water fish is dominated by psychrotrophic Gram-negative rodshaped bacteria belonging to the genera *Pseudomonas*, *Moraxella*, *Acinetobacter*, *Shewanella* and *Flavobacterium*. Members of the *Vibrionaceae* (*Vibrio* and *Photobacterium*) and the *Aeromonadaceae* (*Aeromonas* spp.) are also common aquatic bacteria and typical of the fish flora. Gram-positive organisms as *Bacillus*, *Micrococcus*, *Clostridium*, *Lactobacillus* and coryneforms can also be found in varying proportions, but in general, Gram-negative bacteria dominate the microflora.

Microbial invasion

The flesh of healthy live or newly-caught fish is sterile as the immune system of the fish prevents the bacteria from growing in the flesh. When the fish dies, the immune system collapses and bacteria are allowed to proliferate freely. On the skin surface, the bacteria to a large extent colonize the scale pockets. During storage, they invade the flesh by moving between the muscle

fibres. Found that only a very limited number of bacteria invaded the flesh during iced storage. that bacteria can be detected by microscope in the flesh when the number of organisms on the skin surface increases above 10^6 cfu/cm². This was seen at both iced and ambient temperatures. No difference was found in the invasive patterns of specific spoilage bacteria (e.g., *S. putrefaciens*) and non-spoilage bacteria.

Since only a limited number of organisms actually invade the flesh and microbial growth mainly takes place at the surface, spoilage is probably to a large extent a consequence of bacterial enzymes diffusing into the flesh and nutrients diffusing to the outside.

Fish spoil at very different rates and differences in surface properties of fish have been proposed to explain this. Skins of fish have very different textures. Thus whiting (*Merlangius merlangus*) and cod (*Gadus morhua*) which have a very fragile integument spoil rapidly compared to several flatfish such as plaice that has a very robust dermis and epidermis. Furthermore, the latter group has a very thick slime layer, which includes several antibacterial components, such as antibodies, complement and bacteriolytic enzymes.

Bacteria on fish caught in temperate waters will enter the exponential growth phase almost immediately after the fish have died. This is also true when the fish are iced, probably because the microflora is already adapted to the chill temperatures. During ice storage, the bacteria will grow with a doubling time of approximately 1 day and will, after 2-3 weeks, reach numbers of 10^8 - 10^9 cfu/g flesh or cm² skin. During ambient storage, a slightly lower level of 10^7 - 10^8 cfu/g is reached in 24 hours. The bacteria on fish caught in tropical waters will often pass through a lag-phase of 1-2 weeks if the fish are stored in ice, whereafter exponential growth begins. At spoilage, the bacterial level on tropical fish is similar to the levels found on temperate fish species.

The composition of the microflora also changes quite dramatically during storage. Thus, under aerobic iced storage, the flora is composed almost exclusively of *Pseudomonas* spp. and *S. putrefaciens* after 1-2 weeks. This is believed to be due to their relatively short generation time at chill temperatures and is true for all studies carried out whether on tropical or temperate-water fish. At ambient temperature (25°C), the microflora at the point of spoilage is dominated by mesophilic *Vibrionaceae* and, particularly if the fish are caught in polluted waters, *Enterobacteriaceae*.

A clear distinction should be made between the terms spoilage flora and spoilage bacteria since the first describes merely the bacteria present on the fish when it spoils whereas the latter is the specific group that produce the off-odours and off-flavours associated with spoilage. A large part of the bacteria present on the spoiled fish have played no role whatever in the spoilage. Each fish product will have its own specific spoilage bacteria and the number of these will, as opposed to the total number, be related to the shelf life. In Figure 5.10, it is shown that the remaining shelf life of iced cod can be predicted from the conductometric detection time (in TMAO broth), which is inversely correlated with the number of hydrogen sulphide-producing bacteria.

It is not an easy task to determine which of the bacteria isolated from the spoiled fish are those causing spoilage, and it requires extensive sensory, microbiological and chemical studies. First, the sensory, microbiological and chemical changes during storage must be studied and quantified, including a determination of the level of a given chemical compound that correlates with spoilage (the chemical spoilage indicator). Second, bacteria are isolated at the point of

sensory rejection. Pure and mixed cultures of bacteria are screened in sterile fish substrates for their spoilage potential, i.e., their ability to produce sensory (off-odours) and chemical changes typical of the spoiling product. Finally, the selected strains are tested to evaluate their spoilage activity, i.e., if their growth rate and their qualitative and quantitative production of off-odours are similar to the measurements in the spoiled product. The latter step is particularly important, as some bacteria may produce the chemical compounds associated with spoilage but are unable to do so in significant amounts, and they are thus not the specific spoilage bacteria. When stored aerobically, levels of 10^8 - 10^9 cfu/g of specific spoilage bacteria are required to cause spoilage. The spoilage of packed fish is seen at a much lower level of 10^7 cfu *P. phosphoreum* per gramme.

2.9.4. Lipid oxidation and hydrolysis

The two distinct reactions in fish lipids of importance for quality deterioration are:

- A. oxidation
- B. hydrolysis

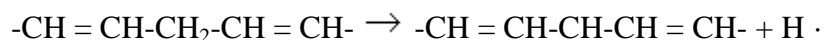
They result in production of a range of substances among which some have unpleasant (rancid) taste and smell. Some may also contribute to texture changes by binding covalently to fish muscle proteins. The various reactions are either *nonenzymatic* or catalyzed by *microbial* enzymes or by *intracellular* or *digestive* enzymes from the fish themselves. The relative significance of these reactions, therefore, mainly depends on fish species and storage temperature.

Fatty fish are, of course, particularly susceptible to lipid degradation which can create severe quality problems even on storage at subzero temperatures.

Oxidation

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The large amount of polyunsaturated fatty acid moieties found in fish lipids (see section 4.2) makes them highly susceptible to oxidation by an autocatalytic mechanism. The process is initiated as described below by abstraction of a hydrogen atom from the central carbon of the *pentadiene structure* found in most fatty acid acyl chains containing more than one double bond:



Contrary to the native molecule, the lipid radical (L) reacts very quickly with atmospheric oxygen making a peroxy-radical (LOO) which again may abstract a hydrogen from another acyl chain resulting in a lipid hydroperoxide (LOOH) and a new radical L. This propagation continues until one of the radicals is removed by reaction with another radical or with an *antioxidant* (AH) whose resulting radical (A) is much less reactive. The hydroperoxides produced in relatively large amounts during propagation are tasteless, and it is therefore perhaps not surprising that the widely used "peroxide value") usually correlates rather poorly to sensorial properties.

The hydroperoxides are readily broken down, catalyzed by heavy metal ions, to secondary autoxidation products of shorter carbon chain-length. These secondary products - mostly aldehydes, ketones, alcohols, small carboxylic acids and alkanes - give rise to a very broad odour spectrum and in some cases to a yellowish discoloration. Several of the aldehydes can be determined as "thiobarbituric acid-reactive substances".

Metal ions are very important in the first step of lipid autoxidation - the initiation process - in catalyzing the formation of reactive oxygen species as for example the hydroxyl radical (OH). This radical immediately reacts with lipids or other molecules at the site where it is generated. The high reactivity may explain that free fatty acids have been found to be more susceptible to oxidation than the corresponding bound ones, because the amount of iron in the aqueous phase is probably greater than the amount bound to the surface of cellular membranes and lipid droplets.

Fatty acid hydroperoxides may also be formed enzymatically, catalyzed by *lipoyxygenase* which is present in variable amounts in different fish tissues. A relatively high activity has been found in the gills and under the skin of many species. The enzyme is unstable and is probably important for lipid oxidation only in fresh fish. Cooking or freezing/thawing rather effectively destroys the enzyme activity.

The living cells possess several protection mechanisms directed against lipid oxidation products. An enzyme, glutathione peroxidase, exists which reduces hydroperoxides in the cellular membranes to the corresponding hydroxy-compounds. This reaction demands supply of reduced glutathione and will therefore cease post mortem when the cell is depleted of that substance. The membranes also contain the phenolic compound α -tocopherol (Vitamin E) which is considered the most important natural antioxidant. Tocopherol can donate a hydrogen atom to the radicals L- or LOO- functioning as the molecule AH. It is generally assumed, that the resulting tocopheryl radical reacts with ascorbic acid (Vitamin C) at the lipid/water interface regenerating the tocopherol molecule. Other compounds, for example the carotenoids, may also function as antioxidants. Wood smoke contains phenols which may penetrate the fish surface during smoking and thereby provide some protection against lipid oxidation.

Hydrolysis

During storage, a considerable amount of free fatty acids (FFA) appears. The phenomenon is more profound in ungutted than in gutted fish probably because of the involvement of digestive enzymes. Triglyceride in the depot fat is cleaved by triglyceride lipase originating from the digestive tract or excreted by certain microorganisms. Cellular lipases may also play a minor role.

In lean fish, for example Atlantic cod, production of free fatty acids also occurs, even at low temperatures. The enzymes responsible are believed to be cellular phospholipases - in particular phospholipase A₂ - although a correlation between activity of these enzymes and the rate of

appearance of FFA has as yet not been firmly established. The fatty acids bound to phospholipids at glycerol-carbon atom 2 are largely of the polyunsaturated type, and hydrolysis therefore often leads to increased oxidation as well. Furthermore, the fatty acids themselves may cause a "soapy" off-flavour.



Self-check 2	Written test
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Name..... ID..... Date.....

Directions: Answer all the questions listed below.

1. What is spoiled fish?
2. Describe two conditions that can cause your fish to spoil?
3. Name signs you can use to identify spoiled fish?

Operation Sheet -2

2.1. Sorting fresh and spoiled fish

A. Materials, tool and equipment

- Potable water and ice
- Fish
- PPE
- Pen
- Paper

B. Techniques /procedures

- Wear PPE
- Prepare all necessary materials
- Carefully inspect caught fish
- Sort them based on observation parameters spoil fish and the good/fresh one.

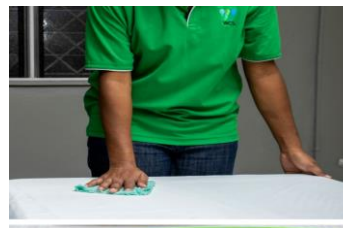
2.2. Manual fish cleaning/gutting work

A. Materials, Tools and equipment required for fish gutting work

- Potable water and ice
- Gutting knives
- Gutting table
- Fish boxes and tubs
- Ice box

B. Procedures

- Thoroughly clean chopping board or flat surface, and knife you will be using to gut your fish.



- I. Wash your hands, remove fish from brine solution or ice box and place the fish with the belly facing you on a clean chopping board or flat clean surface.



7. Make a slit from the anus, along the belly of the fish to the gills (or just under the pelvic fins), taking care not to puncture the internal organs or gut. Purpose: To reduce and remove bacteria present in the fish stomach and intestines thus slowing the spoilage process. A Guide for Proper Post-Harvest Handling of Fish



7. Lift gill cover and carefully cut gill attachments for easy removal.



- I. Carefully grab hold of the gills and remove fish gills pulling the entire gut along. The gut and gills should come out as one complete piece making sure the stomach does not burst open. Take care, as some gills can be sharp and may pierce your gloves and cause cuts.



- [. Note that the fish gut has been removed with the gills intact, without puncturing any internal organs such as the stomach and intestines. Clean fish thoroughly in fresh running water before icing or cooking.



2.3. Icing fish

A. Materials

- Ice
- Clean icebox
- Fish
- PPE

B. Procedure

- Wear PPE and wash hands with soap and water.
- Place some ice at the bottom of the ice box.
- Place fish belly side down on the ice followed by another layer of ice on the fish. Ice must be layered under, around and on top of the fish.
- Place more ice around fish so that the sides are sufficiently covered.



-
- Cover fish completely with ice ensuring no part of the fish is exposed to air.



LAP TEST-2	Performance Test
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Name..... ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hours. The project is expected from each student to do it.

Task 1 Sorting fresh and spoiled fish

Task 2 Perform manual fish gutting work

Task 3 Perform handling fish in ice box

LG #23

LO# 3- Handle during landing and transportation

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Handling fish while uploading and unloading
- Using insulated or refrigerators trucks on land transportation
- Transporting fish
- Controlling time and moving fish through each stage
- Handling and disposing offal's and waste materials
- Record keeping about postharvest handling
- Food safety and hygiene regulations and procedure
- Packing gutted and filleted fish
- Freezing and storing gutted and filleted fishes

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Handle fish while uploading and unloading
- Use insulated or refrigerators trucks on land transportation
- Transport fish
- Control time and moving fish through each stage
- Handle and disposing offal's and waste materials
- Handle record keeping about postharvest
- Food safety and hygiene regulations and procedure
- Pack gutted and filleted fish
- Freeze and store gutted and filleted fishes

Learning Instructions:

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1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 3

3.1 Handling fish while uploading and unloading

Quality of the final products always depends on the Quality of Raw material. Flesh of live fish is free from bacteria. When the fish is dead, bacteria tend to penetrate in muscle & produces metabolites causing spoilage. Elevated temperatures, poor sanitary conditions, inadequate hygiene of workers speed up spoilage. Protection of consumer against food borne diseases and maintenance of manufacturer's reputation mainly based on sanitation applied to food product.

3.1.1. Handling of fish onboard

- Fishing shall not be done from polluted water.
- Fish hold & boat-deck shall be in such type which can be cleaned & disinfected.
- Fish handling surfaces shall be smooth, non-corrosive & free from cracks and crevices.
- Fish contact surfaces should be cleaned after every hauling.
- Ice should be from good quality potable water.
- Walking or standing over fish is not advisable.
- Fish flesh should not be damaged if using showels.
- After sorting immediately fish shall be mixed with ice.



Figure 3.1. Fish with flies

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3.1.2. Handling of fish in landing centers

- Instead of Bamboo baskets, wooden boxes and similar container polythene boxes should be used
- During unloading fishes, fishes should not exposed to adverse elements of nature
- Washing the catch using coastal water is dangerous.
- Sorting the catch on sea beaches should be avoided.
- Fishes de-iced for weighing shall be re-iced & chilled below 20°C as quickly as possible.
- All the containers/contact surfaces used for unloading and weighing shall be cleaned & disinfected immediately.
- Precautions have to be taken to prevent the entry of flies, cats, dogs, rodents etc. in the fish handling premises.



Figure 3.2. Fish with flies

3.2. Using insulated or refrigerators trucks on land transportation

Vehicles should be designed and constructed:

- Such that walls, floors and ceilings, where appropriate, are made of a suitable corrosion resistant material with smooth, non-absorbent surfaces. Floors should be adequately drained;
- where appropriate with chilling equipment to maintain chilled fish or shellfish during transportation to a temperature as close as possible to 0 °C or, for frozen fish, shellfish and their products, to maintain a temperature of –18 °C or below (except for brine frozen fish intended for canning, which may be transported at –9 °C or colder);
- So that live fish and dead fish are transported at temperatures tolerable for the species;
- To provide the fish with protection against contamination, exposure to extreme temperatures and the drying effects of the sun or wind; and
- To permit the free flow of chilled air around the load when fitted with mechanical refrigeration means.

3.3. Transporting fish

Soon after harvest a, quacrops need to be properly packed and preserved 'until consumption. They must reach the consumer's table or processing factory with minimal losses of initial freshness. For this reason special care is taken to pack the' fish in suitable containers that prevent further handling. Freshly harvested fish is generally packed in rectangular wooden or plastic boxes where both salting and icing are done before transportation. The degree of insulation provided by the packing material, and the stacking pattern is to be considered before packing. The traditional wet-lock box and plastic boxes lined with or without .Styrofoam are often used while shipping the fish with ice. A common feature of all packing boxes should be that provision be made for adequate waterproofing of the insulation material so that it does not become waterlogged due to condensation of water vapour on the outer walls or due to meltdown. Transportation of fish can be done by three routes: air water or rail. The method of operation and design of transport adopted must suit the peculiar requirements of the product. Moreover, for

freshly harvested fish, the cold-chain must continue up to the consumer or processor level. The vehicles used for transport of fish on land must have an insulated cabin at the rear end with facilities for maintaining cold temperature en route and drainage of melt water. Apart from this proper air circulation prevents development of warm spots.

3.4. Controlling time and moving fish through each stage

Fish starts to spoil immediately after die so controlling time in each post-harvest handling activity plays a great role for keeping the product quality. Fish are moved through each stage without delay and control the time taken in each stage.

3.5 Handling and disposing offal's and waste materials

There are different waste materials or product which will be produced in work place but the main waste material which will produced in fish gutting and filleting are the following:

- Head and guts, bone and meat scraps/derbies and blood and whole rejected fish as well as cleaning sewerage.
- Fish wastes will be either disposed according to industry work procedures or recycled or re-used or returned to manufacturer.
- Utilize to fish meal and other purposes

These waste materials which are produced in fish post- harvest work have to be removed from the site on regular manner properly. Disposal of this waste is, in many cases similar to regular waste disposal methods. As in, solid materials are often sent to landfills or incinerators. However, this can obviously have a negative effect on the planet something which those who work within agriculture are likely to be particularly passionate about. In fact, the future of farming relies on taking care of the planet. Fortunately, there are other methods of agricultural waste disposal, such as composting and recycling which can be implemented to help protect the environment.

Disposable materials properly buried in deep enough trench and should be covered with quicklime and then with soil or use Burning. But burning is the most difficult because the Fumes and smoke may be a problem to the surrounding environment. Mud holes should be frequently

filled or exclude the animals away from it quickly. On the other hand Fish wastes available from your farm such as trash fish, spoiled fish and fish offal can be used efficiently in several simple ways.

- You may add wastes to your compost plies as an additional source of nitrogen
- You may chop the wastes into small pieces and feed them raw to your animals, especially poultry.
- You may produce highly nutritional cooking oil together with excellent feed for your fish (especially juveniles) and other animals. Simply proceed as follows:
 - ✓ Half fill a metal drum with water;
 - ✓ Start a fire under it and bring the water to a boil;
 - ✓ Finely chop fresh fish wastes and throw them into the boiling water until the drum is three-quarters full;
 - ✓ Boil for about 20 minutes;
 - ✓ Take the drum off the fire;
 - ✓ As the fish oil rises to the surface, skim it off and keep it in a clean container for later use; keep this container tightly closed;
 - ✓ When the water has cooled down, drain it from the drum and collect the fish waste residue from the bottom; it is an excellent ingredient for mixing in animal feeds; you may also dry waste residue, for example in a solar dryer to make a simple fishmeal.

If the fisher-folk process fish in large quantity and the fish scraps are deposited in an open place, this represents a high risk to the environment, public health and safety. Poor disposal of fish waste can produce bad odor and decrease levels of dissolved oxygen. The below are the guiding conditions to control fish waste:

a. Establish fish cleaning area and adopt the following techniques to dispose the waste:

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- Ensure that fish waste and rubbish are disposed properly by keeping them in covered bins;
- Fish waste and rubbish shall be removed from processing area that are emptied and cleaned daily;
- Waste removing opening should have curtain/barrier to avoid entry of flies and insects.

b. Prohibited fish cleaning outside of the designed area.

- Instruct fisher-folk, fish processor not to dispose fish scraps on the bank of the river and lakes.

c. Sign post directing people where and how to clean their fish

Management of fish waste is essential because it will allow fish processors to extract the maximum practical benefits from the fishery products to generate the minimum amount of the waste. The below are the options to manage fish waste:

- Fish waste can be re-processed to produce oil and meal/flour;
- Fish waste can be used in production of silage; used as food for domestic animal/aquaculture;
- Fish waste can be used as fertilizer in land farming

3.6.Record keeping about postharvest handling

To keep records is simply to collect relevant information that can help you to take good decisions and to keep track of activities. Records can be about:

- Raw materials
- Problem encountered
- Length of work
- Hazards and safety
- Techniques and system of work
- Cost expended
- Material availability

- Sustainability of work
- Labor required
- Facilities in work
- Both weight and length measurements measurement before the fish is gutted and frozen.
- Date of the fish and the location where it was caught.
- Both weight and length measurements after gutted and iced, filleted or otherwise cut up.
- Provide side-view photograph

It is important to keep record keeping simple, and to keep records systematic. If records should be of use for the consumer to trace back about the fish, than they must be complete (none missing), they should be true (collected carefully). When record can't be trusted because they are not complete or true, time should not be spent on it at all.

The records can:

- Be used in determining profitability of various techniques used at the farm
- Be used to keep your memory on what you did and/or what happened
- Be used in decision making, especially on a strategic level

3.7.Food safety and hygiene regulations and procedure

Hygiene means conditions and measures necessary in the processing to ensure safety and fitness of the products for human consumption. The Guidance on Good Hygienic Practices for Pre-processing of Fishery Products is intended to provide recommendations for the implementation of good hygienic practices during raw material preparation such as de-heading, gutting, de-shelling, and filleting in order to produce safe products fit for human consumption. Guidance on Good Hygienic Practices includes:

3.7.1. Establishment

A. Location

- Establishment shall not be located in an area that poses environmental risk of contamination to the products such as a polluted industrial area, flooded area, and heavily

air-polluted area. If it is unavoidably located in an area likely to cause contamination, appropriate control measure shall be in place.

- Surrounding area of the establishment shall be clear, clean, free from rubbish and surplus materials and tall grass which could be the harbouring places of rodents, insects and other disease carrier animals.

B. Design

- Layout and processing line shall enhance good hygienic practices
 - ✓ Sufficient space in processing room shall be provided for placement of equipment and tools in order to enable easy cleaning. Processing areas shall be properly designed according to the process flow so as to prevent contaminations from microorganisms, chemicals, and foreign matters.
 - ✓ Unclean areas such as raw material receiving and pre-processing such as de-shelling, de-skinning, de-heading, gutting, etc. shall be separated from the clean areas. If different products are processed in the same area such as shrimp, cephalopods, fish, each production shall be clearly separated. In the production step, such cleaned products should be segregated from the unclean products.
 - ✓ In production of cooked product, the layout shall be properly designed by clearly separating post-cooking area from pre-cooking area in order to prevent microbiological cross contamination from raw to cooked products.
 - ✓ Establishment shall be located separately from housing areas without direct connection, except when there are appropriate measures to prevent product contamination in place.
- Floors of the processing area shall be made of durable materials, easy to maintain, smooth surface, non-slippery, non-absorbent, without crack and in good condition. Floors shall be slightly sloped to allow adequate draining.
- Ceiling and walls of the processing area (including tools and plumbing system installed in the area) shall be made of easy-to-clean material, smooth, non-absorbent, light coloured and in good condition in order to prevent mould. Ceiling in the processing area shall be able to

prevent foreign matters such as spider webs, dusts, rust from overhead metal fixtures and plumbing, falling into the products. Plumbing system such as water and steam pipes should be designed to hide above the ceiling. If these systems are installed underneath the ceiling, pipes shall be clean without steam condensation.

- Drains in the processing area, in particular where excessive use of water is required, should be adequate in number and size with appropriate slope, good drainage, without causing water standing or overflow. Due to the significant amount of water used in the pre- processing of fishery products, appropriate design of the drainage system will accelerate water removing.
- Processing area should have good ventilation to exhaust odour, smoke, steam and heat which are resulted from processing activities. Poor ventilation will cause water condensation from steam which may contaminate the product. Steam generated from product cooking, once condensed will be a good source for microbial growth.
- Lighting should be adequate in the processing areas such as shrimp de-shelling and deveining, cephalopod skin cleaning, raw material washing, etc. to reduce the amount of defected product and ensure that the physical contamination is visible, particularly during washing or sorting out filth or foreign matters in raw materials.
 - ✓ General working areas should have a minimum light intensity of 220 lx, and at least 540 lx at sorting areas.
 - ✓ Light bulbs suspended over the working areas shall be covered and the covers shall be maintained their cleanliness. In case of light bulb dropping or breakage during work, the covers will prevent the broken glass from falling into the products and facilitate cleaning.
- Clothes changing facilities where workwear and personal belongings are stored shall be separated from the processing areas. The facilities should be kept clean and of good ventilation. Personal clothes should not be comingled with workwear.

C. Supplies, equipment and tools

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- All supplies, equipment and tools used in the processing area directly or indirectly in contact with the product shall fit for purposes, easy to maintain with smooth surface, no cracking, non-absorbent and free of rust.
- Cleaned containers and tools shall be stored in an appropriate and clean place and not cause contamination such as good ventilation. Containers and tools shall be kept with enough space from the floor. Such containers and tools used inside the processing areas should not be stored outside that may cause contamination.

3.7.2. Control of operation

A. Raw materials

- Raw material shall be clearly identified by lots. Lot identification shall be recorded and traceable to the source where necessary.
- Temperature of raw materials shall be monitored and recorded upon each receiving. The raw material temperature during transportation should be maintained close to 0oC (except for live aquatic animal such as bivalve molluscs) in order to inhibit microbial growth. If the temperature of raw material upon receipt is high, sensory evaluation on the raw material quality shall be conducted. If the quality is acceptable, the temperature shall be quickly reduced to around 0oC by adding ice and then further processing the raw materials immediately.
- Each lot of raw material received shall be subjected to physical examination and recorded. Defective and early-stage decomposed raw materials shall be culled off prior to further process.

B. Food additives

- Food additives shall be registered or permitted for use by the Thai Food and Drug Administration. For exported product, processors should take into account requirements of the importing countries.
- For storage and use, the food additive shall be clearly labelled on both original container and small re-packed containers to avoid mistaken use.

- Food additives shall be grouped and appropriately stored in a designated area which is clean, of good ventilation and able to prevent disease carrier animals and dusts from contaminating the product. Food additive use shall be properly controlled such as distribution and quantity used.

C. Water supply

- Water in contact with raw materials and product shall be complied with the potable water standard notified by the Ministry of Public Health on the provision of: “containing Coliform bacteria less than 2.2 in 100 ml water as determined by MPN (Most Probable Number) method, absent from *E. coli* and pathogenic bacteria”. Chemical properties shall be in compliance with the Notification issued by the Ministry of Public Health.
- Water supply shall be adequate for processing and cleaning equipment, tools and processing areas. Water treatment shall be hygienic. Water tanks shall be made of easy-to-clean materials, well covered and able to prevent microbial contamination in the water system due to changes of water pressure in the pipes causing a back flow. Pipe ends or water hose tips should not be immersed in water containers during work. A safety valve should be installed at each tap to prevent back flow.
- Water samples shall be examined at least quarterly for microbiological quality on a regular basis and annually for chemical properties.
- If chlorine is applied in the water system, residual chlorine shall be monitored at least twice daily (morning and afternoon). If disinfectants other than chlorine are used, their residues should be monitored as well. If the water quality does not meet the potable water standards, an investigation and corrective actions to improve water supply system shall be conducted.

D. Ice

- Ice used for processing shall meet the potable water standard. If the ice is purchased from an ice making plant, the ice shall be complied with the Notification of the Ministry of Public Health entitled Ice Quality.

- Storage room including containers and tools used in contact with ice shall be in good condition, clean and hygienic as follows:
 - ✓ Transfer of ice from ice making plant to the pre-processing establishment and from storage room to an ice crusher shall not cause contamination.
 - ✓ If ice blocks are used, they shall not be placed directly on the floor.
 - ✓ If crushed ice is used, it shall be transferred from ice making plant in covered containers to prevent contamination.
- Ice is subject to microbiological quality analysis on a regular basis, at least quarterly.

E. Control of initial operation

- Raw material temperature shall be maintained between 0 oC and 10oC during processing by using ice or cold water. If it is not possible to control as such, production time shall be controlled instead.
- If raw material is subject to heat, time and temperature shall be appropriate for the purpose and in compliance with relevant laws and regulations.
- Temperature and time shall be recorded in accordance with the established frequency.
- Upon completion of cooking process, product shall be immediately cooled down to avoid accumulation of heat which will adversely affect product quality and to prevent thermophilic bacterial growth.

3.7.3. Maintenance and sanitation

A. Maintenance

Establishment, equipment and tools shall be maintained in good condition and operational according to their purposes, facilitating good hygienic practices and effectively preventing product contamination.

B. Cleaning and disinfection

- Cleaning program including method and frequency for equipment, tools and establishment should be in place for both before and after work. Disinfection shall be applied after cleaning of the processing area, equipment and tools in direct contact with

food. Such equipment and tools shall not cause product contamination. Thus washing, cleaning and disinfections should be conducted at appropriate frequency such as during lunch break or after work.

- Cleaning tools such as brushes, water wipers shall be non-absorbent, in good condition, not cause contaminations to other tools. They shall be adequate, and stored in an allocated and hygienic storage. As these tools are used for such purposes as cleaning processing equipment including floors and walls, therefore, they should be clean and not cause microbial contamination to the surfaces being cleaned.
- Detergent and disinfectant properties shall be appropriate for use in food processing plant and appropriate for the purposes. For example, household detergents should not be used to remove fat remaining in containers. Appropriate kind and quantity of detergent should be applied according to the instruction on the label. A.3.2.4 Detergents, disinfectants and toxic chemicals shall be stored separately from food ingredients and clearly labelled.
- Effective cleaning shall be monitored on a regular basis and recorded.

C. Pest control

- Rodents, insects, and disease carrier animals shall not be present in the processing area. They are carriers of dangerous diseases which are contagious to humans through the product. Identifications of filth such as hair, insect parts indicated poor sanitary control.
- Building shall be maintained in good conditions. There is no access for insects and disease carrier animals such as bottom clearance of the door connecting to the processing area, ventilation outlets or drainage system opening to outside of the building. All openings should be appropriately covered to prevent rodents and insects.
- Regular control and eradication program for rodents, insects, and disease carrier animals shall be in place. If chemicals are used, they shall be approved by a recognized agency. Dosages used shall be properly controlled. Operators shall have knowledge on the application and shall prevent contamination to product or food contact surfaces.

- Evidence or track of disease carrier animal and openings in the processing area shall be monitored on a daily basis.

D. Waste and waste water management

- Waste such as heads, offal, skins, bones, shells should be regularly removed from the processing area in an appropriate frequency. The transfer should be conducted in a hygienic manner and not cause contamination to product. These waste materials and rubbish are source of microorganism accumulation. If these waste materials are not handled hygienically, they are likely to contaminate the product.
- Waste containers shall be made of easy-to-clean materials, strictly used only for waste materials and kept clean. The designated container is aimed at avoiding cross contamination with the product as microorganisms are significantly accumulated in waste materials. If waste containers are used for containing products, contamination will occur.
- The area for waste and trash shall be separated, closed and hygienic. If the waste area is located outside the building, covers shall be used to prevent odour and rodents, insects, and other animal harbourage and infestations.
- Waste water shall be appropriately discharged without contamination to the product.

E. Toilets

- Adequate number of toilets shall be provided and located separately from processing area. Toilet doors shall not open directly to the processing area.
- Toilet areas shall be in good condition, clean and hygienic as toilets may be a spreading source of the microorganisms causing gastroenteritis to human. If there is unhygienic practice, these microorganisms may contaminate the product and be harmful to consumer health. Toilets should be equipped with non-hand operated taps, liquid soaps, hand drying materials such as paper towels and rubbish bins with cover.
- Waste shall be hygienically disposed off and clearly separated from waste water treatment.

F. Hand wash basin and foot bath

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- Hand wash basin shall be maintained in a good condition, clean and equipped with non-hand operated taps, liquid soaps, hand drying materials such as paper towels or disposable hand towels. The hand operated taps shall be avoided because microorganisms can spread from one person to another using the same taps. Replacing bar by liquid soap will help preventing microbial accumulations on the bar. Repeatedly use of hand towels will not only cause microbial accumulations but also cause microbial transmission to those who have cleaned hands.
- The number of hand wash basin shall be adequate and located at the every entrance and inside the processing area at the practical points.
- Basins containing disinfectants for hand and glove dips shall be available at each entrance to processing area. The disinfectant concentration should be appropriate and monitored. For examples, if chlorinated water is use for disinfection, residual chlorine shall be regularly examined in order to maintain the effectiveness.
- Foot bath shall be installed at each entrance to processing area containing adequate and appropriate concentration of disinfectants. If chlorine is used, the chlorinated water should contain at least 100 ml/L of residual chlorine. The chlorinated water level in the foot bath should be at least maintained to cover the back of the feet.

3.7.4. Personal hygiene

A. Personnel

- Operators in the processing area shall not suffer from serious contagious diseases such as tuberculosis, a carrier of gastrointestinal diseases such as choleras, typhoid, and diarrhoea. They shall undergo medical examination including serious contagious and gastrointestinal diseases before being admitted to work and at least annually in the following years. The medical examination record shall be maintained.
- Operators working in the processing area shall not have open or infected wound or lesions that could contaminate the product except there is appropriate protection such as covering the wound with plaster before putting on gloves. Ill operators with the

symptoms such as fever, sore throat, dysentery, vomiting, infected skin, shall immediately report to supervisor for transfer to another section not involving food or taking a sick leave until full recovery.

B. Personal practices

- Operators shall work in a hygienic manner.
- Operators working in processing area or in contact with raw materials shall always maintain good personal hygiene. They shall wash their hands and dip in disinfectant solutions both before and during work as appropriate, for example, after contacting dirty materials or upon each return to processing area and after using the toilet. Hand washing upon entering the processing area is necessary since the operators may cause contamination after leaving the processing area.
- Clothes and workwear shall be clean and hygienic. Workwear should not be worn from home as microorganisms or dirt from outside may contaminate. Clothes changing or wearing workwear arranged by the pre-processing establishment at the production site will help minimize and control the contamination of dust from clothes. During processing, hair shall be covered and jewelry shall not be worn. Aprons used shall be waterproof with proper length that is not too long and contact the floor. Boots and gloves shall be clean.

3.7.5. Product storage

A. Storage practices

- Storage area shall be located separately from the processing area. Storage shall not cause contamination to the product. The area shall be clean with good ventilation.
- Temperature of product, if not at frozen stage, shall be maintained at close to 0°C at all times.
- Products shall be stored orderly and the area shall be regularly cleaned.

B. Product identification

- Origins of the fishery products during storage shall be identified for traceability purposes.

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3.7.6. Document and record keeping

A. Record on sanitary control shall be available and containing the followings:

- Name and address of the pre-processing establishment
- Structure, materials, equipment and tools
- Maintenance and cleaning program
- Personnel
- Water and ice
- Rodent, insect and disease carrier animal control program
- Quality control for raw material and processing
- Other controls including chemical control and waste management

B. Sanitary control shall be recorded as specified and maintained at least 1 year for further inspection.

3.7.7. Training

Operators in contact with food and quality controllers shall have knowledge or experiences or be trained to understand food safety standard, good hygienic practices for pre-processing establishment and quality control. Training will help operators fully understand the nature of work and food safety at every point of the operation and be able to perform appropriate task.

3.8. Packing gutted and filleted fish

The success of a product cannot be determined right at the end of production line. The product has to pass through a process called packaging which is the means through which it reaches the markets and ultimately consumers. Packaging provides information which are important to the consumer i.e, product identity, its origin, how to use and store it; and nutritional information among others. Good packaging also enhances efficient mechanized handling, distribution and marketing, thus eliminating labour cost which would have to be absorbed into the price of the products. Packaging, because of its diversified designs and the types of materials used, in most cases helps to promote the products.

3.8.1. Role of packaging

The way food products are packed depends greatly on the varied needs of the consumer. Where perishable products such as fish is concerned, convenience, protection as well as attractiveness accorded by the packaging materials used, play an important role in the actual sales of the product. Packaging of any product plays four major functions as containment, protection, utility and communication. The most important function of packaging, however, is the protection it offers to the products. Among other functions, packaging should:

1. Protect the products against dirt, chemical (moisture, odor) and biological agents (insect, microorganisms), adulteration, tempering, contamination, damage, etc.
2. Help ease the distribution and during product display on shelves, boxes, etc.
3. Serve as a means of communication and provide information on the products, whether as requirement or to attract consumers;
4. Help to add value to the product especially with high quality and attractive packaging;
5. Help product promotion to increase product range;
6. Help to minimize the cost of product;
7. Help to extend shelf-life of product.

3.8.2. Packaging requirement

The materials commonly used for packaging of fish and fish products are as follows:

- Split bamboo baskets, plant leaves in mats, wood in boxes;
- Paper or board in boxes, cartons;
- Rigid materials like can;
- Glass container like jars;
- Plastics like bags, pouches, films, sheets, jars, boxes, etc.

For determining better packaging methods and materials for some final fish products, the first and foremost aspects which need to be evaluated are the factors that will affect the products. Generally, answers of the following questions are needed.

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- Does the product require protection of oxygen and any other gases?
- Is it sensitive to light?
- Is this requiring preservation of aroma and moisture?
- Will it be frozen? If so, at what temperature?
- Does the product have sharp edges or points? Some other points related to marketing should be considered as well as follows:
 - Is the product going to retail sale or wholesale?
 - What are the legal requirements for the product in relation to packaging?
 - How much can be afforded in packaging?
 - What kind of packaging would appeal and is best suited to the product?
 - What kind and how much information is needed to put on the packaging?

3.8.3. Type's fish packaging

There are four common types to fish packaging as follows:

A. Bulk packaging of fresh fish

After landing, fish are loaded to woven bamboo basket, wooden or plastic boxes and iced. Now days, wooden and woven bamboo baskets are replaced by plastic boxes all over the world because they are more hygienic, lighter and stronger. Material used for plastic boxes are low density polyethylene, high density polyethylene and polypropylene.

An ideal fish box should be

- Of a suitable size to handle any type of fish comfortably;
- Easy to manage, carry and clean;
- Designed with proper insulation to maintain temperature if iced fish is loaded;
- Designed to allow draining out of melted water if iced fish is loaded;
- Protect the fish from crushing, spoilage, environmental pollution and pilferage;
- Easy to store and effective for transporting chilled fish; available at a reasonable cost.

For handling and transportation of artisanal catch in Bangladesh, an effective low-cost ice box is constructed from easily available low-cost local materials. Woven bamboo basket presently used in fish transportation throughout the country is transformed into insulated ice box very simply and cheaply. In such modified ice box fish cannot come in contact of bamboo splits of the basket, since they are wrapped all along with polysacs and plain polythene sheet. Thus there is no chance of contamination in fish from the split bamboo that generally harbours bacteria and contaminants. It is easy to clean and keep clean too. Plastic container used in shrimp processing plants has been modified to use in transportation and preservation of iced fish. At first, the box is insulated by placing styrofoam sheet in between two layers of side-walls, bottom and the top. A screw-tap is installed at the base of one side-wall to drain out melted water. An insulated lid is fixed at the top. This type of plastic ice-box can be manufactured in any ordinary plastic factory. Commercial fish traders can use this type of durable but lighter ice box to transport wet fish through trucks, ships and other vehicles.

B. Wholesale packaging for fresh/frozen fish

The fresh or frozen fish which are not going for shipment or to the processing factories but to the wholesale market for retail distribution by caterers or retailers should be packaged with due considerations. Traditional packaging materials for fresh and iced fish are wooden or woven bamboo boxes. However, above mentioned modified bamboo basket can also be used for local transportation. Now a days, fibreboard boxes and corrugated board cartons waxed or coated with polyethylene are used for storage and transport of wet fish from port to fish monger, caterer or institution. The most common packaging of frozen fish is the interlocking, printed, polycoated and corrugated fibreboard carton. Expanded polystyrene and corrugated polypropylene boxes are also used for fish and shellfish distribution. The boxes are delivered pre-printed and flat and are folded or stitched in situ. When the box is filled with fish and ice, it is sealed with polypropylene or metal tape. These boxes are non-returnable and capacity varies between 3-28 kg. They can also be used for freezing wet fish, storing wrapped or unwrapped frozen fish and storing individual quick frozen and cured fish products or with cellophane-wrapped and cartoned

products ready for retail distribution. Frozen fish blocks can be packed in polyamide/polyethylene laminated bags. Polyamide gives strength so that it reduces the chance of tearing bags by sharp edges of frozen blocks. Block frozen shrimp, peeled shrimp or other frozen shellfish and fish are packed in fibreboard carton with a liner and then the whole pack is plate frozen.

C. Retail packaging of fresh/frozen fish and fish products Packaging of fresh/chilled fish

In traditional fish markets, wet fish are sold with or without surrounded ice crystals. In modern shopping corner, fresh or chilled fish is packed using styrofoam trays wrapped with cling film. Film is either of polythene or polypropylene. Tray can also be produced by polyvinylidene chloride or polystyrene. This is one of the cheapest and most readily available packaging materials in the fish market. With proper packing and handling, this type of packaging can be quite attractive.

However, this type of packaging can not protect the product from – loss of moisture and aroma; drip from the fillet; contamination (micro-organism, odor from other products, etc.); mechanical and physical damage; oxidation, etc.

The problem of drip from the fillet of fish with cut surfaces can be counteracted by dipping the fish into a solution of sodium tripolyphosphate. Polyphosphate will bind the water and prevent its subsequent loss and shrinkage.

Sometimes chilled fish are packed in modified atmosphere of nitrogen, carbon dioxide and oxygen to extend storage life.

Materials used for modified atmosphere packing must be completely impermeable to gases in order to maintain appropriate gas mixture in the pack. Vacuum packaging is also done that requires high gas protective packaging film like polyvinylidene chloride or polyester. Removal of oxygen reduces aerobic bacterial spoilage, lipid oxidation and subsequent rancidity.

- Packaging of frozen product

Frozen fish and fish products can be packaged by laminated plastic bag or pouch, clear plastic bag, etc. sealed and put inside carton boxes. There are three common types of plastic packaging materials available in the market. These are:

- ✓ Polystyrene
- ✓ Polyethylene
- ✓ Polypropylene

In choosing the plastic materials and cartons for fish products, it is to be emphasized that the materials

- ✓ Should protect the products from moisture and aroma loss, oxidation and rancidity and other odors from permeating into the product;
- ✓ Should not become brittle and torn during storage and display at temperature below –18o to –25oC.

Some of the examples of commonly used packaging materials for frozen products are-

- ✓ Polystyrene trays over-wrapped with polyethylene/ polypropylene film;
- ✓ Polyethylene bag;
- ✓ Plastic bag inside carton box;
- ✓ Waxed paper box.

- **Aseptic packaging**

Cans provide one of the most important aseptic packaging of fish products in retail distribution. Most of the pelagic fish like sardine, mackerel, tuna, etc., salmon and some shellfish are canned for many decades. Retort pouches are recent development of aseptic packaging of fish products that serve as same function as can.

D. Air freight packaging

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All fresh, frozen, live fish and shell fish are air freighted from one country to another or one place to another within the country. In air freighting, the same considerations given to the packaging of any perishable food should be given to the packaging of fish. The air freight container should be highly insulated, easy to handle, heavy to give physical protection to the products, and watertight to protect contamination. Various types of containers made of metals; fiberglass and expanded polystyrene are used.

Modified atmosphere packaging - When the products are treated with the mixture of gases like carbon dioxide, oxygen and nitrogen, during packing to extend the shelf life is called modified atmosphere packaging (MAP). Packing of fish in special mixtures of gases may extend the shelf life by up to 30%, provided that the temperature is kept below +20°C. This is of value to super market chains and other distribution systems in extending the high quality of life of the fish and products.

If the proportion of these gases is accurately controlled at the time of packing is called “Controlled Atmosphere Packaging (CAP). Generally, MAP is achieved by placing the fish in a plastic bag or sleeve, which is flushed with the gas mixture immediately prior to sealing. The plastic bag or sleeve must have a low permeability to the gases used. Usual MAP process line has the system to produce thermo-formed base trays from a continuous roll of the plastic film into which the fish is placed. After the fish is placed in the tray, it then moves along a conveyer belt to a section where a vacuum is drawn in the tray and the void is filled with the appropriate mixture of gases. A film lid is then heat-sealed to the top edge of the tray, completing the process.

The composition of gas mixture varies depending upon the composition of fish- whether the fish in the pack is lean or oily. Oxygen sustains basic metabolism and minimizes the possibility of anaerobic spoilage; carbon dioxide inhibits bacterial and mold activity; and nitrogen is chemically inert and prevents rancidity, mould growth and insect attack by displacing oxygen. For lean fish, a ratio of 30% O₂, 40% CO₂ and 30% N₂ is recommended. Higher levels of CO₂ are used for oily and smoked fish with a comparable reduction in level of O₂ in the mixture, with

the gas mixture ratio becoming 0% O₂: 60% CO₂: 40% N₂. By excluding oxygen, the development of oxidative rancidity in the fish is slowed.

The gas supply to the machine is normally taken from cylinders of pure gas and mixed in correct packing ratio on the machine itself. It is important to control both the ratio of the gas mixture, and the volume ratio of fish to gas. A minimum volume ratio of 1:3 (fish:gas) is recommended. CO₂ permeates packaging films up to 30 times faster than N₂ and is more fat-soluble and water soluble: its solubility increases as temperature is lowered. These factors lead to a reduction of pressure within the pack, resulting in a tendency for the pack to collapse.

Dissolution of CO₂ into the surface of the fish muscle can reduce the pH and sufficiently lower the water holding capacity of the proteins. This result in unsightly drip within the pack, which is often absorbed by placing a cellulose pad beneath the product. The resultant pack has the advantages of retaining any drip and fishy aromas within the package while allowing the customer to view the fish prior to purchase.

The use of MAP for shell-on crustacean appears to inhibit the development of blackening of the shell (black spot), at higher chilling temperatures of 5 to 10°C.

MAP-chilled fish is a most attractive proposition both to the retailer with extended shelf life in store and the customer with cleanliness and convenience; however, the quality is depended upon very carefully controlled temperatures throughout the production, transportation and storage of the raw material and products. The generous use of ice on the fresh fish, accurately controlled chilled storage (less than 2°C) and air conditioned packing rooms are essential to the achievement of maximum shelf life extension. Following recommendations should be considered when using MAP:

- ✓ Use only fresh fish;
- ✓ Ensure fish temperature is below 2°C prior to packing; pack under cool condition and move finished pack to chill store (<2 °C) as soon as possible after packing;
- ✓ Check that the gas mixture being used is suitable for the fish in the pack;

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- ✓ Check the gas mixture on a regular basis;
- ✓ Use refrigerated transport capable of holding the product between 0 to 2 oC during distribution; • Check that the product temperature is between 0 to 2 oC on arrival at the depot or retail store;
- ✓ Store at 0 to 2 oC in display cabinet (or chill store), which should be monitored regularly to ensure this temperature range is achieved;
- ✓ Ensure that shelf life particulars on the label, for example, sell by and use by are within the achievable limits for that particular product.

3.8.4. Printing quality of fish packages

In selecting an appropriate packaging material for any fish products, specification and advice should also be sought from the supplier of the packaging material. Along with its protecting nature, the packaging material should also have good printability and saleability. Now-a-days, there is a printing method called reverse printing which is commonly used for plastic packaging or products. In this method, printing is done on the outside of the inner layer of plastic film, which is then covered with another layer of plastic. This type of printing is especially important for wet and frozen products.

3.8.5. Packaging regulations for fish products

The packaging of fish products must consider a number of regulatory and legal considerations, most important of which are –

- i. Assure that legal packaging requirements are met;
- ii. Protect the products from contamination either from package or from the environment;
- iii. Assure that all materials, including packaging, meet the appropriate requirement of the concerned government;
- iv. Assure that all materials, including packaging, meet the appropriate requirement of the buying country;

- v. Assure that the labeling meets all requirements as to the contents, weights, print, size and other related requirements;
- vi. Assure the label states the contents when required and /or contains the required verbage, such as “imitation” and similar information;
- vii. Assure the label carries any required warnings, e.g, drug, poison, etc.;
- viii. Assure the claims, such as “jumbo size” or “economy size” meet the requirements.

3.8.6. Labeling requirements

Labelling means complying with regulations regarding product manufacture and accordingly, providing necessary information on product for consumer’s satisfaction and protecting rights. Information on labels are important to regulatory agencies, custom officials, traders and consumers. Basic labelling requirement of a product includes common name of raw material, net weight, grade, class, size, count, moisture content or other composition as applicable, name and address of producer, packer and distributor, place of origin, type and amount of ingredients used, date of process, date of expiry/minimum durability date, etc. ‘Instructions for use’ may also be displayed where appropriate. For the products consumed in the domestic market, the producer must comply with the regulations of the own country. But for the product that is to be exported, the labelling must comply with the labelling regulations of the importing countries, along with basic export requirements.

3.9. Freezing and storing gutted and filleted fishes

Raw fish can be stored safely in a refrigerator at 40°F or lower for 2 to 3 days. Oily fish will store longer than lean fish and whole fish will store better than steaks and fillets. There are several factors listed below that will have an effect on how well the fish will store.

- The amount of time that market fresh fish can be refrigerated will depend on:
 - ✓ If it was stored properly after it was caught, before it got to the market.
 - ✓ How fresh the fish was when purchased.
 - ✓ Whether or not the fish was stored properly on ice at the market.

- ✓ The temperatures it is exposed to in transporting from the store to home refrigeration.
- ✓ The type of packaging used.
- The amount of time that fresh caught fish can be refrigerated will depend on:
 - ✓ How the fish was handled after being caught.
 - ✓ How long it was kept alive.
 - ✓ Whether or not it was bruised from flopping around on the bottom of the boat or on the dock.
 - ✓ If there was any damage done to its skin.
 - ✓ How soon it was cleaned and if it was cleaned properly.

Follow the instructions below to store fresh fish in the refrigerator properly.

- Remove the fish from the wrapper. Thoroughly rinse the fish in cold water.
- Pat it dry with a paper towel.
- Line a plate or pan with a double layer of paper towels and place the fish on the towels.
- Cover them tightly with plastic wrap or aluminum foil and place in the coldest part of the refrigerator, the top shelf in the back.
- Be sure the fish is tightly wrapped so that if there are any juices from the raw fish, they will not come in contact with any other food.

Self-check 3	Written test
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Name..... ID..... Date.....

Directions: Answer all the questions listed below.

1. Mention types of records in fish Post-harvest handling work.
2. Write at least 2 importance of record.
3. List down three waste materials produced in fish post-harvest activity.
4. Write tree types of packaging materials.
5. Mention at least five good post-harvest handling of fish onboard.

Reference Materials

Books:

Clucas and Ward (1996) Fish packaging in tropical countries.

FAO. 2020b, Consumption of fish and fishery products

FAO. 2009, Code of Practice for fish and fishery products, First edition. Rome.

Javier Borderías et al, (2018), Trends in fish processing technologies

UNIDO, 2015, Training Manual on Improved Fish Handling and Preservation Techniques

Jirawan Yamprayoon et al, 2009. Good hygienic practices for pre-processing of fishery products

Published in the Royal Gazette Vol. 126 Special Section 187 D

Web addresses

<https://www.fao.org/3/r1076e/R1076E05.htm> (accesses date may, 2, 2023)

<https://www.fao.org/3/v7180e/v7180e06.htm> (accesses date may, 2, 2023)

http://www.who.int/topics/occupational_health/en (accesses date may, 1, 2023)

<https://www.youtube.com/watch?v=mSKxcVZAXjw> (accesses date May, 03, 2023)

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