Chapter 24

Preprocessing of fish and solar fish drying

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Pre-processing of fish

Fish is a highly perishable food which requires proper handling and preservation to increase its self life and retain its quality and nutritional aspects. Therefore, fish pre-processing and preservation are become a very important part of commercial fisheries. Preservation means keeping the fish after landing in a condition of wholesome and fit for human consumption for a particular period. This preservation should cover the entire period from the time of capture of fish to its sale at retailer's counter. The main aim of processing and preservation of fish is to prevent fish from deterioration. Methods which are commonly used to preserve fish and fishery products include the control of temperature using ice, refrigeration or freezing and control of water activity by drying, salting, smoking or freeze-drying *etc* (FAO, 2011). Fish has to be pre-processed in such a manner that it remains fresh for a long time with a minimum loss of flavour, colour, taste, odour, nutritive value and digestibility. Fish processing can be subdivided into fish handling which is the preliminary processing of raw fish and the manufacture of fish products.

Handling:

Fish handling and preservation can be carried out on board of the fishing vessel or on land. In general, some methods for handling and preservation of fish are needed in order to maintain the raw fish quality after catching. Lowering the fish temperature using ice is a popular method for fresh fish preservation. When fishes are captured or harvested for commercial purposes, some pre-processing practices are required to deliver the fish to the next part of marketing chain in a fresh and undamaged condition. Pre-processing means preparation of raw fishes by de-shelling, de-heading, gutting *etc*. to use as raw materials for finished products or for distribution for further processing or cooking. The first pre-processing stage for whole fish includes bleeding, gutting, icing and freezing. Some fish species can be bled and gutted on board, but this work can take much time and some fish species are only primarily washed and put into boxes or tubs with ice and stored in hold of the vessel.

Fish starts to spoil as soon as they have been captured. Concern for quality of fish should begin on board the vessel. The first consideration should be to bring the fish alive and good condition. Fish should only come in contact with clean surfaces. The deck and storage boxes should be free of fish residues, dirt and slime with the use of clean water. Fish should be handled with care. Kicking, trampling the fish will increase the rate of spoilage. Also fish should be chilled as quickly as possible to 0^0C. It is essential to keep the ice and fish together in a covered box. Fish and ice should be packed in alternate layers. Chilled Sea Water (CSW) that includes ice and seawater is used to chill the raw fish. Chilled water (CW) is also often used for chilling the fish and it does not affect the fish. Different types of ice can be used for chilling fish like liquid ice, flake-ice, tube ice and block ice. Among the various types liquid ice has the highest cooling rate and the ground block ice is the slowest. A common way to chill the fish is to arrange it with ice in a fish box.

Today, keeping fish alive for consumption is a common fish handling practice in world wide. In this practice, fish are conditioned in a container with clean water, while the damaged, sick and dead fish are removed. Then fish are starved and if possible water temperature is lowered in order to reduce metabolic rates and make fish less active. Low metabolic rates decrease the fouling of the water with ammonia, nitrite and carbon dioxide that are toxic to fish and impair their ability to extract oxygen from water. A large number of fish species are usually kept alive in a holding basin, floating cages, wells and fish ponds.

Fish handling operations in on board after capture are as follows:

1. Transferring catch from fishing gears to fishing boats
2. Holding catch before handling
3. Sorting/Grading
4. Bleeding/Degutting/ Washing
5. Chilling
6. Chilled storage and unloading *etc*.

These operations can be carried out in several ways. The number of operations and the order in which they are performed depend on the fish species and the gear used, vessel size, duration in which the catch is to be marketed.

Fish are processed both on shipboard and in land-based plants. Fishing vessels deliver their catches to land-based plants or other vessels.

1. Receiving and inspection: Fish is normally inspected to determine the quality of fish.

2. Washing: Fish that have been packed in ice are usually washed in some manner to remove surface slime (high microbial contamination) and other contaminations.

3. Sorting or grading: Fish are usually graded physically according to size, species, sex, area of catch or type of gear used. An experienced person can determine the quality of as-received fish by sensory evaluation (touch, sight and odor). A visual inspection is normally adequate for rating, grading or generally to determine whether the fish is acceptable or not. Grading based on size and geometry is probably more important in processing plants. Machines are made to handle fish over a certain size range in order to maximize the yield.

4. Scaling: It is desirable to remove the scales from fish. The usual scaler is a rotating drum made of screening (1/2 inch). Scales are removed as fish rub against each other and the wire drum while rotating. The loose scales are flushed through the screens by jets of water directed into the machine.

5. Cutting and eviscerating: Fish are prepared for market or processing in many different manners. Always the viscera are removed and the belly wall is thoroughly cleaned or slimed to increase the shelf life or holding time. Depending on the specific density of the fish some or all of the other nonedible portions are removed. Butchering is done by hand or machine. The basic procedure is to remove the head, slit the belly and remove the viscera and lastly remove the fins and tail.

Processing of fish:

Various traditional methods of fish preservation are carried out in world wide. These include air drying and smoking by the use of heat in the smoking kilns, salting, or brining involving the use of common salt (sodium chloride), sun drying through exposure to direct sunlight, solar drying where fish is dried in an enclosure which traps sunlight energy. These preservation techniques increase the shelf-life of fish, maintain the quality of the fish in terms of its nutrient, flavor, texture, and appearance, provide ease of handling and further processing of the fish, and reduce post catch losses thereby ensuring continuous availability of cheap animal protein to the people all year round.

Salting:

As part of a smoking or drying process, salting has been used for thousands of years to preserve marine products. Salting has no adverse effect on the value of fish protein. When fish is placed in a brine solution,

salt penetrates inside the fish and water is extracted from the tissues by osmosis. Higher salt concentration in fish extends its storage life. Several methods of salting are commonly used: dry salting, brine salting and pickle salting. Dry salting is the simplest method and is used primarily for fish with high water content. Granular salt is rubbed onto the outer and inner surfaces of the fish. The wet salting methods (brine and pickle) are recommended for fatty fishes. In brine salting, the entire fish is immersed in an aqueous salt solution. An 80 -100 per cent saturated brine solution (270-360 g of salt per litre of water) is preferred. Some of the factors involved in salting of fish which play an important role are purity of salt, quantity of salt used, method of salting and weather conditions *etc*. During salting process 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 are cut into convenient sized pieces.

Drying of fish:

Drying is the most widely used method of food preservation and is an integral part of food processing. Fish can be stored for long time only by drying. Sun drying of fish is the most widespread method of fish drying in India because of solar irradiance being very high throughout the year. In rural areas, fish is preserved by sun drying. As sun drying technique needs no energy during day time, it is more beneficial to the small scale farmers who can't afford the electricity or other fuel for drying. Even though the cost of sun drying is low, there are significant losses due to spoilage, contamination by dust, and insect infestation. All these disadvantages can be eliminated by using a solar dryer.

The advancement of sun drying is solar drying systems in which products are dried in a closed system in which inside temperature is higher. The development of solar driers has significantly improved the traditional preservation of fish by sun drying. Solar dryers have a number of advantages over traditional drying methods. The driers provide hygienic conditions for fish drying and it exclude rain, insects, animals, and dirt and can produce higher temperatures to reduce the possibility of mold or bacteria spoilage. Solar fish dryers are simple and inexpensive and can eliminate much of the spoilage that occurs with traditional drying methods. It could be constructed by simple technology from inexpensive and readily available materials. It can also be easily operated with effective and efficient performance (Hii *et al.*, 2012).

The objective of a solar dryer is to provide sufficient amount of heat *i.e.* more than ambient heat under given humidity. It increases the vapour pressure of the moisture confined within the product and decreases the relative humidity of the drying air so that the moisture carrying capacity of the air can be increased. Air is drawn through the dryer by natural convection or sometimes by a fan. It is heated as it passes through the collector and then partially cooled as it catches moisture from the material. The material is heated both by the air and sometimes directly by the sun. Warm air can hold more moisture than cold air to maintain relative humidity, so the amount of moisture removed depends on the temperature to which it is heated in the collector as well as the absolute humidity of the air when it entered the collector. The moisture absorption capacity of air is affected by its initial humidity and by the temperature to which it is subsequently heated.

Solar dryers can be categorized into two classes on the basis of the mode of air flow through the dryer, *i.e.* natural convection or forced convection. Dryers that employ forced convection require a source of motive power, usually electricity, to drive the fan that provides the air flow. Solar dryers can also be classified primarily according to their heating modes and the manner in which the solar heat is utilised. In broad terms, they can be classified into two major groups, namely: active solar energy drying system (most of which are often termed hybrid solar dryer) and passive solar energy drying system (conventionally termed natural-circulation solar drying system). The performance of solar dryers is significantly dependent on the weather conditions. Both the heat required for removing the moisture as well as the electricity necessary for driving the fans are generated in the most cases by solar energy only.

Different types of CIFT dryers

ICAR-Central Institute of Fisheries Technology (CIFT), Cochin, has developed low cost, energy efficient and eco-friendly dryers like Solar tray dryer, Solar cabinet dryer, Solar tunnel dryer *etc.* based on solar energy for quality drying of fishes. Apart from fishes, this dryer is also suitable for drying other agricultural products like fruits, vegetables, spices and condiments. All of these dryers are provided with alternative heating source in order to continue the drying process during off sunshine hours especially during night time, cloudy and rainy days.

Solar tray dryer

Solar tray dryer consists of solar air collector, drying chamber with trays and exhaust. The capacity of the dryer is 20 kg. The total heat

absorbing area of solar collector is 10m^2 and drying chamber tray area is 5.4m^2. The trays are made of food grade steel (SS 304) and are stacked one over the other with spacing of 10 cm. In this dryer, supplemental heating is provided by electrical coils placed in the drying chamber.

Solar cabinet dryer

Solar cabinet dryer consists of four drying chambers with nine trays in each chamber. The capacity of the dryer is 40 kg. The total tray area is 20m^2. The trays are made of food grade steel (SS 304) which is stacked one over the other with spacing of 10 cm. The perforated trays accomplish a through flow drying pattern within the dryer which enhances drying rates. Solar flat plate collectors with an area of 7m^2, transmit solar energy to the air flowing through the collector which is then directed to the drying chamber. Electrical back up starts automatically whenever the desired temperature is not attained in the drying chamber, particularly during rainy and cloudy days.

Solar tunnel dryer

Solar tunnel dryer utilizes solar energy as the only source of heat for drying of fish and fishery products. The capacity of the dryer is 5 kg. Total heat absorbing area is 8 m^2, and is made up of polycarbonate sheet. Products to be dried are placed on nylon trays of dimension 0.8 × 0.4 m. The dimension of the drying unit is 2.21 × 2.10 × 0.60 m, and drying takes place by convection of hot air within the drying chamber.

Solar dryers used for drying can be proved to be most useful device from energy conservation point of view. It not only save energy but also save lot of time, occupying less area, improves quality of the product, makes the process more efficient and protects environment also.

Further reading

FAO: Processing fish and fish products Fisheries and aquaculture department, Rome. Updated 31 October 2001. Retrieved 14 March 2011.

Hii, C.L., Ong, S.P., Jangam, S.V. and A.S. Mujumdar. 2012. Solar drying: fundamentals, applications and innovations. National University of Singapore Press, Singapore, pp150.