Handling of Fish Onboard Fishing Vessels

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Fish is a highly perishable food material due to its chemical nature and an average fish has the following composition.

Water	: 65-80%
Protein	: 12-22%
Lipids	: 0.5-16%
Minerals	: 0.1-3%

Although this is a generalized composition there is wide variation depending upon the species. After the fish is landed rapid deterioration will occur due to post mortem changes involving chemical, enzymatic or bacterial agencies. These reactions are particularly favoured by warm and humid climate. The distribution of fish landed is also difficult due to the distance between the main landing places and consumer centers. Hence fish has to reach the consumer as well as the processor by following proper handling and preservation techniques just from the catch. There are several factors, which affect the quality of fish landed.

Effect of catching method on quality

The manner of catching/killing the fish is an important factor that decides the keeping quality of fish. A fish that dies after prolonged struggle in a gill net spoils very quickly compared to a fish killed by a blow. The struggling of fish results in a rapid development of rigor mortis. Fish caught in a trawler develops rigor mortis earlier.

Rigor mortis

One of the important factors determining the spoilage of freshly caught fish is rigor mortis, stiffening of the body. This usually develops within 1-7 hours after death. Rigor mortis gets on and proceeds quickly in very active fish rather than an inert fish. As long as the fishes are alive the circulation system functions even after capture. The following chemical reactions occur during rigor mortis. (Bate *et al*., 1956)

$$ATP \rightarrow AMP + 2P \rightarrow IMP + NH_3 \rightarrow Inosine + P \rightarrow Hypoxanthine \rightarrow Ribose$$

On the other hand fish caught by hook and lines can be immediately killed and bled which is significant in extending freshness and quality. In case of gill net fishing, removal of fish at frequent intervals is advantageous.

Physical damage during hauling and handling

Hauling of fishing gear and handling of fish when the gear is brought aboard often contribute to brushing and tearing of flesh. Transfer of fish in and out of the boats with

hooks, forks, etc., causes physical damages to the fish. It is not uncommon to see fishermen as well as others treading over mackerel and sardine catches at the time of loading and unloading from trucks. Nearly 10% of the catches of mackerel and sardine are affected by physical damage due to rough handling.

The quality of fish reaching the consumer or processing factories will greatly depends on how the fish is handled onboard the vessels, how it is preserved, packed and transported. Preservation of the catch after hauling till it is unloaded at landing centers is the responsibility of personnel on board the vessels. The objective shall be to land the fish in the same condition as it is at the time of catch within the limits of practicability under good commercial practice. As the quality of the end products depends upon the freshness of the raw material, extreme care should be taken in preserving the catch by scientific handling on board the vessels. Cleanliness of the fish hold, storage temperature and packing conditions in general are some of the important factors affecting the quality of fish. The important requirements are to clean and make the catch free from extraneous materials by washing and keeping in chilled condition and maintaining high standard of cleanliness. Sanitation requires particular attention. The fish should not be allowed to contaminate with objectionable microbes, chemicals used in cleaning and disinfection, metals, paints etc. There are various types of fishing vessels and main mode of preservation is icing, Modern vessels are equipped with freezing and cold storage facilities.

Handling of catch starts as soon as it reaches on board. Depending on the gear used the composition of the catch varies. The catch shall be given a wash with clean water to remove the dirt and other foreign materials. The water used for washing should be chlorinated to 10 ppm available chlorine to make it safe. Washing is very essential as it will eliminate most of the surface bacteria which will otherwise penetrate. (Connel, 1975).

Sorting the fish

The mixed catch has to be sorted out into different varieties, species-wise and size-wise. The fish that are bruised, decomposed or otherwise damaged and suitable for preservation as human food shall be separated and either discarded or stored separately for use in fishmeal plants. Other valuable species of fish shall carefully be separated and preserved suitably. It may be advisable to sort the catch species wise and to store in separate containers.

The catch shall never be allowed to remain for long on the deck exposed to sun. Exposure to sun will elevate the temperature of the fish, which in turn facilitate rapid growth of microorganisms and accelerate the bacterial spoilage of the fish. It is observed that shelf life of fish stored in ice considerably gets reduced if the fish is kept exposed, in the initial stages. Therefore, the hauled fish shall not be left on the deck for more time. The fish also shall not be subjected to pressure, as this will damage the fish affecting the quality adversely.

Evisceration and removal of gills

All reasonably large fishes like sharks, rays, ghol, etc., may be eviscerated and bled before preservation on board. Bleeding is usually done by cutting the throat and allowing the fish to remain in cold water for about half an hour. Gutting also can be done simultaneously. While gills are removed the general practice is to leave the head intact. As the gills and

viscera harbour innumerable bacteria, which can bring about spoilage in the fish after its death, removal of gills and guts will enhance the keeping quality of the fish. However, the removal of viscera shall be complete and a thorough washing after the operation is very important. Otherwise the exposed belly portion is liable to be contaminated. Similarly if the fish is not bled, during ice storage the blood will clot and become dark brown affecting the appearance of the meat. The operation of removal of gills and viscera as well as bleeding of the fish has to be done separately and other varieties of fish shall be kept away from getting contaminated. After this operation the fish has to be washed thoroughly before it is packed in ice or preserved otherwise.

Preservation of fish on board the vessel

Preservation of fish by ice is by far the cheapest and reasonably efficient method practised on board the vessel. Generally fish can be stored in ice and kept in good condition for a period of 3-15 days depending on the species (Hansen, 1983). Fatty fishes like oil sardine has a short shelf life in ice. The fish easily gets rancid due to oxidation of unsaturated fatty components so also the belly portion gets softened presumably owing to the action of enzymes and bacteria. Hence even at ice temperature the fish remains in good condition only for a short while (2-5 days). For minimizing the belly bursting in oil sardines either a dip in brine or sprinkling of salt before icing is recommended.

Fish may be packed with ice in boxes as well as in holds. In small boats fish holds cannot be provided and in such cases insulated boxes have to be used. Small size fish are also packed in boxes before stacking in fish holds or pens. This is necessary for avoiding excessive pressure on the fish and resultant damage when heaped in fish holds. However, bigger fishes may be packed in the insulated holds in layers with ice.

Whether in boxes or holds, fish will have to be packed with ice in thin layers. Care shall be taken to provide a thick layer of ice at the bottom, sides and top of the hold or box as heat penetration will be rapid at these areas. Quantity of ice used shall be sufficient to bring down the temperature of the fish and keep the fish at low temperature for sufficient length of time. One kg of ice at 0°C takes 80 kcal of heat while melting. The specific heat of fish has been reported as 0.9 and for cooling 1 kg of fish by 1°C, 0.9 kcal of heat has to be removed. If the fish is at 30°C (room temperature) and it has to be cooled to 0°C, 30x0.9 kcal of heat will have to be removed. 30x0.9/80 kg of ice will be required for this purpose. Therefore theoretically for bringing down the temperature of 1 kg of fish from 30°C to 0°C, about 1/3 kg of ice is required. However, in practice at least 50% ice may have to be used for chilling the fish. Generally icing is done at 1:1 level and ice is replenished at intervals to keep the temperature from rising. For icing, crushed ice of good bacterial quality shall be used. Finally crushed ice will have more surface area per unit mass and cover more fish, enabling rapid removal of heat from fish. However, for packing chilled fish in holds or boxes, crushed ice in the form of small lumps may be used so as not to leave small air pockets within the pack. This will prevent the growth of anaerobic bacteria, causing bilgy odours.

Many species of pelagic fishes such as sardines are easily damaged by pressure. With such fish the shelf life can be enhanced by packing them in boxes with ice both at the bottom and at the top. These boxes are then stacked in the insulated hold. Care shall be taken to see that ice does not protrude above the rim of the boxes as otherwise the fish will be compressed when the boxes are stacked.

Stacking of fish in holds is done by spreading the fish in layers with ice in between. As the fish is a poor conductor of heat, for rapid cooling, the thickness of the fish layers shall be kept small. When fish is stacked in holds, the depths of fish and ice shall not exceed one meter. If depth is increased, the bottom fish will start getting spoiled, due to excessive pressure. Care shall be taken to stack gilled fish with belly cavity facing downwards. Segregation of each day's catch into different lots using coloured paper strips is also advisable. This will help the shore plants to utilize the catch judiciously.

Preservation by RSW

In bigger vessels, which stay at sea for longer periods, preservation of fish by refrigerated seawater is adopted. Seawater contains 3-4% salt and hence the freezing point of seawater is around – 1.5°C. The refrigerated seawater tanks installed on board the fishing vessels can chill the fish rapidly as the fish comes in contact with the liquid from all sides and the heat transfer is accelerated. Further, the fish remains at temperature of -1°C to 2°C throughout. This enhances the shelf life of the fish, which can be landed in fresh condition. RSW. has been widely used in many advanced countries for preserving various species of fish. (Erst, 1984)

In India also some of the trawlers are installed with RSW. tanks. The tanks contain either clean sea water or water fortified with sodium chloride. Depending upon the concentration of salt, the temperature of brine will vary. The brine is chilled by passing over chilling coils and the chilled brine is recirculated in the tank. The fish is dumped into the tank. As the density of fish is less than that of brine the fish will be just floating. The fish can also be suspended in perforated vessels immersed in RSW

RSW preservation has been found quite satisfactory in non fatty fish and bigger sized fish. Such fishes can be stored in RSW. for longer periods than in ice. For fatty fish like oil sardine, rapid development of rancidity is observed (Putro, 1986). Meat of some fish like mackerel gets darkened. To prevent rancidity, bubbling of carbon dioxide through RSW is recommended. Prawn gets black spots easily when preserved in RSW. Otherwise it keeps well. Excessive chilling of RSW results in partial freezing of fish. However, this will prevent penetration of salt into the meat. If the temperature is around –1°C only, there is a possibility of salt penetration into the fish during RSW preservation. Another advantage of RSW is that more fish can be packed per unit volume.

Freezing Preservation on board the vessel

The shelf life of fish in ice and RSW is limited to a few days only. Generally depending on the species of fish the shell life in ice is only 3-10 days. If it is required to keep the catch for longer period on board, freezing will have to be resorted to.

On board freezing is done by employing chilled brine tanks. Highly concentrated or saturated salt solution is used in the tank. The temperature of such solution can be lowered up to -22°C when the liquid will start freezing. The brine is cooled by refrigerated cooling coils and circulated in the tank. The fish or prawn after sorting is taken into perforated plastic bags or bags made of nylon webbings and kept immersed in the cooled brine and allowed to freeze. The freezing time will depend upon the temperature of the brine. Under ideal conditions, freezing will take place in 15-20 minutes when the bags are taken out and stored

in cold rooms on board the vessel. For rapid freezing the size of the bags must be small and the brine has to be cooled rapidly and circulated. Such facilities are available in some of the imported steel trawlers operating in our country.

Handling of Prawns

Many of our boats are more interested in the prawn catches as this brings better prices. As soonas the prawn catch reaches on board, it shall be hosed with clean sea water to remove dirt and debris and shall be stored mixed with ice in 1:1 proportion. Removal of the head before storage in ice will reduce the incidence of black spots. Prevention of free entry of air into the material and avoidance of contamination with copper will also reduce black spot development. Chemical treatments are also useful. Treatment for 2 min in a 0.25% solution of sodium or potassium metabisulfite before storage in ice greatly reduces black spot development. Prawns without any discolouration of the shell or meat are usually packed as headless frozen which fetches the maximum price. Development of discolouration of any sort reduces its value as a raw material. Hence utmost care is required in handling and storage of prawns. One of the early symptoms of spoilage in prawns is the loosening of the head from the 'tail'. Large prawns without any loosening of head is required for packing whole raw frozen prawns. Special care, especially treatment with metabisulfite and storage in water and finely divided ice will help a long way in landing prawns suitable for processing as head on. It is observed in some cases, that the catch is washed in near shore water at the time of landing probably with a view to impart a fresh appearance. The near shore water is polluted to a great extent with harmful bacteria and several chemicals and toxic substances. Washing the catch in such water will definitely be a health hazard and it shall not be practiced.

Facilities required onboard

The following facilities onboard fish vessels will be highly beneficial as bringing the fish to the shore in prime condition.

Water supply

All fishing vessels should have arrangements for a copious supply of bacteriologically sound water. It is difficult for vessels to carry very huge volumes of water on each fishing trip. However, it is possible with a pump arrangement to supply enough quantity of clean seawater. Seawater from open sea is of sufficiently pure bacteriological quality. Water is required to clean the deck, fish hold, containers, catch, etc. Arrangement for chlorination can also be made. Presence of small amounts of available chlorine in the water is a guarantee against high bacterial loads.

Ice

All fishing vessels irrespective of their size shall carry ice. Ice prepared from potable water chlorinated to 10 ppm available chlorine is preferred. Ice is required to cool and preserve the catch. There shall be a proper insulated store for ice. In smaller boats, ice may even be taken in insulated boxes.
Ice manufactured from clean sea water can also be used. Seawater usually contains 3% sodium chloride and the temperature of the ice prepared from seawater will be 30-32°F

compared to 32°F for freshwater ice. In other words sea water ice is a better coolant than fresh water ice. But there are certain difficulties in its manufacture and use. If seawater is frozen as block ice, the distribution of salt will not be uniform. If flake ice is made, this defect is rectified. Fish may absorb the salt, making it unsuitable for certain types of preservation. It may also be difficult to keep the fish at constant temperature with sea water ice because of the leaching of the salt.

Ice – whether fresh water or seawater – shall be stored and handled under hygienic conditions. Ice shall be stored on platforms when separate storeroom is not available, so that the melt water can drain off. Ice shall not be dragged through the deck from the store. Ice crushing machine shall be properly cleaned and hygienically maintained.

Ice left over after a fishing trip shall not be used in the next trip; even if unused. The reason is that the bacteriological quality might have suffered greatly during the trip and the chances for build up of psychrophilic bacteria are more.

Fish hold

Wherever practicable, the fishing vessel shall have a fish hold. The hold shall be constructed in such a way that it is readily accessible for cleaning and disinfection. The material of construction shall be non corrodible and shall not impart colour or odour to the fish. Wood is generally used in boat construction and in such cases the hold may be lined with a suitable non-corrodible material. The fish hold shall be sufficiently insulated and shall be divided into pounds or pens not more than 1.4 x 1.4 m. There shall be sufficient drainage facilities in the hold, so that the ice melt water and other liquid wastes are discharged into a central drain. Fish hold lining should be completely water tight. When chutes are provided for discharging fish to the hold, they shall be fitted in such a way that fish do not have to drop more than 1m into the hold. All surfaces coming in contact with fish shall be made of non corrodible material. In very small boats provision of fish hold is difficult. In such cases, sufficient number of storage containers may be used. Refrigerated sea water or refrigerated brine may also be used in many cases in place of ice. The advantages are (i.) more fish to unit volume (ii.) Lessening of physical damage (iii.) easiness in handling, etc. The greatest disadvantage is the absorption of sodium chloride by the fish.

Containers

All containers used to store fish shall be constructed of non corrodible material. Baskets of bamboo etc. are not to be used as they are very difficult to clean and sanitize. The construction of the containers shall be in such a way that it is easy to clean and disinfect, can be stacked one above the other conveniently without the ice melt-water falling into the container below. The usual boxes are of wood, marine grade aluminum and high-density polythene. Wood, when used shall be planed and coated with rot resistant paint. Otherwise wooden boxes are to be used only once. Boxes of aluminum are good but they make sound. High-density polythene containers do not stand the stress and strain to the extent possible by aluminum.

Cleaning and disinfection

A proper method of cleaning and disinfection shall be followed regularly on board. All equipments, utensils, fish hold etc. shall first be made slime free by scrubbing with a brush after spraying a suitable detergent. Teepol at 0.5% concentration is a good detergent. To the slime free surface a suitable disinfectant shall be sprayed, chlorine is most suitable. For metallic surfaces water containing 100 ppm available chlorine may be used and for wooden surfaces the dose can be upto 1000 ppm. After a contact period of 15 m. the disinfectant may be washed off with clean water. Water under pressure though a hose can also be used at the specified levels of detergent and disinfectant. Such washing may be done at the start of a fishing trip and after unloading the catch. On the deck it may be followed before unloading the haul and after the deck is cleared. Improper cleaning will result in build up of slime and bacteria, which will contaminate the catch.

Personnel hygiene

All persons engaged in handling of the catch on board shall be free from communicable diseases. Medical check up, at least once in every three months is advisable. All the persons engaged in handling of the catch shall wear clean uniforms including headwear. Waterproof coats or aprons and gloves shall be used as and when required. Adequate hand washing facilities shall be provided. Before handling the catch, workers may wash their hands from elbow down using soap followed by disinfection in 200 ppm chlorine water. They may repeat this after visits to toilets, after break in work or at any other time their hands are contaminated. In several cases it is noted that the palm of the workers harbour certain micro-organisms which are not to be present in a food product. That is why importance is attached to hand washing and disinfection. It will be also advisable not to smoke and chew tobacco etc. when handling the fish.

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