
UNIT 21 PROCESSING OF FISH AND OTHER AQUAPRODUCTS

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21.1 INTRODUCTION

About 65-70% of total fish landing of India is consumed fresh. This is due to high demand and preference for fresh fish by the population in India as well as, inadequate provisions to preserve the fish. Therefore, most of the fish is consumed in the local market. Some portion of the catch is iced and transported, but the distance to which they can be distributed is limited and unmarketed fish generally goes waste. Thus it is important to preserve the fish for the following reasons:

- a. It can be distributed to remote places,
- b. It can be stored for a longer period and to make it available in off seasons
- c. To fetch a better price
- d. To avoid wastage and losses

Preservation thus includes, all those methods and means which ensure longer storage of the commodity and make it safe for consumption. You will read in this unit how processing methods help in fish and other aqua product preservation but before that it must be understood how fish spoils.

Objectives

After reading the unit you will be able to:

- describe the different reasons for spoilage of fish,
- explain how spoilage can be prevented,
- explain the principle of several processing and preservation methods, and
- develop new method of fish processing or may help you modify the existing methods of fish processing to suit your requirement.

21.2 HOW DOES FISH SPOIL?

In the previous unit you had read about the composition of fish, and the *post mortem* changes without going into details of spoilage. You would recall that *rigor mortis* is one of the important phases after the death of fish, following which autolytic degradation and microbiological spoilage take place. Both in autolysis and bacterial spoilage, enzymes are the agents that cause change. Bacteria invade deep into the tissue because there is no defense mechanism in the fish body after its death. They secrete enzymes that act on fish tissue. The enzymes native to the fish do not increase but the bacteria multiply if the conditions of growth are favourable. As their number grows, they secrete more enzymes which can degrade the tissue very fast producing undesirable metabolites.

From the last unit you would recall that fish has got high moisture, high protein and high non protein nitrogenous substances. All these favour growth of proteolytic bacteria (bacteria which can breakdown protein as their growth substrate and this breakdown needs the production of enzymes). The microbial enzymatic action results in a series of changes producing odoriferous and flavourous compounds. Initially a sour odour, later a sulphide smell comes from hydrogen sulphide production of amines and free ammonia from amino acids. In marine fish, a few freshwater fish, an odourless compound Trimethylamine oxide (TMAO) is converted to Trimethylamine (TMA) which binds with fatty substances to give a fishy smell. This also happens due to enzymes of bacterial origin. The protein degradation mainly makes the tissue soft and a lot of water that is bound to proteins now dissolves the degraded proteinaceous substances and comes out.

In addition to change in flavour and odour, the micro-organisms affect the appearance of the fish, the slime on skin and gills, initially clear and watery, becomes cloudy, and discoloured. Skin becomes dull, scales tend to come out of the body, and the eyes become opaque. The appearance of the fish gets completely altered. The fish passes through the stages of fresh, stale and finally putrid. It is the degree of spoilage that decides whether the fish can be consumed or not. Thus micro-organisms, especially bacteria are the most important agents of deterioration in raw fish leading to the production of obnoxious and unpleasant odour and flavour.

Pathogens are those which can directly or indirectly cause deleterious effects in the body of the consumer (host). They include both infectious and toxigenic micro-organisms. The toxigenic ones produce toxins in fish. Fish infested with toxins, when consumed causes harmful effects.

Along with the fish spoilage micro-organisms, the pathogens, if present, multiply fast. They may pose serious problems to the consumers. So it is very important that pathogens do not find entry in to the raw material and even if they are present they should be controlled.

SAQ 1

List the change in fish when it spoils

- i)
- ii)
- iii)
- iv)

21.3 CONCEPTS OF FISH PRESERVATION

You would now realize that it is very important to control the spoilage micro-organisms in order to protect fish from deterioration. Controlling micro-organisms can be done by

- preventing their entry
- by removing them physically
- by killing them or
- restricting their growth by creating an unfavourable condition.

Each of the above means of controlling microbial growth have been described individually.

21.3.1 Preventing the Entry of Micro-organisms

Fish live in water. Water harbours a load of micro-organisms which get easy access to the body to fish. The microbes also get entry into the gills which continuously pump water. A lot of micro-organisms go into the intestine along with different food particles. So it is difficult to control the entry of micro-organisms into the body of fish. Human pathogens and spoilage micro-organisms which get entry into the fish after the fish is landed can be prevented by ensuring that all the surfaces that comes in contact with fish are hygienically cleaned.

21.3.2 Removing Micro-organisms Physically

Physical removal of micro-organisms involve washing. Washing with clean, potable water removes dirt, slime from the surface of fish thus reduces the microbial load. The surfaces of fish are rubbed to remove slime, and dirt that helps in removal of micro-organisms. Removal of gills and intestine removes bacteria that are present in them.

21.3.3 Killing Micro-organisms

Killing microbes involves heating or cooling to a degree at which organism are destroyed. Use of antibiotics, radiation, chemicals for these purpose have been found satisfactory. Use of these killing agents is restricted to the conditions that they should not render the fish inedible and they should not adversely affect the consumer.

21.3.4 Controlling Micro-organisms

Bacteria and other micro-organisms depend on water and nutrients for their growth. They grow very fast if the temperature, oxygen level and pH are conducive. A micro-organism either can not grow or grows very slowly if any of these requirements is not favourable. There are thousands of types of micro-organisms differing in their requirements. The objective of preservation thus is not to get free from all micro-organisms but to hinder the known pathogens and spoilage micro-organisms. The amount of water available for bacterial activity is expressed in terms of water activity. In short water activity (a_w) is the ratio of vapour pressure of the fish to that of the pure water. Like pH and temperature, a_w must be within a conducive range for the micro-organisms to grow.

SAQ 2

Fill in the blanks.

- i) The microorganisms which can produce toxin in food are called as
- ii) The entry of pathogens and spoilage microorganisms can be prevented by the surfaces that come in contact with fish.
- iii) The amount of water available for bacterial activity is expressed in terms of

iv) The ratio of vapour pressure of fish to that of pure water in termed as

21.4 IMPORTANT COMMERCIAL METHODS

All preservation methods thus are based on using one or the other mean to affect or prevent the growth of micro-organisms. When a single method proves to be too harsh so as to make the product unpalatable a combination of preservation means are applied. In this section we will examine some important commercial methods of preservation of fish.

21.4.1 Freezing

Freezing is basically removal of heat from a substance until it attains subzero temperature and assumes a hard consistency by the solidification of its water content and hardening of organic tissue. Freezing is a preservation method, based on two principles (1) low temperature is unfavourable to the growth of microorganism leading largely to their death because of the sudden exposure to low temperature (2), solidification of most of the free water in food makes the water unavailable for the activity of microorganisms especially bacteria. Another added advantage of low temperature is that it slows down the activity of autolytic enzymes. As you know every 10 degree increase in temperature raises the rate of biological reaction, by about 2 folds and the reverse happens when temperature is lowered. The activity of the bacteria is reduced because of the reduction in the biological reaction rate.

Freezing process alone is not a method of preservation. It is merely the means of preparing fish before storage at a suitably low temperature. Preservation effects are due to low temperature. Freezing process involves washing, dressing, addition of ingredients if any, and arranging suitably to feed in to the freezers (Fig. 21.1). In order to produce a good product, freezing must be accomplished quickly.

Based on the rate of freezing it has been classified as given in Table 21.1.

Table 21.1: Classification of freezing based on freezing rate.

Types of freezing	Depth of solidification/hour	Types of freezer
Slow bulk freezing	2 mm / hour	Blast room with cold air circulation
Quick freezing	5 – 50 mm/hour	Tunnel air blast freezer
Rapid freezing	50-100 mm/hour	Small products in tunnel air blast freezer
Ultra rapid freezing/ Cryogenic freezing	100-1000 mm/hour	Using liquefied gasses like liquid CO ₂ , liquid N.

Different Types of Freezers

Freezing is achieved by exposing the fish to super-cooled surfaces or super-cooled fluid. The efficiency of heat transfer depends on the mode of heat transfer, temperature of refrigerant and the design of the freezer. However, a freezer for freezing fish is selected considering financial and functional feasibility.

i) Air blast freezer

Freezing is done by blowing continuous stream of cold air over the fish. Air is the secondary refrigerant since it is cooled by a primary refrigerant like evaporated liquid ammonia, chlorofluoro carbon (CFC) flowing through the pipes over which air is blown. The rate of cooling depends on the speed of air flow. The speed of air can not be increased indefinitely since it could cause dehydration of the product.



Fig.21.1: Fish trays ready for freezing.

Air blast freezers are either batch type or continuous type. In a batch type air blast freezer, the freezer is fully loaded with the material. Cold air is blown until the freezing is complete. The insulated chamber has vanes and guides to regulate the direction of air flow ensuring a more or less uniform freezing. In the continuous type, the fish pass through an insulated tunnel over a conveyor belt where the cold air is blasted from the reverse direction. The speed of air is maintained at about 5 m/sec in a batch type air blast freezer and about 10-15 m/sec in a continuous type air blast freezer.

Merits and demerits of air blast freezers

Air blast freezers are most versatile in accommodating any irregular shape and different size of fish. Capital involvement is less in this type of freezer and it needs less labour in processing. It causes slow freezing. Loss due to dehydration is high in this freezer and in this process there is difficulty in maintaining uniformity of freezing and regular defrosting is needed to maintain its efficiency.

ii) Contact plate freezer

In this type of freezer sufficiently cooled metal plates come in direct contact with the fish or its packaging. The product is sandwiched between two metal plates in order to make heat transfer more efficient. The plates are cooled by pumping cold refrigerant through them. With the aid of hydraulic pressure the plates can be moved to obtain a compact product and the close contact needed to ascertain good heat transfer by conduction.

Merits and demerits of plate freezers

The heat transfer is very efficient and the freezing is quicker than air blast freezer. Original shape of the product and package is maintained in case of plate freezer. The water added to fill the air pockets helps in strengthening the block, protects fish during subsequent handling and reduces the chance of dehydration and oxidation during storage. The plate freezing needs considerable preparation and handling, thus is a labour intensive process. It also needs defrosting and air pockets often remain which lead to insufficient freezing.

iii) Immersion freezing

Here freezing is accomplished by immersing the fish in a cool liquid refrigerant or by spraying a refrigerant over the product. The fluid that comes in contact with fish is either the primary refrigerant like liquid nitrogen, liquid CO₂ or secondary refrigerant like brine which has been cooled using a primary refrigerant. The term immersion freezing is more or less restricted to freezing using brine i.e., salt solution, whereas, the term cryogenic freezing is used to describe freezing using liquid nitrogen or liquid carbon dioxide. These two liquids evaporate at -196°C and -78°C respectively and take away the heat from the fish very rapidly causing ultra-rapid cooling.

Merits and demerits of plate freezers

There is negligible weight loss due to dehydration in these kinds of freezers. Oxygen does not come in contact with the product, so there is no oxidation of fat as in the case of air blast freezer. They occupy very less space and can freeze a large quantity in a short span of time. The major disadvantage of these freezers is that the cost of production per kg of fish is very high and these methods are suitable for high value fishes. Added to that, mishandling of the refrigerants causes wastage and can be harmful to the handler.

SAQ 3

- i) Write down two principles of preservation in freezing
 - a)
 - b)
- ii) In air blast freezer the air speed cannot be increased indefinitely because
- iii) In case of plate freezing, a light pressure is applied on the product by the plates to
- iv) The major disadvantage of cryogenic freezing is

21.4.2 Canning

Preservation through canning was first developed by the French confectioner, Nicholas Appert in the year 1795. The process of canning consists of heating the container carrying food under steam pressure to destroy the spoilage bacteria and keeping the container air tight to avoid contamination from outside sources. Though Appert had used glass containers for packing and sealing, the process underwent several changes and in later years, tin plated mild steel containers were used. The term can and canning has been derived from the word canister which means tin container.

The principle involved in preservation by a canning is killing of bacteria by high temperature and inactivating the autolytic enzymes by heat.

Types of cans

Cans are available in various size and shapes. In shape, they can be oval, square or round and of innumerable sizes. Most of the cans are made of steel plate coated with tin. The tin coated steel sheets are further coated with either acid resistant lacquer or sulphur resistant lacquer depending on the type of food packed. Apart from the steel cans, recently flexible pouches that can be sterilised by heat have been used to overcome the transportation problem of cumbersome rigid cans.

Different steps in canning

a. Preparation of raw material

The fish must be cleaned, degutted, and washed to remove slime, blood, bits of viscera etc. The fish have to be cut length to suit the size of specific can.

b. Brining

The cut pieces are immersed in 15% solution of common salt for about 22-30 minutes and then they are drained on a wire basket. The brining makes the texture of the fish tough.

c. Filling of the can and precooking

Specified amount of the fish is weighted and filled in to the cans. The cans are then kept in a steam steriliser otherwise called as retort and steam cooked. This step is known as precooking. The cans are then drained by keeping them in inverted position on trays. Fluid released during cooking is drained off.

d. Addition of filling medium

Hot oil, hot brine or tomato sauce is poured in to the can to fill it to about 90% of the total volume of the can. The lids are lightly pressed on the cans.

e. *Vacuum seaming*

The lids of the cans are then closed in an automated vacuum seaming machine. A vacuum of 10 mm Hg is created before the can is double seamed. This vacuum prevents the cans from getting distorted due to high internal pressure during heat processing.

f. *Heat processing or sterilisation of cans*

Cans are arranged inside a double jacketed retort and steam cooked. The cooking duration is monitored after the temperature of the retort reaches 121.1°C. This step is the most important step in canning practice. The heat processing should be adequate to destroy the most heat resistant bacteria expected in that type of fish.

g. *Cooling*

The retort is opened and cans are plunged into a water tank filled with cold chlorinated water. Cooling is also an important step. Cooling also helps in killing some of the surviving bacteria if any, due to sudden change in temperature. Due to condensation of vapour from the head space of the can, the lids are pulled inside and cans become concave. This is a sign of having proper vacuum inside the can.

h. *Labeling*

The cooled cans are dried and labeled. Labeling should give information about the type of fish, date of manufacture, net weight etc. The canned fish then packed for transport.

Merits and demerits of canning

Canning results in heat processed fish and can be consumed without further processing. It is a useful ready to eat food for people in remote places. The food can remain safe for a very long time without deterioration of quality. It can also be stored at room temperature (Fig. 21.2).

Among the principal demerits, the most important is the weight of the steel container and the filling media. These make the can heavy to transport. Secondly, no single preparation of canned product can suit the taste of a variety of people.



Fig. 21.2: Canned fish can be stored at room temperature without fear of spoilage.

SAQ 4

Fill in the blanks.

- Preservation by canning was first developed by
- The term 'can' has been derived from the word which means tin container.
- Brining of fish prior to canning is done in order to modify the of the fish.
- Heat processing of cans are generally done at°C.

21.4.3 Surimi Production

Mechanically deboned, water washed fish flesh is termed as **surimi** which in other words refers to wet concentrate of fish muscle protein. Surimi is used for the preparation of products like kamaboko, and sausages. Minced fish is the starting material for surimi production and kamaboko is the final product from surimi. The preservation is effected by freezing. The flow chart of the preparation of surimi is given in Fig. 21.3 and some of products are shown in Fig. 21.4.

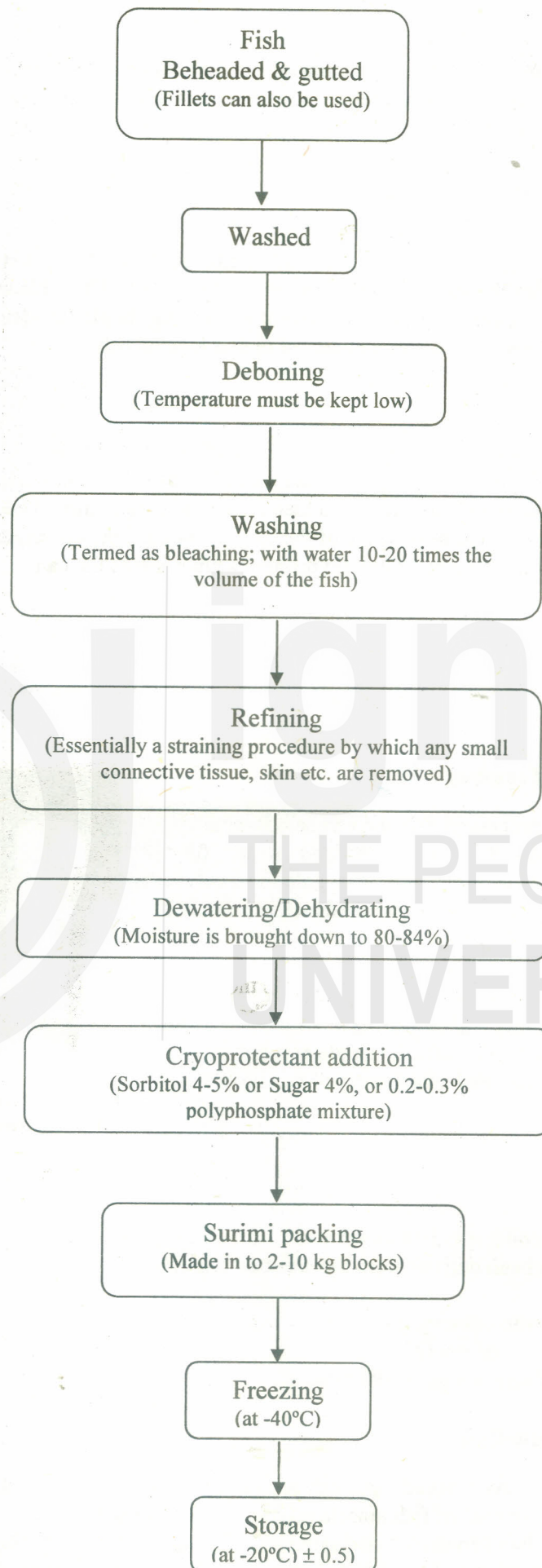


Fig. 21.3: Preparation of surimi (flow diagram).



Fig. 21.4: Surimi rolls and samosas.

Surimi is generally graded for its whiteness which should be about 45-60% of levibond whiteness and for gel strength by various methods. One of the methods employs preparation of a tubular roll of the surimi, cutting a thin slice from it and testing for its resistance to penetration by a needle.

SAQ 5

State True or False.

- Surimi is prepared from kamaboko.
- Surimi is generally heated to preserve them for long period.
- Final moisture content of about 90% is essential in surimi.
- Sorbitol is added to surimi as a cryoprotectant.
- Whiteness of surimi is compared to that of levibond.

21.4.4 Fish Sausage

Fish sausage is a semi-processed ready to eat jelly product. Fish meat with high myofibrillar protein is mixed with ingredients and stuffed into tubular casings before they are pasturised. The pasteurisation helps in binding of the meat in a tubular form. The sealing at both the ends keep the bacterial contamination to a very low level (Fig. 21.5). The short term preservation of sausage is effected by heat i.e., pasteurisation. Different steps in a sausage preparation is given in the flow diagram on the following page. (Fig. 21.6)

The ingredients used for sausage preparation are sugar, salt, egg white, chilli, onion, spices nutmeg, starch etc. Sometimes color solution is added to make the sausage attractive. Sorbic acid is the popular preservative for the sausages. More often sausages are eaten without any more processing and in some cases they are further cooked.



Fig. 21.5: Processed fish sausage.

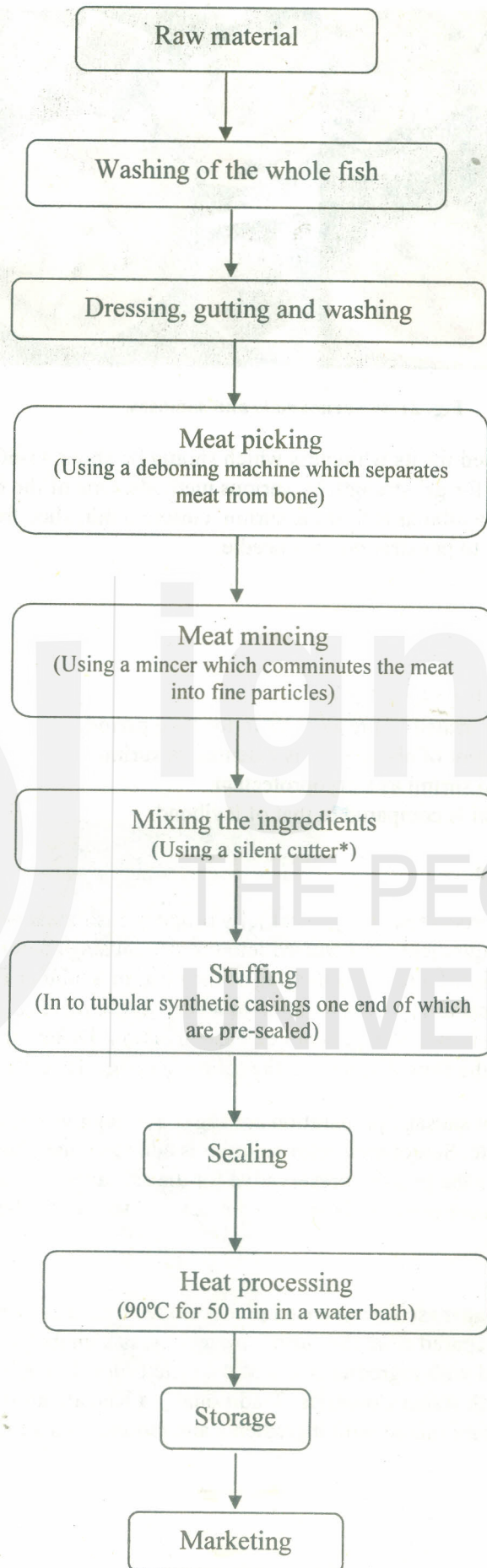
Kamaboko

A range of traditional Japanese surimi based products are termed as kamaboko. Even the shellfish analogs prepared from the surimi are termed as kamaboko. Kamaboko like sausages, are added with ingredients to suit the taste of local people. It is popular in Japan and a few South Asian Countries. Traditionally a Kamaboko is a half cylindrical block of surimi mixed with ingredients and mounted on a piece of wood.

SAQ 6

State True or False.

- Fish sausage are jelly products.
- In fish sausage, preservation is effected by freezing.
- Sausages can be preserved for very long period.
- Sorbic acid is one of the preservatives in fish sausage.



* Silent cutters are mixer like machines for thorough mixing of the ingredients

Fig. 21.6: Procedure for sausage making (flow diagram).

21.4.5 Freeze-drying

Freeze drying is a process that combines both freezing and drying. The fish is first frozen and then the ice formed is sublimated by created low pressure. Sublimation is a process of converting ice into vapour without being converted into water. This happens when the pressure remains below 4.58 mm of Hg and temperature is below 0.0075°C. Since sublimation is essentially the removal of water, the process is a drying process. Once the ice is sublimated the products are not necessary kept under frozen conditions but can be kept in air light moisture free packs because they can readily re-absorb moisture. During sublimation, when the ice evaporates, it takes away heat from the product causing it to cool further. Therefore, additional heat has to be supplied in order to maintain the sublimation process. Since it requires continuous input of energy to continue the sublimation process it is known as accelerated freeze drying. The preservation is due to low water activity and unavailability of oxygen (generally products are packed in an inert gas).

Merits and demerits of freeze drying

Freeze drying removes more than 90% of the moisture leaving the food light, making it easy to transport by air. However, it needs packing in some inert gas to prevent moisture reabsorption. It can reabsorb 95% of the moisture that is removed but the product remains porous and brittle. The reabsorbed water can easily be squeezed out. The material maintains its original shape, if packed in a rigid container. The nutrient loss in freeze drying is negligible.

SAQ 7

Fill in the blanks.

- Conversion of ice into vapour without being converted into water is termed as
- The preservation of freeze-dried fish is due to and
- In order to retain the shape of freeze-dried product, they must be packed in containers.
- The nutrient loss in freeze-drying is

21.4.6 Salting and Drying

Both salting and drying are preservation methods by themselves and in many types of traditional processing methods they are used in combination. Salting can be a preliminary operation to drying, smoking and marinating.

Salting

Salting is a group of operations by which fish is placed in contact with salt and allowed to become permeated by it. The whole process of salting consists of washing, cleaning, gutting the fish and packing them in a container along with the salt. Due to the osmotic difference inside and outside the fish tissue caused by the salt, the salt penetrates into the tissues and moisture is forced out. When this happens it is said that the salt has struck. The principle involved in salting is the removal of water resulting in a low water activity in the tissue. There is a load of bacteria, both spoilage and pathogenic, which can not grow in the presence of salt and at low water activity. Therefore the fish is preserved.

There is a considerable water loss during salting process. In order to achieve a good preservation the salt should be of right quality and finer grade to be dissolved easily. Once the salt concentration in the tissue reach a minimum level to arrest microbial growth, the preservation is effective. Salting can also be done by using a saturated salt solution and keeping the fish immersed in it. This process is advantageous in that

there is an intimate contact between the salt solution and the fish and oxygen is cut off that prevents possible oxidation of fat and the rancid smell due to this oxidation.

Factors influencing salting time

The duration to which salting must be done depends on the following factors

- a. Thickness of the fish: Larger the thickness, longer the salting time required
- b. Salt concentration in the brine (salt solution) – Higher the difference between the salt concentration in fish and that in the brine, faster the salting rate.
- c. Temperature of salting: Higher the temperature, faster the rate of salting.
- d. Quality of salt – Fineness and level of impurities in salt affect the salting rate. Finer particles dissolve fast and make more intimate contact with the product. Impurities affect the salting rate adversely.

Quality of salted fish

Most of the known pathogens can not grow in well salted fish. Few halophilic bacteria can grow on it resulting in discoloration. Halophilic molds can also grow if the salted fish is stored in humid condition. Prior to consumption the salted fish must be washed and soaked in water for re-hydration and then cooked.

Drying

Drying is one of the oldest way of preserving fish. The principle involved here is the reduction of water of the fish below the quality required by the spoilage bacteria. Drying after salting is also a very old conventional way of preserving fish. Dried fish needs to be soaked in water for a considerable length of time for re-hydration, cooked and then consumed. Drying can be of two types, natural drying under the sun (sun-drying) or artificial drying known as mechanical drying using an oven. In recent years drying under vacuum has become popular because the quality of the products is better using this method.

How drying takes place

Moisture is driven out of the fish because of the difference in the vapour pressure of water on the surface of fish and that in the air. The water molecules diffuse into the air until there is equilibrium in the vapour pressure. Low vapour pressure of the air indicates low moisture load in the air and it has the capacity to hold moisture. The flow of air aids the drying process by hastening the diffusion of moisture from the fish. Though the final level of drying remains the same, when there is an air flow the equilibrium stage is reached earlier. Thus the mechanical drying process creates an environment of low moisture and sets a flow of air so that drying is very fast.

Quality of dried fish

A dried fish can not match the fresh fish in its quality. It has got a typical taste which is preferred by some people. It has got a hard texture even after re-hydration; lacks succulence and is sometimes rubbery. Drying process must be complete before the fish is stored. Yellow discoloration, softening of the belly and rancid odour are indicative of bad quality dried fish.

SAQ 8

Answer the following

- i)
 - a) The principle behind preservation salting by is
 - b) Submerging fish in concentrated salt solution for salting process has the advantage that
 - c) The difference is the salt concentration in the brine and in fish tissue is termed as

- d) The salted fish must be soaked in water for several hours in order to
- ii) State True or False.
- Drying is the most modern method of fish preservation.
 - During drying there should not be any air circulation for uniform drying.
 - Dried fish is soft and succulent.
 - Yellow coloration of dried fish indicates best quality of the product.

21.4.7 Smoking

Like salting and drying, smoking is an age old preservation method. Smoking is a preservation process by which fish is rendered delicious due to specific aroma imparted by the smoke and preserved due to some chemical components present in the smoke. In general fish is consumed without any further cooking.

There are two types of smoking procedure, cold smoking and hot smoking. Cold smoked fish are generally salted and dried prior to smoking. The preservation effects are therefore due to the effect of salt, low water activity and bacteriostatic components of the smoke that get absorbed in the fish. The smoking is done between temperature 20-30°C for 8-24 hours depending on the size of fish.

Hot smoking renders fish partially cooked. Light salting to a final salt concentration of 1.5-2% is done by adding dry salt or using concentrated salt solution. The fish are then rinsed in fresh water and hung in the smoking chamber. Smoke is produced by using wood logs, wood shavings and saw dust. The temperature of the chamber is maintained between 80-100°C.

Smoking dries up the fish, kills most of the pathogens and spoilage microflora due to heat and finally loads the fish with an array of bacteriostatic chemicals. Thus the fish is preserved.

Composition of smoke

A large number of compounds constitute the aqueous distillate of smoke. They include different organic acids and their esters, alcohols with 2-3, 4 carbon atoms, aldehyde such as formaldehyde and acetaldehyde, ketones like acetone and methyl ethyl ketone, xylene and phenols. The preservation effect is due to the presence of aldehyde especially formaldehyde, organic acids and phenols. A compound 3-4 benzopyrine, also a constituent of smoke is regarded as a carcinogen.

SAQ 9

Fill in the blanks.

- The preservation of smoked fish is effected due to presence of in smoke.
- Cold smoking is done in a temperature range of
- Hot smoking is done at a temperature of
- is a carcinogenic compound present in the smoke.

21.5 PROCESSING OF OTHER AQUAPRODUCTS

In the earlier section of this unit the focus was on processing fish as the general perception of aquaproducts is production of fish for food. However, there are many other aquaproducts such as plants, algae, water chestnut, lotus seeds, holothurian etc. that are popular as food in many countries of the world. In this section we will describe the processing of some other aquaproducts such as seaweed, holothurian, that are popular as food for human and animal consumption.

21.5.1 Processing of Seaweed

You have read about the culture of seaweed elsewhere in this course. There have been various uses of seaweed. Seaweeds have been used extensively for various purpose in south east Asian countries and in Japan but in India the utilisation is not so diverse.

Seaweeds have been used as animal fodder since ages. In coastal regions, they are used as organic fertiliser since they enriches nitrogen, potassium, phosphorus and iodine content in the soil. Since the protein and carbohydrates of seaweed resist the digestive enzymes, they have low nutrient value. However, seaweeds are used as gelling agents, thickening agents, garnishing agents and are providers of trace element in human food. The popular products like agar, alginic acid are processed from seaweed.

Processing of seaweed into Agar

Red algae belonging to genera *Gellidium*, *Gracilaria*, *Chondrus* and *Phyllophora* are important for the agar industry. The extraction method differs with the species from which the agar is to be extracted. Some of them have to be extracted with hot alkali where as some can be extracted with just hot water. The extraction procedure is very simple and consists of thorough washing of the seaweed and soaking if the raw material is dried. Then the seaweed is boiled and filtered hot and allowed to stand. It forms a jelly when cooled. The jelly is cut in to pieces, dried and ground to powder. For alkali extraction calcium carbonate, or lime is used to raise the pH of the solution for extraction. In some cases, repeated boiling is done to extract maximum amount of agar from the seaweed.

Agar is inert and has low nutrient value. It is used as a food stabiliser for developing formed products. It is widely used for solidification of micro-biological media.

Processing of seaweed for alginic acid

Alginic acid is extracted and purified from brown algae like *Laminaria*, *Ascophyllum*, *Fucus* and *Macrocystis*.

Alginic acid is insoluble in water and can not be extracted with acid. Extraction process involves boiling with water of dried, washed and soaked seaweed and draining off the liquid. Subsequent boiling is done using dilute hydrochloric acid and the supernatant is drained off. The residue is extracted with dilute sodium hydroxide repeatedly and the extracts are pooled. The extracts are then neutralised with hydrochloric acid and bleached with potassium permanganate solution. The precipitated alginic acid is filtered, washed and dried.

Alginic acid and its salt are used for glazing of frozen seafood, as food stabilising material and for sizing and water proofing in fabric industry.

21.5.2 Processing of Holothuria (*Beach de mer*)

The species of Class Holothuroidea are called sea cucumber due to their resemblance with cucumber, *Holothuria scarbra* is the species that is most abundant in India especially on the southern coast. Of late, the culture of this species has been successful. However, at present majority of the sea cucumber are harvested from shallow coastal water within the depth of 10 meters. The product prepared from this species is called *Beach de mer* or trepang. This is used as a delicacy and added in pieces to soups. Special flavoured soup is also prepared from them.

Preparation of *Beach de-mer* is simple. After a thorough wash, the animals are taken live on the pan and heated gently till they emit their internal organs by a process called as self evisceration. They are then washed properly. The animals are taken again and

heated to boil in the water, expelled by themselves. The thoroughly boiled animals are de-skinned, washed and boiled further. They are then dried, packed and exported.

21.5.3 Pearl Processing

The main activities that follow the harvest of pearls are grading of pearls, processing of pearls and jewellery making.

Pearls are graded based on their size, shape, color, luster and surface quality. Pearls are graded into 3 grades A, B and C corresponding to good, medium and poor quality pearls.

The important steps of pearl processing are bleaching of pearls using hydrogen peroxide and their polishing. Hydrogen peroxide used at 3-5% level removes the organic impurities from the surface of pearl. Polishing of pearl is done with salt. The pearls are mixed with salt and are placed on soft velvet cloth. They are then rubbed gently to get better luster. Sometimes small amount of saw dust is mixed with salt for polishing. Jewellery making involves the drilling of pearls to be able to string them.

SAQ 10

State True or False.

- a. Agar has high nutrient value.
- b. Alginic acid is extracted in acid.
- c. *Beach de mer* is a product from sea cucumber.
- d. Self evisceration is a phenomenon found in oysters.
- e. Bleaching of pearl is done in hydrogen peroxide

21.6 SUMMARY

You have learnt in this unit that

- Spoilage of fish is caused by autolytic enzymes and microorganisms (mainly bacteria). In order to preserve fish, we have to arrest the growth of bacteria or eliminate them totally.
- Bacteria can be killed or their growth can be stopped by creating unfavourable growth conditions for them.
- Canning is a method where preservation is done through processing by heat killing the micro-organisms but freezing, drying, smoking, and freeze drying methods can not completely eliminate micro-organisms. Their growth can only be stopped. Salt is also a chemical substance that hinders the growth of common microflora.
- Products like sausage, kamaboko and surimi are dependent on other preservation methods like freezing and heat treatment.
- Processing of several other aquaproducts like sea weed and holothurians is done through other special methods.
- The typical processing method depends on the type of consumer the processor aims at and degree of refinement necessary. Though innumerable diversification on product preparation methods have come into existence, the basic principles remain the same.

21.7 TERMINAL QUESTIONS

1. Answer the following:

- a) How can you recognise a spoiled fish?

.....
.....

- b) When the fish does not smell bad or look spoiled, is it safe to consume it?
.....
.....
- c) Why is freezing considered a dehydration method?
.....
.....
- d) Properly canned fish safer for consumption as compared to other processed food?
.....
.....
2. What do you mean by water activity? Which of the fish preservation methods use alteration of water activity?
3. How is freeze-drying different from freezing or drying?

21.8 ANSWERS

Self-assessment Questions

1. i) Sulphide and ammoniacal smell
ii) Slime becomes opaque
iii) Skin becomes dull
iv) Eyes become opaque
2. i) toxigenic
ii) hygienically cleaning
iii) water activity
iv) water activity
3. i) a) killing of micro-organisms due to cold temperature
b) reduction of water activity
ii) It causes dehydration of the product
iii) Ensure good contact between the product and the plate for efficient heat transfer
iv) High cost of production of frozen products
4. a. Nicholas Appert, b. Cannister, c. Texture, d. 121.1°C
5. a. False, b. False, c. False, d. True, e. True
6. a. True, b. False, c. False, d. True
7. a. Sublimation, b. Low water activity, unavailability of oxygen,
c. Rigid, d. Negligible
8. i) a. Reduction in water activity
b. There is intimate contact between the fish and the solution
c. Concentration gradient
d. Rehydrate the fish
ii) a. False, b. False, c. False, d. False
9. a. Chemicals (aldehydes and phenols)
b. 20-30°C
c. 80-100°C
d. 3,4-Benzopyryne
10. a. False, b. False, c. True, d. False, e. True

Terminal Questions

1. Refer to Section 21.2
2. Refer to Sub-section 21.3.4
3. Refer to Sub-section 21.4.5