

## Chapter 10

### Cured and dried fish products

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Curing is a process by which the fish is preserved by sun drying, salting, smoking, artificial drying etc. This can be done either by any single method or a combination of these methods. Simple sun drying was the widely practiced traditional method of fish preservation. By this, preservation was achieved by removing the water in the fish, thereby retarding the activity of bacteria and fungi. The heat was able to destroy the bacteria to a certain extent. Later on, a combination of salting and drying or salting, smoking and then drying were developed. Salting is one of the oldest techniques for preserving fish, and it is a traditional processing method in many parts of the world. Salting is a simple method of fish preservation. Often, salting is used in combination with drying and smoking. However, if the salting process is carried out incorrectly, due to the use of poor-quality starting materials, that is, stale fish, or, the addition of insufficient salt, the product can spoil and will be lost.

Drying is the removal of water from fish, and like salting, is a very common method of preserving fish, particularly in tropical countries. When sufficient water has been removed fish will be preserved because water is essential for bacteria and enzymes to survive and work to spoil fish. Drying is often used in combination with salting and or smoking for additional preservation.

#### **How does salt preserve fish?**

Salt is a valuable agent in helping to prevent spoilage. Salt preserves by extracting water. This is called dehydration (drying), and happens because water from inside the fish is drawn out into the strong salt solution outside the fish. As the water moves out, the salt moves in, penetrating deep into the flesh of the fish. Water is essential for bacteria (germs) to grow, so if the water is removed, bacteria cannot grow. Furthermore, the spoilage bacteria do not like salty conditions. The more salt in the fish, the more they dislike it. It is important to use clean, dry salt for preserving fish. Dirty salt should not be used and if the salt is wet, it must first be dried. There are some special bacteria that like to live in salt-- these are called the salt-loving bacteria or

halophiles. They require salty conditions to grow and can easily be identified in salt because of their pink or red colour. These specialised bacteria can spoil fish, producing unpleasant smells.

### **Salting methods**

There are two methods of salting fish-- wet salting and dry salting.

**Wet salting:** The principle of wet salting is to keep the fish for a long time in a solution of salt and water, otherwise known as 'brine'. Brining and pickle curing are the two methods used for wet salting. Which method is used depends on whether the product will be further processed by drying or smoking, or just preserved with salting. Brining requires the water used to be saturated with salt. To make the brine, mix four parts of clean water and one part of salt (for example, 10 litres (2 gallons) of clean, fresh water to 2.7 kg-3.6 kg (6-8lbs of dry salt) in a clean, large plastic drum. Keep adding salt to the water, until no more salt will dissolve.

The next step depends on what kind of fish you want to salt. If the fish is large, it is best to cut off the head, and gut and clean the fish before soaking it in the brine. Large fish must be cut open, and it is preferable to take out the backbone. Fish which are covered in a heavy coating of scales must be scaled. In places where the flesh is thick, slashes must be made so that the salted brine can penetrate the flesh. Very large fish should be cut into thin fillets. If the fish is small, it can be soaked after it has been gutted and gilled. After the fish has been prepared according to its size, it must be cleaned and put in the brine. Stir the mixture every 20 to 30 minutes. Brining will take as little time as 30 minutes for light salting, or up to 24 hours for medium salting. Fish for drying, smoking and canning are usually brined prior to processing.

**Dry salting or Kench curing:** In this method the fish is salted, but the juices, and brine (pickle) are allowed to drain away. For 2 parts of fish, 1 part of salt is needed. Layers of fish are separated by layers of salt and placed into a wooden box that has slats cut out of the sides, enabling the draining of juice. It is important to layer the fish with the first layer being flesh-side upwards, and the next layer of fish being flesh-side down. The final layer should be salt. The box has a lid placed on top of the stack and weighted to press the fish down. This encourages faster salt penetration and water removal. Salting time varies from three days to a week, depending on the type and size of fish. This method cannot be recommended for general use in the tropics as the fish are not covered by the brine or pickle and are therefore more susceptible to spoilage and insect attack. Exposure to the air and the presence of salt also encourages the rate of fat oxidation

which gives rise to discoloration and the characteristic rancid flavour. Recommended fish are barracuda, parrotfish, snapper and shark.

In dry salting, the size of salt crystals is important. Fine crystals tend to dissolve too quickly and are dragged down and drained, whereas large crystals dissolve very slowly and there is a risk of deterioration. Fine crystals and larger crystals should be combined. The fine crystals will dissolve quickly and salt will penetrate the flesh immediately. The large ones will dissolve slowly to maintain the salt's action during the whole time of salting. To store dry salted fish, first brush off all excess salt, and place fish neatly in a strong plastic bag. Seal the bag, and keep it somewhere cool, and away from sunlight. The fish should be inspected at regular intervals. If there has been a period of damp weather, and the dried fish show signs of moisture, they should be given a few hours of air drying. If signs of rust and mold appear, the fish should be scrubbed in a light salt brine containing some vinegar, then spread out to dry in the air for a day or two. The product should last for many months.

**Pickle salting:** Pickle curing is a type of wet salting where the fish is layered by granular salt (fish-to-salt ratio of 1-part fish to 0.3 or 0.4 parts salt by weight) which, dissolves in the surface moisture of the fish forming solution which penetrates into the fish removing moisture from the fish. The fish is allowed to remain in this self-brine. If the self-brine is not sufficient, saturated brine is added to immerse the fish. For salting, keep the fish in to flesh to flesh and skin to skin form. After each layer of fish sprinkle on a thin layer of salt. Make sure you finish with a layer of fish, skin upwards, and a final layer of salt. Water from the fish will quickly start to form. The surrounding salt will dissolve in this water. This is called the pickle. It is retained inside the container and will eventually cover all the fish. Place a clean piece of wood weighed down with clean stones on the top of the fish until salting is completed. This will take 36 to 40 hours for small, whole fish and three to four days for large pieces of fish. Wet salted fish should be consumed within 2 months of storage at an ambient temperature. It will keep for several months if stored in a cool place.

**Mona curing:** Mona curing is mainly adopted for medium to small size fishes. Before salting, the intestine and entrails are removed by pulling out through the gill region without split opening the fish. The flesh is not exposed during salting thereby causing less contamination and the

product has a shelf stability of about two months. The yield obtained by this method is about 70%.

**Pit curing:** In this method, fish is mixed with salt (4:1) and placed in pits dug on beaches. The pits may be lined with palymrah / coconut leaves. After 2-3 days of maturation, the fish is taken out for marketing in wet condition and packed in bamboo baskets and transported to markets without drying. The quality of fish cured by this technique is poor with a shelf stability of upto three weeks only.

**Colombo Curing:** Colombo curing is similar to pickling process which is widely practiced in Sri Lanka. A piece of dried Malabar tamarind (*Garginia cambogea*) is kept in the abdomen portion of the gutted and cleaned fish which is further stacked in airtight wooden barrels filled with brine. Fishes cured by this method has a shelf life for upto 6 months.

#### **Type of salted fish products:**

- Heavy salted fish- salt content of fish muscle is above 20g/100g water phase
- Medium salted fish - salt content of fish muscle is above 10g/100g water phase and is lower or equal to 20g salt /100g water phase
- Light salted fish - salt content of fish muscle is above 4g/100g and is lower or equal to 10g salt /100g water phase

#### **Signs of spoilage in salted fish**

**1. Reddening or pink:** The fish takes on a red colouring. This is caused by red halophilic bacteria. These organisms are usually found in solar salt.

**2. Dun:** Dun is characterised by a peppering of light brown or fawn spots on the fish. This is mainly caused by growth of halophilic mould called *Sporendonema epizoum*. During the initial stages of appearance of moulds on the fish, it is possible to remove them manually. In advanced stages it penetrates into the flesh. To avoid the mould growth, it is necessary that the fish be dried, packed and stored properly to avoid uptake of moisture. It is caused by the use of impure salt and unsanitary practices during preparation.

**3. Souring:** Fish which has soured has a bitter taste. Souring is due to improper salting which results in the uneven distribution of salt throughout the muscles of the fish.

**4. Salt burn:** The fish is extremely dry and cannot be rehydrated. This happens when too much fine salt has been used. This salt draws out the surface moisture so rapidly that protein in the fish becomes solid, which stops the fish from taking in water later on. A mixture of large and small grain sizes is recommended for dry salting of fish

**5. Sliming:** The surface of the fish acquires a slippery coating of slime. This usually occurs in brined fish because of inadequate salting, lack of freshness of fish, and other factors.

**6. Case hardening:** Under certain conditions, where the constant rate drying is very rapid due to high temperature and low relative humidity, the surface of the fish can become 'case hardened' and the movement of moisture from the deeper layers to the surface is prevented. This can result in a fish which is dry at surface. However, the centre remains wet and hence spoils quickly.

**7. Rancidity:** This is caused by the oxidation of fat, which is more pronounced in oil rich fishes like mackerel, sardine etc. The unsaturated fat in the fish reacts with the oxygen in the atmosphere forming peroxides, which are further broken down into simple and odoriferous compounds like aldehydes, ketones and hydroxyl acids, which impart the characteristic odors. At this stage the colour of the fish changes from yellowish to brown referred to as rust. This change results in an unpleasant flavour and odour to the product, leading to consumer rejection.

**8. Insect Infestation:** Spoilage due to insect infestation occurs during initial drying stages as well as during storage of the dried samples. The flies which attack the fish during the initial drying stage are mainly blowflies belonging to the family Calliphoridae and Sarcophagidae. These flies are attracted by the smell of decaying matter and odours emitted from the deteriorating fishes. During the glut season when the fish is in plenty and some are left to rot, these flies come and lay their eggs. These eggs develop into maggots, which bury within the gill region and sand for protection from extreme heat. and develop mainly when conditions are favourable. The most commonly found pests during storage are beetles belonging to the family Dermestidae. The commonly found beetles are *Dermestes ater*, *D. frischii* and *D. maculates*

**9. Fragmentation:** Denaturation and excess drying of fish results in breaking down of the fish during handling. Fish can become brittle and liable to physical damage when handled roughly. Insect infestation is also a reason behind fragmentation in dried samples. It is necessary that fresh fish be used as raw material to ensure a good finished product.

## **Prevention of spoilage in cured fish products**

### **Raw material**

- ✓ Fish must be as fresh as possible. Fatty fish is best wet salted, while lean fish is best dry salted. Take care not to damage fish during handling.
- ✓ Salt must be clean and dry. Note: mix of 1/3 small crystals:2/3 large crystals for dry salting. Fine crystals are usually better for wet salting
- ✓ Use clean water

### **Processing methods**

- ✓ Ensure that hands, clothing, cooking utensils and work surfaces are perfectly clean.
- ✓ Take note of the time required for each step of the salting process.
- ✓ Pay attention to the amount of salt or brine/fish weight ratio.
- ✓ Containers must be clean, and possess a secure lid.

### **Handling of finished products**

- ✓ Dry salted fish can be enclosed in clean/dry plastic bags or wrapped and secured inside dry banana leaves.
- ✓ The salted fish must be stored in a clean, and if possible, cool place. Keep it away from dust, insects, rodents and direct sunshine. Not only is it important to obtain a good product, but it is also important to keep it in good condition.

## **Indian Standard Specification for Common Salt for Fish Curing**

**Physical properties** - The material shall be crystalline, white, pale pink or light grey in colour, free from visible contamination with clay, grit and other extraneous adulterants and impurities.

**Microbial quality:** Salt shall be free from halophilic microorganisms, the most common of them being the red halophilic bacteria.

**Particle Size:** The material shall be between 2.36 mm and 5.00 mm in size.

**Moisture Content:** The moisture content of the material shall be not more than 6.0 percent by mass

**Table 1: Requirements of common salt for fish curing**

Sl.No	Characteristics	Grade 1	Grade 2
1.	Matter, insoluble in water, percent by mass, Max	0.5	1.0
2.	Sodium chloride (as NaCl), percent by mass, Min	98	96
3.	Calcium and magnesium (as Ca), percent by mass, Max	0.5	-
4.	Soluble iron compounds (as Fe), parts per million, Max	10	20
5.	Matter soluble in water other than NaCl, percent by mass, Max	1.5	3.0
6.	Copper (as Cu), parts per million, Max	1	1

### **Drying phases of fish**

1. Initially, water on or near the surface of the fish evaporates. The rate of drying depends on: i) surface area of the fish (size), ii) speed of air movement over the fish, iii) relative humidity of the air.

2. The second phase occurs when the surface of the fish has evaporated. The drying rate in this phase depends on: i) the nature of the fish. Fat in fish flesh retards water movement; ii) fish shape. The thicker the fish, the longer the time of drying; iii) temperature, iv) water content. Drying will proceed more rapidly at higher temperatures; The higher the water content, the longer the time of drying.

### **Methods of Drying**

Drying of fish is most often done using sun drying or mechanical dryers. Sun drying depends heavily on the natural weather conditions since the fish is dried by heat from the sun and the air current carries the water away. Here there is no control over the operations and many a time the losses cannot be substantiated. Hence it is necessary that the operations be controlled to get a product, which has an extended shelf life, but at the same time the texture, taste and flavour is maintained. It is here that artificial driers where processing parameters are controlled gain a lot of importance. Such processes are carried out in a controlled chamber or area. Such products

have advantages over sun-dried products since they have better keeping quality and longer shelf life.

In mechanical driers, removal of water from the fish is achieved by an external input of thermal energy. This is an expensive method since there is need for fuel for heating and maintenance of the temperature. The drying chamber consists of a long tunnel in which the washed and cleaned fish is placed on trays or racks. A blast of hot air is passed over the material to be dried. After the required degree of drying the product is removed from drier and packed. These can be broadly classified into two types. In one type, the heat is transferred into the product through a hot gas, usually air. Eg. Kiln dryers, cabinet dryers, tunnel dryers and fluidized bed dryers. In the second type, the heat is transferred into the product through a solid surface, which may also be used as the cabinet for the product to be dried. E.g., drum dryer, vacuum dryer

### Signs of spoilage in dried fish

1. **Case hardening:** The fish has a chalk-white appearance, and is hard and brittle. This is caused by over-rapid drying, which leads to drying out of the outside of the fish while the inside is still moist.

2. **Mould growth:** The growth of black, blue and green moulds on dried fish is evident. This is due to the high moisture content of the fish either because it was not dried properly or, because it took up moisture from the air and became sufficiently wet to let mould grow.

3. **Reddening:** As with spoiled salted fish, reddening may also occur in spoiled dried fish. Reddening is caused by the red halophiles (salt-loving bacteria) which grow on the dried fish when impure salt contaminated with these bacteria is used

### Quality standards for dried fish products- Bureau of Indian standards (BIS)

Sl. No	Product	Moisture (%)	Sodium chloride (%)	Acid insoluble ash
1.	Dry salted cat fish	35	25 (min)	1.5
2.	Dry salted Dhoma	35	10-15	2
3.	Dry salted Horse mackerel	35	25-30	1.5



4.	Dry salted Thread fin	40	25	1.5
5.	Dry salted leather jacket	35	25-30	1.5
6.	Dry salted Mackerel	30	25-30	1.5
7.	Dry salted Jew fish (Ghol)	40	25	1.5
8.	Dry salted seer fish	35	25-30	1.5
9.	Dry salted shark	35	25-30	1.5
10.	Dry salted Tuna	35	20-25	1.5
11	Dried salted Anchovy	-	15 (Max)	1.5

### Prevention of spoilage in dried fish

In order to prevent spoilage, care and attention must be used during

1. **Processing:** The fish used must be fresh, prepared correctly according to size, and dried under the required climatic conditions. Using drying racks above the ground will protect against pests.
2. **Transport:** When the fish has dried, it can be packaged into clean plastic bags, or dry secured banana leaves and transported. If the fish is to be sold, it can be displayed inside rat-and-insect-proof boxes, covered with mosquito netting and placed on a table. In this way, the product can be viewed by customers, without being handled.
3. **Storage:** The dried fish must be stored in a place that is free of insects and rodents. The best type of store house is raised on stilts above the ground, in a well-ventilated, shady spot.

### Microbiology requirement for salted fish /dried fish

Parameters	Limit
Total plate count	Not more than 5 laksh/g
<i>E. coli</i>	Not more than 20/g
<i>Staphylococcus aureus</i>	Not more than 100/g
<i>Salmonella &amp; Shigella</i>	Absent in 25g
<i>Vibrio cholerae</i>	Absent in 25g
<i>Vibrio parahaemolyticus</i>	Absent in 25g

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