

23. PREPARATION OF DRIED FISHERY PRODUCTS

A. Jeyakumari, GirijaBehere, L. Narasimha Murthy, Laly S.J.

Mumbai Research Centre of ICAR-Central Institute of Fisheries Technology, Navi Mumbai

*jeya131@gmail.com

Introduction

Being highly perishable in nature, fish need to be handled, processed, packaged and distributed properly to maintain its quality and nutritional attributes over longer periods of time by preventing spoilage. Curing, salting, smoking, pickling and drying of fish are the cheapest, oldest traditional methods of preservation in India. However, it leads to the production of poor quality fish products due to the use of poor quality raw material and salt. Salting prevents spoilage by penetration into fish flesh. Further drying leads to the removal of water from fish, leading to reduced bacterial growth and autolytic activity. Salting may be done as dry salting or wet salting. There are two common methods of salting fish-- wet salting for fatty varieties and dry salting for lean varieties. Pickling uses fish with salt, vinegar, spices and sugar whereas smoking uses salting, drying, heating and smoke components.

Drying and its basic principle

About 1/4th of the landed fish are dried and is one of the oldest fish preservation methods having huge demand in domestic and international markets. Drying takes place in two distinct phases. In the first phase, whilst the surface of the fish is wet, the rate of drying depends on the condition (velocity, relative humidity etc.) of the air around the fish. If the surrounding air conditions remain constant, the rate of drying will remain constant; this phase is called the 'constant rate period'. Once all the surface moisture has been carried away, the second phase of drying begins and this depends on the rate at which moisture can be brought to the surface of the fish. As the concentration of moisture in the fish falls, the rate of movement of moisture to the surface is reduced and the drying rate becomes slower; this phase is called the 'falling rate period'. Drying is the removal of water from fish to such an extent where most of the microbes, enzymes and moulds will be inactive and will not grow due to reduced moisture and water activity. In general, moisture content of 15-20% is aimed. Water activity levels below 0.6 lead to complete restriction for microbial growth. Water activity is the ratio of the water vapour pressure in the flesh of the fish to the vapour pressure of pure water at the same

temperature and pressure. It ranges between 0 and 1, and is a parameter that measures how available the water is in the flesh of the fish.

Advantages of fish drying

Drying of fish is less expensive method fish preservation with shelf life of about 4-6 months. It retains nutrients in fish and produces more concentrated forms. Drying needs limited and less expensive equipments. Storage space required for dried fish is comparatively less and dried products can be stored at ambient temperatures. Costs involved in distribution of dried products are also lesser compared to other techniques of preservation and processing.

Drying Techniques

Drying is usually carried out by two techniques or combination of both which includes natural or sun drying and artificial drying or dehydration. Natural drying utilizes atmospheric conditions like temperature, airflow and humidity using open sun drying. Artificial drying is done by mechanical driers for removal of moisture from fish under controlled conditions.

Traditional Method of sun drying is the simplest type of drying. Solar and wind energies are utilized as the energy source. Fish is dried by heat from the sun and the air current carries the water away. Drying is by removal of water from skin surface and later from the interior of fish. It is used for small and lean fish. It depends heavily on natural weather conditions. It is usually practiced in unhygienic conditions resulting in poor quality. Drying on beaches leads to contamination of fish with sand, filth and other foreign matter. Use of unpurified cheap salt and seawater, drying without protection from dogs, cats and birds, leading to poor quality finished product. Drying on coir mats, bamboo mats, jute sacks and raised platforms reduce contamination to certain extent.

Rack drying is hygienic method of fish drying under sun. Racks can be made by use of poles and webbing material ensuring air circulation under and over the fish causing less contamination with sand and dust.

Solar drying is a method by which the sun's heat is converged and utilized for drying. The energy of the sun is collected and concentrated to produce elevated temperatures and an increased rate of drying. A black surface is used for converting the solar heat. Raising the air temperature increases the amount of water the air can hold, thus the relative humidity will be

reduced and the air will be able to absorb additional water vapour. Solar tent driers and cabinet driers are working on this principle.

Artificial/ Mechanical type of drying uses external thermal energy by the aid of burning fuel or electrical heater making it an expensive method. Heat can be transferred by hot gas/ air or heat is transferred through the solid surface. Kiln dryer, cabinet dryer, tunnel dryer and fluidized bed dryer are examples of heat transfer by hot air. Drum dryer, rotary dryer and vacuum dryer are examples of dryers using heat transfer through solid surface. Freeze drying involves removal of moisture from fish under vacuum quickly cooling fish due to heat energy transfer.

Rate of drying

Size of fish, surface area, temperature, relative humidity, air velocity, fat content and moisture content in fish are the factors which affects drying.

Drying of fish and shrimps

Preparation of fish and shrimp for drying

Raw material must be as fresh as possible. Proper icing until processing is recommended. In case of unavailability of ice, cleaning of fish with fresh/ sea water, placing in a clean box and covering it with wet cloth is recommended. Lean or semi fatty fish are suitable for drying. Use of clean tables, knives using 10 ppm chlorinated water is preferable and advised. Fish and shrimp can be washed using clean water immediately after procurement. Dressing of fish before washing by gutting and descaling is advised. Small fishes can be salted directly after cleaning it well. Large fishes should be cut into butterfly style. Large fish, like shark, should be cut into strips or small rectangles to ensure adequate drying.

1. Dried shrimp

Shrimp is an important source of high quality protein and is an extremely perishable commodity and quality loss can occur rapidly after catch. Drying preserve the food by reducing the water available for microbial growth and increase shelf life and thus prevent wastage of food. Drying reduces the weight and volume, minimizing packing, storage, and transportation costs and enables storability of the product under ambient temperatures. Sun drying of prawn is a simple and the oldest known method of prawn preservation and is considered as the least expensive method of prawn preservation. Sun drying depends on the

weather conditions and it requires a large open space area exposed to direct sunlight and it is generally inefficient. In the modern industrial drying, the use of mechanical dryers provide less drying time, high efficiency and higher drying rates.

Ingredients for dried shrimp

Shrimps	:	1 kg
Salt (10%) (for brine solution)	:	100 g
Citric acid (0.2%) (for brine solution)	:	2 g
Potable water (l) (for brine solution)	:	1.2 l L

Method of Preparation

Generally shrimps can be dried in two methods.

Total Drying

1. Wash and clean the fresh shrimp in potable water.
2. Drain off the water.
3. Weigh the shrimp and dip in boiling 10% brine solution containing 0.2% citric acid for 30 seconds.
4. Take the shrimp out and drain off the water.
5. Open/sun dry the shrimps in clean and raised platforms/ high racks. Otherwise mechanical drier can also use.
6. The prawns dried in this way will have shelf life of 6 months.
7. Pack the dried prawn in good quality laminated pouches.

Shrimp Pulp Drying

1. Wash and clean the fresh shrimp in potable water.
2. Drain off the water.
3. Weigh the shrimp and put in boiling 3.5% brine solution containing 0.2% citric acid for 20 minutes.
4. Take the shrimp out and drain off the water.
5. Open/sun dry the shrimp in clean and raised platforms/high racks. Otherwise mechanical drier can also use.
6. De-shell the shrimp either manually or mechanically.
7. Pack the dried shrimp pulp in good quality laminated pouches.

Preparation of Brine Solution

1. Ingredients serially numbered from 2 to 4 are required for Brine Solution.
2. Take 1.2 L of potable water; add 35 gm (3.5%) salt and 1.2 gm (0.2%) citric acid to the water. Mix the solution properly to get brine solution.

2. Dry salted fish

Drying and salting of fish are used in combination for preservation of fish by reducing microorganisms' growth and autolytic enzymatic activities. In the preparation of dry-salted fish (mackerel, leather jacket, seer fish, shark, cat fish, threadfin, jew fish, horse mackerel and croakers), the fresh fish is split open by a cut from dorsal side along the vertebral column and the entrails and gills are removed. The knife is passed deep along the vertebral column and the fish is flattened out. Scores are made on the thick fleshy parts by passing the knife lengthwise. After washing the fish, salt shall be smeared in proportion of not less than 1:4 by mass on the cut surface of the fish and the fish is kept under cure for not less than 24 h. Salt used for curing shall conform to IS 594. The salted fish is washed slightly to remove excess of un-dissolved salt and dirt. The fish is dried in sun spread over drying racks for a period of 10 to 18 h over two to three days. During drying, the fish is turned upside down occasionally to facilitate quicker and even drying. The fish while drying shall be protected against contamination from dirt, sand, flies and insects. In the case of large size fish, it may be cut longitudinally into pieces of suitable size.

Ingredients for salted dried fish

Fish	:	1 kg
Salt (10%) (for brine solution)	:	160-350 g
Saturated salt solution (10 ppm chlorinated)	:	1 L
Calcium propionate (for saturated salt solution)	:	50 g

Method of Preparation

1. Wash and clean the fresh fish landed immediately in clean water or clean sea water to remove slime, adhering dirt etc.
2. Remove the gills and viscera (especially big fishes); clean and wash the fish.
3. Make a lateral cut along the center of the back bone and split open the fish.
4. Apply salt to fish in 3:1 to 6:1 ratio (fish to salt). The amount of salt may vary depending

on the size of the fish.

5. Keep salted fish for 1-2 days to absorb the salt properly.
6. Wash clearly the salted fish in saturated salt solution.
7. Immerse the salted fish in saturated salt solution containing 5% calcium propionate and 10 ppm chlorine for 2-5 minutes.
8. Take the fish out and allow the water to drain off.
9. Open/ sun dry the fish in clean and raised platforms/stacks/high racks till the moisture content reaches 25% or below. Otherwise mechanical drier can also use.
10. The fishes dried in this way will have shelf life of 6 months.
11. Pack the dried fish in good quality laminated pouches.

Preparation of Saturated Salt solution to immerse the Fish

Saturated salt solution (10 ppm chlorinated) : 1 L

Calcium propionate (for saturated salt solution) : 50 g

Note1: Small fishes (anchovy) can be dried without salting.

Note 2: Preparation of 10 PPM Chlorinated Saturated salt Solution - Add 350 gm salt to 1 liter 10 PPM chlorinated solution at room temperature and mix well to get required solution.

Note 3: Preparation of 10 PPM Chlorinated Solution - Add 116 µl (micro liter) of 8.58% Sodium Hypochlorite solution to 1liter water to get 10 PPM chlorinated (1 litre) solution. This can be upscale based on the requirements.

3. Dried Bombay duck

In the preparation of dried Bombay duck, the fresh fish as soon as it is landed is washed with clean water to remove all adhering impurities and hung in pairs on ropes between vertical poles, the jaws being used for locking in pairs. The fish is dried in the sun. It may also be dried in artificial dryers.



Figure: Drying of Bombay duck

4. Laminated Bombay duck

In the preparation of laminated Bombay duck, the fresh fish is thoroughly washed in clean water. The guts are removed and then washed well again. The gutted fish are suspended from a scaffold for surface drying for about 2 h. At this stage, remove the head, tail and fins using a sharp knife or scissors and split longitudinally along the belly portion. Bones can be removed if required. Dip the fish thus laminated in sufficient quantity of 1 percent brine (prepared from refined salt) for 20 min. Drain the fish and spread on drying racks to a moisture level of 16-17 percent. Flatten the product by means of a roller press. Trim the sides to get pieces of uniform size. Dry the product again for 1-2 h so that the final moisture content is about 15 percent. It is always advantageous to use a tunnel drier for drying the product to improve the quality of the finished product.

Problems associated with quality of dried fish

Spoilage	Causative Agent	Changes in Fish Quality
Dun Spoilage	Halophilic mould, <i>Sporendonema epizoum</i>	1. Development of brownishblack/chocolateoryellowbrown spotsareseenonthefleshy parts 2. Leads to breakdown of fat and proteinbesidesproductionofmycotoxins
Pink or red spoilage	Halophilic bacteria: <i>Halobacterium salinaria, H. cutirubum, Sarcina morrhuae, S. litoralis and Halococcus spp.</i>	1. Reddening of wet or partially dried salted fish 2. Appears as slimy pink patches on the surface of fish
Rancidity/ Rust Spoilage	Oxidation of fat in fatty fish	1. Colour of fish changes to brown 2. Also lead to loss of nutritional value, development of unpleasant odour and flavour
Case hardening	Over-rapid drying	1. Chalk-white appearance, and making fish hard and brittle
Insect manifestation	Blowflies during initial drying stages; beetlesespecially <i>Dermestess</i>	1. Making powdering of fish and bones only remain 2. Can be avoided by maintaining proper

	<i>pp.</i> ; mites such as <i>Lardoglyphuskonoi</i>	hygiene and sanitation
Fragmentation	Denaturation and excess dry in goffish	1. Fish can become brittle and is liable to physical damage when handled roughly
Presence of sand	Unhygienic drying	1. Sand particles and foreign matter

Spoilage in dried fish can be prevented by proper care and attention during processing, use of fresh quality raw materials, drying racks or solar drying of fish. Packaging of dried fish in clean plastic bags or any other dry suitable packaging material is advisable. Storage of fish in a place free from insects and rodents on raised and ventilated shady stores is advisable. Sodium sorbate/Calcium sorbate/Potassium sorbate (200mg/kg maximum either single or in combination expressed as sorbic acid) is in the list of permitted preservatives/food additive which can be used in salted fish in the Food Safety and Standards Authority of India (FSSAI) regulation. Treatment with sodium chloride and 0.1% citric acid prior to drying has shown to improve quality. Many spices and plant derived products have proven antibacterial, antifungal and antioxidant properties. Betel leaf extract can be used as a good substitute to chemical antioxidants in fish. Addition of 5 % turmeric in curing salt has been reported to improve the quality of dried white baits. But, these are not used on commercial basis, since the large quantity required to get the desired results may alter the characteristic odour, flavour and colour of the product.

Dry fish packaging

Packaging materials and products liable to enter into contact with fishery products should not impair the organoleptic characteristics of the fishery products; not be capable of transmitting to the fishery products substances harmful to human health; and be strong enough to protect the fishery products adequately.

Commonly used packaging materials for dried fish are palmyrah leaf baskets, coconut leaf baskets, bamboo baskets, newspaper baskets and gunny bags. None of them is an efficient packaging material. Since the packaging is permeable, the product absorbs moisture and gets soggy. It is seen that this fish is prone to attack by insects, rodents or other pests. The fish also arrive at the destination in an exposed condition. Hence, these packaging materials afforded least protection to the product.

For exports, dried fish is bulk packed in hessian sacks. Such packages do not provide protection from moisture absorption, oxygen or insects. Plywood boxes and waxed corrugated cartons are also used for packing large quantities. Dried fish should be packed in a sturdy container such as a wooden or cardboard box fitted with a lid in order to totally enclose the product. Open boxes, although protecting the fish from physical damage, are not effective against high humidity and insect attack. Properly sealed cartons, made from waxed or plastic coated board, should be sufficiently moisture proof and rigid enough to withstand rough handling. Dried fish, being highly sensitive product, needs to be packed in modern plastic based films/laminates and the possibility of vacuum packing/gas flushing of products also has been examined. Currently laminate films of polyester/polyethylene are mostly used for packaging of dried fish. Polyester films have good strength properties and reverse colour printing can also be done. Polythene is heat sealable and has good food contact application. HDPE woven bags laminated with 100 gauge LDPE are suitable for bulk packaging and LDPE or PP bags for small packaging are suitable for storing dry fish.

Reduced Oxygen Packaging (ROP) for dried fish

Reduced Oxygen Packaging (ROP) is the reduction of the amount of oxygen in a package by removing oxygen; displacing oxygen and replacing it with another gas or combination of gases. It includes vacuum packaging and modified atmosphere packaging. Vacuum packaging (VP) can be effectively used to reduce fat oxidation. Modified atmospheric packaging includes packaging of fish with a mixture of gases based on the composition and fat content of the fish.

Indian Standard Specifications for Salted/ salted dried fish

Quality standards for dried fish products as recommended by Bureau of Indian Standards (BIS)

Indian Standard (IS 14950:2001) fish-dried and dry-salted-specification

Product	Moisture (Percent by mass), Max	Sodium chloride (on moisture free basis), percent by mass	Acid insoluble ash (on moisture free basis), percent by mass, Max
Dry-SaltedCatFish	35	25 (min)	1.5
Dry-SaltedDhoma	35	10-15	2

Dry-SaltedHorseMackerel	35	25-30	1.5
Dry-SaltedThreadfin(Dara)	40	25 (min)	1.5
Dry-SaltedLeatherJacket	35	25-30	1.5
Dry-SaltedMackerel	30	25-30	1.5
Dry-SaltedJewFish(Ghol)	40	25 (min)	1.5
Dry-SaltedSeerFish	35	25-30	1.5
Dry-SaltedShark	35	25-30	1.5
Dry-SaltedSurai(Tuna)	35	20-25	1.5
Dried Bombay Duck	15	7.5 (max)	1.0
Laminated Bombay Duck	15	6 (max)	1.0
Dried Fish Maws	8	-	1.5
Dried Prawns	20	5 (max)	1.0
Dried Shark Fins	10	-	1.5
Dried White Baits	15	2.5 (max)	1.5

Quality standards for dried fish products as recommended by FSSAI

Food Safety and Standards (Food Products Standards and Food Additives) Amendment Regulations, 2016

According to FSSAI standards, dried, salted and dried products means products prepared from fresh or wholesome fish after drying with or without addition of salt, the fish shall be bled, gutted, beheaded, split or filleted and washed prior to salting and drying, salt used to produce salted fish shall be clean, free from foreign matter, show no visible signs of contamination with dirt, oil, bilge or other extraneous materials, the product shall be free from foreign matter, objectionable odour and flavour, the product shall conform to the microbiological and chemical requirement as laid down in the regulations. Characteristics requirements include water activity level at 25 °C of less than 0.78; salt content not less than 12%, histamine content (max) up to 200 mg/kg and acid insoluble ash on dry basis not more than 1%.

Food additives for use in salted fish (Appendix A: List of Food Additives) in Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2016: Sodium sorbate/Calcium sorbate/Potassium sorbate (200 mg/kg maximum singly or in combination expressed as sorbic acid)

Microbiological requirements for salted fish or dried salted fish include; total plate count <5 lakh/ g, *E. coli*<20/g, *S. aureus*<100/g, *Salmonella*, *Shigella*, *Vibrio cholerae* and *Vibrio parahaemolyticus* all absent in 25 g.

Novel drying techniques

Other than conventional drying, there are various techniques which may be used for fish drying which includes microwave assisted drying, high electric field drying, infrared drying, heat pump drying, ultrasonic vacuum drying as novel techniques which can reduce drying time and improve product quality.
