

PRACTICAL METHODS FOR PRESERVING SEAFOODS

SALTING AND DRYING (A Training Manual)

> WOMEN'S FISHERIES DEVELOPMENT SECTION South Pacific Commision Noumea, New Caledonia

> > Canadian International Development Agency

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SALTING AND DRYING

(A Training Manual)

(photo of women processing

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Original text: English

South Pacific Commission Cataloguing-in-publication data

Prepared for publication by Pasifika Communications Ltd in collaboration with the SPC Women's Fisheries Development Project, and printed by Pasifika Communications Ltd, Suva, Fiji,

ACKNOWLEDGMENTS

The contents of this training manual have been compiled mainly from lecture notes and practical sessions used as part of a national workshop organised by SPC's Women's Fisheries Development Project. The workshop titled *"Improved Seafood Management Skills for Women in Ha'apai, Vava'u and Tongatapu"* was held in Tongatapu, Kingdom of Tonga from the 3 to 7 June 1996.

For their contribution to the production of the manual, I would like to thank the following SPC personnel: Steve Roberts, Postharvest Fisheries Adviser, for his technical expertise and support in providing additional information and reviewing the content of the text, Terii Luciani of the Fisheries Information Section for providing his skills in artwork; and Caroline Nalo and Jim Thompson of the Publications Section for their editing skills.

I am also greatful to Dale Hermanson and Glen Hughes of Pasifika Communications Ltd, Fiji, for the editing, layout, graphics, printing and binding of the manual.

I thank Mr M.Uno, of Yamaha Motor Corporation Ltd, for permission to use the illustrations on drying, wet salting and dry salting that are found in the Appendicies. The illustrations are taken from the booklet *Handling and Processing Fish for Your Richer Life* produced by Yamaha Motor Corporation Ltd.

Publication of this manual has been made possible by the financial support of the Government of Canada, to whom the South Pacific Commission would like to express its sincere appreciation.

Patricia Tuara Women's Fisheries Development Officer

TABLE OF CONTENTS

Manual objectives Resource material Introduction	3 4 5
LESSON ONE	
Processing seafood	6
1.1 Types of processing1.2 Why process fish and shellfish?	6 7
LESSON TWO	
Fish spoilage	9
2.1 What causes fish spoilage?2.2 How do you minimise spoilage?	9 11
LESSON THREE	
The process of salting as a means of preservation	13
 3.1 How does salt preserve fish? 3.2 How should fish be prepared for salting? 3.3 Salting methods 3.3.1 Wet salting 3.3.2 Dry salting 3.4 How do you cook salted fish? 3.5 Since of spoilage in salted fish 	13 13 14 14 16 17
3.6 Preventing spoilage	18
LESSON FOUR	
The process of drying as a means of preservation	20
4.1 How should fish be prepared for drying?4.2 Methods of drying	20 21

4.3 Measuring the drying rate of fish234.4 How do you cook dried fish?244.5 Signs of spoilage in dried fish244.6 Preventing spoilage24

LESSON FIVE	
Practical exercises in salting and drying	26
5.1 Wet salting of fish5.2 Dry salting of fish5.3 Fish jerky5.4 Spicy dried clam5.5 Spicy dried squid	26 27 28 29 30
CONCLUSION	31
GLOSSARY	32
REFERENCES	33
AUDIO-VISUAL OVERHEAD TRANSPARENCY AIDS	

PRACTICAL METHODS FOR PRESERVING SEAFOODS

MANUAL OBJECTIVES

After studying this training manual, participants should be able to:

- 1. Understand that preservation is one of a number of ways for processing seafoods;
- 2. Identify the main causes of fish spoilage and explain how salting and drying reduce spoilage;
- 3. Describe the steps in carrying out salting and drying, paying particular attention to ensuring careful handling of the raw material during preparation, processing and storage;
- 4. Identify and prevent fish spoilage due to incorrect preservation methods.
- 5. Preserve fish and shellfish by carrying out practical exercises in salting and drying.

RESOURCE MATERIAL

Overhead transparencies

- AV 1 Processing seafoods
- AV 2 Wet salting (brining)
- AV 3 Dry salting
- AV 4 Signs of spoilage: Reducing spoilage
- AV 5 Drying fish
- AV 6 Signs of spoilage in dried fish: Reducing spoilage

Ingredients and equipment for practical exercises

Raw materials

lean fish such as snapper, or parrotfish, vellowfin tuna, kingfish,	<u>Equipment</u>
marlin or swordfish	knife
clams	large spoon
squid	chopping board
salt	mixing bowl
sugar	frving pan
soy sauce	applying part
lemons	cooking pot
	storage container with lid
Flavour enhancers	drying tray

Flavour enhancers

garlic pepper chillies ginger mixed spices How to preserve seafood so that it can be stored over a period of time is a question that is often asked by women in many island countries. At times, more fish and shellfish may be harvested than can be consumed. At other times, there is the need to store food for consumption during periods when resources are scarce, such as following a cyclone.

The purpose of this manual is to provide information on how to prolong the shelf life of seafood, keeping it in good condition for later consumption. Focusing on the two preservation methods of **salting** and **drying**, the manual aims to teach the principles and methods of both techniques.

Written as a training guide for trainers, the manual features detailed information, practical exercises, audio-visual teaching aids and photos.



PROCESSING SEAFOOD

Once a fish has been caught it passes through a number of processes or stages before it is consumed or sold for consumption.

PRACTICAL EXERCISE

At this point you may ask the participants to list the types of processes they know. This can be written on an overhead transparency, and added to. AV 1 in the appendices has the full list which can be put onto an overhead. The point to make is that fish passes through a number of processes (depending on the required final form) before it is consumed.

1.1 Types of processing

These processes may include the following:

washing cleaning heading gutting grading filleting de-boning skinning chilling freezing gilling and scaling finning salting drying smoking canning marinating packaging

These processes can be divided into primary processing and secondary processing.

Primary processing includes the steps that enable fish to be stored or sold for further processing, packaging and distribution. These steps are in the first column above.

Secondary processing includes the production of 'value-added' products. Such processes are in the second column.

1.2 Why process fish and shellfish?

There are a number of reasons for processing fish/shellfish. Five reasons are provided below:

1. To supply food that is safe to eat

To ensure that the fish and shellfish you consume at home or sell at the market are safe to eat, they must be washed, and gutted thoroughly to remove all dirt and slime. Shellfish (as filter feeders which may be found in polluted waters) must be left overnight in water to clean out any internal impurities. Fresh water shellfish should be kept overnight in fresh water, while marine shellfish must be kept overnight in clean sea water.

2. To minimise loss/waste of a valuable food commodity

In many island countries, seafood may be one of the few food items which provide the protein requirements within a diet. Care must be taken to ensure that the preparation of fish and shellfish is carried out correctly to ensure that there is no loss or waste of this important source of nutrition.

3. To meet quality standards and consumer preferences

When processing food for the consumer, you must pay attention to hygiene in the handling of the seafood. You can then be assured that the food you provide for consumption is of a high standard. At the same time, when preparing the seafood, you may need to take into consideration definite preferences on the type of seafood the consumer will eat. For example, whereas smoked or salted fish may be an important food item in the diet, clams may not be.

4. To sell and make a profit by adding value and increasing convenience to the consumer

Value can be added by removing a part or parts from the body of the fish/shellfish. For example, removing the scales from a fish, or removing the shell from a shellfish may increase their selling price and will reduce the preparation work of the buyer. Alternatively, value can be added by adding ingredients in the preparation of seafood. By marinading to modify flavours, adding breadcrumbs and spices, the seafood can be converted into fish jerky, fish fingers, spicy dried clam, or fish cakes. This will provide the consumer with a variety of seafood dishes.

5. To extend the shelf life of the foods so that the food can be made available out of season or when it is not possible to catch or purchase fresh food

Seafood can be processed to extend its shelf life. Chilling is a method of processing which is used to preserve the life of fish and shellfish. Keeping the fish at low temperatures slows the rate of growth of bacteria and slows spoilage rates. In addition, the processing of seafood through salting, drying, or smoking can preserve the food, enabling it to be stored and used when necessary.

Processing as a means of preserving seafood is the topic which we will be concentrating on in this training manual.

LESSON TWO

FISH SPOILAGE

We noted in the previous section, that one of the reasons for processing fish and shellfish is to preserve the seafood so that it has a long shelf life. In island countries where there may be times when food is scarce, as in the case of damaged crops due to cyclone weather, there may be a need to store food supplies.

The aim of preservation is to maintain food quality and nutritional value over a long period of time by preventing spoilage.

2.1 What causes fish spoilage?

Spoilage is brought about by 3 destructive processes:

- enzymic decomposition,
- bacterial action,
- oxidation.

Enzymic decomposition

Enzymes are powerful biological chemicals that occur in the tissue of all living animals. They perform important functions, either by breaking down large food compounds into smaller ones in the stomach and gut, as in digestion, or, by helping to make new compounds for building new body tissue or for producing energy. In the living animal the body keeps a close control on what enzymes do. However when the animal dies this control is lost. The enzymes will start attacking the flesh of the body, breaking large compounds down to smaller ones, just like the process of digestion.

Enzymes can only operate in the presence of water. They are also sensitive to temperature. The preferred temperature is the ambient temperature, that is, they like it warm. In the tropics this can be in the range of about 20 to 35° C.

Bacterial action

Bacteria or germs are tiny living organisms that are found everywhere in nature. They are so small that millions can exist in an area the size of a pin head. Most people associate bacteria with harmful diseases and sicknesses. But they are not all bad. They are, however, a problem in the handling of food--not only do they spoil food, but they can cause food poisoning.

POINTS TO NOTE!

It is important to know that harmful, food-poisoning bacteria are not found on fish in their natural home in the water. It is when they come into contact with dirty, uncleaned surfaces and are poorly handled that they can pick up the potentially dangerous, food-poisoning bacteria.

Fish carry millions of bacteria on their external surfaces (skin and gills) and in their intestines. A healthy, living fish uses its natural defence mechanism to protect it against the harmful effects of bacteria. However, when the fish dies, the defence mechanism stops working. This allows the bacteria the opportunity to feed on the flesh, multiply in their millions, and eventually spoil the fish.

Conditions which allow bacteria to multiply are:

- ambient temperatures,
- · presence of water,
- a source of food.

Bacteria will enter the flesh easily if the fish has been damaged through improper handling and storage (e.g. if the skin of the fish is damaged, or the guts of the fish are not all removed).

Oxidation

Rancidity is a more widely-used term for oxidation. It occurs when oxygen in the air reacts with oil or fat in the flesh of the fish. This leads to a sour or stale, unpleasant smell or taste. (Many people in the Pacific may recognise this phenomenon: when copra is dried in the sun it often develops a strong, unpleasant smell. This is brought about by oxidation).

Fatty **pelagic** fish like skipjack, scads and sardines store fat in their flesh and can turn rancid quickly if not handled and stored properly.

White-fleshed demersal fish store fat in their livers, so these must be

POINTS TO NOTE!

The agents causing spoilage:

- 1. are present in the seafood when it is harvested,
- 2. can be introduced while handling the food during the preservation process,
- 3. can be introduced during the storage of the food before and after processing.

removed during gutting.

When frozen, fatty fish are stored improperly they can still spoil through oxidation, even though the temperature is too low for bacteria to grow or enzymes to work effectively.

2.2 How do you minimise spoilage?

In the previous section we considered the factors that allow fish to spoil. In order to minimise spoilage, it is necessary to combat the effects of enzymes, bacteria and oxidation. By understanding the conditions that they prefer, we can create the opposite condition which helps to preserve and protect the food. For example, we know that bacteria and enzymes work best at ambient temperatures. If we change the temperature by lowering it, as in chilling or freezing, the food can be stored for much longer. Let's consider this in more detail:

Bacteria and enzymes like ambient temperatures and need to operate in the presence of water. They do not like low temperatures, or very high temperatures. They do not like to work in dry conditions. Many processing procedures in fact create the conditions that bacteria and enzymes do not like.

- 1. Lowering the temperature: Chilling food in the refrigerator or with ice slows down the destructive processes of enzymes and bacteria. The shelf-life of food can therefore be extended by many days. If we lower the temperature further, as in freezing, much longer storage times of many months are possible because all bacterial action and virtually all enzymic action is stopped.
- 2. Raising the temperature: High temperatures kill bacteria and destroy enzymes. Processes such as cooking (boiling, frying, baking, etc.), hot smoking, canning, pasteurising and so on extend the keeping time of the food.
- **3. Drying or dehydration:** Removing water from the food by drying it in some way is an effective method of stopping bacteria and enzymes from spoiling food. Drying can take place under the sun and wind (natural drying) or in a mechanical drier. Salting helps the drying process too, as it binds the water, making it unavailable to bacteria. Some high-temperature processing such as hot smoking uses a combination of drying and high temperatures to control bacteria and enzymes.

To stop oxidation of fatty fish we must protect the product so that oxygen in the air can not reach the product. The simplest way to do this is to pack the fish in plastic bags that do not allow air to pass through. In addition to the use of preservation methods mentioned above, spoilage can be reduced through **careful handling** and **storage** practices.

Careful handling of fish means that at all stages, it is important to prevent damage to the fish.

Safeguard against:

- bruising the flesh,
- breaking the skin,
- damaging the guts.

Any form of damage enables bacteria and enzymes to enter and contaminate the fish. Practising good hygiene through the use of very clean hands and clothing, equipment and work spaces is essential when handling seafood.

When packing fish, care must be taken to prevent damage through overpacking. In addition, when storing chilled fish, the chill-store temperature should be as close to 0 degrees Celsius (0°) as possible. At the same time the storage room should be kept clean and tidy and free from contamination.

LESSON THREE

THE PROCESS OF SALTING AS A MEANS OF PRESERVATION

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, with salt and fish, and sometimes water, as the only ingredients. 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.

3.1 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.

3.2 How should fish be prepared for salting?

First, we must use raw material of the best quality to make the best products. Stale or spoiled fish cannot be improved (or saved) by any form of processing, and that includes salting.

To salt effectively, fish must be prepared so that water removal and salt uptake can take place quickly and easily. The following guidelines should therefore be followed:

- the thickness of flesh of the fish must not be more than 25 to 30 mm (about 1 inch);
- small, whole fish need only be gilled and gutted if they are thinner than this;

- medium-sized fish should be split through the back, then gilled and gutted;
- large fish can either be filleted, with the skin left on or split and the flesh scored deeply at 25mm (1 inch) intervals;
- very large fish must be filleted and the flesh cut into 25 mm (1 inch) strips;
- it is best to scale the fish, because the removal of water and penetration of salt will be easier.

3.3 Salting methods

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

3.3.1 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.

POINT TO NOTE!

When using the wet method, it is best to use a fine salt that dissolves faster. Large crystals can be ground to make them smaller and easier to 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.

POINT TO NOTE!

Fatty fish are best salted using the wet method. Recommended fish are mackerel and sardine.

After the fish has been prepared according to its size, it must be cleaned and put in the brine. Place a clean piece of wood weighed down with clean stones on top of the fish to keep the fish below the surface. 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.

Pickle curing entails preparing the fish as before. The fish are then laid alternately with dry salt in a water-tight container, such as a plastic container, using a fish-to-salt ratio of **1 part fish to 0.3 or 0.4 parts salt by weight**. That is, for 10 kg of prepared fish you **MUST** use 3 to 4 kg of clean, dry salt. If less salt is used, then the fish will spoil.

Start by weighing the fish. Calculate how much salt is needed and weigh out this quantity of salt. Place a layer of gutted, opened and washed fish pieces flat on the salt, flesh side down. In other words, flesh to flesh and skin to skin. After each layer of fish sprinkle on a thin layer of salt. Keep placing a layer of fish then a thin layer of salt until all the fish and **ALL** the weighed salt is finished. 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.

TEACHING HINT

To summarise the steps in wet salting, put up the overhead transparency (AV. 2). The transparency shows a graphic description which can be used to go over the main points, before beginning the practical exercise.

PRACTICAL EXERCISE

Prepare the ingredients/equipment for the 'Wet Salting of Fish' practical exercise section in 5.1. Depending on the size of the class, divide into groups of 3 or 4 for the exercise.

3.3.2 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, you need 1 part of salt. 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. Alternatively, fish can be layered with salt in a woven basket, with the pickle draining through the holes between the woven material. The fish should be restacked, or re-packed, every 24 hours, so that the fish previously on top now end up on the bottom. More salt should be added as required. This is done to provide uniform salting and pressure which helps squeeze water out of the fish. Salting time varies from three days to a week, depending on the type and size of fish.

POINTS TO NOTE!

To ensure that fish dries well, dry salting is ecommende for lean fish, not fatty fish. Recommended fish are barracuda, parrotfish, snapper and shark.

To ensure effective salting, a combination of 1/3 small salt crystals (1 mm in size) and 2/3 large salt crystals (3-5 mm in size) should be used

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

while in storage. 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.

TEACHING HINT

Use the overhead transparency (AV. 3) to summarise the steps in the dry salting of fish.

PRACTICAL EXERCISE

Prepare ingredients/equipment for the 'Dry Salting of Fish' practical in section 5.2

Divide the class up into groups of 3 or 4 people to carry out the practical.

3.4 How do you cook salted fish?

The concentration of salt is so high in salted fish products that it is necessary to remove much of the salt before the fish is cooked. This can be done by putting salted fish in clean, fresh water, for a minimum of 12 hours. The water will need to be changed about 3-4 times to encourage the removal of salt. Remember, the fish which has been soaked in this way will also have taken up some water. Without the presence of the high concentration of salt, the fish is now not preserved, and can spoil, just like fresh fish, in a very short time. So only soak enough fish for your family's needs', then it can all be cooked soon after the salt has been removed.

TEACHING HINT

Use overhead transparency (AV. 4) as a guide when discussing the spoilage of salted fish.

3.5 Signs of spoilage in salted fish

1. Reddening

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. 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.

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.

3.6 Preventing spoilage

In order to prevent spoilage, care and attention must be used in 3 areas:

1. 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.

Water Use clean water.

2. Processing methods

- *Hygiene* Ensure that hands, clothing, cooking utensils and work surfaces are perfectly clean.
- *Time* Take note of the time required for each step of the salting process.

Quantity of Pay attention to the amount of salt or brine/fish salt or brine weight ratio.

Containers Containers must be clean, and possess a secure lid.

3. Handling of finished products

- *Packaging* Dry salted fish can be enclosed in clean/dry plastic bags or wrapped and secured inside dry banana leaves.
- Storage 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.



THE PROCESS OF DRYING AS A MEANS OF PRESERVATION

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.

Drying of fish takes place in two phases:

- 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. Drying will proceed more rapidly at higher temperatures;
- iv) water content. The higher the water content, the longer the time of drying.

Dried products are not always as popular as they used to be and it is very difficult to market such products to consumers who are not familiar with eating them. It is possible, however, to produce some more interesting dried products by the addition of other ingredients to the fish in the form of a marinade. This marinated raw material can then be dried. In the practical exercises we include a recipe for fish jerky, which involves the soaking of fish in a marinade of spices and soy sauce, followed by drying.

4.1 How should fish be prepared for drying?

As with the preparation of fish for salting, fish selected for drying must be as fresh as possible. If ice is available, the freshly-caught fish should be placed on ice until it is required for processing. If no ice is available, clean the fish with fresh or sea water, place it in a clean box and cover it with a wet cloth or mat to protect it from sunlight, dust and flies. However, without ice, the fish will need to be processed as soon as possible.

The fish most suitable for drying are lean fish and fish with a low fat content, such as tilapia, shark and most white-fleshed fish.

POINT TO NOTE!

Do not use fatty fish such as mackerel, sardines, anchovies, or tunas such as skipjack, for drying. They usually become rancid during the drying process because of fat oxidation.

Fish must always be gutted before drying. Depending on the size of the fish it can be prepared in several ways:

- large fish, like shark, should be cut into strips or small rectangles to ensure adequate drying;
- small fish need only be gilled and gutted before drying;
- small fish and fish which have been cut into strips can be dried, hanging from a rod;
- racks (flat wire-mesh racks and vertical hanging racks) can be used to dry fish which have been split down the back bone. Such racks ensure that the fish is evenly dried all over.

POINT TO NOTE!

Never dry fish on the ground. It will take longer to dry, and will be contaminated by dust, dirt, flies and rodents.

4.2 Methods of drying

Drying of fish is most often done using sun drying or mechanical dryers.

Very small, thin fish can be dried straight away in the sun if they are brought in early enough in the morning, and the sun is shining. If these conditions are not fulfilled, the fish must be put for one night in brine, or dry salted. They can then be dried the next morning. If it happens to be raining the next day, it is necessary to wait until the weather has cleared up. In this latter case it will be necessary to wash the salt away from the fish by soaking it in fresh or salt water for a couple of hours before drying; this depends again on the tastes of the consumers and on the purpose for which the fish is cured. If it rains while the fish are drying, the fish must be kept dry by covering or transferring them under shelter. If fish are laid on racks to dry, it is best to turn them over every two hours so that they will dry quickly. In the case of large fish, hanging is better if they are merely split. A stainless steel rod is passed through the eye sockets or the mouth and gills of the fish, so that fish are suspended about 5 cm space from each other in a line.



A mechanical dryer being used to dry fish jerky strips

Normally the fish will be dried after three to four days. If a great quantity of fish has been dried and is to be kept for some time, the best way is to pile it up in a dark place, off the ground and preferably on wooden boards. It should then be covered with a sack or mat. After a fortnight the fish should again be laid in the sun for one or two hours and then put away as before.

Drying racks can be made from bamboo, or wood. One flat rack raised on legs can be used. One layer of fish is then laid on top of the rack. Alternatively, domed shaped racks featuring 2 sloping sides of wooden slats meeting at a point can be used. For the dome rack, the fish can be suspended from nails attached to the slats so that they are hanging vertically. Make sure the gaps between each slat are wide enough to avoid the fish touching each other. The fish can be protected from insect and bird attack by placing a net over the drying rack.



1. At ground level air moves slowly. At a height of one metre or above the ground, air currents are stronger;

2. Racks allow air to circulate around the product and increase the drying rate;

3. Fish are less likely to be consumed by domestic animals such as **rodents** and insects;

4. Fish are kept cleaner because they cannot come into contact with dirt on the ground;

5. Sloping racks allow excess water to drain away from the gut and gill cavities;

6. Fish can be easily protected from rain since they can be covered with plastic or other water-proof material.



Wet salted reef fish is left to dry in the sun on covered mesh trays.

Mechanical dryers allow drying regardless of weather conditions and produce a more uniform product. The cost of mechanical dryers is quite high and so their use tends to be limited to commercial processing plants.

4.3 Measuring the drying rate of fish

When drying unsalted fish, an easy way to check water loss is to weigh the fish before and after drying:

- lean fish, such as shark and grouper, should lose 75 76% of their original weight;
- medium, fatty fish, such as tilapia should lose 72 73% of their original weight;
- fatty fish, such as sardine and mackerel, should lose 67 68% of their original weight.

If the weight reduction takes longer than 2 - 3 days, under good drying conditions, the fish is too thick. It must be filleted or cut into strips before drying.

If weight reduction is so slow that the fish spoil, the fish will have to be discarded.

TEACHING HINT

Use the overhead transparency (AV. 5) as a summary of the steps in the drying of fish.

3 PRACTICAL EXERCISES

There are 3 recipes to carry out here: Fish Jerky (recipe found in section 5.3), Spicy Dried Clam in (5.4), and Spicy Dried Squid (5.5). The teacher must ensure that there are sufficient drying trays/racks for the products. The group can be divided into 3 smaller groups, each concentrating on one recipe.

4.4 How do you cook dried fish?

Dried fish can be used in the same way as fresh fish if it is soaked for 2 - 3 hours before cooking. A properly dried fish can contain up to 80 per cent of its weight in protein. There are very few foods with this characteristic.

4.5 Signs of spoilage in dried fish

TEACHING HINT

Use the overhead transparency (AV. 6) as a guide when discussing 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.

4.6 Preventing spoilage

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.

If you pay particular attention when processing, transporting and storing dried fish, you can be sure of a good-quality dried-fish product. The dried fish will remain edible for a long time. It will satisfy both your family, and, if for sale, will attract and keep customers.

SECTION FIVE

PRACTICAL EXERCISES IN SALTING AND DRYING

Please take note that these practical exercises have been carried out under workshop conditions. The quantities of ingredients used are small scale for domestic production (for the family) rather than large scale for commercial production.

5.1 Wet salting of fish

Materials:

medium and large fish salt chopping board knife drying tray dish or bowl

Procedure:

- 1. Prepare saturated brine solution. Mix 4 parts of clean water to 1 part of salt (for example, 4 cups of water to 1 cup of salt) in a large bowl. Keep adding salt to water until no more salt will dissolve.
- 2. Wash and remove dirt. Scale fish and split at the back (dorsal side). Remove all internal organs.



The fish is split down the backbone and soaked in a brine mixture.

- Wash split fish to remove blood and dirt. Make sure to scrub out the kidney and belly linings.
- 4. Soak fish in brine for 2 3 hours (depending on the size of the fish and the preference of the consumer).
- 5. Stir the brine from time to time to prevent it from becoming diluted at certain localities.
- 6. Remove fish from brine and rinse in fresh water.
- 7. Drain properly and dry on drying racks (flesh-side facing upwards)
- 8. Put trays on rack and place fish under the

sun for 2 - 3 days or until dry. Turn fish every hour or two to have uniform drying.

9. Cool fish and place in baskets lined with dry banana leaves or in plastic bags. Store in a cool, dry place.

5.2 Dry salting of fish

Materials:

1 kg lean fish

300 - 400g clean salt

(such as snapper, parrotfish, barracuda, or shark cut into strips) (a mix of 1/3 small salt crystals approx 1 mm in size and 2/3 large salt crystals approx. 3-5 mm in size). wooden box storage container (should have 1/2 cm side openings between slats to enable liquid to drain away)

knife

Procedure:

- 1. Remove the scales and internal organs from the fish. Wash thoroughly and drain.
- 2. Place a layer salt at the bottom of the tray.
- 3. Rub fish with salt and place on top of the layer of salt. Sprinkle the fish with sufficient salt to cover it.
- 4. Fill up the container with fish/salt layers.
- 5. Put enough salt on top of the last layer to ensure the fish is covered completely.



The fish is completely covered in salt. In this 'classroom demonstration' the fish is placed in a plastic storage container. However when carrying out the recipe at home, a wooden box with side openings should be used, as described in the recipe.

6. Cover the container properly and store at room temperature.

Some people like the salty taste of fish prepared this way, but it is always possible to wash the salt from the fish by soaking in fresh water before use.

5.3 Fish jerky (Fish soaked in a marinade and dried)

Materials:

• Marinade: (for 1litre, mix together the following, ensuring sugar and salt are dissolved)

1 litre (2 pints) soy sauce Juice from 5 - 6 lemons 150 g (6 oz) sugar 50 g (2 oz) salt

Add the following finely ground flavourings and spices according to taste:

garlic, pepper, chillies, ginger, mixed spices.

 At least 5kg or 11lbs of fresh fish (yellowfin tuna, kingfish, marlin, or swordfish)

knife large spoon chopping board mixing bowl

Procedure

- 1. Prepare the marinade.
- 2. Fillet or loin the fish, remove the skin and carefully trim away the dark red muscle.
- 3. Cut thin slices of fish flesh along the length of the fillet to a thickness of about 5 mm (1/4 inch).
- 4. Wash the slices in lightly salted water, then place them in the marinade. Either use a plastic container with a good sealed lid or put the mixture of fish and marinade in plastic bags, one inside the other. Secure with a knot or an elastic band
- 5. The fish slices must be completely covered by the marinade and left to soak for about 1 1/2 hours with occasional mixing. If a stronger flavour is preferred, leave the fish to soak for a longer period.
- Remove the marinated fish after the required time and wash quickly in fresh water to remove the brown colour of the soy sauce from the surface.

- 7. Drain well and lay the strips on a mesh tray. Place in a sunny and windy spot for one or two days. The time it takes for the product to dry will depend on the weather. An alternative method is to dry the fish in a warm oven with a fan switched on to produce good air circulation, at a temperature no greater than 40 degrees celsius. Turn the fish strips over regularly.
- 8. The marinated fish is ready when the flesh is completely dry and has a reasonably tough and chewy texture.

Store in sealed plastic containers, bags or glass jars, in a cool place. The product is preserved and therefore requires no refrigeration. It should keep like this for many weeks or months.



Strips of tuna fish are added to the marinade.

5.4 Spicy dried clam

Materials:

clams sugar salt ground pepper mixing bowl cooking pot drying tray

Procedure:

- 1. Boil or steam clams to remove from shells.
- 2. Wash to remove dirt.
- Drain and mix well with ingredients. (For every 1 kg clam meat, add 3 tbsps sugar, 1 1/2 teaspoons salt, and 1 1/2 teaspoons pepper.)





After the clams have been coated with the spices, they are laid on a tray for drying.

5.5 Spicy dried squid

Material:

squid pepper (ground) salt sugar knife frying pan drying tray

Procedure:

- 1. Split squid and remove head and internal organs. Peel off the skin.
- 2. Wash and cut into strips (2 cm wide).
- 3. Mix with ingredients. (For every 1kg of strips, add 3 tablespoons sugar, 1 teaspoon pepper, and 1 teaspoon salt).
- 4. Let stand for 30 minutes, then boil for 3 minutes.
- 5. Drain well and spread on a tray. Dry until chewy. Make sure the tray is above the ground on a box or stand, and is covered with secured wire mesh to keep away flies and rodents.

CONCLUSION

Preserving seafood does not require costly ingredients and complicated technology. This manual has shown how to keep fish and shellfish edible over a period of time, using basic ingredients and equipment. Often all that is needed is the fish/shellfish, water, salt, cooking utensils and drying racks.

However, **care** must be taken during **every step** of the process. By paying attention to the rules of hygiene, careful handling and processing, packaging and storage, you can produce good-quality dried and salted products which have a long shelf life.

GLOSSARY

Ambient temperature	-	degree of heat or coldness in the outside air
Bacteria	-	germs
Cured	-	fish which has been preserved by drying, smoking, pickling; or a combination of these methods; or preserved using vinegar. Fish which is refrigerated or canned is not cured.
Dehydrated	-	dried due to removal/loss of water
Demersal fish	-	fish living on the floor of the ocean. Includes flounders
Enzymes	-	biological chemical substances produced by living cells which speed up reactions in the body
Evaporate	-	lose moisture to the atmosphere
Halophilic bacteria	-	salt loving germs
Marinade	-	mixture of spices, oils and sauces used for flavouring food
Pelagic fish	-	those species of fish which normally live in the upper part of the water column
Primary processing	-	first processing of a fish which enables consumption, storage or selling. Includes washing, gutting, de-boning etc.
Rancidity	-	state of smelling or tasting badly (like stale fat)
Rehydration	-	taking up water
Rodents	-	rats and mice
Saturated	-	soaked thoroughly. No more of the substance can be added
Secondary processing	g-	the second stage of processing, includes salting, drying, canning, smoking, marinating
Shelf life	-	expected amount of time a seafood product remains in high quality condition for consumption
Solar salt	-	salt obtained from the sea

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Processing seafoods

Primary processing

Secondary processing

washing cleaning heading gutting grading grading de-boning de-boning chilling chilling freezing gilling scaling finning

salting

drying

smoking

canning

marinating

packaging

AV.2





Source: Yamaha Motor Co., Ltd.

AV. 4

Signs of spoilage in salted fish

- 1. Reddening
- 2. Dun
- 3. Souring
- 4. Salt burn
- 5. Sliming

Reducing spoilage

- 1. Raw material
- 2. Processing methods
- 3. Handling of finished products



Source: Yamaha Motor Co., Ltd.

AV.5

Signs of spoilage in dried fish

- 1. Case hardening
- 2. Mould growth
- 3. Reddening

Reducing spoilage

- 1. Processing
- 2. Transport
- 3. Storage