Seafood Processing

By

Tony Chamberlain
and
Gabriel Titili

With contributions from

Irene Novaczeck
and
Johnson Seeto

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Project Leader
Tony Chamberlain
Marine Studies Programme
The University of the South Pacific
PO Box 1168
Suva, FIJI ISLANDS
Email: chamberlain@usp.ac.fj

Project Team
SPC Noumea Coordinator - Lyn Lambeth
CETC Coordinator - Nu'ufou Petaia
Project Advisers - Gabriel Titili, Irene Novazcek
USP Coordinator - Samasoni Sauni
Editors - USP: Fred Mills, Karen Chamberlain; SPC: Kim Des Rochers

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Preface to the Series

The majority of Pacific Island countries rely on the sea as a major source of food. While women are not involved in offshore deep sea fishing, they are active in collecting and gleaning shellfish and other edible sea species from the nearshore areas and inside the reef. Women also prepare fish either for sale or home consumption. In this preparation process, women are involved in cleaning, gutting, cooking and selling various seafoods. In many atoll countries, women are also involved in the preservation of seafood by drying or smoking. In view of women's role in fisheries activities and the importance of seafood in the region, it is vital that women learn not only the correct handling methods for seafood, but also how to use marine resources wisely for the future.

This manual is part of the Community Fisheries Training Series, and is designed to meet the wide need for community fisheries training in the Pacific, particularly for women. The series was originally developed for the SPC Community Education Training Centre (CETC). The fisheries course at CETC began in 1999 as a joint effort with the USP Marine Studies Programme. It was a response by the Centre to meet the needs of women in the region to improve their skills in small-scale fisheries activities. The USP Post Harvest Fisheries Project was also working to provide post harvest fisheries training for men and women in the region; hence the joint venture between the two institutions in 1999. The two groups of women who have since been through the course have found the training interesting and useful.

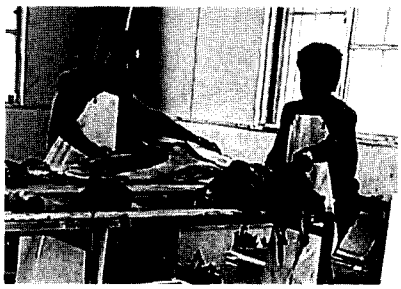
Since its inception in 1999, the course has been taught jointly by the USP Marine Studies Programme staff in Fiji Islands and the SPC Community Fisheries Section staff based in New Caledonia. Funding has come from Canada, New Zealand, Australia and the International Ocean Institute - Pacific Islands.

I wish to acknowledge the assistance of and major contribution by Tony Chamberlain, Lecturer of the USP Marine Studies Programme/Post Harvest Fisheries Project; Patricia Tuara, previous SPC Community Fisheries Adviser; Lyn Lambeth, SPC Community Fisheries Officer and other trainers in previous years.

I am grateful to the Marine Studies Programme technical staff who have given their time to training women and also the USP for facilities and equipment used during the course. I acknowledge Dr Jimmie Rodgers, Senior Deputy Director-General of SPC in Suva and the SPC Management for supporting CETC, by providing facilities and resources towards the implementation of the Fisheries course. We hope you enjoy this manual in the series.

Best wishes for a successful fisheries training programme.

Nu'ufou Petaia
Principal
SPC Community Education Training Centre (CETC) Narere, Fiji Islands
March 2001



Primary processing

Chapter One - Primary Processing

Introduction

Processing is done to:

- prepare seafood for eating, marketing, storage, packaging or further processing;
- extend the time seafood can be kept so it is available during food shortages;
- transport seafood over long distances; and
- add value to the seafood product, particularly in export markets.

There are two types of fish processing: primary and secondary. Primary processing prepares the fish for secondary processing by cleaning it, and cutting it to suit the purpose of the secondary process. Secondary processing changes the nature of the flesh itself in order to reduce spoilage, extend shelf life, change flavour or add value to the product.

The following table shows some of the processes a fish may pass through from capture to marketing:

Landing of fish onboard canoe or into collecting baskets	
Bleeding	Primary Processing
Gutting and gilling	
Washing and cleaning	
Processing (filleting, salting, smoking, cooking etc.)	Secondary Processing
Packaging	
Labelling	
Storage	
Distribution and marketing	

Fish will stay fresh longer if the gills and guts are removed, and the blood drained soon after catching.

Bleeding

With large fish such as yellowfin tuna, it is useful to drain the blood as soon as the fish is landed. Bleeding helps slow deterioration and spoilage by:

- helping decrease cooling time as the fish loses heat as it bleeds - especially if the fish is bled while the heart is still able to pump blood;
- improving flavour and quality by removing waste products such as lactic acid, which built up while the fish is struggling during capture; and
- helping produce a better-coloured flesh with fewer bruises, blood spots, and other defects.

It is important to bleed sharks because their blood contain high amounts of ammonia that make the fish smell and taste bad.

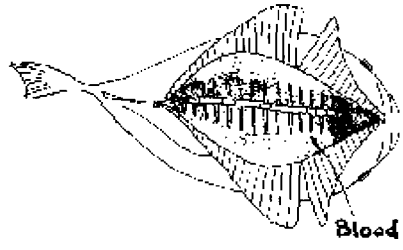
There are many ways you can bleed fish but the simplest method is to firmly cut across the throat, severing the main artery that runs from the gills to the heart.

Cut across the throat.

With large fish, it is useful to bleed each fish as soon as it as caught. It is important to wash the remaining blood and guts out of the gut cavity, and to wash slime off the skin.

Gutting

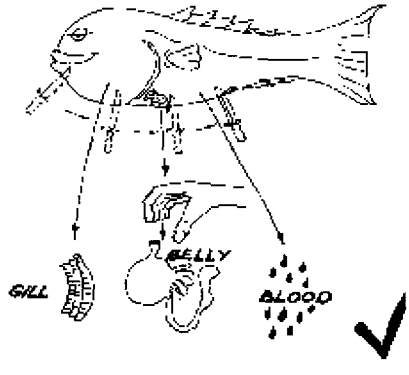
In the Pacific many consumers do not like their fish gutted or gilled. However, gutting and gilling reduce the available **bacteria** present in the fish, and so help to slow spoilage. Correct gutting and gilling are especially important if the fish is going to be stored for any length of time. Fish should be gutted as soon as possible after catching them. A sharp knife is used to slit through the stomach to remove the guts. Be careful not to cut through the stomach or gall bladder as this can contaminate the the rest of the fish. By removing the gut you remove bacteria that cause spoilage, in particular, bacteria in the food eaten by the fish prior to capture. Additionally, removal of the gut reduces **enzymes** present in the stomach and intestines.



Wash out remaining blood.

Gutting

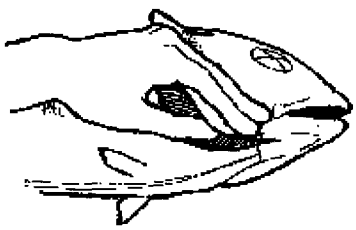
1. *Slit the stomach.*
2. *Remove guts, membrane, and solid blood along backbone (use a stiff brush to scrub out solid blood).*
3. *Wash the fish inside and outside to remove slime.*



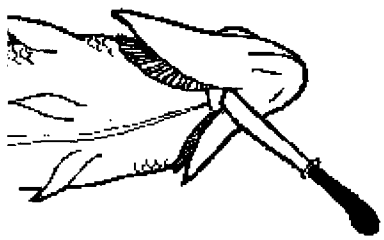
Fish gilling, gutting and bleeding.

Gilling

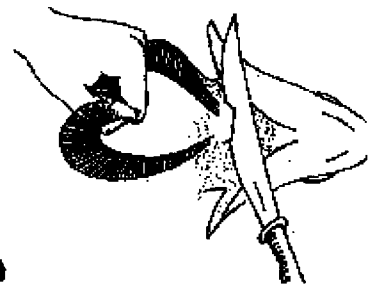
As with the guts, gills naturally contain a large amount of bacteria that can contaminate fish flesh and accelerate spoilage after the fish dies. Removing the gills, and thereby removing the source of bacteria, is another method of slowing spoilage.



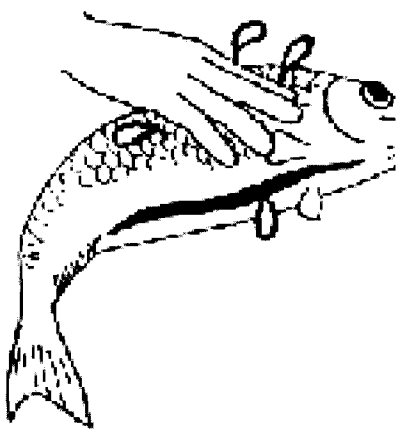
Lift the gill cover.



Cut gill attachments.



Lift out gills.



Wash fish thoroughly.

Washing

After removing the guts and gills you should remove the blood lining that is attached to the backbone. To do this you will need a small soft brush (small scrubbing brush or toothbrush) that will not damage the fish meat. The fish should then be washed in clean fresh or seawater. Brush the skin of the fish to remove dirt and blood, and enhance the natural skin colour.

Your final product will depend upon the quality of the raw material. If the fish is spoilt or rotten there is no way the original quality can be obtained. It is important that all processing is carried out correctly. Fish is a perishable food and will spoil and damage easily.

Fillets and steaks

A fillet is a slice of meat cut along the backbone of the fish. Filleting leaves behind only the skeleton and head. Many Pacific Islanders fillet large fish, but prefer smaller fish to be left whole. Most prefer to buy the whole fish and prepare the fish in their own way.

Fillets.

At the Nauru fish market, fish sellers fillet the large yellowfin tuna and cut pieces to satisfy their customers. Fish fillets are commonly consumed as fish and chips. In Solomon Islands small fish and chip shops are a growing business.

Steaks.

Steaks are made by cutting vertically through the backbone. These cuts are used on large fish as they take up less space, and can be used or sold separately from the fish carcass.

Activity

Practice primary processing by gutting and gilling, filleting and preparing steaks. Do you have different ways of filleting to other students in the class? Whose fillets shows the best recovery (leaving the least amount of flesh on the carcass)? Do you think this is due to technique or practice?

Abaiang, Kiribati: Butterfly filleting milkfish.

Knives

Knives are one of the most important tools in the seafood industry. The choice of knife, how it is handled, sharpened and maintained are crucial in ensuring the best quality product. Correct handling and maintenance are also essential for worker safety and preventing injuries.

Sharpening and maintaining knives

A blunt knife will not cut properly and can damage the fish product. Sharpening will ensure that the knife cuts cleanly and with ease. Sharpening is done by removing metal along the cutting edge, using a grindstone, a stone or a steel. A grindstone is the coarsest of the three, setting the shape of the knife and removing defects from the blade. A stone forms the cutting edge and a steel maintains the cutting edge.

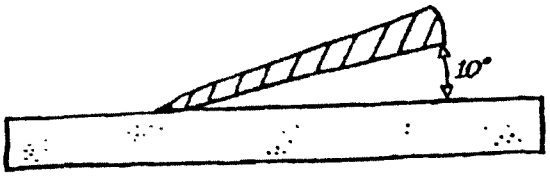
Nukefatau, Tuvalu: Sharpening a filleting knife.

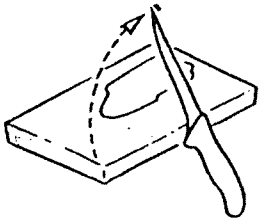
Sharpening stones

A variety of stones can be used to set the cutting edge of a knife. The most common stone is made of silicone carbide. The stone should be soaked in water before use. It is also important lubricate the stone by adding water while sharpening.

Steps for sharpening a knife using a stone:

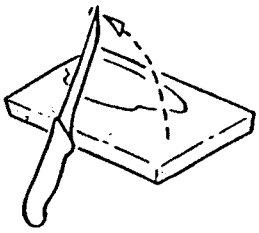
1. Clean the knife and add water to the stone.
2. Place the tip of the blade on the end of the stone with the blade at an angle of 10° as shown below:





Move the fish backwards, in an arc.

3. Hold the knife with all four fingers around the handle with the thumb at the back and slightly on the topside. The other hand can be placed on top of this hand for extra support.
4. Move the knife backwards (from tip to heel) in an arc across the stone (from corner to corner) with firm pressure. Always move the knife in one direction. Running the blade forwards and backwards or round and round on a stone should be avoided.
5. Repeat this process as often as necessary.
6. Turn the knife over and repeat the process.
7. To finish off the process and make the knife ready for cutting, turn the blade slightly towards the cutting edge and make single light strokes on alternate sides of the knife.

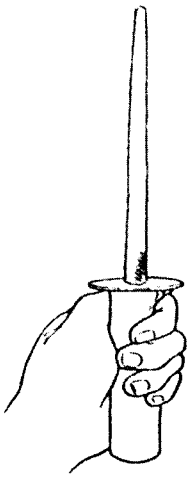


Turn the knife over and repeat.

The cutting edge will now be very thin and will roll over to form a lip. This lip needs to be removed to retain the cutting edge of the blade. A steel is used to do this.

Using a steel

A steel does not create a cutting edge but helps maintain the edge and keep it straight. The better the quality of steel used, the finer the cutting edge. Lower grade steels are likely to rust. Steels should always be clean and free of rust.

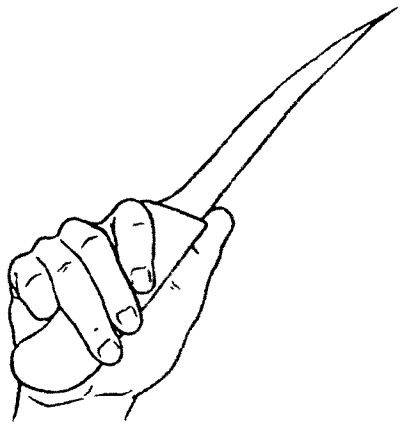


A steel.

Steps to sharpening a knife using a steel:

1. Clean your knife.
2. Hold the knife in your natural hand by its handle. Tuck your thumb around the opposite side of the handle with your little finger positioned underneath the handle as shown. This will help you to hold the knife at the correct angle against the steel.
3. Hold the steel in the other hand making sure that your thumb is under the guard at the base of the steel, to prevent you from cutting yourself. The steel should be at an angle of 70° from the body.

4. Place the heel of the knife at the top of the steel and turn it slightly, about 10° towards the cutting edge.
5. With light pressure and a downward stroke move the knife firmly from the heel of the blade through the cutting edge. Finish the stroke at the point of the blade. This action should finish just above the base of the steel guard.
6. Repeat this process on the other side of the blade.



A few slow accurate strokes are better than many fast strokes.

Storing your knife

When not in use knives should be stored in a hygienic and secure place such as a clean rack on the wall. Knives should never be left in a place that can cause harm to someone.

Cleaning knives

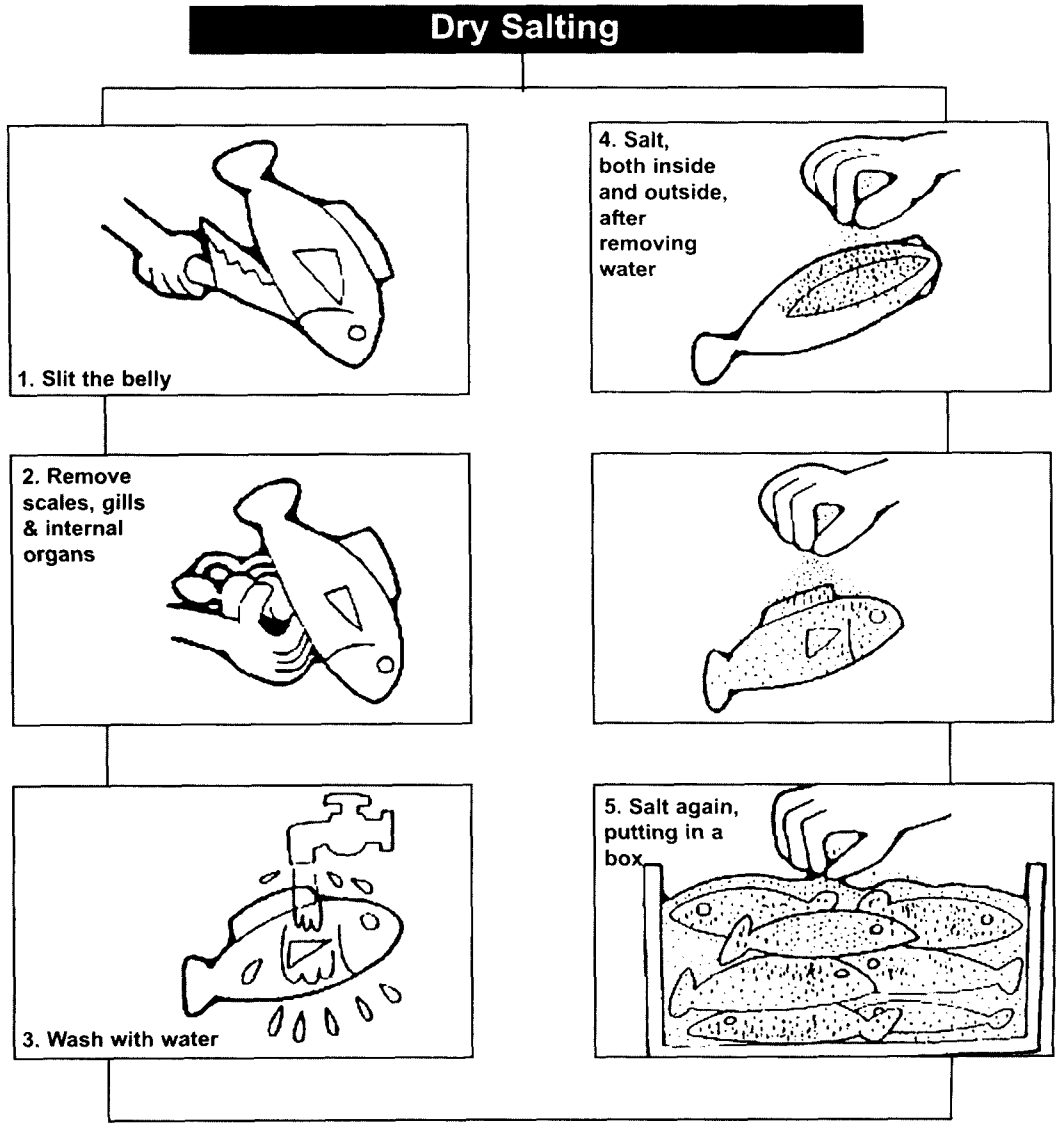
Knives should be kept hygienically clean to prevent cross contamination to the food being cut.

Both the blade and handle should be scrubbed daily with a scrubbing brush or nylon scouring pad and detergent solution. It should then be rinsed and sanitised. Ensure the knife is cleaned after coming into contact with contaminated surfaces.

Dry salting

Dry salting involves rubbing grains of salt onto the surface of the fish. It is important to ensure that the entire surface of the fish is covered in salt and that the thicker flesh areas of the fish receive more salt to endure equal penetration. Alternatively you can apply dry salt in a layer system as shown below.

Salt
Fish
Salt
Fish
Salt
Pallet



Kench salting involves placing the prepared fish and salt in alternating layers. However, unlike **pickle** *curing, the liquid that forms is allowed to drain away.*

Layers of fish and salt are often stacked 1-2 m high. A cover on top of the stack presses the fish down. This encourages faster salt penetration and water removal. Kench salting in a woven basket allows the pickle liquid to drain through holes in the weave.

The fish should be restacked every 24 hours so that fish previously on top end up on the bottom. Add more salt as required.

It is important that both sides of the fish are covered in salt.

Brining

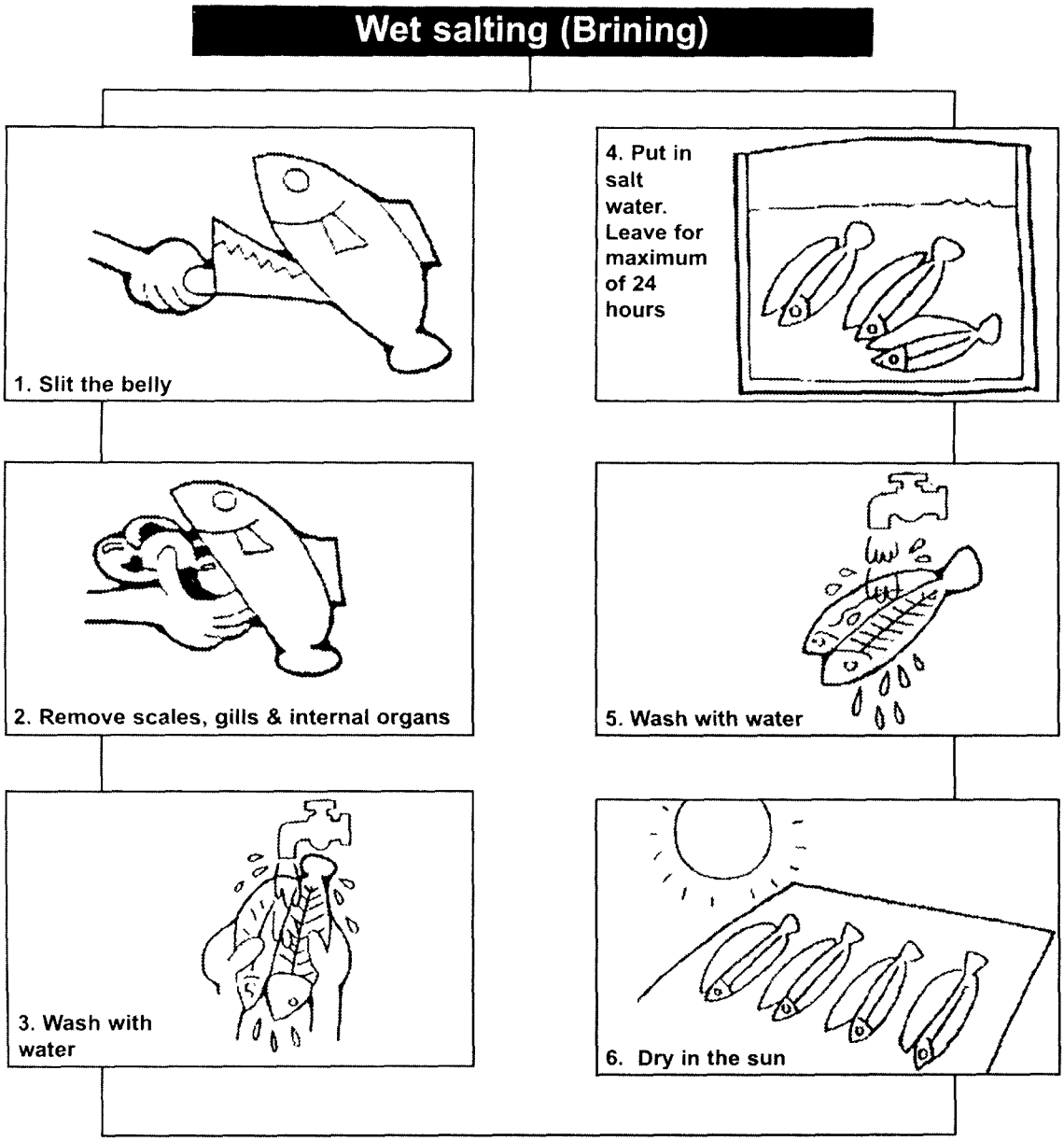
Brining involves soaking fish in a prepared concentrated salt solution, made by dissolving salt in water. The process is used when a light to medium salt content is desired. Fish are usually brined before drying or smoking. Brining has a number of advantages when smoking or drying fish:

- salt helps prevent spoilage by removing water needed for bacteria and enzyme activity;
- salt helps prevent spoilage as bacteria will not grow in high salt concentrations;
- salt removes water from the flesh of the fish and reduces the amount of time taken to dry the fish;
- brining adds flavour to smoked or dried fish; and
- brining gives an attractive gloss or surface on smoked or dried fish.

A brine using about 210 grams of salt for every litre of water is often recommended, although various brine strengths may be used. Fish should be immersed in the brine solution for about 3-6 hours, depending on the size and fat content of the fish. Fish with a high fat content such as mackerel require longer brining times than less fatty reef fish.

The brine process:

1. Dissolve 2.7 to 3.6 kg (6 to 8lbs) of dry salt in 10 litres (2 gallons) of clean, fresh water. Use a clean container such as a large plastic drum.
2. Add prepared fish. They should float to the surface.
3. Use a clean wooden cover weighed down with clean stones to keep fish below the surface.
4. Stir the mixture every 20 to 30 minutes. Brining takes 30 minutes for light salting, and up to 24 hours for medium salting Fish are then ready for drying or smoking.



Cooking salted fish

Before salted fish is cooked it is necessary to remove much of the salt content. The fish should be placed in clean, fresh water for a minimum of 12 hours before cooking, changing the water three to four times to hasten salt removal. Note that fish takes up water when soaked in this way. No longer protected by high concentrations, of salt, the fish is now vulnerable to rapid spoilage. Consequently, it is best to soak only enough fish for the family's immediate needs.

Signs of spoilage in salted fish

Reddening	The fish takes on a red colouring. This is caused by red **halophilic bacteria**. These organisms are usually found in **solar salt** or other salt prepared from seawater.
Dun	Dun is characterised by a peppering of light brown spots on the fish and is caused by the growth of mould. It is controlled by good sanitation, good ventilation and keeping processing areas and equipment dry.
Souring	Fish that has soured has a bitter taste. Souring is due to improper salting, which results in the uneven distribution of salt through the fish flesh.
Salt Burn	The fish is extremely dry and cannot be rehydrated. This happens when too much fine salt has been used. The salt draws out the surface moisture so rapidly that the protein in the fish becomes solid, which stops the fish from taking in water later on.
Sliming	The surface of the fish acquires a slippery coating of slime. This usually occurs in brined fish and is caused by inadequate salting, use of low quality fish, high temperatures and high humidity.

Preventing spoilage

In order to prevent spoilage, careful attention should be applied in three areas.

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. A mixture of 1/3 small crystals and 2/3 large crystals for dry salting is best. Fine crystals are usually better for wet salting.
- Use clean water.

Processing methods

- Ensure hands, clothing, cooking utensils and work surfaces are hygienically clean.
- Take note of the time required for each step of the salting process.
- Pay attention to the amount of salt or brine to fish ratio.

Handling of finished product

- Dry salted fish can be enclosed in a clean dry plastic bag or wrapped and secured inside a dry, clean banana leaf.
- The salted fish must be stored in a clean, cool place. Keep it away from dust, insects, rodents and direct sunshine.

Activity

1. Prepare fish using the dry salt method.
2. Prepare fish using the brine method.

Pasturised shellfish meat in marinade

Pasturised shellfish meat in strong vinegar can be stored at room temperature for up to 6 months. The natural liquor draining out of the meat will dilute the vinegar, so first soak the meat in vinegar for 24 hours, drain and then pack into jars. Cover meat with freshly made hot marinade and steam or heat in water (75°C for 8 minutes or 85°C for 30 seconds). Tighten lids and label with date.

Marinades

Use vinegar that is 4-6% acetic acid, (other acids should not be used). Check the label to find out the strength of the vinegar that you have. To dilute a 6% vinegar to 4% vinegar, add 1 cup of water to 2 cups of the 6% vinegar.

Make sure that salt and sugar are dissolved in the vinegar before adding other ingredients. Select your favourite herbs, spices, flavourings (for example cloves, lemon grass, basil, onions, chillies, garlic, ginger), or even sea plants. Add one or more flavours to the vinegar. Use 1 tablespoon of spices to 4 cups of vinegar. Simmer for 15 minutes or until the flavour suits you. Strain the solids. Your flavoured vinegar in now ready for use.

Drying

Like salting, drying is a common method of preserving fish in many countries. The facilities vary from country to country and range from simple, traditional equipment, where fish are spread on timber racks to dry, to more complex equipment such as mechanical solar dryers. Solar radiation (using the sun's heat) is widely used as a direct source of energy to dry and dehydrate foods of various kinds.

Dried fish products can be enhanced to produce more flavour. For instance, the addition of other ingredients to the fish in the form of a marinade adds to the flavour of the dried product.

Drying removes water, which is essential for bacteria and enzymes to survive and spoil fish. When enough water has been removed, fish will be preserved. Drying can also be carried out in combination with salting or smoking. Salting helps start the drying process by removing some of the water from the flesh. Dried fish, if stored under the right conditions, can be kept unspoiled for several months.

Types of drying	Thickness	Temp.	Air speed
Slow drying		low	slow
Fast drying		high	fast

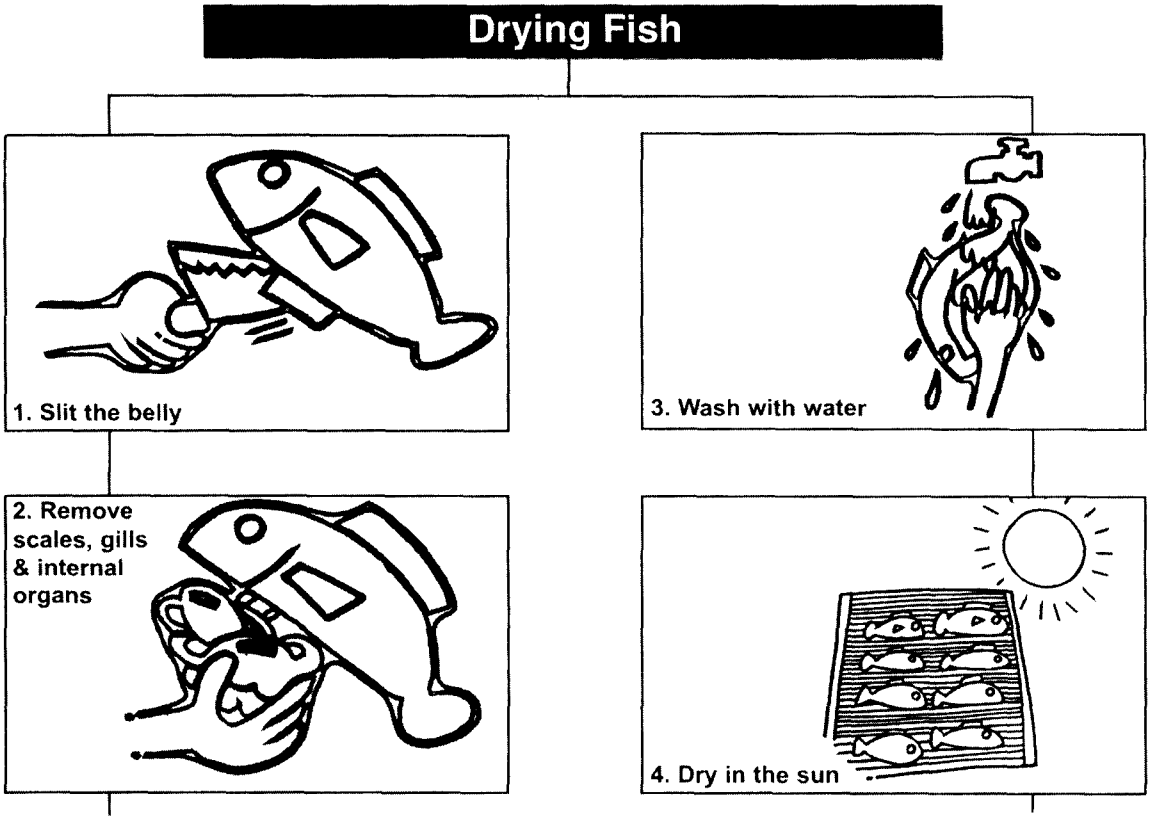
Drying fish involves two phases:

The first phase involves the evaporation of water on or near the fish. The rate of drying depends on:

1. surface area or size of the fish;
2. speed of air movement over the fish; and
3. relative humidity of the air.

The second phase occurs when the surface moisture of the fish has been evaporated. The drying rate of this phase depends on:

1. fat content - fat in fish retards water movement so the fattier the fish the longer the drying time;
2. fish shape - the thicker the fish the longer the drying time;
3. temperature - drying will occur more rapidly at higher temperatures; and
4. water content - the higher the water content the longer the drying time.



Preparing fish for drying

As with salting, fish must be as fresh as possible. If ice is available, 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 seawater,

place in a clean box and cover with a wet cloth to protect from sunlight, dust and flies. Process fish as quickly as possible. The most suitable fish for drying are lean fish with a low fat content such as tilapia, shark and most white-fleshed fish.

Fatty fish such as mackerel, sardines, or tunas may 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, such as shark, should be cut into thin strips or small rectangles to ensure adequate drying;
- small fish need only to be gilled and gutted before drying;
- small fish and sliced fish can be dried hanging from a rod; and
- racks (flat wire mesh and vertical hanging racks) can be used to dry fish that has been split down the back bone. Racks ensure that the fish is evenly dried all over.

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

Abaiang, Kiribati: Salted dried milkfish.

Drying methods

There are three drying methods:

1. natural drying,
2. mechanical drying, and
3. freeze drying.

Kiribati: fish drying on pole.

Natural drying - This method involves drying fish under the sun, to evaporate water. The sun's energy can be used more efficiently in solar dryers and black boxes, which trap more of the sun's heat. Natural drying is perhaps the most popular method of seafood preservation in the Pacific region, especially in rural communities. The type of equipment used for drying includes:

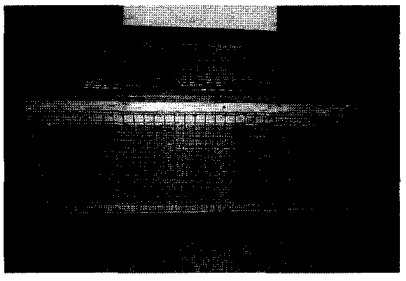
- raised racks or poles;
- cabinet dryers;
- drying sheds; and
- drying tents.

Raised - rack or pole drying is traditionally done by placing fish on racks or poles that are positioned at some length above the ground. Wind and heat from the sun help dry the fish. Fish dried on racks can be easily protected from rain by covering with a sheet of polythene or waterproof material.

Tarawa: Raised rack drying.

Advantages of this method of drying include:

- rapid drying rate - air currents at the height of the raised rack are stronger than at ground level and pass freely over and under the fish;
- protection from domestic animals and some pests;
- protection from ground contamination;
- sloping racks provide drainage, allowing water to drain from water pockets in the gut and gill cavities; and
- fish are easily protected from rain since they can be covered with plastic or other waterproof material.



Palau: Drying in a flyscreened cabinet stops insect infestation.

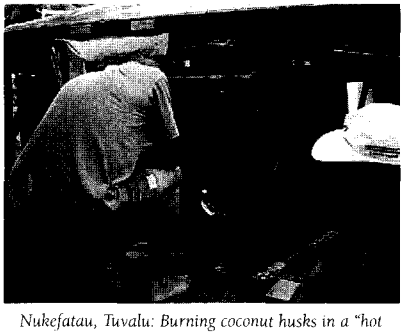
Sun drying is very weather dependent - rain, cloud cover, humidity - and does not protect the product from airborne contaminants, or insect infestation.

It is not uncommon for blowflies to lay eggs on fish during the early stages of drying. The eggs hatch into larvae, or maggots, which can cause considerable damage to drying fish. Blowfly infestations are considerably reduced when fish are dried quickly. Small fish, which dry in a day or two, are not usually attacked, as the newly hatched blowfly larvae perish from lack of moisture.

The most serious long-term problem are beetles of the *Dermestidae* family, which infest fish during drying but, unlike blowflies, continue to be attracted to, and breed in, dried fish. If undetected, they continue to cause damage up to the time of consumption. Losses from beetle infestation can be very high during the final stages of drying, and during storage and distribution.

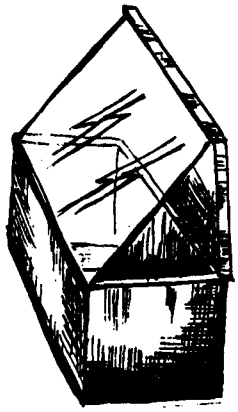
Insects are also potential carriers of pathogenic bacteria and may represent a health hazard.

Insects can be controlled in a variety of simple ways, such as fly-proof screens, self-closing doors, sticky fly traps or swats, and storage in sealed polyethylene bags. High temperature, microwave and ionised radiation treatments can be used to kill insects that have already infested dried fish.

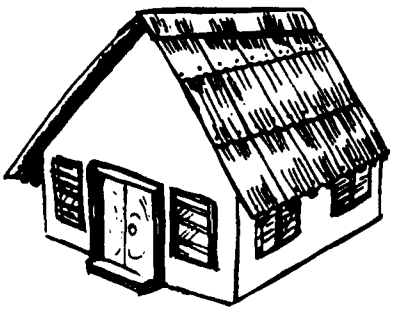


Nukefatau, Tuvalu: Burning coconut husks in a "hot box" under a solar solar cabinet helps dry fish on cloudy days.

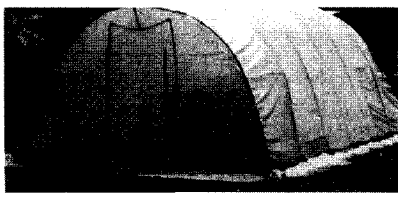
Some simple equipment, such as cabinet dryers or drying sheds, can be used to speed the natural drying process, and protect the drying fish from insects and adverse weather conditions. Adverse weather conditions can interrupt the drying process and cause slow and uneven drying, resulting in spoilage.



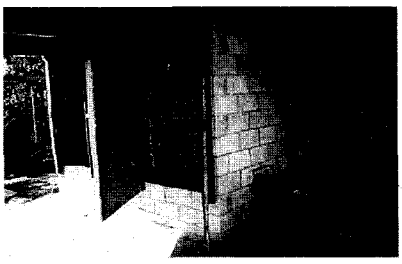
Cabinet dryer.



Drying shed.



Drying tent.



Tonga: A gas heater blows warm dry air into these drying cabinets.

A cabinet dryer is a wooden, rectangular box or cabinet with a sloping glass face. The interior is painted black to absorb heat from the sun. The sloping face enables more rays to penetrate the cabinet when the sun is lower in the sky.

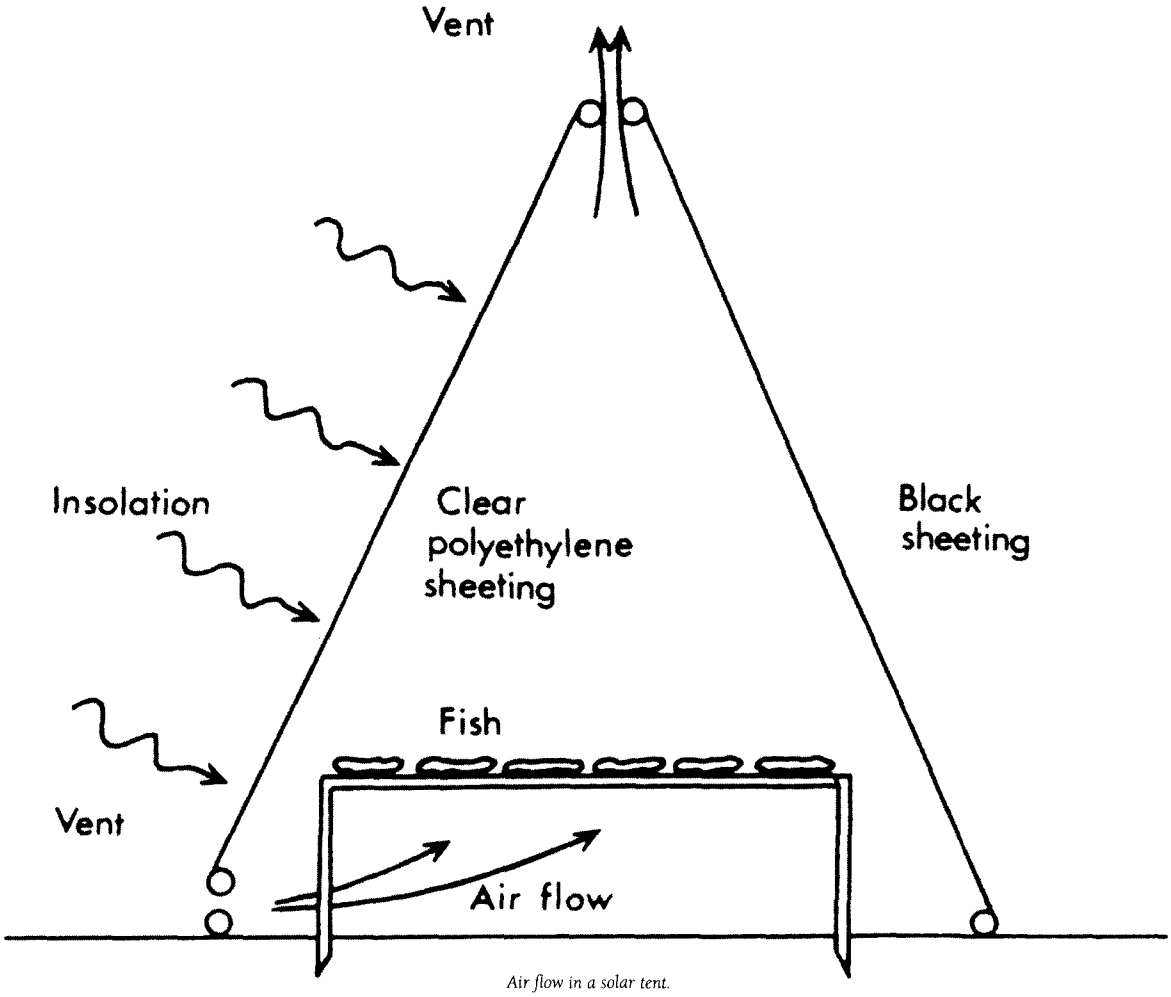
Fish drying trials using cabinet dryers have been reported with varying results. In Papua New Guinea the cabinet dryer was found to be unsuitable because it was not rain-proof and drying efficiency was found to be only slightly better than that achieved by simple sun drying. However, an 8 kg capacity cabinet dryer tested in the Galapagos Islands and Ecuador had drying rates much higher than open sun drying; moisture content of fish was reduced to 13% on average, while open sun drying gave a product with 21% moisture content. The quality of the product was also much better.

Drying sheds are covered in transparent, corrugated **perspex** sheets. The sun's rays penetrate the sheets and a considerable amount of heat builds up inside the sheds. As moisture builds up inside these structures it condenses on the surfaces and runs off. Limited ventilation helps keep down the humidity, while preventing the escape of too much heat.

Drying tents, made of thick plastic, are also effective. Drying tents protect fish from insects and rain, and hasten the drying rate by increasing the temperature inside the tent.

Mechanical drying uses electricity to run heaters and fans. With mechanical drying it is possible to control temperature, humidity, and air flow. However, it is more expensive than natural drying.

Freeze drying involves placing the fish in a vacuum where moisture from the fish is drawn out under low pressure. This results in rapid freezing as well as drying. The fish freezes after about 15% of the water has been evaporated. Freeze drying requires a high energy input and is only possible for products that will command a high price when sold. Freeze dried fish can be stored indefinitely under natural conditions, as long as the packaging remains resistant to water. When the package is opened, the moisture in the air helps to rapidly reconstitute the product.



Air flow in a solar tent.

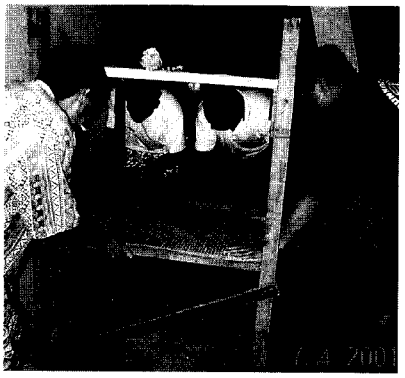
Building a solar dryer

The following instructions are for a large solar dryer designed to trap the sun's heat and speed the drying process. The same design can be used to build a smaller dryer by reducing the lengths given for all the materials.

Materials

- bamboo
- rope or strong twine
- two metres (7 feet) of 3 metre-wide black plastic
- six metres (20 feet) of 3 metre-wide clear plastic
- some big stones.

Tarawa, Kiribati: Building a wooden frame for a solar cabinet.

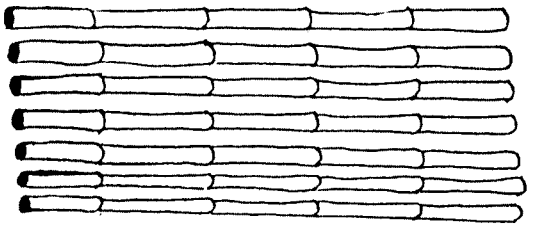


Tonga: Nailing flyscreen to bottom of solar cabinet.

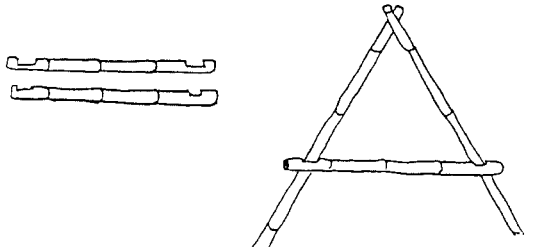
Tonga: Nailing UV-resistant plastic onto solar cabinet.

Method

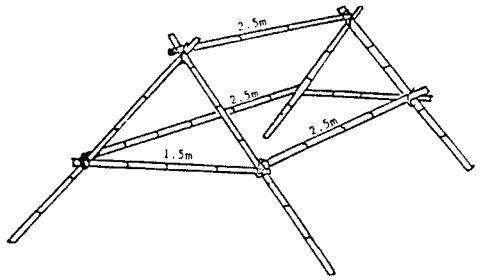
1. Cut seven pieces of bamboo, all the same length: 2.5 metres (8.5 feet) long.



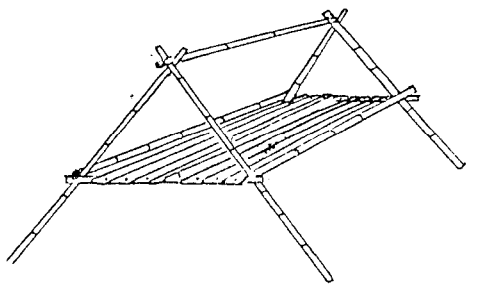
2. Cut two pieces of bamboo 1.5 metres (5 feet) long. Cut a groove big enough to hold a piece of bamboo 10 cm or 4 inches from each end of the two pieces as shown below.



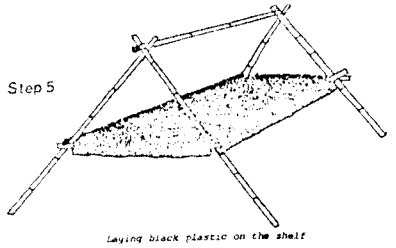
3. Tie all the pieces of bamboo together securely to make a frame. This is what the frame should look like.



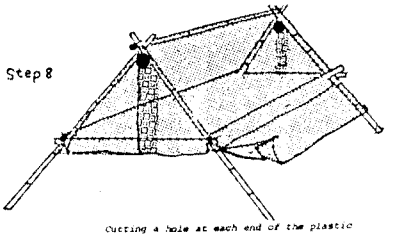
4. Take five pieces of bamboo, all 2.5 metres (8.5 feet) long. Split them in half to get ten pieces of split bamboo. Lie them flat to make a shelf, as shown. Nail them down at each end or use vines or split cane to tie then down.



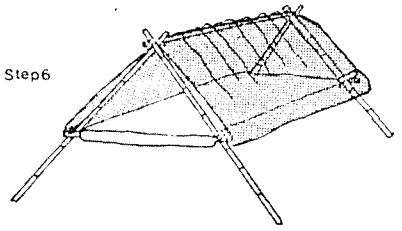
5. Cut 2 metres (7 feet) of black plastic and spread it over the shelf. If black plastic is too hard to get, blacken the shelf with charcoal and cover with clear plastic. A black surface absorbs heat better and holds the heat in.
6. Cut 6 metres (20 feet) of clear plastic. Put it over the top and down the sides of the frame. Fold the ends of the plastic.



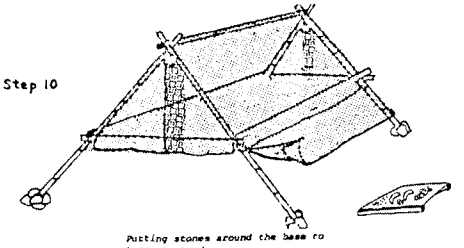
Laying black plastic on the shelf



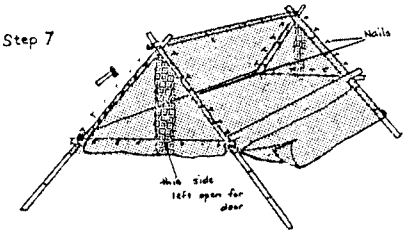
Cutting a hole at each end of the plastic



Covering the frame with clear plastic



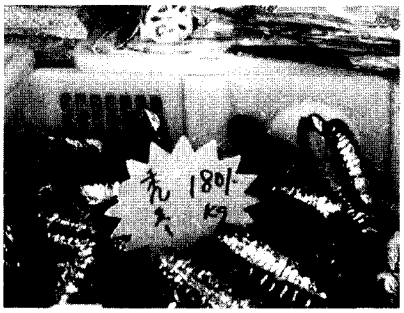
Putting stones around the base to keep it steady.



7. Pull the plastic across the ends of the frame as shown. Nail the plastic down at both ends along the shelf of one side of the frame. The other side of the frame is not nailed down all around. Leave an opening to put food inside the dryer.
8. Cut a hole about 10 centimetre (4 inches) wide in the plastic at the top of each end to allow enough air to get inside. You may wish to cover this opening with netting to keep out flies.
9. The dryer should be used in a place where there is plenty of sun, particularly during the hottest part of the day. However, this depends on your climate. If the food gets too hot, it will bake rather than dry out. Experiment to find the best location for the food dryer.
10. Put stones around the base of the dryer to keep it steady.
11. To use: place food on a raised rack for drying. Place in the dryer. Close the flaps for the door.

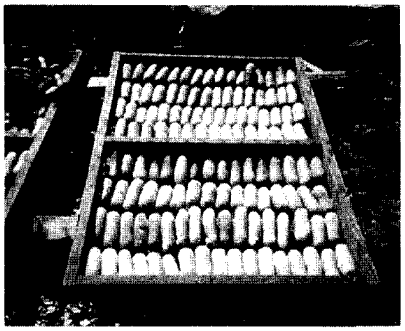
Note: Taken from Storing and Preserving Pacific Island Foods, Appendix 1, Building a Solar Dryer page 116-119. The South Pacific Community Nutrition Training Project.

Nuku'alofa, Tonga: dried sharkfin.



Singapore: Dried sea cucumber on sale.

Viwa Island, Fiji: Drying sea cucumber in a copra dryer.



Nuku'alofa, Tonga: Sun drying seacucumber.

Dried fish products of the Pacific Islands

Dried products such as beche-de-mer, shark fins, tuna and reef fish are being exported to a number of overseas countries outside the Pacific, especially Asia.

Sun dried shark fin

Dried shark fins are mainly used in Chinese cooking as a thickening agent in soups; hence dried shark fins are mostly exported to China and Hong Kong. The fins, mostly the dorsal, pectoral and lower caudal, are cut off and any flesh is removed. Shark fin is the only sun dried product that doesn't require pre-treatment. The fins are washed in water and either hung up or spread out to dry in the sun for up to one month. The dried fins are then packed in sacks under pressure so that they are flattened during storage.

Dried sea cucumber

Sea cucumbers are processed into beche-de-mer and exported to Asian markets. Sea cucumber products are either boiled or eaten raw. The Chinese, for whom beche-de-mer is a traditional food, taught Pacific Islanders their processing techniques, and harvesting sea cucumbers is now an important artisanal activity in Fiji, Solomon Islands, Papua New Guinea and New Caledonia.

In some countries people are diving deeper and longer using hookah or scuba gear to collect valuable sea cucumbers. People who are not properly trained in the use of this gear have become paralysed after diving beyond safe limits. Only properly trained people should use hookah and scuba gear.

Processing beche-de-mer

- *Boil in clean seawater for about 15 minutes until the ends of the animal become rubbery. Boiling time will depend on the species and size of the animal. If the sea cucumber starts to swell it may have to be pierced or it will burst.*
- *Slit the animal to within 3 cm from each end, open up and remove the gut contents. Clean with sea water.*
- *Boil for 15 to 40 minutes until a dry, rubbery feel is achieved.*
- *Smoke dry for 24 to 48 hours or sun dry for four days.*
- *Pack in copra/hessian sacks or woven plastic sacks for shipping.*

Sea cucumbers are usually processed near collecting grounds. Storing the product poses no particular problem because, once it is dried, it requires no refrigeration. The Hong Kong and Singapore markets are within reasonably easy reach of the Pacific Islands, many of which are linked to Asia by regular shipping lines. Properly dried, good quality beche-de-mer produced in the South Pacific is popular with Chinese consumers and can fetch high prices.

Earn more from your sea cucumber

Sea cucumbers species that are suitable for processing into beche-de-mer are worth a lot of money in Asian markets. However, Pacific Islanders who collect, boil, slit, re-boil, gut, smoke, dry, and bag these sea cucumbers do

not get much money for their efforts or their valuable resource. Pacific Islanders would get more money if they did the final processing and packaging. The final processing is simple.

Re-boil the dried beche-de-mer to soften them. Scrub off the outer sand, mud and skin. Remove the "inner skin" and mouth piece. Re-boil and then dice into small pieces for soup, or as larger chunks for adding to Asian chicken meals. Re-dry (usually by sun or oven) on trays, pack into air tight plastic bags and seal in an attractive box. This product can be sold to local Asian families or restaurants or into Asian markets, (with the help from Fisheries Departments or Trade-Investment Boards). In this it's possible to eliminate the middle-person, thereby keeping earnings in Pacific Island countries, creating more jobs locally, and receiving more money for marine resources.

Singapore: An assortment of 6-7 soaked sea cucumbers on sale.

Salted and sun dried fish

Salted and sun dried fish is widely produced throughout the Pacific. Salting and sun drying is one of the oldest methods of fish processing known worldwide. Tunas, sharks, reef fish and many other species are salted and sun dried. Fish are cut open and grooves sliced in the underside of the flesh. Crystalline salt is rubbed liberally into the flesh and excess salt shaken off. The fish are arranged in a trough or cement vat for 3 to 4 days so the salt can draw liquids from the tissues of the fish by osmosis. They are then removed, washed well in seawater to remove any superficial salt and sun dried until the product gets hard, typically for up to seven days.

Majuro, RMI: Dried fish in Gibson's Supermarket.

Activity

1. For those who are familiar with drying fish, record the answers to this dried fish survey and compare results:
   - What gear do you use to dry fish?
   - How long does it take for your fish to dry?
     On a cloudy day ——————hours
     On a sunny day——————hours
   - Is your fish dried thoroughly?
   - Does it go mouldy?

2. Build a solar dryer
   - Make a prototype sun or solar dryer (rack or pole dryer) that you think will be effective in your environment.
   - Try to use as much local material as possible.
   - Record all the materials used and the steps taken in making the dryer.
   - In making the dryer try to identify the advantages and disadvantages of your model.
   - Discuss possible ways to overcome these disadvantages.

Marinating strips of tuna.

Fish jerky

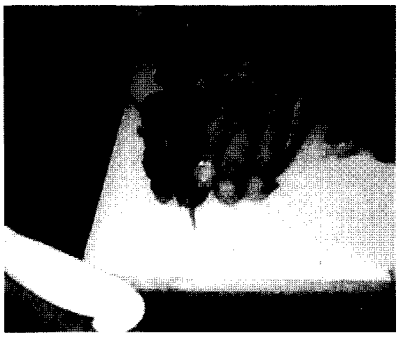
Turning fish into **jerky** adds flavour and enables the fish to be stored for long periods without refrigeration. Prior to drying, the fish is soaked in a strong marinade. Cheap by-catch, shark or tuna are good fish to use for making jerky.

The production of a dried tuna snack product (jerky) is a potential income-generating use of low value, locally caught tuna in remote Pacific Islands. These fish are otherwise of little value. This potential has already been realised in Tuvalu, which is producing its own "Teriyaki Tuna" jerky product and which is having some success as a snack food sold in duty free shops at airports.

Marinade Ingredients for 5 kg fish			
Lemon Soy	**Teriyaki**	**Pepper**	**Chilli**
1 litre soy sauce juice from 4-5 lemons 50 g salt 100 g sugar *ground garlic, ginger, chillies, mixed spice to taste	400 g teriyaki marinade/paste 15 g garlic powder or ground garlic 15 g ginger powder or ground ginger 5 g red rice flour* 350 ml water	250 g pepper marinade/paste 10 g pepper* 220 ml water	400 g chilli marinade/paste 15 g chilli powder or ground chilli 350 ml water

*optional

To make fish jerky:



Nukefatau, Tuvalu: Slicing yellowfin tuna.

1. Ensure that the processing area and equipment are clean and free of flies.
2. Recovery: 26kg Yellowfin tuna > 14 kg loins > 10 kg slices; 3 kg Skipjack tuna > 1 kg loins > 0.35 kg slices.
3. Fillet and loin fish (cut out the strip of bones down the middle of the fillet), remove skin and carefully trim away the dark red muscle.
4. Push fillet along a cloth to remove scales and dry.
5. Cut thin slices of fish flesh along the length of the fillet to a thickness or about 5 mm or 1/4 inch.
6. Wash the slices in lightly salted water, then place them in a prepared marinade (see below).
7. 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 tie. Ensure the fish and marinade are well mixed.
8. Spread marinade over bottom of container. Lay slices out over the bottom of the container. Spread marinade over the top of the slices. Put new slices on top. Continue to stack. The fish slices must be completely covered by the marinade. Mix occasionally.
9. Put lid on container and leave for at least 2 hours. If a stronger flavour is required, leave for a longer period.
10. Remove the marinated fish after the required time and wash quickly in fresh water to remove the colour of the marinade from the surface.

11 Drying -
- make sure the dryer is clean, fly-proof, rain-proof and with plenty of ventilation.
- Lay slices out in the dryer, close together without touching.
- Close dryer and take outside in the sun or over an oven.
- Optimum temperature is 30 to 40°C. During drying, turn the jerky regularly for even drying.
- The product is ready when the flesh is completely dry and has a reasonably tough and chewy texture. Put product into plastic bags for storage if required. The product is preserved and so requires no refrigeration. It will keep for many weeks.

Nukefatau, Tuvalu: Drying yellowfin tuna jerky.

12 Packing -
- The packing room should be separate from the processing room. It should be clean, cool, clean and free from flies.
- Ensure the tables are clean and dry.
- Collect dried fish from the dryers in a sealed bin.
- Separate the product into two bins (if required) one for domestic use and the other for export.
- Prepare bags for 50 gm or 25 gm orders, label and date.
- Package 50 gm or 25 gm product into the prepared bags.
- For export - insert oxygen scavenger (for example ageless) into the bag, making sure that the scavenger is placed behind the product. Seal the bag. Check for air leaks by squeezing the bags. Pack into boxes.

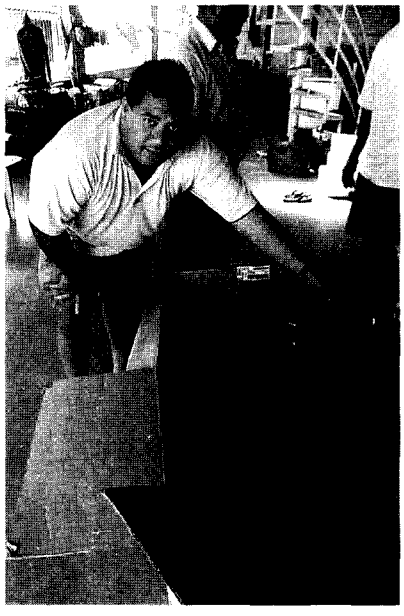
13. Quality -
- Reject any jerky that appears contaminated or too moist, dry or oily.
- Check for appearance and flavour.

Tarawa: Tuna jerky on sale at the Otintaai Hotel.

Shark jerky

- *Any shark species can be used for jerky processing but blue shark is particularly good. Other fish, beef and venison can be prepared in this way.*
- *Fillet the shark into strips 1/2 inch thick and 2 inches wide. Cut across the grain for a more tender product.*
- *Prepare marinade, using 1/8 cup teriyaki sauce, 6 drops tabasco sauce, 1 teaspoon garlic powder, 1 teaspoon onion powder and 2 teaspoons salt for every 1 kg of fish. Experiment with other marinades.*
- *Place marinade and shark in a plastic bag, mixing well.*
- *Marinate blue shark in fridge for 8 hours (or 12-15 hours for other shark species).*
- *Remove and place on rack. Sprinkle black pepper on both sides of the strips.*
- *Place racks in oven and set temperature for 60°C.*
- *Dry for approximately 12 hours. Check flesh and remove before it becomes too dry.*
- *The finished product should be firm, dry and tough, yet not so dry that it crumbles to the touch. When chewed, the meat should be rubbery. Overcooked jerky comes out crumbly.*
- *Store in airtight jars in a cool place.*

Suva, Fiji: Altona smoker.



Rarotonga, Cook Islands: A small domestic box smoker.

Modern mechanical kilns can control:

- relative humidity
- smoke density
- air speed
- temperature.

Small electric or liquid fuel smoke ovens are commercially available in some countries. If these are not available, smokers that use hardwood fires can easily be made from wood, sheet metal, bricks, cement or mud. You'll need an area for the fire, an area to confine the smoke, racks to hold the shellfish meat, and a small draft to keep the smoke moving.

Smoke can be produced from a slow-burning hardwood fire in a fire pit. A charcoal fire in a metal pan can be used by sprinkling hardwood chips or sawdust over the hot charcoal. The source of smoke must be placed at the bottom of the smoke oven. The body of the smoker can be a simple space enclosed by canvas, metal, bricks, mud or wood. A 44 or 55 gallon drum, old refrigerator, or ice box can be used, or you can build your own design. Racks are needed to hold the prepared fish or shellfish meat. If the pieces are small, a small wire mesh or perforated metal sheet is needed. The racks should not be fixed to the smoker because they will have to be removed. Applying vegetable oil to the racks will stop the meat from sticking to them. Alternatively, meat can be stacked onto thin pieces of wood or wire. Meat should be separated to allow smoke to envelop each piece.

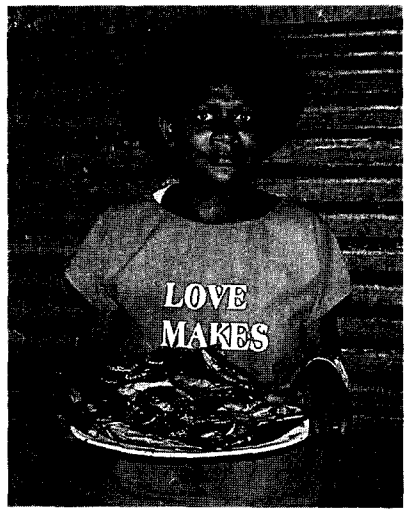
Vents at the top of the smoker must allow enough draft to keep the smoke moving over the product. It is possible to build simple dampers to control how much smoke is leaving the top vent and how much air is entering the bottom vent, (near the smoke source). Baffles, or pieces of perforated metal that prevent smoke from rising straight up the middle of the oven should be built in to disperse the smoke more evenly over the racks.

Wood source

Select a locally available hardwood. A variety of trees can be used depending on the country. In Fiji for example, mahogany sawdust gives good flavour to smoked foods. In atoll countries, coconut husk is often used, although this can give a bitter taste. Sawdust can be collected from sawmills. If collecting from a carpenter or joiner, be sure that the wood does not contain toxic glues, paint or varnish. It is recommended that mangrove wood not be used as mangroves are becoming depleted in many communities. Mangrove areas are very important to a healthy marine environment as they provide nursery and feeding areas for many marine species. Mangroves also protect against coastal erosion and storm damage.

In addition to wood, other available materials such as cow dung, coconut husks and sugar cane trash can also be used for smoking. A good source of uncontaminated sawdust is log conversion sites, and sawmills that cut logs into lengths of timber. Do not use sawdust from

resinous trees such as pines as this may give an unpleasant taste to the smoked product.



Viwa Island, Fiji: A tasty meal.

Smoked fish products

Smoked-boiled fish

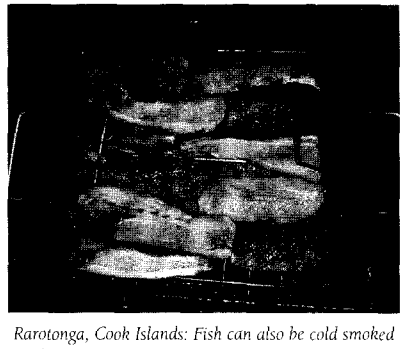
Small fish are cut lengthwise into two pieces. Large fish are filleted. Fish are placed in salted water (traditionally copper pans) and brought to the boil. The scum that rises is removed. Fish are boiled for 20 to 30 minutes until the flesh is cooked. They are then removed carefully, placed on racks above the fire and left to smoke for 6 to 12 hours.

Dried smoked-boiled fish

The initial preparation of dried smoked-boiled fish is identical to that of smoked-boiled fish. To make the dried product, the smoked-boiled fish is left out in the sun to dry. It usually takes 5 to 6 days of bright sunshine to make the fish really hard. The product can be sold to fishermen going on long voyages, sent to markets for local sale, or exported.

Soft dried smoked-boiled fish

Boiled, smoked and soft dried products are ready to eat or can be cooked with other seasonings. Fish are boiled, smoked lightly on both sides, and partially dried in the sun. This method of processing is less expensive, but the fish is not preserved for a long period of time.



Rarotonga, Cook Islands: Fish can also be cold smoked with no prior cooking to make a tasty snack or meal.

Hard dried smoked-boiled fish

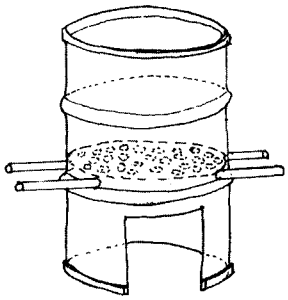
Boiled, smoked and hard dried fish are sun dried for days after the boiling and smoking process. Skipjack tuna is a commonly used species for making hard dried smoke-boiled products. This product is used by Pacific Islanders and is exported to Asia.

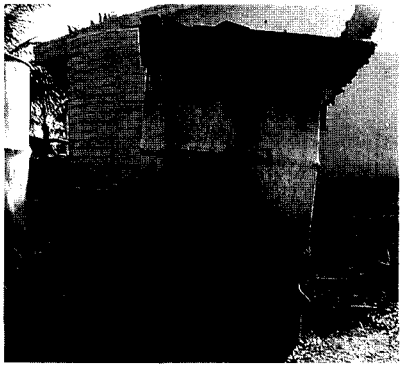
Fish hams

Large fish are best prepared as fish hams. Suitable species are tuna, barracuda, spanish mackerel, jacks or trevallies, and large red snapper. The fresh fish is washed thoroughly in clean water. The head is cut off just at the back of the gills so that the collarbone is still attached. The belly is split and the guts removed. The fish is split down the back into two equal pieces and the backbone, fins, tail and belly flaps removed. Fillets and strips may also be used, but should be no more than one inch thick.

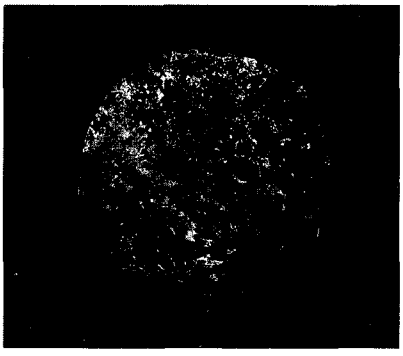
The fish sides are sprinkled thoroughly with pure salt, inside and out, so that all exposed areas are covered. The sides are then packed in a barrel with the bottom layer skin side down and the others skin side up. Salt should be sprinkled over the bottom of the barrel and between each layer, so that the final proportions of salt to fish is about one part salt to four parts fish by weight. A weight should be placed on top of the fish to keep it below the surface of the brine that forms.

After two days the fish should be repacked and more salt added between layers of fish. The old brine may be strained and used to cover the stacked

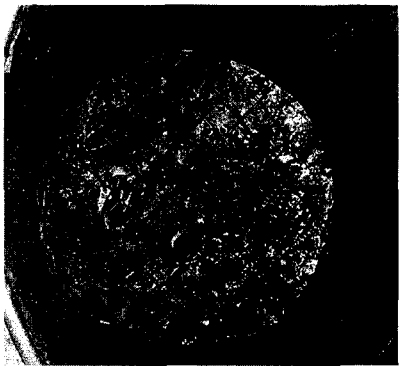




Tarawa, Kiribati: Drum smoker.



Smoke spreader at bottom of drum.



The bottom fish rack sits on crushed soft drink cans.

Materials

- One 44 or 55 kg gallon oil drum
- Two iron rods, 50 cm long
- One hessian bag, pandanus mat or plywood board to cover the top
- Some lengths of galvanised steel rods (2-3 mm in diameter) for support rods.

Method

1. Knock out the top and bottom of the oil drum with a hammer and chisel, keep the top or bottom to use as a smoke divider.
2. Make a square hole (for the fire opening) around 30 by 30cm in the side of the drum at one of the ends, keep the panel that is removed. It will serve as an air inlet control for the fire and a door to access the fire.
3 Drill four holes (the diameter of the iron rods) in the side of the drum, above the fire opening.
4. Put the two rods through the holes parallel to each other. This will be the support for the smoke divider. The ends sticking out can be used to lift and carry the smoker.
5. Drill as many holes as possible in the spare top (or bottom) of the drum, this will become the smoke divider.
6. Put the smoke divider on its support.
7. If the drum is new, make a large fire inside in order to burn all remaining oil and paint inside. Remove ashes when finished.
8. Fish can be hung on rods in the smoker, or placed on trays made from thin metal screen or chicken wire.
9. Supports for the rods or trays can be made by cutting two iron bars to fit inside the smoker and hanging them inside with 4 hooks made of galvanised wire.
10. With a bag or mat used as a lid you can now smoke any kind of product. The remaining top or bottom of the drum may also be fitted with wooden handles and used as a lid.

Use

Control the temperature inside the drum by:

- increasing or decreasing the size of the fire inside;
- closing or opening the top of the drum with the cover; or
- enhancing or reducing the amount of airflow through the drum.

Control the airflow by:

- placing or removing the lid on top;
- closing the fire opening in front more or less with the leftover panel; or
- lifting the smoker off the ground and resetting it on stones.

Shark liver oil

Shark meat can be eaten unprocessed or smoked. Tropical shark liver oil is low in vitamin A and, therefore, not in demand for making into medicines. However, shark liver oil can be used for other purposes such as rust preventative for steel, leather treatment or as a general purpose oil.

Practically all the oil from sharks is in the liver and sometimes 60% of the liver weight is oil. It is easy to recover up to 50% of the weight of raw liver as oil. Boil the minced livers with half their volume of water. There is a risk of burning the mixture if this is done over an open fire, so place the container into a larger pot containing water. The heat obtained by boiling the water in the outer container is sufficient to render the oil from the livers. On standing, the oil settles on the surface and can be ladled off and strained through sacking to remove all solid matter. The clean oil should then be stored in tightly sealed cans.

Packaging seafood products

Wrapping or packaging a fish product protects it from damage and contamination by pests, dirt, germs, hair, odours, etc. Packaging often makes the product more attractive and convenient for the consumer. In addition, some forms of packaging allow for information to be recorded about the product. This may include date of processing, use by date, ingredients and preferred storage conditions. For some products and in some countries packaging and labelling may be required by law.

Activity

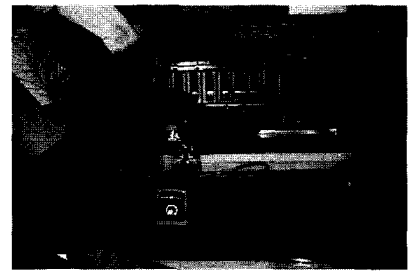
1. Write down ways of packaging that could improve the quality of your seafood.
2. Compare ideas with the class.

Seafood product development

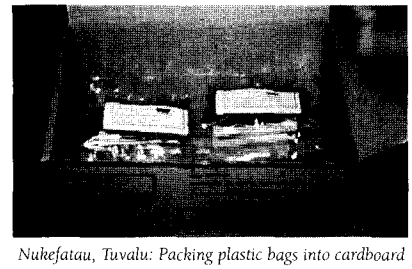
Value adding refers to the practice of taking a low value, readily available product and processing it into a higher value product. Many companies make considerable profit by adding value to raw materials from the Pacific and selling them overseas. Local communities could earn more money if they did their own value added processing.

Activity

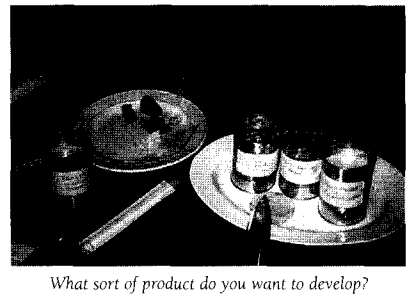
In this activity you will examine value added products that could be produced locally. You should gain an understanding of the considerations involved in developing a new seafood product, and of factors contributing to the success of the product in local or overseas markets.



Nukefatau, Tuvalu: Heat sealer used for closing plastic bags.



Nukefatau, Tuvalu: Packing plastic bags into cardboard cartons.



What sort of product do you want to develop?

Procedure:
Form small working groups of 3 to 5 people.

Product survey:
Each group will find and list as many seafood products and products made from marine resources as possible. Conduct a search by looking in kitchen cupboards, friends' houses, shops, supermarkets, newspaper advertisements, magazines, chemists, etc. Gather evidence of your finds and show the class (e.g. newspaper advertisements, labels, packaging and promotional material).

Choosing a product:
Using ideas from your survey chose a value added product that could be produced locally. Justify your choice using the following questions as a guide:

- Is the raw material fully exploited at present, or is there room to consider commercial development? Can the resource be sustainably harvested?

For example, tuna fisheries in this region are one of the few remaining sustainable fisheries in the world. Adding value to tuna and other offshore pelagic fish is one type of small-scale commercial enterprise that could be developed throughout the Pacific.

- Do customary laws interfere with the commercial development of the raw material?
- Can the raw material be farmed?
- Can the raw material be harvested and processed locally?
- Can the product be packaged locally?
- Are there enough trained and motivated workers in your community? Can the product be produced on an ongoing basis?
- Is there a demand for your product, locally or overseas? Can enough be sold to make the business profitable?

Presentation:
Present the results from your survey and make a case for your product of choice. The teacher will judge each group on the extensiveness of their survey work, and on the feasibility of their product development ideas.

Words and Their Meaning

Bacteria - microscopic, one-celled organisms found in the environment, some of which cause illness and disease.

Brine - a salt and water solution used for soaking seafood, usually before drying or smoking.

Enzymes - protein substances present in the muscle and gut which start or speed up chemical reactions.

Germs - a common name used for micro-organisms that cause disease, for example some viruses and bacteria.

Halophilic bacteria - bacteria that are able to grow in high concentrations of salt.

Jerky - small strips of marinated and dried meat, e.g. teriyaki tuna jerky.

Kench - refers to the layered pile of fish and salt in the process of dry salting or kench salting. The liquid removed from the fish is allowed to drain away rather than collecting as with pickle curing or wet salting.

Marinade - a sauce, typically of oil, vinegar and spices, in which meat, fish or other food is soaked before cooking in order to flavour or soften it.

Marinating - to soak in a marinade.

Osmosis - the transfer of water across a selectively porous membrane. Osmosis causes salt in solution to move from an area of higher concentration (the brine) to an area of lower concentration (the fish flesh).

Oxidation - oils and fats in dead fish combine with oxygen to develop a bitter (rancid) taste.

Perspex - a tough transparent plastic made of an acrylic resin, used as a substitute for glass.

Pickle - a liquid, especially brine or vinegar, used to preserve meat or vegetables.

Pickling - to put something in a pickle to make it tender, give it a special taste and to help preserve it, e.g. octopus tentacles pickled in vinegar.

Shucking - removing meat from the shell of shellfish.

Solar salt - a form of salt made by evaporating seawater in the sun.

Spores - dormant (inactive) bacterial cells protected by a tough outer coat. Spores are formed by some bacteria to enable them to survive harsh conditions such as extreme heat or cold, or lack of nutrients and water. Once conditions are favourable again the spores are activated and the bacteria are able to multiply.

Related Resources

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