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Good fish handling

A guide to good tuna processing techniques
for small-scale tuna processors

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Rural fish processing, Buariki, North Tarawa, Kiribati, 2022.



Urban fish processing facility Newerewere, Tarawa, Kiribati, 2022.



The context

Artisanal fish landing sites are not always the best location for fish processing due to high levels of fish spoilage or fish waste.

This guide recommends further processing of fish within the community environment, where high loads of fish processing are dispersed sometimes over many kilometers.

The rural environment where communities need income generation and access to fish for their daily livelihoods is often an ideal location for fish processing.

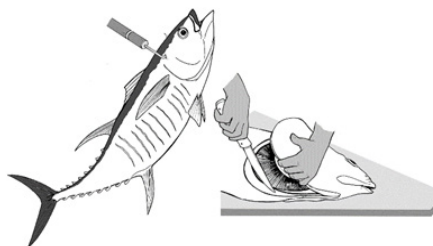
In order to ensure food safety, a contained fish processing environment is essential when dealing with fish processing in an urban setting.

When fish have just been caught

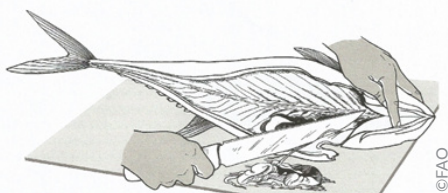


If left on a boat without consideration for preservation, high-quality fresh fish will quickly spoil. Spoiled fish are wasted fish and cannot be considered safe for consumption.

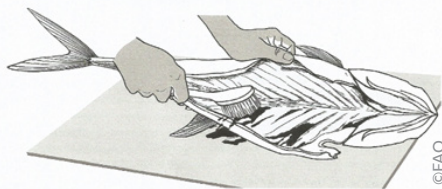
Fresh fish cannot be neglected. Spoilage of fish in the Pacific Islands climate is very fast. There must be measures taken to preserve fish. To ensure that fish remains fresh and safe to process and consume by the time it is landed on shore, you must gill and gut it immediately after catching on board the fishing boat.



By removing the internal organs and gills, spoilage can be delayed, and will prevent bacteria and enzymes from moving into the fish flesh from the organs.



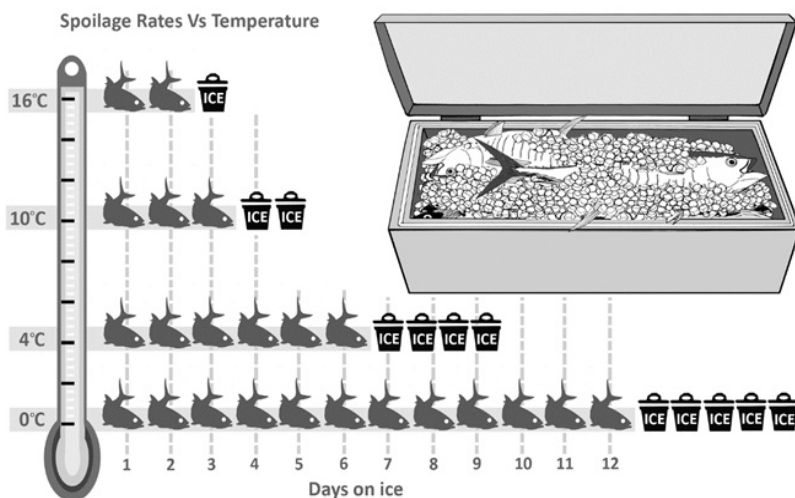
The blood inside the fish stomach cavity should be thoroughly removed and cleaned with clean sea water. A scrubbing brush is ideal for this step.



After fish is gilled, gutted and cleaned, it should be packed in ice, completely covering all surfaces of the fish, inside and outside.



If there is no ice, wrap fish in clean wet hessian sacks or wet cloth, keep wetting with clean sea water every 30 minutes. This technique can be used for short storage time between 2 and 6 hours. To ensure safety and good quality fish must be landed on shore within a few hours of being caught.



For longer storage periods, the fish must be covered with sufficient amount of ice. The more ice used – the longer the fish can be stored and preserved.



What causes fish spoilage?

The production of good quality, nutritious and safe fish products requires good handling, hygiene and processing of fish.

After the fish dies, its colour, texture and smell change. If these changes continue long enough, the fish will become spoiled and unfit for consumption. The time it takes fish to spoil depends on: the fishing method used to catch it, how it is handled and the temperature it is kept after catching. For example in hot temperatures like 25 °C and above, fish will be spoiled in 12 hours if it is not chilled in ice.

There are several things that cause fish to spoil, mainly bacteria, enzymes, and rough handling.

Bacteria

Since fish is a low acid food, it is very susceptible to the growth of bacteria that cause food poisoning. Fishery products can become contaminated with bacteria and toxins if they have not been properly dried (<https://www.fda.gov/downloads/food/guidanceregulation/ucm252418.pdf>). The shelf life of dried products is usually considered to be long, and therefore, they are commonly stored and distributed without refrigeration. The characteristic of dried foods that makes them shelf stable is their low water activity.



Bacteria can be introduced into the fish during processing, from the air, unclean hands, insanitary utensils and equipment, contaminated water, and sewage. There are a number of strategies for the control of pathogenic bacteria in fish and fishery products. They include:

- ▶ controlling the amount of moisture that is available for pathogenic bacteria growth (water activity) in the product by drying;
- ▶ controlling the amount of salt or preservatives, such as sodium nitrite, in the product;
- ▶ managing the amount of time that fish is exposed to temperatures that are favourable for pathogenic bacteria growth and toxin production.

During the drying process, the heat of the sun and movement of air remove moisture which causes the fish to dry. In order to prevent spoilage, the moisture content needs to be reduced to 25 percent or less. The percentage will depend on the oiliness of the fish and whether it has been salted. Sun-drying does not allow very much control over drying times, and it also exposes the fish to attack by insects or vermin and allows contamination by sand and dirt. Such techniques are totally dependent upon the weather conditions. The ideal is dry weather with low humidity and clear skies.

Enzymes

Fish, lobsters, crabs, and all other animals have enzymes inside their stomachs. They help to keep animals alive. After fish dies, the enzymes start to digest or eat it. They eat into the stomach and flesh of the fish and make it soft. Enzymes work faster when the fish is warm. So keeping fish cool or chilled on ice will help slow down enzyme spoilage.

Rough handling

Fish are very easily damaged and must be handled with care both at sea and on land. Throwing, dropping, standing on fish can make it bruised, softened, and result in poor texture for eating. When the fish is damaged this way, bacteria and enzymes can move easily into the flesh speeding up the spoilage process.



Good practice at sea and on land

There are some important rules we need to follow at sea on board and on land before and during processing to stop fish spoilage and make sure the fish are safe to eat. These rules also enable us to produce the best quality dried products:

Be quick

Keep equipment clean

Keep it cool

Keep yourself clean

Keep fish clean

Handle with care

Be quick

The longer the fish are left in the water or on board the fishing boat before it is landed the more time it has to spoil. The sooner the net is hauled in after fishing and the boat reaches the shore – the better the quality of the fish for processing. The sooner processing starts and the fish are dried, the better the quality of the final product.

Keep it cool

The spoilage of fish is directly related to temperature. The higher the temperature, the faster the spoilage. Any reduction in the temperature



prior to processing will maintain the quality of the fish for longer. Fish can be kept cool by being packed with ice. This is an effective method that requires no special equipment and preserves the fish for a longer period of time, however the fish still begins to deteriorate within a few hours.

Put the ice in an insulated fish box with a lid. For every 1 kg of fish you will need at least 1 kg of ice to chill it. As the ice melts, keep adding more as needed, especially if you are storing the fish for a few days.

Ice should be:

- ▶ made from drinking quality water;
- ▶ stored in clean boxes or bags;
- ▶ purchased from a government-approved provider;
- ▶ if water is mixed with ice make sure only clean water is used.

If you do not have ice, then cover the fish with a clean wet cloth/blanket. Keep the cloth wet. The evaporation of water from the cloth helps to keep the fish cool.

Keep fish clean

At sea, on board the fishing boat, as well as onshore it is good to follow these rules:

- ▶ keep fish in a clean place or a proper box;
- ▶ keep fish away from any chemicals such as fuel or detergents;
- ▶ wash fish in clean water as soon as possible before processing to remove bacteria and dirt;
- ▶ keep the boat and processing area clean and free from animals and pests.

Keep equipment clean

At sea, on board the fishing boat, and onshore during processing, packing and storage it is important to:

- clean all equipment (boat, basins, baskets, knives, tables, chopping boards, drying area or racks, packaging equipment, store) before processing;
- use clean fishing gear;
- use only clean pipe or well water, or clean water found offshore;
- inspect equipment regularly for damage and keep in good condition (e.g. drying racks).

Animals (e.g. dogs, cats, rats) should not be allowed in places where fish are handled and processed, dried or stored.

Always dispose of fish waste and rubbish properly, including waste water used for cleaning.



Fish processing

Prime cuts

This section provides instructions for people who would like to produce dried fish products. The guide describes the following steps:

- ▶ handling and processing fish in a hygienic way;
- ▶ filleting;
- ▶ slicing;
- ▶ marinating;
- ▶ drying; and
- ▶ packaging.

The processed and dried products which are shelf-stable food products for human consumption do not require a cold chain and therefore can be transported, stored and sold easily.

Offcuts

The financial viability of any fish processing activities depends on the effective utilization of the offcuts to increase potential income generation beyond just the prime cuts of tuna and other fish.

There are many recipes that utilize offcuts and provide variety of meals for households and for sale. Amongst them are tuna sausages, rolled tuna, tuna samosa and smoked tuna.

These alternative products mostly need to be consumed within a short time frame or stored in cold chain refrigeration or freezing.

Units of measure



coffee mug



tea cup



tablespoon



teaspoon

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Hygiene requirements



When processing fish, you should wear clean clothing. You may wear old clothes can be used, but they need to be freshly cleaned. You cannot care for infants at home, and then immediately start processing fish, unless you change into clean clothes.



First finger nails are cleaned, than hands are washed with soap.

The processing area should be clean. The table and all equipment, knives, cutting boards, containers, buckets must be well cleaned with a sanitizer. To produce a safe and effective sanitizer mix one small lid/cap of a bottle of liquid bleach with one litre of water.



Wash the fish and place on a sanitized processing table. Do not waste water: use your hands or a cup instead of pouring water from a bucket. Reducing volumes of waste water also helps maintain a hygienic processing environment. Please refer to p.36 for a full list of requirements.



Filleting the tuna



With a sharp knife cut along the central bone while lifting the upper loin.



Remove the blood meat and the rib cage.



The tuna loin is laid flat on the cutting board, one knife is used to cut in under and remove the skin. The second knife can hold the tail end secure it.



Then the skin is held by hand while the knife continues to remove the skin.



Another approach to remove skin from tuna is to punch the tip of the knife just under the skin and carefully cut around the meat of the tuna with the knife directly under the skin.



When processing always place tuna fillets/loins with skin down to the process table. Never place the tuna flesh onto the table or surfaces that have scales and fluids from processing.



Slicing tuna with skin

The scales are removed and the fish is washed. The tuna is filleted and placed skin down on a cutting board.





This produces a butterfly type cut where the skin holds the tuna together to become a much larger slice of tuna. This provides a nice presentation even when processing smaller sized tuna. The author learned this technique from the island of Arorae, Kiribati.

Slicing tuna loin with skin removed

Tuna loins can be frozen and then semi thawed, then sliced either with sharp knives concentrating on maintaining a very even thin slice, or using bacon slicer to produce uniform thin slices of tuna.

Mechanical slicing produces higher quality product and due to the accuracy of the slices drying is more uniform and reliable, therefore improved food safety is achieved as every piece of tuna is exactly the same thickness.





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Marinating

When marinating sliced tuna, handle it carefully as fresh sliced tuna is very fragile. Using your hand, splash some marinate into the bottom of a wide basin or a tub, cover the entire bottom with a good amount of marinate, then lay tuna slices flat covering the bottom of the basin, then splash paint these with marinate, when all well colored with marinate

add another layer of sliced tuna. After three or four layers are marinated, take your basin and turn it upside down onto another tray and pass it over to the people loading the drying racks. The marinating time is basically just the time it takes to color the tuna slices on both sides. Carefully handle each individual slice of tuna through the marinate process and when placing onto drying racks.



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Marinades

1

Pepper

Light soy sauce	1/3 coffee mug
Salt	6 g (2 teaspoons)
Sugar	10 g (1 tablespoons)
Black Pepper (fresh crushed pepper corns)	15 g (5 teaspoons)
Fresh water <i>(don't add at one time see how the mix goes)</i>	800 ml (2 coffee mugs)
Minced garlic	1 tablespoon

2

Teriyaki

Light soy sauce	1/2 coffee mug
Salt	10 g (1 tablespoon)
Sugar	50 g (5 tablespoons)
Garlic	2 g (1 teaspoon)
Cumin (fresh crushed cumin seeds)	5 g (2 teaspoons)
Fresh water	800 ml (2 coffee mugs)

3

Chili

Light soy sauce	1/3 coffee mug
Salt	10 g (1 tablespoon)
Sugar	50 g (5 tablespoons)
Chilli paste (hot) or 3 fresh chili, finely chopped	50 g (3 tablespoons)
Cumin (fresh crushed cumin seeds)	5 g (1 teaspoon)
Minced garlic	2 g (1 teaspoon)
Fresh water	800 ml (2 coffee mugs)

Rubbed fish: salt/spiced

4

Salt	8 teaspoons
Chilli powder	4 teaspoons
Sugar	14 teaspoons

5

Salt	8 teaspoons
Chilli powder	14 teaspoons
Tumeric	6 teaspoons



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Drying

The FishFAD solar convection drier with heater back up provides an excellent style of dried product as the drying process is gentle and does not achieve temperatures above 50 °C.

Be careful when selecting a drier design, as some may provide excessive temperatures which tend to harden the surface of the sliced tuna and this can result in a tough texture of product and may destroy some of the natural flavours of the tuna or the marinates.



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Once you load your slices onto the drying racks and commence drying, remember to turn the product over after approximately 1 hour when the top surface of the tuna is not moist. This will prevent the wet underside of the slices being stuck to the drying rack.

When you believe the product is dry, test the pieces by pinching the slices with the tips of your fingers, the product should not be soft or spongy (not dry).



Clear polycarbonate roof sheets, or thick UV-resistant clear plastic, can be used to protect fish on the drying racks during scattered rain showers.

Drying under the clear polycarbonate roofing sheets will increase temperature to over 40 °C which flies cannot tolerate. This is a good method to manage fly problems. Flies are attracted to the fresh tuna meat only on the first day of drying, day 2 and day 3 do not have this problem.



Note that any product that is not dried correctly must be held in some type of cold chain overnight, placed in plastic bags, stored on ice, stored in a solar freezer.

Using passive energy drying systems

The FishFAD project working with Food Stream Australia has developed an appropriate passive energy drying system to help improve food safety when drying tuna in rural locations, that may not have any cold chain facilities. The potential to be able to reliably control the drying process means improved food safety is achieved as all product can be dried in an appropriate time frame. We must remember that fish that is not being dried continuously may not achieve a water activity below 0.8 Aw that may cause development of dangerous bacteria, even botulin.





The heat energy store has a clear acrylic lid to allow a high temperature build up inside the energy store during the sunlight hours. At night the clear acrylic lid is removed and the energy store insulated lid is closed.

The fire box has a sealed lid so the chimney smoke goes down in under the energy store and returns back out and up the chimney. This heating system is used at night or when there is extended rain periods.

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Packaging

It is very important to follow good hygiene and sanitation practices when handling dried tuna, as this is a point of easy contamination. The product has been dried in the sun and sanitized by the sun, good practices must be adopted with dried product.

Dried product should be held overnight in a large plastic bag or fish tub with a lid. This will help equalize the moisture throughout the product. Dried tuna should not be packed in vacuum packed pouches. A simple well sealed plastic pouch will allow further equalization of product when packed. The drier pieces of tuna will absorb the moisture from pieces that are not completely dry. A simple well sealed plastic pouch will allow further equalization of moisture within the product.



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A commercial packaging process has a table designed to hold tubs of dried fish, where dried pieces are trimmed, weighed and sealed in attractive labelled pouches. The table work flow should be organised to ensure no double handling of product.

Fish offcuts processing

Tuna sausages

Tuna sausages are an excellent utilization of fish offcuts. Scrape the fresh meat off the bones of the tuna and take all the little pieces of tuna meat, some blood meat can be included. Chop the tuna meat into very small pieces with a knife, its not a difficult job, you do not need a mincer.

Synthetic sausage casings are readily available, ensure to use edible synthetic casings that do not require refridgeration.



Ingredients

minced tuna	1 kg (tuna is finely chopped with a knife on a cutting board)
cooked rice	$\frac{3}{4}$ coffee mug, chopped with knife on cutting board
cooking oil	$\frac{1}{3}$ coffee mug (olive oil is the best, but can be substituted with vegetable oil)
salt	1 heaped tablespoon
cumin seeds	4 teaspoons, freshly crushed
black pepper corns	5 teaspoons, freshly crushed
garlic	5 teaspoons, minced
light soy sauce	3 tablespoons
milk powder	2 tablespoons
ice water	1 $\frac{1}{2}$ coffee mugs (add slowly to avoid the mince getting too mushy or sloppy)



Rolled tuna

Another method to utilize tuna offcuts is to chop the offcuts very fine with a knife, add a marinate and then roll to required thickness (3 to 5 mm). Use any of the marinade recipes provided on p. 20.

In the picture two red cutting boards maintain an even thickness of the roll, two pieces of plastic are lightly rubbed with vegetable oil to prevent tuna meat sticking. Once the tuna meat is rolled evenly, place on a drying rack and remove the top piece of plastic, let it dry for about 30 minutes and then flip it over carefully and remove the last piece of plastic.

These dried sheets of tuna are cut into jerky style strips, then packaged and marketed as the tuna jerky cuts.



Tuna samosa

Boil the tuna bones, and offcuts/gill area, head, cheeks etc. Add a little amount of vinegar. Boil to the point when the meat comes off the bone. Cut garlic and onions fine, crush fresh or roasted cumin seeds (to roast cumin seeds lightly heat them in a pan).

Combine, flour, salt and warm water. Mix and turn into a dough. Roll out very thin. Place a standard size dinner plate on the dough and cut around the plate to have a plate size disc of pastry. Lightly heat both sides of the pastry disk in a non-stick frying pan with no oil, then cut it evenly into three triangle-shaped pieces. Turn the pieces of pastry into a cone shape: wet your fingertips with water to make the pastry joins stick, stuff the samosa and then fold

the lid over and glue in place (with water on your fingertips). Deep fry samosa in vegetable oil.

Ingredients

Pastry

all purpose flour	2 cups
cooking oil	3 tablespoons
salt	1/2 teaspoon
warm water	1/2 cup (add slowly until suitable dough for rolling)

Filling

tuna offcuts	1 kg, cooked, finely chopped
fresh cumin seeds	2 tablespoons, crushed
minced garlic	1 tablespoon
chili	1 tablespoon, finely
chopped onion	3 tablespoons, finely chopped



Smoked tuna

A simple used 200 l drum smoker will produce a nice product. In this picture there is a second 200 l drum around the first drum: this provides insulation and improves the efficiency of the smoking process. Note that there is a fire box in the base and a metal baffle with holes above the fire to prevent flames reaching any product.

The smoker pictured has three levels of shelves supported by 10 mm steel rod punched through the drum sides. For cold smoking, very little smoke is required, in the fire box at the base, use very small amount of coconut husk and only have it smoldering to maintain a temperature of below 34 °C.

For hot smoking simply increase the amount of fire and smoke.

Method:

To prepare the brine mix 6 tablespoons of salt in 0.5 l of water

Marinate thinly sliced tuna in brine for 15 minutes. Tuna with skin has to be marinated for 25 minutes.

Rinse tuna lightly and place in solar drier for 45 to 90 minutes until tuna becomes tacky. Then place it into smoker (black pepper can be sprinkled onto the product at this time).

Cold smoke at the temperature no higher than 35 °C for 8 to 10 hours.



Option A: pack in plastic pouches and store in refrigerator to be sold as a product that must be cooked.



Option B: dry tuna in a solar drier for 2 to 3 days and package as a shelf stable product. No refrigeration required

Hot smoke between 80 to 90 °C for 2–4 hours.

Cooled smoked fish must be refrigerated and eaten within 2 to 5 days or frozen for longer storage periods.

Micro-canning tuna

Must be supervised by suitably trained people



Canning jars/mason jars/wide mouth jars with special single-use lids and bands are washed well. Or tin cans are made ready.



Tuna is cut to the correct length to fit the jars or cans.



The tuna is weighed to match the size of jars or cans being used. Water is added to the correct height as marked on the jar's or to suit the cans. Salt and vegetable oil can be added. A spoon is placed down into the jar or can to ensure any air is released from around the tuna pieces.



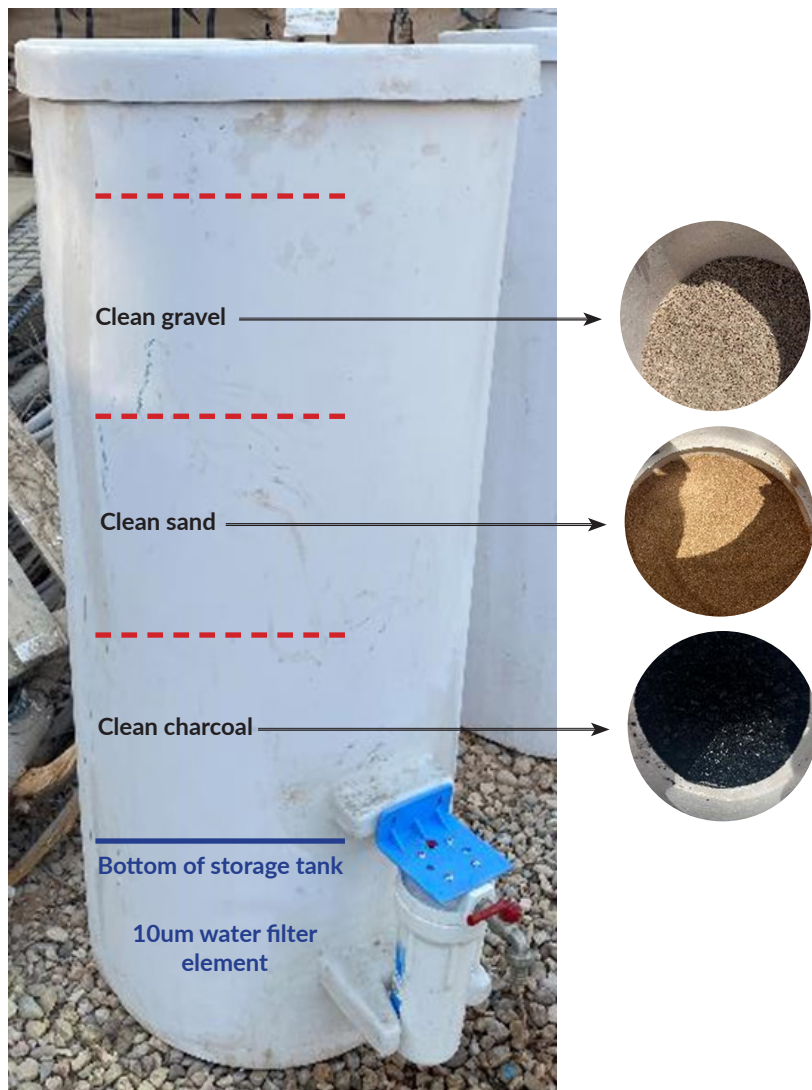
Cans are sealed with a hand seamer, suitably trained people to ensure the seamer is functioning correctly to achieve a good seal of lids.



It is extremely important that only **correct canners are used for any micro-canning**. Household pressure cookers are not suitable and cannot reliably achieve a food safe canned product.

Water filtration

Safe water is essential for any fish processing operations. Below is a simple filtration system that can help ensure safe water is available.



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Solar freezers



Throughout the Pacific we are seeing extensive use of solar freezers for storage of fish.

The picture above highlights major concerns for food safety when large volumes of fresh tuna are placed at once into a solar freezer. It is impossible for any level of control of quality/food safety of the tuna in this situation, tuna in the center may not achieve an acceptable level of cooling for many hours, in fact these tuna in the center could be badly spoiled and pose serious risk to food safety after a few days.

Shelves inside the freezer would help to space out the fish so that cold air can circulate throughout freezer compartment. Prefrozen blocks of ice would greatly assist the freezer to achieve better cooling conditions for the stored tuna.

Methane digesters

When designing semi-commercial fish processing facilities, consideration should be given to use of a methane digester of appropriate size to effectively manage waste and provide access to liquid fertilizer for gardening and gas for cooking.





Sanitation Standard Operating Procedures (SSOP)

Small-scale fish processing FishFAD

Aim: To provide consumers with safe good quality food that is good value for money.

Facility

- ▮ floors, walls, ceilings, window frames, doors and all equipment kept clean;
- ▮ water used in food processing must be portable, non-portable water can be chlorinated 10 mg per litre for cleaning.

Staff hygiene

- ▮ a high standard of cleanliness of all staff working within the premises;
- ▮ suitable light coloured clean clothes to be worn by staff;
- ▮ fingernails scrubbed every morning and after every toilet visit;
- ▮ no jewellery, nail polish, perfume;
- ▮ small cuts are well-covered with waterproof dressing;
- ▮ no smoking, spitting, picking nose, food or drinks in any processing area;
- ▮ stay home if you are sick, including diarrhoea, chronic sore throat, infected wounds.

Cleaning and sanitation

All fish handling surfaces, tables, fish boxes, knives, cutting boards and other items cleaned and sanitized frequently.

Fresh fish

All fresh fish stored and prepared with adequate quantities of ice.

Frozen products

Rapid reduction in temperature to -18°C

Processed products

- ▶ keep a register of the processing operations and associated processing conditions;
- ▶ fish smoking and drying carried out in separated locations;
- ▶ fish not to be dried on the ground;
- ▶ all ingredients must be clean and stored in suitable packaging to prevent contamination;
- ▶ after smoking or drying, products cooled and stored in suitable containers to prevent contamination;
- ▶ package products in suitable packaging that is strong enough to protect the product.

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