Manual on hygienic ice production for the small-scale fisheries sector in Timor-Leste

Module 4

Introduction of the cold chain principle

in the Timor-Leste

small-scale fisheries sector

Regional Fisheries Livelihoods Programme for South and Southeast Asia (RFLP)

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"This publication has been made with the financial support of the Spanish Agency of International Cooperation for Development (AECID) through an FAO trust-fund project, the Regional Fisheries Livelihoods Programme (RFLP) for South and Southeast Asia. The content of this publication does not necessarily reflect the opinion of FAO, AECID, RFLP, or the Ministry of Agriculture and Fisheries of Timor-Leste."

Introduction

The cold chain is a technical term used to describe the conservation of a commodity or product intended for human consumption, within a low temperature range from the point of harvest to the time it reaches the consumer. Correct implementation of a cold chain system ensures food safety at each stage in the supply chain beginning with capture or harvest of aquatic products until final consumption by the consumer.

The cold chain is used in small-scale fisheries to maintain the aquatic product within a temperature range of between + 4 °C to 0 °C, using ice and/or in combination with other chilling systems, observing proper catch handling techniques from the time of capture or harvest until the product reaches the consumer.

This document provides information on how to start and maintain a cold chain system appropriate for use by small-scale fisheries, and describes the procedures and equipment required to do so.

Sequence

The diagram below illustrates the step-by-step actions that small-scale fishers need to follow in order to ensure sound food safety principles, and to keep their aquatic product within the correct cool temperature range.

CHILLING
Apply ice to the gutted, cleaned catch immediately after harvest. When using direct icing for chilling, the catch should be placed inside a catch storage box on top of a layer of ice approximately 30 mm thick and covered with approximately 60 mm of ice on top and 30 mm on all sides. Fill the stomach cavity with ice to quickly lower the catch temperature. When using chilled sea water (CSW) for chilling, the catch should be placed carefully and fully submerged, into a 50% ice / 50% seawater solution. Check the ice melt regularly at intervals of 1 hour or less, and replenish the ice as necessary to compensate for ice melt. This activity is the starting point of the cold chain. The catch temperature should drop to between + 4 °C to 0°C after approximately 20 to 40 minutes depending on the size of the fish and the thickness of the flesh.

TRANSPORT
During transport from the fishing grounds to the landing site, it is necessary to check the melt-down rate of the ice and to keep the ice uniformly distributed over the catch. If the weather is rough, prevent the catch from moving around inside the dedicated storage area or compartment, to avoid damage. Keeping the catch well iced will ensure that the catch temperature is maintained within a range of between + 4 °C to 0°C.

HANDLING
Avoid prolonged exposure of the catch to direct sun light, heat, and wind. If possible, after registration and grading keep the catch well iced and in insulated containers stored in a shaded place. Always handle the catch with respect and care, in order to avoid physical impact and damage to the catch.

The length of the cold chain depends on the number of processes and steps the product or commodity has to pass through from harvest, until it reaches the consumer.

Key elements in the cold chain

Start of the cold chain

The chilling process commences moments after the catch has been harvested from the sea. Chilling is best done using ice, either by applying it directly to the catch, which is called 'direct chilling', or by fully submerging the catch into a 50%/50% mixture of seawater and ice, called 'chilled sea water' and known as CSW chilling. The quick lowering of the temperature is important to slow down the growth rate of any spoilage bacteria which are present on the surface of the catch, and to slow down enzyme reactions. Ice used in small-scale fisheries must be made from water of drinking water quality, or clean sea water, meaning it is free of biological and chemical contaminants.

Ice types which can be used for small-scale fisheries include:

Type of ice	Mass	Surface area	Melting capacity
Block or plate ice	Large	Small	Slow action
Crushed and nugget ice made from block ice or by machine	Medium	Medium	Medium action
Tube or cube ice	Medium	Medium	Medium action
Flake ice/scale ice	Small	Large	Rapid action
Slush ice	Large	Liquid	Ultra rapid action
Dry ice	Small	Large	Ultra rapid action

Chilling methods

Chilling can be achieved by by the use of:

- Direct chilling is the most convenient method for large sized catch species. All types of ice can be used for direct chilling, but slush ice and flake ice are the most efficient direct chilling methods followed by crushed ice and chunked block ice. Tube or cube ice is the least efficient ice type for this chilling method. However it has the advantage that the mass in relation to the exterior surface is low so the melt process is slow making it better suited for longer periods of preservation.
- Chilled sea water (CSW), which is a mixture of block ice in chunks and sea water in a 50%/50% mixture. Smaller sized fish species, like scads and sardines are most conveniently

chilled using CSW, because they are usually caught in such large volumes, that it is impractical to individually gut and clean them. Larger fish, which have significant muscle tissue bulk, can first be pre-chilled using CSW and then moved into direct ice chilling to save ice.

- Slush ice is also by definition a CSW chilling method, but it is seldom seen in small-scale fisheries, because it requires special transport equipment and is expensive to produce.

Depending on the size and thickness of the flesh and its fat content, the temperature should drop rapidly from the prevailing sea water temperature to approximately +4^{0}C to 0^{0}C in a matter of 30 minutes, or even less if the mixture is agitated or stirred.

It is crucially important to replenish the ice regularly to maintain the cold chain at the appropriate temperature, regardless of which type of chilling system is used. Once a cold chain is established, documented and validated, it forms the basis for a value chain and allows tracking and tracing of the aquatic product. Cold chain documentation is best done at the catch landing site, where the National Directorate of Fisheries and Aquaculture (NDFA) representative will register the catch temperature before the catch is weighed.

Key elements for establishing a value chain

The primary reason for establishing a cool chain is to ensure food safety. However there is significant link between the establishment of a cold chain and the establishment of a value chain, because cold chain documentation will prove that the product has been kept at the correct temperature and is therefore likely to be safe for human consumption. This cold chain documentation can add value at the landing site or fish processing plant, because thereafter only a simple quality control check and grading is required, before the product can be packed and exported. This additional product value will financially compensate small-scale fishers for the extra effort and investment in the purchase of ice.

For cold and value chain implementation in small-scale fisheries it is imperative that ice must be readily available at local landing sites and auction centres, at affordable prices for small-scale fishers.

Small-scale fisheries boats should be designed and sized to allow incorporation of thermally insulated catch storage boxes, containers, compartments or areas, which meet basic hygiene requirements, and fisheries legislation requirements.

The off-loading and auction system at the landing site must be well defined, and legalized, with the landing site managers and local small-scale fishers trained on the implications of establishing an auction system.

Finally the authorities must ensure that the cold chain can be documented. This will be necessary for export facilities such as processing plants to provide export documentation which satisfies the requirements of importing countries/markets.

The importance of cold chain establishment

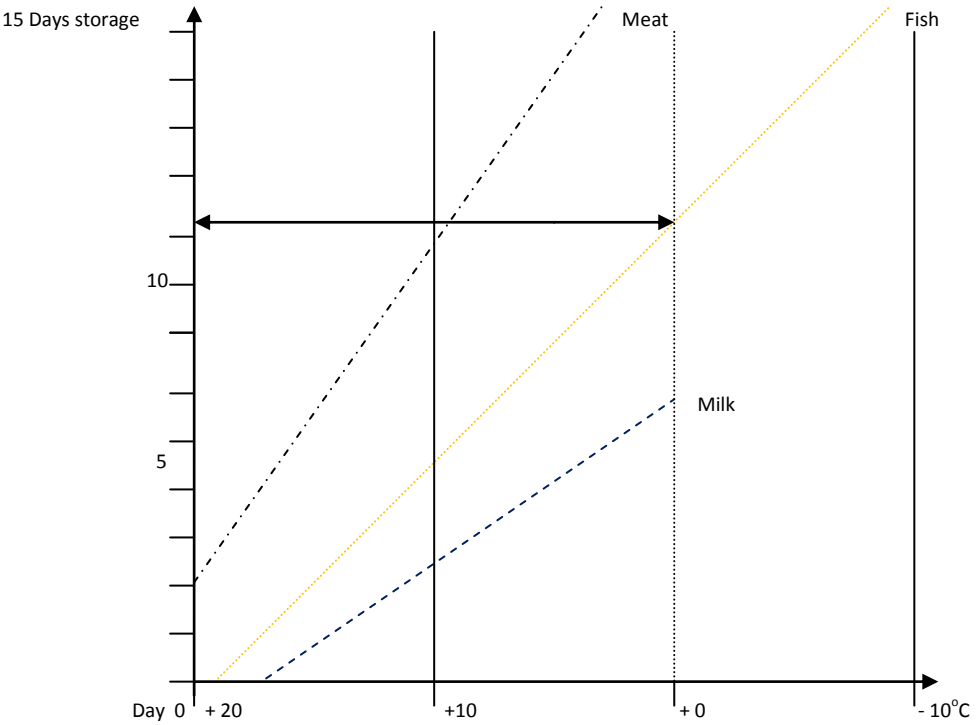


FIGURE 1 Typical spoilage curves for different types of commodities

Figure 1 illustrates the approximate typical and expected spoilage curves of meat, fish and milk at different temperatures over time. The curves are not 100% accurate and will vary slightly, but they provide a good indication of expected spoilage rates. The figure shows that if fresh fish is kept at 0°C, it will only begin to degrade after over 10 days storage, if the cool chain integrity is maintained, i.e. there is no break in the chain.

Photo series

Start of a cold chain using direct icing after gutting on September 29, 2010. The catch was delivered from Oecussi district to Dili and was at the time of gutting estimated to have a post-harvest age of between 3 to 4 days. The fish were gutted at MAF and the cold chain was started at 17.00 hours.

Fish stored using direct icing, 5 to 6 days after harvest.

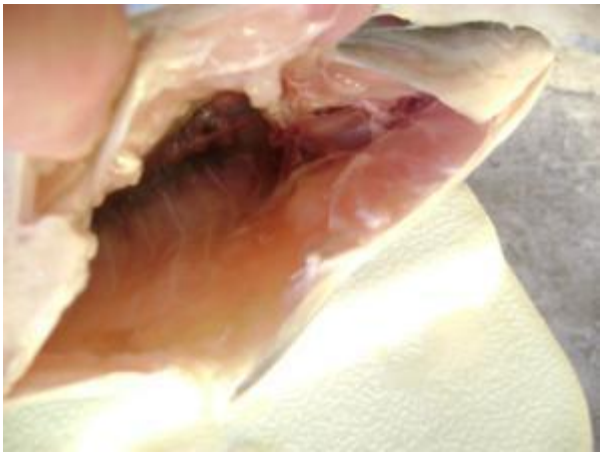
Fish stored using direct icing, 7 to 8 days after harvest.

Fish stored using CSW icing 7 to 8 days after harvest.

Fish stored 7 to 8 days using direct icing and then 3.5 days stored in CSW, i.e. 10.5 to 11.5 days post harvest.

A typical set of fish gills following 7 to 8 days storage using direct icing and then 3.5 days stored in CSW.

The gills have no odor and there is an insignificant amount of slime. The gills have lost their natural color, because of the long exposure to ice storage and being submerged in CSW for 3.5 days.



Fish flesh after 7 to 8 days storage using direct icing and then 3.5 days stored in CSW.

The flesh is still firm to the touch and has a good, transparent color and a slightly sweet aroma associated with sea weed.