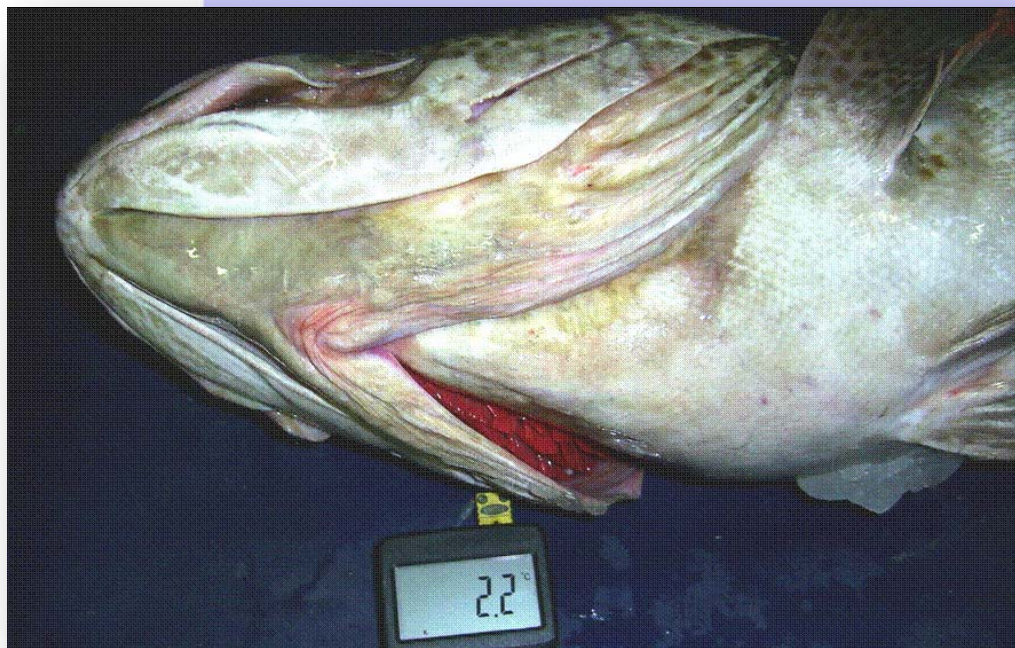


Handbook on High Value Fish Handling



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TRAINING DEPARTMENT

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Foreword

This Handbook is an offshoot of the project on Post-harvest of Under-exploited Resources conducted by the Southeast Asian Fisheries Development Center/Training Department (SEAFDEC/TD) based in Samut Prakan, Thailand. This Handbook aims to promote the accumulated knowledge at SEAFDEC/TD on the various aspects of fish handling technology for small- and medium-scale fisheries in the Southeast Asian region.

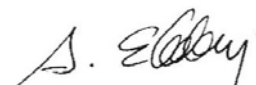
At present the limited fisheries resources and increasing cost of fuel make it necessary to improve post-harvesting techniques and handling skills in order that the fish caught from the source meet the high quality of freshness being asked for by the customers. The freshness of the fish is very important and has become a major concern in the fishing industry. Fish is difficult to be kept in preserved form for a long period of time. Recently, refrigeration system has been introduced to preserve fish onboard fishing boats, with features that include ice making machine, seawater chilling system or freezing system as auxiliary features. Thus, fish handling technique combined with simple refrigeration system has also been promoted for the local fishermen in Southeast Asia to enable the fishers to properly preserve the quality of fish and to improve their incomes.

However, SEAFDEC/TD observed that the reduced quality of the fish is mostly due to human handling skills. Onboard the fishing vessels, after the catch has been sorted, the high quality fish is iced in boxes and stowed in the hold while the trash fish portion is usually mixed with ice and stored in the bulk. The fish are often forced into the ice boxes and stowed in such a way that the weight of the upper layers is passed on to the lower portions, causing bruises to the fish and in some cases bacterial contamination could even occur.

The fish boxes and holds are washed down in ports with unclean water. The fish is emptied from the boxes directly into jetties and sorted for sale. Fish destined to far flung markets is sent by road or rail packed into large boxes. Most often than not, the boxes which could last for may be ten or more journeys become very dirty as they are not well cleaned before and after use, and are recycled and re-used.

Fish processing which has been promoted in the Southeast Asian region is also a means of preserving the fish. In order that the fishery products are safe for human consumption and at the same time meet the quality standards required by the export markets, it is important that the raw materials used in producing the fishery products are of good quality. This brings down to the need to preserve the fish in its fresh form onboard the fishing vessels to ensure that the fish and fishery products that are derived from these raw materials are safe for human consumption.

In this Handbook, SEAFDEC/TD outlines the best management procedures in preserving the freshness of the fish from the fishing vessels until the fish is prepared for the markets.



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Appropriate Fish-handling Technologies

Chilling and keeping the fish with ice is a very simple technique in fish handling operation. The use of ice and insulated containers has been practiced in both developed and developing countries for a long time. Onboard the fishing vessels, chilling the fish with refrigerated seawater or a mixture of ice–seawater is the most common handling system. The procedures involved in this process are summarized in the following guidelines:

1. Preparation and handling procedures



- a. Maintain and keep the facilities onboard fishing vessels clean and hygienic especially while handling fish (Fig. 1). Hands and gloves should be washed before handling the fish or before entering the fish hold.

Figure 1. Fish handling onboard the M.V. SEAFDEC

Smoking, drinking or eating in working areas or while handling fish should be prohibited. Wear clean clothes, and do not cough or sneeze near the fish or containers. Animals (pets or stray) should be prohibited from entering the working areas.



- b. Make sure the deck and fish hold is cool and clean before hauling the fish onboard (Fig. 2). If the deck surface is hot when fish is about to be hauled, cool it down first by pumping in seawater. This will keep the deck cool and prevent the temperature of the fish from rising.

Figure 2. Preparing the M.V. SEAFDEC 2 for onboard handling with the use of a deck hose to cool down the working area



The increased temperature of the fish will affect its quality and reduce its shelf life. A rubber mat could also be used to protect the fish from a hot deck, and if necessary spread ice over the mat.



Fig. 3A

This would lead to bruising the fish or reducing its subsequent value. Throwing fish to the containers should also be prohibited. Place the baskets or containers near the fish and the handlers of the fish should stay as close as possible instead (Fig. 3A, 3B).

c. Take gentle care while the sorting and handling of the fish proceed, in order not to damage the fish on deck. While handling fish, do not walk over the fish or step on it or trample the saleable fish.



Fig. 3B

Figure 3A. and 3B. In taking care and in gently handling the fish, fish baskets are prepared and placed near the sorting operators for onboard handling, as in the M.V. SEAFDEC 2

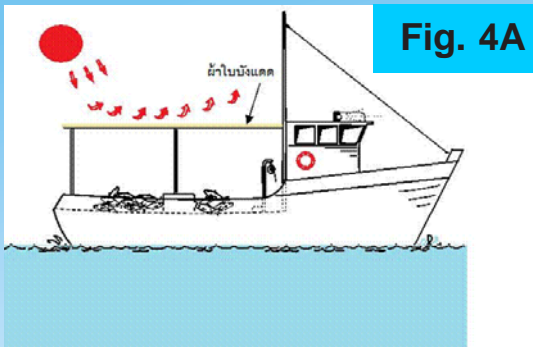


Fig. 4A

d. Avoid exposing the fish to direct sunlight and wind while handling on deck (Fig. 4A, 4B). To keep the fish cool, wash the baskets of fish gently using a deck hose.



Fig. 4B

Figure 4A. A protection sun roof in the handling area is recommended to avoid exposing the fish to direct sunlight and wind

Figure 4B. Heat gain on fish while handling under sunlight without sun roof protection

Sorting of fish on deck should be completed as quickly as possible in order to minimize exposure to sunlight and wind. Washing is needed to cool down and reduce the number of bacteria that could contaminate the fish.

Fig. 5A



The lag time of efficient cooling would lead to more rapid spoilage of the fish as well as loss of its freshness and shelf life.

- e. Do not overload fish boxes or fish baskets.

Avoid overloading the fish box or container (Fig. 5A). Overloading the fish box or container will affect the fish scales or break their skin. When fish are pressed, they are exposed to early deterioration due to attack of bacteria, and could lead to increased number of bacterial growth (Fig. 5B).

Fig. 5B



Figure 5A. Loading of fish with cooling medium should be just enough to fill the box size (not overflowing)

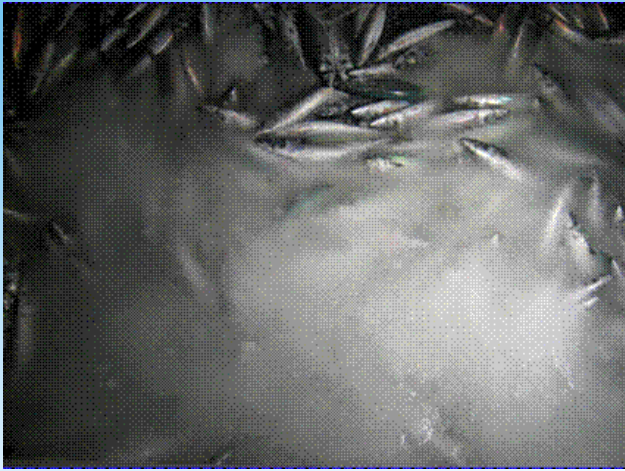
Figure 5B. Overloading containers with fish will cause slow cooling of the medium and could break the skin of the fish due to weight pressure.



- f. Fish should be cleared from the deck after handling. Keep the working area clean and ensure that no fish are trapped in the deck corners. Deck, fish hold, container boxes, hand gloves, and other fish handling equipment should be washed and scrubbed after each operation (Fig. 6).

Figure 6. M.V. SEAFDEC2 crew cleaning all fish handling equipments and deck area with deck hose after each operation

2. Preservation of fish



- a. Chilling fish should be the first priority. Fish should be placed quickly into chilled water as soon as possible, net repairs should not be a priority and not allowed at this time.

Place the cleaned fish into cold chilled seawater immediately within 40 min from landing (Fig. 7).

Figure 7. Fish is placed immediately into slush chilled seawater at 4°C

- b. Chilled ice-seawater should be kept clean with the water temperature maintained at about -3 to -4 C before fish are added (Fig. 8A, 8B).

Fig. 8A

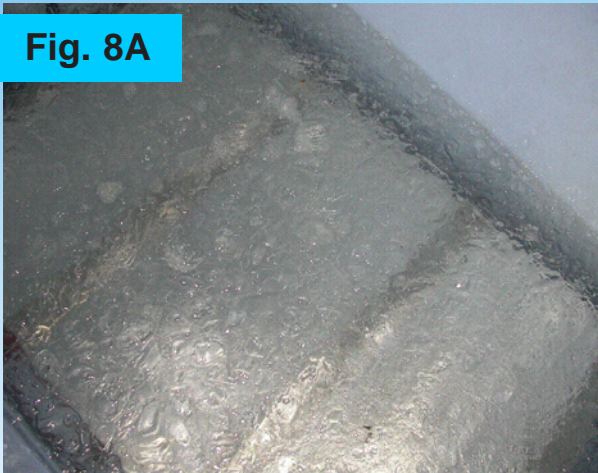
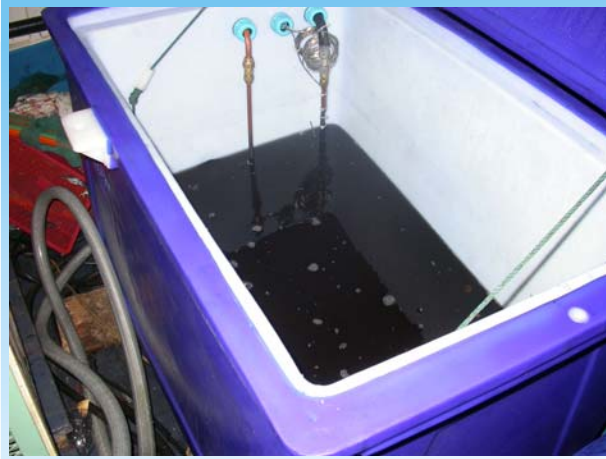


Fig. 8B



Figure 8A Clean chilled ice-seawater, **Figure 8B.** With temperature maintained at -4 C

The temperature and cleanliness of the chilled ice-seawater should be monitored to ensure that each new batch of fish is rapidly cooled without overloading the system.



Replace chilled water and ice if needed after each operation or when water is discolored indicating contamination from earlier loads of fish or squid (Fig. 9). In case refrigeration is used, ice build up on refrigeration plates or coils in chilled tanks should be removed or defrost.

Figure 9. Dirty chilled ice seawater containing ink from squid, must be replaced for the next operation



c. As soon as fish is thoroughly chilled, fish should be transferred from the chilled tank to the container box and packed with crushed ice in storage room or refrigerated storage room within 8 hours after adding the fish to the chilled water. If this process is delayed, water and salt will permeate to the fish.

Fish should be removed from the chilled water when the temperature at the center of the fish container is reduced to about -1 °C (Fig. 10).

Figure 10. Chilled fish to be removed and transferred to cold fish hold.

Transfer the fish into the working room for packing or storage (with ice or freezing). These processes should be conducted quickly within 15 minutes, to avoid the warming up of the fish or possible contamination from the dirty surface.



d. Temperatures of chilled tanks, storage room and fish should be monitored and recorded to ensure that fish is preserved at correct temperatures (Fig. 11).

Figure 11. Temperature of fish 4 and half hours in slush chilled seawater down to 2.2°C



Regularly monitor and record temperatures of the chilled tanks, holding room and fish (Fig. 12). Ice should be added when required to lower the fish temperature down to -1 °C within seven to eight hours.

A compressor may be used if additional ice as required.

Figure 12. Check and maintain the temperature of chilled slush seawater which should be within the range between -3°C to -4°C

3. Ice required for chilling fish

The ratio for mixing ice, water and fish in insulated or chilled tanks vary depending on the climate temperature. FAO Fisheries Circular No. 773 (FAO, 1984) gives the following ratio for tropical climates;

1kg water: 2kg ice: 6kg fish

The amount of ice, fish and seawater necessary to chill fish can be calculated using the following equation.

$$I_w = \frac{(S_w + F_w)S_t}{80}$$

Where:

- I_w = The amount of ice required for chilling fish (kg)
- S_w = Seawater weight for chilling fish (kg)
- F_w = Amount of fish needed to be chilled (kg)
- S_t = Seawater temperature (°C)
- 80 = A power of ice to make chilled water close to 0 °C (Latent heat of fusion of ice)

Example: A necessary ice required to chill fish 300kg from initial temperature(28°C) to 0°C can be calculated using equation as above mention as following

$$Ice = \frac{(50+300)28}{80} = \frac{9800}{80} = 122.5 \text{ kg}$$

Conclusion: Ice about 122kg and seawater 50 liters required to chill fish from 28 degree (seawater temperature) to zero degree Celsius

4. Ice required to preserved fish at 0 C

The Table below shows the weight of ice needed to cool down 10 kg of fish to 0 C at various ambient temperatures.

Ambient temperature	Weight of ice needed
°C	kg
30	3.4
25	2.8
20	2.3
15	1.7
10	1.2
5	0.6

Source: FAO, 1984

5. Chilling operation



- a. The temperature of the chilled ice-seawater should be down to -3 to -4 C and it should be prepared at the time when the boat arrive the fishing ground.

A mixture of 2 parts of ice and one part of seawater will preserve six parts of fish down to 0 to -1 C. Fish will not freeze at this temperature while there is no risk of partial freezing and related quality loss (Fig. 13).

Figure 13. Squid in chilled box is placed in ice seawater in chilled tank

- b. Ice seawater should be well stirred or circulated by pumping. Temperature in the top surface may differ from the deeper layers due to the different specific gravity of the seawater and freshwater in the ice mixture. Thus, to maintain salt density concentration, about 2 to 3% of salt by weight of the ice should be added (Fig. 14A, Fig. 14B).

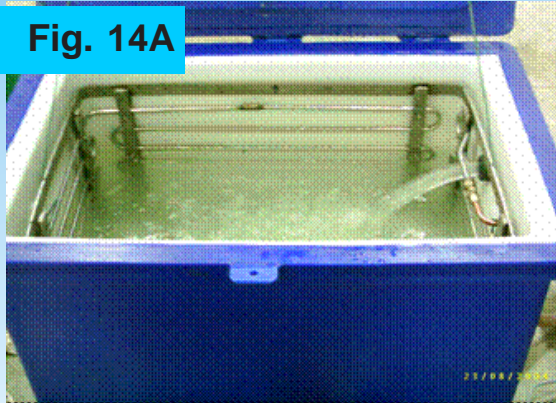
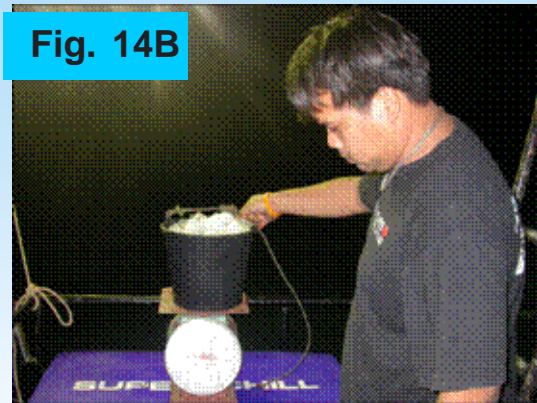
**Fig. 14A****Fig. 14B**

Figure 14A. A circulation pump is used to improve the chilling efficiency,

Figure 14B. Salt is added to maintain the seawater gravity of chilled ice seawater system



- c. Before chilling the fish in chilled ice seawater, fish should be washed and cleaned.

Fish landed onboard should be washed immediately with clean seawater to remove mud, slime and blood (Fig. 15). This is particularly important for fish caught by trawlers.

Figure 15. Deck hose is used not only for cleaning but also to cool down the fish temperature before chilling

Chilled tank for chilling fish should be insulated, water tight and large enough to avoid damage of fish bodies due to collision into each other or due to the rolling and pitching of the boat. In large boats, several small pools are used which have shown to be more effective.

6. Storage temperature

The recommended storage temperature for all common frozen fishery products is minus 20 °F or -30 °C. Bacterial action is completely arrested at this temperature. Storage temperature of fresh fish (unfrozen) is maintained at 0 to -1 °C

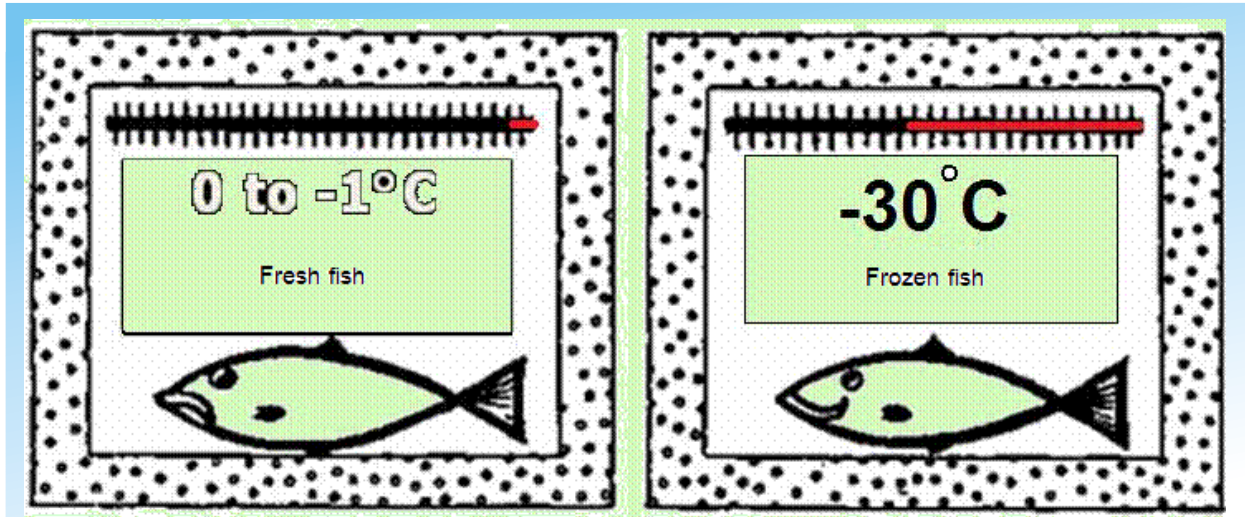


Figure 16. Recommended temperature of unfrozen fish hold (left) and recommended temperature of frozen fish hold (right)

7. Fish unloading and handling

- a. Unload fish quickly, and avoid unloading during the hottest period of the day.
- b. Check and record the temperature of each product to be transported.
- c. Transport to be used should be an insulated container to avoid excessive temperature. The door should be closed in between loading of each pallet.
- d. In case of long distance transportation where refrigerated container is used, loading the fish and the trip should start early in the morning to keep the fish cool and to ensure that the truck is cold when fish are loaded.
- e. In arranging and cleaning the fish or container at the port, do not use water from the port area as the water quality may be poor. This will prevent the rapid spoilage of the fish by bacteria contamination from the water.

The calculation of refrigeration requirement for cooling fish, by mean of heat to be removed (H) as the following equation is used.

8. A simple calculation of compressor requirement

The calculation of refrigeration requirement for cooling fish, by mean of heat to be removed (H) as the following equation is used.

$$H = [(M_f \times C_p) \times (t_s - t_e)] / h$$



Where

H	=	heat of fish to be removed during cooling (kcal)
Mf	=	mass of fish (kg)
Cp	=	specific heat of fish (0.8 kcal/kg °C)
ts	=	initial temperature of fish (°C)
te	=	final temperature of fish (°C)
h	=	time requirement to freeing all of fish from initial temperature to final temperature

Example:

Find the amount of heat is required for cooling fish 10 tons from climate temperature (30°C) to -30°C within 8 hours

$$\begin{aligned} H &= [(Mf \times Cp) \times (ts - te)] / h \\ &= [(10,000 \times 0.8) \times (30 - (-30))] / 8 \\ &= 60,000 \text{ Kcal/h} \end{aligned}$$

Therefore: Heat about 60,000 Kcal/h is required to remove heat from 10 tons of fishes by refrigeration system.

9. Squid handling Technique

For onboard squid preservation in small fishing boat, the chilling technique using chilled ice-seawater at low temperature as mentioned above is recommended. In addition, some specific techniques for handling squid onboard are outlined below:



- a. Handling process starts when the squid is hauled onboard. Squid is sorted gently, weighed and washed with clean water (Fig. 17)

Figure 17. Squid is sorted and washed with clean seawater.



Squid has a special substance not found in fish. This substance is known as ink. Live squid is always spread with ink, which affects its chilled quality. Thus, leave the squid for 20 to 30 minutes to completely stop the spread of its ink (Fig. 18).

Figure 18. Waited until its is completely stop the spread of its ink.



- b. Preparation of squid before chilling in chilled seawater, wash squid with clean seawater and leave squid for about 20 to 30 minutes and finally wash the squid again with seawater to remove the ink (Fig. 19).

Figure 19. After squid has completely stop spread of its ink , wash again with clean seawater



- c. Chilled basket with cover plate on top should be provided. Before chilling the squid in chilled ice-seawater, it must be cleaned in order to reduce the amount of ink in the chilled water. This ink will discolor the squid and reduce the quality of the chilled water. In placing the cleaned squid in chilled basket, do not over load the basket or container (Fig. 20). Before taking the squid to the chilled tank, squid must be cleaned and make sure it is without contamination.

Figure 20. Cleaned squid in chilled basket

- d. Leave squid in cold chilled ice-seawater with temperature maintained at about -3 to -4 °C for 4 to 5 hours, at this time the temperature of the squid should be about 0 to -1 °C but the squid is not frozen (Fig. 21).



Figure 21. Round shaped squid after having been chilled for 4 hours in chilled seawater (in Rayong Province)

- e. After the squid is completely chilled, there are two ways of preserving the quality of the fresh squid: one is by using crushed or flake ice, and another is by refrigeration system. For a small-scale fishing boat, when the fishing ground is near the shore, ice is used to preserve the squid instead of a refrigeration system.

A method of preserving the squid with ice after complete chilling, makes use of a very thin plastic to cover the top of the squid basket before ice is placed on top and storing the basket in ice cold storeroom onboard (Fig. 22).



Figure 22. Preserving squid with ice after completely chilled by using very thin plastic to cover the top of squid basket



Figure 23. Squid left for 4 hours in chilled tank and frozen onboard at -30°C



Figure 24. Squid preserved with ice for 10 days in ice storage room but without pre-cooled (chilling) process



Figure 25. Squid preserved with ice for 10 days in ice, in the same storage room but underwent 4 hours pre-cooled (chilling) process with chilled ice-water



Figure 26. Squid preserved with ice for 10 days with 4 hours pre-cooled (chilled in ice-seawater) process with freezing temperature maintained at -30°C

Conclusion

Onboard freshness preservation of fish by chilling below freezing point before freezing is the best process. The temperature should be about -25 to -30°C . Squid frozen for 10 days could maintain its freshness as indicated by its k-value at 42.63% and the accepted score of its physical form at level 9. These results are nearly the same as the quality of fresh squid compared with the quality of 1 day squid which indicated a k-value of 38.89%.

From this case study, squid chilled in cold seawater and preserved with ice for a period of 10 days is better than only icing the squid. The result of the former indicated a K-value of 62.92% and physical form acceptance at 7.75 level mark. Squid which is preserved in ice without chilling had a K-value of 66.12% and physical form acceptance level of 6.68 marks.

Note and Recommends for onboard fish handling

Maintaining freshness by chilled and icing technique or refrigeration system with temperature below the freezing point of about -3 to -4°C for a period of 3 to 7 hours before handling with ice or freezing, is recommend to preserve fish onboard.

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