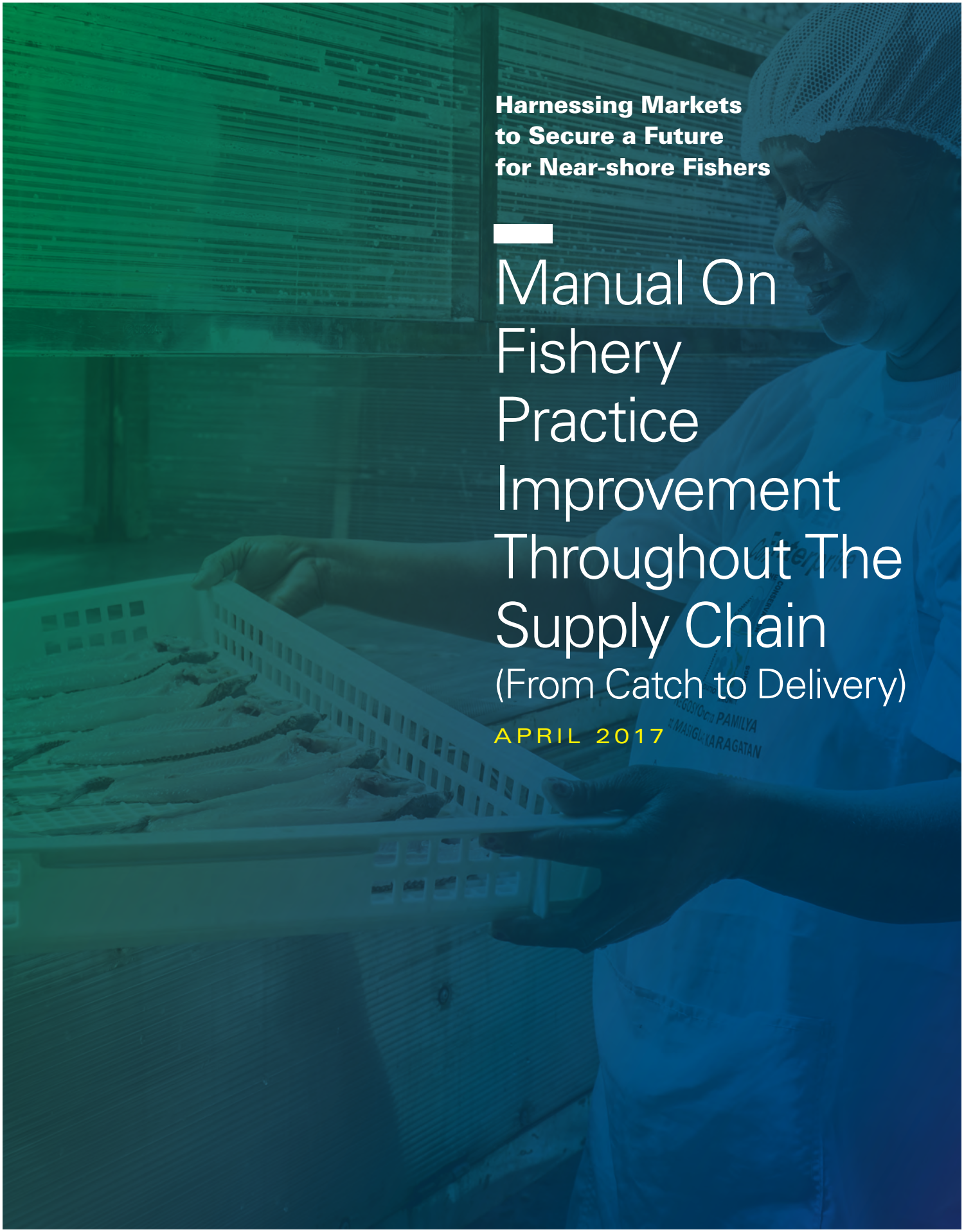

Harnessing Markets to Secure a Future for Near-shore Fishers

Manual On Fishery Practice Improvement Throughout The Supply Chain

(From Catch to Delivery)

APRIL 2017

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Acknowledgment

This report is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents of this report are the responsibility of the authors do not necessarily reflect the views of USAID or the United States Government.

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INTRODUCTION

Improved practices along the fish supply chain can minimize post-harvest losses and waste, and make fish safe for consumption hence maximizing returns. Oftentimes, simple practices, like proper hygiene and sanitation, can be effective in adding value to fresh and processed fishery products. Improved practices can help people benefit more from the fish they catch, process and sell. Also, the adoption of improved practices by fishers, processors, traders, and distributors can result to better business and regional trade. Furthermore, implementing improved practices along the fish supply chain will not only increase fish and seafood supply for human consumption but it can also reduce the pressure on the wild-capture fish stocks, thus higher sustainability.

Food losses occur in all stages of the fish supply chain: during catching/harvesting operations, post-harvest handling and processing, storage, distribution and consumption. Fish losses and waste include nutrient and/ or economic loss from fish that can be potentially used as human food. Economic losses could be through physical deterioration that resulted from poor handling and processing, or the discarding of by-catch. Economic losses are also possible for fish specifically captured for other purposes such as fish meal, which is fishing of small pelagic species that could be directed to human consumption. Economic losses can also occur during glut season. With the lack of cold storage or processing capabilities, an oversupply of fish may drastically flood the market consequently reducing the market value of fish and the fisher's profits. Failure to properly handle freshly caught fish can cause a partial or total loss of the catch, and temporary economic hardship for the fisher and the distributor. A high incidence of post-harvest losses has been recognized as an economic problem affecting the development of the fisheries sector of a country. The annual loss due to downgrading of fish can mean a loss in potential revenue in the traditional fisheries sector. Immediate preservation methods can significantly reduce this loss, including from glut catches when the processing, distribution and marketing system cannot cope with the catch. In order to ensure the highest quality of fish products for the consumer, the concept 'farm-sea to market-table food pathway blocks' must be cleared or lessened. This entails significant steps or careful methods from the time the fish is caught until it reaches the end user.

Today's consumers are more concerned with food safety than ever before, and high-value markets such as EU, Japan and the United States have strict regulations to enforce and ensure quality and safety. Developing country markets are also placing increased attention on food safety and sanitary measures, not only for exported products, also in compliance with the regulatory requirements in the importing countries. Moreover, to a greater degree than before, citizens of developing countries demand safe and wholesome food, in general, and fish products, in particular. Rising levels of economic well-being, improved market information, education and awareness programs will help to shorten the gap between demand and supply of safe and wholesome fish and fish products.

1. FISH SPOILAGE

This section will only deal with the spoilage of fresh fish while all aspects of spoilage in processed fishery products will be discussed under Section 2.2.

Temperature is the single most important factor affecting the rate of fish spoilage or deterioration and reproduction of micro-organisms. For species prone to scombrotoxin (histamine) production, mainly tuna-like species, and also a range of other species, such as sardine and milkfish, time and temperature control may be the most effective method for ensuring food safety. It is therefore essential that fresh fish, and their products that are to be chilled, be held at a temperature as close as possible to 0 °C.

The characteristics of the various microorganisms are fundamental, which makes microbiological food safety issues so complex. For instance, one type of microorganism may prosper under conditions that are considered deadly to a different microbe. Some microbial pathogens cause disease by infecting the human host, while others produce toxins that cause illnesses. There are also some pathogens that can multiply in food during storage while others cannot. Since most microorganisms can reproduce within a matter of minutes, these pathogens can evolve quickly if given environmental stresses select for strains with unique survival characteristics.

Within the period of time which elapses between the death of a fish and its consumption, a large number of biochemical and physico-chemical changes take place. The entire process involved in this conversion can be divided into three stages.

1. The pre-rigor state in which the muscle tissue is soft and pliable and is characterized biochemically by a fall in the ATP and creatine phosphate levels as well as an active glycolysis
2. The stiff and rigid condition known as rigor mortis. The onset of rigor may occur 1–7 hours following death, with many factors also determining the duration.
3. The post rigor state in which meat and fish gradually tenderize, becoming sensory attributes acceptable as aging progresses

Immediately after death the muscle is totally relaxed and the limp elastic texture usually persists for some hours, thereafter the muscle will contract. When it becomes hard and stiff, the whole body becomes inflexible and the fish is in rigor mortis. This condition

usually lasts for a day or more and then rigor resolves. The resolution of rigor mortis makes the muscle relax again and it becomes limp, but no longer as elastic as before rigor. The rate in onset and resolution of rigor varies from species to species and is affected by temperature, handling, size and physical condition of the fish. Any delay in rigor will therefore prolong the keeping time of the fish.

Rigor mortis starts immediately or shortly after death if the fish is starved and the glycogen reserves are depleted, or if the fish is stressed. The method for stunning and killing the fish also influences the onset of rigor. Stunning and killing by hypothermia (killing by iced water) give the fastest onset of rigor, while a blow on the head, gives a delay of up to 18 hours. The technological significance of rigor mortis is of primary importance when the fish is filleted before or in rigor. In rigor, wherein the fish body will be completely stiff, the filleting yield will be very poor and rough handling can cause gaping. If the fillets are removed from the bone pre-rigor the muscle can contract freely and the fillets will shorten following the onset of rigor. Dark muscle may shrink up to 52% and white muscle up to 15% of the original length. If the fish is cooked pre-rigor the texture will be very soft and pasty. In contrast, the texture is tough but not dry when the fish is cooked in rigor. Post-rigor the flesh will become firm, succulent and elastic.

The importance of rigor mortis in fish has been recognized in the fishing industry, since in addition to delaying microbial spoilage, it affords stiffness to the fish which is generally acknowledged as a sign of good quality by the consumer. The rigor period, however, is also a distinct disadvantage with respect to the filleting of fish, since it renders the fish too stiff to facilitate this process. The process is therefore carried out following dissolution of rigor, or on trawlers, immediately prior to the development of rigor mortis.

Causes of Spoilage

Fish are among the world's most perishable commodities. Spoilage in fish is usually rapid since fish allow good microbial growth being highly nutritious (16–22 % protein), having a high moisture content (66–81%), and a relatively neutral pH value (7.2–7.4). Fresh fish spoilage is mainly bacterial in nature aided by enzymatic activity. Bacterial and enzymatic spoilage are largely temperature dependent; the higher the temperature, the faster the rate of spoilage. The rate of spoilage varies from fish to fish and can be summarized as follows: fatty fish spoil faster than lean fish; small-sized fish spoil faster than large fish of the same species; cold-water fish spoil faster than warm-water fish; and round fish spoil faster than flat fish.

Bacteria can be divided into four main groups depending on their response to temperature. Most commonly, the cardinal temperatures for growth (minimum, optimum and maximum growth temperatures) are used. With chilled fish, the factor of most concern is the Minimum Growth Temperature (MGT), which represents the lowest temperature at which growth of a particular microorganism can occur. If the MGT of a microorganism is greater than 10oC, then this microorganism will not grow at chill temperatures (Alasalvar and Quantick, 1997). Hence, the groups of most concern in chilled fish are the psychrophiles (cold-loving) and psychrotrophs (cold-tolerant). The effect of reducing temperature is generally to decrease the rate of enzyme activity. This applies not only to the chemical and biochemical changes in fish but also to the activities of microorganisms. Psychrophiles and psychrotrophs are better adapted to growth at chill temperatures. Hence, chilling alone cannot be relied upon to prevent all microbial growth, but can prevent the growth of some types and retard the rate of growth in others.

Enzymes

Enzymes are protein substances present in the muscle and in the gut of fish which initiate or speed up chemical reactions. Enzymes found in the fish gut are most active at warm temperatures. The longer fish are exposed to high temperatures, the faster their spoilage.

Chemical

Spoilage of fish due to chemical changes mainly occurs during storage in ice or in frozen condition. The oxidative processes in the lipid fraction are purely chemical in nature. However, enzymatic (microbial or tissue enzymes) degradation may also occur. Chemical changes or rancidity of lipids may involve lipid autolysis (enzymatic hydrolysis with free fatty acids, and glycerol as main product) and auto-oxidation (the reaction of unsaturated lipid with oxygen).

Characteristic of Fresh and Spoiled Aquatic Products

The freshness quality and the extent of spoilage of aquatic products after catching and before consumption are generally evaluated by using human senses (sight, smell and touch). The typical characteristics of fresh and spoiled aquatic products (fish and squid) are shown below (Table 1).

2. HYGIENE AND SANITATION

The potential effects of harvesting and handling of products, on-board fishing boat/vessel handling, or during in-plant production activities on the safety and suitability of fish and their products should be considered at all times. Specifically, this includes all points where contamination may exist and specific measures must be taken to ensure the production of a safe and high quality product. The type of control and supervision necessary will depend on the size of the

Aquatic Product	Fresh	Spoiled
01 Fish	• Gills: Odor: fresh, seaweedy (no unpleasant smell) Color: Bright red	Off odor (sour, sulfidy, or ammoniacal, fecal) Yellowish, grayish or dull brown color
	• Eyes: Clear, bright (cornea clear black) and bulging (convex, protruding)	Blood shot, cloudy or completely white; completely sunken
	• Body Color: Normal bright, glossy and shiny	Faded or dull color
	• Flesh: Firm and elastic; springs back when pressed	Very soft; finger impression remains when pressed
	• Scales: Adhere strongly	Loose
02 Squid	• Fresh, sweet odor	Off odor (sulfidy and / or ammoniacal)
	• Creamy-white colored skin; no dark spots*	Discolored; dark spots or reddish or pinkish brown skin*
	• Firm, rubbery texture	Very mushy and slimy texture
	• Transparent Quill intact	Transparent Quill easy to remove

**The color of squid (fresh and spoiled) will vary depending on the species.*

Table 1. Sensory Characteristics of Fresh and Spoiled Fish and Squid

operation and the nature of its activities (Codex, 2016).

The hygiene control program should take into consideration the following:

- Prevention of waste and debris build-up;
- Protection of fish, shellfish, and their products from contamination;
- Hygienic disposal of any rejected material;
- Monitoring of personal hygiene and health standards;
- Monitoring of the pest control program;
- Monitoring of cleaning and sanitizing/disinfecting programs;
- Monitoring of the quality and safety of water and ice supplies.

A Permanent Cleaning and Sanitation/ Disinfection Program

A permanent cleaning and sanitation/disinfection program should be drawn up to ensure that all parts of the fishing boat/vessel, processing facility, and equipment therein are cleaned appropriately and regularly. The program should be re-assessed whenever changes occur to the fishing boat/vessel, processing facility, and/or equipment. Part of this schedule should include a "clean as you go" policy. A typical cleaning and disinfecting process may involve as many as seven separate steps:

01 **Pre-cleaning.** Preparation of area and equipment for cleaning. Involves steps such as removal of all fish, shellfish, and their products from area; protection of sensitive components and packaging materials from water; removal by hand or squeegee of fish scraps, etc.

02 **Pre-rinse.** Rinsing with water to remove remaining large pieces of loose soil.

03 **Cleaning.** The removal of soil, food residues, dirt, grease or other objectionable matter.

04 **Rinse.** Rinsing with potable water or clean water, as appropriate, to remove all soil and detergent residues.

05 **Sanitation/Disinfection.** Application of chemicals, approved by the authorized agency, and/or heat to destroy most micro-organisms on a surface.
06 **Post-rinse.** A final rinse with potable water or clean water to remove all sanitizer/disinfectant residues, as appropriate.
07 **Storage.** Cleaned and sanitized/disinfected equipment, container and utensils should be stored in such a way as to prevent their contamination.

Check of the Efficiency of Cleaning

The efficiency of the cleaning should be controlled as appropriate. Handlers or cleaning personnel, as applicable, should be well trained in the use of special cleaning tools and chemicals, methods of dismantling equipment for cleaning, and they should be knowledgeable in terms of the significance of contamination and the hazards involved.

Designation of Personnel for Cleaning

In each processing plant or vessel, a trained individual should be designated as responsible for the sanitation of the processing facility or vessel and the equipment therein.

Maintenance of Premises, Equipment and Utensils

Buildings, materials, utensils, and all equipment in the establishment, including drainage systems, should be maintained in a good state and order. Equipment, utensils, and other physical facilities of the plant or vessel should be kept clean and in good repair. Procedures for the maintenance, repair, adjustment and calibration, as appropriate, of apparatus should be established. For each item of equipment, these procedures should specify the methods used, the persons in charge of their application, and their frequency.

Pest Control Systems

Good hygienic practices should be employed to avoid creating an environment conducive to pests. Pest control programs may include preventing access, eliminating shelter and infestations, and establishing monitoring, detection, and eradication systems. Physical, chemical and biological agents should be properly applied by appropriately qualified personnel.

Water

When a fish-processing establishment has its own supply of fresh water or seawater or other water sources, and chlorine is used for the treatment of water that may come in direct contact with fish and fish products, the residual content of chlorine should not exceed that of potable water. The use of higher concentrations of chlorine in water treatment in the primary production-to-consumption food chain is subject to approval by the competent authority, where appropriate. Attention must be paid to the possible formation of potentially toxic compounds such as chloramines when adding chlorine to seawater.

Ice

The ice used for chilling aquatic products should be produced using potable water or clean water. The ice should be protected from contamination by storing them in a container with a lid.

Waste Management

The processing waste, packaging waste, and other waste materials should be removed from the premises of a processing facility or vessel on a regular basis. There should be facilities for the containment of offal and waste material; they should be properly maintained. The vessel waste discharge should not contaminate vessel water intake systems or incoming product.

Facilities and Equipment

Facilities and equipment should include adequate means to hygienically wash and dry hands. Sufficient toilet and changing facilities for personnel should be available and suitably located and designated in the processing establishment.

Personnel Hygiene and Health

Personnel hygiene and facilities should be as such to ensure that an appropriate degree of personal hygiene can be maintained in order to avoid contamination.

- No person who is known to be suffering from, or who is a carrier of, any communicable disease or has an infected wound or open lesion should be engaged in preparation, handling or transportation;
- Where necessary, adequate and appropriate protective clothing, head coverings and footwear should be worn;
- All persons working in a facility should maintain a high degree of personal cleanliness and should take all necessary precautions to prevent contamination;
- Hand washing should be carried out by all personnel working in a processing area;
  at the start of fish or shellfish handling activities and upon re-entering a processing area — immediately after using the toilet.
- The following should not be permitted in handling and processing areas:
  - smoking;
  - spitting;
  - chewing or eating;
  - sneezing or coughing over unprotected food;
  - the adornment of personal effects, such as jewelry, watches or pins, or other items that, if dislodged, might pose a threat to the safety and suitability of the products.

Training

Training on fish hygiene is of fundamental importance. All personnel should be aware of their role and responsibility in protecting fish from contamination and deterioration. Handlers should have the necessary knowledge and skills to enable them to handle fish hygienically. Those who handle strong cleaning chemicals or other potentially hazardous chemicals should be instructed in safe handling techniques.

3. USE OF ICE

High temperatures increase the rate of fish spoilage and low temperatures slow it down. Therefore, if the temperature of fresh fish is low, then quality is lost slowly. The faster a lower temperature is attained during fish chilling, the more effectively the spoilage activity is inhibited. Chilling is the most common practice in keeping the freshness of fish. Chilling means the reduction of temperature to some point below (-1.1 to -2.2oC) or above (0oC) the freezing point of the fish muscle.

Methods of Chilling

There are several ways of chilling fish. The most commonly used methods are:

Wet Ice (Icing). Icing is by far the most common and useful way of chilling the fish catch. Cooling is effected by the direct contact between the melted ice and the fish.

Concept of Icing

1. Heat from source flows to low temperature sink
2. Heat absorbed by sink. Latent heat of melting released. Ice melts to water
3. Melt water splashes on fish. Melt water warms up as fish cools
4. Warmed melt-water cools in contact with ice
5. Cooled melt-water contacts fish deeper in the container and cools the fish

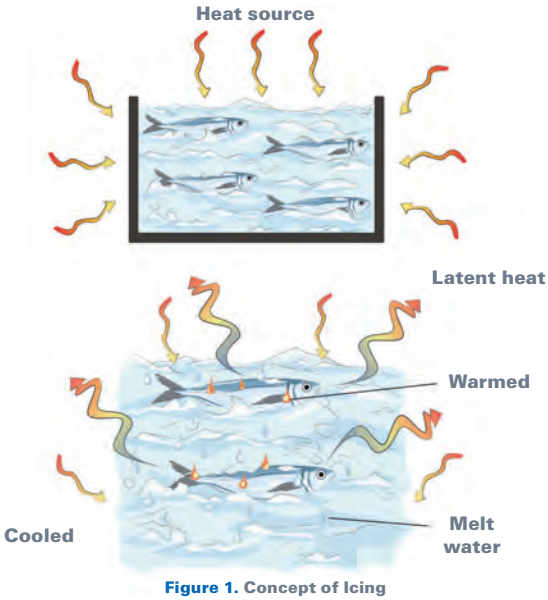


Figure 1. Concept of Icing

Chilled Seawater (CSW) or Ice Slurry. This is also known as "slush ice" which is a mixture of seawater and crushed ice. CSW has several advantages over icing: it chills fish much faster than icing, fish in the slurry do not suffer physical damage that can be caused by the pressure exerted by other fish put on top, and washing of the fish occurs during the storage in the slurry. However, fish that are stored in the ice slurry do not necessarily keep longer than iced fish.

Types of Ice

The most common types of ice (Fig. 2) used in small scale fisheries in the Philippines are block ice and ice water.

Block Ice. Ice blocks are rarely used directly for cooling fish because of their size and weight. They must be crushed into smaller pieces before using them for chilling fish.

Ice Water. This is a home-made ice packed in plastic bags. In many fishing villages in the Philippines that have no access to block ice, this type of ice is widely used. The ice water bags are directly used in chilling fish.

Figure 2. Types of Ice

Types of Containers

The choice of containers for keeping fish will greatly determine the end quality of the iced product. Containers made from plastic materials are now widely used in many fishing areas. The term plastic describes a wide range of materials such as polyethylene (PE) and polypropylene (PP) and polystyrene (PP). Polyethylene, in general, has excellent toughness; it is resistant to chemicals, oil and grease; inert to food; and has extremely low water vapor transmission properties. Polypropylene (PP), on the other hand, is more rigid, stronger and lighter than polyethylene. Among the plastic containers, boxes made from polystyrene (PS) or styrophore are becoming more popular nowadays because of their light weight and cheaper cost in comparison to PE and PP boxes. A PS box has several disadvantages such as low durability (breaks easily), and absence of drainage outlet for melt-water. Moreover, the container is more difficult to move/transport because it lacks hand grips. The container requires additional wooden frame support for easy transport.

Pointers in Handling Chilled Fish

It must be noted that no form of processing will

improve the quality of a spoiled or partially spoiled fish. Hence, it is important to maintain quality by good handling practices from harvest to consumption. The following must be taken into consideration when handling chilled fish:

- **Temperature.** Low temperatures (around 0oC) must be maintained until the commodity reaches the consumer. The fish must be chilled as soon as possible and kept chilled before processing and during all stages of fish preparation.
- **Time.** All delays must be kept to minimum. The length of time the fish can be kept in a chilling medium must also be known to the fish handler.
- **Contamination.** Care must be taken that no contamination occurs during chilling and during the storage of chilled fish. Good hygiene and sanitation (good housekeeping) must be observed at all times.
- **Damage.** Physical damage such as bruises, cuts, punctures etc. must be avoided when handling chilled fish.

IMPROVED PRACTICES
1. FRESH FISH

In 2014, 46 percent (67 million tons) of the fish for direct human consumption were live, fresh or chilled fish, which in many markets are the most preferred and highly priced forms. In recent decades, major innovations in refrigeration, ice-making and transportation have allowed a growing distribution of fish in fresh and other forms (FAO, 2016).

Figure 3. Fish Supply Chain

A. The Fish Supply Chain

The supply chain for fish starts in the fishing ground, at sea or in inland waters, or at the aquaculture site, and it ends with the consumer, who can be in the same country or in another country. The supply chain links a network of harvesters, processors, retailers, distributors, transporters, storage facilities and suppliers that all work together to produce, deliver and sell a product to the consumer (Fig. 3).

The fish supply chain is influenced by factors such as: market demand, prices, seasonality, climatic conditions, population demographics, economic situation, fuel prices, policy and legal environment. The perishable nature of fish requires special attention to handling, grading and packing, and the market price is usually dependent upon the quality of fish (although this is not always true when demand does not match supply).

1.1 Fisher
During Catching/Fishing

There are active fishing methods, such as trawling, where fish is quickly removed from the net, and passive fishing methods, such as gill netting, where fish may enter the net and stay there for several hours until retrieval of the net. If nets are not checked and cleaned regularly, there is the risk of quality loss due to spoilage or also, the risk of physical loss due to predation from other fish. If fish are not removed carefully from the nets, the flesh of the fish can be bruised or damaged due to struggling. When using hook and line, the fish should be removed from the hook quickly to avoid physical damage to the fish which can speed up spoilage. Fish which are caught alive should be killed immediately (by stunning or immersing the fish in ice slurry) to stop struggling thus avoiding being bruised or damaged, which can hasten spoilage.

To minimize spoilage, contamination of catch, and physical damage, the following are important:

- Fresh fish should be chilled immediately after capture;
- Use clean ice and insulated container;
- Protect packed fish in insulated container from the heat of the sun;
- Sufficient ice should be available for chilling during fishing;
- Ice should be protected from sunlight to reduce melting;
- Fish containers should be able to accommodate small and big fish.

If ice is not available, it is important to protect the fish from sunlight by using a wet clean cover. Fish should be chilled or iced immediately upon landing. Fish should be handled with care, thus dropping or throwing and standing on fish should be avoided during fishing and handling. The use of wooden or metal containers is not advisable for storing fish. Rusting metal containers and wood splinters may present hazards to the consumers. To avoid contamination of the fish, animals should not be allowed on board the boat. The boat should be used solely for fishing and for fish transport. Fishing in harbor waters or in waters close to villages should be avoided because of contamination from household waste-water and discarded fuel or oil from fishing boats. In addition, beach and harbor water should never be used for cleaning fish and boats. If possible, only potable water or clean water found offshore should be used for cleaning purposes.

The boat and equipment should be thoroughly cleaned using clean water and approved detergents before each fishing trip. In addition, the boat and equipment should be regularly inspected for damage and necessary maintenance should be carried out. If the fishing method involves the use of bait fish, certain precautions are needed. Bait fish are likely to be spoiled and contain large numbers of spoilage bacteria that could contaminate the catch. Special care must be taken to separate bait fish from the catch to avoid the contamination of the latter.

Proper icing should be practiced in order to quickly reduce the fish temperature to that of melting ice, thus significantly slowing down spoilage. Any low-quality fish that is caught should be segregated from good quality fish to avoid cross contamination.

During Landing/Offloading

Once fish is landed, they may be sold directly at markets or further processed. Fish should be landed in authorized landing sites. It should be landed from fishing boats and weighed, sold or processed quickly, and kept chilled. In landing sites where basic facilities (clean water, toilets) are lacking, there is a great danger of contamination due to some unhygienic practices which could take place. This could increase the risk of passing on diseases to consumers and landing site users. Using the beach as a toilet may result in fish being contaminated with pathogens. If the landing site is not fenced off, domestic animals may cause contamination of the landed fish. Absence of potable water to wash hands during auctions may increase the risk of contamination from the visitors (due to physical contact with the fish) bidding for the landed fish. Long auction processes and offloading times in high ambient temperatures can spoil the product if it is not properly kept on ice.

Typical causes of fish spoilage at fish landing sites:

- Not keeping the fish cool during landing, selling, and transfer to the fish transport vehicle;
- Delays in transferring fish from the boat/collecting boat to chilled storage facilities;
- Use of dirty ice and container during re-icing;
- Rough handling of fish by throwing and dropping; putting fish on the ground will contaminate the fish with dirt and bacteria;
- Washing of fish in contaminated nearshore water.

1.2 Wholesaler/Retailer/Processor

Fishers who process and market their own catch, fish processors, fresh fish and processed fish traders, and transport vehicle owners should have knowledge on how to maintain the good quality of fish and how to keep the fish safe for consumption during transport, before processing and during storage and selling of fish.

During Transporting/Distributing

Transporting fresh fish in the trunk of a car or on other vehicles such as tricycle and open truck without ice and without proper container can subject the fish to high ambient temperature, to contamination from dirt, insect infestation, and animal attack. During transport, the fish should be properly iced to last the duration of the trip. The iced fish should be transported using insulated boxes to ensure that the low temperature of the fish is maintained until it reaches its final destination. Any delay during fish transport should be avoided; the fish should be re-iced if the temperature has risen. If possible, temperature monitoring of the product should be carried out throughout the transport duration. Transport vehicles should be washed with clean water and approved detergents. They must only be used for the transport of fish.

Ideally, fish transport vehicles should be designed and constructed as follows:

- the walls, floors and ceilings, where appropriate, are made of a suitable corrosion-resistant material with smooth, non-absorbent surfaces. Floors should be adequately drained;
- where appropriate with chilling equipment to maintain chilled fish during transportation to a temperature as close as possible to 0 °C;
- so that live fish are transported at temperatures tolerable for the species;
- to provide the fish with protection against contamination, exposure to extreme temperatures and the drying effects of the sun or wind; and
- to permit the free flow of chilled air around the load when fitted with mechanical refrigeration means.

During Processing

Fish for processing should be fresh, in good condition, and free from contaminants (bacterial, chemical, and physical). The fish should be kept chilled until it is processed. Fish should be prepared (fillet, split etc.) in a

hygienic way before processing and washed with clean water thoroughly to remove blood, slime, scales, and bacteria. Fish should be checked for parasites. Freezing at –20 °C or below for seven days or –35 °C for about 20 hours for fish intended for raw consumption will kill parasites. Processes such as brining or pickling may reduce the parasite hazard if the products are kept in the brine for a sufficient time but may not eliminate it. Candling, trimming belly flaps and physically removing the parasite cysts will also reduce the hazards but may not eliminate them.

The processing area, equipment and utensils must be kept clean and in good condition. In addition, fresh fish and equipment used for processing fish should not come into contact with processed products as this can contaminate the processed products with bacteria which may cause food poisoning. If additives are used, they must be permitted substances. Pesticides or insecticides must never be used on fish during processing, on equipment used for processing, or on final products as these chemicals are harmful to the consumers and the workers. Any waste products from processing must be disposed of in a manner which does not harm the environment, either the water or land. Processing waste should be kept in an enclosed place to prevent entry of flies, rats and other pests. The waste should be quickly disposed of properly. Filleting, salting, and other processing activities should be done in a separate area. Finished products must be packaged and handled in a careful manner to avoid contamination so they remain safe to eat.

During Storing

Containers used for storage of fresh fishery products must be designed in a manner as to ensure both their protection from contamination and their preservation under sufficiently hygienic conditions and, more particularly, they must provide adequate drainage of melt-water. Ensure that fish are properly iced or chilled and packed in proper containers. Re-icing must be carried out as often as is necessary: the ice used must be made from potable water or clean seawater, and be stored under hygienic conditions in containers provided for the purpose. The temperature of the fish should be monitored regularly during storage.

Selling at Market

Freshness plays a key role in the decision of a consumer when purchasing a fish. Hence, fish traders should ensure that the good quality of fish is maintained and that it is safe to eat. Fish should be sold in a proper place meant for selling food, away from things which contaminate fish. A market should be covered so that the fish and the seller are protected from sun, heat and adverse weather conditions.

Pointers During Selling of Fish at Wet Market

- Fish should be handled carefully and not thrown or placed on the ground;
- They should be displayed on a raised surface which is easy to clean and sanitized/disinfected, such as cement or ceramic tiles. This display counter should be sloping to allow water to drain away;
- Fish should be chilled using ice on display and during storage. The fish on display should be not heaped to make chilling difficult; clean ice should be available;
- There must be a supply of clean water for washing the fish, display surface and equipment such as knives and weighing scales and containers;
- Fish sellers must have access to hand washing facilities and proper toilets.
- Care should be taken not to let the surface of the fish dry out; clean water or ice should be used to keep the outside of the fish wet;
- The display surface and equipment should be washed daily after use. It is good to use a detergent and sanitizer to get rid of as much dirt and bacteria as possible;
- Any waste products should be kept in a closed container such as a plastic bin with a lid. The waste must be disposed of in a proper manner at the end of each day;
- Any fish which is stored must be kept on ice in a properly insulated and easily cleanable box designed for food; good icing practice should be applied;
- The market area should not have animals or pests present and pest control must be implemented. If a chill or cold store is available, it should be used for storing fish which have been iced and are in proper containers such as insulated boxes;
- Fresh fish must be displayed separately from cooked or processed products to avoid cross contamination;
- If an ice making machine is available, it should be well maintained and properly managed.
- Fish sellers should know why fish spoil and how to assess quality;
- Anyone selling fresh fish should have a medical check-up every 6 months. Sellers should practice good personal hygiene and wear clean light colored protective clothing. There should be no spitting, sneezing, coughing over the fish; smoking should be prohibited.

Retail Display of Chilled Seafood in a Store or Supermarket

- Products in chilled display should be kept at 4 °C (40 °F) or below. Temperatures of products should be monitored at regular intervals;
- Ready-to-eat items and molluscan shellfish should be separated from each other and from raw food products in a chilled full-service display. A display

diagram is recommended to ensure that cross-contamination does not occur;
- If ice is used, proper drainage of melt water should be in place. Retail displays should be self-draining. Replace ice daily and ensure ready-to-eat products are not placed on ice upon which raw product has previously been displayed;
- Each commodity in a full-service display should have its own container and serving utensils to avoid cross-contamination;
- Care should be taken to avoid arranging product in such a large mass/depth that proper chilling cannot be maintained and product quality is compromised.
- Care should be taken to avoid drying of unprotected products in full-service displays. Use of an aerosol spray, under hygienic conditions, is recommended;
- Product should not be added above the "load line" where a chilled state cannot be maintained in self-service display cases of packaged products;
- Product should not be exposed to ambient room temperature for a prolonged period of time when filling/ stocking display cases;
- Fish in full-service display cases should be properly labeled by signs or placards to indicate the commonly accepted name of the fish so the consumer is informed about the product.

Chilled Storage of Products at Retail

- Products in chilled storage should be held at 4 °C (40 °F);
- Fish should be properly protected from filth and other contaminants through proper packaging and being stored off the floor;
- A continuous temperature-recording chart for fish chill rooms is recommended;
- The chill room should have proper drainage to prevent product contamination;
- Ready-to-eat fishery products should be kept separate from each other and other raw food products in chilled storage. Raw products should be stored on shelves below cooked products to avoid cross-contamination from drips;
- A proper product rotation system should be established. Such a system may be based on first-in, first-out (FiFo) usage, production date or "best before" date on labels, or sensory quality of the lot, as appropriate.

1.3 Consumer (During Transporting, At Home)

The best method of assessing the freshness or spoilage of fish is by sensory evaluation techniques. It is advisable for consumers to use appropriate sensory evaluation criteria to evaluate the acceptability of fish and to do away with fish showing less essential quality characteristics.

Pointers During Selling of Fish at Wet Market

- The consumer should choose fresh fish by checking the sensory attributes (see Table 1);
- Insulated container should be used to transport the fish;
- The fresh fish should be prepared and cooked as prompt as possible. The fish should be kept cool until cooking;
- Cooked fish should be served while still hot to prevent food poisoning

2. PROCESSED FISHERY PRODUCTS

The manufacturing of processed products is a value-adding process, wherein the "incremental value" of fresh fish in the market place is increased. Value-addition already starts from the time a fisher adds ice into the fish, thus enabling the fisher to get a better price for his product. Processing, such as preparing the fresh fish, e.g. cutting and filleting, then packing and freezing, can greatly enhance the value of the fish.

Only fresh, good quality fish should be processed. Processing poor quality fish will produce poor quality products. Processing in unclean places will subject the product to contaminants such as bacteria and other hazards, thus speeding up fish spoilage and causing illness to the consumers. Insects, such as fly maggots and beetles may inhabit the fish during processing and storage. Some domestic animals may also be tempted to try out the fish. This can result to product quality deterioration and post-harvest losses. The quality and safety of fish will also be compromised if the processing activities are carried out in an improper environment, such as on the floor or ground, and without applying proper hygienic measures, such as use of clean water and presence of toilet facilities.

Pointers to ensure that processed dried products are of good quality and safe to eat

- Always select good quality fish (fresh, no damage, not contaminated) for processing as this gives good finished products;
- Fish for processing should be kept cool by storing them in clean insulated containers;
- Fish should not be placed on the ground as they will pick up dirt and bacteria;
- Fish should be processed as soon as possible to avoid spoilage;
- Fish should be dried in a hygienic manner by using a solar dryer;
- When drying fish on drying racks, turning them manually every hour or two will speed up drying.

A. Dried Fish: Dried Flying Fish/Rabbitfish (Siganid) and Squid

Salting and drying can reduce water in fish and squid, thus making it hard for bacteria and enzymes to survive. Fish processing, if done well, can produce good

quality products that can fetch a high market price and can also be kept for longer periods. Good quality products can be easily sold because consumers prefer them.

2.1 Receiving Raw Materials (Flying Fish, Rabbit Fish, Squid)

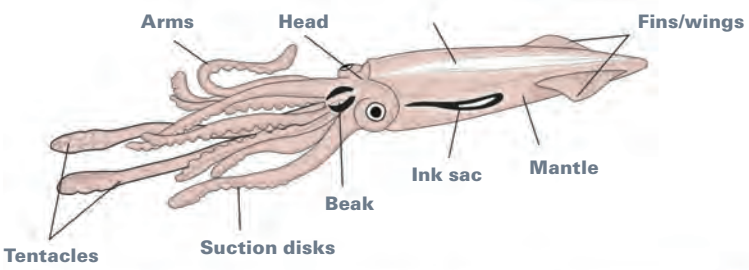
As described in Section 1, fresh fish should be handled with care, kept at chilled temperature, delays in processing fish avoided, and contamination prevented.

Fresh cephalopods, such as squid (Fig. 4), cuttlefish, and octopus, are highly perishable and should be handled with great care at all times as to prevent contamination and inhibit the growth of micro-organisms. Squids should not be exposed to direct sunlight or to the drying effects of wind, or any other harmful effects of the elements, and should be carefully cleaned and chilled to the temperature of melting ice, 0°C (32 °F), as quickly as possible. Chilled squids keep better when they are placed in ice slurry after harvest. In order for squids to stay fresh longer and stay undamaged (no skin tear and ruptured ink sac), there should be no direct contact between the ice and squids during re-packing. Plastic sheet layers between ice and squids can protect squids from being damaged.

2.2 Preparing the Raw Materials

Rabbitfish (siganid) and flying fish should be split by making a cut parallel to the backbone straight down from the throat or nape to the tail and in such a way as to prevent uneven and ragged edges or a loss in recovery. If the backbone is to be removed, the fish should be split so deeply that the remains of the backbone (the tail-bone) should lie free. It is important to cut the bone rather than to break it from the flesh. Splitting of fish should be carried out expertly so that blood in the nape and blood clots are removed. Immediately after splitting, the fish should be washed in sufficient running potable water or clean seawater to remove all blood from the fish. All impurities, blood and livers should be removed. Using chilled water for washing the split fish is a very effective way of removing blood. The presence of parasites should also be checked and visible parasites should be removed. In case the black membrane has to be removed, it should be done after the splitting step.

Removal of internal organs including the quill/pen and beaks of squid should be done carefully to prevent breaking the ink sac, thereby discoloring the mantle or tube cavity. Any by-product of this process that is intended for human consumption, such as tentacles or mantle, should be handled in a timely and hygienic manner. Squid should be washed in clean seawater or potable water immediately after gutting to remove any remaining material from the tube cavity and to reduce the level of micro-organisms present on the product. Adequate supply of clean seawater or potable water should be available for the washing of whole and split squids. Care should be taken to prevent waste material from cross-contaminating the product.



Box 1. Cephalopod Species in the Philippines

English Name	Common Name	Scientific Name
Squid	Tagalog: *Pusit, Bankutan choko, Chokon glumot* Visaya: *Nocos, Locos* Ilocano: *Bomagto*	*Loliolus (Nipponololigo) sumatrensis* *Sepioteuthis lessoniana* *Uroteuthis (Uroteuthis) bartschi* *Uroteuthis (Photololigo) edulis* *Uroteuthis (Photololigo) chinensis* *Uroteuthis (Photololigo) duvaucelii* *Uroteuthis (Photololigo) singhalensis* *Uroteuthis (Photololigo) vossi* *Uroteuthis reesi*
Cuttlefish	Tagalog: *Kulambutan, Bankuta* Visaya: *Bagolan*	*Sepia pharaonis* *Sepia aculeata* *Sepia andreana*
Octopus	Tagalog: *Pugita* Visaya: *Kugita* Ilocano: *Curita*	*Octopus mebraneceous* *Octopus aegina* *Octopus cyaneus*

Source: PNS BAFS 136:2014

Figure 4. Squid Anatomy

3 Brining

For the preparation of dried fish, brining is preferable to dry salting because in brining, the salt is uniformly distributed throughout the fish flesh. In case of dried squids, no salting is used. Brining is also less tedious than dry salting. Big bulk of fish can be salted during brining in comparison to dry salting where each fish has to be rubbed with salt individually. The salt for brining should be clean and food grade. Aged or stored salt are preferred to newly manufactured salt. Newly manufactured salt may contain a high number of halophilic (salt-loving) bacteria and molds that can survive the drying process. Some molds can produce toxins (e.g. Aflatoxin) which are hazardous to human health.

Salt for brining should be checked to ensure that it is clean, not re-used, free from foreign matter and foreign crystals, and shows no visible sign of contamination with dirt, oil or other extraneous materials. Potable and clean water should be used for brine preparation. Freshly-made brine should be used for the salting

Salting

Salting is one of the earliest techniques for preserving fish. Salting preserves by lowering the moisture content of the fish to the point where bacterial and enzymatic activities are delayed.

Salt removes water from the fish by osmosis. The method is called salting when salt is the only means of preservation.

Types of Salt

Salt (sodium chloride) almost always originates from the evaporation of seawater. Salt can be classified as:

- solar salts resulting from the evaporation of sea or salt-lake water by sun and wind;
- rock salts mined from underground salt deposits or dried up salt lakes; and
- evaporated salts coming from deeply buried salt deposits.

Methods of Salting

There are two general methods of salting fish:

- **Dry Salting or Kench Process.** This method is carried out by rubbing fish with salt just before packing and sprinkling salt in each layer of fish. The water removed by the salt is allowed to drain. The fish are repacked in salt periodically with the fish on top placed at the bottom. This is done to provide uniform salting and pressure which helps squeeze water out of the fish. Dry salting is recommended for lean fish due to oxidation problems in fatty fish. For practical operations, the quantity of salt used should not exceed 35–40%.
- **Wet Salting.** Wet salting can be brining or pickle curing. In wet salting, brining is done by placing fish in a solution of salt and water (usually saturated) until the desired salt concentration is attained in the fish. In pickle curing, the fish are layered alternately with dry salt. The liquid or the pickle formed is retained inside the container until it covers all the fish.

Source: Espejo-Hermes (1998).

Standard for Dried Rabbitfish (Danggit)

A. Physico-chemical requirements of dried rabbit fish

Characteristic	Requirement
Water Activity (**aw**) maximum at 25°C	0.75
Salt content % (NaCl)	12.0*
Histamine content (ppm, edible portion, maximum)	20.0 mg/100g

B. Size of the product as determined by the length of the product (whole fish)

Size Designation	Length
Small	6.1 - 7.0 cm
Medium	7.1 - 8.0 cm
Large	8.1 - 10 cm

** Salt content may vary provided that the prescribed water activity is not exceeded. Source: PNS/BAFPS 68:2008.*

operation; do not re-use brine. The ratio of brine to fish (usually 1:1 for split fish and 1.25:1.0 for whole fish) and the concentration of the brine (not lower than 10%) should be adjusted to the desired product; time and temperature control (<4 °C) is important if the brine concentration is lower than saturated. The concentration of brine should be checked at regular intervals, incorrect concentration should be adjusted prior to use. The brining duration will depend on the size of the fish and the desire of the buyer; hence it is recommended to sort the fish according to size. Appropriate and clean containers such as plastic or cement lined vats and plastic barrels should be used as container for salt and brine. Metal containers are not suitable because they easily corrode.

4 Rinsing/ Draining/ Laying on Drying Racks

Rinsing of brined fish should be done to remove excess salt and other internal organs not effectively removed during the preparation of split fish. This process is essential to improve the appearance of the final product. Salt caking on the surface of the dried products may occur when super saturated brine is used. It is not advisable to carry out the rinsing operation when the fish are already arranged on the drying trays because only one side of the fish will be washed. Clean and potable water should be used for rinsing. Draining of fish should be carried out using a screened tray. This step should be carried out quickly. Split fish should be arranged on the drying tray with the skin side down

5 Drying

Drying is a simple way of preserving fish and squids and is often carried out using the heat of the sun. The drying process should be completed in a short period, e.g. 1–2 days, to prevent contamination with dirt, sand, and bacteria. It is recommended to use solar dryers, in order to protect the products from contamination, weather (rain), insect infestation (flies and beetles), birds and domestic animal attacks. Fish (rabbitfish and flying fish) and squids should be sun-dried away from sources of contamination such as roads, factories, farms, and areas, where burning or fires are on-going. Use of raised racks is recommended because this protects the fish from animal attack. The drying rack tray mesh material should be non-corrosive and easy to clean. Care must be taken when drying to avoid high temperatures which can cause case hardening in fish. The resulting hard surface layer can completely stop the removal of water from the inner portion of the fish thus resulting to fish spoilage. The time and temperature used for drying will depend on fish species, size, and the handling and stacking of the fish. To ensure proper drying, the fish should be of similar sizes.

6 Labeling and Packaging

The packaging operation should be done to minimize

the risk of contamination and spoilage. Packaging of dried fish and squids should be carried out when the products have cooled down to room temperature. Packaging of still warm products can result to sweating of products inside the packaging, particularly when packed in plastic bags. Packaging material should be clean, sound, durable, sufficient for its intended use, and of food-grade quality. Only packaging material and labels complying with the specifications of the processors should be accepted into the processing facility. Labels that are to be used in direct contact with the fish and squids should be made of a non-absorbent material and the ink or dye used on that label should be approved by the authorized agency. Packaging should be properly stored, considering the temperature and humidity of the storage area. A systematic stock rotation plan should be developed and maintained to avoid out-ofdate materials. Packaging should be properly protected and segregated to prevent cross-contamination. The packaged products should meet appropriate standards for labeling and weights.

7 Storing the Dried Products

If dried fish and squids are not stored properly, they will become moist, and molds can grow on the products. Presence of molds in the dried products will make the products unsightly and unsafe to eat, thus causing economic losses. Dried fish are also susceptible to insect attack during storage which can lead to losses. Dried products should be stored in a dry and cold place, preferably inside a chill room, where the humidity and temperature are not conducive for mold growth and attack from insects, particularly beetles, becomes unlikely.

8 Transporting and Distributing the Dried Products

It is particularly important throughout the transportation of dried products that care be taken to minimize any rise in temperature and humidity. Moreover, appropriate measures should be applied to minimize damage to the dried products and their packaging. Packages should be checked regularly by weight control. End-products should be checked by a metal detector and/or other detection methods, as applicable, to rule out that any physical hazards in the product. Packaging of cartons or plastic bags to master shipping containers should be done without delay and under hygienic conditions. Both consumer packages and shipping containers should be appropriately lot-coded for product tracing in the event of a product recall.

Cases and boxes should be completely dry since moisture affects the mechanical characteristics of boxes; and the protection of containers against damage during transportation may not be sufficient. Metal containers should be kept dry during transportation in order to avoid corrosion and/or rust. Before loading, the cleanliness and suitability of the cargo hold of the vehicles should be checked. Loading and transportation should be conducted in such a way as to avoid damage to or contamination of the products and to ensure the integrity of packaging. After unloading, the accumulation of waste should be avoided and any waste should be disposed of in a proper manner. Loading should be done in such a way that ensures a good air-flow between product and wall, floor and roof panels. Monitoring of air temperatures inside the cargo hold should be also carried out during transportation by using a recording thermometer.

B. Seafood Snack Products

Importance and Functions of Ingredients

Flour and starch serve as fillers or binders for seafood snack products, such as fish balls and quekiam. All -purpose flour, cassava or potato flour have good binding effects when cooked: they can be easily shaped and handled, and they contribute to the texture and expansion of the final product.

Salt is an essential ingredient, which adds flavor to the final product. It also improves the gelling property of the fish flesh, making it more suitable for fish balls manufacture.

Spices are pungent or aromatic natural products, of vegetable origin, used as food flavorings. Spices can also improve the texture of the product. Garlic, onion, and pepper (black and white) are the common spices used in seafood snack products, such as fish balls, nuggets, etc. Spices can add and improve the flavor of a product. Some spices also have anti-oxidative and antibacterial properties.

Oil. Vegetable oil can be used to modify the product texture as well as to make the product whiter when ingredients with darker color are used in the formulation. With the addition of vegetable oil, a product with a smoother texture can be attained. Addition of oil tends to weaken the gel texture, but it reduces the rubbery and chewy texture of the product. In addition to textural modification, the addition of oil may improve freeze-thaw stability, by preventing the development of a sponge-like texture resulting from free syneresis (leaching of liquid).

Seasonings/Food Enhancers (Additives). MSG or monosodium glutamate is the most available food enhancer. Hydrolyzed vegetable proteins (HVP), glycine, alanine, and mirin (fermented rice wine with a sweet taste and unique aroma) are also flavor enhancers.

Leavening/Raising Agent. The function of leavening

agents is to produce gas in the form of bubbles in the flour mixture during mixing or baking to make the product light. Baking powder is the most common leavening used in many products using flour. It is more suitable than baking soda as a raising agent.

8.1. Fish and Squid Balls, and Quekiam

These value-added products are popular in the Philippines as street food. They are not only tasty but they are nutritious, too.

8.1.A. Receiving Fish, Squid and Ingredients

Good quality fish and squids should be used for fish balls, quekiam, and squid balls manufacture. Only ingredients complying with the specifications of the processors should be accepted into the processing facility. Ingredients should be stored properly taking into consideration the temperature and humidity of the storage place. A systematic stock rotation plan should be developed and maintained to avoid out-ofdate materials. Ingredients should be properly protected and segregated to prevent cross-contamination. Defective ingredients should not be used.

8.1.B. Preparing Minced Fish, Minced Squid and Ingredients

Preparation of minced fish and squid should be carried out hygienically and at low temperatures to prevent spoilage. The fish is filleted, skinned, and then minced or ground using a meat grinder to loosen or break down the muscle fibers, thus enhancing extraction of salt-soluble proteins. For squid, the mantle is skinned, cut into small pieces, and then minced. The method of skinning should not contaminate the product nor should it allow the growth of micro-organisms, e.g. for squid, use of enzymes or hot water techniques for skinning should have defined time/temperature parameters to prevent the growth of micro-organisms. If necessary, the mince should be washed and should be adequate for the type of product desired. Stirring during washing should be carried out with care, but it should be kept as gentle as possible in order to avoid excessive disintegration of the minced flesh, which will reduce the yield. The washed minced flesh may be partially de-watered by straining. Special attention should be taken to ensure that during the straining operation, the minced flesh is kept cool. The resulting wastewater should be disposed of in a suitable manner. The minced flesh should be kept chilled while waiting to be processed into balls and quekiam. Minced flesh has a large surface area which can be easily attacked by bacteria. Ingredients are also prepared with utmost care to prevent contamination. Ingredients should be freshly prepared daily and kept chilled before use. All utensils and equipment to be used during the preparation of minced products should be clean and dry.

8.1.C. Adding Ingredients

Food-grade salt is added to the minced flesh to enhance the extraction of the salt-soluble protein. This network of salt-soluble proteins, when set by cooking, gives the "springiness" to the finished product. Other ingredients and water are added for flavor and texture enhancement. Mixing of ingredients with the ground fish/squid should be carried out at low temperatures. When mixing minced flesh with ingredients and additives, they should be blended in the proper proportions to achieve the desired sensory quality. This operation can be done using a silent cutter or food-processing equipment. Additives should be foodgrade as well. Flour and starches should be mixed first with the baking powder before these are blended with the other ingredients.

8.1.D. Forming Into Balls and Quekiam

Fish and squid ball products can be formed manually (if in small quantity) or with the use of fish ball or quekiam forming machines. For small quantities of quekiam, a cake decorating dispenser can be employed. Under tropical conditions, the fish mixture will easily "set" at room temperature, thus giving resistance during forming. It is very important to keep the mixture chilled all the time to make ball or quekiam forming easier. Formed products should be checked closely for proper shape, weight and texture.

8.1.E. Setting in Water

Once formed, the minced products should be set either in water or air to obtain the maximum gel strength and to prevent deformation of balls before cooking. The formed products are usually set in water at ambient temperature, 28–30°C for 2–3 hours or at warm temperature, 40–45°C for 20–30 minutes. However, both practices are unsafe because of the possibility that the duration of the setting could not be properly monitored if there are many products being manufactured at the same time. It is advisable to set the formed products in cold water (10–15°C) or they should be kept inside the chill room to rule out loss of quality and to prevent spoilage. All the formed products should be kept chilled at all times before cooking.

8.1.F. Cooking Fish/Squid Balls and Quekiam

After setting, the formed products are cooked quickly in boiling water or steamed. The balls and quekiam should be placed in boiling water and should be removed when they float. During cooking, the temperature should not be below 80°C. Disintegration of the gel structure occurs at temperature range of 60–75°C, thus resulting in "softening" or mushy-like texture of the final product. To test if the products are cooked, a fish ball can be dropped on a hard surface and if it bounces back, it can be proclaimed cooked. If in doubt, the core temperature of the fish ball should be

checked (at least 70°C); cutting some balls is a method to check if the core is already done and the product cooked. The cooking vat should not be overfilled with the balls to avoid drastic drop in the cooking temperature. Overfilling of the cooking vat will also slow down the cooking process. Always check the temperature of the cooking water.

8.1.G. Cooling, Packaging, and Storing of Finished Products

Cooling should be done properly, immediately after cooking, to ensure uniform cooling of the batch and to avoid holding at temperatures that encourage the growth of bacteria. Cooling times should be kept as short as possible and every effort should be made to avoid contamination of the product during this period. Cooling of the cooked/steamed products should be carried out using a fan or by placing the products inside a chill room. The products should be placed in trays and cooled before packing in plastic bags. The minced fish products should be packaged then refrigerated or frozen without delay after cooling, under clean and hygienic conditions. The packaging should be clean, sound, durable, sufficient for its intended use, and of food-grade material. If the final products are frozen, they should be stored in a clean, sound, and hygienic environment. Severe fluctuations in storage temperature (more than 3°C) must be avoided. Extended storage period (depending on fat content of species used) should be avoided. Products should be properly protected from dehydration, dirt, and other contaminants.

8.1.H. Transporting and Distributing the Finished Products

When the final products are to be transported in chilled condition, the products should be buried in ice using insulated containers. For deep-frozen conditions, there should be no break in the cold chain. The temperature should be maintained at -18 °C (maximum fluctuation ±3°C) until the final destination of the products is reached. Cleanliness and suitability of the transport vehicle to carry frozen food products should be checked. It is advisable to use temperature-recording devices during the delivery to the customer.

8.2. Fish Kroepeck

Kroepeck is a dried product traditionally made from ground rice with fresh shrimp or fish added to it. The use of fish protein concentrate (FPC) in kroepeck making has not only made the preparation of kroepeck easier but it has also increased the protein content of the product. Fish protein concentrate (FPC) or fish powder is a fine-light colored dried product from fish. The color may vary depending on the fish species used. It is used as a protein supplement in human diet. It is usually added to food preparations to enhance the protein content in the diet. FPC can keep long due to its low moisture and fat content.

8.2.A. Receiving FPC and Ingredients

The FPC, flour, and corn starch should be inspected for broken packaging material, signs of rodent and insect infestations, and other damage, such as dirt on packaging materials and wetness. Cleanliness and suitability of the transport vehicle to carry food products should be examined. Representative samples of the ingredients should be taken and examined to ensure that the product is not contaminated and meets specifications for use in the end product. Ingredients should be shipped on transportation vehicles that are suitable for handling food products and ingredients. Vehicles that have previously hauled potentially unsafe or hazardous material should not be used for hauling food products or ingredients. All other ingredients and packaging material should be stored in a dry and clean

Quality Changes in Frozen Fish Products

Frozen fish products undergo some changes during storage, such as the gradual development of off-flavors and off-odors, and other physical deterioration. The defects may pass unnoticed, but after a sufficiently long period of storage these might intensify and the products become unpleasant to eat. The rate of quality loss will depend on the storage temperature and the extent of temperature fluctuation.

- **Protein Denaturation.** Proteins undergo irreversible changes in sensory quality, such as in appearance and texture. These changes are accompanied by loss in functional properties of the muscle proteins (mainly solubility, water retention, and gelling ability) and lipid emulsifying properties as well as by gradual decrease in enzyme activities.
- **Lipid Changes.** Rusting and rancidity are brought about by the changes occurring in lipids during frozen storage of fatty products. Rusting refers to the movement of oil to the surface of fish during cold storage, resulting to a yellow or light brown discoloration. The rust discoloration has been ascribed to Maillard-type reactions of amino acids or free amino group of proteins with reducing sugars or with some lipid oxidation products. Rancidity is the unpleasant odor and color that develop when fats have undergone oxidation during storage. It is characterized in its early stage by a distinguished fishy odor and flavor followed by a n unpleasant taint, described as linseed oil or paint.
- **Freezer Burn.** This damage is due to excessive drying resulting to matt (white patches on the surface of frozen products) and subsequent change in the appearance of the thawed product.
- **Dehydration and Weight Loss.** During cold storage, dehydration of frozen products tends to occur naturally. The surface of the frozen products becomes very dry and porous. This condition renders the products totally unacceptable. Loss in weight is due to physical damage from dehydration.
- **Development of Cold-Store Flavor and Odor.** Frozen products acquire characteristic cold-store odor and flavor due to improper and extended cold storage.

place under hygienic conditions and appropriately, in terms of temperature and humidity. A systematic stock rotation plan should be developed and maintained to avoid outdated materials. Ingredients should be protected from insects, rodents, and other pests. Defective ingredients and packaging material should not be used.

8.2.B. Mixing of FPC and Ingredients

All dry ingredients should be mixed together first before adding the water. Water should be potable and at ambient temperature. If clumping occurs, a blender should be used.

8.2.C. Preparing the Mixture for Steaming

The pans should be cleaned properly before use. The pans are rubbed with a thin layer of cooking oil using a clean cloth. This should be done so that the steamed mixture can be easily removed from the pan.

8.2.D. Steaming the Mixture

The pan with the mixture should be placed inside the steamer when steam is already generated. The temperature should be monitored closely to ensure that drying of the mixture can occur.

8.2.E. Cutting and Drying of the Steamed Mixture

The pans should be cooled before cutting the steamed mixture into strips. Removal of the cut strips becomes easy when pan is done cooling. Cooling of the pans can be done either by air (using a fan) or by using water. The pans should be placed in a container filled with water. The cut strips are removed from the pans once cooled and arranged on clean drying trays. The strips should be dried for an hour or until dry to touch, and then cut into squares. This step can prevent the curling of the kroepeck if the drying process is carried out very fast. Drying should be carried out inside a solar dryer to protect the products from contamination. The drying process of the kroepeck is completed when the product becomes brittle or when it easily breaks.

8.2.F. Packaging, Storing, and Distributing Dried Kroepeck

Packaging material used should be clean, sound, durable, sufficient for its intended use, and of food-grade quality. Packaging material should be examined for compliance with the prescribed standard. The packaged dried kroepeck should be stored in a dry and cool place. Temperature and humidity of the storage place should be monitored.

Before the transport of the finished product to the customers, special attention on the cleanliness and suitability of the transport vehicle to carry food products should be checked.

C. WASTE MANAGEMENT

In the fish supply chain from the fisher to consumer, production of waste can hardly be avoided. Fish containers (which are mainly made of plastic materials) used during fishing and during transport to fish landing, processors and markets, need regular replacement due to constant use. Considerable wastes are also produced during processing (from the raw material) or from the packaging material used to package the finished product. Hence, it is of importance to put in place a system throughout the fish supply chain on how to manage all the wastes that are being produced.

1. VALUE ADDITION OF FISH AND SQUID WASTE

Fish species such as flying fish have a round body, and processing waste could amount to 30–35%. Processing waste can be converted into fermented products (fish paste and fish sauce) and fish meal for animal feed. Recovered livers from fish may be used for extraction of fish oils or may be used in the preparation of liver paste and pate. Extracts from fully hydrolyzed fish stomachs may be used in the manufacture of bouillons or fish flavorings. Skin may be converted into crispy snack items. Enzymes, and lipids, particularly omega 3-fatty acids, may be recovered from fish offal.

The non-edible parts of squid such as the internal organs, skin, quill or pen, beak and eyes, comprise about 30% of the total weight of the animal. These can be converted into fish meal or used as bait. Skin, together with damaged or low-grade raw material, can be ensilaged and sold as high-protein feed. The eyes of squid can be used in the paint and cosmetic industries, as well as in the manufacture of luminous dials. The ink from the squid sac can be used for the manufacturing of dyes and ink. The quill or pen can be a valuable source of high-quality chitin and chitosan.

2. PACKAGING WASTE

A wide-range of packaging materials, particularly plastics, are now widely used in the Philippines. Traditional fish containers like galvanized tubs (banera), bamboo and rattan baskets have almost been completely replaced by plastic containers such as high density polyethylene and polystyrene or styrofoam containers. Polystyrene is becoming popular due to its low cost and weight (light to use). However, this type of container does not last long, thus frequent replacement of the container becomes necessary. In many fishing villages in the country, waste from this type of container is becoming a serious problem because these are mainly discarded into the sea. Plastics when discarded into the sea are broken down into micro-particles and may be ingested by aquatic animals, thus posing a danger not only to the aquatic animals but to human health as well. Therefore, all plastic waste

from the seafood processing value chain needs to be included in the municipal solid waste management systems.

D. MANUFACTURED PRODUCTS
1. DRIED PRODUCTS

Dried fish makes up the bulk of processed (cured) fishery products in the Philippines. Dried fish is a staple item in the Filipino diet; thus it is accepted and consumed by almost all income groups and in almost all localities of the country. Dried fish which cannot be sold in consumer markets due to poor quality are sold to fish meal factories.

1.A. Dried Fish (Rabbitfish and Flying Fish)

Materials and Equipment

- Rabbitfish (danggit)
- Flying fish
- Salt
- Brining vats/containers
- Drying trays, Solar dryer
- Plastic bags

Procedure

1. Wash fish thoroughly with clean water. Split fish.
2. Remove internal organs. Wash fish, preferably with chilled water, to remove blood effectively.
3. Soak in saturated brine for 30–40 minutes, depending on the size and salt desired in the finished product.
4. Drain the fish from brine and rinse with potable water.
5. Arrange the fish (skin side down) on drying trays and dry under the sun or inside a solar dryer.
6. Turn the fish over once or twice a day to have uniform drying.
7. Cool the fish and pack in plastic bags. Store in a cool and dry place.

1.B. Dried Squid

Materials and Equipment

- Squid
- Drying trays, solar dryer
- Plastic bags

Procedure

1. Wash the squid with clean water. Split and remove internal organs.
2. Wash split squid thoroughly. Drain.
3. Arrange the squid on drying trays. Dry under the sun or inside a solar dryer.
4. Cool and pack in plastic bags.
5. Store in a cool and dry place.

Fish Meal

Fish meal is a dried fishery product from excess catch, waste materials from fish processing plants, rejects, and market surpluses. Fish meal contains high amounts of easily digestible proteins, minerals, vitamins, and almost all the necessary trace elements and essential amino acids. It is an essential ingredient in ready-mixed poultry and hog feeds. Almost all species of fish can be used in the preparation of fish meal. Other raw materials which can be utilized in fish meal production include: fish waste (consisting of the head, tail, fins, and viscera), scrap fish that do not command a good price in the market, and dried fish which are unmarketable due to poor quality (Espejo-Hermes, 1985).

Methods of Salting

- **Dry Reduction Process.** The species of fish usually processed in this manner are those with low fat content. Fish meal manufactured by this method contains all the water-soluble compounds, and a large percent of oil which lowers the quality of the meal. This process involves drying, grinding, and packaging.
- **Wet Reduction Process.** The bulk of the world's fish meal and oil today is manufactured by the wet reduction method. The main steps of the process are cooking for coagulation of the protein, thereby liberating bound water and oil, separation by pressing the coagulate, yielding a solid phase (press cake) containing 60–80% of the oil-free dry matter (protein, bones) and oil, and a liquid phase (press liquor) containing water and the rest of the solids (oil, dissolved and suspended protein, vitamins and minerals).

Source: Espejo-Hermes (2006).

1.C. Fish Protein Concentrate (FPC)

Materials and Equipment

- 5 kg fish
- Salt
- Steamer
- Cooking pot
- Measuring spoons
- Measuring cups
- Muslin cloth
- Drying trays
- Grinder/pulverizer
- Plastic bags
- Bottles, wide mouth

Procedure

1. Clean the fish thoroughly in running water.
2. Steam fish until cooked.
3. Separate flesh from bones and visceral organs.
4. Mince the flesh.
5. Weigh the flesh and prepare 5% brine solution (for a liter solution, dissolve 50 g salt in 950 ml water). The ratio of the minced flesh to brine is 1:1.5.
6. Boil minced flesh in the solution for 15–20 minutes.
7. Cool a bit and pour over a muslin cloth, then press out the water from the minced meat while it is still warm.

8. Dry the press cake under the sun or in a solar dryer.
9. Pulverize and pack in plastic bags or bottles.
10. Store in a cool, dry and dark place.

1.D. Fish Kroepeck

Ingredients

- 4 tbsp. FPC
- 1 tbsp. salt (refined)
- 2 cups wheat flour*
- 1 ½ tsp. ground pepper
- 2 cups cassava atarch/cornstarch*
- 3 ½–4 cups Water
- Cooking oil
- MSG (optional)

Utensils/Equipment

- Baking pans/tins (20 x 20 cm)
- Steamer
- Measuring spoons and cups
- Drying trays
- Knife
- Piece of cloth or Brush

Procedure

1. Combine all dry ingredients. Add water and blend well.
2. Place 3–4 tablespoons of the mixture on a greased pan.
3. Steam for 2 minutes or until the mixture becomes translucent.
4. Cool and cut the steamed mixture into strips and carefully remove from the pan.
5. Arrange the slices on drying trays.
6. Dry under the sun or in a solar dryer for an hour or more (until dry to touch) and cut into squares. Dry the product until it becomes brittle.
7. Pack in polyethylene bags and store in cool and dry place.

*Can be replaced with rice (old/stored). Soak rice in water (1:1) overnight. Grind the soaked rice and proceed following the procedure above.

1.E. Fish Meal (Wet Reduction Method)

Materials and Equipment

- Fish offal
- Drying trays
- Steamer
- Grinder

Procedure

1. Steam fish offal. Drain well and place on a drying tray.
2. Dry steamed offal under the sun or in a solar dryer.
3. Grind the dried meal.
4. Pack in a plastic container. Store in a cool and dry place.

2. MINCED PRODUCTS

Minced flesh from fishery products can be utilized in imitation products (crab legs, scampi, shrimp dumpling, etc.) or in traditional foods such as fish/shrimp/squid balls, nuggets, sausages, burgers, and others. Minced fish products are classified as intermediate moisture food (IMF) because of their high moisture content, which shortens their keeping quality. The minced products are usually kept refrigerated or frozen to lengthen their keeping time or shelf-life.

2.A. Fish Balls

Ingredients

- 1 cup minced fish
- 1 tbsp. salt
- 1 ½ cups flour*
- ½ tsp. ground pepper
- ½ cup cassava starch*
- 2 tsp. baking powder
- ½ tsp. MSG (optional)
- 2 tbsp. minced onion
- 3/4–1 cup cold water
- 2 tsp. garlic or 1 tsp. garlic powder
- 1 tsp. sugar (optional)

Procedure

1. Grind or mix minced meat with salt.
2. Add sugar, MSG, pepper, garlic powder, and onion. Mix well. (Maintain low temperature during mixing).
3. Mix together flour, starch, and baking powder. Add to the fish mixture. Add water slowly into the mixture.
4. Form into balls manually or by using a fish ball-forming machine.
5. Set the fish balls in cold water for 20–30 minutes.
6. Cook fish balls in water, 90–100°C.
7. Cool properly and pack in polyethylene bags.
8. Chill or freeze.

*Cassava flour can be used instead of wheat flour and cassava starch.

2.B. Squid Balls

Ingredients

- 1 cup minced squid
- 2 ½ cups cornstarch/cassava starch
- 1 ½ tsp. sugar
- 2 tbsp. minced onion
- 1 tbsp. salt
- 2 tsp. minced garlic
- 1 tsp. baking powder

Procedure

1. Wash the squid thoroughly. Remove the head, ink sac, and internal organs by pulling the tentacles.
2. Split the mantle to remove the remaining viscera.

Clean well.
3. Remove the skin of the mantle and wings/fins, then wash in cold water.
4. Cut the mantle into small pieces and grind.
5. Mix the ground flesh with salt. Blend well.
6. Add the remaining ingredients and mix thoroughly. (Mix starch and baking powder before adding into the mixture).
7. Form into balls manually or by using a ball-forming machine.
8. Set the fish balls in cold water for 20–30 minutes.
9. Cook squid balls in water, 90–100°C. (The squid balls are already done if the balls bounce when dropped on a hard surface).
10. Cool and pack in polyethylene bags.
11. Chill or freeze.

2.C. Fish Quekiam

Ingredients

- 4 cups minced fish
- 2 ½ tbsp. salt
- 2 cups flour
- 1 ½ cups cornstarch/cassava starch
- 1 tsp. baking powder
- ½ tsp. MSG (optional)
- 2 tbsp. five spice powder (Guyong powder)
- 1–1 ½ cups cold water
- 2 tbsp. minced onion
- ½ cup vegetable oil

Procedure

1. Mix fish meat and salt.
2. Add vegetable oil, onion, guyong powder and MSG. (Maintain low temperature during mixing).
3. Mix flour and cornstarch and baking powder. Add to the fish mixture.
4. Add cold water and mix well.
5. Form into quekiam manually (use a cake decorating dispenser) or use a quekiam-forming machine.
6. Boil until cooked. (Alternatively, the quekiam can also be fried until brown).
7. Cool properly and pack in polyethylene bags and freeze.

3. FERMENTED PRODUCTS

Fish paste and sauce are not salt but in many parts of Southeast Asia including the Philippines, these fermented products take over the seasoning role of salt. Fermentation of fish is an old technology employed for the preservation of fish, which are highly perishable. Fermentation is usually defined as the breakdown of organic substances into simpler components mainly by the action of enzymes aided by microorganisms. Fish paste and sauce may be prepared from marine species such as anchovies, small sardines and scads, or freshwater species of fish. Fish paste and sauce can also be prepared from the fish canning processing waste (head, tails, fins, visceral organs, and other solid waste) and the waste from other fish processing operations. a.

Fish Paste and Sauce*

Materials and Ingredients

- Fish offal
- Meat grinder
- Salt
- Bottles, wide-mouth with lids

Procedure

1. Wash the fish offal. Drain well.
2. Grind the offal and weigh.
3. Compute salt required to salt the ground offal. Use the ratio of 1 part salt (coarse) to 4 parts ground offal. If fine salt is used, 1 part salt to 5 parts offal should be used.
4. Mix salt and ground offal thoroughly. Put the mixture in wide-mouth bottles. Close the lid.
5. Place the bottles under the heat of the sun. Shake the bottles every 2 days for 2 weeks.
6. Store mixture for 3 months in a warm and dry place. Separate the clear liquid (patis) that formed on top of the mixture. Strain the remaining mixture to separate the undissolved component to get the fish paste (bagoong). Brine extractions of fish residues can also be made by using freshly prepared saturated brine. The brine should be prepared from potable water and food-grade salt.
7. Fill fish sauce and fish paste into bottles with lids. (The fish sauce can be pasteurized by heating the liquid for 5–10 minutes at 90°C).

*Anchovies and small fish are the typical raw materials for fish paste and fish sauce.

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ANNEX 1. GLOSSARY

Additives | Any substance the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food (including any substance intended for use in producing, manufacturing, packing, processing, preparing, treating, packaging, transporting, or holding food; and including

any source of radiation intended for any such use), if such substance is generally recognized, among experts qualified by scientific training and experience to evaluate its safety, as having been adequately shown through scientific procedures to be safe under the conditions of the intended use.

Aflatoxin | Poisonous carcinogen that is produced by certain molds, Aspergillus flavus, which grow in food commodities like grains, and sometimes in moldy dried fish.

Barrel | A cylindrical container made of wood or plastic or other suitable food contact material with a lid for watertight closure.

Brine | Solution of salt and water.

Brining | The process of placing fish in brine for a period of sufficient length for the fish tissue to absorb a specific quantity of salt.

Candling | Passing fillets of fish over a translucent table illuminated from below to detect parasites and other defects.

Case hardening | Hardening of the surface of fish meat. Hard cover is formed on the surface of fish meat caused by high temperature and quick heating process.

Clean seawater | Refers to seawater which meets the same microbiological standards as potable water, and is free from objectionable odor and substances.

Contaminant | Any biological or chemical agent, foreign matter or other substances not intentionally added to food that may compromise food safety or suitability.

Contamination | The introduction or occurrence of a contaminant in fish, shellfish or their products.

Drying | The process in which the moisture content in the fish is decreased to appropriate required characteristics under controlled hygienic conditions.

Dry-salting | The process of mixing fish with suitable food-grade salt and stacking the fish in such a manner that the resulting brine drains away.

Facility | Any premises where fish or fishery products are prepared, processed, chilled, frozen, packaged, or stored.

Fillet | A slice of fish of irregular size and shape removed from the carcass by cuts made parallel to the backbone.

Fish | Any of the cold-blooded (ectothermic) aquatic vertebrates. Amphibians and aquatic reptiles are not included.

Fish sauce | A translucent, not turbid liquid product with a salty taste and fish flavor obtained from fermentation of a mixture of fish and salt.

Fresh fish | Refers to fish or fishery products that have received no preserving treatment other than chilling.

Full-service display | A display of chilled fish, shellfish, and their products to be weighed and wrapped by establishment personnel at the request of the consumer.

Gaping | When fish are filleted, the cut surface is normally smooth and glossy. Sometimes, however, the flesh separate from one another so that slits or holes appear in the fillet and, in bad cases, it may even drop to pieces when it is skinned; fillets like this are said to gape.

Hazard | A biological, chemical or physical agent in food or the condition of food with the potential to cause an adverse health effect.

Minced fish | Comminuted flesh produced by separation from skin and bones.

Packaging | The process in which processed fish is put in a container to avoid contamination and prevent dehydration.

Potable water | Freshwater fit for human consumption. Standards of potability should not be lower than those contained in the latest edition of the International Standards for Drinking-water issued by the World Health Organization.

Raw materials | Fresh and frozen fish, shellfish, and/or their parts that may be utilized to produce fish and shellfish products intended for human consumption.

Retail | An operation that stores, prepares, packages, serves, or otherwise provides fish, shellfish, and their products directly to the consumer for preparation by the consumer for human consumption. This may be freestanding seafood markets, seafood sections in grocery or department stores, packaged, chilled or frozen, and/ or full service.

Salt | A crystalline product consisting predominantly of sodium chloride. It is obtained from the sea, from underground rock salt deposits or from vacuum processed and refined brine.

Salting | The process of treating fish with salt of food-grade quality to lower water activity in fish flesh.

Sanitation/Disinfection | The reduction by means of chemical agents and/or physical methods in the number of micro-organisms in the environment to a level that does not compromise food safety or suitability.

Saturated | The water phase of the fish muscle is saturated with salt (26.4 g Salt/100 g Water Phase).

Split fish | Fish that have been cut open from throat or nape to the tail, with gills, guts, roe, or milt removed. Head and whole or part of backbone may be left in or removed.

Storage | The process in which products are kept under conditions to assure their safety and quality.

Water activity | The ratio of water vapor pressure of the substance to the vapor pressure of pure water at the same temperature. Loosely bound water or available water needed to support biological activity.

Source: www.fao.org/fao-who-codexalimentarius

ANNEX 2. CONVERSION TABLE

Volume	
1 teaspoon (tsp.)	5 milliliters (ml)
1 tablespoon (tbsp.)	15 milliliters
2 cups	½ liter (l)
1 liter	1000 milliliters
Weight	
1 kilogram (kg)	1000 grams (g)
Fish (minced)	
1 cup	150 grams (approximately, depending on fish species)
Flour (sifted)	
1 cup	100 grams
Cornstarch/Cassava Starch	
1 cup	100 grams
Rice	
1 cup	250 grams

Sugar (granulated)	
1 tsp.	5 grams
1 tbsp.	15 grams
1 cup	200 grams
Pepper (ground)	
1 tbsp.	5 grams
Onion (minced)	
1 tbsp.	15 grams

Salt	
1 tsp. (refined)	5 grams
1 tbsp. (coarse)	10 grams
Baking Powder	
1 tsp.	5 grams
Shortening	
1 tbsp.	15 grams
1 cup	250 grams

ANNEX 3. BRINE PREPARATION OF REQUIRED STRENGTH

(The amount of salt to be dissolved in water to obtain required brine strength; brine strength measure at 16°C or 61°F)

Specific Gravity	% Salt byWeight	Baumé Degrees U.S. Standard	Salinometer Degrees °S	Salt (kg) to be Dissolved in 100L water
1.007	1	1.0	3.8	1.0
1.014	2	2.0	7.6	2.0
1.022	3	3.1	11.4	3.1
1.029	4	4.1	15.2	4.3
1.037	5	5.2	19.0	5.3
1.044	6	6.1	22.7	6.4
1.051	7	7.0	26.5	7.5
1.058	8	7.9	30.3	8.7
1.066	9	8.9	34.1	9.9
1.073	10	9.8	37.9	11.1
1.081	11	10.9	41.7	12.4
1.089	12	11.9	45.5	13.6
1.096	13	12.7	49.3	14.9
1.104	14	13.7	53.1	16.3
1.112	15	14.6	56.8	17.6
1.119	16	15.4	60.6	19.0
1.127	17	16.3	64.6	20.5
1.135	18	17.2	72.0	22.0
1.143	19	18.1	75.8	23.5
1.151	20	19.0	79.6	25.0
1.159	21	19.9	83.4	26.6
1.168	22	20.9	87.2	28.2
1.176	23	21.7	91.0	29.9
1.184	24	22.5	94.8	31.6
1.192	25	23.4	98.5	33.3
1.201	26	24.3	100.0	35.1
1.204	26.4	24.6	-	35.9

Source: FAO (1976)