

Chapter 4: Dried Fish and Fishery Products

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Potential Food Safety Hazard

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Pathogen growth in the finished product as a result of inadequate drying of fishery products can cause consumer illness. Examples of dried fish products are: salmon jerky; octopus chips; dried shrimp; and, stock fish. (FDA, 2001)

Control Measures

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Dried products are usually considered shelf stable and are, therefore, often stored and distributed unrefrigerated. The characteristic of dried foods that makes them shelf stable is their low water activity (a_w). Water activity is the measure of the amount of water in a food that is available for the growth of microorganisms, including pathogens. A water activity of 0.85 or below will prevent the growth and toxin production of all pathogens, including *Staphylococcus aureus* and *Clostridium botulinum*, and is necessary for a shelf-stable dried product. *S. aureus* grows at a lower water activity than other pathogens, and should, therefore, be considered the target pathogen for drying for shelf-stable products.

Some dried products that are reduced oxygen packaged (e.g. vacuum packaged, modified atmosphere packaged) are dried only enough to control growth and toxin production by *C. botulinum* type E and nonproteolytic types B and F, and are then refrigerated to control growth and toxin formation by *C. botulinum* type A and proteolytic types B and F, and other pathogens that may be present in the product, including *S. aureus*. A water activity of below 0.97 will prevent the growth of *C. botulinum* type E and nonproteolytic types B and F, and is necessary for these refrigerated, partially dried products.

This chapter covers the control of the drying process to prevent the growth and toxin production of pathogens, including *S. aureus* and *C. botulinum* in the finished product. Such control is critical to product safety. This chapter does not cover the growth of pathogens, including *S. aureus*, that may occur as a result of time/temperature abuse during processing, including before

or during the drying process. It also does not cover the control of *C. botulinum* type A and proteolytic types B and F, and other pathogens that may be present, including *S. aureus*, during refrigerated storage of reduced oxygen packaged, partially dried products (FDA, 2001).

FDA Guidelines

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Controlling pathogen growth and toxin formation by drying is best accomplished by:

- Scientifically establishing a drying process that reduces the water activity to 0.85 or below, if the product will be stored and distributed unrefrigerated (shelf-stable);
- Scientifically establishing a drying process that reduces the water activity to below 0.97, if the product will be stored refrigerated (not frozen) in reduced oxygen packaging;
- Designing and operating the drying equipment so that every unit of product receives at least the established minimum process;
- Packaging the finished product in a container that will prevent rehydration.

You should select a packaging material that will prevent rehydration of the product under the expected conditions of storage and distribution. Additionally, finished product package closures should be free of gross defects that could expose the product to moisture during storage and distribution.

Pathogen growth is not a concern in dried products that are stored, distributed, displayed and sold frozen, and are so labeled. These products need not meet the control measures outlined in this chapter since drying in this case is not critical to product safety. Similarly, drying may not be critical to the safety of dried products that are stored refrigerated, unless they are reduced oxygen packaged, since refrigeration may be sufficient to prevent pathogen growth in aerobically packaged products.

The drying operation used in the production of smoked or smoke-flavored fish is not designed to result in a finished product water activity of 0.85 or below.

Because spores of *Clostridium botulinum* are known to be present in the viscera of fish, any product that will be preserved by salting, drying, pickling, or fermentation must be eviscerated prior to processing (see Compliance Policy Guide sec. 540.650). Without evisceration, toxin formation is possible during the process even with strict control of temperature. Evisceration must be thorough and performed to minimize contamination of the fish flesh. If even a portion of the viscera or its contents is left behind, the risk of toxin formation by *C. botulinum* remains. Small fish, less than 5 inches in length, that are processed in a manner that prevents toxin formation, and that reach a water phase salt content of 10 percent in refrigerated products, or a water activity of below 0.85 (Note: this value is based on the minimum water activity for growth of *S. aureus*) or a pH of 4.6 or less in shelf-stable products, are exempt from the evisceration requirement (FDA, 2001)

State Guidelines

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New York: Processed fish (includes dried fish and fishery products) (Corby, 1999)

All processed fish shall be produced pursuant to a scheduled process established by a competent processing authority. A copy of said scheduled process shall be available for examination in each fish processing establishment. Each scheduled process shall identify the name and address of the competent processing authority by whom it was established. The scheduled process shall include processing methods, procedures and controls for each product, as well as packaging and labeling requirements. Whenever a deviation in a scheduled process occurs, as disclosed by records, processor check or otherwise, the processor shall destroy all product affected by said deviation or hold it for a determination as to whether it is adulterated within the meaning of Section 200 of the Agriculture and Markets Law.

Process Establishment

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Process establishment (except where finished product water activity analysis is the monitoring procedure): The adequacy of the drying process should be established by a scientific study. For shelf-stable products, it should be designed to ensure the production of a shelf stable product with a water activity of 0.85. For refrigerated (not frozen), reduced oxygen packaged products, it should be designed to ensure a finished water activity of less than 0.97. Expert knowledge of drying process calculations and the dynamics of mass transfer in processing equipment is required to establish such a drying process. Such knowledge can be obtained by education or experience or both. Establishment of drying processes requires access to adequate facilities and the application of recognized methods. The drying equipment must be designed, operated and maintained to deliver the established drying process to every unit of product. In some instances, drying studies will be required to establish the minimum process. In other instances, existing literature which establish minimum processes or adequacy of equipment, are available. Characteristics of the process, product and/or equipment that affect the ability of the established minimum drying process should be taken into consideration in the process establishment. A record of the process establishment should be maintained (FDA, 2001).

Critical Aspects of Processes

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Critical aspects of drying processes may include:

- Drying time;
- Input/output air temperature, humidity, and velocity;
- Dry and wet bulb temperatures at dryer inlet and outlet;
- Flesh thickness;
- Accuracy of thermometers, recorder thermometer charts, high temperature alarms, maximum indicating thermometers, and/or digital data loggers; and
- Accuracy of other monitoring and timing instruments (FDA, 1998).

Analytical Procedures

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Water activity

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See [Chapter 1](#).

Drying Processes

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Examples of seafood processes are provided for information only. The National Seafood HACCP Alliance does not endorse or recommend specific seafood processes.

Air dried and pressed mullet roe

Clean roe from blood, gall bags, bits of intestines, and black skin. Wash thoroughly and drain. Roll roe in fine salt, using about 1 pound (454 g) of salt per 10 pounds (4.5 kg) of roe. Remove from salt in 6-12 h and brush well to remove excess salt. Lay roe out to dry in direct sunlight. Turn roe at least every h during the first day and bring roe indoors in the evening. Place boards and weights on the roe during the first night or 2 to compress them slightly. Cure for about 1 week under good drying conditions until the roe is reddish-brown and feels hard. Dip dried roe in melted beeswax. Cool for 15 min, wrap in waxed paper, and store in a cool dry place (Jarvis, 1987).

Bag-shaped dried squid

Remove the head and skin from the body. Turn body inside out and wash to remove ink and other substances. Hang the reversed body on the end of a spit and dry in the sun. After drying for 1/2 d, reverse the body to its normal condition. Shape the body daily until dry (Tanikawa et al, 1985).

Balyk (dried sturgeon meat)

Remove the back flesh from the sturgeon. For large fish, cut the back flesh either lengthwise only, or else both lengthwise and crosswise. Place pieces of fish in a tub so they do not touch each other or the sides of the tub. Cover pieces with a thick layer of salt and leave for 9-12 d. Use 2 pounds (907 g) of saltpeter (potassium nitrate) to 1,800 pounds (816.5 kg) of salt to give the fish a reddish color. If desired, add allspice, cloves, and bay leaves to the brine. Soak the salted sturgeon in freshwater for about 24 h to remove excess salt. Dry 4-6 weeks until a slight mold covers the balyk. High quality balyk is soft and tender with a reddish or orange-brown color, and has an odor something like that of a cucumber. It must be transparent, show no traces of putrefaction, have no bitter taste, and not be too salty (Jarvis, 1987).

Boiled-dried abalone

Remove abalone from shell and trim away viscera. Salt 3-7 d. Wash and boil for 5 min. Dry 7-10 d (Tanikawa et al., 1985).

Boiled-dried sand lance

Wash fish in water to remove scales and impurities. Place fish in baskets and boil in salt water for about 15 min or when the fish float. Use 1-1.2 kg salt to 20 L water. Drain fish and dry on mats 2-3 d (Tanikawa et al., 1985).

Boiled-dried sardines

Use sardines or anchovies about 10 cm long. Wash fish in water to remove scales and impurities. Place fish in baskets and boil in salt water for about 15 min or when the fish float. Use 1-1.2 kg salt to 20 L water. Drain fish and dry on mats for 2-3 d (Tanikawa et al., 1985).

Boiled-dried sea cucumber

Place live sea cucumbers in freshwater for a short time to clean out intestinal tract. Remove intestine from the anus with an eviscerating apparatus. Clean abdominal cavity with a thin brush. Put sea cucumbers in salt water at 3°Bé (Baumé) at 95°C for 1.5-2 h. Deflate bodies that swell during the cooking process. Drain sea cucumbers and remove adhering foam with a spatula-like implement. Straighten body shapes and cool. Roast at 70°C and air-dry for 5 d (Tanikawa et al., 1985).

Boiled-dried scallop

Boil fresh scallops 5-8 min and remove body from shell. Remove mantle and viscera and wash in freshwater to remove sand or pieces of shell. Boil scallops in a salt solution (2.8 kg of salt to 20 L water) 20-30 min. Air-dry 10 d, bringing the scallops inside at night (Tanikawa et al., 1985).

Boiled-dried shark cartilage

Cut cartilage from jaw, fin and head into 7-9 cm lengths. Soak in hot water to remove attached meat. Boil again and air-dry in the sun (Tanikawa et al., 1985).

Boiled-dried shellfish meat

Boil shellfish (oysters, clams, mussels) in seawater to open the shell. Remove shellfish meats and boil in seawater again to increase the firmness of the meats. Air-dry (Tanikawa et al., 1985).

Dried abalone

Remove abalone from the shell. Store meats in about 50° salimeter salt brine for several d to remove mantle fringe and preserve the flesh during drying. Wash and cook for about 30 min in water just below the boiling point. Dry on shallow pans in the sun for 4-5 d, turning at intervals. Cook again for 60 min and dry over a low charcoal fire. Rinse in boiling water and dry in the sun for about 6 weeks (Jarvis, 1987).

Dried clams

Shuck clams and boil in salt water for about 10 min. Spread on trays and air dry 2-3 weeks (Jarvis, 1987).

Dried cod I

Remove head, viscera, and backbone. Dry in the sun until the moisture content is less than 30% (Tanikawa et al., 1985).

Dried cod II

Split cod at the dorsal side and remove viscera. Wash fish with freshwater and remove black membrane from belly cavity. Salt in brine or dry salt. For brining, soak fish in salt solution of 18° Bé that was previously boiled and cooled. Place cod in tank and cover with brine. After 1 d, change brine and press fish down with a weight for 1 d. For dry salting, layer cod with a sprinkling of fine salt between layers. Use about 190-200 kg salt for 1,000 split fish. Salt for 10 d. After salting, wash the fish with a salt solution of 4° Bé and drain. Dry salt the fish again and rinse with freshwater before drying. Air-dry on mats (Tanikawa et al., 1985).

Dried cod fillet

Fillet fish and skin. Salt in brine or dry salt. For brining, soak fish in salt solution of 18° Bé that was previously boiled and cooled. Place cod in tank and cover with brine. After 1 d, change brine and press fish down with a weight for 1 d. For dry salting, layer cod with a sprinkling of fine salt between layers. Use about 190-200 kg salt for 1,000 split fish. Salt for 10 d. After salting, wash the fish with a salt solution of 4° Bé and drain. Dry salt the fish again and rinse with freshwater before drying. Air-dry on mats (Tanikawa et al., 1985).

Dried cod stomach

Remove cod stomach, gullet and gills in 1 piece. Air-dry (Tanikawa et al., 1985).

Dried cuttle fish

Split the head and body and remove the eyes. Wash and dry for 7-8 d on a bamboo blind (Tanikawa et al., 1985).

Dried herring

Remove gills, milt, and viscera. Dry in the sun for 2-3 d. Cut out backbone from the caudal fin to the head and cut off the belly flesh horizontally along the lower line of the backbone. Air-dry for an additional 2-3 weeks (Tanikawa et al., 1985).

Dried herring roe

Soak herring roe in seawater for 4-5 d to remove blood and increase firmness. Wash in a freshwater spray. Drain and air-dry for about a week (Tanikawa et al., 1985).

Dried mullet roe I

Place unbroken roe bags in tubs and sprinkle with salt or soak in brine, using about 5 quarts (4.73 L) of salt per 100 pounds (45.4 kg) of roe. Cure for 10-12 h, drain, and spread on boards in the sun to dry. Take roe in each night to prevent them becoming wet from dew. Dry for about 1 week in fair weather. Dip in 50% beeswax and 50% paraffin and store under refrigeration (Long et al., 1982).

Dried mullet roe II

Place unbroken roe sacs in tubs and sprinkle with salt or soak in brine. Use about 6 kg of salt for 50 kg of roe. Salt for 10-12 h and drain. Place roe on wooden board and cover with a plate and weight. After 1 d, spread roe in the sun to dry. Dry for about 20 d, bringing the roe inside at night (Tanikawa et al., 1985).

Dried octopus: levantine cure

Eviscerate the octopus and wash thoroughly in seawater. Spread octopus out on trays, elevated a few feet above the ground, in the sun. Dry for 10 d to 2 weeks depending on the weather and the size of the octopus (Jarvis, 1987).

Dried octopus: oriental cure

Eviscerate the octopus and wash thoroughly in seawater. Simmer the octopus for about 45 min in water just below the boiling point. Spread octopus out on trays, elevated a few feet above the ground, in the sun. Dry for 10 d to 2 weeks depending on the weather and the size of the octopus. A low charcoal fire can be used in drying (Jarvis, 1987).

Dried pollock

Remove head, viscera, and backbone. Dry in the sun until the moisture content is less than 30% (Tanikawa et al., 1985).

Dried salmon

Break the backbone just back of the head immediately after capture to bleed the fish and to prevent thrashing and bruising of the flesh. Cut off head, leaving the collarbone or nape. Insert a knife at the collarbone and cut along the backbone to within 2-3 inches (5.1-7.6 cm) of the tail. Make a similar cut just under the backbone and break backbone off close to the tail. Scrape out viscera, membranes and other offal, and wash flesh. Make a series of transverse cuts, about 3-4 inches (7.6-10.2 cm) apart, to facilitate drying.

Hang fish flesh side out from poles on a drying frame. Put 1 side on each side of the pole. Dry for 10 d to 2 weeks in ordinary weather. Dry longer if drying conditions are not good or the fish are large. Store in a cool dry place (Jarvis, 1987).

Dried-salted jack mackerel, mackerel and saury

Split fish on ventral side and remove viscera. Wash fish in freshwater. Dry-salt overnight and air-dry on mats (Tanikawa et al., 1985).

Dried-salted yellowtail

Split the fish on the ventral side and remove the viscera. Wash with freshwater. Make several lines of half-cuts on the surface of the fish body to allow salt to penetrate easily. Soak the fish in a dilute salt solution to remove blood and other extraneous material. Salt for 4-5 d, using 15-16 kg salt for each 10 big yellowtail. Wash with freshwater and air dry in the sun (Tanikawa et al., 1985).

Dried sardines

Wash small anchovies (6-9 cm long) in freshwater. Spread on mats and air-dry. Turn anchovies several times a day. Move drying fish inside during the night. Dry for several d (Tanikawa et al., 1985).

Dried shark

Remove fins and dress the fish. Wash the dressed fish to remove blood and bits of viscera. Insert 2-3 pieces of cane into the flesh crosswise to hold the fish open. Hang on poles to dry in the air. Dry about 4-7 d (Jarvis, 1987).

Dried shark fins I

Cut fins from sharks. Salt or dust with lime and dry in the sun (Long et al., 1982).

Dried shark fins II

Cut fins off at the joint connecting the fin with the body. Trim away all fleshy parts, leaving only the true fin with its rays. Wash and spread on low bamboo or wickerwork frames to dry in the sun. Turn the fins from time to time. Dry for 2-3 weeks, bringing the fins into a dry shelter at night (Jarvis, 1987).

Dried shark fins III

Cut fins off at the base, avoiding the attachment of the meat as much as possible. Wash in seawater or dilute salt solution with a scrubbing brush. Rinse in freshwater. Bore a hole through the bony part of each fin. Hang fins by a string and air-dry for 2-3 weeks (Tanikawa et al., 1985).

Dried shark fins IV

Remove shark fins and soak in freshwater for 4-5 d. Heat in hot water (90°C [194°F]) for 20-30 min to swell and to remove the epidermis. Cut off cartilage at the base of the fins. Separate the fin rays from the base to the central part by removing the gelatinous substance present between the fin rays. Air-dry (Tanikawa et al., 1985).

Dried shrimp

Wash shrimp and cook in large kettles. Add 10-20 quarts (9.46-19.93 L) of salt to the water per 900 pounds (408.2 kg) of shrimp, depending upon the weather. Use more salt in damp weather than in dry. Put shrimp in water after the water reaches a boil and start the cooking time when the brine again comes to a boil. Cook for 15-45 min, depending upon the size and amount of shrimp and the weather. The shrimp are cooked when there is a clear space between the meat and the shell.

Drain the shrimp for 15 min and spread them on drying platforms. Turn the shrimp frequently to promote drying and prevent spoilage. Cover shrimp at night with tarps placed over A-shaped trusses to protect them from rain and dew. Dry for 24-48 h in favorable weather, longer with larger shrimp and high humidity. Remove the shells from dried shrimp mechanically and sift on a coarse wire screen to remove meats (Jarvis, 1987).

Dried shrimp (peeled after drying)

Wash shrimp and boil for 30-40 min in salt water (about 360 kg salt per 20 L water). Air-dry the shrimp. Pass dried shrimp through a barrel-like device with revolving short levers to remove shells (Tanikawa et al, 1985).

Dried shrimp (peeled before drying)

Remove heads and shells from shrimp. Boil shrimp and air-dry (Tanikawa et al, 1985).

Dried shrimp with shell

Wash shrimp and boil for 30-40 min in salt water (about 360 kg salt per 20 L water). Air-dry the shrimp (Tanikawa et al, 1985).

Dried skates or rays

Lay the fish on its back and make 2 circular cuts down the ventral side. The first slices away the lower wall of the mouth and gill cavity, leaving the wall hanging as a flap. The second cuts away the lower wall of the abdominal cavity, leaving this as a flap. Remove viscera and make a vertical cut from above through the backbone from the head to the base of the tail. Make 1-2 short slashes on each side of the thick base of the tail. Make a series of cuts across the disk of the fish, penetrating to the skin below. Rub sand into each cut and lay the fish in a hole in the beach

for about 24 h. Wash the fish, drain, and rub a small amount of coarse sand into the flesh. Hang across pole racks to dry in the open air. Dry for 4-5 d (Jarvis, 1987).

Dried squid

Wash and split the squid. Remove the quill and ink sac. Scrape the inside of the body thoroughly. Spread squid out in the sun to dry, turning at frequent intervals for the first few d. Take squid inside every evening to protect from night fog and dew. Dry for about 10 d (Jarvis, 1987).

Dried squid ("biko-surume")

Cut a hole at the end of the body near the fin. Thrust a bamboo spear through the hole so that the hole remains in the dried product (Tanikawa et al., 1985).

Dried squid ("mizu-surume")

Split body and remove viscera and eyes. Remove most of skin. Stretch body on a kite-shaped frame and dry (Tanikawa et al., 1985).

Dried squid ("niban-surume")

Split the belly side of the mantle from the head to the tail. Remove ink sac and cut the viscera off from the head. Split head and remove the jaws and mouth. Remove quill. Soak in freshwater to whiten the surface of the body. Wash in seawater, or 2-3°Bé brine, to remove mucus and other substances. Rewash in freshwater to remove salt. Hang the squid in the sun with the fin of the body on 1 side and the tentacles on the other. Dry for 3 d if the weather is favorable. Bring the squid inside each evening to protect them from the weather. When the squid are 2/3 dry, shape them to keep the desired appearance (Tanikawa et al., 1985).

Frozen-dried Alaska pollock

Split fish on the ventral side and remove viscera. Soak in freshwater for 2 d to remove blood. Change water 4-5 times/d. Hang fish outdoors to freeze completely. Air-dry for about 70 d (Tanikawa et al., 1985).

Halibut rackling

Remove head and clean fish, leaving the collarbone or nape. Remove viscera, split fish into 2 sides, and remove the backbone. Cut the sides into long narrow strips about 1 inch (2.5 cm) wide, leaving the strips joined together at the collarbone. Wash the pieces thoroughly to remove all traces of blood and drain. Soak the strips in 95° salimeter salt brine for 1-2 h. Hang the fish to dry in a shady place where they will be exposed to as much breeze as possible. Dry for 1-2 weeks (Jarvis, 1987).

Moonface-shaped dried squid

Split the belly side of the mantle from the head to the tail. Remove ink sac and cut the viscera off from the head. Split head and remove the jaws and mouth. Remove quill. Soak in freshwater to whiten the surface of the body. Wash in seawater, or 2-3° Bé brine, to remove mucus and other substances. Rewash in freshwater to remove salt. Hang the squid in the sun with the fin of the body on 1 side and the tentacles on the other. Dry for 3 d if the weather is favorable. Bring the squid inside each evening to protect them from the weather. When the squid are 2/3 dry, stretch them side ways into a round shape (Tanikawa et al., 1985).

Salted and air-dried tuna roe I

Wash roe and drain for a few min. Place roe in saturated salt solution and cure for about 12 h. Rinse roe sacs and pierce with a knitting needle to allow moisture to escape. Place roe sacs on a marble slab sprinkled with salt. Scatter additional salt over the roe and place a second marble slab on top. After several h, add additional weight to the top slab. Cure for 2 d, then remove weights, turn over roe sacs, pierce roe sacs again, and sprinkle with fine salt. Replace weights and cure for an additional 4-5 d. Remove weights and rinse roe in strong brine. Hang roe sacs from a line and dry in the shade for several d until they are hard and reddish-brown. Brush with olive oil or coat with beeswax (Jarvis, 1987).

Salted and air-dried tuna roe II

Clean roe and remove oviduct, adipose tissue, and large vein. Force blood out of small veins. Puncture lower end of each sac in several places. Wash thoroughly in seawater, drain for a few min, and cover the roe completely with salt. Cure in the salt for 24-36 h. Rinse roe in seawater and drain. Sprinkle salt on a large board and place roe in rows on the board. Add roe until there are 6-7 layers, sprinkling salt on top of each layer. Place stack in a screw press and apply light pressure. Each day, remove the roe; rinse in seawater, resalt, and return to screw press, applying increased pressure each time. After 9-10 d, wash and scrub with freshwater, and hang in the shade to dry for about 15 d (Jarvis, 1987).

Salted-dried pierced sardines

Wash fish in freshwater and soak in a salt solution of 6-7° Bé for 4-5 h. Pierce the fish through the eyes or from gill slit to mouth with a stick. Dip the fish in freshwater to wash and air-dry for 5-6 d (Tanikawa et al., 1985).

Salted-dried round sardines

Wash fish in seawater. Mix 15-16 kg fish with about 15% salt and cover with water. Salt for 6-8 h, stirring 2-3 times. Pierce each 10 fish from mouth to gill slit with a stick and air-dry. Turn the fish after they are 2/3 dry (Tanikawa et al., 1985).

Salted-dried split sardines

Split fish bodies at the ventral or dorsal sides and remove gills and viscera. Soak fish in a 15-18° Bé salt solution or dry salt over night with 20-30% salt. Wash fish with freshwater, place

skin-side down on trays and air-dry. Turn the fish over when they are 2/3 dry (Tanikawa et al., 1985).

Salting and drying cod, cusk, haddock, hake, and pollock

Clean (eviscerate) cod, cusk, haddock, hake, and pollock at sea. Remove heads, split open fish and remove 2/3 of the backbone (that portion from the head to the lower end of the abdominal cavity). Wash fish.

Butt method

In summer, salt all fish in butts or other watertight containers. In winter, fish are often salted in kenches. A butt is a large barrel (formally a molasses hogshead) and is about 3 feet (0.91 m) in diameter and 4 feet (1.22 m) high. Throw cod face down (flesh side up) into butts and sprinkle salt uniformly over each layer. Each butt requires 6.5-7 bushels (229-247 L) of coarse salt. With finer salt, a slightly larger quantity is often added. In hot weather, more salt is required. Pile the fish high above the top of the butt; and place the last few layers, which are exposed, with backs up. Place a pile of salt on top of the fish. The salt and fish settle slowly and within 1-2 d sink below the top of the butt. After the fish have settled, place a bushel (35.2 L) or more of salt on top. The salting process requires about 3 weeks' time.

Kench method

A kench is a regular pile of fish made by laying them on their backs with napes and tails alternating. Spread a considerable quantity of salt over each layer. Turn the top layer of fish with backs up. As the salt extracts the water from the fish it runs to the floor and drains off. Since the fish do not stand in brine it is much more difficult to obtain uniform penetration of salt by the kench method; therefore there is much greater danger of spoilage (souring) by this procedure than by the butt method. Use about 20 pounds (9.1 kg) of salt on each 100 pounds (45.4 kg) of fish.

Water-horsing

Remove fish from butts or kenches and wash with seawater or brine to remove any objectionable slime. Transfer fish to a building or room having a good concrete floor. Kench the fish on frames about 8 inches (20.3 cm) above the floor. Place weights of various kinds on the kenches to press surplus brine out of the fish. Allow the fish to drain and slowly dry in the kenches; the longer they remain on kenches the less time they must remain on the flakes for final drying.

Drying on flakes

After kenching, place the partially dried fish flesh side up on flakes for further drying. A flake is a rack or lattice bed about 3 feet (0.91 m) wide constructed of triangular strips about 1 inch (2.5 cm) wide (at the base) and nailed about 3 inches (7.6 cm) apart to a substantial framework. Build flakes in the open air about 30 inches (76.2 cm) above the floor. When a rainstorm is imminent,

collect the fish in piles and cover with small rectangular boxes with peaked roofs called "flake boxes."

The degree to which the fish are dried depends upon the trade. Fish to be sold in the southern states, must be drier than fish to be marketed locally. Fish for export must be dried as completely as possible. Export fish are dried further in specially constructed heated dryers (Long et al., 1982).

Salting and drying mullet

Split the fish along the back, "mackerel style," so they will lie flat in a single piece, leaving the backbone in. Heads may or may not be removed. Save roe and salt separately. Eviscerate and wash fish to remove all traces of blood from under the backbone and clear away the dark belly cavity skin. If heads are left on, clean out all traces of the gills. Score each fish longitudinally along the backbone and also through the flesh on the topside of the fish. Wash and soak in a light brine solution for about 30 min to remove all traces of blood and slime. Remove from brine and drain for about 15 min.

Use "dairy fine" mined salt and dredge each fish in the salt, rubbing some into the scored cuts on each side. A shallow pan or box about 2 feet (0.61 m) square is convenient for this operation. Pack the salted fish, layer by layer, into barrels or tubs with flesh side up except for the top layer which is packed flesh side down. Sprinkle a little salt on the bottom of the container and over each layer of fish. Place a weight on top of the pack to keep the fish under the surface of the brine that forms. Allow the fish to cure in this brine 36-48 h. Remove fish from brine and drain for 15-20 min.

Dry on drying racks made with frames of wood covered with wire mesh and standing on legs 3-4 feet (0.91-1.22 m) high. Dry in the shade under a roof without walls and so located that as much of a current of air as possible will pass over the fish. Oxidation or "rusting" sets in immediately if drying is done under the direct rays of the sun. Lay the salted fish on the racks skin side down, and turn 3-4 times the first day. At night, to prevent spoilage through dampness which causes souring and molding, take fish to a sheltered cover (inside if possible). Drying time usually averages 4 d, but is dependent upon the weather and the size of the fish. The drier the finished product is, the less danger there will be of reddening or rusting. The fish is cured when the surface looks dry and hard and the thumb can be pressed into the thick part of the flesh without leaving an impression (Long et al., 1982).

Skinned dried squid

Wash and split the squid. Remove the quill and ink sac. Scrape the inside of the body thoroughly. Remove about 2/10 of the skin at the end of the body. Dry for about 5 d. Shape the squid before drying is completed (Tanikawa et al., 1985).

Stockfish

Prepare stockfish from cod, haddock, hake, cusk, or coal fish. Split the belly open from the pectoral fins to a little below the anal opening, leaving the isthmus in a solid piece. Cut the head on the ventral side as far as the backbone, following a line just in front of the pectoral girdle. Break the head loose from the body. Remove the viscera and roe, and remove all viscera, blood and other offal. Leave the air bladder intact. Split the fish in 2, except for a short section near the tail, and remove about 2/3 of the backbone. Wash the fish in seawater to remove all traces of blood, liver and kidney. Tie the fish in pairs with a loop of strong twine around the tails. Hang the fish over poles so that the 2 of a pair hang on either side of the drying pole. Arrange poles so that air blows between the rows of fish. Turn the fish every few h. Protect the fish from birds with netting. Fish may also be dried in artificial dryers. Dry the fish until no impression can be made when the thick flesh along the backbone is pressed between thumb and forefinger (Jarvis, 1987).

Trepang (dried sea cucumber) I

Split sea cucumber down the side, scrape clean, rinse, and boiled for 10-30 min, depending on size and variety. Spread cooked sea cucumbers on racks to dry in the sun, turning at frequent intervals during the first part of the drying process. Dry about 20 d in good, clear weather (Jarvis, 1987).

Trepang (dried sea cucumber) II

Boil sea cucumber for about 20 min. Slit open and remove viscera. Place in sun and leave until almost dry. Transfer to smokehouse and smoke for 24 h. Spread smoked sea cucumber on mats in the sun until completely dry (Jarvis, 1987).

Trepang (dried sea cucumber) III

Eviscerate sea cucumber and then boil for 15-20 min in seawater. Wash well with freshwater. Dry in a smokehouse for about 4 d, turning the sea cucumbers frequently during the first day (Jarvis, 1987).

Veziġa (dried sturgeon spinal chord)

Remove head and tail from fish. Remove spinal chord from the backbone. Pull the spinal chord out at the tail end with a bailing hook and by hand. Wash thoroughly to remove slime and blood. Press out jelly-like material from inside the chord by squeezing the chord between the fingers. Split larger chords lengthwise to remove material. Wash chords in freshwater until clear in color. Hang chords in current of air until thoroughly dry (Jarvis, 1987).

References

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Corby, J. 1999. Personal communication, Director, Division of Food Safety and Inspection, Department of Agriculture and Markets, State of New York, Albany, NY.

FDA. 1998. Pathogen growth & toxin formation as a result of inadequate drying. Ch. 14. In *Fish and Fishery Products Hazards and Controls Guide*, 2nd ed., p. 175-182. Department of Health and Human Services, Public Health Service, Food and Drug Administration, Center for Food Safety and Applied Nutrition, Office of Seafood, Washington, DC.

FDA. 2001. Pathogen growth & toxin formation as a result of inadequate drying. Ch. 14. In *Fish and Fishery Products Hazards and Controls Guidance*, 3rd ed., p. 191-200. Food and Drug Administration, Center for Food Safety and Applied Nutrition, Office of Seafood, Washington, DC.

Jarvis, N.R. 1987. *Curing of Fishery Products*. Teaparty Books, Kingston, MA.

Long, L., Komarik, S.L., and Tressler, D.K. 1982. *Food Products Formulary, Volume 1: Meats, Poultry, Fish, Shellfish*, 2nd ed. AVI Publishing Co., Westport, CT.

Tanikawa, E., Motohiro, T. and Akiba, M. 1985. *Marine Products in Japan*, revised ed. Koseisha Koseikaku Co., Ltd., Tokyo.