

# Recommendations for On Board Handling of Albacore Tuna

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## Introduction

Increasingly, fishermen are gearing up for albacore tuna as opportunities decrease in traditional fisheries like salmon. New albacore fishermen, and long time veterans, need to be aware that albacore and other tuna-like fishes have unique characteristics and require special handling. Improperly handled albacore can cause severe illness from scombroid poisoning and greatly limit growing alternative markets for non-cannery tuna. Rapid chilling and proper handling on the vessel reduce the risk of illness and produce a reliably high quality product.

This publication provides information on how to deliver high quality albacore, including: 1) some unique characteristics of albacore and other tuna-like fishes, 2) scombroid poisoning and how it can be prevented, 3) proposed U.S. Food and Drug Administration (FDA) seafood regulations, 4) metal stain, and 5) step by step handling and chilling recommendations that will reliably produce a wholesome, safe food.

## Characteristics of Albacore and Other Tunas

Experienced fishermen know that albacore, and all other tunas, have higher body temperatures than salmon, rockfish and most other fishes. The body temperature of most other fishes when landed is the same as the water temperature. A recent study found that the backbone temperature of troll caught albacore ranged from 75° to 92°F and averaged 84.5°F. An average albacore was 25°F warmer than the temperature of the surface waters where they were caught. Actual body temperature depends on fish size, the extent to which the fish struggled during capture, and water temperature.

Decomposition or spoilage is caused primarily by the chemical breakdown of the flesh by enzymes produced by naturally occurring bacteria. This spoilage process is faster at higher temperatures and proceeds more rapidly in warm albacore than in cold-blooded fishes.

Albacore store energy in chemical compounds such as adenosine triphosphate (ATP). While the albacore is alive, ATP is used for swimming and other cellular needs. It is replenished through a process requiring oxygen. As albacore struggle during capture, they deplete their supply of ATP and oxygen and begin to produce ATP through an alternate pathway that also produces lactic acid.

They also generate more heat than their temperature-control mechanism can handle.

After death, albacore can no longer regulate body temperature or flesh pH (acidity/alkalinity). ATP is broken down by enzymes to compounds that are associated with off-flavors in "stale" fish, flesh temperature remains high, and the flesh remains slightly acidic. The harder an albacore struggles during capture and/or thrashing around on deck, the higher the flesh temperature and acidity. Poor handling after capture can easily result in rapid quality loss and decomposition.

## Scombroid Poisoning

Albacore and other tunas contain relatively large amounts of the amino acid histidine in their flesh (amino acids are the building blocks of proteins)<sup>2</sup>. After the fish dies, bacterial enzymes break down the histidine to histamine. Humans consuming fish containing histamine, can become ill with scombroid poisoning. Symptoms include a metallic, sharp or peppery taste, nausea, vomiting, abdominal cramps and diarrhea, oral blistering and numbness, facial swelling and flushing, headache and dizziness, palpitations, hives, rapid and weak pulse, thirst and difficulty in swallowing. Most victims of scombroid poisoning recover within 24 hours; antihistamines usually lead to immediate improvement. Fish most often implicated in this illness include: mahi mahi, tuna, bluefish, mackerel, and bonito.

In 1993, there were several cases of scombroid poisoning reported in Newport, Oregon from unfrozen albacore sold from a fishing vessel to a restaurant. In order for histamine to form in the fish, the albacore had to be mishandled at some point between capture and consumption. The best way to prevent scombroid poisoning is rapid chilling on the vessel and controlling the temperature of the fish throughout storage and distribution. Once histamine forms in a fish, it cannot be eliminated by cooking, freezing or smoking. Histamine production occurs rapidly at high temperatures, but slows dramatically at temperatures below of 40°F. Fish held at 90°F can become toxic within six hours and fish held at 70°F can become toxic within 24 hours<sup>3</sup>.

## Proposed FDA Regulations

Proposed new FDA seafood regulations may have a major effect on albacore fishermen. In general, these proposed regulations call for



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monitoring selected steps in the production of seafood products in accordance with HACCP (Hazard Analysis Critical Control Point) principles. In fisheries for albacore and other scombroid toxin forming fishes, handling on the fishing vessel is a critical control point in the production of a safe and wholesome product.

FDA's proposed regulations for scombroid toxin forming fishes recommend that buyers ensure that the fish were chilled rapidly to 40°F after capture, and that the fish were not held at time/temperature combinations that would allow histamine production. For vessel operators, this may require:

- 1) Time and temperature logs for each storage compartment (well, tote or other container) to show that:
  - a) the fish were chilled to an internal temperature of 40°F or below as rapidly as possible after landing on the vessel,
  - b) the fish were maintained at or below 40° after landing on the vessel, and
  - c) the fish were delivered with a maximum core temperature of 40°F;
- 2) Records to show that thermometers agree within  $\pm 2^\circ\text{F}$  of standard thermometers; and
- 3) Fish inspection for decomposition with no more than 2.5% of the fish in each lot showing sensory decomposition.

If these criteria are not met, each lot of fish may have to be tested for histamine. Histamine testing is expensive and is probably not available in most ports. The current FDA regulatory level is 5 mg histamine/100 g flesh. Fish containing more histamine than this cannot be used as food. How rapidly fish must be chilled to 40°F under this proposed regulation is unclear at this time.

### **Metal Stain**

Metal stain (skin dye) is a blackening of albacore meat that takes place during the canning process. It is caused by a chemical reaction with metals that accumulated at low levels (parts per million) in the fish while on the vessel. Blackening is obvious only after canning, leaving no alternative but to destroy the product after the expense of ex-vessel purchase, shipping and canning. If metal stain is not caught in routine inspections, it could lead to a recall at great expense to the cannery and to the reputation of albacore products.

Fish accumulate corrosive metals (copper, zinc, iron, nickel, cadmium, etc.) through direct contact with metal in the hold or through indirect contact via the refrigeration system (e.g., a copper or copper-nickel chiller brine-freeze system). These metals tend to accumulate most in areas where the skin of a fish is abraded. To avoid metal stain, replace corrosive metals in the refrigeration system (pumps and tubing) and the hold with stainless steel or plastic.

### **Recommended On Board Handling Procedures**

The following handling procedures were developed based on research and industry experience with albacore and other tuna species.

**1. Prepare the Deck.** Clean and sanitize the landing area and the slush ice tank or brine tank daily using detergent and water

followed by a dilute solution of household chlorine bleach (one teaspoon per gallon of water). Have the slush ice tank, brine chilling tank or blast freezer ready to receive fish. With a slush ice tank, drain melt water from the ice and add seawater after the first strike. Chilling/freezing systems should be at the recommended temperatures when the first fish is landed. Have all handling equipment at hand and clean. These include knives, sharpening tools, gaff, and spiking tool or club. Use a landing mat (a piece of carpet) to reduce scale loss and bruising.

**2. Landing.** Land the fish as quickly as possible after it is hooked. Prolonged struggle will result in higher body temperatures and reduced quality. If you use a gaff, gaff the fish in the head or through the lower jaw, never in the body or you will destroy and contaminate the edible flesh. Keep fish in a single layer on deck rather than stacking them like cord wood.

**3. Stunning.** Stun the fish immediately after it comes on deck to eliminate scale loss and bruising. It is easier to stun the fish when it is still on the gaff or the hook remover. Club the fish with a modified bat, mallet, or lead filled steel pipe on the soft spot right above the eyes.

**4. Brain Spiking (optional).** Another option is to immobilize the fish immediately after, or instead of stunning, by destroying the brain. (Spiking the brain is a required procedure for production of sashimi grade tuna worldwide.) In addition to immobilizing the fish, brain destruction helps stop the production of heat and acid, and the loss of energy rich compounds.

To spike an albacore, position yourself so that you are balanced with the fish positioned on its belly, and the spiking tool (an ice pick or a sharpened screwdriver) firmly in one hand and the fish's tail in the other. Do not attempt spiking without complete control of your balance, the spiking tool, and the fish. Place the spike at the soft spot above the eyes at a 30 degree angle to the horizontal. Push the spike quickly into the skull maintaining the 30 degree angle while holding the tail with your other hand. Move the instrument from side to side to destroy the brain. The fish will shudder, all the muscles will flex, the mouth will open, and the pectoral fins will flare. After one or two seconds the fish will go limp if done properly.

If not done properly, the fish can shudder violently creating the potential for personal injury, and further scale loss and bruising to the fish. With slippery conditions this procedure can be a challenge, but after several attempts brain destruction is swift and thorough.

**5. Bleeding.** Bleeding improves the appearance of uncooked tuna loins and may help initially to reduce fish temperature on deck. It is essential for sashimi grade fish. Fish should be bled for 10 to 15 minutes after stunning (brain spiking) and then immediately chilled. Bleeding is most efficient when done immediately after the fish is landed, and when the heart is left intact to take advantage of its pumping action. If possible, orient the fish head down and spray with water to prevent clotting. Bleeding can be accomplished in at least three ways; use the one easiest for you. If one cut does not produce blood, try one of the other methods. Using more than one cut may promote more efficient bleeding.

**Pectoral Cut:** This cut is the most common in tuna fisheries worldwide. With the fish on its side measure 1.5 to 2 inches (about

the width of two fingers) from the base of (under) the pectoral fin along the midline. Make a shallow cut about 1/8 to 1/4 inch wide and 1/4 inch deep along the raised ridge near the midline using a clean, sharp knife with a narrow blade. If this cut is made too deep or too wide, usable flesh can be destroyed and reduce the fish's value. Flip the fish over and repeat the cut on the other side. We found this cut to be very effective with albacore.

**Gill Cut:** The gill arch cut is the one most commonly used now in the U.S. albacore fishery. With the fish on its side, lift the gill cover and sever the gill arch and/or insert the knife behind the gill through the gill membrane, and cut up toward the spine, severing the blood vessels at the top of the gills.

**Throat or Nape Cut:** This cut involves cutting the blood vessel between the heart and the gills. It can be done in either of two ways, depending on the preference of the buyer. With the fish on its back or side cut the "V" shaped nape between the gill covers and the body of the fish to the artery just below the surface. An alternative that leaves the head firmly attached to the body is to make a shallow cut just inside the point of the "V" of the nape, lift the artery with your finger, and cut. The heart is about three inches behind or inside the point of the "V". Take care not to sever the heart or you will lose the pumping action the heart provides. Experienced albacore fishermen have variations of this cut that they find faster for them. We recommend finding the heart and the artery running between the heart and the gills in your first fish or two, and find what is easiest for you.

The amount of blood lost in the process of bleeding an albacore has not been determined. Albacore 12 pounds and over are between 8 to 12 % blood by weight, with larger fish having the least percent blood<sup>4</sup>. You can generally drain only 20 to 50 % of the blood from the fish because most of the blood is held up through surface tension and coagulation in many of the tiny capillaries that supply the muscles and make up the tuna rete system. A 12 pound albacore that loses 40% of its blood would lose about a half pound of its total weight: a nineteen pound albacore would lose between a half and three quarters of a pound in total weight. Bleeding will not significantly reduce the revenue received per fish.

### Chilling and Freezing

Albacore should be placed into a chilling or freezing system within 15 minutes of capture to ensure the delivery of a high quality product without histamine. As a general rule, one day of shelf life is lost for each hour an albacore is left on deck. This rate of decomposition is three times that of other fishes.

Rapid chilling should pose few problems during scratch fishing, however, it can be very difficult when large numbers of warm fish are caught within a matter of minutes. The only way to ensure safe, quality fish in this case is to match your capture rate to your refrigeration capacity. This may involve adding refrigeration capacity for the high scores, or reducing catch to ensure the safety and quality of the fish already on deck.

### Fresh Fish

If you are planning to deliver fresh albacore to a cannery buying station, check with them first. Some canneries may not buy iced fish due to uncertainty over how quickly the fish were chilled and

the possibility of histamine formation. Make sure you have a buyer.

Chill fish first in slush ice, a mixture of two parts ice and one part seawater before icing. Albacore will cool four to five times faster in slush ice than on ice because the fish are completely surrounded by the chilling medium, and the rate of heat transfer in a liquid is about 25 times faster than in ice. Albacore iced without prechilling will form air pockets around the warm fish resulting in inefficient cooling and poor quality. For example, a recent study found that a 24 pound round albacore held on ice cooled to 61°F in 8 hours. A fish of the same weight held in slush ice cooled to 59°F in only 2.5 hours and to 40°F in 7 hours<sup>1</sup>.

The slush ice tank should be insulated, with a tight fitting, insulated lid, and maintained so that ice is always present. This will require that ice be added periodically depending on catch rates, weather conditions, and the extent of insulation. Add fish to the slush ice tank as they are landed - not all at once. In addition to a substantial loss of shelf life and quality that result from fish left sitting on the deck, slow, inefficient cooling will result from overloading the chilling system. Mechanically refrigerated tanks with stainless steel coils might be an option for some operators.

A mixture of 2 parts ice and one part seawater will maintain a temperature of 30° to 32°F. Because fish begin to freeze at temperatures below this, there is no risk of partial freezing and related quality loss.

Ice and freshwater will tend to float on the surface of the slush ice mixture, creating sharp temperature differences, even in a shallow tank. Warm temperature pockets can also become trapped between fish. Agitate the mixture periodically with a pump, by bubbling air in the tank, or manually with a paddle to minimize these potential problems.

**Transfer the fish to ice storage when the backbone temperature reaches 50°F and continue to cool the fish to 40°F or below.** Holding fish in slush ice for more than 12 hours may lead to excessive water absorption and bleaching. Proper management of the chilling system requires that the internal temperature of the fish be measured periodically throughout the fishing trip. This can be done simply by using a piercing probe meat thermometer, available through most refrigeration equipment suppliers. There are also a number of digital, battery operated, piercing probe thermometers available on the market. When measuring the temperature place the probe close to the backbone on one side of the fish about two inches behind the pectoral fin (the thickest part). After some experimentation, the proper chilling times can be determined for certain slush ice mixtures, fish sizes, loading density, etc.

How you ice your fish after they are removed from the slush tank varies by vessel. If possible, ice fish in single layers in each available bin. Before adding a new layer of fish, gently pack down the ice with a shovel to eliminate any air pockets that may have formed. Cover each bin with an ice blanket. The amount of ice required to chill fresh albacore will vary with a number of factors such as the length of the trip, catch rate, and the extent of insulation in the fish hold and the slush ice tank. In general, proper chilling will require about two pounds of ice per pound of albacore. Each operator must determine the amount of ice they require based on vessel characteristics and fishing pattern.

Do not hold iced albacore on the vessel more than five days. Because the maximum high quality shelf life of albacore is 11 to 14 days under ideal conditions, the consumer must have access to the product within this time frame. Because it often takes seven days to move fish through the distribution process to the customer, trips lasting over five days result in inferior fish reaching the consumer.

### Frozen Fish

Most freezer systems used at sea today for albacore are adequate to deliver a high quality product suitable for alternative markets provided that the fish are chilled quickly (within 15 minutes of capture), and that the freezer system maintains a constant temperature (varies no more than 5°F), even at night. Repeated freezing and thawing results in a low quality product unsuited for alternative markets. Precautions are advised to prevent the introduction of heat to the fish hold when adding fish from on deck. This can be accomplished by adding a false hatch that temporarily seals the opening to the deck while working below. High quality fish should be held frozen on board the vessel no longer than 30 days.

Below are specific recommendations for different freezer systems. These recommendations are based on international practices<sup>5</sup>.

**Air Blast Freezing.** Air systems must be maintained at 0°F or colder. Because fish freeze slower in air than in water, air systems require colder temperatures. The air blowing over albacore in a blast freezer should not be warmer than -20°F and should move at a velocity greater than 400 feet per minute. Fish should be transferred to a separate storage area at -20°F or below, with no air movement, after the core temperature reaches -5°F. In addition to storage in still air, glazing and or bagging can also minimize dehydration.

**Brine Immersion/Dry Storage Freezing.** Freeze albacore in a saturated brine at 10°F and transfer the fish to dry storage when the backbone temperature reaches 20°F or less. This takes about 5 to 10 hours depending on the size of the fish. Dry storage should be at -20°F or below.

**Spray Brine Freezing.** Spray brine systems should maintain a temperature of 10°F or below to prevent excessive salt absorption and produce a high quality product. Although the lowest temperature a brine freezing system can maintain is -6°F using a 23.3% salt solution (88.3 salimeter degrees) under ideal circumstances, 0°F is a practical lower limit. Strict temperature control is essential if spray brine frozen albacore are delivered for alternative markets, because salt absorption is linked directly to increased temperature (18°F and above). This means that refrigeration systems must run 24 hours a day. Depending on the capacity of the freezer system, some vessels may consider a deck brine box to prechill the catch before introducing fish into the hold. This approach could prevent thawing previously caught fish with newly captured, warm fish, and provide a more consistent fish hold temperature.

### Summary

Albacore has tremendous potential for a variety of markets. Producing albacore of consistent high quality and free of histamine is the most critical step for maintaining cannery markets and building new ones. Eliminate corrosive metals from your refrigeration system and hold area. Retrieve fish as quickly as possible after they strike and stun or kill the fish immediately to preserve quality and to eliminate bruising and scale loss. Bleed fish to improve the flesh appearance. The most important step in delivering high quality albacore is to chill or freeze the catch quickly to 40°F or below to prevent decomposition and the formation of histamine. If you are planning to deliver iced albacore, be sure you have a buyer. Measure the chill, freezing and holding temperatures of your fish throughout each trip to identify weak points in the system.

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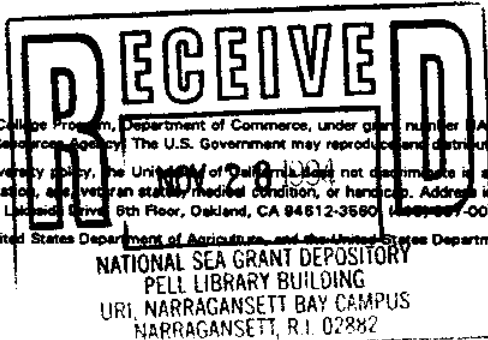
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