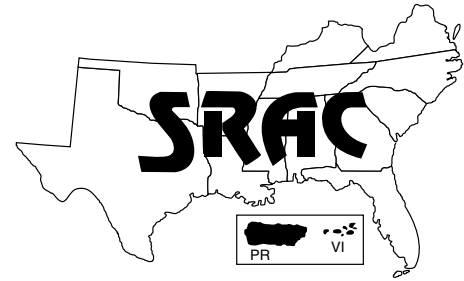


Southern Regional Aquaculture Center



August 2001
Revised

Processing Channel Catfish

Juan L. Silva^{1,2}, Gale R. Ammerman¹, and Stuart Dean²

Catfish of the proper size are sold iced, frozen, or battered and breaded in the following forms: whole; dressed (deheaded, eviscerated and skinned); filleted; steaked; or as strips or nuggets. Size control of fillets to within 1- to 2-ounce weight increments is essential in marketing the filleted product. Fish of the appropriate size that will yield the number of fillets needed are processed by hand at filleting tables or by automatic filleting machines. The fillets are trimmed to yield the nugget and the shank fillet, then sized and either frozen or packed in ice for shipment. Channel catfish "steaks" are prepared by cutting large fish into cross-section pieces. The steaks are then individually quick frozen (IQF) or packed in ice. Other products are derived from these primary cuts.

In order to make various product forms, several steps must be completed in processing channel catfish (*Ictalurus punctatus*) into a marketable product. These include receiving and weighing the live fish at the processing plant; holding them alive until needed; then stunning, deheading, eviscerating, skinning, chilling, size grading, freezing or ice packing, packaging, warehousing, icing, and shipping the finished product. Brief descriptions,

flow diagrams, and photos of the main steps in processing catfish into refrigerated (Fig.1) or frozen (Fig. 2) products are described in this publication.

Receiving and stunning

Before they are purchased for processing, fish are evaluated for undesirable characteristics such as overall appearance and off-flavors by

experienced "taste testers." Sample fish are taken from the pond at least three times: two weeks before harvest, the day before harvest, and the day of harvest. If any fish sample is deemed unsatisfactory, fish from that pond will not be accepted until the condition improves. Fish are loaded into aerated water tanks and transported from the pond to the processing facility. The fish are unloaded from the truck into baskets for weighing and then placed in an aerated holding vat or directly onto a conveyor belt to the plant. In most cases, fish enter the processing line directly from the trucks and are kept in holding vats only long enough to sustain plant operation if fish delivery is delayed (Fig. 3). The fish are placed in cages or carried on a belt that passes under electrodes where they are stunned with an electrical current for a

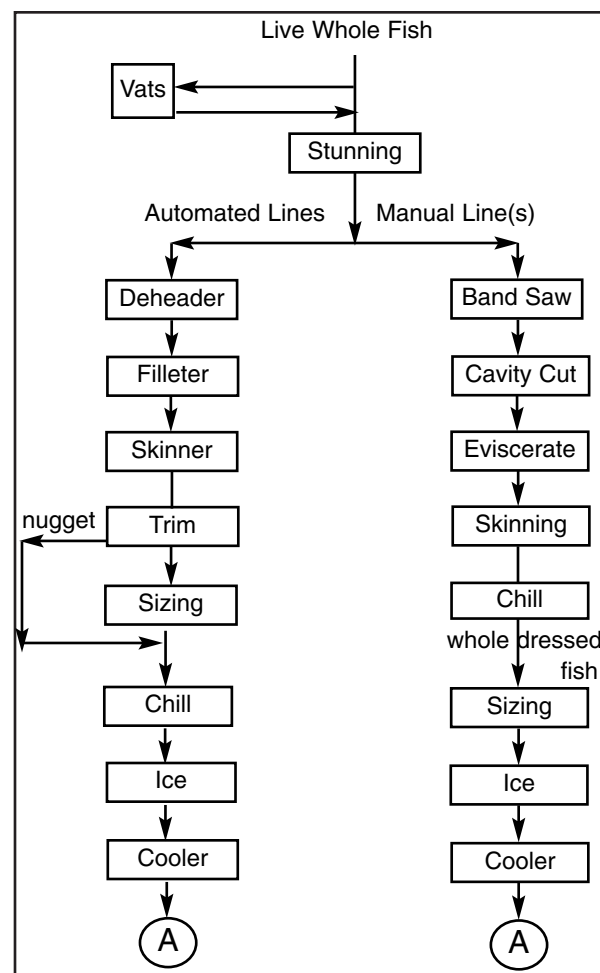


Figure 1. Flow diagram for processing ice-packed channel catfish fillets (manual and automatic).

¹Department of Food Science and Technology, Mississippi State University

²Food and Fiber Center, Mississippi State University

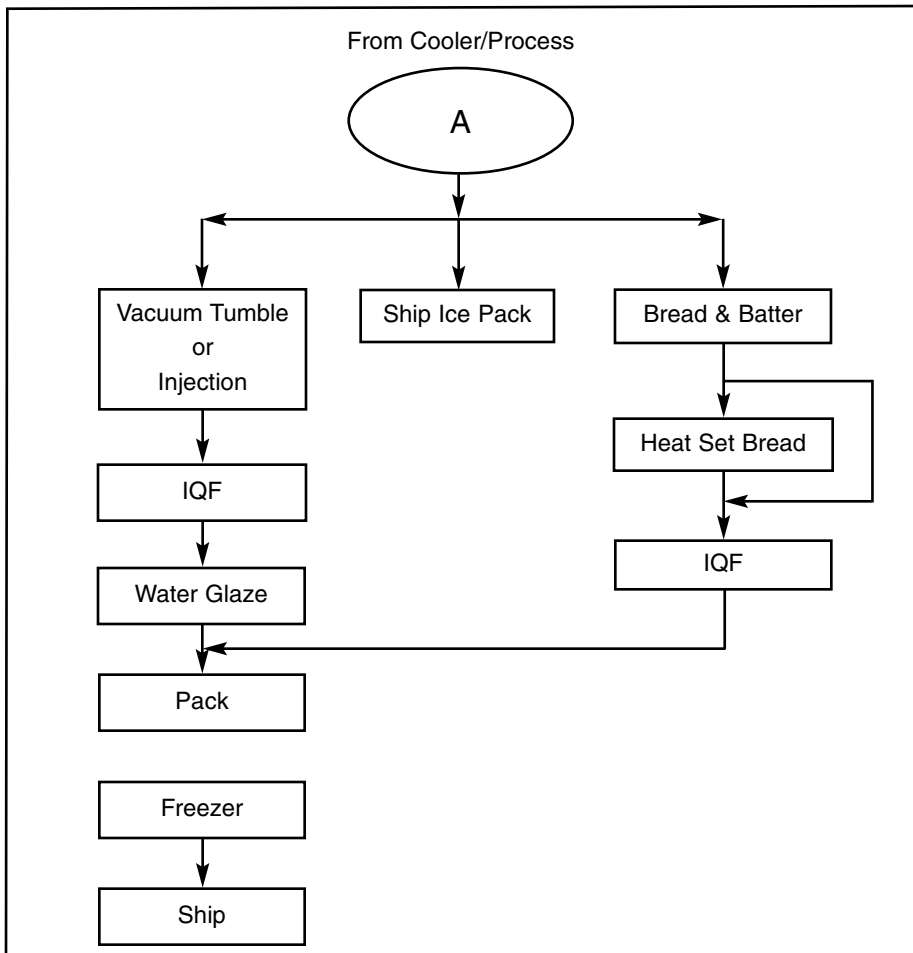


Figure 2. Flow diagram for processing frozen channel catfish fillets.



Figure 3. Fish are held in holding tanks (vats) before processing.

few seconds. This makes them easier and safer to handle by workers (Fig. 4). The fish are moved into the processing plant on a distribution conveyor belt (Fig. 5). The dressing area is divided from the receiving area (outside) by a wall. The fish are conveyed and manually or automatically size graded for each filleting operation. Fish other than catfish (sometimes called “trash fish”) are sometimes present in ponds and may be inadvertently harvested with the catfish. These fish are discarded at this point. Oversized fish (fish larger than what can be handled by automatic filleting lines) are sent to the manual draining/filleting line for processing.

Manual dressing

Deheading

From the distribution conveyor belt, the stunned catfish drop into a holding bin for each processing line. In general, fish are sorted into each line automatically (by weight) or manually to attain maximum yield and efficiency in the automated lines. The first line operator is the lay-up person, who positions each catfish for quick and efficient head removal by the bandsaw operator (Fig. 6). The head is pushed into a chute that routes it to a waste disposal conveyor belt below the band saw, and the carcass proceeds to the evisceration operation. A good band saw operator can process 40 to 50 fish per minute.

Evisceration

The body cavity is opened by hand with a knife, and viscera are withdrawn through a suction tube (vacuum eviscerator) (Fig. 7). One deheader will feed about six evisceration stations. Viscera are conveyed to the offal collector, and the eviscerated carcass proceeds to the skinning operation.

Skinning

The membrane skinner has been the standard industry machine for skinning channel catfish since its introduction. This machine has a rotating roller with sharp “teeth” that present the fish to a sharp blade held in place by spring pressure



Figure 4. Fish are electrically stunned before processing.

(Fig. 8). Very close tolerances between the blade and roller teeth make it possible to remove only the skin as the fish is passed over the roller. This tolerance is important in determining yield and fat content of the final product, since most fat is

located underneath the skin. Capacity is about 12 to 14 fish per minute per operator. Most processors use two operators per machine, so the machine capacity is 24 to 28 fish per minute.

Chilling

After deheading, eviscerating and skinning, the whole dressed fish is lightly spray-washed and conveyed into the chill tank where it is immersed in a mixture of ice and water, or cold water ($\leq 35^{\circ}\text{F}$) refrigerated indirectly with ammonia. Chilling is the process of lowering the temperature of the fish by immersing them in cold water for a set period of time. Fish are held in the chill tank for 10 to 30 minutes, depending on size, at a temperature of 38°F or less (Fig. 9). Fish must be cooled rapidly and held below 40°F to attain low microbial load, good flavor, and maximum shelf-life, and to ensure overall quality. Fish may gain up to 1 percent weight by water absorption at this point, but most is



Figure 5. Distribution belt from stunning to primary processing.

lost before packaging. It is extremely important to control the microbial build-up in the chiller water, because this is directly related to the safety and shelf-life of the fish. Because chiller water is usually not changed until the end of the day, a turnover rate of about 1 gallon of water per 5 pounds of fish is recommended. Some processors add up to 20 parts per million of chlorine to the chiller water or rinse water. Water is added continuously to replace water uptake. Fat is also skimmed off. Some processors place this step before the skinning operation and after the evisceration station.

Size grading

When fish leave the chill tank they are conveyed into a grading or a sizing station. Here they are sorted by weight. In small plants, grading may be a hand operation; in larger plants, mechanical or electronic sizing systems are used. These use a photoelectric cell (a scale which weighs the fish and sends an electronic signal) to send a signal to the correct "station/ gate" to open and let the fish out when it passes through (Fig. 10). These graders usually size fish in 2-ounce intervals. These fish are then ice-packed, injected and frozen, or further processed as explained later.

Automatic filleting

The stunned fish are manually sorted by size or automatically sorted by weight as described earlier. Depending on the number of automatic lines, whole fish are sorted in different size/ weight ranges so as to attain maximum yield and productivity. Each filleting line can process up to 60 fish (120 fillets) per minute. The fish are then placed vertically (or horizontally in some deheaders) with the head up on an automatic deheader (Fig. 11). This is a rotating machine with several knives that cut off the head and pull most of the viscera with it. The deheaded fish, with some remaining viscera, are dropped onto a holding table. The head and viscera are sent to an offal room. Fish from the holding table are taken individually by an operator and positioned onto guides (head first) to be filleted. The filleting machine has two

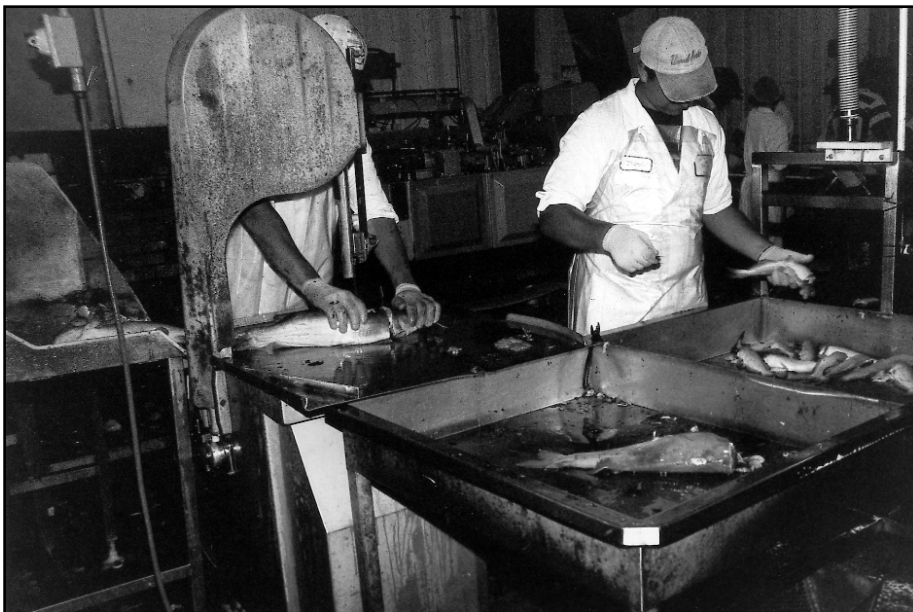


Figure 6. Deheading operation with a band saw (manual).



Figure 7. Evisceration (vacuum) stations to remove viscera manually before skinning.

rotating knives in series that cut the fillets from the frame (Fig. 12). The fillets drop skin down onto a conveyor belt, while the frame and remaining viscera drop onto the offal line. These are carried to the offal station by a conveyor belt, water flumes or vacuum. The fillets are conveyed to the skinner where they are pressed against two rotating knives that remove the skin. The fillets are sprayed with water that may contain up to 50 ppm total chlorine to reduce bacterial load; then they are conveyed to the trimming table. Fillets are trimmed

manually with a filleting knife to separate the nugget and bones from the finished fillet, called the "shank" (boneless) fillet (Fig. 13). Trimmers are sometimes paid by production and yield, by weighing fillets in and shank fillets, nuggets and trimmings out. This is a labor-intensive operation, requiring 12 to 16 trimmers per filleting line. The shank fillets are then placed on a conveyor belt, cooled in a rotating chiller with ice water or refrigerated water and conveyed to the grading station. Here they are sorted automatically by weight. Shank fil-

lets are sorted in 2-ounce increments from less than 3 ounces to more than 17 ounces. Fillets for fresh market are dropped in tagged boxes with a plastic liner and iced to a 1:2 fish to ice ratio by weight. The remainder are placed on tagged plastic totes and held in a cooler until frozen or otherwise processed.

Freezing

Before freezing, channel catfish products are treated (injected or tumbled) with a polyphosphate solution that acts as an antioxidant and prevents excessive water loss during freezing.

The most important part of maintaining excellent quality frozen fish is ensuring that they are processed and frozen rapidly, and held at 0 °F or below until used (Fig. 2). The temperature at the core of the fish must be reduced from 32 to 15 °F in 30 minutes or less for the fish to be considered quick-frozen, and for it to retain its original quality. Surface freezing alone is not sufficient because the fish will thaw in storage before refreezing, which leads to textural breakdown, oxidation and shorter shelf-life. The channel catfish are IQF (Fig. 14) in a cryogenic tunnel or mechanical spiral freezer. Carbon dioxide, liquid nitrogen, or conventional mechanical (ammonia) freezing systems are being used in various plants to freeze channel catfish. The choice of freezing media and machinery is mainly a question of economics. Depending on the source, production rates of more than 2,000 pounds per hour are handled by mechanical freezing. The fish or fish pieces are evenly distributed manually on the conveyor belt to the freezer. The variable speed belt is regulated so that the fish remain in the freezing chamber for the required time and are completely frozen when they exit the tunnel.

Packaging

Frozen

When whole frozen fish leave the freezer, they are conveyed through a water bath or sprayer. A coating of ice (glaze) is formed over the fish. This is the first step in packaging. The IQF, glazed, whole fish or



Figure 8. Mechanical skinning operation of whole fish.



Figure 9. Channel catfish in a chill tank.



Figure 10. Automatic size graders used for dressed and filleted catfish.

fillets are sized and packaged in cardboard shipping cases lined with polyethylene bags. The whole frozen fish are divided by weight (in 2-ounce increments) and packed in 15-pound boxes. Frozen fillets are packed in 15-pound boxes, with fillets divided into lots within a 1- to 2-ounce range (Fig. 15). They are weighed and may pass through a metal detector (a critical control point in HACCP plans) before warehousing and shipping.

Ice-packed

Whole iced fish are divided into the same size categories as whole frozen fish and packed in ice in 50-pound shipping boxes that contain 30 pounds of fish and 20 pounds of ice. Steaks are packed in 15-pound shipping cartons.

Warehousing

Frozen channel catfish are held at 0 °F (or below if required by state law) in a frozen storage warehouse until shipped. The iced product is usually packed and shipped within 48 hours in refrigerated trucks. It is held at the processing plant in refrigerated storage at 30 to 38 °F until shipped.

Recent developments and new technologies

The catfish processing industry is still very young. It has evolved from a mostly manual batch operation into a semi-automatic, semi-continuous operation. This has led to increased production and quality. However, there is much room for improvement in productivity, efficiency and yield, quality and chill life, and safety. One of the advantages of catfish is the freshness of the product. Theoretically, a fish may enter the plant and be ready for distribution in 2 to 4 hours. Catfish also can have a long shelf life. However, there are still problems with manual trimming, lowering temperature quickly, handling, and product flow. Some innovative technologies are becoming available to increase production, yield, quality, and safety of the product.

One system recently developed takes the fish, after receiving and stunning, into a hopper feeding



Figure 11. Automatic deheading station.

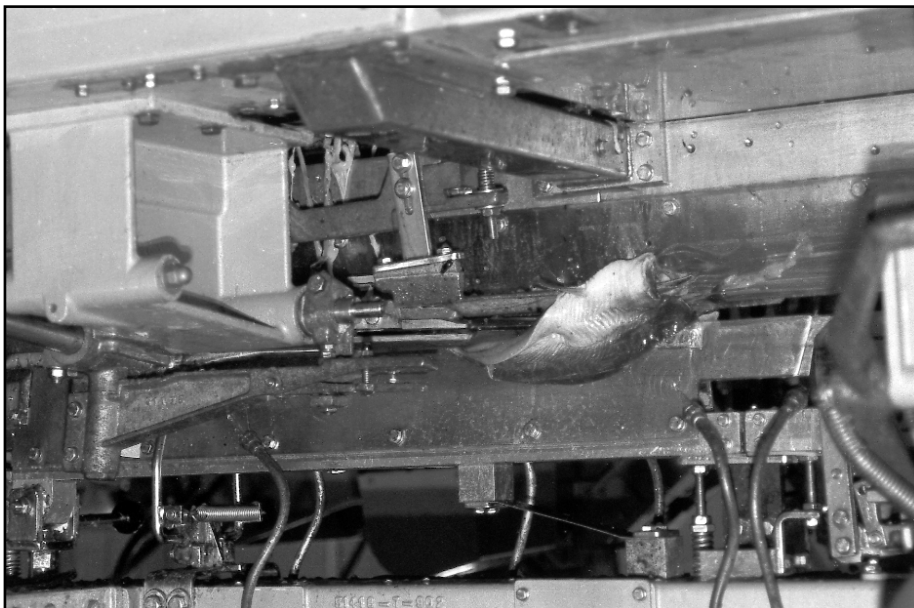


Figure 12. Automatic filleting machine.



Figure 13. Manual trimming of fillets from automated lines.

deheader/viscerator unit that removes most of the viscera, the pelvic fins, and head. A secondary evisceration system removes the remaining viscera and most of the tail fin. This primary process could be segregated from the filleting process. The fish is then conveyed to an air-agitated, counter-flow, two-stage chiller. The prechiller cleans and removes most of the blood, while the chiller cools the headed and gutted product. This is then placed in a filleting machine that removes the dorsal bone. The fillets are then sent to a trimming line (less trimming needed) and on to icing/grading or other processes. The resulting frame also yields a better quality mince (less blood and viscera). This process is designed to flow better, produce a better quality product, and perhaps lower the incidence of bacteria. The rapid cooling and better eviscerating improve filleting and trimming processes, yield and quality.

Another technology combines machine vision with a cutting-edge (water pressure) to produce uniformly cut strips and other products. The fillet is presented to a camera that processes the image and sends a signal to the cutter to produce the most efficient, uniform cut.

Processes such as prechilling fish before processing have been attempted. However, catfish are subtropical/temperate fish, and if chilled immediately after harvest or receiving, may produce a pink, soft and exudative muscle.

Grading and quality control software and hardware are now available from many vendors. This technology allows the production and quality assurance departments to follow operations continuously and make adjustments rapidly. Such software also can be used to monitor critical control points in a Hazard Analysis and Critical Control Points (HACCP) system.

Requirements and regulations

Federal, state, local and, if exporting, international regulations must be followed from the design to the production stages. These regulations cover Good Manufacturing Practices, GMPs (Title 21, Code of



Figure 14. Fillets are individually quick frozen (IQF), glazed and packaged.

Federal Regulations, part 110, www.fda.org), as well as environmental and occupational safety. Some of the agencies that oversee catfish processing operations are the U.S. Food and Drug Administration (FDA); the Environmental Protection Agency (EPA) and its state equivalent; state health and/or agriculture departments; the Occupational Safety and Health Administration (OSHA); and others. Recent regulations require seafood processing plants to conduct a hazard analysis and implement a Hazard Analysis and Critical Control Points (HACCP) plan (Title 23, Code of Federal Regulations, part 123, www.fda.org), including Sanitation Standard Operating Procedures (SSOPs).



Figure 15. Frozen fillets are placed in plastic-lined boxes, weighed, and passed through a metal detector (if needed).



This publication was supported in part by a USDA-CSREES Grant No. 98-38500-5865 from the United States Department of Agriculture, Southern Aquaculture Center. Publication is an update of SRAC Publication No. 183 by Gale R. Ammerman.