Post-Catch Fish Handling for High Quality Fish Products

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Post-Catch Fish Handling for High Quality Fish Products

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Abstract : The quality of fresh fish is affected by all aspects of the handling, including catching and landing, holding prior to processing, and killing, as well as nerve destruction, bleeding, and chilling. Vigorous movements of the fish during catching and landing cause adenosine triphosphate (ATP) to be consumed and lactic acid to accumulate, leading to a decrease in pH in the fish muscle. These changes cause the deterioration of fish flesh. This report discusses some good practices of fish handling that promote the production of high quality fish.

Key words : ATP, bleeding, electric shock, freshness, holding, nerve destruction

Introduction

Fish handling practices are very important for obtaining high quality fresh fish products. Transferring fish caught in the wild to cages for holding is useful for allowing them to recover from fishing stress, and both instant killing and the use of electric shock during landing are effective methods for immobilization. The destruction of the spinal cord inhibits cramping of the muscle, bleeding prevents deterioration in quality and softening, and immersing in slurry ice is an effective method for chilling fish. High quality fresh fish is not only used for eating raw as "sashimi", but also for processed fish products, and it is especially suitable for making frozen fish products. Several good practices for handling caught fish are briefly discussed in this report.

Holding caught fish before landing

Holding is defined as keeping fish alive in a cage for a short period of time without feeding. The advantages of the holding are to allow them to recover from fishing stress, to make adjustments for shipment, and to allow preparation for good practices in fish handing as mentioned below. Holding is popular in Kyushu in western Japan, where the portion of each fish species that is held prior to further processing is 5 to 20% of horse mackerel, 1 to 5% of chub mackerel, and 5 to 90% of yellowtail. Holding is an effective way to allow the fish to recover from stress experienced during the catch, including the recovery of fish muscle to a state of high adenosine triphosphate (ATP) content and low lactic acid content. ATP content in the dorsal muscle of Japanese scad (*Decapterus maruadsi*) was 4.1μmol/g immediately after being caught with a surrounding net, and the lactate content of the muscle was 34.5μmol/g. After holding, the ATP and lactate content was 8.6μmol/g and 4.1μmol/g, respectively 7.0[1)].

Landing fish by electric shock

If fish struggle vigorously when being landed, any gains of holding the fish to recover from fishing stress will be wasted. Japanese scad forced to sustain movement for 5 min in a holding tank showed decreased ATP content in the dorsal muscle (from 8.6 to 1.3μmol/g), increased lactic acid content (from 4.1 to 59.0μmol/g), and decreased pH (from 7.0 to 6.3)[1].

Several methods are candidates to prevent vigorous movement of fish. Administration of anesthetic or carbon dioxide is effective in anesthetization; however, the use of anesthetic in animals for food is strictly limited in Japan, and treatment with carbon dioxide causes vigorous movement before the fish are anesthetized. Electric shock is another method for preventing vigorous movement.

Although electric shock has been used for landing wild and aquacultured tuna[2], it has not been used for smaller fish such as horse mackerel and chub mackerel. Therefore, we constructed an electric shocker system for landing smaller fish from holding cages (Fig. 1, 2). Using the system on horse mackerel (weight, 129 ± 25 g; body length, 22 ± 1.9 cm) caused them to temporarily be immobilized. Only fish located between the electrodes got the electric shock, and those fish started moving several seconds after the electrical current was stopped. Electric shock is thus a suitable method for preventing fish from moving vigorously at landing. Fish immobilized by this method are of high quality, with high ATP and low lactic acid content, as well as high pH. However, due to strong muscle contractions induced by the electric shock, the backbone was sometimes broken; the frequency of broken backbone was greater at higher electric shock voltages. Therefore, further study is necessary to determine suitable voltage of the electric shock.

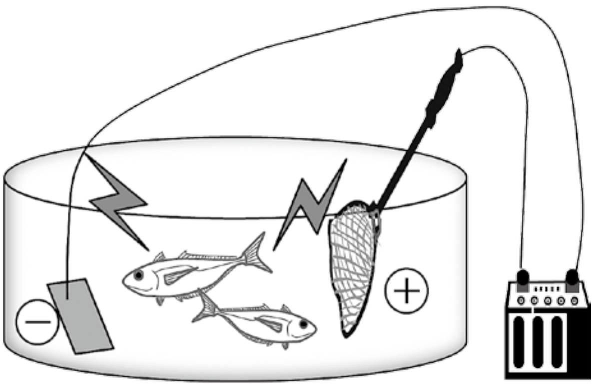

Fig. 1 Schematic of electric shocker system for landing smaller fish without vigorous movement from the holding cage[1]

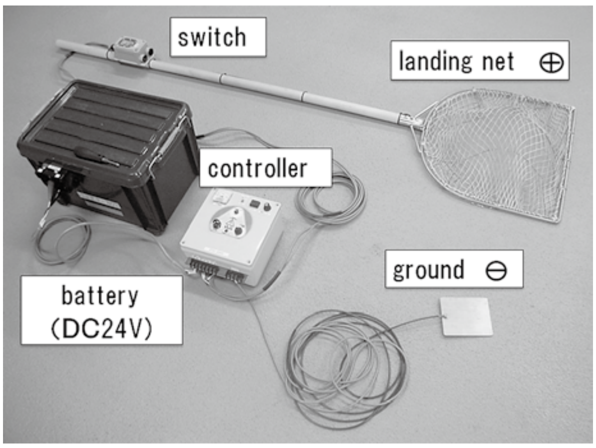

Fig. 2 Components of the electric shocker system

Instant killing by sticking the spinal bulb

Fish should be killed instantly to prevent vigorous movement after landing. When the spinal bulb is destroyed, nerve signals from brain to the muscles are cut and voluntary movement is inhibited. The spinal bulb is generally destroyed by sticking a knife or a rod. The ATP content in the dorsal muscle of aquacultured bluefin tuna killed by destroying the spinal bulb was 6.2μmol/g, whereas the content in fish that were not killed by an instantaneous method was 0.1μmol/g[2]. Instantaneous killing inhibits voluntary movement, and thus results in high quality fish flesh with high ATP, low lactic acid content, and high pH.

Destruction of the spinal cord

Even if the spinal bulb is destructed, muscle cramping occurs. The involuntary movement is caused by the reflex mediated through the spinal cord[3]. The spinal cord is generally removed by threading a metallic wire or plastic rod, or by blowing compressed air, through the spinal hole of the backbone. To examine the effect of removing the spinal cord, an experiment was conducted using two farmed yellowtail. Both were killed by removing the head, and the spinal cord of one was then destroyed by threading a metallic wire[2]. Both fish were then kept at 4℃. Large and small cramps were observed only in the fish in which the spinal cord was not destroyed. The cramp continued for 90 min after the fish was killed. The body temperature of the fish with the intact spinal cord was higher. As shown in Fig. 3, ATP content and pH of the dorsal muscle during storage were higher in yellowtail in which the spinal cord had been removed than in the fish with the intact spinal cord. Hence, removing the spinal cord is an effective method for preventing muscle cramps, promoting chilling, and acquiring high quality fish with high ATP content and high pH.

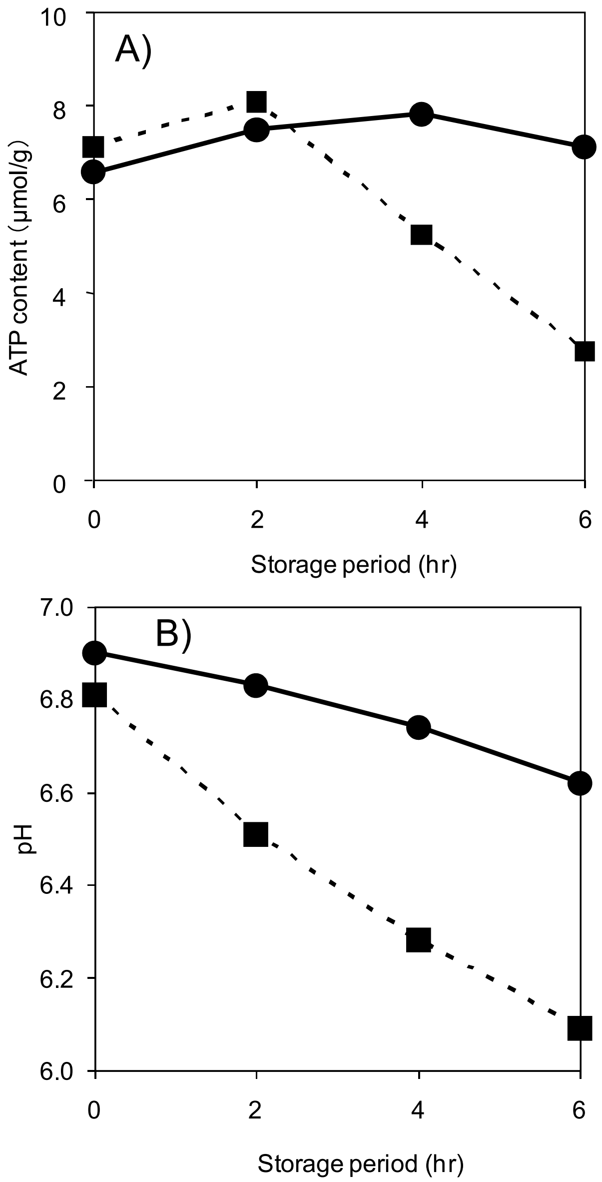

Fig. 3 ATP content (A) and pH (B) in dorsal muscle of yellowtail during storage at 4℃. Each fish had been killed by removing the head, and the spinal cord was destroyed (circle) or intact (square)[2].

Bleeding

Bleeding the fish prevents deterioration of quality and softening of muscle tissue, reduces the bloody smell, and gives the muscle a bright red color[4, 5]. Bleeding is generally conducted by cutting the artery to gill, cutting the tail, or both, and then storing the fish in cold seawater or a mixture of ice and seawater to complete the bleed.

No significant differences were observed between cutting the tail, cutting the artery to gill, or cutting both in the efficiency of bleeding chub mackerel. Bleeding reached 3.1% of body weight. Cutting in the middle of the lateral line under the pectoral fins is a more effective bleeding method (3.6%) than cutting the tail (2.5%) in bluefin tuna[2]. Therefore, the most effective bleeding method differs by fish species.

Chilling in slurry ice

Slurry ice is a mixture of ice and brine, usually a NaCl solution. The size of the ice particles is small (typically 0.1 to 1 mm in diameter). Slurry ice can be transferred using a pump system, making it applicable for use on the fishing boat, at market, and in the food processing plant. Owing to the greater surface area contact of slurry ice around the fish compared to the use of crushed ice, the heat transfer to the slurry ice is faster than that of crushed ice. Slurry ice contact is gentle to the fish, and little surface damage is incurred. Salinity, temperature, and ice packaging factor (IPF) can be easily controlled. Based on these advantages of slurry ice, it has been used to chill fish following landing. The effect of this chilling technique on the quality of chub mackerel has been shown to preserve high quality fish flesh with high ATP and high pH[6]. There are, however, problems of chilling fish by slurry ice. If the fish is immersed for too long, cold shock rigor may set in. Hence, fish should be stored on ice after 30 min of immersion in slurry ice. The eyes become dull due to the high salinity and low temperature of slurry ice. Therefore, the salinity and temperature should be controlled.

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