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PRESENTING FISH FOR SALE ON THE JAPANESE MARKET

by

Kuniji Harada
 NSW Fish Marketing Authority
 Sydney, Australia

Recent profitable exports of chilled fresh tuna from the Pacific to Japan have encouraged the export of non-tuna *sashimi*-grade fish such as Australian garfish, trevally and snapper. However, exporters have been disappointed at the low prices received for these fish, especially in the case of trevally. The reason that these exports have commanded only low prices is the condition in which the fish have been presented for sale, and not seasonal fluctuations in the market. It is imperative that producers, if they are to command top prices on Japanese markets, understand the expectations of Japanese fish traders.

Definition of terms

Traditionally, whenever quality permits, the Japanese consume almost any fish in its raw state. When the fish is served on its own the dish is called *sashimi*; when served with vinegared rice, it is called *sushi*. The most important aspect in determining the quality of the fish is its freshness.

Fishermen, wholesalers and retailers have all endeavoured to control the freshness of this raw *sashimi* fish for many years and several effective handling techniques have been developed. These include bleeding, ice slurry treatments and in particular a spiking treatment called *iki-jime*. In addition to brightness of skin colour and gills or clarity of the eyes, the Japanese use rigor mortis as the most significant criterion in determining the freshness of their fish (Figure 1).

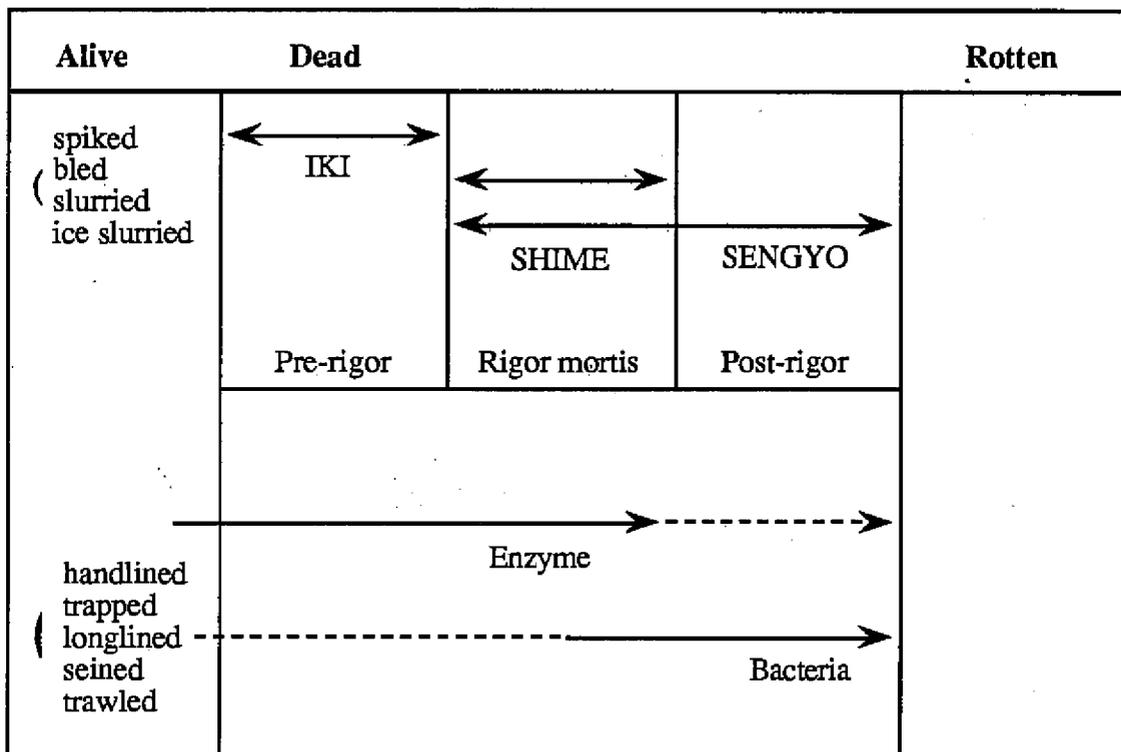


Figure 1. Changing of freshness according to rigor mortis

Live fish, which attract the highest price, are termed **katsugyo**. About 10 per cent of all fish sold at Tsukiji Market in Tokyo are live. The highest quality fresh fish are produced from live fish by the **iki-jime** method and are termed **iki** fish. **Iki** is a term reserved for fish which are determined to be still in the pre-rigor stage, in other words, the fish is brain-dead but muscle tissue is still alive with enzymic activities.

Most **katsugyo** sold in the Japanese markets are used in preparing the expensive pre-rigor quality **iki** fish with the **iki-jime** method.

A special form of **sashimi** called **arai** — wrinkled fillets produced by dipping in cold water — can be obtained only from **iki** fish.

Local Japanese fishermen who cannot supply live fish usually supply **iki** fish treated by **iki-jime**. However, the duration of the pre-rigor stage can be prolonged by **iki-jime** treatment for no more than 10 to 20 hours, depending on the species, and fishermen who cannot supply **iki** fish because of too distant fishing grounds are forced to supply rigor mortis stage **shime** fish.

Shime fish are those spiked with the **iki-jime** treatment but offered at market already in a stage of rigor mortis (see Figure 2). Fish which are spiked by the **iki-jime** method and immediately treated on board by ice slurry as well may have their rigor mortis prolonged for up to three to seven days.

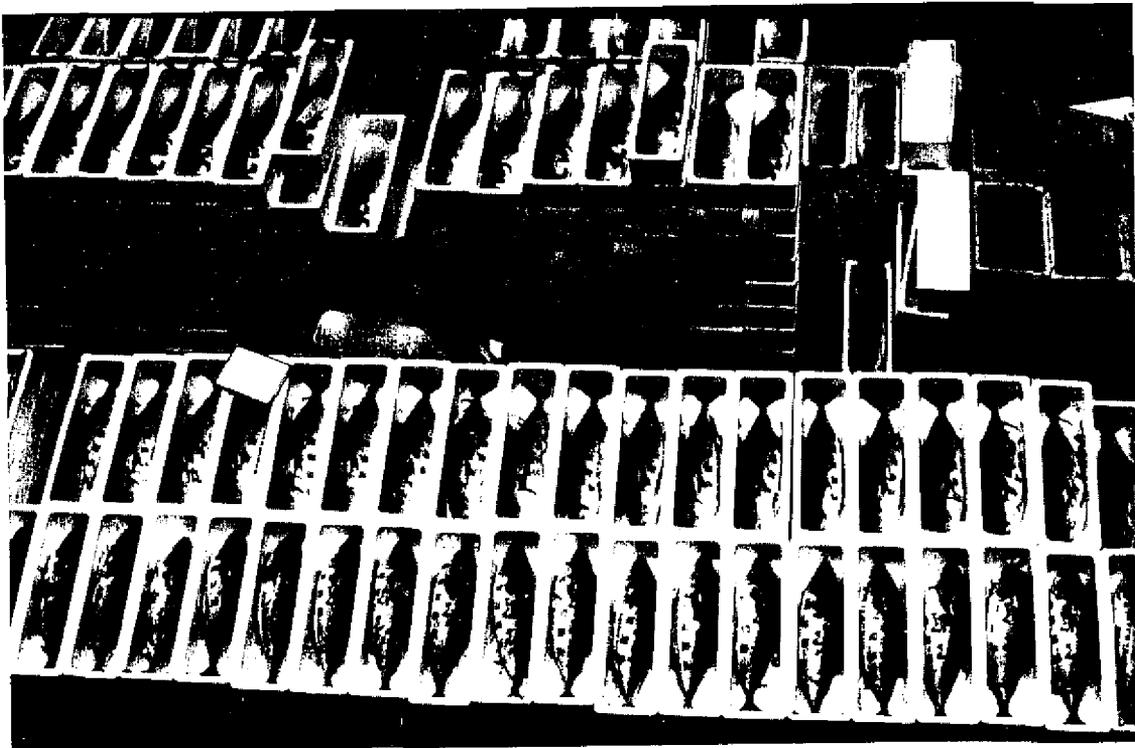


Figure 2. Rigor mortis shime kingfish (on ice) at auction at Tsukiji Market, Tokyo.

The quality of **shime** fish is considered to be second only to **iki** fish and these fish are also sold as **sashimi**-grade **iki-jime** fish. Fish smaller than 500 grams, such as yellowtail and slimy mackerel, are treated by ice slurries without being spiked or bled. In this case the treatment is called **kori-jime**, and the condition of the fish is still considered to be **sashimi**-grade.

It is common for **iki fish** to arrive at market in the stiff **shime** stage and consequently unable to command the best price. However, it should be realised that they are still **iki-jime** fish and therefore command a better price than those fish in which rigor mortis has set in but which have not been spiked, bled or slurried at the fishing grounds.

As the softened post-rigor muscle is different from the relaxed pre-rigor muscle common to **iki** fish and easily recognised, it is difficult for fish in the former condition to achieve good prices on the Japanese market. This was the Australian experience during the export trials of trevally from New South Wales.

Metabolism

The metabolism of fish is similar to that of other animals in that the oxidation of glycogen is used to produce heat or energy for the body and muscles, and energy for muscle contraction is gained from adenosine triphosphate (ATP).

Fish metabolism is largely influenced by oxygen and the temperature of the environment. The air we breathe is about 18 per cent oxygen whereas sea water, on average, contains a mere 0.0006 per cent (six parts per million) of oxygen. Also, water is about 780 times more dense than air, making it heavy and difficult for fish to move through. Theoretically, a fish exposed to air can generate 780 times more power without water resistance. This means that 1/200 horsepower can be generated by a one kilogram fish regardless of size. A 200 kg tuna, for example, can generate one horsepower.

When fish are cruising in the water their body's biochemical metabolism is normal, with enough oxygen being supplied by blood circulation. Almost immediately after death, most enzymic activities are still functioning but, without oxygen being supplied by blood pumped from the heart, the heat producing glycogen ceases to recycle and accumulates as lactic acid (glycolysis). The ATP continues to break down, acting on the myosin and actin to produce actomyosin. This continuously contracts the muscles until all the ATP is used up, at which point rigor mortis results.

Maintaining the freshness of fish is simply a matter of preventing these enzymic activities and keeping as much as possible of the original amount of glycogen and ATP in the muscle by cooling, freezing, curing and cooking (which destroys enzymes) immediately on catching.

Spiking and bleeding

When fish are alive, most of the enzymes involved with the physiological functions are controlled by the nervous system. When landed, the fish struggles and undergoes enormous muscle contractions. Without oxygen available through the gills, the ATP is quickly used without being recycled, and the fish simply suffocates. Fish such as slimy mackerel, when left on deck struggling for only 10 minutes, use twice as much ATP within their muscles as do spiked **iki-jime** fish.

During the glycolysis process (when the glycogen turns to lactic acid) the muscles are marinated (Noguchi, 1967) and there is a rise in body temperature. This can be some 10 degrees Celsius in tuna and slimy mackerel, and even squid show a rise of between two and three degrees.

Spiked **iki-jime** fish, with damaged hindbrains, cannot respond to their changing environment or act autonomically to contract the muscles or maintain the right temperature. Consequently much of the original amount of ATP and glycogen within the muscle is restored and body temperature is kept lower.

As well as carrying oxygen and nutrients to muscles and organs, blood is also the agent for removing the waste produced in these areas. Bleeding is therefore an effective way of ridding the fish of wastes which spoil the quality of the meat, and also acts to prevent heating or to lower body temperature rapidly.

Fish generally first circulate blood to the gills, where it is oxygenated. It is then pumped directly to the body system by the heart (which consists of one ventricle and one auricle) with the help of the arterial bulb. Reasonable bleeding can therefore be obtained by cutting the artery anywhere, but the usual position is on the gills or the caudal peduncle (base of the tail). For tuna, both sides of the subcutaneous blood vessels (artery and vein) are cut near the pectoral fins.

The *iki-jime* method is used to destroy and/or isolate the nervous system from other organs. In particular, its object is to destroy the medulla oblongata, that part of the hindbrain which is responsible for most of the autonomic reactions (Figure 3).

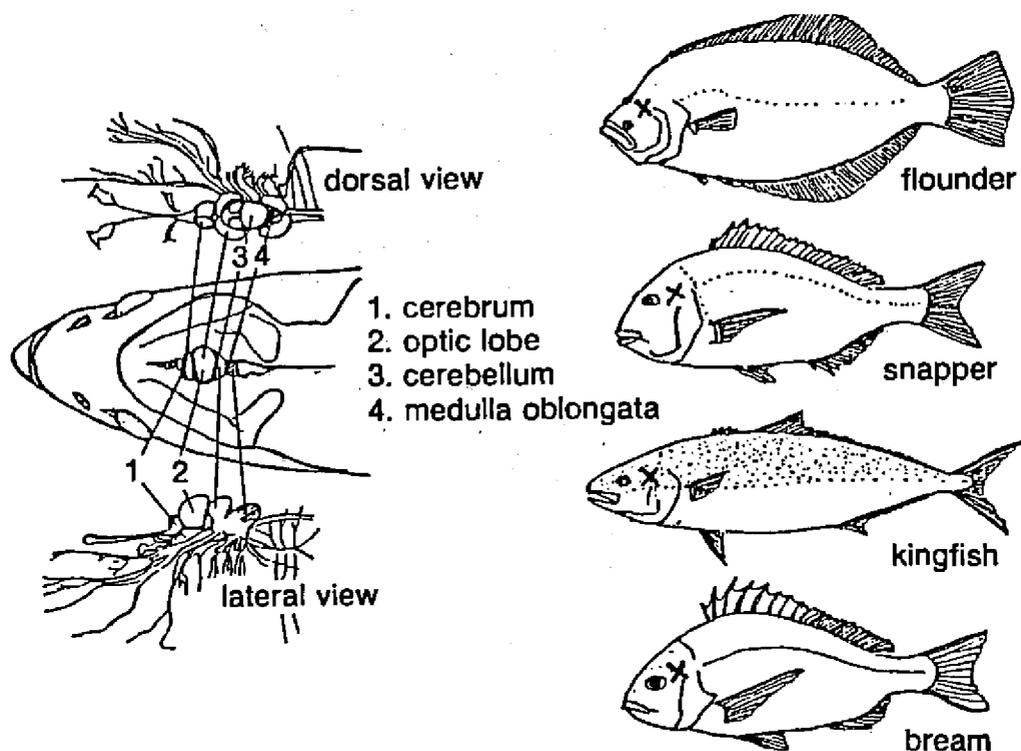


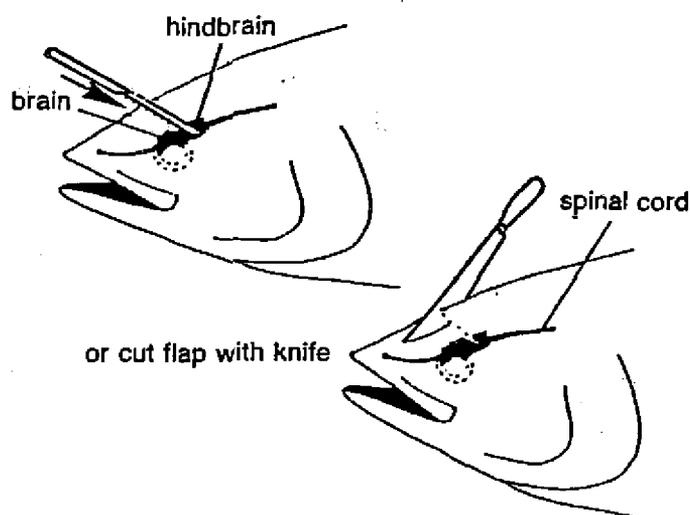
Figure 3. Position of medulla oblongata and spiking position

There are several methods for spiking the hindbrain or bleeding the pre-rigor *iki* or rigor mortis *shime* fish. In the case of *iki* fish such as trevally (but excepting snapper and some other fish), all live fish in the markets are cut or slit on their head with a heavy knife to isolate the hindbrain from the spinal cord.

As the spinal cord is also responsible for some autonomic reaction, fish over three kilograms are often killed by inserting wire down the spinal cord. Tuna longliners in New South Wales are presently using similar methods to destroy the spinal cord of large tuna (Figure 4). On certain fish, in addition to coring, the blood vessels on the cordal part are slit to facilitate bleeding.

Presentation is important in *shime* fish. Damage to the surface of the fish should be avoided if possible by spiking through the right side, using a sharp implement which will only show a small mark on the left side. In Japan, all fish are served with their head to the left and a spike mark will therefore be positioned underneath.

1. Expose brain cavity with coring tool



2. Insert wire or monofilament as far down spinal cord as possible

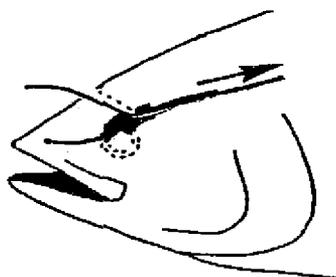


Figure 4. Method of coring and killing for sashimi tuna

Kingfish presented as *iki* fish usually have their heads half-severed and the spinal cord spiked by wire. They are bled by slitting near the base of the tail without ice. *Shime* kingfish, however, are spiked through the underside of the hindbrain, using a sharp knife, by opening the gillcover. They are bled at the same time by slitting the gills. In this way no mark shows on the outside. After ice slurry treatment, these fish are kept at all times in polystyrene boxes with ice.

The ice slurry

Under anaerobic conditions, ATP within the muscles ceases to recycle. When about two-thirds remain, rigor mortis sets in. Depending on the species, temperature and physical handling, this may take between 10 and 20 hours.

It is not clear if the wrinkling on *arai* fillets is caused by rigor mortis or some other muscle reaction by enzymes. But it is understood that no wrinkling effect is achieved if the fish is not fresh enough to retain more than two-thirds of the original ATP in the muscle. By lowering the temperature of brain-dead *iki-jime* fish, it is possible to slow down enzymic activity and maintain the ATP.

The setting-in of rigor mortis is faster if fish are treated in cold temperatures using either ice or ice slurries. To prolong the pre-rigor state, and achieve *arai* effects, the spiked *iki* fish are cooled by lowering their temperature in a slurry tank only five to six degrees below the normal living water temperature for that particular fish.

For **shime** fish, however, it is desirable that rigor mortis sets in fast and strong and lasts as long as possible. These fish are therefore treated by ice slurry immediately after spiking. Bleeding and ice slurring are the most effective and fastest methods for chilling fresh fish for rigor mortis **shime** fish.

Depending on what fish are to be treated, and where, the ice slurry is made using either ice and sea water or fresh water with salts. In fact, using just fresh water for cooling and chilling is not ideal for presentation — regardless of the quality of the fish — as it causes leaching of the skin colour, clouding of the eyes and browning of the gills.

It is important to control the salinity of the slurry if fish are to be stored in it for a long time. Ideally, for most fish, storage time should be less than three hours. Japanese fishermen are generally prepared to achieve the right salinity and water temperature according to species by using a thermometer and specific gravity gauge to judge if extra salt and ice are necessary. For example, about half the salinity of sea water (1.8 %) is used for snapper, while a salinity similar to sea water (3.5 %) is used for squid.

Salts in an ice slurry bring down the freezing point, and sea water (with a salinity of around 3.5 %) will freeze at about minus 1.8 degrees Celsius. To avoid freezing the fish, the salinity of the slurry should therefore be carefully monitored.

Fishing methods and ATP

Spiking is effective only on live fish. However, it is not necessarily a successful treatment for fish which have been netted and are likely to have used up their ATP before spiking, and Japanese fishermen generally keep stressed and exhausted fish at rest in a set net or in an on-board circulating holding tank.

However, ATP recovery is largely dependent on the species and the original condition of the fish, and that may be influenced by season, type of migration, feed, size and age. Poorly fed, large or old fish rarely recover — they usually die, particularly when a high degree of glycolysis has developed and lactic acid becomes slow in being recycled.

It is vital for fishermen to select the best and most appropriate fishing methods in order to produce the best **iki-jime** fish. Handlines or droplines are the best catching methods. For some species, bottom longlining or trapping are reasonable methods. Seined and trawled fish, after a long haul, often show no signs of rigor mortis, having already used their ATP. They are definitely unsuited for **sashimi**-grade fish.

References

- Huss, H.H. (1986). *Fresh fish quality and quality changes*. Manual prepared for FAO Training Program on Fish Technology and Quality Control.
- Noguchi, E. (1967). *Harvesting fisheries*. (In Japanese.) Ed. by Association of Japanese Fisheries Resources.
- Harvey, R. (1982). *A code of practice for air-freight chilled fish*. New Zealand Fishing Industry Board.