FRESH FISH FOR FARAWAY PLACES

Physiology professor Kenji Kugino has developed a novel method for transporting live fish over long distances.

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Professor Kenji Kugino

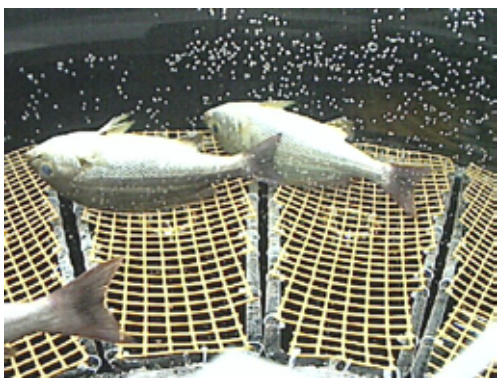
As the Japanese culinary culture of consuming raw fish has spread around the world in recent years, the global demand for the freshest possible fish of many species has increased. However, it is difficult to transport live fish long distances over land or sea, and frozen fish is not always well suited to sushi or sashimi dishes.

The transportation of live fish conventionally requires a special truck to carry a tank holding seawater maintained at a low temperature to slow the movement of the fish. A large initial investment is needed for the truck because it must be fitted with a blower to deliver oxygen to the seawater, a refrigerator pipes to chill the seawater, and a power supply unit to run these devices. Moreover, the tank needs to hold a huge amount of seawater – about ten times the volume of the fish being carried – to prevent harmful degradation of the water quality caused by the ammonia in fish waste and reduce the risk of the fish bumping into one other and damaging their bodies. Transportation costs are therefore very high because the volume of fish that can be carried in this way is quite small.

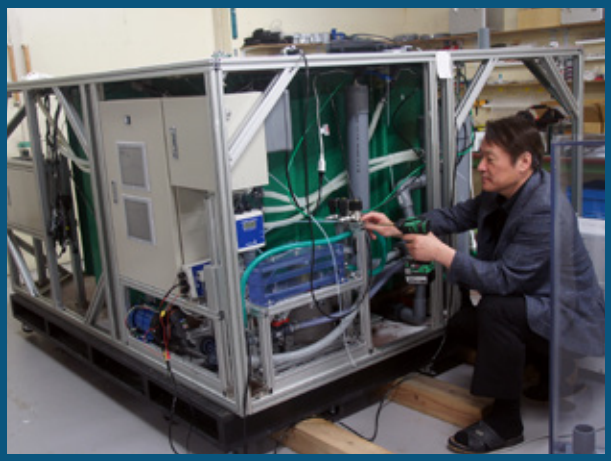
A new technology developed by Professor Kenji Kugino at the University of Nagasaki provides a solution to this problem. By anesthetizing the fish in seawater dissolved with carbon dioxide (which under normal circumstances would be lethal) and concurrently adding ultrafine oxygen bubbles, the new technology enables the safe, long-distance transport of large volumes of fish. Because the fish are anesthetized, both their movement in the water and the amount of waste they produce are minimal.

Professor Kugino specializes in human physiology, but in 2009 was inspired by a casual conversation with a friend to work on the development of the new fish transportation technology.

"My friend told me that many research projects had been conducted with a view to transporting fish from Kyushu to Tokyo but without success," says Professor Kugino. "It occurred to me I might resolve the problem



Chicken grunts anesthetized with dissolved CO_2 in seawater oxygenated with fine bubbles.



Professor Kugino alongside the CO_2 administering anesthesia device

A prototype of the container for transporting anesthetized fish is loaded onto a truck for a test conducted in May 2015.

through anesthesia."

That same weekend Professor Kugino read many research papers on fish anesthesia but found no successful example of long-duration anesthesia for aquatic organisms nor any explanation for why fish anesthesia was problematic. From his experience with animal testing, however, he intuited that the respiration of the anesthetized fish became so shallow that they soon died of oxygen deprivation.

Professor Kugino came up with the idea of keeping fish alive in tanks of seawater by providing them with oxygen in quantities several times greater than in normal seawater (100% of dissolved oxygen), much in the same way that a doctor places an oxygen mask on an anesthetized person. He discovered that by aerating seawater using ultrafine bubbles less than several dozen micrometers in diameter, fish could take in sufficient oxygen to survive for many hours through the contact of the fine bubbles with their gills. In December 2009 Professor Kugino completed his development of the fish anaesthesia technology, which causes no harm to the fish or to the humans who consume it.

Professor Kugino volunteered his expertise to his friend at the Marine Biotechnology Inc., which in 2013 began work to commercialize the new technology.

"I have not been involved in the management of the company," says Professor Kugino. "I have simply guided its engineers in the manufacture of the container during my holidays. It was a bit like doing home carpentry on the weekend."

It took two years to complete the container prototype, and in May 2015 the company carried out a demonstration test transporting twenty chicken grunts brought in at the port of Saikai in Nagasaki Prefecture to Tsukiji fish market in Tokyo, more than 1,200 kilometers away. All the fish survived the journey with no ill effects. A second demonstration test in which fish will be shipped in the same container to Singapore and to Las Vegas in the United States will be conducted in January 2017. The use of the containers for commercial routes in Japan will start in April 2017.

The aim in the future is for containers to be developed that are suitable for air transportation so that fresh Japanese fish can be delivered all over the world.

"Japan catches a wider variety of fish than any other country," says Professor Kugino. "Japanese fish are products which we can be proud to share with the whole world. We hope that many people will come to discover the genuinely great taste of fresh Japanese fish, and I will be delighted if our technology helps to achieve that wish."

All photos: Courtesy of Kenji Kugino