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Quality assurance of raw fish based on HACCP concept

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Abstract

Now, raw fish "sashimi" is becoming popular in other countries. It is well known that temperature control is the most important for the preservation of raw fish. It is also important to predict the remaining days of the validity as sashimi. It was revealed that the quality of raw fish and the remaining days of the validity as "sashimi" could be estimated simply and rapidly based on K_I value. Judging from the concept of HACCP, it is apparent that the quality estimation of raw fish based on K_I value is better than that based on histamine content. It was also suggested that the fish freshness is able to be estimated from the temperature history of fish.

K_I value represents the ratio (%) of the total amount of inosine (HxR) and hypoxanthine (Hx) to that of IMP, HxR and Hx.

Keywords: Fish quality; K_I value; HACCP; T–T–T

1. Introduction

There is no quality control for fresh fish except for time–temperature–tolerance. However, long-term storage of fish is not recommended because biochemical changes such as the lipid oxidation occur even if the fish are kept in cold storage.

According to the HACCP practice, histamine can be used as an indicator for the quality evaluation of fresh fish. However, it is impossible to estimate the quality of fresh fish "sashimi" based on histamine content.

Raw fish "sashimi" is becoming popular in other countries. Therefore, the quality of raw fish should be evaluated based on the freshness indicator "*K* value" rather than histamine. *K* value represents the ratio (%) of the total amount of inosine and hypoxanthine to that of ATP-related compounds. It has already been elucidated that there is a good relationship between *K* value and the muscle changes after instant death of fish.

Now, ATP, ADP and AMP contents decrease rapidly and IMP contents increase sharply at 0 °C within about 24 h after death. Furthermore, inosine (HxR) and hypoxanthine (Hx) contents increase when IMP contents begins to decrease. Therefore *K* value was simplified to K_I value represents as the ratio (%) of total amount of HxR and Hx to that of IMP, HxR and Hx.

In this paper, a simple and rapid estimation of the remaining days of the validity as sashimi using K_I value is discussed in detail.

2. Changes of ATP-related compounds after the death

It is very important to understand the changes of fish muscles after death in order to keep the muscles in good conditions judging from food safety and hygiene.

These muscles have a very complicated structure and composition.

In living muscle cells, a wide variety of biological (enzymatic) reactions occurs. On the other hand, in dead cells, these reactions continue or take place in a disturbed way, and cause changes that are generally considered to lead to deterioration. Therefore, changes in the composition of raw materials affect food safety. Moreover, food with good qualities such as flavor, texture and taste are not produced from raw materials with poor quality.

Generally, postmortem changes in fish meat can be briefly represented as follows though they have a time

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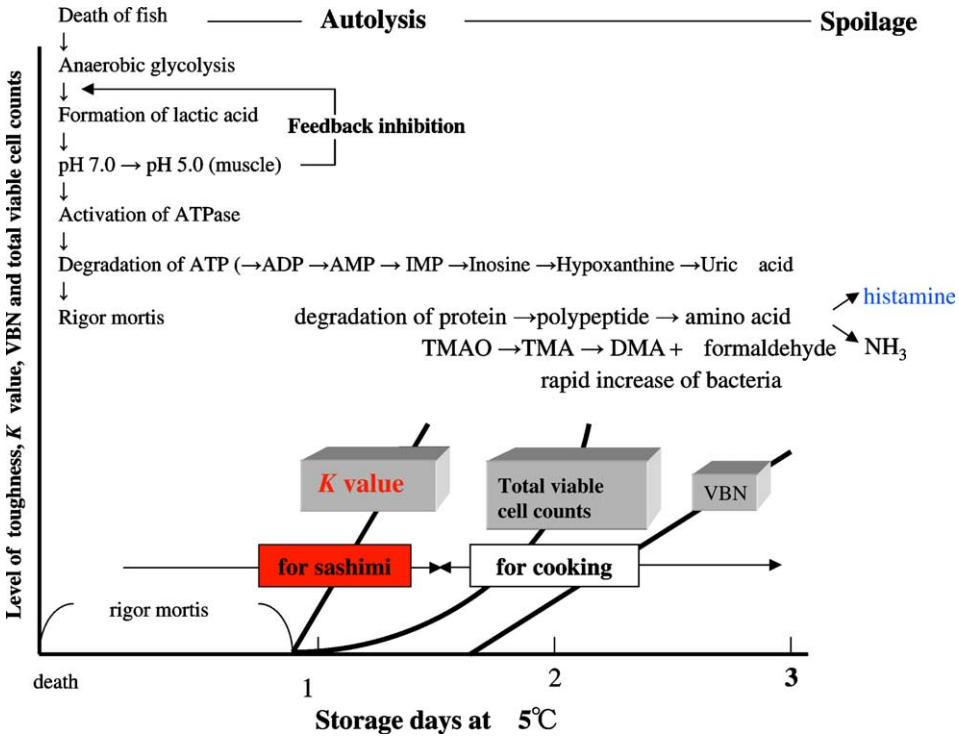

Fig. 1. Postmortem changes in fish meat.

lag based on differences in fish species and history from catching till death:

Catching → Rigor mortis → Dissolution of rigor mortis → Autolysis → Spoilage

These reactions are shown in details in Fig. 1 (Watanabe, 1983, 1993). Namely, from the time of death until the consumption as food, a large number of the biochemical and physiochemical changes take place in fish muscles.

The changes of muscles after death and the changes in ATP content are generally closely related. Animals maintain energy for living through the oxidation of all kinds of organic compounds in their bodies. Therefore, ATP contents in the muscles of the same species of animals are nearly constant, assuming that there are no changes of their living environment. However, due to the decrease in oxygen supply to the tissue after fish death, anaerobic metabolism takes over, resulting in the conversion of glycogen to lactic acid. With a decrease in ATP content and creatine phosphate (Bate-Smith & Bendall, 1947, 1949), actin and myosin gradually associate to form inextensible actomyosin (onset of rigor mortis). The stiff and rigid condition of muscle tissues is known as rigor mortis. Fish generally exhibit rigor mortis starting from about 1 to 6 h after death. The duration generally differs with many factors such as species, the method of killing fish, the catching conditions and storage temperature. According to Bendall and Davey (1957), the pattern in the prerigor muscle, which is soft and pliable, consists of small amounts of di- and tri-phosphopyridine nucleotides and ADP, and a large amount of ATP, whereas during and after rigor mortis, these components change to either di- or monophosphopyridine, inosine, hypoxanthine, IMP, IDP, ITP, AMP and ADP. IMP is vastly predominant. Moreover, according to Jones and Murray (1957), Murray and Jones (1958), ATP, ADP, AMP, diphosphopyridine and IMP contents in the skeletal muscle of rested codling (*Gadus callarias*) were 5.34, 0.76, 0.069, 0.107 and 1.26 μM/g, respectively, whereas those contents in the muscle of agonized codling were 0.26, 0.426, 0.057, 0.398 and 5.86 μM/g, respectively. 80% of ATP seemed to be dephosphorylated and deaminated. ATP contents in the muscle kept at 2 °C for 24 h decreased suddenly and IMP contents increased. On the other hand, there is scarcely any ATP left in the muscle kept at 2 °C for 6 days. IMP contents simultaneously decreased to 0.66 μM/g.

3. Autolysis of fish muscle and formation of histamine

Following the dissolution of rigor mortis, a gradual tenderization of fish meat occurs and high-molecular-weight compounds such as proteins, lipids and glycogen are gradually degraded into low-molecular-weight compounds, which can be utilized more readily by