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| | 作成者: 福島, 英登, 谷口, 成紀, 前田, 俊道, 福田, 裕 |
| | メールアドレス: |
| | 所属: |
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# Occurrence and Characteristics of Burnt Meat in Cultured Yellowtail

Hideto Fukushima[1], Shigenori Yaguchi[1], Toshimichi Maeda[1] and Yutaka Fukuda[1]

Graduate School of Fisheries Science, National Fisheries University
[1] Department of Food Science and Technology, National Fisheries University
[†] Corresponding author: Hideto Fukushima
Graduate School of Fisheries Science, National Fisheries University, 2-7-1 Nagata-honmachi, Shimonoseki 759-6595, Japan
E-mail: hfukushi@fish-u.ac.jp

**Abstract** : In order to examine the occurrence of burnt meat in yellowtail *Seriola quinqueradiata*, fish were processed by different slaughter methods, including instantaneous killing and after being allowed to struggle in sea water for 15 min or in air for 5 min, and the biochemical properties of the muscle tissues were investigated. The muscle from instantaneously killed fish maintained increased pH and adenosine triphosphate (ATP) content compared with fish that struggled; however, the muscle from fish that had struggled showed immediate decreases in ATP and pH. Muscle tissues at various pH levels were then incubated at 26, 28, and 30℃ for 10 min and the changes in Hunter's whiteness were compared. Muscle held at 26℃ did not show a change in color between pH 5.4 and 6.4. Muscle held at 28℃ also showed hardly any changes in color at pH >6.0, but the muscle showed increasing Hunter's whiteness with decreasing pH at pH <6.0. Similarly, muscle held at 30℃ showed increasing Hunter's whiteness with decreasing pH. These results suggest that both body temperature and pH are closely related to the occurrence of burnt meat in yellowtail.

**Key words** : ATP, burnt meat, cultured yellowtail, pH

## Introduction

Tuna is caught by various methods, such as single-rod fishing, round haul fishing, and long-line fishing. In addition, the production of cultured tuna has been increasing recently. In general, caught tuna is transferred to food processing factories where it is subsequently processed.

On occasion, muscle with abnormal appearance is observed. The appearance of fish meat that is pale in color is called 'burnt meat', and it is frequently found in tuna and yellowtail[1)]. Burnt meat is exudative and fibrous in texture, and fish with this characteristic fetch lower prices. The mechanism of developing areas of burnt meat remains poorly characterized; however, it is empirically known that burnt meat often occurs in summer, particularly in fish that were exhausted by exertion during capture. Therefore, the development of burnt meat is expected to be closely associated with body temperature and slaughter method, which both influence the pH[2)]. In the case of pork, abnormal meat is termed PSE (Pale, Soft and Exudative) and is similar in character to the burnt meat of tuna[3)]. When pigs are subjected to stress, their body temperature increases and the pH of their meat decreases. PSE meat is known to occur under the conditions of pH <5.7 and body temperature >30℃ following slaughter. In this study, the conditions and factors of producing burnt meat were investigated using cultured yellowtail.

## Materials and Methods

### Materials

Yellowtail *Seriola quinqueradiata* cultured at the Kuroi culture farm in Yamaguchi Prefecture was used in this study. Three cultured yellowtail were caught and processed by the following three slaughter methods: (i) fish were instantaneously killed by destroying the medullary immediately after being caught; (ii) fish were allowed to struggle in sea water for 15 min and then the medullary was destroyed; and (iii) fish were allowed to struggle in air for 5 min and then the medullary was destroyed. After slaughter at the culture farm, the fish carcasses were transported to our laboratory. Fish were stored at room temperature (20–21℃), and temporal changes in body temperature, pH and adenosine triphosphate (ATP) content of the dorsal ordinary muscle were examined.

### Body temperature

Body temperature was measured by inserting an SWP II-04M probe (Sato Keiryoki Mfg., Tokyo, Japan) into the central part of the fish carcass near the backbone.

### Analysis of fish muscle pH

Dorsal ordinary muscle (5.0 g) was collected and homogenized with 25 ml of 0.02 M monoiodoacetic acid solution. Subsequently, the pH of the mix solution was analyzed by an HM-25R pH meter (DKK-TOA, Tokyo, Japan)

### Analysis of the ATP-related compounds in fish muscle

Approximately 5.0 g of dorsal ordinary muscle was taken and extracted with 10% perchloric acid[4]; then, ATP-related compounds were quantified in the separate fraction using high-performance liquid chromatography systems (HITACHI co. Ltd).

### Burnt meat

To examine the reflected color of dorsal ordinary muscle, 10 mm-thick slices were cut and packed in plastic bags to avoid exposure to water, and incubated in water baths at 26, 28, and 30℃ for 10 min. After incubation, the color of each cutlet was measured with a chroma meter (Minolta CR-400, Konica-Minolta, Tokyo, Japan) and the $L^*$, $a^*$, and $b^*$ values were obtained. Hunter's whiteness was calculated using the following formula:

Hunter's whiteness = $100 - [(100 - L^*)^2 + a^{*2} + b^{*2}]^{1/2}$

## Results and Discussion

### Changes in body temperature, muscle pH and ATP content

The changes in body temperature of fish killed instantaneously and fish that had struggled in air are shown in Fig. 1. In the case of tuna, the body temperature around central position was over 30℃ immediately after capture[5]. In contrast, the body temperature of yellowtail was near the ambient room temperature and the temperature of instantaneously killed fish decreased more quickly compared with the fish that had struggled in air. Furthermore, cramps occurred in the instantaneously killed fish later than in the fish that had struggled. When the cramp occurred, body temperature increased slightly in both fish.

Next, the changes in pH and the ratio of ATP to total ATP-related compounds during the postmortem period are shown in Fig. 2. Instantaneously killed fish maintained a high ratio of ATP almost 80% and decreased only slightly after 1 h (Fig. 2A). However, the fish that had

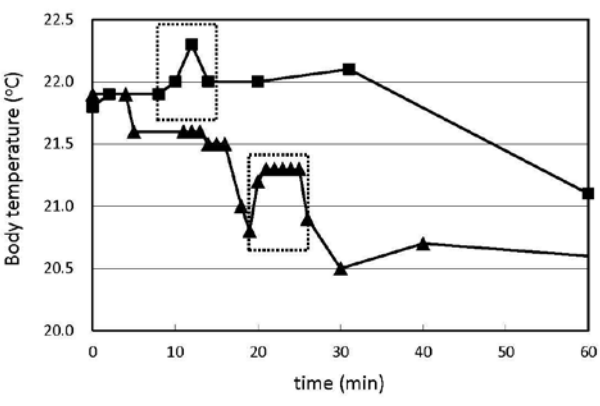


**Fig. 1** Changes in body temperature of instantaneously killed fish (triangles) and fish that had struggled in air for 5 min (squares). Areas enclosed by dotted lines indicate the occurrence of cramps.

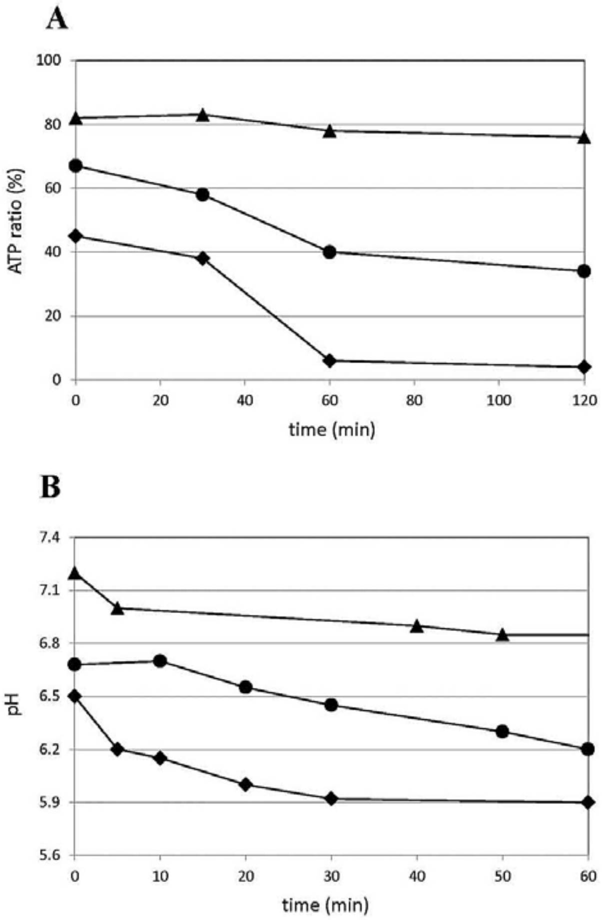


**Fig. 2** Changes in pH (A) and the ratio of ATP to total ATP-related compounds (B) of instantaneously killed fish (filled triangles) and fish that had struggled in water for 15 min (circles) or in air for 5 min (squares).

struggled in water and air showed low ATP ratios of 67 and 45%, respectively, immediately after slaughter, and then the ratio of ATP rapidly decreased to 40% and to below 10% after 1 h, respectively. Similarly, muscle of the instantaneously killed fish maintained a high pH for 1 h. In contrast, the muscle of fish that had struggled in water or in air had lower pH than did that of instantaneously killed fish (Fig. 2B). Based on the fish that had struggled in air showing decreased ATP content and muscle pH earlier than the fish that had struggled in water, it is thought that struggling in air is more stressful than struggling in water.

### Occurrence of burnt meat

To examine the mechanism of producing burnt meat,

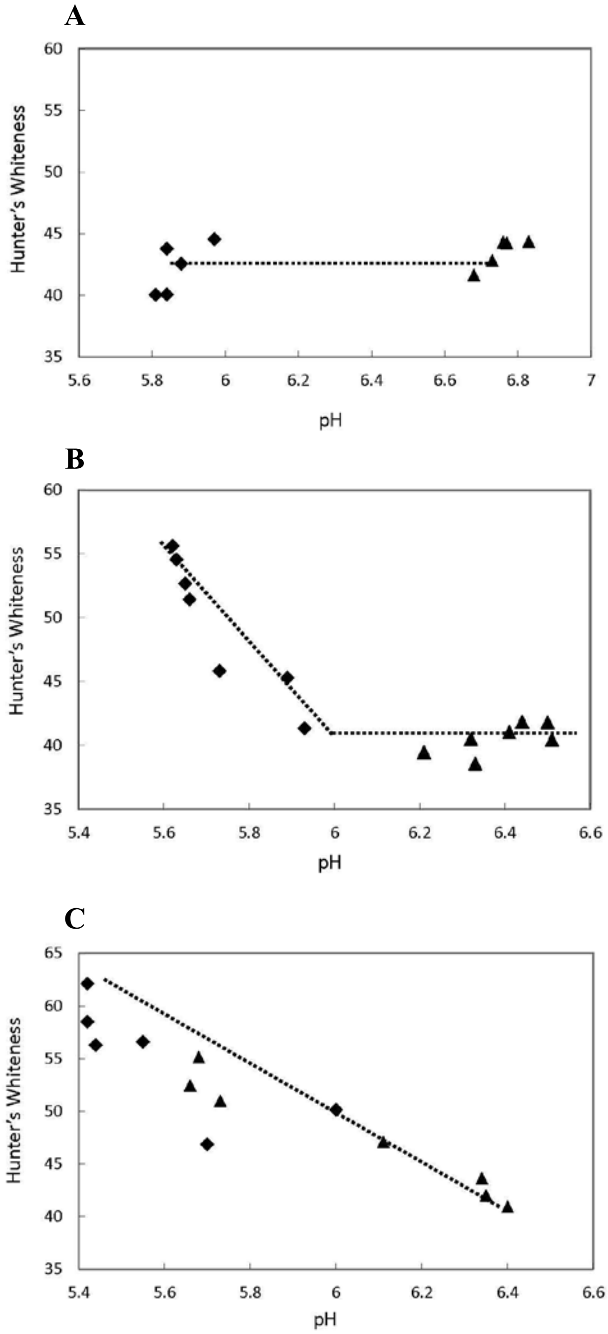


**Fig. 3** The relationship between Hunter's whiteness and pH of muscle incubated for 10 min at 26 (A), 28 (B), or 30℃ (C). Samples were obtained from instantaneously killed fish (triangles) and fish that had struggled in air for 5 min (squares).

muscle tissue samples with various pH were incubated at 26, 28, and 30℃ for 10 min, and the color change was measured (Fig. 3). Samples were prepared from both the instantaneously killed fish, which has a relatively high pH, and the fish that had struggled, which has a lower pH. Normal (not incubated) muscle showed a Hunter's whiteness between 40 and 45, irrespective of pH. Muscle incubated at 26℃ did not show a color change for samples at pH 5.8 to 6.8 (Fig. 3A). Muscle incubated at 28℃ also showed only slight change in color for samples with pH >6.0, but muscle with pH <6.0 showed increased Hunter's whiteness to 55 with decreasing pH (Fig. 3B). Similarly, the muscle incubated at 30℃ showed increased Hunter's whiteness from 40 to 62 along with decreasing pH (Fig. 3C). These results suggest that both body temperature and pH are closely related to the development of burnt meat. In particular, when muscle was incubated at 28℃, the only the fish that had struggled showed increased Hunter's whiteness, indicating the possibility that other factors may also be related to the occurrence of burnt meat. Consequently, it is thought that appropriate slaughter methods and cooling of the fish body have the effect of preventing the development of burnt meat.

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## References

1) Shiro Konagaya: A review of the abnomal conditions of fish meat: Jellied meat and Yake-Niku, spontaneously done meat.Nippon Shokuhin Kogyo Gakkaishi, **29**, 379-388 (1982).

2) Mora D. A., Hamada Y., Okamoto A., Takeishi A., Tachibana K. Characteristics of burnt meat in cultured yellowtail *Seriola quinqueradiata. Fish. Sci.* 73: 651-659 (2007).

3) Fernandez X., Forslid A., Tornberg E: The effect of high post-mortem temperature on the development of pale, soft and exudative pork: Interaction with ultimate pH, Meat sci., **37**, 133-147 (1994).

4) Ehira S, Uchiyama H, Uda F, Matsumiya H. A rapid method for determination of the acid-soluble nucleotides in fish muscle by concave gradient elution. *Nippon Suisan Gakkaishi*, **36**, 491-496 (1970).

5) Carey F. G., Teal J. M: Heat conservation in tuna fish muscle. *Proc. Nat. Acad. Sci. USA* **56**, 1464-1469 (1966).