

The Effects of Salts as Enhancer on the Shrinkage of Raw Fish Muscle in Japanese Traditional "Arai" Dish

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1. INTRODUCTION

Japanese cooking has a great variety of raw fish dishes. Some dishes such as "sashimi" or "sushi" have become known for the typical Japanese food. However, an unique raw fish dish called "arai" in Japanese has not been unnoticed. "Arai" is a very traditional Japanese dish made from extremely fresh marine food; for example, carp, sea bass, shrimp, and crab. When a sliced pre-rigor fish is washed in water for a while, its muscle tissue shrinks to change into a preferable appearance. Washing for "arai" preparation has been considered to lead to a rapid depletion of adenosine 5'-triphosphate (ATP) in muscle and, consequently, to accelerate rigor mortis.¹⁾ Calcium ion regulates the activity of Mg²⁺-ATPase that induces contraction or rigor in muscle. The object of this study was to investigate the effects of calcium ion and magnesium ion in washing water on the shrinkage of raw fish muscle.

2. MATERIALS AND METHODS

2.1. Preparation of the "arai" samples

Live sea bass was killed instantly and filleted. The dorsal muscle was cut at right

angles to the backbone into slices 3 mm thick, and the slices were divided into six groups. The first group, untreated raw slices, was used as a control. The other five groups were used to prepare "arai" samples by five different methods. 1) The slices were washed with stirring at a defined speed in 0 °C deionized water for 5 min. 2) The slices were washed in 18°C deionized water for 3 min. 3) The slices were washed in 49°C deionized water for 20 sec. 4) The slices were washed in 100mM CaCl₂ solution at 18°C for 3 min. 5) The slices were washed in 100mM MgCl₂ solution at 18°C for 3 min.

2.2. Sensory evaluation

The differences of appearance and texture between control and "arai" samples were evaluated with the paired comparison test and ranking method.

2.3. Chemical analysis

ATP and related compounds were quantified with high performance liquid chromatograph as previously reported²⁾ with a slight modification: they were eluted with 200mM NaH₂PO₄ (pH 2.9), absorbance at 260nm. Lactic acid was determined by using lactate dehydrogenase (Boehringer Mannheim Co.).

Table 1
Amounts ($\mu\text{mol/g}$) of ATP and related compounds in sea bass muscle slices

Treatment	ATP	ADP	AMP	IMP	Ino	Hyp	Total
Control	4.3	2.4	0.3	3.0	0.5	0	10.5
1	3.3	2.3	0.3	3.8	0.6	0	10.3
2	2.5	1.9	0.4	4.0	1.1	0	9.9
3	0.5	1.0	0.2	6.7	3.0	0.1	11.5
4	0.3	1.3	0.2	8.1	0.9	0	10.8
5	5.2	2.9	0.4	2.0	1.0	0	11.5

ATP, adenosine 5'-triphosphate; ADP, adenosine 5'-diphosphate; AMP, adenylic acid; IMP, inosinic acid; Ino, inosine; Hyp, hypoxanthine; 1, washing in deionized water at 0°C; 2, washing in deionized water at 18°C; 3, washing in deionized water at 49°C; 4, washing in 100mM CaCl_2 solution at 18°C; 5, washing in 100mM MgCl_2 solution at 18°C.

2.4. Measurement of textural properties

Bending index was shown by measuring the angle from the horizontal of a slice by cantilever bending when one half of the slice is fixed on a horizontal surface and the other half of 1.5 cm length projects and is free to bend. Rupture stress and rupture strain were measured by the constant speed compressive rupture test using a creepmeter (Yamaden Rheoner model RE 3305).

3. RESULTS AND DISCUSSION

3.1. Sensory evaluation

The sample prepared by washing in CaCl_2 solution shrank strongly compared with the samples by washing in deionized water. On the other hand, the sample prepared by washing in MgCl_2 solution showed no change in appearance.

3.2. Chemical analysis

Table 1 shows that little ATP remained in the sample prepared by washing in CaCl_2 solution. The inosinic acid content increased accordingly. In addition, a large amount of

lactic acid was accumulated in the sample prepared by washing in CaCl_2 solution.

3.3. Textural properties

The sample prepared by washing in CaCl_2 solution had a low value for bending index and a high value for rupture stress, suggesting that the muscle had been stiffened very much.

In conclusion, the addition of calcium ion to water for washing treatment accelerated the degradation of ATP and glycolysis that yielded a large amount of ATP, and in consequence the energy of ATP was supplied to induce strong contraction in muscle. As a result, the muscle became stiff. The degree of shrinkage was related to ATP depletion as well as the level of stiffening in texture.

REFERENCES

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2. M. Matsumoto and H. Yamanaka, Nippon Suisan Gakkaishi, 56 (1990) 1145.