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Evaluation of *Kokumi* Taste of Japanese Soup Stock Materials Using Taste Sensor

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It is difficult to describe the *Katsuobushi* (dried bonito) taste, especially that of *Karebushi* (molded died bonito), because it contains heartiness (*kokumi*) taste. Therefore, there is no study on the taste of *Karebushi*. In this study, we revealed the *kokumi* taste of *Karebushi* and other Japanese soup stock materials using a taste sensor.

1. Introduction

Dried-and-smoked fish products are commonly called *fushi* in Japan. A variety of *fushi* products such as dried bonito (*Katsuobushi*), dried bullet tuna (*Sodabushi*), dried mackerel (*Sababushi*), dried mackerel-scad (*Muroajibushi*), dried flying fish (*Agobushi*) and dried sardine (*Iwashibushi*) are manufactured, but the word *fushi* is usually used to specify dried bonito (*Katsuobushi*), whose production occupies almost half of the total production of *fushi*.

Katsuobushi, one of the Japanese traditional preserved foods, has been widely used as a seasoning, and it is an indispensable soup stock material for Japanese-style dishes.

The production processes of *Katsuobushi* are as follows: (1) making fillets from fresh bonitos, (2) boiling the fillets, (3) cooling and boning, and (4) smoking, where the boneless fillets are placed in a smoking furnace for half a day, followed by drying in open air for half a day. This process is repeated about ten times. Smoking is important for drying, flavoring, antioxidizing, and decomposition of protein.[1-3] The product of these processes is called *Arabushi*. (5) The final process is molding, where the *Arabushi* is placed in a room for two weeks to allow molding, mainly by *Aspergillus*, on the surface. The molded *Arabushi* is then dried in the sun. This process is performed 2–4 times. The molding process is indispensable for improving the flavor and taste of *Katsuobushi*. The

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final product is called *Karebushi*. Generally, it takes about two months to complete the manufacturing of *Karebushi*.

Katsuobushi abundantly contains amino acids and 5'-inosinic acid (5'-IMP), and has been used as a seasoning in Japan, and some chemical studies on the taste of *Katsuobushi* have been reported.[4-8] Although a principal taste-active component was identified as 5'-IMP,[4] Fuke *et al*. reported the contribution of other components to the characteristic taste of *Katsuobushi*.[5] Hosokawa *et al*. reported differences in the amounts of taste-active components (such as free amino acids and their related compounds, nucleotides, organic acids, and peptides) among the dorsal, abdominal, and dark muscle parts of *Katsuobushi*.[6] Kotani *et al*. determined the contents of free amino acids and 5'-ribonucleotides on 27 samples of *fushi* (14 samples of *Katsuobushi*, 2 of *Sodabushi*, 4 of *Sababushi*, one of *Muroajibushi*, 2 of *Urumeiwashibushi*, and 4 of *Niboshi*), and demonstrated that *Katsuobushi* and *Sodabushi* were higher in total free amino acids and lower in 5'-ribonucleotides than *Sababushi*, *Muroajibushi*, and *Niboshi*.[7] Okuma and Abe[8] reported that the contribution of histidine-related compounds (free histidine, carnosine, and anserine) to the buffering capacity of the hot water extract of *Katsuobushi* was as high as 40%.

However, little has been reported concerning the *kokumi* taste of *Katsuobushi*. In this paper, we report the evaluation of the taste of *Katsuobushi* and other soup stock materials using a taste sensor, particularly *kokumi* taste.

2. Materials and Methods

2.1 *Fushi products*

Fushi products are dried bonito (*Katsuobushi*), dried bullet tuna (*Sodabushi*), dried mackerel (*Sababushi*), dried mackerel-scad (*Muroajibushi*), dried flying fish (*Agobushi*), and dried sardine (*Iwashibushi*). *Fushi* products, obtained from a *fushi* factory in Kagoshima prefecture, were shaved just before use. A thousand milliliter of water was boiled, then the flame was reduced. Thirty grams of shaved *Katsuobushi* was then placed in the boiled water, and then it was allowed to stand for 5 min. The resulting shaved *Katsuobushi* was removed by filtration. The filtrate was subjected to taste analysis.

2.2 *Instrument*

The taste-sensing system SA402B of Intelligent Sensor Technology Co., Ltd., (Atsugi, Kanagawa, Japan) was used to measure the *kokumi* taste of various samples. The electrode set was attached to a mechanically controlled robot arm. The detecting sensor part of the equipment consists of eight electrodes, each associated with a corresponding *kokumi* value.

3. Results and Discussion

3.1 *Fushi products*

Figure 1 shows that *fushi* products are divided into two groups. One is the *Katsuobushi* group, the other is the *Zatsubushi* group. *Zatsubushi* is the generic name

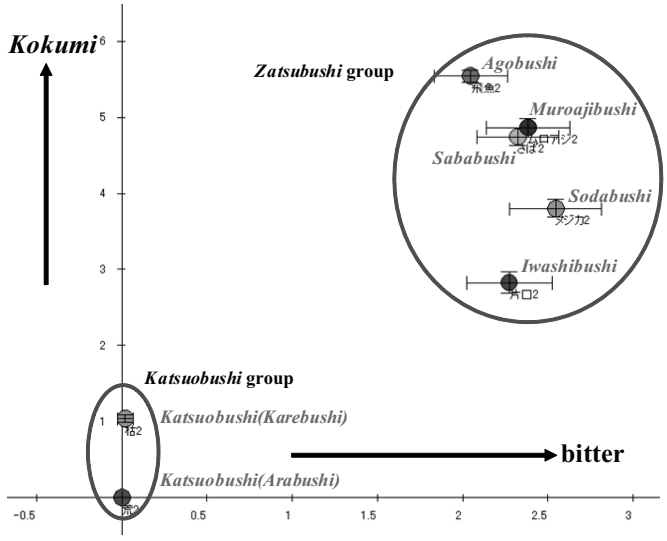


Fig. 1. *Kokumi* and bitter tastes of *fushi* products using taste sensor.

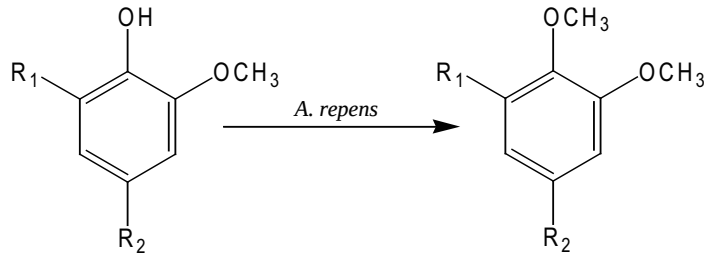
for *fushi* products, except for *Katsuobushi*. The *Zatsubushi* group has a rich *kokumi* taste that accompanies bitter taste, particularly *Agobushi*. The soup stock of *Agobushi* is suitable for ramen soup.

3.2 *Arabushi and Karebushi*

Katsuobushi has two types: one is named *Arabushi*, which is produced by smoke treatment after boiling, and the other is named *Karebushi*, which is produced from *Arabushi* by molding treatment. The molding step is a type of fermentation by *Aspergillus* species, and the step requires a considerably long period of about 2 months. Therefore, the amount of *Karebushi* manufatcured is limited by this step, and thus, it is expensive. However, *Karebushi* is more fascinating to many people because of its mild taste and flavor.

From the viewpoints of flavor, fragrance, and texture, molded dried bonito is milder than the nonmolded one. The difference between the molded and nonmolded ones is minimal. The manufacturing process of dried bonito was established in the 17th century, and the molding process was established in the 18th century. At that time, the purpose of molding was to improve its shelf-life. At ordinary temperatures, dried bonito will decay, but the molded dried bonito will not decay. In those days, there were no freezers. Molding is a simple preservation method. However, recently, the purpose of molding has been to create a mild flavor, fragrance, and texture.

In a previous paper,[9] we reported that *Aspergillus* species isolated from *Katsuobushi* *O*-methylated some phenols and made the pungent smoky flavor milder (Fig. 2). Such



	R_1	R_2
Guaiacol	H	H
Creosol	H	CH_3
2,6-Dimethoxyphenol	OCH_3	H

Fig. 2. O-Methylation of phenols by *Aspergillus repens.*

ability of the mold is very interesting to us from the standpoint of the alteration of organic compounds by microorganisms.[10-17] However, there have been a few papers on the fate of the nonvolatile components of *Katsuobushi* during the molding process.[18,19]

The characteristic taste of *Karebushi* using a taste sensor has become apparent (Figs. 3 and 4). *Arabushi* extracted for 60 min has an astringent and sour taste. However, *Karebushi* has only *kokumi* taste. The molding period (2 times=1 month, 4 times=2 months) contributes to creating the *kokumi* taste of *Karebushi*.

The *kokumi* compounds of *Zatsubushi* and *Karebushi* await further investigation. Experiments directed toward this line are in progress.

3.3 *Bonizyme*

Agobushi and *Karebushi* represent soup stocks of Japanese cuisine. However, these are expensive materials, and thus difficult to use easily. Therefore, we introduced Bonizyme, a *kokumi* liquid seasoning. Bonizyme is an extract of *Katsuobushi* obtained by enzymolysis, a sort of fish sauce made with *Katsuobushi*. The name is derived from bonito and enzyme.

The *kokumi* taste of noodle soup is enhanced by the addition of Bonizyme ranging in concentration from 0.5 to 2%. The addition of Bonizyme to noodle soup has been recommended to improve the *kokumi* taste at a low price (Fig. 5).

The *kokumi* enhancing effect of Bonizyme is attributable to peptides. Bonizyme is an extract of dried bonito obtained by enzymolysis. Using two enzymes in complex prevents the occurrence of bitter taste. Fifty percent of the gustatory components is free amino acid, and the other 50% is a low-molecular-weight peptide.

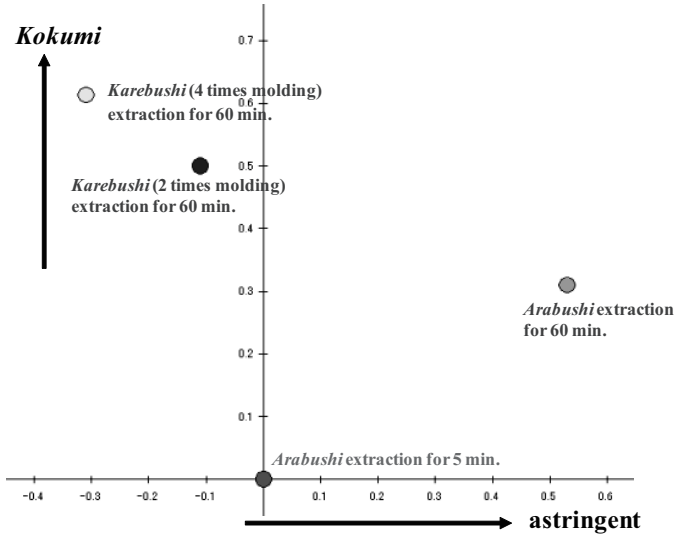


Fig. 3. *Kokumi* and astringent tastes of *Katsuobushi* (*Arabushi* and *Karebushi*) using taste sensor.

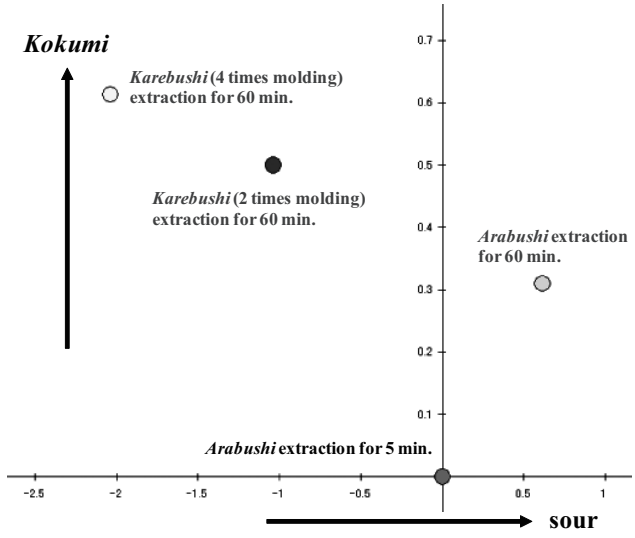


Fig. 4. *Kokumi* and sour taste of *Katsuobushi* (*Arabushi* and *Karebushi*) using taste sensor.

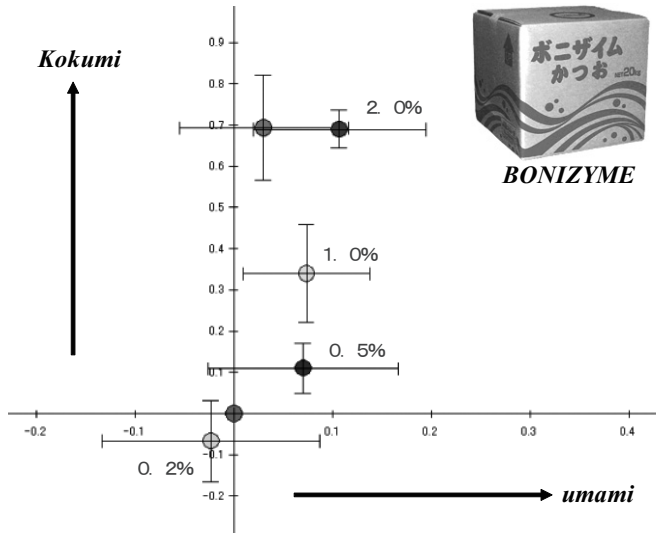


Fig. 5. *Kokumi* and umami tastes of noodle soup added with Bonizyme using taste sensor.

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