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Applicability of a taste sensing system to objectively assess taste of seafood

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Introduction

Taste plays one of the important roles in determining food preference of consumers and commonly used to evaluate food during sensory tests by members of the test panel. Sensory tests are useful for evaluating acceptance and preference of consumers, but cannot completely exclude subjective assessments. To solve this solution, taste sensor technologies have been developed [1] and taste sensor system has been used for attempting to evaluate the taste of various foods [2-6].

In seafood, the system has been attempted to dried bonito stock [7], seaweed sauce [8] and Pacific oyster [9]. But applicability of the system has not been sufficiently verified. In the present study, we estimated the taste intensity of extract from fish muscle, nori (sheets of dried laver seaweed), and squid in order to test the applicability of the system for seafood assessments.

Materials and methods

Cultured young yellowtail (n=3), *Seriola quinqueradiata*, were dissected into 3 sections, dorsal ordinary muscle, ventral ordinary muscle and dark muscle. One hundred ml of homogenate of each muscle in 4 times volume of distilled water was put into 100 mL plastic tube and warmed in boiled water for 10 min with vigorous mixing at 5 minutes after beginning of warming, cooled on ice and then centrifuged. The supernatant was estimated for taste intensity with the taste sensing system SA402B (Intelligent Sensor Technologies, Inc., Kanagawa, Japan) as described below. Cultured bluefin tuna (n=5), *Thunnus orientalis*, muscles were dissected from 3 sections as well as in yellowtail. Twenty g of cut muscle cubes (about 3-5 mm) were put into 100 ml plastic tube with 80 mL of distilled water and then treated with the same procedure in yellowtail.

One sheet of each three different commercial grades of nori (excellent, high and middle class) was cut into 576 pieces (24×24). Two g of pieces from each nori sheet was weighed, added to 100 ml distilled water, mixed vigorously, stood for 10 min at room temperature with vigorous mixing at 5 minutes after beginning of standing, filtered with Kimwipes (Nippon Paper Crecia Co., Ltd. , Tokyo, Japan) and then the filtrate was estimated for taste intensity.

Frozen Japanese common squid, *Todarodes pacificus*, and purpleback flying squid, *Sthenoteuthis oualaniensis*, were purchased from commercial suppliers. The frozen mantles of neon flying squid, *Ommastrephes bartramii*, were treated with the same procedure as yellowtail.

The extracts were estimated for taste intensity using the taste sensing system according to the manufacturer's protocol. The system can measure eight kinds of taste criteria as shown in Table 1. The estimated intensity of taste (EIT) was calculated from the sensor output by using manufacturer's application. A reference solution was used as a tasteless sample with taste criteria set to zero. Exactly, the taste criterion whose EIT value is over zero can be used for analysis. But in saltiness and sourness, the EIT values over -6 and -13 can be used for analysis, respectively, because the reference solution contains 30mM KCl and 0.3 mM

Table 1. Estimated intensity of taste in extracts from dorsal ordinary muscle of yellowtail, nori (Excellent grade) and mantle of Japanese common squid

	Sourness	Bitterness	Astrin-gency	Umami	Saltiness	After taste of bitter-ness	After taste of astrin-gency	After taste of umami
Yellowtail	-23.09	**0.10**	-0.83	**14.53**	-10.62	-0.40	-0.42	**10.49**
Bluefin tuna	-36.04	**1.32**	**0.63**	**14.22**	-11.21	-0.45	-0.49	**7.61**
Nori	-25.31	**6.50**	**0.94**	**12.43**	**13.99**	-0.15	**0.42**	**1.90**
Japanese common squid	-31.15	**0.38**	-0.36	**14.23**	**-0.81**	-0.36	-0.46	**21.68**

The values with bold characters indicate can be used for analysis.

tartaric acid.

Results and discussion

In the case of yellowtail, the EIT values of umami, richness and bitterness were over zero in all extracts from 3 different sections (Table 1), so these taste criteria can be used for the analysis. There was no difference of the EIT of bitterness and umami among sections. On the other hand, the EIT of richness of extracts from dorsal ordinary muscle was highest in order ventral ordinary muscle and dark muscle (Fig. 2 A). According to the manufacturer's protocol, one unit of the EIT is defined as the smallest difference which a person can distinguish. The difference of the EIT values between extracts from dorsal ordinary muscle and red muscle was over one unit, indicating that person can distinguish two extracts. We examined influence on taste intensity of the extraction condition. The centrifugation force and ice cold time hardly influence to EIT, but the EIT of richness increased in a boiling-time-dependent manner (data not shown).

In tuna, four kinds of taste criteria were used in all extracts from 3 different sections of muscle (Table 1). The EIT of richness was different among the sections as well as in yellowtail (Fig. 2B). The EIT of richness of extract from dorsal ordinary muscle was higher than that of dark muscle. In both yellowtail and tuna, the system could discriminate the extracts from different sections of muscle.

In nori, the EIT of 6 taste criteria were used in all extracts from the 3 different grades of nori (Table 1). Principal component analysis using the EIT of astringency, umami and richness indicated that PC1 scores of excellent grade nori were highest in order high and middle class, resulting that the system was able to discriminate different grades (Fig. 3A). The plus sign for PC1 was observed in the EIT of umami and richness, suggesting that taste intensity of umami and richness in excellent grade nori was higher than that in middle grade nori.

In squid, the EIT of 4 taste criteria was used for analysis in all extracts from mantles of the 3 species of squid (Table 1). Principal component analysis using all

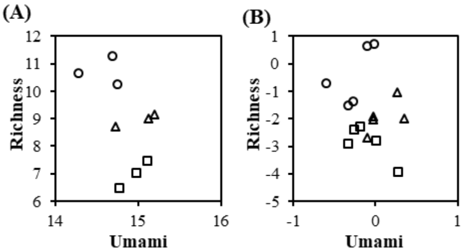

Fig. 2. Umami and Richness intensities of fish extract. (**A**) Yellowtail (n=3) muscle in 3 different sections. ○: dorsal ordinary muscle, △: ventral ordinary muscle, □: red muscle. (**B**) Bluefin tuna (n=5) muscles in 3 different sections. The extract of the other bluefin tuna ordinary muscle was used as a control with taste criteria set to zero. Symbols are the same as in yellowtail.

EIT indicated that PC1 scores in neon flying squid were higher those in Japanese common squid and purpleback flying squid and that PC2 score in purpleback flying squid were higher than that of Japanese common squid, resulting that the system was able to discriminate the different species of squid (Fig. 3B). In addition, we estimated the taste intensity of extracts prepared from arms (including tentacles), fins and mantle in Japanese common squid and neon flying squid (data not shown). As a result, there was no difference between arms and fins, but the EIT of mantle extract was higher than values of arms and fins in both species, indicating that the system can discriminate the extracts from different sections of squid.

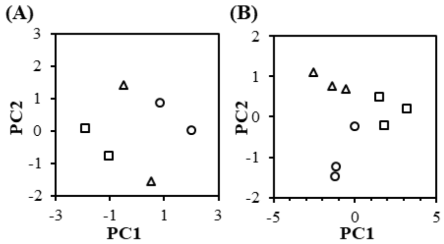

Fig. 3 Scatterplots of principal component analysis (PCA). **(A)** Extracts from 3 different grades of nori. ○, excellent grade: △, high class: □, middle class. (**B**) Extracts from 3 different species of squid. ○, Japanese common squid (n=3): △, purpleback flying squid (n=3): □, neon flying squid (n=3).

In the present study, the system could discriminate the taste intensity of the extracts among different sections of fish muscle, different grades of nori and different species of squid. So, the taste sensing system is applicable as an objective measure of seafood taste, when the extracts are prepared from seafood.

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