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Taste Sensing System and Its Application to Beef

Katsushi Sato, Hidekazu Ikezaki, Akira Taniguchi, Kiyoshi Toko*, Keisuke Sasaki**, Mitsuru Mitsumoto** and Hiroyasu Nakai**

Anritsu Co. Research Laboratory, Onna, Atsugi-shi, Kanagawa, 243-8555, Japan
*Kyushu University, Fukuoka, 812-8581, Japan
**National institute of Animal Industry, Tsukuba-norindanchi, Ibaraki, 305-0901, Japan

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1. Background :

Evaluation of food taste in food manufacturing still largely depends on sensory tests carried out by a panel who actually taste the food. However, the data obtained has problems in terms of objectivity and repeatability due to the individual taste differences and health conditions of the panel, while the tests tax the panels to the point of fatigue. Against this back ground, development of a taste sensing system which is capable of detecting human taste senses and supports the panel in new product development and/or food manufacturing lines has been awaited. We have been developing a novel taste-sensing system that mimics human taste sensory sense.

2. Objectives :

The concept of taste sensor is very different from that of chemical sensors, which detect specific chemical substances such as sodium ion or glucose. However, taste cannot be measured even if all the chemical substances contained in foodstuffs are measured. Human do not distinguish each chemical substance, but feel the taste in itself; the relationship between chemical substances and taste is not clear. It is also not practical to arrange so many chemical sensors as the number of chemical substances, which amounts to over 1000 in one kind of foodstuff. Moreover, there are interactions between taste substances, such as a synergistic effect or a suppression effect. Coexistence of monosodium glutamate (MSG) and disodium inosinate (IMP) enhances the umami taste. Discrimination of each chemical substance is not important here, but recognition of the taste itself and its quantitative expression must be made. The taste sensor using lipid membranes as a concept of global selectivity which implies the ability to classify enormous range of chemical substances into several groups, as really found in the taste reception in biological systems.[1-2] Thereupon we have applied our taste sensor to the evaluation of beef taste and measured four sets of samples of beef over four months.[3]

3. Methods :

3.1. Taste Sensor and measuring method :

The development of a taste sensing system which imitates the taste sensing mechanism of living organisms had been attempted. Lipid membranes imitating living organisms were artificially composed, and taste sensing by recognizing the signal patterns from multiple taste sensors having different characteristics was tried. The system outline of this is shown in Figure 1.

Lipid membrane sensors were made by fixing the lipids in polymer film which play an important role in taste detection. Signal outputs were obtained as the electric potential changes of the lipid membranes when the taste substances were adsorbed. At that time, the lipids having different response characteristics were selected as membrane materials, to make taste sensors with different properties. Taste discrimination was carried out by recognizing the signals obtained from these taste sensors in the form of patterns.

The taste sensor has been applied to many kinds of foodstuffs such as beer, coffee, sake, green tea and milk; it is shown that the taste can be measured quantitatively.[4-5] Eight kinds of sensors related to beef taste were selected for the evaluation (see Table 1). The sensor output values was utilized by principal component analysis.

3.2 Sample preparation:

We measured four sets of samples which are meat from sirloin of Wagyu, domestic Holstein and imported beef. We measured three types of treatments a sample meat. These samples were extracted from each of fresh meat, boiled meat and broiled meat. For the measurement, samples must be liquid. The filter was used to eliminate fat.

3.3 Method of Analysis:

The data from the multiple membrane sensors were studied by means of a principal component analysis. We got a taste map from 4 sets of samples. Holstein beef was chosen as a reference standard in the measurement results.

4. Results and Discussions :

Figure 2 shows the results of principal component analysis of beef samples which are Wagyu, Holstein and imported beef. X and Y dimensions are the principal component 1 (PC1) and the principal component 2 (PC2), respectively. From figure 2(a) and 2(b), it was clear that areas of Wagyu and imported beef were symmetrical with respect to the position of Holstein beef. The arrow direction likely indicates deliciousness to Japanese. On the other hand, from figure 2(c) broiled meat could not be distinguished, because Wagyu, Holstein and imported beef were coexisting. It is thought that the sample from broiled meat would be different depend on conditions such as heat temperature, also heating time.

5. Conclusions :

We applied the taste sensing system to beef samples. We found that the taste of Wagyu beef was distinguished from Holstein and imported beef by fresh meat, boiled meat. The taste sensing system will clearly benefit the meat market, where it could be used for the evaluation of beef taste. It will also be possible to establish a taste standard for beef, allowing taste to be evaluated objectively.

6. Pertinent literature :

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(4) K. Toko, T. Murata, T. Matsuno, Y. Kikkawa, K. Yamafuji: Sensors and Materials **4** (1992) 145

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7. Acknowledgments :

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Table 1 Lipid membranes used in the taste sensor

Channel	Lipid membrane
1	Dioctyl phenyl phosphonate
2	Didecyl phosphate
3	Oleic acid
4	Decyl alcohol
5	Trioctylmethylammonium chloride
6	Tetradodecylammonium bromide
7	Oleyl amine
8	Dioctyl phosphate + Trioctylmethylammonium chloride

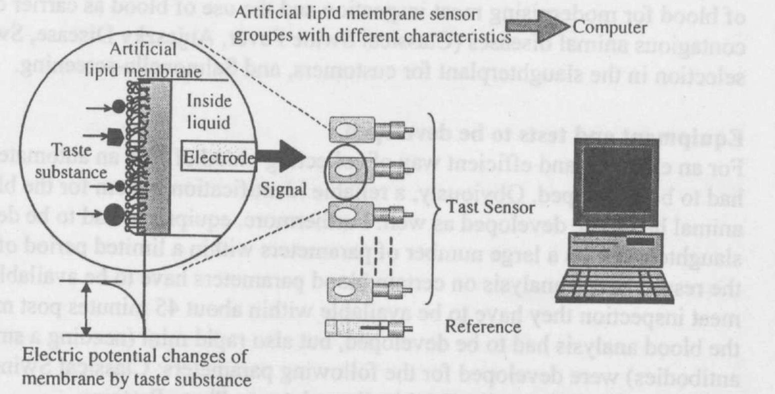

Fig. 1 Taste Sensing System

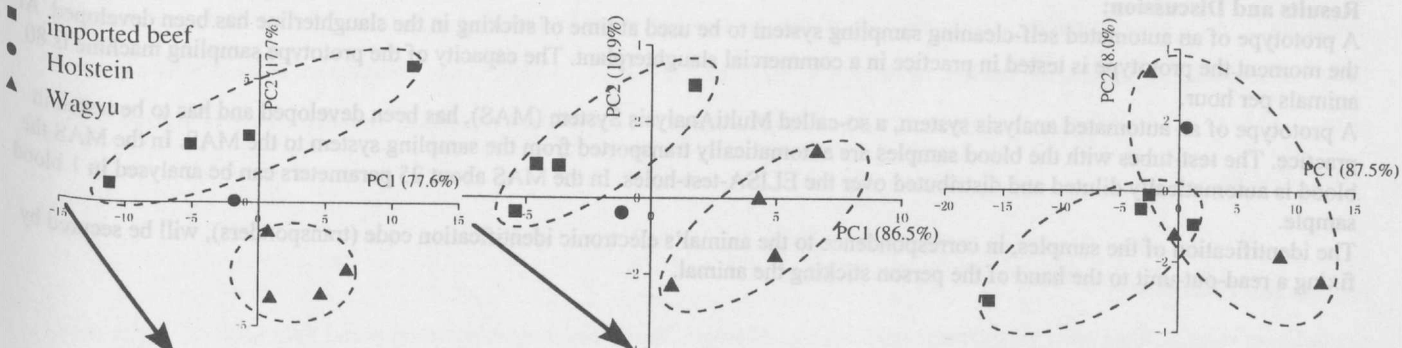

Fig.2 Principal component analysis applied to the sensor output of beef extracts