

# Umami Taste in Japanese Traditional *Miso* Soup for the Elderly

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## Abstract

Elderly people often suffer from taste disorder, with subsequent appetite loss. A reduction in umami-taste sensitivity is strongly related to appetite loss. Under these circumstances, how is umami taste considered and applied to foods for the elderly in Japan? In this study, we measured the concentration of L-glutamate (a typical umami amino acid) in 658 different *miso* soups served in 220 institutions for the elderly in Japan. *Miso* soup is a popular Japanese savory soup made with soup stock (*dashi*) and fermented soybean paste (*miso*), both of which are abundant in umami substances. The concentration of L-glutamate in the *miso* soups was the highest among the measured amino acids (Av  $\pm$  SD: 156.3  $\pm$  101.3 mg/100 g) with a very large range (15.7–697 mg/100 g, CV: 64.8%). We also measured the sodium concentration in the same *miso* soups (Av  $\pm$  SD: 328.5  $\pm$  70.1 mg/100 g) and found that it is controlled in a narrow range (CV: 21%). We should further investigate whether these concentrations are preferred by the elderly, for the improvement of their appetite and nutritional status.

**Keywords:** Elderly; Miso soup; Umami taste; Glutamate concentration

## Introduction

Mealtimes are often a great pleasure in daily life, especially for the elderly [1]. However, many elderly persons suffer from taste and/or smell impairment caused by senescence itself, medication, and/or diseases, and they are thus unable to enjoy many foods [2,3]. According to the research on the taste sensitivity of patients with taste impairments, a reduction in umami taste sensitivity showed a strong association with the reduction of food palatability [4,5]. Umami taste-which is one of the five basic tastes along with sweet, salty, sour and bitter tastes-is a major taste quality of soup stock, the so-called “savory” taste. The most typical umami substance is L-glutamate (Glu), a non-essential amino acid [6]. In the present study, we investigated the Glu concentration in *miso* soup served in hospitals and nursing homes for the elderly in Japan. *Miso* soup is a very popular Japanese traditional savory soup and is served at least once a day in such institutions. *Miso* soup is made by boiling various ingredients such as vegetables in soup stock (*dashi*) and seasoning the stock with fermented soybean paste (*miso*). We collected *miso* soup from institutions for the elderly all over Japan, because there are many local varieties of *dashi* and *miso* that are used as the source of umami substances for *miso* soup. In addition to the Glu concentration in *miso* soup, we analyzed the concentrations of Inosine 5'-Monophosphate (IMP) [7] and Guanosine 5'-Monophosphate (GMP) [8], which are other types of umami substance, nucleotides. The sodium (Na) concentrations of the soup samples were also analyzed.

## Materials and Methods

### Sample collection

Ten *miso* soups were collected from a typical elderly hospital in Kyushu, a southern island in Japan (Institution A), and three *miso* soups were collected from a typical elderly nursing home in the same area (Institution B). We also collected 2 or 3 *miso* soups from each of the five institutions from each prefecture in Japan. The *miso* soup samples were frozen immediately after being prepared at the originating institution and thawed just before our analysis.

### Analysis of Glu concentration

The chunky ingredients in each *miso* soup sample were removed with a strainer, and the supernatant of the soup was collected. The

supernatant was diluted 20-fold with ultrapure water and then filtrated using a 0.45- $\mu$ m filter and a 10-kDa centrifugal ultrafiltration unit. The amino acid concentration in the filtrate was analyzed by an L-8900 amino acid analyzer (Hitachi High-Technologies Corp., Japan).

### Analysis of IMP and GMP concentrations

Quantitative analyses of IMP and GMP concentrations of the filtrate of *miso* soup were performed by an HPLC method (Separation: CAPCELL PAK NH<sub>2</sub> UG 80 (Shiseido Co., Ltd., Japan), 30 mM (NH<sub>4</sub>)<sub>2</sub>HPO<sub>4</sub> (pH 3.0 w/H<sub>3</sub>PO<sub>4</sub>)/CH<sub>3</sub>CN = 95/5, Detection:  $\lambda$ =254 nm).

### Analysis of Na concentration

The Na concentration of the supernatant was analyzed by an ICPS-8100 inductively coupled plasma atomic emission spectrometer (Shimadzu Corp., Japan).

### Statistical analysis

Analysis of variance (ANOVA) and calculation of correlation coefficients were performed using SPSS 16.0 (SPSS Japan).

## Results and Discussion

### Variance of Glu concentration in *miso* soup within institutions for the elderly

We first analyzed the variation of the Glu concentration of *miso* soup within two institutions, using samples from Institutions A and B (Figure 1). The Glu concentration of *miso* soup at Institution A was 36  $\pm$  4.0 mg/100 ml (Av  $\pm$  SD, n=10), and that of Institution B was 98  $\pm$  7.0 mg/100 ml (n=3). Despite the variation in ingredients, the

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Received May 11, 2012; Accepted July 25, 2012; Published July 27, 2012

Citation: Kawai M, Hirota M, Uneyama H (2012) Umami Taste in Japanese Traditional *Miso* Soup for the Elderly. J Nutr Food Sci S10:005. doi:10.4172/2155-9600.S10-005

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variance of Glu within each institution was relatively small, with an approx. 10% coefficient of variation (CV) in both institutions. Thus, the Glu concentration in *miso* soup might strongly depend on the *dashi* and *miso* used, and might depend less on other ingredients. Therefore, we decided to collect 2 or 3 types of *miso* soup from each institution to determine the Glu concentration in the *miso* soup served in such institutions for the elderly in Japan. Although every institution for the elderly serves several special diets (e.g. low-salt diets for patients with hypertension, low-sugar diets for patients with diabetes), we collected only *miso* soups used for patients receiving a regular diet for the comparison.

### Concentrations of umami substances, Glu, and nucleotides in *miso* soup served in institutions for the elderly in Japan

We collected 658 samples of *miso* soup served as part of the regular patient diet from 220 institutions, which represented about five

		Average	SD	CV (%)	Min	Max
Amino acids	Gly	5.6	2.6	45.5	0.0	23.2
	Ala	14.0	5.1	36.2	0.0	35.0
	Ser	10.5	3.4	32.2	0.0	27.4
	Thr	6.8	2.6	37.6	0.0	19.8
	Cys	0.9	1.6	181.4	0.0	11.0
	Met	4.3	1.6	38.1	0.0	9.8
	Val	12.2	4.0	32.8	0.0	30.6
	Leu	18.6	6.4	28.0	1.0	42.1
	Ile	9.8	3.4	34.4	0.0	25.7
	Phe	12.1	3.8	31.8	0.0	27.6
	Tyr	9.7	3.6	37.2	0.0	24.1
	Trp	7.4	2.7	36.1	0.0	15.5
	Glu	156.3	101.3	64.8	15.7	697.0
	Asp	14.0	5.9	42.3	1.0	69.0
	Gln	12.9	13.7	106.4	0.0	74.2
	Asn	3.7	10.1	276.4	0.0	82.4
	Lys	16.7	5.0	29.7	0.0	37.0
Arg	23.6	11.0	46.4	1.0	110.8	
His	8.5	6.5	76.6	0.0	52.9	
Pro	10.5	4.0	37.8	0.0	34.7	
Nucleotides	IMP	8.8	8.5	96.3	0.0	63.2
	GMP	1.6	3.1	200.7	0.0	27.4
	Na	328.5	70.1	21.3	142.6	595.8

mg/100g, n=658

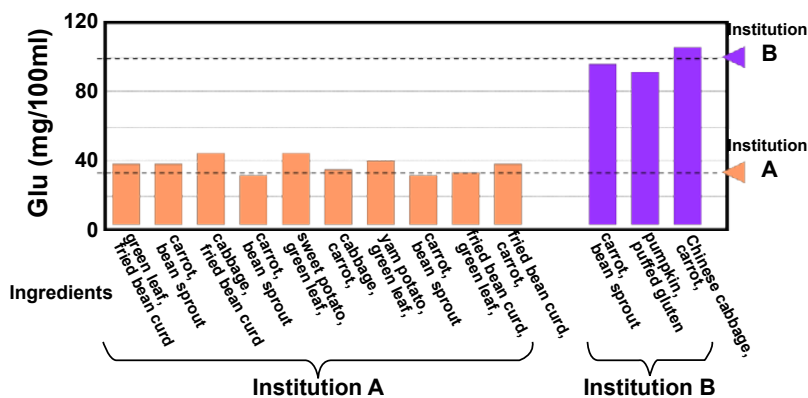
**Table 1:** Concentration of amino acids, nucleotides, and Na. Amino acids are shown in abbreviation of IUPAC.

institutions per prefecture in Japan. The samples' average concentrations of amino acids including Glu are shown in Table 1. Glu was the most abundant protein amino acid in free form; however, its concentration showed a large CV ( $Av \pm SD$ :  $156.3 \pm 101.3$  mg/100 g (range: 15.7–697 mg/100 g, CV: 64.8%).

In the one-way ANOVA, the main effect of institution was significant ( $F(219, 438)=6.110$  ( $p=0.000$ )). The main effects of *dashi* (five categories: dried bonito (*katsuo-bushi*), dried sardine (*iriko*), ready-made, natural ingredients + ready-made, and non-classifiable *dashi*) ( $F(4, 653)=37.538$  ( $p=0.000$ )), and *miso* (seven categories: soybeans only, soybeans + rice, soybeans + wheat/barley, mixed, umami seasoning-added, umami seasoning-added + mixed, and non-classifiable *miso*) ( $F(6, 651)=5.071$  ( $p=0.000$ )) were significant. That is, because each institution had its own usage of *dashi* and *miso* for *miso* soup, the Glu concentration of *miso* soup differed by institution, but the Glu concentration was almost constant within each institution, as in the cases of Institution A and Institution B.

The average Glu concentration by prefecture (Figure 2) was higher in the middle region of Japan and lower in the southern region of the country. Most of the institutions in the southern region used dried sardines for *dashi* (*iriko-dashi*) and soybeans and wheat/barley *miso* (*mugi-miso*), which are relatively low in Glu content. In the middle part of Japan, such as the Kanto district where Tokyo is located, many institutions used ready-made *dashi* in which Glu and IMP/GMP are supplemented as umami seasoning. Several dietitians at institutions with low-Glu content in high-Glu districts, such as Kanto district, reported that elderly patients had complained about the unpalatability of *miso* soup with a diluted taste. This might be partly because the elderly people in such high-Glu districts were used in foods with high Glu contents.

We also measured the concentration of another type of umami compound, the 5'-purinemononucleotides IMP and GMP, which show synergistic umami enhancement when mixed with Glu (Table 1). These nucleotides are present in meat products such as dried fish used for *dashi*, e.g., dried bonito and dried sardines. We found that the concentration of IMP was  $8.8 \pm 8.5$  mg/100 ml, and that for GMP was  $1.6 \pm 3.1$  mg/100 ml. However, *miso* contains phosphatase, which degrades nucleotides into nucleosides (compounds lacking umami taste) during cooking and storage, and thus our measurements of the concentrations of IMP and GMP of *miso* soup might be less reliable.



**Figure 1:** Variance of Glu concentration within two institutions. The dotted lines represent the average for institution A and institution B.

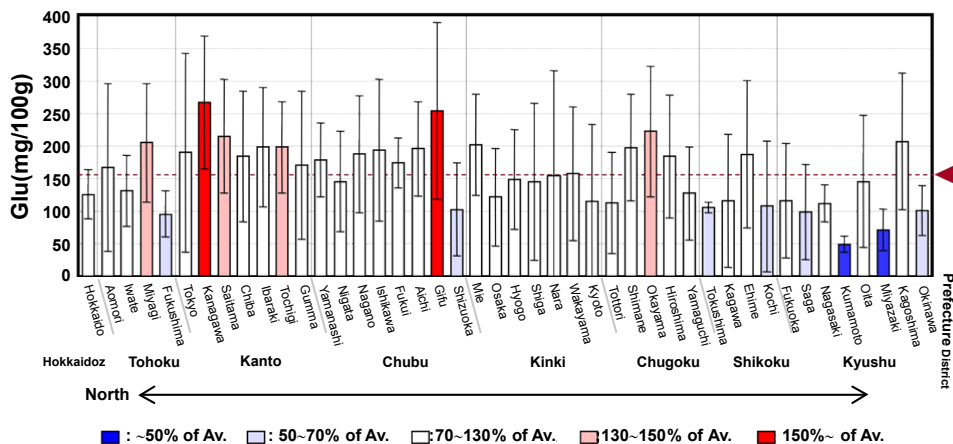


Figure 2: Average Glu concentration by prefecture. The dotted line represents the average.

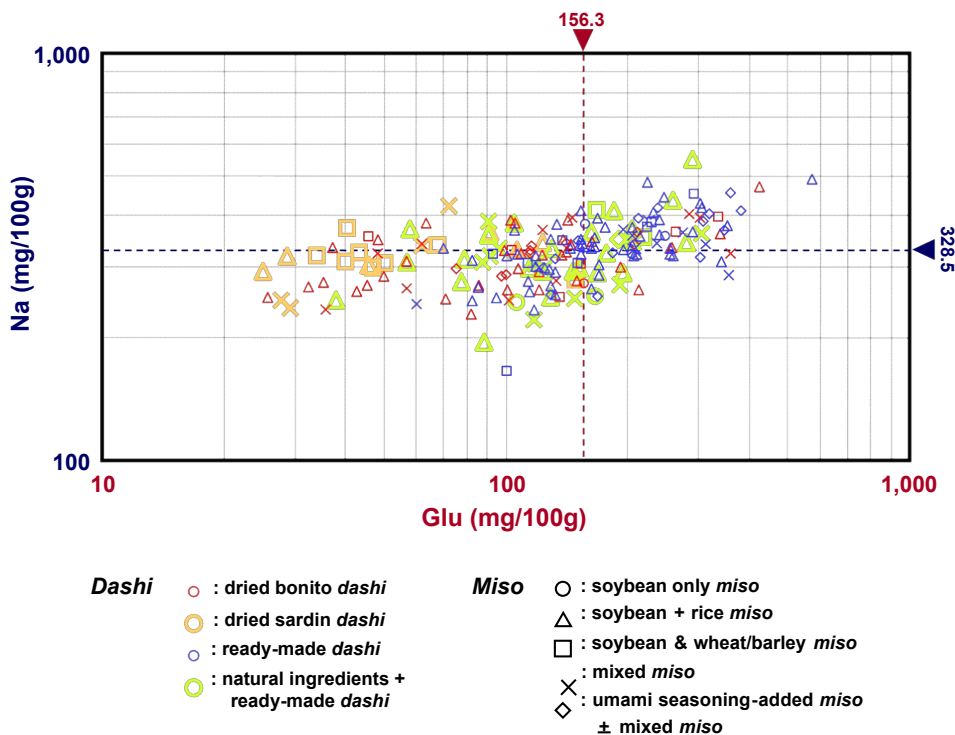


Figure 3: Glu and Na concentration within each institute. The line pattern of each symbol shows the type of *dashi*, and the shape of each symbol represents the type of *miso*, as shown under the graph. One symbol represents an average value (2 or 3 *miso* soups) of each institution. Therefore, each symbol represents the major *dashi* and *miso* values of each institution. Concentrations are represented in logarithmic axes, because taste intensity is proportionate to the logarithmic value of the concentration of each tastant.

### Relationship between concentrations of Glu and Na

The Na concentration fell within a narrower range than that of Glu, between 142 and 596 mg/100 g ( $328.5 \pm 70.1$  mg/100 g, CV: 21%), as shown in Table 1. The relationship between Glu and Na is shown in Figure 3. A significant positive correlation was found between the Glu and Na concentrations ( $r=0.534$  ( $p=0.000$ )). *Miso* contains high Glu and Na because it is made with salted and fermented soybeans. Some ready-made *dashi* contains high Glu and Na because its major ingredients are sometimes NaCl and umami compounds. These aspects of *miso* might explain the positive correlation between the concentrations of Glu and Na in *miso* soup.

### Umami taste in foods for the elderly

Most people perceive that overall flavor is enhanced when umami compound is added to foods appropriately. For example, when an umami compound, Monosodium L-Glutamate (MSG), was added to a diluted beef broth, the flavor characteristics such as thickness, mouth-fullness, impact, and overall taste were improved [9]. In another study, umami compounds were important for the characteristic flavor of fish, crab, clam, and other seafoods [10,11]. Thus, because umami compounds intensify flavor, Glu salts are sometimes used for compensation for the bland taste of salt-reduced foods [12–18]. Several reports showed that

salt content could be reduced by as much as 30% by using MSG, though it contains Na (0.12 g Na/1 g MSG; cf. 0.40 g Na/1 g NaCl) [12,15].

However, the elderly often have appetite loss due to low umami-taste sensitivity [4], and it may be possible to improve their appetite by intensifying the umami taste via the fortification of the appropriate seasonings. We might be able to intensify the savory taste of Japanese *miso* soup by partial substitution of *miso* or ready-made *dashi* with a small amount of umami seasonings such as MSG, reducing Na at the same time to reduce the risk of hypertension. Many Glu-rich traditional fermented seasonings around the world [19] tend to have high Na content because NaCl is indispensable for bacteriostasis during long-term fermentation. In Asia, there are various traditional local high-salt sauces or pastes made with soybeans, fish, shrimp, and/or meat. Elderly people tend to prefer traditional dishes cooked with such traditional fermented seasonings; e.g., the *miso* soup made with fermented salted soybean paste (*miso*) examined in the present study. In such scenarios, the partial substitution of fermented seasonings by umami substances might be effective for cooking for the elderly, especially in persons with reduced umami-taste sensitivity.

## Conclusion

We measured the concentration of a typical umami compound, Glu, of *miso* soup, a popular Japanese soup served in institutions for the elderly in Japan. The Glu concentration was the highest among amino acids (Av  $\pm$  SD: 156.3  $\pm$  101.3 mg/100 g). However, its range was very large (15.7–697 mg/100 g, CV: 64.8%), unlike that of the *miso* soup Na concentration.

## Acknowledgments

We thank the institutions for their supply of *miso* soup samples and the staff of Ajinomoto Pharmaceuticals Co., Ltd. and Ajinomoto Nutrition Foods Co., Ltd. for their support in contacting respective institutions.

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This article was originally published in a special issue, **Nutrition and Human Health: Health Benefits of Umami Taste in Asian Cuisine** handled by Editor(s). Dr. Hisayuki Uneyama, Ajinomoto Co., Inc., Japan.