

Assessment of Umami Taste Sensitivity

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Abstract

Patients with gustatory disorders often complain of persistent impairment of umami taste, a synonym for savory or broth-like flavor, even after the recovery of the other four basic taste sensations (sweet, salty, sour, and bitter). Umami taste is important for maintaining not only the quality of life but also good health, and therefore, it seems important to assess and treat the impairment of umami taste perception. At present, however, there is no clinical test for umami taste, even though tests for the other four basic tastes have been widely used in quantitative gustometry. We have developed a new method to clinically assess the sensitivity of umami taste using a filter paper disc (FPD) with monosodium glutamate (MSG) as the prototype umami substance. We found that some elderly patients complained only of the loss of umami taste sensation, whereas the sensation of the other four basic tastes (sweet, salty, sour, and bitter) was normal. Those patients without normal umami taste sensitivity were all over 65 years old, and complained of appetite and weight loss, resulting in poor general health. After treatment, their umami taste threshold recovered, and they regained appetite and weight.

In this article, we review our and related studies concerning umami taste.

Keywords: Umami taste sensitivity test; Elderly; Weight loss; Appetite loss

Significance of Umami Taste for Elderly

Enjoying delicious foods is one of the greatest sources of pleasure and satisfaction. To be able to perceive the palatability of foods, it is necessary to remain healthy. The taste referred to as umami became recognized as the fifth basic taste (besides: sweet, sour, salty and bitter) one decade ago. At the beginning of the 20th century, a Japanese scientist from Tokyo University, Kikunae Ikeda, noticed that an unidentified taste quality, distinct from the other four basic tastes, was present in palatable foods. He found this taste most clearly in the Japanese broth, “-dashi-”, prepared from Japanese sea tangle (konbu), a type of kelp that has been traditionally used in Japanese cooking. He succeeded in isolating salts of the amino acid glutamate as umami taste substances in 1908 [1]. It took about 100 years, however, before umami was widely accepted as a basic taste [2,3]. Recent progress in molecular biology has identified umami taste receptors in taste buds of the tongue. T1R1/T1R3 is considered an umami-specific receptor that can discriminate between umami and other tastes [4].

It was recently reported that taste receptors exist not only in the oral tissues but also in the gut, like T1Rs receptors in cells of the duodenum [5,6]. This suggests that nutrients can be detected as tastants not only in the mouth but also by sensing cells in the gut. Indeed, Uneyama et al. [7] reported that only glutamate could activate the gastric branch of the vagal afferent nerve among the 20 amino acids. Gustatory stimulation by monosodium glutamate (MSG) is now known to promote the secretion of saliva [8], and gastric [9] and pancreatic juice [10]. Moreover, supplementation of meals with MSG has been shown to affect gastric emptying [11]. Therefore, it is certain that umami will facilitate the preparation for digestion/absorption of nutrients through stimulation of the brain via taste receptors in the oral cavity. Umami will also play a role in the gastric phase assists digestion/absorption and metabolism of nutrients by further stimulating the gastric branch of the vagus nerve through gastric MSG sensors. Thus, umami taste sensation is very important to maintain the health of the gastrointestinal tract, particularly for the elderly, since their physiological



Figure 1: Filter paper disk test for assessment of taste disorders. We tested six concentrations of MSG and five of the other four basic taste solutions (sweet, salty, sour and bitter). The lowest concentration that a patient can detect and recognize was determined as the RT (recognition threshold) for each taste.

functions and basic physical condition decline with age. At present, however, there is no clinical assessment for umami taste sensitivity.

Materials and Method

The filter paper disc (FPD) method, which can measure the recognition threshold (RT) for the four basic tastes sweet, salty, sour, and bitter, is clinically used for the assessment of taste disorders in Japan [12]. The FPD method is generally applied to three different innervated areas (bilateral: anterior tongue / posterior tongue / soft

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Case	Age	Sex	Chief Complaint	Systemic disease	Number of Drugs	Oral Dryness	Other Symptoms
1	69	M	No palatable of food and alcohol	Chronic gastritis, Prostatitis	6	+	Facial pallor, Dryness of oral mucosa
2	62	F	Sticky mouth, loose taste, Heavy lying of stomach	Chronic gastritis	2	+	Glossitis, Dryness of oral mucosa, N.P. by stomach examination
3	69	F	No palatable of food, No appetite by sand like food sensation	Gastric polyp	0	-	Facial pallor, Glossitis, Atrophy of tongue
4	74	F	No palatable of food, No appetite by heavy lying of stomach, Tongue smart by food	None	0	-	Glossitis, Atrophy of tongue, N.P. by stomach examination
5	75	F	Loose taste, No appetite, Heavy lying of stomach	Coxarthrosis, Agrypnia	5	+	Tongue pain, Atrophy of tongue, Dryness of oral mucosa
6	77	F	No palatable of food, Loss of weight, Heavy lying of stomach	Diabetes, Osteoporosis	10	-	Dryness of oral mucosa, N.P. by stomach examination
7	78	F	No palatable of food, Dry mouth, Loss of appetite,	Septicemia, Multiple organ failure, Cerebral meningitis	8	+	Scar in the mouth and face, Paralysis of scar region, Dryness of oral mucosa

Patient's age, sex, chief complaint, description of systemic disease, number of prescription drugs, oral dryness and other symptoms.

Table 1: Outline of patients with umami taste disorders.

Case	Age	Sex	Umami-taste sensitivity Measurement value (No. of test solution)	Flow rate of Saliva (gum test: ml/10min)	Weight change	Systemic condition
1	69	M	5 → 2	3.1 → 6.6	-1kg → +1.5kg	poor → good
2	62	F	Scale Over → 2	6.2 → 12.0	-1kg → +1kg	poor → good
3	69	F	5 → 2		25.8 -3kg → +0.5kg	poor → good
4	74	F	5 → 2		15.8 -3kg → +0.5kg	poor → good
5	75	F	Scale Over → 2		13.2 -2kg → +0.5kg	poor → good
6	77	F	Scale Over → 3		23.6 -3kg → +1kg	poor → good
7	78	F	Scale Over → 2	7.6 → 11.6	-2kg → +1kg	poor → good

Umami-taste test solution: Monosodium Glutamate (MSG)

(No. 1: 1 mM; No. 2: 5 mM; No. 3: 10 mM; No. 4: 50 mM; No. 5: 100 mM; No. 6: 200 mM).

The umami-taste RT before and after treatment was measured on the glossopharyngeal innervated area. Scale Over: patient could not recognize umami taste by test solution of number 6.

Table 2: Changes in various clinical values for patients with umami taste disorders following treatment.

palate), since the cause of a taste disorder might derive from the obstruction of distinct gustatory nerves (see the article in this issue of the journal related to taste disorders by Sasano). However, umami taste is not yet clinically assessed in regular bases at the present, thus there is no information about umami taste disorders.

In an attempt to begin gathering information about umami taste, we developed an additional FPD method to test umami sensitivity using MSG test solutions at concentrations of 1, 5, 10, 50, 100 and 200 mM [13] (Figure 1). As a preliminary test, we measured the RT of MSG sensitivity in healthy young-adult subjects (n=50, 21.0 ± 4.2yr) and healthy elderly subjects (n=22, 80.2 ± 7.9yr), because it has been reported previously that the RT is higher in the elderly than in the young for L-glutamic acid [14] and MSG [15].

Results and Discussion

We found no significant difference in the RT between young-adult and elderly subjects for each innervated area (anterior tongue/posterior tongue/soft palate) with this method (in submission). Accordingly, this method can be used for the assessment of umami taste disorders regardless of the subject's age.

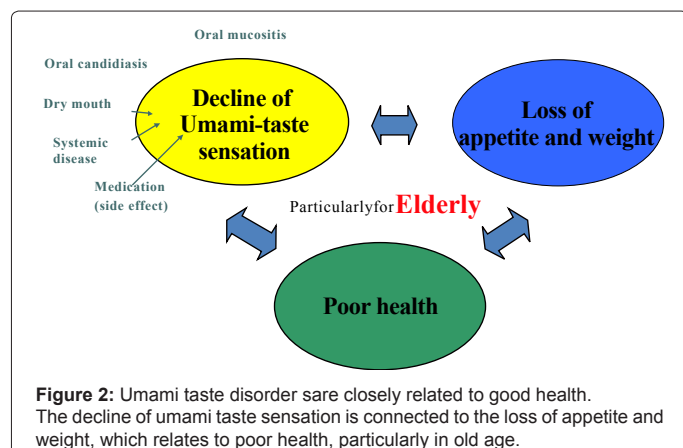
In this study, approximately 80% of the subjects showed RT in the range of 5 to 10 mM MSG for the posterior tongue and the soft palate, respectively, and in the range of 10 to 50 mM for the anterior tongue. Thus, most healthy subjects, both young and elderly, exhibited a lower threshold in the posterior tongue and soft palate than in the anterior tongue. This may be due to the larger number of taste buds in foliate or circumvallate papilla in the posterior tongue and soft palate

than in the anterior tongue. This idea may be partly supported by Halpern, who described that the posterior part of the tongue may elicit umami taste, whereas stimulation of the anterior part of the human tongue with MSG did not induce umami taste, and stimulation of the anterior tongue induced some combinations of the four basic tastes [16]. Consequently, it might be necessary to set different criteria for the assessment of RT between the anterior tongue and the posterior tongue and soft palate.

Regarding recognition of umami taste, Japanese subjects are familiar with the taste of MSG because they ordinarily eat foods rich in umami substances such as dashi, a broth made of kelp (L-glutamate) or dried bonito flakes (inosinate). When Americans or Europeans taste MSG, they typically describe it as brothy, soupy, meaty, and savory. These term sare is used for the qualitative description of umami taste by Western cultures. However, umami taste is often incorrectly described as salty, sour, sweet-sour or sweet [17] in taste tests in Europe. For this reason, to measure MSG thresholds examiners need to train subjects for the taste recognition of MSG before analysis. Generally, subjects are familiarized with the taste of supra-threshold concentrations of MSG [18], and they are informed about the quality of MSG-taste before testing [17]. Thus, information about the quality of MSG-taste to patients or subjects before umami taste testing might be necessary to assess the accurate umami taste sensitivity, particularly when individual sare not familiar with umami substances.

Clinical application of the umami taste sensitivity test and the umami taste disorder in patients

Patients with taste disorders often complain about the low



palatability of food and/or persistent impairment of umami taste, although the other four basic taste sensations (sweet, salty, sour, and bitter) are normal, even after these four basic taste sensations have improved by clinical treatment [19]. At this point, it is unknown whether such patient's complaints relate to the specific loss of umami taste sensation, since there is no clinical test for the assessment of umami taste sensitivity. Therefore, we examined the patients who visited our clinic complaining of taste disorders by means of the new umami taste sensitivity test using MSG as described above [13]. We compared the RT for the umami taste sensation to MSG between patients and normal volunteers. In seven out of forty-four patients with taste disorders (16%), the RT for umami taste was higher than that in normal volunteers, whereas the RT for the other four basic tastes were all within normal range. All those patients who showed low umami taste sensitivity were over 65 years old, and complained of appetite and weight loss, resulting in poor health. Interestingly, their main complaints in most cases were: food was not palatable and they were not eating normally because of appetite loss. These patients showed various systemic diseases, such as chronic gastritis, gastric polyps, prostatitis, coxarthrosis, diabetes, septicemia and similar disorders (Table 1). We tried to find the cause of their umami taste disorder. Potential local factors were considered for each patient, such as oral stomatitis, oral candidiasis, oral dryness, in addition to general systemic diseases. Since all of these patients were elderly, umami taste dysfunction might be associated with aging. Dry mouth is also strongly related to umami taste disorders based on our previous study, which indicated that the treatment for dry mouth is often effective against hypogeusia [20]. Treatments for dry mouth and oral diseases in addition to systemic disease improved entirely the ability of patients to subjectively perceive umami taste, and the RT for MSG was similarly improved (Table 2). Patients also improved remarkably their appetite and weight because food palatability increased for them, thus they were able to enjoy foods by regaining the sensation of umami taste, which also improved their health. Umami itself is not particularly palatable; however, umami makes a variety of foods palatable. Solution of MSG is also not very palatable, but MSG enhances foods palatability [21-23]. Taking these facts into account, our treatment for the patients with umami taste disorder may contribute their food palatability.

These results suggest that retaining umami taste sensation is important, particularly for the elderly, to maintain good health (Figure 2), and that umami taste assessment in patients with tasted is orders is an important reference to understand their health status.

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