

The discovery of umami (the fifth basic taste) and its implications

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1) The discovery of umami

The four basic tastes of sweet, sour, salty and bitter were world-widely accepted for hundreds of years. When a Japanese scientist, Kikunae Ikeda of Tokyo Imperial University, paid careful attention to the complex flavor of asparagus, tomatoes, cheese and meat, he noticed a common and yet absolutely singular taste which was different from the conventional four tastes about a hundred years ago. He also recognized this taste quality in delicious soup stock or 'dashi' made from kombu (kelp), which has been traditionally used in Japanese cuisine for more than 1000 years. He started investigating the main taste substance of kombu and discovered that the taste was produced by an amino acid, glutamate, and named it 'umami'. Soon after the discovery of umami, Ikeda found that monosodium glutamate (MSG) rather than glutamate alone was the most useful substitute inducing umami because it was neutral in pH, readily soluble in water, and had a strong umami taste, high stability, and absorbed no humidity.

Ikeda's pupil, Shintaro Kodama, identified 5'-inosinate for the delicious component of bonito flakes in 1913, and Akira Kuninaka also identified 5'-guanylate from dried shiitake mushroom in 1960. It is now well accepted that umami substances are divided into two groups: a group of L-amino acids represented by MSG, and another of 5'-ribonucleotides and their derivatives represented by inosine 5'-monophosphate (IMP) and guanosine 5'-monophosphate (GMP). Umami substances have a unique property which is known as the synergistic effect: when the two groups of umami substances are mixed, umami of the mixture becomes much stronger than the sum of umami of the individual components in the mixture. This synergistic effect was first

reported by Kuninaka in human subjects using mixtures of MSG and IMP or GMP.

2) Umami is the fifth basic taste

In 1985, an international symposium on umami was held in Hawaii where scientific evidence was presented through physiological, psychological, biochemical, nutritional and behavioral approaches demonstrating that umami was the fifth basic taste, along with sweet, sour, salty and bitter. It was at this event that the Japanese word umami was accepted into the international vocabulary of taste.

Molecular studies have suggested that the T1R1/T1R3 heterodimer, mGluR1 and mGluR4 function as umami receptors in taste cells of mice. Although these receptors respond broadly to amino acids including glutamate, human T1R1 and T1R3 expressing cells respond selectively to glutamate and show synergistic responses to mixtures of MSG with IMP or GMP.

Recent research has shown that there are glutamate receptors not only on the tongue but also in the gastric mucosa. When a piece of food enters the stomach, and glutamate receptors detect the presence of glutamate, this information is relayed to the brain in addition to inducing local reactions to exert various physiological responses including regulation of gastrointestinal functions and control of feeding behavior.

Taste sensation plays a role in conveying information to us about which foods are good and which are harmful. A sweet taste signals a source of energy such as sugars and carbohydrates, a salty taste signals the presence of minerals that are essential to help maintain the optimal balance of body fluid. A sour taste warns us when food is rotten or unripe. A bitter taste signals that something such as a toxin is harmful to the body. Umami comes from amino acids or nucleotides and signals the presence of proteins which are essential to human life.

Umami is the first taste encountered by breastfed babies since human breast milk contains a high concentration of glutamate which is almost the same as that found in kombu dashi.

3) Seasoning aspect of umami

Besides the fifth basic taste of MSG as umami, it has a function to enhance the deliciousness of foods, namely seasoning effects. The role of MSG may be similar to that of salt, that is, salt itself has a salty taste and addition of salt during cooking makes dishes delicious because of its seasoning effect. The existence of umami is a fundamental part of what makes our food taste good, and we describe the experience it offers as savory, rich, brothy, tasty, chickeny, delicious or meaty.

An example of seasoning aspect of umami can be presented in new-born babies who show facial expressions depending on whether the stimulus is good or bad. When you put a vegetable soup into the mouth of a baby, the baby shows aversive reactions, but when you add MSG to the soup, the baby shows preferable facial expression to this mixture, indicating that addition of MSG increases the deliciousness of vegetable soup. The similar seasoning effect of MSG is shown in adults for various food items. Because of this seasoning effect, umami-rich dishes are delicious with less usage of salt. It was 1909 that MSG was first marketed in Japan as a seasoning.

Since no natural food items exist that contain only umami substances, umami-rich stock has traditionally been used as the basis of cooking all over the world. Various kinds of stock are made using a variety of ingredients, with kombu and bonito flakes being used in Japanese 'dashi', and meat and vegetables used in Western 'bouillon' and Chinese 'tan'. The stocks generally contain a multitude of different amino acids including glutamate more than any other amino acids. However, Japanese kombu dashi is rich in glutamate, and dried bonito contains large quantities of inosinate, giving each of them a purer and simpler flavor. A mixed stock of these two umami-rich ingredients, which is called ichiban-dashi, gives synergistically enhanced umami. The dashi is used to add umami to almost all boiled dishes and soups to make them delicious, just as bouillon is used in Western cooking.

4) Umami around the world

Umami is actually used in various forms all over the world. In Asia, umami is mainly found in beans and grain, fermented seafood-based products, shiitake mushrooms, kombu and dried seafood. In Western cuisine, there are also fermented or cured products derived from meat and dairy products, namely ham and cheese. The most well-known umami-rich ingredient is the tomato.

Almost all the popular and favorite foods provide appealing features, such as plenty of fat and salt, textural variety, attractive color and design, but underlying all the sensory experiences and common to all the foods are the glutamates, indicating that umami plays a central and crucial role. Although umami was first identified and described with specific reference to Japanese foods, it has clearly always been, and will certainly continue to be, a fundamental feature of world-wide cuisine.

Finally, Dashi has healthy merits in contrast to high-calorie flavorings such as butter and cream, and for this reason, dishes that reveal Japan's traditional and delicious umami are becoming more popular especially in the West.