Umami taste and receptors: essay

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INTRODUCTION

We have always known the existence of four basic tastes; sweet, salty, sour and bitter. However there is a fifth taste, which is not well recognized and that is ‘ UMAMI’. It was first discovered byKikunae Ikeda, a Japanese scientist. He believed that the flavor of meat, fish, seaweed broth; was due to some unknown compound which was different from the four primary tastes. He termed it as ‘ umami’ (savouriness) and showed that this peculiar taste was contributed by glutamic acid and its salts (mainly monosodium glutamate). Therefore, we can say that umami is mainly the taste of certain amino acids like glutamate, aspartate and its salts. Now, umami taste has been recognized due to the wide presence of glutamate in a variety of foods like sea food, cheese, meat and so on.

When we eat food, our tongue senses and perceives the taste because it shows the presence of taste buds, which help us differentiating between these 5 tastes. They are basically epithelial cells that are connected to sensory neurons and the signal is sent to the brain for perception of the taste. At the end or base of each taste bud, there are basal cells which produce supporting cells, which eventually form the taste receptor cells. These receptor cells recognize the tastants (soluble chemical compounds) and corresponding signal is sent. The taste bud cells are classified into 4 categories: Type I; Type II, Type III and Type IV. Type II cells express G protein-coupled receptors (GPCRs) and downstream effectors for sweet, bitter and umami taste compounds and are directly stimulated by these tastants.

The different type of tastes and their receptors:

- SWEET: developed basically due to carbohydrates which bind to the G-protein coupled receptors (GPCRs). Each receptor is made up of 2 subunits; namely T1R2 and T1R3; and these are bound to G proteins. Sometimes, they may be inhibited by leptin, which opens their potassium channels.
- SALTY: developed due to salts like sodium chloride (table salt), sodium bicarbonate (baking soda).
- SOUR: it is mainly due to acidic compounds like vinegar, citrate etc. The receptors for sour taste recognize the protons from acids which lead to depolarization of cell by closing its potassium channels and this results in release of serotonin into the synapse and transmission of signal to the brain.
- BITTER: it is contributed by compounds like quinine, phenylthiocarbamide. It is usually not consumable. The binding of these take place to G protein coupled receptors and signaling occurs in a manner similar to that of receptors for sweet.

UMAMI TASTE AND ITS RECEPTORS

Identification of umami taste as such is difficult. Although many of the food items have that taste, but none of them have a pure umami taste. This can be said because the anion of glutamate gives an umami taste but the cation contributes to some other taste. For example in monosodium glutamate, the sodium ion gives a slight salty taste. A most common test performed to identify the umami taste is to compare equimolar solutions of sodium chloride and monosodium glutamate. Both of it will have a salty taste but something more in MSG is identified as umami.

However, in order to recognize the sweet, bitter and umami tastes, it is necessary that there is a release of adenosine 5' triphosphate from taste bud cells because it is a neurotransmitter that activates the neural gustatory pathways. In such a case, calcium homeostasis modulator 1 (CALHM1), which is a voltage gated ion channel is extremely important. Calhm 1 is specifically expressed in sweet, bitter and umami sensing type 2 taste bud cells. Experiments were conducted in which calhm 1 was taken off from mice and these mice showed impairment in perception of these tastes. However they showed normal perception for salty and sour taste. Therefore, calhm 1 is an ATP release channel that is voltage gated and is required for perception of umami tastes along with sweet and bitter.

Initially it was found out that matabotropic glutamate receptor (mGluR4) was responsible for the perception of umami taste. It was then established that the umami taste is sensed by a heterodimeric G-protein coupled receptor which is made up of any 2 subunits from T1R1, T1R2, and T1R3. They can be present in any combinations of these.

In humans, L-aspartate and L-glutamate strongly stimulate umami. The human umami taste receptor is made up of T1R1 and T1R3 subunits, each of which has approximately 850 amino acids and 7 transmembrane helices. The extracellular N terminus has a VFT domain (Venus flytrap domain) and a cysteine rich domain which is bound to the heptahelical domain. Glutamate causes closing of the VFT domain.

It can be understood that umami is mediated by both mGluR4 and T1R1+T1R3 receptors.

Binding of glutamate to the GPCRs, leads to production of secondary messengers like triacylglycerol and inositol triphosphate, which binds to the type 3 inositol triphosphate receptor and calcium release is induced from TRPM5. TRPM5 then leads to depolarization of taste cells and release of ATP occurs. The signaling cascade is then continued. Both Gα gustducin and Gα transducin are involved in umami signaling.

As we are aware, the taste of umami is not well recognized by the people. Hence, there are several clinical tests that can be performed to check for sensitivity of umami among different individuals in a population. One such test is filter paper disc method, where filter paper discs are dipped in various concentrations of monosodium glutamate (MSG) and kept at different positions of tongue in an individual. In such a way, recognition threshold (RT) is estimated, which is the lowest concentration recognized by people. It is usually found out that the RT of anterior tongue is higher than that of posterior tongue. Such a test enables to differentiate between normal and abnormal umami taste sensations. Some of the other tests to check the sensitivity include: whole mouth method, taste strip method, painting method and the dripping method.

CONCLUSION

Although the fifth taste, umami has been known for several decades; it has not received a wide public recognition. Scientists are still working to get the best out of umami taste and its receptors. Recently, a team of scientists from

University of Miami have come up with a receptor for umami which they say is a modified form of mGluR4, which lacks the end of the molecule. This terminal region is required for the strong binding of glutamate to the receptor, and its absence shows the sensitivity. The authors claim that the truncated molecule of mGluR4 has all properties needed for it to be an umami taste receptor. They further show that the receptor responds to the same concentration of glutamate as it can be tasted. Therefore, there is still a lot to be discovered about the mysterious and peculiar taste of umami and its recptors.

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