Monosodium Glutamate: The Distinct Flavor

The food industry is a business of mass production and consumption. Plants and animals that are grown in bulk in farmlands nationwide are processed later at large factories. It is no surprise that some of the most popular snack foods have a lengthy list of ingredients. The various chemicals found in food serve to enhance the color, texture, flavor, and shelf life. There are hundreds of food additives such as ascorbic acid, aspartame, and xanthan gum and a common food additive which is known as monosodium glutamate (MSG). Yet, most people do not fully understand what is MSG and how it can be dangerous to a person’s health. It is an ingredient often targeted as the cause of “Chinese Restaurant Syndrome” which leaves people with nausea, fatigue, and chest pains. This leads one to investigate the mystery of what is MSG, and what it does to the human body?

MSG, also known as sodium glutamate, is a sodium salt of the naturally abundant glutamic acid. MSG was first recognized by Kikunae Ikeda at the Tokyo Imperial University in 1908. He was interested in the pleasant flavor in the Japanese broth containing Kombu seaweed. He was successful in isolating and identifying the flavored compounds in it. This led him to the discovery of what’s known as the umami taste. Umami flavor is described differently than the other 4 tastes: sweet, salty, bitter, and sour. Umami has a “meaty” but mild flavor. He was able to extract L-glutamic acid from the seaweed soup broth and conclude that as the umami component.

Professor Kikunae Ikeda
In order to study other L-glutamic acid salts, Ikeda tested calcium, magnesium, potassium, and ammonium. He settled with sodium as the salt for MSG because it was the most soluble, easiest to crystalize, and best tasting. Ikeda then went on to patent and start producing MSG. With help from Ikeda, Ajinomoto was founded by Saburosuke and Chuji Suzuki in 1909 to produce MSG. Today, industrial manufacturers produce MSG as a flavor enhancer because it balances the overall taste of products. Ajinomoto USA has also formed, and to this day they still contribute in worldwide MSG production.

Today, MSG is produced from the fermentation of starch, sugar beets, sugar cane, and molasses. The production process was discovered in the early 1950s when E. coli were observed to excrete amino acids which yield L-glutamic acid. Because L-glutamic acid could be improved through the addition of ammonium salts, the bacteria Cornynebacterium glutamicum was used because it strictly excreted (S)-glutamic acid (MSG) from ammonia and carbohydrates in vegetables [1]. The reaction is as follows:

\[ C_{12}H_{22}O_{11} \text{ (carbohydrate)} + 3O_2 + 2NH_3 \rightarrow 2C_5H_9O_4N \text{ (glutamic acid)} + 2CO_2 + 5H_2O \]

The nitrogen source is added to the culture through ammonium salts, urea, or pure ammonia gas. Ammonia gas is preferred because of its ability to maintain the pH at physiological levels. The fermentation process is aerobic, and thus uses oxygen. Keeping control of the temperature and oxygen levels, the fermentation runs about 35-45 hours. At the end, the fermented broth is centrifuged to remove any solids, and the supernatant is kept for further purification. The broth has its pH adjusted to 3.2, to reach the isoelectric point of glutamic acid. The isoelectric point is simply the pH where the amino acid has no electrical charge. Then crystallization is induced with seed crystals to get the resulting (S)-glutamic acid. Sodium then can be added to keep the salt neutralized. The advantage of this method is that the yield is around 60%, and it only produces the desired (S) enantiomer of glutamic acid. The (R) enantiomer is not desired because it is tasteless. MSG powder will be white and odorless, and dissociates into glutamate and sodium in water. The molecular composition of MSG is C$_5$H$_8$NO$_4$Na with a molar mass of 169.111 g/mol. The solubility in water is 74 g/100mL.

For flavor purposes, MSG also enhances other taste-active compounds when combined with meat, fish, and vegetables. For example, this effect is seen in MSG reacting with disodium inosinate and disodium guanylate. These substances are tasteless in the absence of MSG, but upon its addition MSG will produce a flavor 6-8 times stronger than expected [1]. It will improve the taste of most food, but excessive amounts will make food unpleasant. MSG has also been used to help reduce the intake of sodium chloride. It is capable of improving flavors even if the salt chloride content has been reduced up to 30% of a standard amount.
MSG from manufacturers Ajinomoto

The most controversial subject about MSG has been whether or not it is safe as a food additive. The “Chinese Restaurant Syndrome” was created when many people described several unpleasant symptoms after consuming take out Chinese food. These symptoms include numbness, chest pain, headache, nausea, and drowsiness. Yet, the amount of MSG necessary to lethally kill a person is around 15-18 g/kg body weight. This is a large amount, and would not be consumed accidentally by any normal human.

In 1959, the U.S. FDA labeled MSG as “Generally Recognized as Safe” (GRAS). However, there is a small group of people that appear to have an MSG allergy when exposed to 3 g in the absence of food. The studies on MSG have not indicated any threat from MSG, but testimonies still report the adverse effects of it.

Furthermore, Dr. Russell Blaylock has studied MSG and determined that MSG is an excitotoxin. An excitotoxin is a chemical that causes a brain cell to become overstimulated. As a result, an influx of calcium ions will go into the post synaptic cell. The high levels of Ca^{2+} will activate many cellular degradation processes eventually leading to the cell death [3]. This gives MSG the potential to increase permanent damage to the brain and nervous system. Neurological diseases such as Alzheimer’s, Parkinson’s, and Lou Gehrig’s also have a higher reported chance [4]. The FDA has stated that the function of glutamate receptors have been linked with neurological diseases in laboratory animals [4]. Glutamate receptors are located in neuronal cells, with most of them residing in the brain. Glutamate is used as a neurotransmitter responsible for the excitation of neurons. These processes are important for neural communication, memory formation, and learning [5]. Glutamate receptors are also found in heart tissue and in the heart’s electrical conduction system [2]. Yet, the FDA dismisses the fact that consuming MSG will contribute to any neurological problems through lack of evidence.
The reason that the food companies do not remove MSG from their products is because of sale purposes, so products are not compromised. However, to avoid getting caught they have tried relabeling MSG by using obscure ingredients. On the other hand, people have argued that all substances are poisons depending on the amount that a person is consuming. This proves that table salt is no more dangerous than MSG at small levels, yet it is very toxic at high levels. Finally, people also question whether there is a difference between natural L-glutamic acid and processed L-glutamate. They are technically the same, except that L-glutamic acid produced commercially is subject to impurities such as D-glutamic acid, and pyroglutamic acid. These impurities might also be part of the reason that MSG is harmful to people.

Therefore, the history of MSG is a continuous debate of whether food companies should rely on it for flavor. There is also an argument from one side on whether MSG has been the problem to many medical conditions, while the other side concludes that there is no evidence of MSG being linked to headaches, numbness, chest pain, nausea, and heart problems. However, the FDA has confirmed that some people are allergic to it. Thus, it has not yet determined why natural glutamate produces no side effects, whereas commercially produced MSG does. The truth appears to be conclusive that MSG is generally harmless, but should be consumed in moderation.
Works Cited


