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Effects of Monosodium Glutamate on Biological Systems (Review)

CHEMISTRY

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ABSTRACT

Monosodium Glutamate (MSG) is one of the world's most extensively used food additives used in meats, poultry,seafood, snacks, soups and stews.MSG produces a flavour that cannot be provided by other foods. Most of the studies have been done on animals which have shown that MSG has Neurotoxic effects in brain, obesity ,metabolic defects, "Chinese restaurant syndrome" and harmful effects on sex organs. In humans the toxic effect of MSG has not been much reported.

Glutamate is one of the most common amino acids found in nature. It is the main component of many proteins and peptides, it plays an essential role in human metabolism.

MSG is the sodium salt of glutamate and is simply glutamate, water and sodium. MSG is produced in many countries around the world through a natural fermentation process using molasses from sugar cane or sugar beets, as well as starch and corn sugar .MSG contains only one-third the amount of sodium as table salt, sodium chloride. When small quantities of MSG are used in combination with a reduced amount of table salt during food preparation, the flavor-enhancing properties of MSG allow for far less salt to be used during and after cooking.

MSG may have following types of effects on biological systems.

Nervous System;Glutamate is the excitatory neurotransmitter in the mammalian central nervous system (CNS) playing an important role in both physiological and pathological processes (Mattson ,2008). Glutamate receptors are dispersed throughout the central nervous system including amygdala, hippocampus and hypothalamus where they regulate many vital metabolic and autonomic functions (Collison et al. 2012). MSG is used as an agent which in high doses causes neuronal necrosis in hypothalamic arcuate nuclei in neonatal rats (Pelaez et al. 1999). Although the toxic effects of MSG on the CNS have been shown in some animal studies, there are problems to apply these results` to human MSG intake.

Obesity; Most of the studies have been carried out in animals(rats). The potential link between MSG and obesity includes the MSG effect on energy balance by increasing palatability of food and by disrupting the hypothalamic signaling cascade of leptin action (He et al. 2011, Hermanussen and Tresguerres 2003).In animals MSG could induce liver injury likely as a consequence of incipient nonalcoholic steatohepatitis, contributing to inflammation.MSG intake may be linked to elevated serum free fatty acids, triglycerides, insulin and bile synthesis (Collison et al. 2010b). The studies showed that MSG diet influenced both hepatic and adipose tissue in both adult (Onyema et al. 2006, RomanRamos et al. 2011) as well as in offspring metabolism (Afifi and Abbas 2011, Collison et al. 2010b). Obesity after MSG diet in rats Is the result of leptin resistance (Dolnikoff et al. 2001), but in humans MSG could lead to obesity due to the increase in the intake of high caloric savory foods, in which MSG enhances liking resulting in learning reinforcement (Bannai and Torii 2013).

Chinese Restaurant Syndrome ;According to certain studies Monosodium glutamate is believed to be associated with CRS,it includes numbness or burning at the back of the neck, arms and sometimes into the anterior thorax, associated with a feeling of general weakness and palpitation ('Chinese restaurant syndrome' 1968). Followed by The symptoms of flushing, dizziness, syncope, and facial pressure (Geha et al. 2000). But certain studies have shown that MSG has little effect on CRS (Kerr et al. 1979), Headaches or other symptoms after Chinese food intake could be rather associated with exceptionally high concentrations of fat and sodium typical for Chinese restaurant meals (Freeman 2006).

Effect on Reproductive Organs; Most of studies has been done on animals,In male Swiss Albino mice subcutaneous administration of MSG had effect on primary spermatocyte (Das and Ghosh 2010). On increasing the dose of MSG administered at the same time to newborn rats resulted in the decreased weight of pituitary glands and testes and lowered testosterone level in 4 months old sexually mature male rats (Miskowiak et al.1993). In female Swiss Albino mice,subcutaneous injection of MSG effected ovarian tissue (Das and Ghosh 2011).Due to subcutaneous application and period of MSG administration it is somewhat difficult to get observations on humans.

Other Effects;

Few years back MSG intake have been proposed to effect several other systems. Also asthma was considered to be triggered by MSG.But certain reviews have shown that these studies did not have the robust experimental design and were not reproducible to bring the evidence that MSG is related to asthma response (Freeman 2006, Beausoleil et al. 2007). Also the recent study has shown that there is no connection between MSG and asthma in Chinese adults (Shi et al. 2012b). Several studies have brought evidence about the associations between MSG-induced obesity and other systems. A human study has found a positive association between MSG intake and hemoglobin increase only in men. The authors hypothesized that MSG effect could be mediated via leptin due to the potential role of leptin in hematopoiesis (Shi et al.2012a).It has also been shown that MSG influences are complex and its effects on particular system lead to the changes in the other system.

Prevention of MSG Toxic Effects;

Vitamin C has been shown to have a protective role against toxic nerve cell in male albino rats (Hashem et al. 2012).All antioxidants reduced MSG-increase in serum alanine aminotransferase, aspartate aminotransferase and γ-glutamyl transferase(Farombi and Onyema 2006). Similar results have been found in the study of vitamin E effects in rats fed by MSG .Quercetin has been shown to normalize HDLcholesterol,reduce insulin, leptin, glucose and creatinine levels and increased glutathione peroxidase and superoxide dismutase activities after MSG subcutaneous application (Seiva et al. 2012).

Conclusions

Monosodium glutamate (MSG) enhances the flavour of food. In numerous animal studies,toxic effects of MSG on central nervous system, reproductive organs , disturbances in metabolism with the increase in more parameters including insulin, fatty acids and triglycerides in serum has been observed. Also it affected the liver function resulting in oxidative stress in liver.MSG intake in human studies was associated with increased levels

of several circulating amino acids, however no changes in the postprandial glucose and insulin were found, which was in contradiction to animal studies. The relationship between MSG and increased haemoglobin was shown in men and MSG intake was somewhat associated with headache and subjectively reported pericranial muscle tenderness. Chinese restaurant syndrome and asthma were not proved to be associated with MSG intake. Vitamin C, vitamin E, quercetin and diltiazem had protective effects on MSG-induced toxic changes.MSG brings out the best natural flavors in food, working well in reduced-sodium and reduced-fat dishes and can reduce total sodium by 30 to 40 percent without influencing palatability.

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