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AJIMOMOTO (MSG): A FIFTH TATSE OR A BIO BOMB

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ABSTRACT

This review assesses many of the health implications associated with monosodium glutamate (MSG) in humans and animals. MSG is the sodium salt of glutamic acid and has been used all over the world for its flavor enhancing properties. The prevalence of this salt as a food additive in Asian cuisine and other diets makes MSG a relevant aspect of the human diet worldwide. It increases the appetite by stimulating the appetite centre but nowadays it has been debated for its safety and harmful effects as it affect almost every major organ in the body. The studies on experimental animals have confirmed toxic effect of MSG in different organs, mainly manifested by increased oxidative stress, cytotoxicity, immunosupresion, reproductive toxicity(males and females), obesity, asthma, autism and numerous other ailments. For thirty years, scientists and researchers have used MSG in their experiments to purposely create obese and pre-diabetic test subjects, trigger epileptic seizures, create ischemic strokes, produce oxidative stress, neurobehavioral abnormalities and destroy cell tissues in vivo and in vitro. Additionally, MSG is known to produce impairment in memory retension, damage in the hypothalamic neurons, alterations in mitochondrial lipid peroxidation and antioxidant status in different regions of brain. Beside this MSG induces a shift in the carbohydrate metabolism towards lipogenesis leading to hyperlipidemia and hyperglycemia. Furthermore, MSG induced oxidative stress in erythrocytes, liver, kidney, heart and brain of experimental animals has also been documented. Debate over the healthiness of MSG and its associated health problems has led to a negative public opinion of the additive. Present review make it safe to conclude that MSG has the potential to create several health hazards and thus advocates strict guidelines and mass awareness regarding its use.

KEYWORDS: Ajinomoto, cytotoxicity, cognitive deficits, mono sodiium glutamae, obesity.

INTRODUCTION

Food additives have been used to keep the quality, texture, consistency, taste, color, alkalinity or acidity of foods to make them more acceptable to the users. Their use has reached alarming proportions and humans are daily exposed to these chemical substances in their foods without defining the exact and safe limit. Kombu and other seaweeds were added to food in Japan to enhance flavor, since thousands of years ago. In 1908 a Japanese scientist discovered that the active ingredient in kombu is glutamic acid. Glutamic acid is one of the most abundant amino acids found in nature and exists both as free glutamate and bound with other amino acids in protein. Animal proteins contain 11–22% by weight of glutamic acid and the plant proteins have as much as 40% glutamate. Glutamate is found in a wide variety of foods and as a result of its flavour enhancing effects, glutamate is often deliberately added to foods usually as purified monosodium salt called monosodium glutamate or MSG.[1] It can produce a unique taste that improve the quality of food intake by stimulating chemosensory perception and proposed in various types of patients with cancer, radiation therapy and organ transplantation to improve appetite.[2] It is also used intravenously as an adjunct in the treatment of encephalopathies associated with hepatic disease.[3]

MSG (C 5 H 8 NO4Na) contains 78% of glutamic acid, 22% of sodium and water.[4] The number of foods that contain MSG is astounding. It is present in chips, cold cuts, fresh produce that has been sprayed with pesticide, gelatin and in virtually every food served in every fast food restaurant in the United States. Jelly, Pastry, Candy, Biscuit, Fruity, Bread, Chocolate, Juice, Cerelac, Jam, Burgerburger, french-fries, pizza, cold drinks, noodles, chocolate etc contain MSG. The most alarming fact is the food industry increases the amount of MSG put in our food every year.[5]

MSG has a distinctive taste that falls outside the region of the four classic tastes: sweet, sour, salty and bitter. This taste is called “Umami,” also referred to as “XienWei” in Chinese or “savory, “broth-like” or “meaty taste” in English. During the Second World War American quarter masters noticed enhanced taste of Japanese army rations. They introduced monosodium glutamate to the food industry after the war.[6]

It was subsequently patented by Ajinomoto Corporation of Japan in 1909. In its pure form, it appears as a white crystalline powder that as a salt, dissociates into sodium cations and glutamate anions while dissolving (glutamate is the anionic form of glutamic acid).[7] MSG is used with trade names such as Ajinomoto, Vetsin, Ac'cent and Tasting Powder. It was once

made predominantly from wheat gluten, but is now made mostly from bacterial fermentation.[8] High daily intake of MSG results in accumulation and rise of glutamic acid concentration in blood.[9] The protein bound glutamate become free only after it goes to small intestine, hence the glutamate as bound of protein has no such effects of enhancing the taste of food at this level. Recentevidence suggests that taste and palatability are mediated through specific glutamate receptors locatedon the taste buds and in the stomach.[10] and plays physiologic actions beneficial to gut function bystimulating the gastric vagus nerve. Based on this MSG was started being used as a food additive andnow this is one of the world's most extensively used food additives which is ingested as part of commercially processed foods.[11]

Glutamic acid primarily serves as an important excitatory neurotransmitter in central nervous system but it also serves as an energy source for certain tissues and as previously reviewed as a substrate for glutathione synthesis.[12] These effects of glutamic acid are carried out via multiple receptor types, namely ionotropic (iGluR) and metabotropic glutamate receptors (mGluR). iGluR are pharmacologically defined as NMDA, AMPA and kainate receptor, while mGluR consists of so far eight defined different receptors. Glutamate receptors are present in the central nervous system, mouth, lungs, intestines, muscle and other "peripheral"locations. This electrical firing of neurons makes food with added free glutamic acid taste good.

Free glutamic acid can cause problems. Brains have many receptors for glutamic acid and some areas, (eg. hypothalamus) do not have an impermeable blood-brain barrier. Thus free glutamic acid from food sources can get into the brain, injuring and frequently killing neurons and also many allergic reactions have been reported.[13] These observable reactions range from mild and transitory to debilitating and life threatening. The first published report of an adverse reaction to MSG appeared in 1968.[14] The first evidence that MSG caused brain damage in the form of retinal degeneration was published in 1957 [15] and the first published report of brain lesions, obesity, and other disturbances in mice treated with monosodium glutamate was published in 1969.[16] Currently, the safe concentration of MSG in foods and its toxicity in human is still a controversial issue.[17]

Though MSG improves taste stimulation and enhances appetite, reports indicate that it is toxic to human and experimental animals.[18] The Food and Drug Administration (FDA) categorized MSG as a safe substance in 1959. However, the FDA commissioned a report that an unknown percentage of the population might react to MSG and develop MSG symptom complex.[19]

All commercially produced glutamic acid is termed "MSG". Glutamic acid is a non-essential amino acid, i.e., the body can produce its own glutamic acid, and does not depend upon getting glutamic acid from ingested food. Food manufacturing and chemical plants produce glutamic acid commercially. However glutamic acid, produced outside the body (for use in food, drugs, dietary supplements, cosmetics, fertilizers, personal care products, etc), can cause brain lesions,neuroendocrinedisorders, learning disabilities, neurodegenerative diseases and many adverse reactions in humans and animals.[6] MSG when consumed in large quantities may have effects on cell growth, chromosomes and may lead to cancer.[20,21] Furthermore, long-term intake of MSG was shown to induce hyperphagia, obesity, asthma, memory impairment and damage to hypothalamic neurons.[22] Findings from research on neurotoxicity and on injury to the developing infant's endocrine system made baby food industry voluntarily remove monosodium glutamate from their products in the early 1970s. But they often left free glutamic acid in their products, as "autolyzed yeast and hydrolyzed vegetable protein (HVP)". Today free glutamic acid is ubiquitous in processed food. Thus, the addition of MSG to foods can ultimately be considered a health hazard.[23] MSG has some other effects that include retinal degeneration, endocrine disorder and some pathological conditions such as addiction, stroke, epilepsy,brain trauma, neuropathic pain, schizophrenia, anxiety, depression, Parkinson’s disease, Alzheimer’s disease, Huntington’s disease and amyotrophic lateral sclerosis.[4] It cannot be stated that MSG is the cause of such varied conditions as epilepsy and Alzheimer’s disease, although there may be concerns of its involvement in their etiology.[24]

Free Glutamic Acid Reactions in Sensitive People include Arrhythmias, rise or drop in blood pressure, tachycardia, Angina, Flu-like achiness, Joint pain, Stiffness,Dizziness, Light-headedness, Loss of balance, Disorientation, Mental confusion, Anxiety, Panic attacks, Hyperactivity, Behavioral problems in children, Lethargy, Sleepiness, Insomnia, Migraine headache. Numbness or paralysis, Slurred speech),Diarrhea, Nausea/vomiting, Stomach cramps Irritable bowel, Bloating etc. The respiratory complications include asthma, shortness of breath, chest pain, tightness, Runny nose, Sneezing Skin (Hives or rash).[25]

Since free glutamic acid is cheap and since its neurotoxic nerve stimulation enhances so wonderfully the flavor of basically bland and tasteless foods, such as many low-fat and vegetarian foods, manufacturers are eager to goon using it and do not want the public to realize any of the problems.[25] Thus MSG is being added in common food stuffs under

different names most probably to keep people unaware of its presence and possibly of its avoidance. Names of ingredients that always contain processed free glutamic acid: include Any“hydrolyzed protein, Calcium caseinate, Sodium caseinate, Yeast extract, Torula yeast, Yeast food,Yeast nutrient, Autolyzed yeast Gelatin. Anything “hydrolyzed”Any “hydrolyzed protein”Calciumcaseinate, Sodium caseinate, Yeast extract, Whey protein, Whey protein concentrate,Whey proteinisolate, Soy protein, Soy protein concentrate, Soy protein isolate. Anything “protein”, Anything“protein fortified”Soy sauce, Soy sauce extract. Anything “enzyme modified”, Anything containing“enzymes”, Anything “fermented”Anything containing “protease”, Vetsin, protein, Whey protein,Whey protein concentrate, Whey protein isolate. Protein powders contain glutamic acid, which,invariably, will be processed free glutamic acid (MSG). Individual amino acids are not always listed onlabels of protein powders. If you see the word “protein” in an ingredient label, the product contains MSG. Beside them following are ingredients suspected of containing or creating sufficient processed free glutamic acid to serve as MSG-reaction triggers in HIGHLY SENSITIVE people: Corn starch, Corn syrup, Modified food starch, Lipolyzed butter fat, Dextrose, Rice syrup Brown rice syrup, anything “enriched”, anything “vitamin enriched”, anything “pasteurized”AnnattoVinegarBalsamic vinegar certain amino acid chelates (Citrate, aspartate, and glutamate are used as chelating agents with mineral supplements.[26]

The optimal palatability concentration for MSG is between 0.2 and 0.8% with the largest palatable dose for humans being about 60 mg/kg body weight.[27] However,there are claims that there has been suppression of information on the toxicity/safety of MSG.[4] Although there is no problem if MSG is present in small amounts in any one food, the problem moves to a much graver scale if small amounts are in different common foods that are consumed daily. Moreover, MSG might fall under different titles (as listed above), making it very difficult to determine what foods contain this additive.[28]

The estimated average daily MSG intake per person in industrialized countries is 0.3– 1.0 g, but it depends on the MSG content in foods and an individual’s taste preferences.[29] A typical Chinese restaurant meal contains between 10 and 1500 mg of MSG per 100 g.[30] The oral dose that is lethal to 50% of subjects (LD 50) in rats and mice is 15.000– 18.000 mg/kg body weight.[31] According to a joint inquiry by the governments of Australia and New Zealand in 2003, a typical Chinese restaurant meal contains between 10 and 1500 mg of MSG/100 g.[32] Because food processors and manufacturers do not have to list the amount of MSG on their

packaging, we have no way of knowing what a normal person or child would ingest in a days period. According to industry research 0.6% MSG added to food is optimal for making people eatprogressively more and faster If this is the case, as much as .6% of a person's daily diet could be made up of MSG. In a daily intake of 2kgs of laced food the adultor child would receive a 12 gram dose of Monosodium Glutamate. A 12 gram dosage of MSG is lethal to a one kg rat.[33] The mechanism of glutamate toxicity remains unknown but several studies have proposed an apoptotic pathway.[34] Surprisingly, in Nigeria, most communities and individuals often use MSG as a bleaching agent for the removal of stains from clothes. After that there is a growing apprehension that its bleaching properties could be harmful or injurious to the body, or worse still inducing terminal diseases inconsumers when ingested as a flavour enhancer in food. Despite evidence of negative consumer response to MSG, reputable international organizations and nutritionist have continued to endorse MSG.[24]

This review assesses many of the health implications associated with MSG in humans and animals. The effects of MSG on different systems and its potential pathological influence on different organs is assessed.

1. EFFECTS ON CNS

A study reports that MSG consumption may have some deleterious effects on the cerebellum of adult wistar rats at higher doses and may affect the functions of the cerebellum and lead to tremor, unstable and uncoordinated movement, and ataxia.[35] According to Samuels (1999), the evidence of toxicity is overwhelming. Exposed laboratory animals suffered brain lesions and neuroendocrine disorders.[36] A dose-dependent action of MSG in the developing brain, characterized by significant microglial reaction in the cerebral cortex is also reported. The study indicates that MSG can influence cortical excitability, during brain development and the reported data suggest caution when consuming MSG, especially in developing organisms.[37]

MSG is also used to produce neurotoxicity in an experimental model. In a study, oraladministration of 2.5 g/kg body weight of MSG for 14 days resulted in degeneration and loss of corticalneurons particularly the Purkinje cells.[38] MSG (2 g/kg body weight) dissolved in physiological saline solution or sodium chloride solution at an equimolar concentration (control group) was injected intraperitonealy (i.p.) for 7 consecutive days, which significantly reduced body weight, locomotor activity, muscle grip strength and foot fault in rats.[39] These finding are consistent with earlier reports showing a variety of neurobehavioral abnormalities

and motor deficits in rats following MSG administration.[40]

MSG, in high doses causes neuronal necrosis in hypothalamic arcuate nuclei in neonatal rats.[41] However, MSG effects are more extensive and not limited to hypothalamic area. MSG (4 mg/g, subcutaneously, on post- natal days 1, 3, 5 and 7) led to prefrontal cerebral cortex changes, including fewer neurons, shorter and less ramified dendritic processes.[42] and loss of cortical cell number from postnatal day 8-14 compared to control rats. The same dose of MSG injected subcutaneously on days 2, 4, 6, 8, and 10 of postnatal life resulted in 30% and 40% reduction of pituitary weight in ages of 6 and 12 months respectively.[43] Furthermore, numerous studies have shown that neonates treated with MSG exhibited neuronal cell death with reduction of photoreceptor and glial cells.[44,45]

2. EFFECT ON COGNITIVE FUNCTIONS

MSG, has been shown to be toxic to neurons in vivo [46] and in vitro.[47] This neurotoxicity ofL-glutamate has been implicated both in the acute degenerative changes that occur after status epilepticus, hypoglycemia, ischemia and trauma and in such chronic neurodegenerative disorders as Huntington's disease, olivopontocerebellar atrophy, Alzheimer's dementia, Parkinsonism, andamyotrophic lateral sclerosis (ALS).[48]

Glutamate is one of the most abundant amino acids in the central nervous system (CNS). It exist in atypically high concentration in brain regions that are critical in the mediation of cognitive performance such as cerebral cortex, dentate gyrus of hippocampus and striatum [49] indicating the amino acid plays an important role in higher cognitive functions including memory formation.[50] Glutamate is important in synaptic plasticity, learning, and development. Over the last four decades, a direct correlation between the neuroexcitatory and neurotoxic properties of glutamate has been linked to activation of excitatory amino acid receptors. This stimulation leads to an enzymatic cascade of events ultimately resulting in cell death.[51]

Interactions of glutamate with its ionotropic, mainly NMDA, receptors have been found to lead to neurotoxic changes in some experimental situations by allowing excessive amounts of calcium to enter the neuron.[52] Glutamate’s activity at the synaptic cleft is carefully balanced by receptor inactivation and glutamate re uptake. When this balance is upset, excess glutamate can itself become neurotoxic.[51]

Park and his colleagues in 2000 found that single intraperitoneal injection of 4.0 mg/g bodyweight of MSG caused significant damage to hypothalamic neurons in the arcuate nucleus and impaired memory retention in adult mice.[49] in another study subcutaneous administration of 4.0 mg/g bodyweight of MSG to male neonate rats induced excitotoxicity, leading to cell death in prefrontal cerebral cortex. Another study using also high dose glutamate (4.0 mg/g body weight) reported reactivity of astrocytes and glial cells in the fronto-parietal cortex, including hyperplasia and hypertrophy. While MSG's similarity to glutamate might be the reason for its neurotoxicity, it is important to note the extremely high dosage administered in these animal studies. The study concluded that acute administration of monosodium glutamate has a retardant effect on novelty induced behaviors in male mice.[53]

3. MSG- CYTOTOXICITY AND GENOTOXICITY

In a study on Alium cepa, MSG have inhibitory or stimulatory effect on the cell cycle on Allium root tip cells which is an indication of likely toxicity by MSG. In the experiment, MSG induced decreased mitotic index. This might occur at pre-prophase where cells are prevented from entering. This reduction in mitotic cell division, probably suggests that it may be a potential harmful food flavor enhancer.

Furthermore, they may bind to tubulin and prevent the formation of the mitotic spindle. BakareandAdeyemo (2004) have reported that there was gradual decrease in the number of chromosome aberrations at higher MSG concentration. This suggests increased toxicity and an inhibitory effect on metaphase and anaphase stages of cell division. In conclusion, MSG has potential cytotoxic and genotoxic effects in the root tip cells of A. cepa.[54]

It can lead to certain irreversible cytogenetic effects in plants and even in higher organisms. Further research should be conducted for the comparison of result from other test systems used to detect genotoxic potential of chemicals(cell line, micronucleus analysis of human lymphocytes,comet assays or single cell gel electrophoresis.[55]

4. MSG AND POSSIBLE INFLUENCE ON APPETITE AND OBESITY

Today, obesity becomes endemic; about 1.7 billion people on the planet are overweight. World Health Organization has declared obesity a global epidemic. Metabolic disturbances in obesity causes a number of diseases, namely, cardiovascular diseases (hypertension, atherosclerosis, coronary heart disease), stroke, insulin-dependent diabetes, premature death, diseases of musculo-skeletal system (osteochondrosis and metabolic-dystrophicarthritis),

hepatobiliary disease (gallbladder dyskinesia, chronic cholecystitis, cholelithiasis) and number of tumor sites, including lung cancer, breast cancer, uterine cancer and ovarian; in women, there is a violation of ovarian-menstrual cycle dyslipidemia. Obesity reduces life expectancy by 3 to 5 and, sometimes, in severe forms, for 15 years.

Obesogenic properties of monosodium glutamate were studied for decades. The arcuate nucleus contains neuron bundles that are associated with neuroendocrine functioning, specifically human growth hormones, as well as subject to the effects of leptin and insulin inhibition that is known to affect appetite and the amount of food consumption. Leptin is a protein hormone involved in the regulation of appetite and metabolism. Leptin is produced mainly by white adipose tissue and its levels are related to the amount of adipose tissue and affects both food consumption and hunger. Adiposity refers to the amount of fat found in adipose tissue.[56]

The amount of consumption of MSG could play a role in weight gain. Glutamate relays signals between the brain, nervous system, and digestive system. Many studies suggest that the scarring of the arcuate nucleus of the hypothalamus indirectly contributes to the increase in adiposity and body mass measured in rats and humans, as well as facilitating leptin resistance and the level of food consumption.[57]

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.[58] The inflammatory basis of MSG-induced obesity was demonstrated in the 19 th weeks old rats which were treated by subcutaneous injections of 2 mg/g of MSG on postnatal days 2 and 4 and by subcutaneous injections of 4 mg/g on postnatal days 6, 8 and 10. MSG increased mRNA expression of interleukin-6, tumor necrosis factor-alpha, resistin and leptin in visceral adipose tissue, it increased insulin, resist in and leptin levels in serum and it also impaired glucose tolerance.[59] MSG increased the expression of several genes implicated in adipocytes differentiation, elevated serum free fatty acids, triglycerides, insulin and bile synthesis.[60] There are the findings of elevated aspartate aminotransferase and alanine aminotransferase in adult male Wistar rats treated with 0.04 mg/kg and 0.08 mg/kg of monosodium glutamate mixed with the grower's mash for 42 days, with degenerative changes on the liver and dilatation of the central vein.[61] A decrease in thermogenesis and metabolism, regardless of the underlying mechanism, is the most likely explanation for why MSG leads to weight gain and BMI increases.[62]

5. EFFECT ON IMMUNE SYSTEM

By enabling a continuous intake of high amounts of MSG, modern nutrition can increase the oxidativestress and result in cytotoxicty in many organs, especially in thymus.[22] Numerous findings indicated asignificant expression of glutamate receptors on immune cells. The possible relationship between glutamate concentrations and lymphocyte reactivity has been documented.[63] as well as the inhibitory effect on lymphocyte proliferation. The latter effect is probably mediated by mGluR5 activation.[64] It increases the intracellular calcium level and via several reactions, it leads to programmed cell death. Recent findings demonstrate that MSG inhibits the in vivo and in vitro proliferation of thymocytes while the inhibition depends on dose and time. Furthermore, these studies demonstrated that the inhibited thymocyte proliferation was due to a decrease in cell viability, while thymocytes die via apoptotic mechanism under both in vitro[65] and in vivo conditions.[66] High MSG-induced cytotoxicity was also documented in liver, kidney and brain, the fact of which indicates that MSG plays a possible role in inducing immune disorders as well as various chronic diseases. One of the mechanisms involved in MSG-induced thymocyte apoptosis was the down-regulation of Bcl-2 protein expression, while the level of Bax protein has not been changed.[65,66] MSG-induced apoptosis and altered level of Bcl-2protein in thymocytes are also related with oxidative stress. Namely, the treatment of animals with MSG resulted with an increase in oxidative stress within the kidneys, liver, brain and thymus (and presented the possible mechanism of cell toxicity.[34] The excessive generation of oxygen reactive species (ROS) in cells is known to damage DNA, lipids and proteins. Lipid peroxidation in cellular membranes damages the polyunsaturated fatty acids especially in lymphoid cells, and sensitizes T cells to apoptosis by decreasing the expression of Bcl- 2 protein.[67]

6. EFFECT ON REPRODUCTIVE ORGANS

MSG administration in newborn rats resulted in the decreased weight of pituitary glands andtestes and lowered testosterone level in 4 months old sexually mature male rats.[68] MSG has a toxic effect on the testis by causing a significant oligozoospermia and increase abnormal sperm morphology in a dose-dependent fashion in male Wistar rats.[69]

It has been implicated in male infertility by causing testicular hemorrhage, degeneration and alteration of sperm cell population and morphology.[70] Moore[71] reported that MSG affects the structure and function of male reproductive system and showed to be toxic to the testis of human and experimental animals. Boodnard et al.[72] mentioned that administration of MSG

to rats led to atrophic changes in the testis and destruction of Sertolli cells and Leydig cells.Nayatara et al. recorded MSG reduction in testicular weight and decrease in the sperm count in rats treated with MSG. Treating rats with MSG caused decrease in testicular weight, decrease in tubular diameter, reduction in germinal epithelium height, decrease in the spermatic count and abnormalities of sperms morphology.[73]

7. EFFECTS ON HEMATOLOGICAL PARAMETERS

All doses of MSG administered showed significant decrease in neutrophil count and the decrease is higher in the groups that received treatment for longer daysin a study. This might be that MSG has a direct toxic effect on the neutrophils in the blood or it has a deleterious effect on blood production in the bone marrow, especially on the progenitor cells (aplasia) and that it is time-dependent. Neutrophils along with monocytes provide the first line of defense against invading micro organism, toxic substances, and foreign substances emphasizing the important role neutrophils play in the body defense.[74] While alterations in counts of Hb and RBC were all indicative of anemic conditions in the treated animals. Hence, these findings support the fact that mono-sodium glutamate despite its flavoring functions is detrimental to health.[75]

8. EFFECT ON VISION

Like the brain, there are glutamate receptors in the human eye. According to the article “MSG Found to injure Retina, Damage Eyesight,” in an experiment conducted in Japan, a group of rats were put on a diet high in MSG for six months. The rats’ retinal nerve layers thinned by up to 75 percent. At the end of the six months, all of the rats had severe vision impairment, simply because their diet was high in MSG.[76]

9. MSG CROSSES THE PLACENTA ENDANGERING THE FETUS

MSG has been shown to cross the placental barrier in rats, and new studies suggest that in cases where human mothers who suffer from intrauterine infection are at risk to Glutamate causing excitotoxic perinatal brain injury to the fetus: Monosodium-L-glutamate given subcutaneously to pregnant rats caused acute necrosis of the acetylcholinesterase positive neurons in the area postrema. The same effect has been observed in the area postrema of fetal rats.The process of neuronal cell death and theelimination of debris by microglia cells proved to be similar in pregnant animals and in their fetuses.

However, embryonal neurons were more sensitive to glutamate as judged by the rapidity of the process and the dose-response relationship. These observations raise the possibility of transplacental poisoning in human fetuses after the consumption of glutamate-rich food by the mother.[77]

10. EFFECTS ON LIVER AND KIDNEY

Liver is the largest gland in the mammalian body. The hepatocytes have metabolic functions that deal with very essential processes such as detoxification, deamination, transamination, removal of ammonia in the form of urea, biosynthesis and release of the non-essential amino acids and plasma proteins with the exception of immunogamma globulins, gluconeogenesis, storage of glycogen, conversion of carbohydrates and proteins into lipids, synthesis of lipoproteins, phospholipids and cholesterol, oxidation of fatty acids, storage of iron in the form of ferritin as well as storage of vitamins A, D and B12.

The Kidney is a paired organ located in the posteriorabdominal wall, whose major functions include the removal of toxic metabolites and waste products from the blood and regulation of the amount of fluid and electrolytes balance in the body. To test functions of the kidneys routine urinalysis is used to measure serum urea,creatinine, sodium and potassium and serum bicarbonate. A significant increase in the liver and kidney weight of the rats was observed after administration of MSG at two employed doses. Thus, could be attributed to an increase in activity of inflammatory agents that could have resulted to inflammation of liver and kidney tissues.[78]

The results of the investigation have shown that mono-sodium glutamate (MSG) at low doses is capable of producing alterations in the body weight and liver and kidney functions. These alterations appear in the liver and kidney probably because these organs are mainly responsible for detoxification of foreign compounds in the body. The results showed that MSG at doses of 0.6 and 1.6 mg/g of body weight may cause an adverse effect on the hepatic and renal functions which might be due to oxidative stress induced by MSG on the liver and renal tissue.[79]

11. EFFECTS ON PITUTARY FUNCTIONS

Pro-opiomelanocortin (POMC) is a hormone precursor produced mainly in the hypothalamus and pituitary gland. In the pituitary, post-translational processing of POMC generates secretory peptide hormones – principally, the adrenocorticotrophic hormone. This result has

demonstrated that MSG has different effects on POMC gene expression between pituitary gland and pituitary tumor cells. This suggests that MSG has a neuronal excitatory effect on pituitary functions that enhances POMC gene expression by increasing the stress input through the central nervous system in response to high doses of MSG treatment.[80]

12. MSG INDUCED PHYSIOLOGICAL STRESS

A study found significant decrease in the red blood cell and white blood cell counts and decrease in hemoglobin concentration of the whole blood of the MSG treated groups of rats. The concentration of hemoglobin depends on the RBC counts in whole blood. The hemoglobin concentration decreases with the reduction in RBC count that impairs the hematopoietic process in the bone marrow that causes speciation of blood cells, specially the RBC and WBC; and causes the release of blood cell species to the peripheral blood circulation. MSG may suppress the hematopoietic system presumably by exerting cytotoxicity in pluripotent stem cells in bone marrow that undergoes to speciation through mitosis. These results suggest that exogenous glutamate affects the metabolic profiles in body presumably by altering glutamate mediated signal transduction mechanism. The cardiovascular risk factors like total cholesterol. LDL- cholesterol and triglycerides have been increased in MSG treated rats. On the other hand the concentration of cardiovascular protective metabolites like HDL-cholesterol is decreased in MSG treated rats. From the results it may be suggested that MSG enhance the cardiovascular risks by increasing the concentration of cardiovascular risks metabolites. In our study we found significant increase in glucose concentration in the MSG treated animals. This might be due to inhibition of the entry of glucose into the cells either by the deficiency of insulin or by insulin insensitivity; or by the increase in glycogenolytic activities in the liver. From the study it may be concluded that MSG suppresses the physiologic functions of the organ systems by reducing the availability of oxygen in tissues through the inhibition of the production of red blood cells, the cell mediated immunity by suppressing the production of WBC, and by increasing the cardiovascular stress as a result of the induction of metabolism related to the production of cardiovascular risk metabolites with the active involvement of the hypothalamic hunger-satiety neuronal pathways.[81] Apart from these plethora of effects MSG is also a trigger of asthma, headache and migraine.

CONCLUSION

There are very few chemicals that people are exposed to, that have as many far reaching physiologicalchanges on living beings as Monosodium Glutamate does. MSG directly causes obesity, diabetes, triggers epilepsy, destroys eye tissues, is genotoxic, proasthamatic etc. etc. MSG's only reported role in food is that of 'flavour enhancer.' Is that use worth the risk of the myriad of physical ailments associated with it? Does the public really want to be tricked into eating more food and faster by a food additive? Multinational companies and big brands have made us so much accustomed to these products and public at large has been kept ignorant regarding associated health risks.We have started using these substances in abundance and by discarding the natural products that are easily available from nature we have endangered our life but life of coming generations too. Unfortunately, we have attached to them the tag of status symbol goods. If we don't use such products, we are looked down upon as backward by our own society. The children afflicted with such symptoms will be born with physical and mental handicaps. Just like in Hiroshima and Nagasaki (impact of Atom Bomb) and Bhopal (MIC tragedy) where the progeny was and is still being affected by aftermaths of these events, It is not unlikely to be said that our exposure to MSG will have disastrous impact on our progeny as well.

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