REVIEW OF STUDIES WITH EFFECTS OF MSG IN LIVER, KIDNEY AND OTHER TISSUES IN ANIMAL MODEL

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ABSTRACT

A naturally found excitatory neurotransmitter, known for its UMAMI taste, is Monosodium Glutamate (MSG). It was known to be safe prior to 1950. People were enchanted with the delicious recipes of some of the restaurants in Far East. Regular restaurant visitors started getting trouble with particular food items. These food items had MSG as one of the chief ingredients. In 1968, an author described the Chinese restaurant syndrome (Kwok’s Disease) with symptoms of headache, chest discomfort and facial flushing. Since then several researchers launched extensive research projects in search of toxic role of MSG in human beings. It was documented in late 60s that MSG produces oxygen derived free radicals as evidenced by increased lipid peroxidation products and disturbance of central endocrine axis affecting wide spread areas in body along with causing learning difficulty and obesity in children, irreversible hepatic damage and gonadal dysfunction. An attempt is made to review the studies with effects of MSG in liver, kidney and other tissues in Animal model.

Keywords: Monosodium Glutamate, Kwok’s Disease, Neurotransmitter.

INTRODUCTION

Although most of the body tissues are affected by MSG but liver, as chief metabolic centre and kidney as chief organ of excretion, have been main targets of researchers after central nervous system.

Hamaoka & Kusunoki studied the growth pattern of visceral organs in monosodium L-glutamate treated obese mice having hypothalamic lesion. After subcutaneous injections of MSG (2mg/g b.w. for 5 days) to neonatal mice they found reduction of the weights of kidney, heart and testes while they observed weight of liver to be low up to 12 weeks and identical with control mice thereafter which they attributed to occurrence of fatty change in a hypoplastic liver [1].

Malik et al. (1994) observed significant increase in content of total lipids, phospholipids, triglycerides and free fatty acids in liver of adult male mice 31 days after the last injection of MSG (2 mg, 4 mg and 8 mg/g of b.w., for 6 days). They also observed shifting of carbohydrate metabolism towards lipogenesis leading to hyperlipidemia [2].

Yoshida et al found that MSG treated (2mg/g b.w., s.c.) mice became obese 9 weeks after birth and were found with higher blood levels of glucose, total cholesterol, HDL-cholesterol, GPT and cholinesterase along with greater triglyceride content of liver relative to control mice. They noted marked fatty change in liver of ‘MSG obese’ mice. In another set of ‘MSG obese mice’ they observed that high fat diet with probucol for 2 weeks significantly reduced the development of fatty liver [3].

Choudhary et al observed increased level of calcium, ascorbic acid and lipid peroxidation products in hepatic microsomes after subcutaneous injection of MSG (4 mg and 8 mg/g b.w. for 6 days) to adult mice. They also found decreased glutathione content and increased activities of enzymes like superoxide dismutase, indicating oxidative stress in hepatic microsomes in treated mice [4].

Diniz et al did a study on adult male Wister rats that were fed with MSG along with standard diet. They observed a rise in voluntary food intake and food conversion ratio. They concluded that MSG caused overfeeding that induced metabolic disorders associated with oxidative stress in absence of obesity that could be reduced by supplementation of dietary fibres [5].

Al-Agha carried out a study to demonstrate toxic effects of oral administration of MSG (2 mg/g b.w. and 3 mg/g b.w.) in adult albino rats. He found dose depended damage to kidney that included loss of brush border of proximal tubules, necrotic changes in tubular lining, infiltration of inflammatory cells in interstitium,
shrinkage and diffuse hyaline thickening of capillary endothelium [6].

Kaledin et al observed reduction in incidence of liver tumor nodule formation by diethyl nitrosamine (known carcinogen) after a prior exposure of neonatal mice to MSG (2 and 4 mg/g of body weight on alternate days from 1st to 9th day after birth) substantiating anti-tumorigenetic role of MSG. They also found reduction of body size, weight of testes and seminal vesicles and increase in fat content of body which they attributed to disturbance of functional activity of sex steroids and other hormones taking part in the regulation of metabolism of body fat and energy [7].

Ortiz et al administered MSG by high intraperitoneal dose that caused appearance of epileptic seizures in Wister rats. On sacrificing the animal 15, 30 and 45 minutes after the seizure they found increase in serum concentration of Alanine aminotransferase, aspartate aminotransferase and lipid peroxidation products (as evidence of oxidative stress) along with degenerative changes in liver and kidney [8].

Farombi et al examined the modulatory role of dietary antioxidants vitamin C, vitamin E and quercetin on MSG (injected at a dose of 4 mg/g b.w. intraperitoneally) induced oxidative damage in liver, kidney and brain of rats. They also documented preventive role of simultaneously administered dietary vitamin C and quercetin on genotoxicity of MSG in bone marrow of rats [9].

Onyema et al found hepatotoxicity in young rats induced by gavage of MSG for ten days (0.6 mg/g b.w.). They found that on simultaneous administration of vitamin E at a dose of 0.2mg/g b.w. there was amelioration of the MSG induced lipid peroxidation evidenced by a several biochemical parameters indicating reduction in reactive oxygen species (ROS) in liver [10].

Eweka and Om’Iniabohs studied the effect of oral administration of MSG on the kidney of adult rat. MSG at a dose of 3 g and 6g in two batches of rats respectively (each weighing 185 g), was fed with growers’ mesh for fourteen days. They found dose dependant distortion of cytoarchitecture of renal cortex in the form of reduction in Bowman’s space and number of renal corpuscles with stromal vacuolation and distortion of renal corpuscles [11].

Eweka and Om’Iniabohs also studied the effect of oral administration of MSG in a dose of 3 g and 6 g in adult Wistar rats. MSG was given with growers mesh for fourteen days. Exposed rats after sacrifice on fifteenth day of experiment showed dose dependent cyto-architectural distortions, atrophic and degenerative changes in hepatocytes along with dilatation of central veins [12].

**Review of studies showing effect of MSG in other tissues**

Lechan et al studied the synthesis of luteinising hormone releasing factor and thyrotropin releasing factor in the hypothalamus of MSG treated neonatal albino mice. They found marked reduction in the number of neuronal cell bodies within arcuate nucleus of hypothalamus [13].

Pizzi et al found that neonatal administration of MSG in male and female mice manifested in reduced reproductive ability in adulthood. They experimented with both sexes of mice by injecting MSG in a gradually increasing dose ranging from 2.2 - 4.2 mg/g of b.w. starting from 2nd day to 11th day of neonatal life. They observed that there was impairment of hypothalamo-hypophysial regulation of reproductive function [14].

Kuznetsova et al observed that neonatal administration of sodium glutamate (2 mg/g of b.w. alternate day for 5 days) decreased the motor and investigative activity, anxiety and sexual motivation and increased basal corticosterone in adult mice [15].

Dhindsa et al with doses of 2 mg/g, 4mg/g and 6mg/g of MSG studied the histogenesis of bone and bone marrow after subcutaneous, intraperitoneal and oral administration of MSG in mice. They found repression of ossification of developing endochondral bone and massive accumulation of adipose tissue with receded haemopoietic tissue within bone marrow [16].

Rigdon et al observed that administration of high doses of MSG to rats during first postnatal week resulted in severe loss of retinal ganglion cells and interneurons [17].

Bouvier et al observed that uptake of glutamate into retinal glial cells helped to terminate its neurotransmitter action by keeping its extra cellular concentration below neurotoxic level [18].

Kubera et al found that treatment with MSG in neonatal mice and rats significantly reduced cell mediated immunity in the form of decreased host versus graft reactions. Babu et al claimed that generation of free radicals was the cause of damage to circumventricular organs of the brain of mice [19].

Fajrman et al. (1995) reported an excitatory amino acid transporter protein for L-aspartate and L-glutamate in cerebellum of frogs that maintained extra cellular glutamate concentration below excitotoxic levels and claimed that it might limit the activation of adverse reproductive outcome of MSG [20].

McCall et al claimed that hyperosmolarity was a prerequisite for MSG induced neurotoxic changes in brain of rat, based on their observation that brain lesion was not induced in animals fed with excessive doses of MSG with free access to water [21].

Tsukahara et al found that ‘MSG induced obese mice’ were unable to maintain body temperature on cold exposure. They explained it to be due to blockage of deiodinase activity for thyroxin in brown adipose tissue under the effect of MSG [22].

Dingleline and Conn reported that central ionotropic receptors served as primary taste transducer of MSG and peripheral metabotropic glutamate receptor modulated the flavour enhancing effect of MSG in mammalian brain [23].

Singh K et al observed that subcutaneous injection of MSG (4 & 8 mg/g b.w.) to adult male mice induced oxidative stress in arterial tissue by lowering the activity of anti-oxidant enzymes. Luciene et al found that oversecretion of insulin in low glucose in ‘MSG obese mice’ was due to enhancement of general parasympathetic tonus [24].
SUMMARY AND CONCLUSION

The dietary intake of Monosodium glutamate (MSG) in human at present is not that great to cause such changes but looking at gross individual variations in pattern of injury and susceptibility in animals, MSG should always be used with caution.

Finally it is recommended that monosodium glutamate be considered as a potentially toxic substance on liver and kidney of mammalian tissue and chronic use should be avoided.

REFERENCES

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