Histological studies of the effects of monosodium glutamate on the kidney of adult Wistar rats

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Citation

Abstract
The effect of monosodium glutamate, used as food additive on the Kidneys of adult wistar rat was investigated. Both adult male and female Wistar rats (n=24) average weight of 185g were randomly assigned into two treatments (n=12) and control (n=6) groups. The rats in the treatment groups received 3g and 6g of Monosodium glutamate thoroughly mixed with the grower’s mash daily for fourteen days. The control rats received equal amount of the grower's mash without Monosodium glutamate added daily. The grower's mash was obtained from Edo Feeds and Flour Mill Ltd, Ewu, Edo State and the rats were given water liberally. The rats were sacrificed on day fifteen of the experiment. The Kidneys were carefully dissected out and quickly fixed in 10% formal saline for histological procedures. Histological changes observed in the treated kidney sections included the distortion of the renal cortical structures and some degree of cellular necrosis. Our results suggested that the functions of the kidney could have been adversely affected due to the distortion of the cyto-architecture of the renal cortical structures and cellular necrosis associated with the kidney. It is recommended that further studies aimed at corroborating these observations be carried out.

INTRODUCTION
Monosodium glutamate otherwise known as AJI-NO-MOTO is the sodium salt of glutamic acid. Glutamate is one of the most common amino acids found in nature and is the main component of many proteins and peptides of most tissues. Monosodium glutamate contains 78% of glutamic acid, 22% of sodium and water. Glutamate is also produced in the body and plays an essential role in human metabolism. It is a major component of many protein-rich food products such as meat, fish, milk and some vegetables.

Various environmental chemicals, industrial pollutants and food additives have been implicated as causing harmful effects. Most food additives act either as preservatives, or enhancer of palatability. One such food additive is Monosodium glutamate (MSG), and in Nigeria MSG is sold in the open market stalls and stores in Nigeria as “Ajinomoto” marketed by West African Seasoning Company Limited; as “Vedan” or “White Maggi” marketed by Mac and Mei (Nig) Limited.

When Monosodium glutamate is added to food, it provides a flavoring function similar to the naturally occurring free glutamate: which differ from the four classic tastes of sweet, sour, salty and bitter. As food additive, Monosodium glutamate is described and listed on food labels as a “Flavoring” or “hydrolysed vegetable protein”. Through its stimulation of the orosensory receptors and by improving the palatability of meals, Monosodium glutamate influences the appetite positively, and induces weight gain. Despite its taste stimulation and improved appetite enhancement, reports indicate that Monosodium glutamate is toxic to human and experimental animals.

In Nigeria, most communities and individuals often use Monosodium glutamate as a bleaching agent for the removal of stains from clothes. There is a growing apprehension that its excellent bleaching properties could be harmful or injurious to the tissues and organs of the body, or worse still inducing terminal diseases in consumers when ingested as a flavor enhancer in food. Despite evidence of negative consumer response to Monosodium glutamate, reputable international organizations and nutritionist have continued to endorse Monosodium glutamate, and reiterate that Monosodium glutamate has no adverse reactions in humans.

The Food and Drug Administration (FDA) of the United States reports that Monosodium glutamate is safe and that it should be maintained on the “Generally Recognized as Safe” (GRAS)-list of foods. Monosodium glutamate is thus reportedly permitted as a safe food additive that needs no
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specified average, daily intake or an upper limit intake requirement. Nigeria Agency for Food and Drug Commission (NAFDAC) has also expressed the view that MSG is not injurious to health.

In 1968, the first published report of an adverse reaction to Monosodium glutamate appeared in the New England Journal of Medicine where it was reported that Monosodium glutamate was neurotoxic; killing brain cells, causing retinal degeneration, endocrine disorder and also associated with a number of pathological conditions such as addiction, stroke, epilepsy, brain trauma, neuropathic pain, schizophrenia, anxiety, depression, degenerative disorders such as Parkinson's disease, Alzheimer's disease, Huntington's disease, and amyotrophic lateral sclerosis. 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 its etiology. Monosodium glutamate causes increase in alkaline phosphatase activity in the small intestine.

The toxic effect of Monosodium glutamate was further corroborated by the work done on the testis, causing significant oligozoospermia and increase abnormal sperm morphology in a dose-dependent fashion in male wistar rats. It has also been established that Monosodium glutamate may be implicated in cases of male infertility as it causes testicular hemorrhage, degeneration and alteration of sperm cell population and morphology.

The Kidney is a paired organ located in the posterior abdominal wall, whose functions include the removal of waste products from the blood and regulation of the amount of fluid and electrolytes balance in the body. As in humans, the majority of drugs administered are eliminated by a combination of hepatic metabolism and renal excretion. The kidney also plays a major role in drug metabolism, but its major importance to drugs is still its excretory functions. Since the kidney is involved in the excretion of many toxic metabolite waste products, particularly the nitrogenous compounds, it would therefore be worthwhile to examine the effects of Monosodium glutamate (MSG) on the kidney of adult Wistar rat.

MATERIALS AND METHODS

The present manuscript was registered and given due approval for the methodology therein by the ethical review committee of the University of Benin, Benin City as stipulated by the Nigerian Health Research ethics committee.
RESULTS
The micrograph of the kidney in the control group (C) showed normal histological features. The section indicated a detailed cortical parenchyma and the renal corpuscles appeared as dense rounded structures with the glomerulus surrounded by a narrow Bowman’s spaces. (fig.1)

The kidneys of the animals in group A treated with 3 g of MSG revealed some level of cyto-architectural distortion of the cortical structures as compared with the control. (fig.2)

The kidney sections of animals in group B treated with 6 g of MSG revealed marked distortion of cyto-architecture of the renal cortical structures, and degenerative and atrophic changes. There were vacuolations appearing in the stroma. The renal corpuscles were less identified and the Bowman’s spaces were sparsely distributed as compared to the control group. (fig.3)

DISCUSSION
The results of the haematoxylin and eosin staining (H & E) reactions showed that administration of MSG caused varying degrees of cyto-architectural distortion and reduction in the number of renal corpuscle in the treated groups which was at variance with that of the control group. There were degenerative and atrophic changes observed in the kidneys that received the high dose (6 g) of MSG.

It may be inferred from the present results that higher dose and prolonged administration of Monosodium glutamate resulted in degenerative and atrophic changes observed in the renal corpuscle. The actual mechanism by which Monosodium glutamate induced cellular degeneration...
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observed in this experiment needs further investigation. The necrosis observed is probably due to the high concentration of the MSG on the kidney. Pathological or accidental cell death is regarded as necrotic and could result from extrinsic insults to the cell as osmotic thermal, toxic and traumatic effects.\textsuperscript{13} Physiological cell death is regarded as apoptotic and organized programmed cell death (PCD) that is mediated by active and intrinsic mechanisms. The process of cellular necrosis involves disruption of membranes, as well as structural and functional integrity. Cellular necrosis is not induced by stimuli intrinsic to the cells as in programmed cell death (PCD), but by an abrupt environmental perturbation and departure from the normal physiological conditions.\textsuperscript{14}

The experiment also revealed some histological abnormalities and cyto-architectural distortion of the renal cortical structures, which may be ascribed to the effects of MSG on the kidney. The renal cortical structures are distorted as against that of the control rats. The results of this experiment suggest that the distortion of the cyto-architecture of the kidney could have been associated with functional changes that may have been detrimental to the health status of the animal which may have been due to the interference of MSG on the kidney. In cellular necrosis, the rate of progression depends on the severity of the environmental insults. The greater the severity of the insults the more rapid the progression of neuronal injury.\textsuperscript{15} The principle holds true for toxicological insult to the brain and other organs.\textsuperscript{16} It may have been inferred from the present study that prolonged administration and higher doses of MSG resulted in increased toxic effect on the kidney.

The kidney sections treated with higher doses of MSG were most severely affected in this experiment.

CONCLUSION AND RECOMMENDATION

The results obtained in this study following the administration of 3 g and 6 g per day of Monosodium glutamate to adult wistar rats causes disruptions and distortions of the cyto-architecture of the kidneys. This resulted in the cellular necrosis, and sparsely distribution of the Bowman’s spaces. With these results, it is probable that the functions of the kidney may be adversely affected. It is recommended that further studies be carried out to examine these findings.

CORRESPONDENCE TO

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