

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

A Eweka

Citation

A Eweka. *Histological studies of the effects of monosodium glutamate on the kidney of adult Wistar rats*. The Internet Journal of Health. 2006 Volume 6 Number 2.

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 water₁. 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 vegetables₂.

Various environmental chemicals, industrial pollutants and food additives have been implicated as causing harmful effects₃. 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 bitter₄. 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 gain₅. Despite its taste stimulation and improved appetite enhancement, reports indicate that Monosodium glutamate is toxic to human and experimental animals₆.

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 humans₇. 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

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 health₈.

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 sclerosis₁. 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 intestine₉.

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 rats₁₀. 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 morphology₁₁.

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 excretion₁₂. 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 metabolic 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.

Registration at Middle East Anesthesiology Research council as: MEARC(AER)1/7/07 HISTOLOGICAL STUDIES OF THE EFFECTS OF MONOSODIUM GLUTAMATE ADULT WISTAR RATS. Andrew O. Eweka, MB.BS, MSc (Anatomy). DEPARTMENT OF ANATOMY, SCHOOL OF BASIC MEDICAL SCIENCES, COLLEGE OF MEDICAL SCIENCES, UNIVERSITY OF BENIN, BENIN CITY, EDO STATE, NIGERIA.

ANIMALS

Thirty Two, adult wistar rats of both sexes with average weight of 185 g were randomly assigned into three groups A, B and C of (n-8) in each group. Groups A and B of (n-16) serves as treatments groups while Group C (n-8) is the control. The rats were obtained and maintained in the Animal Holdings of the Department of Anatomy, School of Basic Medical Sciences, University of Benin, Benin city, Nigeria. They were fed with grower's mash obtained from Edo feed and flour mill limited, Ewu, Edo state) and given water liberally. The rats gained maximum acclimatization before actual commencement of the experiment. The Monosodium glutamate (3 g/ sachet containing 99+% of MSG) was obtained from Kersmond grocery stores, Uselu, Benin city.

MONOSODIUM GLUTAMATE ADMINISTRATION: The rats in the treatment groups (A and B) were given 3g and 6g of MSG thoroughly mixed with the grower's mash, respectively on a daily basis. The control group © received equal amount of feeds (Grower's mash) without MSG added for fourteen days. The rats were sacrificed on the fifteenth day of the experiment. The kidneys were quickly dissected and fixed in 10% formal saline for routine histological techniques. The 3 g and 6 g MSG doses were chosen and extrapolated in this experiment based on the indiscriminate use here in Nigeria due to its palatability. The two doses were thoroughly mixed with fixed amount of feeds (550 g) in each group daily.

HISTOLOGICAL STUDY

The tissue were dehydrated in an ascending grade of alcohol (ethanol), cleared in xylene and embedded in paraffin wax. Serial sections of 5 microns thick were obtained using a rotatory microtome. The deparaffinised sections were stained routinely with haematoxyline and eosin. Photomicrographs of the desired results were obtained using digital research photographic microscope in the University of Benin research laboratory.

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)

Figure 1

Figure 1: Control section of kidney (Mag. X 400)

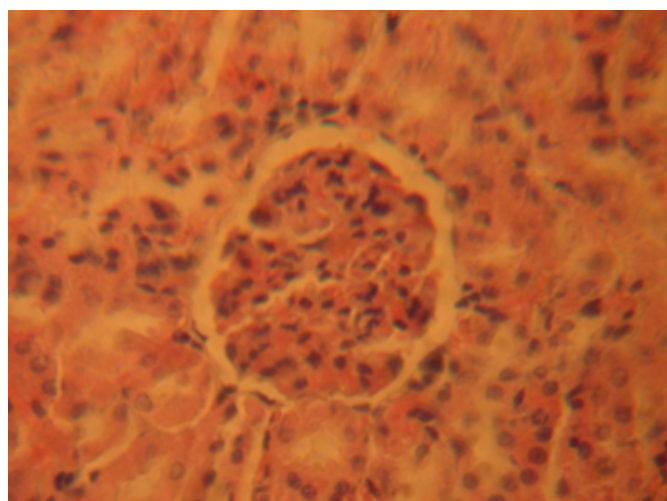


Figure 2

Figure 2: Treatment section of the kidney of rats that received 3 g MSG. (Mag. X 400)

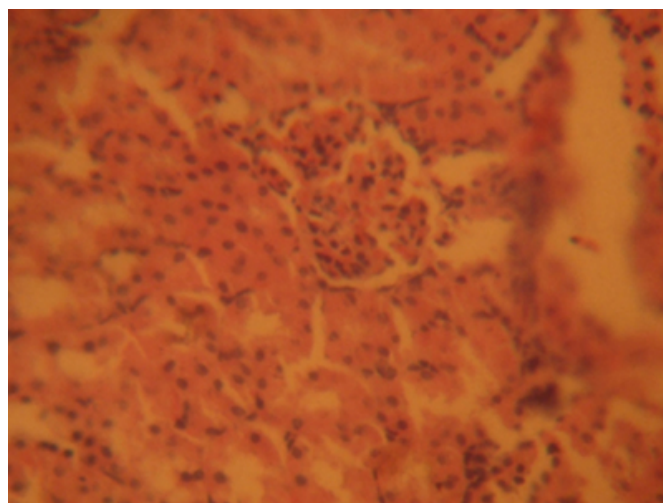
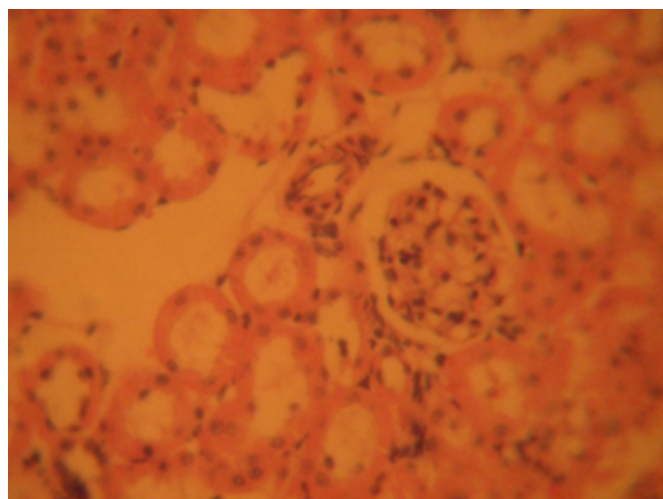


Figure 3

Figure 3: Treatment section of kidney of rats that received 6 g of MSG (Mag. X 400).



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

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.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.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.¹⁵ The principle holds true for toxicological insult to the brain and other organs.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

Dr. Andrew O. Eweka, MB.BS, MSc (Anatomy).

DEPARTMENT OF ANATOMY, SCHOOL OF BASIC MEDICAL SCIENCES, COLLEGE OF MEDICAL SCIENCES, UNIVERSITY OF BENIN, BENIN CITY, EDO STATE, NIGERIA Email: andreweweka@yahoo.com Tel: +2348023390890, +2348038665346, +2348055216031.

References

1. Adrienne Samuels: The Toxicity/Safety of MSG; A study in suppression of information. Accountability in Research. 1999 6 (4): 259-310,
2. IFIC Review of Monosodium glutamate. 1994: Examining the Myths
3. K-othmer Encyclopedia of Chemical Technology. Fourth Edition: Wiley. 1992 Pp 571-579.
4. Leung A, Foster S. Encyclopaedia of common Natural Ingredient used in Food, Drugs and Cosmetics. New York: Wiley. 1996 pp373-375
5. Moore KL: Congenital malformations due to environmental factors; Developing Humans W.B. Saunders Co. Ltd Philadelphia 2nd Ed
8. 173-183
6. Biodun D, Biodun A: A spice or poison? Is Monosodium glutamate safe for human consumption? National Concord, 4th Jan 1993. p5.
7. Okwuraiwe PE. : The role of food and Drug Administration And control (FDA&C) in ensuring the safety of food and food ingredients. A symposium held at Sheraton Hotel, Lagos. 1st Sept. 1992: 6-15.
8. Rogers PP, Blundell JE: Umani and appetite: Effects of Monosodium glutamate on hunger and food intake in human subjects Physiol. Behav. 1990: 486:801-4.
9. Mozes S, Sefcikova Z: Obesity and changes of alkaline phosphatase activity in the small intestine of 40 and 80-day old rats subjected to early postnatal overfeeding of monosodium glutamate. Physiol Res. 2004 53(2).
10. Onakewhor JUE, Oforofuo IAO, Singh SP: Chronic Administration of Monosodium glutamate Induces Oligozoospermia and glycogen Accumulation in Wister rat testes. Africa J. Reprod Health; 1998 2 (2): 190-197-86.
11. Oforofuo IAO, Onakewhor JUE, Idaewor PE: The effect of Chronic Admin of MSG on the histology of the Adult Wistar rat Testes: Bioscience Research Communications. Vol. 9, No. 2, June 1997: 30-56.
12. G: Basic and Clinical Pharmacology 7th edition, Appleton and Lange, Stamford CT. 1998. pp. 372-375
13. Farber, J.L, Chien, K.R; Mitnacht S: The Pathogenesis of Irreversible cell Injury in Ischemia: Am.J Pathol.; 1981:102: 271-281
14. Belluardo M, Mudo G and Bindoni M: Effect of early Destruction of the mouse arcuate nucleus by MSG on age Dependent natural killer activity Brain Res., 1990: 534:225-333

Author Information

Andrew O. Eweka, MB.BS, MSc (Anatomy)

Department Of Anatomy, School Of Basic Medical Sciences, College Of Medical Sciences, University of Benin