Histological Studies Of The Effects Of Monosodium Glutamate On The Lateral Geniculate Body Of Adult Wistar Rats

A Eweka, F Om'Iniabohs

Citation

A Eweka, F Om'Iniabohs. *Histological Studies Of The Effects Of Monosodium Glutamate On The Lateral Geniculate Body Of Adult Wistar Rats*. The Internet Journal of Nutrition and Wellness. 2007 Volume 5 Number 1.

Abstract

Histological effects of Monosodium glutamate (MSG) commonly used as food additive on one of the visual relay centres namely the lateral geniculate body (LGB) of adult Wistar rat was studied. The rats of both sexes (n=24), average weight of 185g were randomly assigned into two treatments (n=16) and control (n=8) groups. The rats in the treatment groups received 3g and 6g of MSG thoroughly mixed with their feeds for fourteen days, while the control rats received equal amounts of feeds without MSG added. The rats were fed with growers' mash purchased from Edo Feeds and Flour Mill Ltd, Ewu, Edo State and were given water liberally. The rats were sacrificed on day fifteen of the experiment. The lateral geniculate body was carefully dissected out and quickly fixed in 10% buffered formaldehyde for routine histological study.
The histological findings after H&E staining indicated that the treated section of the lateral geniculate body (LGB) showed some varying degree of reduced cellular population based on its sparse distribution, degenerative changes, cellular hypertrophy, and intercellular vacuolations appearing in the stroma.
These findings indicate that MSG consumption may have a deleterious effect on the neurons of the intracranial visual relay centre and this may probably have some adverse effects on visual sensibilities by its deleterious effects on the cells of the lateral geniculate body (LGB) of adult Wistar rats. It is recommended that further studies aimed at corroborating these observations be carried out.

INTRODUCTION

Pathological processes frequently involve the body's normal responses to abnormal environmental influences. Such noxious external influences as pathogenic microorganisms, trauma, dietary deficiencies and hereditary factors acting alone or in a complex interaction with environmental factors, cause diseases[1]. Various environmental chemicals, industrial pollutants and food additives have been implicated as causing harmful effects[2].Most food additives act either as preservatives or enhancer of palatability. One of such food additive is monosodium glutamate (MSG) and it is sold in most open markets and stores in Nigeria as “Ajinomoto” marketed by West African Seasoning Company Limited.

The safety of MSG's usage has generated much controversy locally and globally[3]. In Nigeria, most communities and individuals often use MSG as a bleaching agent for the removal of stains from clothes. There is a growing apprehension that its bleaching properties could be harmful or injurious to 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 MSG, reputable international organizations and nutritionist have continued to endorse MSG, reiterating that it has no adverse reactions in humans. Notably of such is the Directorate and Regulatory Affairs of Food and Drug Administration and Control (FDA&C) in Nigeria, now NAFDAC has also expressed the view that MSG is not injurious to health[4].

MSG improves the palatability of meals and thus influences the appetite centre positively with it resultant increase in body weight[5]. Though MSG improves taste stimulation and enhances appetite, reports indicate that it is toxic to human and experimental animals[6]. 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[7]. It has been implicated in male infertility by causing testicular hemorrhage, degeneration and alteration of sperm cell population and morphology [8]. It has been reported that MSG has neurotoxic effects resulting in

brain cell damage, 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[9]. 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.

The lateral geniculate body and superior colliculus constitutes the intracranial visual relay centres. The Lateral geniculate body in mammals is considered as part of the thalamic nuclei for processing visual information[10]. In rats the Lateral geniculate body receives input from the geniculate leaflet, which participates in the regulation of circadian function through its projection to the circadian pacemaker of the hypothalamus[11].

Cerebral nuclei such as the medial and lateral geniculate bodies, inferior and superior colliculi have higher glucose utilization than other structures[12]. There is also a correlation between functional activity and metabolic rate such as in the visual and auditory system[12].

The effects of MSG on the intracranial visual relay centre may not have been documented, but there have been reports that it may be implicated in varied symptoms of dizziness, itching, vomiting, abdominal pain, headaches, diarrhea, tinnitus, increase hearing loss, macular rash, neutropenia and convulsion. It is probable that the adverse effects of MSG on vision such as dizziness may be due to direct effect of MSG on this visual relay centre. This present study was to elucidate the histological effects of MSG on the lateral geniculate body of adult Wistar rats.

MATERIALS AND METHODS

ANIMALS: Twenty four (24) adult Wistar rats of both sexes with average weight of 185g 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 growers' 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 (3g/ 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 growers' mash, respectively. The control © group received equal amount of feeds (growers' mash) without MSG added for fourteen days. The rats were sacrificed on the fifteenth day of the experiment. The lateral geniculate body was quickly dissected out and fixed in 10% buffered formaldehyde for routine histological techniques. The 3g and 6g 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 (550g) 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 7 microns thick were obtained using a rotatory microtome, and thereafter stained routinely with haematoxyline and eosin after (H&E) method[13]. Photomicrographs of the desired sections were made for further observations.

RESULTS

The control sections of the Lateral geniculate body showed normal histological features with the neurons appearing distinct and the glial cells normal without vacuolations in the stroma (Figure 1).

The sections of the Lateral geniculate body from the treatment groups appeared to have affected all the rats in each group equally, showing some varying degree of reduced cellular population, based on its sparse distribution, degenerative changes, cellular hypertrophy, and intercellular vacuolations appearing in the stroma. The degenerative changes were more pronounced in the group that received 6g of MSG. (Figure 2 & 3)

Figure 1

Figure 1: Photomicrograph representing the control section of the lateral geniculate body (Mag. x400).

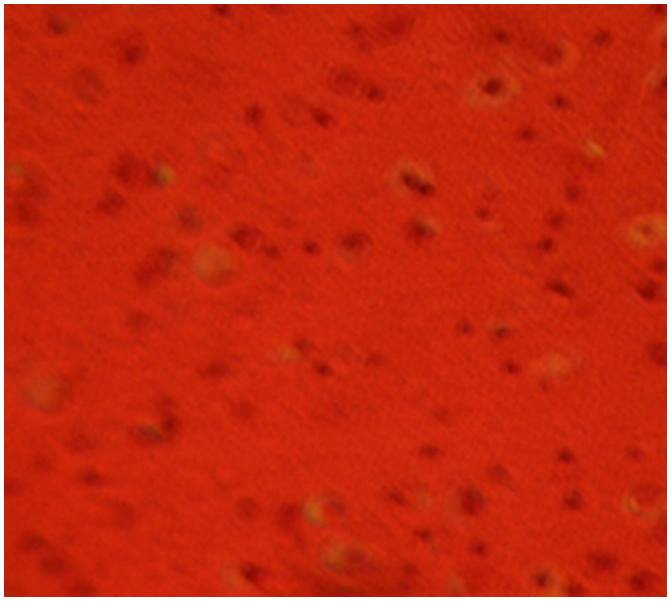


Figure 2

Figure 2: Photomicrograph representing the treatment section of the lateral geniculate body. (3g MSG) (Mag.x400)

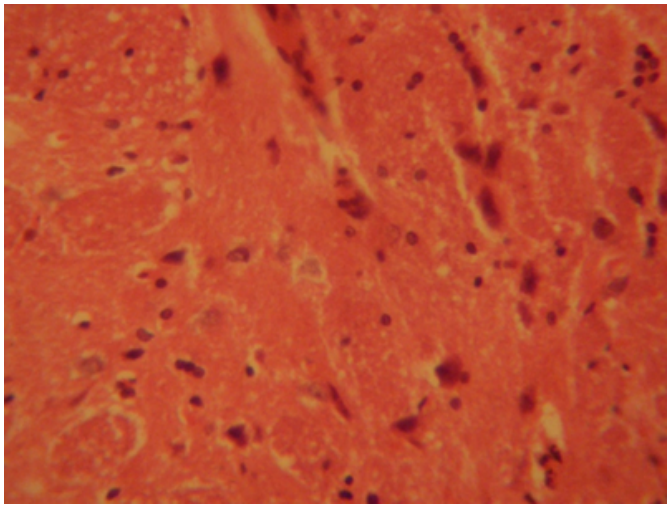
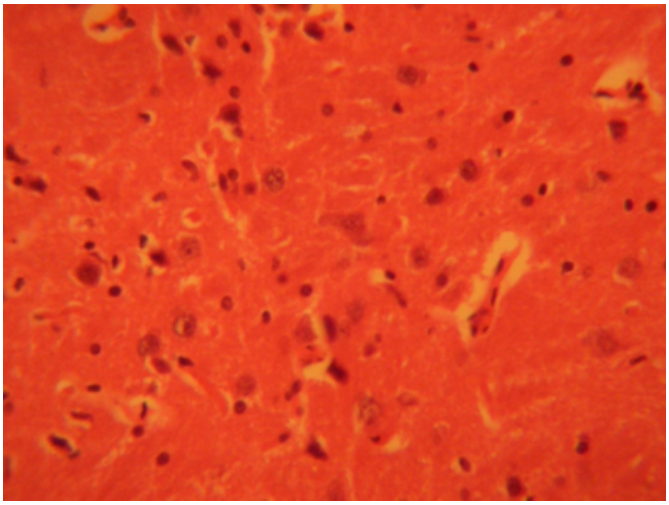


Figure 3

Figure 3: Photomicrograph representing the treatment section of the lateral geniculate body (6g MSG) (Mag.x400)



DISCUSSION

The results (H & E) revealed that administration of MSG showed some decreased cellular population, degenerative changes, cellular hypertrophy and vacuolations which appeared in the stroma of the treatment groups compared with the control section of the lateral geniculate body. Neuronal degeneration has been reported to result in cell death, which is of two types, namely apoptotic and necrotic cell death. These two types differ morphologically and biochemically[14]. Pathological or accidental cell death is regarded as necrotic and could result from extrinsic insults to the cell such as osmotic, thermal, toxic and traumatic effects[15]. It was reported that cell death in response to neurotoxins might trigger an apoptotic death pathway within brain cells[16]. Cell death in response to neurotoxins occurs as a controlled event involving a genetic programme in which caspase enzymes are activated[16].

The process of cellular necrosis involves disruption of the membranes 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[17].

Extensive cell death in the central nervous system is present in all neurodegenerative diseases[16]. The type of nerve cell loss and the particular part of the brain affected dictate the symptoms associated with an individual disease[16]. In this study MSG may have acted as toxin to the cells of the lateral geniculate body, affecting their cellular integrity and causing

defect in membrane permeability and cell volume homeostasis.

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.[18] The principle holds true for toxicological insult to the brain and other organs[17]. The prime candidates for inducing the massive cell destruction observed in neurodegeneration are neurotoxins[16]. These may be substances present in small amounts in the environment, or even naturally occurring chemicals such as glutamate used by the brain as transmitter's substances[16]. The latter when present at a critical level can be toxic to the brain cells they normally excite[16]. It is inferred from this results that prolonged and high dose of MSG resulted in increased toxic effects on the LGB. The decrease in cellular population observed in this study may have been as a result of cell death caused by the toxic effect of MSG.

The vacuolations observed in the stroma of the lateral geniculate body in this experiment may be due to MSG interference.

CONCLUSION AND RECOMMENDATION

The results obtained in this study following the administration of 3g and 6g per day of MSG to adult Wistar rats, causes spares cellular population, cellular degenerative changes, cellular hypertrophy and vacuolations in the lateral geniculate body of adult Wistar rats. These results may probably affect the functions of the lateral geniculate body in visual sensibility in adult Wistar rats. It is recommended that further studies be carried out to corroborate these findings.

References

1. Allen GH. The genetic basis of diseases, in General pathology
Churchill Livingstone Medical Division Longman Co. Ltd, N.Y. Pp
35056. 1987
2. Moore KL. Congenital malformations due to environmental factors;
Developing humans. W.B. Saunders Co. Ltd, Philadelphia 2nd Ed Chap 8.
pp 173-83, 2003
3. Biodun D, Biodun A. A spice or poison? Is monosodium glutamate safe for
human consumption? National concord. 1993; 4th Jan. p5.
4. 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.
5. Rogers PP, Blundell JE. Umani and appetite: Effects of monosodium
glutamate on hunger and food intake in human subjects. Phsiol. Behav.
1990: 486:801-4.
6. Belluardo M, Mudo G, 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
7. 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.
8. Oforofuo IAO, Onakewhor JUE, Idaewor PE. The effect of chronic
administration of MSG on the histology of the Adult wister rat testes:
Bioscience Research Communications. 1997 Vol. 9, No. 2
9. Samuels A. The Toxicity/Safety of MSG; A study in suppression of
information. Accountability in Research 1999. 6(4): 259-310.
10. Altman AS, Bayer CS. Time of Origin of neurons of rat superior
colliculus in relation to other components of the visual and visiomotor pathways. Experimental Brain Research.1981, 42: 424-434
11. Moore RY, Card JP. Intergeniculate leaflet: An anatomically and
functionally distinct subdivision of the lateral geniculate complex. J.
comparative Neurology. 1984; 344: 403-444
12. Siesjo BK. Utilization of substrates by brain tissues. Brain energy
metabolism. John Wiley and Sons, USA. 1978 101-130.
13. Drury RAB, Wallington EA, Cameron R. Carleton's Histological
Techniques: 4th ed., Oxford University Press NY. U.S.A. 1967 279-280.
14. Wyllie AH. Glucocorticoid-induced thymocyte apoptosis is associated
with endogenous endonuclease activation. Nature: London 1980
284:555-556.
15. Farber JL Chein K R, Mittnacht S. The pathogenesis of Irreversible cell injury in ischemia; Ame J. Path.1981; 102:271-281
16. Waters CM. Glutamate induced apoptosis of striatal cells in rodent model
for Parkinsonism. Neuroscience 1994 63:1-5
17. Martins LJ, Al-Abdulla NA, Kirsh JR, Sieber FE, Portera-Cailliau C.
Neurodegeneration in excitotoxicity, global cerebral ischaemia and target
deprivation: A perspective on the contributions of apoptosis and necrosis. Brain Res. Bull. 1978. 46(4). 281-309
18. Ito U, Sparts M, Walker JR, Warzo I. Experimental cerebral ischemia
in Magolian gerbils(1). Light microscope observations. Acta Neuropathology. USA. 2003. 32:209-223.
19. Eweka AO, Adjene JO. Histological studies of the effects of monosodium
glutamate on the medial geniculate body of adult Wister rat.

Electron
J. Biomed. May 22, 2007.
20. Espinar A, Garcia-Oliver A et al. Neuroprotection by melatonin
From glutamate-induced exocitoxicity during development of the
cerebellum in the chick embryo: J. pineal Res. 2000; 2: 818.
21. Urena-Guerrero ME, Lopez-perez SJ, BeasZaratel B. Neonatal
monosodium glutamate treatment modified glutamic acid decarboxylase
activity during rat brain postnatal development: Neurochem. Int. 2003;
42(4): 269-276.
22. Gispen WH. Molecular and functional neurobiology: Elsevier
Publishing Company, USA. 1976 102-104.

Author Information

A.O. Eweka
Department Of Anatomy, School Of Basic Medical Sciences, College Of Medical Sciences, University of Benin

F.A.E. Om'Iniabohs
Department Of Anatomy, School Of Basic Medical Sciences, College Of Medical Sciences, University of Benin