

# Histological Studies Of The Effects Of Monosodium Glutamate On The Cerebellum Of Adult Wistar Rats

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## Abstract

Histological effects of Monosodium glutamate (MSG) commonly used as food additive on the cerebellum of adult Wistar rats were carefully 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 cerebellum was carefully dissected out and quickly fixed in 10% buffered formaldehyde for routine histological study after H&E method.

The histological findings after H&E methods indicated that the treated sections of the cerebellum showed disruption of the Purkinje and granular layers, sparse granular cell distribution, cellular degenerative changes in the granular layer with the group that received 6g of MSG more severe. These findings indicate that MSG consumption may have some deleterious effects on the cerebellum of adult Wistar rats at higher doses and by extension may affect the functions of the cerebellum and may lead to tremor, unstable and uncoordinated movement, and ataxia. It is recommended that further studies aimed at corroborating these findings be carried out.

## INTRODUCTION

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. Various environmental chemicals, industrial pollutants and food additives have been implicated as causing harmful effects<sub>1</sub>.

The safety of MSG's usage has generated much controversy locally and globally<sub>2</sub>. 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<sub>3</sub>.

MSG improves the palatability of meals and thus influences the appetite centre positively with it resultant increase in body weight<sub>4</sub>. Though MSG improves taste stimulation and enhances appetite, reports indicate that it is toxic to human and experimental animals<sub>5</sub>. 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<sub>6</sub>. It has been implicated in male infertility by causing testicular hemorrhage, degeneration and alteration of sperm cell population and morphology<sub>7</sub>. It has been reported that MSG has neurotoxic effects resulting in brain cell damage<sub>8</sub>, 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<sub>9</sub>.

The cerebellum is a region of the brain that plays an important role in the integration of sensory perception and motor output. It is located in the inferior posterior portion of

the hindbrain, directly dorsal to the pons, and inferior to the occipital lobe<sup>10</sup>. The cerebellum contains nearly 50% of all neurons in the brain, but it only takes up 10% of total brain volume and receives nearly 200 million input fibers<sup>10</sup>. The basal ganglia and cerebellum are large collections of nuclei that modify movement on a minute-to-minute basis. The output of the cerebellum is excitatory, while the basal ganglia are inhibitory. The balance between these two systems allows for smooth, coordinated movement, and a disturbance in either system will show up as movement disorders like tremors, Nystagmus and Ataxia<sup>11</sup>. Since the cerebellum is involved in the coordination and control of voluntary movement it may be susceptible to injury particularly in situation of toxicity. It would therefore be worthwhile to examine the effects of Monosodium glutamate (MSG) on the cerebellum of adult Wistar rat.

## **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, Uslu, 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 cerebellum 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. The deparaffinized sections were stained routinely with haematoxyline and eosin. Photomicrographs of the desired sections were made for further observations.

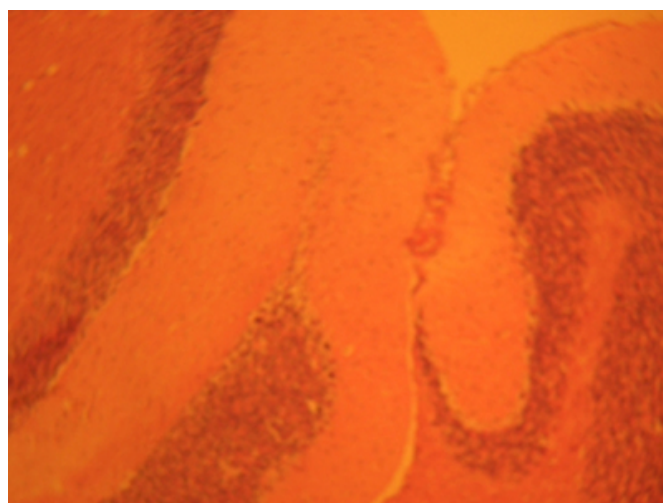
## **RESULTS**

The control sections of the cerebellum showed normal histological features with the well organized three cortical cell layers; the nearly cell-free molecular layer occupied mostly by axons and dendrites, a monolayer of large Purkinje cells, and the dense layer of granule cells, and the white matter in the centre of each folium (Figure1).

The treatment sections of the cerebellum showed some histological changes that were at variance with those obtained in the control. There were evidence of disruption of the Purkinje and granular layers, with sparse granular cell distribution with the group that received 6g of MSG more severe. There were also cellular degenerative changes in the granular layer of those treated with 6g of MSG. (Figure 2 & 3).

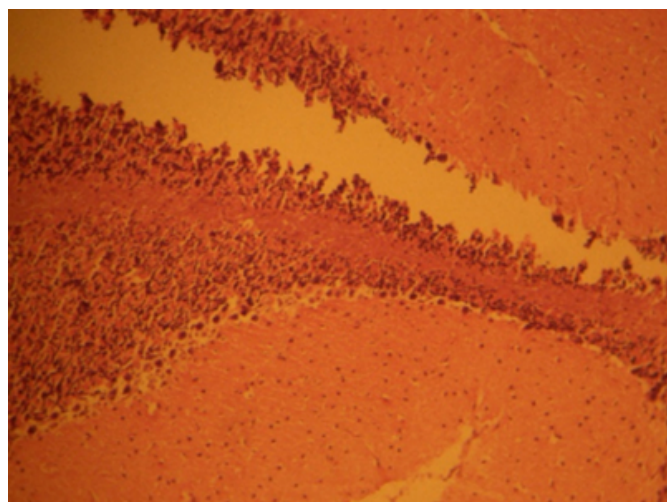
### **Figure 1**

Figure 1: Control section of the Cerebellum (Mag. x400).



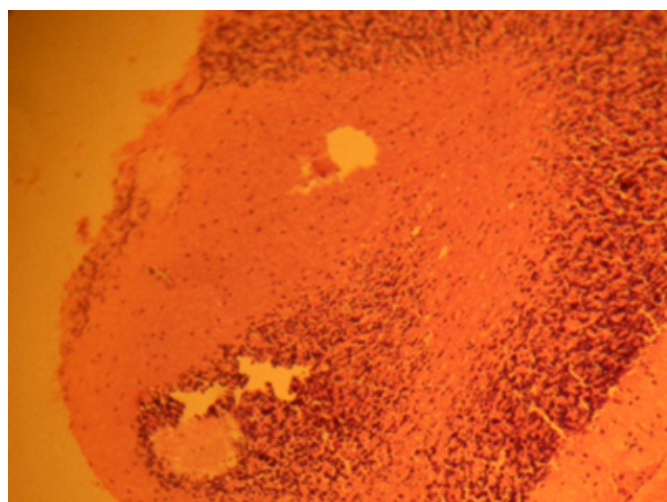
**Figure 2**

Figure 2: Treatment section of the cerebellum, showing disruption of the Purkinje and granular layers. (3g MSG) (Mag.x400)



**Figure 3**

Figure 3: Treatment section of the cerebellum, showing disruption of the Purkinje and granular layers, with sparse granular cell distribution. (6g MSG) (Mag.x400)



**DISCUSSION**

The results (H & E) reactions revealed that with increasing dose of monosodium glutamate consumption there was varying degrees of cellular disruption and degeneration of the Purkinje's and granular cells of the cerebellum in the treatment group compared to the control sections. The necrosis observed is in consonance with the findings recorded in the work carried out by Eweka and Om'Iniaboh's, where it was noted that MSG had a destructive effect on Brunner's gland of the duodenum and the small intestinal mucosa of adult Wistar rats<sup>12</sup>.

The result of this experiment suggests that the distortion of the Purkinje's and granular cells of the cerebellum could have been associated with functional changes that may be detrimental to the health of the rats. Chemically induced neurodegeneration is usually characterized by different patterns of neuronal cell death, gliosis, swollen or destroyed axons, or destruction of myelin sheath<sup>13</sup>. 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<sup>14</sup>. 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<sup>15</sup>. Cell death in response to toxins occurs as a controlled event involving a genetic programme in which caspase enzymes are activated<sup>16</sup>. MSG may have acted as toxins to neuronal cells, affecting their cellular integrity and causing defect in membrane permeability and cell volume homeostasis.

**CONCLUSION AND RECOMMENDATION**

The results obtained in this study revealed that monosodium glutamate consumption could affect the histology of the cerebellum. The Purkinje and granule cells of the treated sections of the cerebellum showed some cellular disruption and degenerative changes. With this result it is probable that the functions of the cerebellum as the organ for the coordination and control of voluntary movement may be adversely affected. It is recommended that further studies be carried out to corroborate these findings.

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