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Evaluation of the cardiac effect of monosodium glutamate (Ajinomoto) in albino rats

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Abstract

Monosodium glutamate (MSG) is a common food ingredient and taste enhancer, but consuming large amounts of it has prompted many questions about its safety and potential negative effects, particularly on the heart. Therefore, this present study evaluated the effect of MSG on the heart. Eighteen (18) albino rats were randomly grouped according to their body weight into 3 groups A, B, and C with 6 rats in each group. Group A were used as controls. Group B received high dose (4 mg/kg) of the monosodium glutamate concentration while group C received a low dose (2 mg/kg) of the monosodium glutamate concentration for twenty-one (21) days. The activity of the heart was assessed by determining the level of CK-MB, LDH and AST in the serum. It was observed that rats on high dose of MSG gained significant weight when compared to control group. A non-significant ($P>0.05$) decrease in CK-MB, statistically significant ($P<0.05$) increase in LDH and statistically significant decrease in AST were seen in the high dose MSG group when compared to the control group. Low dose MSG group did not show any significant alterations in the biochemical parameters measured. The histopathology analysis showed that the myocardial fibres of the high dose and low dose MSG group are normal. These results showed that MSG can cause weight gain at high dose, but there was no observable damage to the heart at high and low doses.

Keywords: Monosodium Glutamate; Chinese restaurant syndrome; Myocardial fibres; Heart; Histopathology

1 Introduction

Monosodium Glutamate (MSG) is a white, crystalline powder that is almost entirely odorless. It is a sodium salt of glutamic acid, an amino acid found in meat, poultry, and other foods high in protein [1]. It is sold in most markets as "white maggi" or "ajinomoto" as a food enhancer and additive [2]. It is produced through the partial neutralization and acid hydrolysis of vegetable proteins or through the action of micrococcus glutamicus on a carbohydrate source like sugar beet molasses [3].

MSG has been reported to be cardiotoxic to humans, and by extension, laboratory animals, especially at large doses [4]. Cardiotoxicity refers to as damage to the myocardium as a result of build-up of toxins [5]. It is also known as cardiac dysfunction or cardiac failure. Most common symptoms of cardiotoxicity include dyspnea, heart palpitations, blood pressure variation, chest pain, malaise, and with complications including congenital heart failure, cardiomyopathy, myocardial infarction and sudden death [6].

Certain biochemical markers are implicated in cardiotoxicity. The commonest markers used in diagnosis include Aspartate Amino Transferase (AST), Lactate Dehydrogenase (LDH) and isoenzyme Creatine Kinase (CK-MB). Generally, these cardio enzymes are intracellular enzymes and are very low in the serum. Therefore, these enzymes, which reveal the degree of cardiac destruction from oxidative stress and lipid peroxidase, leak out into the plasma when a cell membrane is disrupted and increase drastically [3].

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Concerns about the safety of MSG and its potential negative health consequences, particularly on the heart, have been raised by researchers [7]. Longer trials in humans, however, would be challenging to carry out due to dietary compliance issues and ethical issues [8]; therefore, rats still remain the most productive models for measuring the cardiotoxic effect in mammals. This study aims to investigate the cardiac effect of MSG on Albino rats.

2 Material and methods

2.1 Chemicals and Reagents

MSG was purchased from Ogbete Main Market, Enugu State, Nigeria. All reagents were bought from Randox Laboratory Ltd. in the UK.

2.2 Experimental Animals

Eighteen (18) adult albino rats, weighing 120-180 g, were acquired from the animal house of the College of Veterinary Medicine, University of Nigeria. The rats were housed in a metallic cage with a regular temperature of 22 ± 3 ^{o}C and a 12-hour light-dark cycle. The animals were monitored for 14 days earlier than the experiment date, in order to allow them to acclimatize to the environment. The experimental design and management complied with institutional regulations, detailing the use of rats and the guidelines for the handling and usage of vertebrates in study published by the American Physiological Society [9].

2.3 Preparation of Monosodium Glutamate

2 mg of MSG was dissolved in 1ml of water for group C (low dose). 4 mg of MSG was dissolved in 2 ml of water for group B (high dose).

2.4 Experimental Design

The Eighteen (18) albino rats were divided into 3 groups (A-C); 6 rats in each group. They received the following treatments on a daily basis for 21 days:

- Group A (control): Nothing was administered.
- Group B: received oral administration of high dose of MSG solution (4 mg/kg body weight)
- Group C: received oral administration of low dose of MSG solution (2 mg/kg body weight)

2.5 Sacrificing of Animals and Sample Collection

Under chloroform anesthesia, the left ventricle of the heart was punctured to obtain blood samples for the determination of serum CK-MB, LDH, and AST. The heart was then removed for histological examinations.

2.6 Biochemical Analysis

The serum activities of the CK-MB and LDH were determined using enzyme immunoassay method [10]. AST was estimated using colometric method [11].

2.7 Histopathological analysis

Paraffin wax embedding method was employed to prepare the removed heart. Sections of the organ were made at a thickness of 5 microns, and Hematoxylin and Eosin staining technique was used for better general examination of the tissues [12]. An Olympus™ light microscope was used to examine the tissue sections.

2.8 Statistical Analysis

Version 7.0 of Graph Pad Prism (San Diego, CA, USA) was used to analyze the data. The data of the biochemical experiments were represented as mean ± SEM (standard error of mean). One-way analysis of variance (ANOVA) was used to determine the degree of significance. Probability levels below 0.05 ($p<0.05$) were taken as being significant.

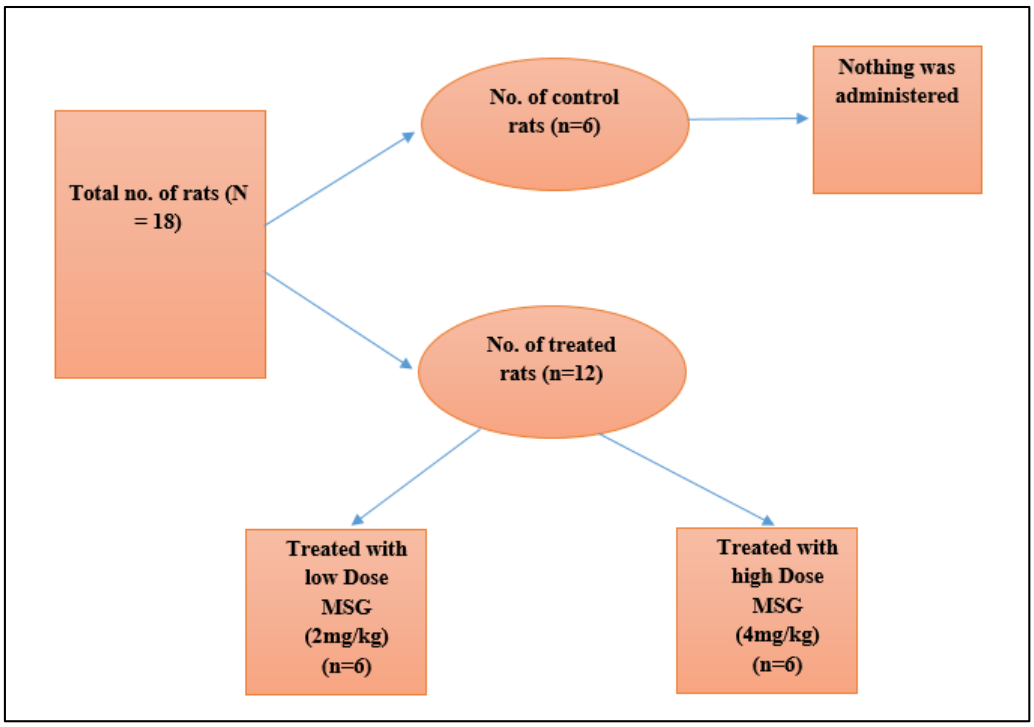

Figure 1 Flow chart of study design

3 Results

Effects of monosodium glutamate (MSG) on body weight of rats following 21days administration is represented in Fig. 2. It was observed that rats in the high dose of MGS (4 mg/kg) group gained significant weight when compared to control rats. The mean increase in body weight was highest in the high dose of MGS (4 mg/kg) in comparison with other groups.

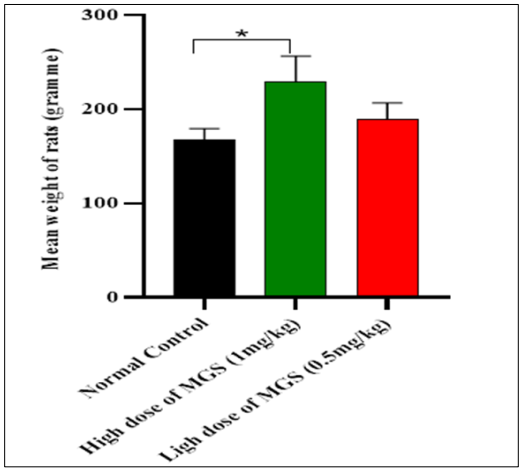

Figure 2 Effects of MSG on body weight of experimental rats

3.1 Biochemical Results

The activity of the heart was assessed by determining the level of CK-MB, LDH and AST in the serum (Table 1). There was a non-significant ($P>0.05$) decrease in CK-MB, statistically significant ($P<0.05$) increase in LDH and statistically significant ($P<0.05$) decrease in AST in the high dose MGS-treated group when compared with control group. We observed that the Low dose MGS-treated group showed no substantial alterations in the biochemical parameters measured.

Table 1 Comparison of cardiac biomarkers of treated groups with the controls Groups

GROUP	CK-MB (ng/ml (0.5)	LDH (U/L)	AST (U/L)
A: Normal Control	3.217 ± 1.05	816.94± 16.24	21.75 ±3.07
B: High dose of MGS (1mg/kg)	0.867 ± 0.36	1331.48 ± 13.17**	17.87 ± 2.27*
C: Low dose of MGS (0.5mg/kg)	0.993 ± 03.72	820.64 ±14.45	20.09 ± 1.93

**p<0.01 or *p<0.05 is significant when control is compared with all other groups.

3.2 Histological Results

In group A, Myocardial fibres appear normal with a well conserved morphology. The tissue section of high dose MGS-treated group showed normal myocardial fibres with no significant alteration observed (Group B). In addition, the heart section of low dose MGS-treated group showed normal myocardial fibres with no significant alteration observed (Group C). The histopathological findings were in tandem with the biochemical results as we observed that MSG did not pose any serious observable danger to the heart at the doses studied.

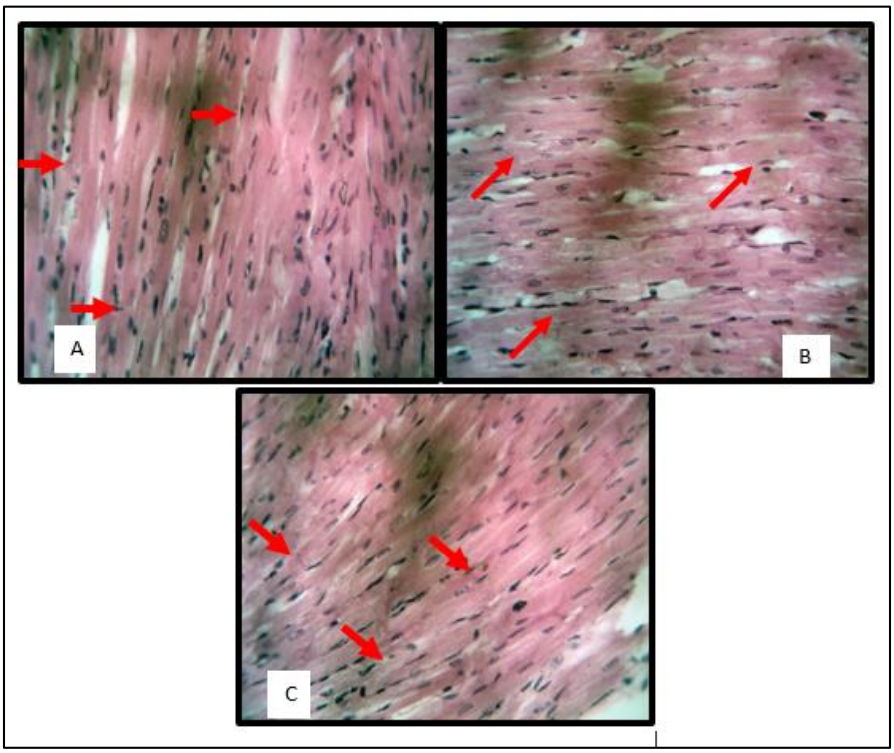

Figure 3 Representative micrograph of the heart of animals. Group A- Myocardial fibres (arrows) appeared normal. Stain: Haematoxylin and Eosin. Magnification: X40. Group B- Myocardial fibres (arrows) appear normal. Stain: Haematoxylin and Eosin. Magnification: X40. Group C- Myocardial fibres (arrows) appear normal. Stain: Haematoxylin and Eosin. Magnification: X40

4 Discussion

It has been determined that MSG exposure increases the risk of becoming obese, because leptin signaling in the hypothalamus is interrupted and glutamate neurotransmission signals are associated with energy balance [13], which causes the exposed animal to consume more food while being less active [14]. According to our study, it was observed that rats on high dose of MGS (4 mg/kg) showed a significant increase in weight when compared to normal control group. This result is in tandem with the study carried out by Akataobi, which showed that rats treated with MSG experienced a significant increase in weight when compared to the control group [15].

Furthermore, this study showed a statistically non-significant decrease in CK-MB, a slightly increased levels of serum LDH and decreased levels of AST in the high dose MGS-treated group when compared to normal control. However, the

low dose MSG-treated group showed no significant alterations in the biochemical parameters measured when compared to the control group. In contrast to our study, Banerjee et al. posited that rats treated with MSG (400 mg/kg and 600 mg/kg) experienced a significant increase in CK-MB, LDH and AST, with the rats on 600 mg/kg showing the highest increase [16].

The histopathological findings in this study showed normal myocardial fibres with good morphology in all the study groups A-C. The findings were in tandem with the biochemical results as we observed that monosodium glutamate (MSG) did not pose any serious observable danger to the heart at the doses studied. This finding is similar to the study carried out by Malik and Sabahelkhier, which showed that 0.5 g MSG caused no change on the heart tissues of rats, with less significant degeneration of the heart tissues when treated with 1g of MSG [17]. However, in a study carried out by Okon et al. they found out that prolonged or increased consumption of MSG can drastically affect the histological organization of the heart muscle fibres [18].

5 Conclusion

From the investigation, monosodium glutamate (MSG) can cause weight gain at high dose, but do not pose any serious observable danger to the heart at the doses studied.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest

Statement of ethical approval

Ethical approval for the study was duly obtained from the Ethics Committee of University of Nigeria, Nsukka, Nigeria.

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