EVALUATION OF MONO SODIUM GLUTAMATE INDUCED NEPHROTOXICITY IN ADULT WISTAR ALBINO RATS

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ABSTRACT

The main significance of this research is to investigate the effect mono sodium glutamate (MSG) on the kidney of Wistar albino rats on a daily intake for a different time interval. Forty Wistar albino rats of body weight 200 ± 30 gm (6-7 month old) were used in the present study. Animals were divided into four groups of five male and five females i.e. one control and three treatment groups. Group I served as a control and received normal distilled water while group II, III and IV received MSG at the dose level of 70 mg/100 gm of body weight daily for a period of 30 days, 45 days and 60 days. Decreased in body weight observed in that group of animals who received MSG at the dose level of 70 mg/100 gm of body weight for a period of 60 days. However, decrease in Haemoglobin, PCV and Neutrophill was also observed in group III and group IV (MSG at the dose level of 70 mg/100 gm of body weight for a period of 45 days and 60 day). The value of RBC was also decreased in the group IV (MSG at the dose level of 70 mg/100 gm of body weight for a period of 60 days). However the value of WBC was significantly increased in the animal of group III and group IV. In the biochemical parameters, the value of SGPT and SGOT was significantly increased in the group III and group IV (MSG at the dose level of 70 mg/100 gm of body weight for a period of 45 and 60 days). BUN and Creatinine were significantly increased in the group IV animals. Kidney histopathology showed some pathological changes in renal glomerulus and renal convoluted tubules, swelling in lining endothelium of the glomeruli, loss of brush borders of proximal convoluted tubules as well as necrotic lesions. The study suggests that continuous...
consumption of MSG dosage range tested herein may result in varying degrees of kidney injury, depending on the concentration administered.

KEYWORDS: Nephrotoxicity, Monosodium Glutamate.

INTRODUCTION
Monosodium glutamate (MSG) is also known as sodium glutamate. It is the sodium salt of glutamic acid, one of the most abundant naturally occurring non-essential amino acids.\[1\] It is classified by the U.S. Food and Drug Administration as generally recognized as safe (GRAS) and by the European Union as a food additive. MSG has the HS code 29224229 and the E number E621. Industrial food manufacturers use MSG as a flavor enhancer because it balances, blends and rounds the total perception of other tastes.\[2,3\] Trade name of monosodium glutamate includes Accent, Aji-No-Moto, and Vestin. Glutamate is one of the most common amino acids in nature and is the main component of many proteins and peptides of most tissues. MSG contains 78% glutamic acid, 22% sodium and water. Glutamate is also produced in the body and plays an important role in human metabolism. When present in its “free” form, not “bound” together with other amino acids in protein, glutamate has a flavor-enhancing effect in foods.

Use of MSG in food has grown in the last 30 years and is still growing. MSG is found in most soups, salad dressings, processed meats, frozen entrees, ice cream, and frozen yogurt, in some crackers, bread, canned tuna, and very often in "low fat" and "no fat" foods to make up for flavor lost when fat is reduced or eliminated. It can be found in cosmetics, pharmaceuticals, and dietary supplements. It is found in feeding products and in infant formula. MSG mixes well with many different forms of livestock. (e.g. beef, pork, poultry, fish) many vegetables, sauces, soups, and marinades. But like other basic tastes, except sucrose, MSG improves the pleasantness only in the right concentration: an excess of MSG is unpleasant. The unique flavor and taste of this compound had been categorized and established as a separate taste sensation “umamai” taste.

The safety and toxicity of MSG had become controversial in the last few years because of reports of adverse reactions in people who have eaten foods that contain MSG. Many studies had confirmed the adverse reactions of MSG. It has been found that MSG caused headache, vomiting, diarrhoea, irritable bowel syndrome, asthma attacks in asthmatic patients and panic attacks.
Some histological changes were noticed in the liver and kidneys of some of the animals randomly selected necessitating a full evaluation of its effect on liver and kidney microanatomy at doses well below those known to be toxic. More recently, chronic exposure to low dose MSG has been shown to result in damage to pancreatic structures including necrotic, degenerative changes to pancreatic exocrine and endocrine cells.

MATERIALS & METHODS

Collection of Monosodium glutamate
Monosodium glutamate was procured from local supplier in the amount of 500 gm as it is easily available in the local market. 40 Healthy Wistar albino rats were selected for the experimentation. The average weight of each animal is 200 ± 30 gm. All the animals acclimatized for one week in standard laboratory condition.

Study design

**Group-I** – Included ten rats (five male and five female) that were given a daily oral dose of only distilled water at the dose level of 5 ml/kg body weight for a period of 30 days.

**Group-II** – Included ten rats (five male and five female) that were given a daily oral dose of MSG at the dose level of 70mg/100 g body weight for a period of 30 days and they were sacrificed.

**Group-III** – Included ten rats (five male and five female) that were given a daily oral dose of MSG at the dose level of 70mg/100 gm body weight for a period of 45 days.

**Group-IV** – Included ten rats (five male and five female) that were given a daily oral dose of MSG at the dose level of 70mg/100 gm body weight for a period of 60 days.

Table – 1 Distribution of groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Dose (mg/g b.wt.)</th>
<th>Treatment days</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group – I</strong></td>
<td>control group</td>
<td>30 days</td>
</tr>
<tr>
<td><strong>Group – II</strong></td>
<td>MSG 70 mg/100 gm of body weight</td>
<td>30 days</td>
</tr>
<tr>
<td><strong>Group – III</strong></td>
<td>MSG 70 mg/100 gm of body weight</td>
<td>45 days</td>
</tr>
<tr>
<td><strong>Group – IV</strong></td>
<td>MSG 70 mg/100 gm of body weight</td>
<td>60 days</td>
</tr>
</tbody>
</table>

Preparation and administration of test compound
The preparation of test compound Monosodium Glutamate (MSG) was done freshly, few minute prior dosing. The test substance was dissolved in distilled water to obtain final
concentration. The animals were dosed by oral gavages at approximately the same time each day where possible, using a graduated syringe and a stainless steel intubation cannula. The dose volume for each animal was 10 ml/kg body weight (Fig. 1).

**OBSERVATIONS**
The following parameters were studied.

**Mortality**
All the animals were observed daily for any mortality up to day 30\textsuperscript{th} for group I and II, day 45\textsuperscript{th} for group III and day 60\textsuperscript{th} for group IV.

**Clinical Signs**
All the animals were observed at least twice daily to record any symptoms of ill-health or behavior changes. The clinical observations include – changes in skin and fur, in the eyes and mucosa membrane, in the respiratory, circulatory, central nervous and autonomous system and behavior. Clinical signs were graded as follows 0 = No clinical signs, + = mild, ++= moderate, +++= high, ++++= severe.

**Body weight**
The body weight of each rat was recorded before the start of experiment and after that every week up to the end of the experiment. The mean body weights of different groups and sex were calculated from the individual weights.

**HAEMATOBIОCHEMICAL STUDY**

**Haematological study**
The following estimations, with their units of measurement as listed below, were performed using Coulter ACT diff\textsuperscript{®} Haematology Analyzer. Haemoglobin (Hb) (g/dl), Packed cell volume (PCV) (%), Total red cell count (Total RBC) (x106/cmm), Total white cell count (Total WBC) (x103/cmm), Platelet Count, Total (Platelets) (x103/cmm), Mean corpuscular volume (MCV) (fl), Mean corpuscular hemoglobin (MCH) (pg), Mean corpuscular hemoglobin concentration (MCHC) (g/dl), Clotting time measurement (seconds) was performed manually using standard techniques, Differential WBC counts: Were determined by microscopy of blood smear, stained with-Wright's stain, counting 100 cells – Neutrophils (N) %, Lymphocytes (L) %, Eosinophils (E) %, Monocytes (M) %.
Biochemical study
Plasma chemistry parameters, with their units of measurement as listed below, were analyzed using the “Erba Smart lab Random Access Batch Analyzer/Erba EC5 Plus Analyzer” (Transasia Bio-Medicals Ltd., India) using standard methodology: Total Protein (g/dl), Total Cholesterol (Cholesterol) (mg/dl), Albumin (g/dl), Triglycerides (mg/dl), Creatinine (Creatinine) (mg/dl), Alanine aminotransferase (ALT) (IU/L), Urea Nitrogen (UN) (mg/dl), Aspartate aminotransferase (AST) (IU/L), Bilirubin (mg/dl), Glucose (mg/dl).

Terminal Studies
On completion of the study all the animals were sacrificed by CO₂ inhalation. A full necropsy was performed on all animals which included examinations of the external surface of the body all orifices, thoracic and abdominal cavities and their content.

Absolute organ weight
The organ weight of kidneys of each rat was recorded on different days such as on day 31st for group I and II, on day 46th for group III and on day 61st for group IV. The organs were weighed using a Citizen Electronic Weighing Machine, CY-220-MP-300.

Fig. 1 Administration of test compound
Histopathological examinations
After scarification and dissection, the specimen of kidney was removed immediately and fixed in 10% buffer formal saline for 24 hours, then washed and dehydrated in ascending grades of alcohol. After fixation, kidneys were embedded in paraffin blocks and processed for the preparation of 5 µ thickness sections with the help of YSI-115 Precision Rotary Microtome. These sections were subjected for following stain; Hematoxylin and Eosin (H & E).

STATISTICAL ANALYSIS
All the data were analyzed using the one way analysis of variance (ANOVA) followed by Tukey HSD test carried out to determine the source of a significant effect. Results were expressed as Mean ± S.E.M., p<0.5 is taken as accepted level of significant difference from control.

RESULTS

Haematological parameters
The haemoglobin concentration was statistically significant decrease (p<0.05) in both the group III and group IV (MSG at the dose level of 70 mg/100 gm of body weight for 45 days and 70 mg/100 gm of body weight for 60 days) in comparison to control. The concentration of RBC was significantly decrease (p<0.05) in group IV (MSG at the dose level of 70 mg/100 gm for 60 days) when compared to control group. WBC was significantly increase (p<0.05) in group III and IV (MSG at the dose level of 70 mg/100 gm of body weight for 45 days and 70 mg/100 gm of body weight for 60 days). The value of mean corpuscular volume (MCV) and Packed cell volume (PCV) was observed high in the group IV (MSG at the dose level of 70mg/100 gm of body weight for a period of 60 days). However the value of Mean corpuscular haemoglobin concentration (MCHC) was decreased in the group IV when compared to control group.

Differential leukocyte counts
The differential leukocyte count Monocytes, and Eosinophils showed statistically non-significant (p>0.05) change in all the groups, whereas the value of Neutrophils was decrease significantly (p<0.05) in groups III and IV. Furthermore, the value of lymphocytes was significantly increase (p<0.05) in groups III and IV (MSG at the dose level of 70 mg/100 gm of body weight for 45 days and 70 mg/100 gm of body weight for 60 days) as compared to control group.
Table for haematological parameters is listed below.

TABLE – 2: SUMMARY OF HAEMATOLOGY

<table>
<thead>
<tr>
<th>Parameters</th>
<th>GROUPS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group-I Distilled water (5ml/kg body weight)</td>
</tr>
<tr>
<td>Haemoglobin (Hb) (g/dl)</td>
<td>13.74±0.77</td>
</tr>
<tr>
<td>Total red cell count (x10⁶/µl)</td>
<td>7.43±0.50</td>
</tr>
<tr>
<td>Total white cell count (Total WBC)(x10³/µl)</td>
<td>11.8±0.55</td>
</tr>
<tr>
<td>Packed cell volume (PCV) (%)</td>
<td>44.12±0.50</td>
</tr>
<tr>
<td>Mean corpuscular volume (MCV) (fl)</td>
<td>59.57±3.88</td>
</tr>
<tr>
<td>Mean corpuscular haemoglobin (MCH) (pg)</td>
<td>18.56±1.66</td>
</tr>
<tr>
<td>Mean corpuscular haemoglobin concentration (MCHC) (g/dl)</td>
<td>31.15±1.88</td>
</tr>
</tbody>
</table>

DIFFERENTIAL LEUKOCYTE COUNT (%)

| Lymphocyte       | 76±1.03 | 75±1.41 | 85±1.03* | 87±7.68 |
| Neutrophils      | 21±0.94 | 22±1.31 | 13±3.05* | 12±2.14* |
| Monocytes        | 1±0.73  | 1.0±0.73 | 1±0.63   | 1.0±0.48 |
| Eosinophils      | 2±0.66  | 2.0±0.69 | 1.0±0.78 | 1.0±0.94 |

Values are statistically non significant from control (P> 0.05)

TABLE – 3: SUMMARY OF BIOCHEMICAL CHANGES (Mean±SE)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>GROUPS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group-I Distilled water (5ml/kg body weight)</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>3.66±0.30</td>
</tr>
<tr>
<td>Total Protein (g/dl)</td>
<td>7.07±0.07</td>
</tr>
<tr>
<td>Bilirubin total (mg/dl)</td>
<td>0.44±0.02</td>
</tr>
<tr>
<td>Bilirubin Direct (mg/dl)</td>
<td>0.14±0.013</td>
</tr>
<tr>
<td>Alanine Aminotransferase (ALT) (IU/L)</td>
<td>21.57±0.09</td>
</tr>
<tr>
<td>Alkaline phosphatase (ALP) (IU/L)</td>
<td>80.35±0.57</td>
</tr>
<tr>
<td>Aspartate aminotransferase (AST) (IU/L)</td>
<td>83.02±0.02</td>
</tr>
<tr>
<td>Blood Urea Nitrogen (BUN) (mg/dl)</td>
<td>22.86±0.088</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>0.21±0.017</td>
</tr>
<tr>
<td>Glucose (mg/dl)</td>
<td>114.9±0.14</td>
</tr>
</tbody>
</table>

Data are expressed as Mean ± S.D. (n=10)

Values are statistically not significant from control (P> 0.05)
Absolute organ weight
At the next day of end of the dose administration the kidneys were removed, washed in ice-cold 1.15% KCl solution to remove blood and other extraneous substances, dried in a filter paper and weighed. There was no change recorded in the weight of kidney of group II and group III (MSG at the dose level of 70mg/100 gm of body weight for 30 and 45 days) as compared to group I (control group). Whereas, the weight of kidney was increased in the group IV (MSG at the dose level of 70mg/100 gm of body weight for 60 days) as compared to control group.

Table 4 Organ Weight

<table>
<thead>
<tr>
<th>Groups</th>
<th>Kidneys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group-I: Distilled water control</td>
<td>1.21±0.01</td>
</tr>
<tr>
<td>Group-II: MSG 70 mg/kg body weight for 30 days</td>
<td>1.08±0.014</td>
</tr>
<tr>
<td>Group-III: MSG 70 mg/kg body weight for 45 days</td>
<td>1.7±0.02</td>
</tr>
<tr>
<td>Group-IV: MSG 70 mg/kg body weight for 60 days</td>
<td>3.2±0.2*</td>
</tr>
</tbody>
</table>

*p<0.05 as compared to control

Necropsy finding
On completion of the study (day 31st for group I and II and day 46th and 61st for group III and IV) all the animals were sacrificed by CO₂ inhalation. A full necropsy was performed on all animals which included examinations of the external surface of the body all orifices, thoracic and abdominal cavities and their content.

NECROPSY FINDINGS
ABDOMINAL CAVITY

i. Opening and general examination- In the abdominal cavity all the organs were present in normal position. There was no fluid, adhesion, blood and any neoplastic growth observed.

ii. Spleen- spleen was found to be normal and no morphological changes were recorded in any of the MSG treated groups.

iii. Digestive system- No change was observed.

iv. Liver and biliary ducts- No gross pathological changes were observed in the MSG treated group II and III. However, mild congestion was observed in the group IV (MSG at the dose level of 70mg/100 gm body weight for 60 days).
v. **Urinary apparatus**- Kidney showed normal size, colour, and consistency in the MSG treated group II and III but the mild increase in the weight of kidneys and midl congestion was observed in the group IV (MSG at the dose level of 70 mg/100 gm of body weight for 60 days).

vi. **Male/female genital apparatus**- Showed normal colour, consistency and no inflammatory changes were recorded in any of the MSG treated groups.

**Histopathological findings**
The rats were sacrificed at the end of the dose administration (such as day 31st for group I and II, day 46th for group III and day 61st for group IV). The tissues of kidneys were quickly dissected and fixed in 10% formal saline for routine histopathological technique. The tissues 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 rotator microtome. The deparaffinised sections were stained routinely with haematoxyline and eosin. Photomicrographs of the desired results were obtained using digital research photographic microscope.

**The individual histopathological findings of all groups were as follows.**

**Group I** – This group includes ten Wistar albino rats (5 male and 5 female) and only distilled water given to this group for a period of 30 days. Necropsy of this group was conducted on day 31st and the **tissues** of kidneys were dissected from the animals. As this group served as a control group, no microscopical changes were recorded in kidneys (Fig. 2).

![Fig. 2 showing normal glomerular and tubular structure in vehicle control group wistar albino rats. H&E 10×10X.](image-url)
**Group II** – This group includes ten Wistar albino rats (5 male and 5 female) and this group of animals were treated with the Monosodium glutamate (MSG) at the dose level of 70mg/100 g body weight for a period of 30 days through oral administration and they were sacrificed on day 31st.

Microscopic examination of kidneys of this group showed dilation of the Bowman’s space, contraction of the renal glomerulus and hypercellularity which are in keeping with renal injury (Fig. 3).

![Figure 3 showing contraction of the renal glomerulus and hypercellularity in wistar albino rats treated with Monosodium glutamate (MSG) at the dose level of 70mg/100 g body weight for a period of 30 days. H&E 10×10X](image)

**Group III** – This group contains ten Wistar albino rats (5 male and 5 female) and they were given an orally administration of MSG at the dose level of 70 mg/100 gm body weight for a period of 45 days and they were sacrificed and the tissues kidneys were dissected and subjected to microscopical changes. Microscopic examination of the kidneys specimens of the rats of this group showed variable pathological changes in glomeruli and renal convoluted tubules. Such changes exhibited an existence of hydropic degeneration of the tubular epithelium with vacuolization and tubular dilation with intralumenal hyaline casts and cortical tubular degeneration in kidneys (Fig. 4)

**Group IV** – This group also contains 10 Wistar albino rats (5 male and 5 female). This group of animals received MSG through oral administration for a period of 60 days at the dose level of 70 mg/100 gm of body weight. The animals of this group were sacrificed on day 61st.
Microscopic examinations of kidneys specimens of the rats of MSG group IV after 60 days administration showed mononuclear inflammatory cellular infiltration in interstitial tissues. Also it was noticed that there were swelling in the lining endothelium of the glomeruli associated focal areas of glomerular atrophy. Dilation and hyperemia in the intertubular cortical blood vessels and focal hemorrhage between the tubules were seen clearly. Loss of brush border of proximal convoluted tubules as well as necrotic lesions were also observed (Fig. 5).

Fig. 4 T.S. of kidney showing contraction of the renal glomerulus, dilation of woman’s capsule, hydropic degeneration of tubular epithelium and intraluminal hyaline cast in wistar albino rats treated with Monosodium glutamate (MSG) at the dose level of 70mg/100 g body weight for a period of 45 days. H&E 10×10X

Fig. 5 T.S. of kidney showing glomerular atrophy, swelling of glomerular epithelium, loss of brush border, necrotic changes in tubular epithelium, hyperemia in cortical blood vessels and intraluminal hyaline cast in wistar albino rats treated with Monosodium glutamate (MSG) at the dose level of 70mg/100 g body weight for a period of 60 days. H&E 10×10X
DISCUSSION

Although several international organizations and government institutions have declared MSG safe for consumption, literature has shown that continuous administration of Monosodium glutamate (MSG) can alter normal range of hematological parameters.\[4\] However, such studies dealing with the effects of MSG on hematological parameters are scare. Therefore, this study examines the effect of monosodium glutamate on hematological parameters such as packed cell volume (PCV), hemoglobin (Hb), red blood cells (RBC), mean cell volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), neutrophill and lymphocyte count in Wistar albino rats, as well as the 30 to 60 days post administration effects. The present study showed that both dose and concentration produce significant effect on hematological parameters. But causal relationship between MSG and adverse reactions is far from being established.\[5\]

Red blood cells count suggests that it probably reduces the life span of red blood cells in the blood which might be as a result of direct toxicity. This might also have been mediated through a deleterious effect on the hemopoietic stem cells in the bone marrow. The present study shows MSG administration has a significant effect on the neutrophill, hemoglobin, packed cell volume and red blood cells, indicative of a compromised immune status and poisoning respectively in the treated animals. Hence, these findings support the fact that monosodium glutamate despite its flavoring functions is detrimental to health.\[6\]

In the present study, administration of MSG resulted in impairment of some renal biomarkers reflected by the significant increase in urea, Creatinine and albumin. Effect of MSG on Kidney functions parameters shows the mean kidney function values of the rats treated with MSG from the table urea, albumin and Creatinine levels were significantly increased when compared with the control and above the normal reference values (Table 3).

It is generally believed that the increased urinary albumin excretion in most renal insult is mostly glomerular in origin. This may be due to increased intraglomerular pressure, loss of negatively charged in the basement membrane, and increased basement membrane pore size.\[7\]

Furthermore, the biochemical alterations induced by Monosodium glutamate treatment in the current study were augmented by the observed histopathological changes in the examined renal tissues of rats treated with MSG.
Remarkable elevated level of urea, albumin and Creatinine were recorded in the rats that were given Monosodium glutamate orally at the dose level of 70 mg/100 gm of body weight for a period of 60 days when compared to control. Serum urea and Creatinine increases as the ability of the kidney to filter fluid within the body declines. In a very general term a rising level of Creatinine significance an increasing problem with poorly performing kidneys.\cite{8, 9}
Hence there are possible link between MSG and renal impairment.

The present study indicated that the Monosodium glutamate induced marked histopathological alterations in the kidney tissues of rats such tissues impairment, swelling of the lining epithelium of glomeruli, injured brush order of proximal convoluted tubules, necrotic lesions of the urinary tubules and focal hemorrhage between the degenerative renal tubules. Similar results have been reported by others.\cite{10, 11, 12, 13}

In the present investigations, many renal tubules of the rat kidneys showed marked degenerative lesions under the effect of MSG. This is justifiable since the renal tubules are particularly sensitive to toxic influences, in part because they have high oxygen consumption and vulnerable enzyme systems, and in part because they have complicated transport mechanisms that may be uses for transport of toxins and may be damaged by such toxins. Also the tubules come in contact with toxic chemicals during their excretion and elimination by the kidneys.\cite{14}

Such degenerative changes were markedly pronounced in the proximal convoluted tubules. These findings reinforce those of Koechel et al., (1984) and Damjanov (1996), who found that many chemicals had a direct nephrotoxic action and exerted their effects principally on the proximal convoluted tubules.\cite{15, 16}

The presence of necrosis may be related to the depletion of ATP, which finally leads to the death of the cells.\cite{17} Renal medullary necrosis occurs as a primary manifestation of renal disease. The mechanism of which is poorly understood, but it seems to involve a vascular change.

Also, prostaglandin synthetase is found in the kidney, primarily in the medulla, and inhibition of this enzyme resulted in decreased production of prostaglandin E2 (PGE2) and loss of its vasodilatory effect on juxtamedullary arterioles.\cite{18}
One possible mechanism for the tubular lesions is the direct toxic effect on the cell function.\textsuperscript{[19]} Damage to the brush border and leakage of alkaline phosphates (ALP) and gammaglutamyltransferase (GGT) enzymes, which are associated with the brush border of the renal tubules, as a result of toxin binding to the brush border and considered as an early marker of toxic tubular insult.\textsuperscript{[20, 21, 22, 23]}

Other possible mechanisms for the tubular lesions may involve reactive intermediate or oxidative stress, or both.\textsuperscript{[24]} Biologically reactive intermediates are electron-deficient compounds (electrophiles) that bind to cellular electron-rich compounds, such as proteins and lipids.\textsuperscript{[25]} Mixed-function oxidases catalyze the formation of their toxic metabolites. Reactive intermediates bind covalently to critical cellular macromolecules and interfere with normal biological activity. Oxidative stress is induced by increasing production of reactive oxygen species (ROS), such as superoxide anion, hydrogen peroxide and hydroxyl radicals.\textsuperscript{[25]} ROS can induce lipid peroxidation, inactivate cellular enzymes, depolymerize polysaccharides, and induce deoxyribonucleic acid breaks and chromosome breaks.

Superoxide dismutase (SOD) is a naturally occurring intracellular enzyme that catalyzes the breaks down of superoxide radicals.\textsuperscript{[26]} Ischemia leads not only to an increase in superoxide production, but also, to a rapid depletion of SOD.\textsuperscript{[27]}

The detection of Lymphocyte inflammatory cells in the present study indicated the production of chronic inflammatory disease under the effect of MSG. This result agreed with Ashry et al., (1990) who demonstrated chronic active cells accompanied by inflammatory cells in the hepatocytes after administration of codeine.\textsuperscript{[28]}

This study could be regarded as preliminary research findings, which necessitate further investigation to establish the mechanism of toxicity of the compounds on the studied organs. Prospective studies should consider tissue histology, aspect of reproductive and genetic toxicity, mutagenecity and carcinogenicity effects. Nevertheless findings have shown that the granular study is significant and that Monosodium Glutamate is likely to produce severe toxicological effects on liver and kidney when consumed in high dose.
CONCLUSION
From the present study, it can be concluded that continuous consumption of MSG in the dosage range tested herein may result in varying degrees of kidney injury, depending on the duration and concentration of the MSG administered.

ACKNOWLEDGMENTS
I am thankful to all the authors who’s helped me during my research.

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