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The role of shilajit in reducing the toxicity of monosodium glutamate on liver enzyme and kidney functions in albino mice

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Abstract. ***Background.*** *A flavor enhancer that sees extensive usage in the food business is monosodium glutamate (MSG). While many studies have shown that long-term consumption of MSG can cause oxidative stress in animals, especially in their liver and kidneys, it was the goal of this study to examine the biochemical effects of hepatitis and kidney inflammation caused by different doses of MSG and the protective effect of shilajit water extract in albino mice. This research is designed to assess the biochemical toxicity of various dosages of MSG on the kidney and liver function in albino mice.* ***Materials and methods.*** *Fifty adult mice were randomly assigned to one of five groups (10 animals each). In contrast to the experimental group (G2) that received MSG at a dose of 2 g/kg body weight, the control group (G1) received pure water. The third group (G3) received the same amount of MSG plus 100 mg/kg of shilajit extract. In contrast to the fourth group (G4), which received a higher dose of MSG (4 g/kg body weight), the fifth group (G5) received the same amount of MSG in addition to 200 mg/kg of shilajit. The oral medications were maintained daily for a period of 14 days. On day 15, the animals were euthanized after being put to sleep. Following that, biochemical analysis was performed on the collected samples. This included testing for renal function indicators (such as creatinine and urea) and liver enzymes (such as AST, GGT, ALP, and ALT).* ***Results.*** *Compared to the control group, groups G2 and G4, which received just MSG, had a significant rise ($P \leq 0.05$) in liver enzyme levels (ALP, AST, and ALT), suggesting substantial liver damage. On the other hand, shilajit extract showed a significant decrease in these levels, suggesting that it may provide some protection against the toxicity caused by MSG.* ***Conclusions.*** *The current study found that when high doses of monosodium glutamate were administered, it caused significant disturbances in the function of both the liver and the kidneys. They were manifested by a significant increase in the levels of liver enzymes (AST, ALT, ALP, and GGT), as well as an increase in renal function indicators (urea and creatinine), which indicated that these organs had suffered tissue and functional damage as a result of excessive oxidative stress.*

Keywords: *monosodium glutamate; shilajit; liver; kidney; liver enzymes; renal function*

Introduction

People are increasingly going against the recommendations of healthy eating programs like the DASH diet by consuming more processed foods and fast food [1]. Artificial sweeteners, hydrogenated fats, and flavor enhancers like monosodium glutamate (MSG), which is used widely in the food industry, have all seen an uptick in use due to this development [2]. Glutamic acid is abundant in both plants and animals, and it is one of the most prevalent amino acids that are not considered essential. On the other hand, Ajinomoto is one of the terms for MSG. Magnesium stearate, or MSG, is essentially the sodium salt of glutamic acid [3]. Of its total composition, 78 % is glutamic acid and 22 % is salt and water [4]. Naturally occurring glutamate is found in a wide variety of foods, including tomatoes, milk, cheese, mushrooms, and seafood. Animal tissues may also contain glutamate. Glutamate is not only produced by the body but also plays an essential role in metabolic processes [5, 6].

MSG is a prominent component in many Asian cuisines, particularly those of China, Thailand, and Japan [7, 8]. Its

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presence increases taste and stimulates appetite, making it a popular choice for cuisines in these countries. In spite of the fact that the United States Food and Drug Administration (FDA) has classified MSG as Generally Recognized as Safe (GRAS) [9], there is still a great deal of controversy among medical professionals and scientists over the possible adverse effects that it may have on human health. Investigations conducted by other researchers have shown a connection between it and harmful effects on the central nervous system, liver, and kidneys, in addition to the potential adverse effects on reproductive function. The oxidative stress, calcium imbalance, and glutamate receptor activation that occur in the brain are the mechanisms that are responsible for these consequences [10, 11].

One possible mechanism by which MSG causes neurotoxicity is via increasing the activity of N-methyl-D-aspartate (NMDA) receptors. The cascade of events begins with an overabundance of calcium ions entering neurons, which triggers cell-destructive enzymes [8, 11]. The organic component shilajit, on the other hand, is found in nature and is harvested from rocks in hilly areas like the Himalayas. Because of its many biological and pharmacological properties, shilajit has been a staple of traditional medicine for hundreds of years [12]. Among the compounds found in shilajit are those that possess anti-inflammatory effects. These chemicals have the potential to decrease the pain and other symptoms associated with inflammatory illnesses, such as arthritis and chronic musculoskeletal pain [13, 14]. With its benefits on cardiovascular health, which include improved blood circulation and management of blood cholesterol levels, shilajit may also help protect the liver from dangerous compounds by reducing oxidative stress and enhancing cell repair mechanisms, according to recent study [15]. Shilajit also has the potential to protect the liver from toxic substances. Due to the powerful antioxidant and immunomodulatory capabilities that they possess, fulvic acids and other active compounds are responsible for the majority of these effects [16].

Shilajit is an appealing natural medical drug [17], and this is due to the fact that it can lessen the negative effects that some chemical chemicals, such as monosodium glutamate (MSG), have on the kidneys, liver, and central nervous system. In light of the aforementioned, the purpose of the current inquiry is to evaluate, using albino mice serving as a model, the biochemical effects of MSG at different doses and the effectiveness of an aqueous shilajit extract in mitigating these effects, with a specific focus on markers of liver and kidney function.

Materials and methods

Methodology for the synthesis of monosodium glutamate and shilajit

In accordance with the procedures outlined in the research, distilled water was used to dissolve the monosodium glutamate (MSG) powder to achieve two concentrations: 2 and 4 g/kg body weight [18]. The two quantities of shilajit extract (100 and 200 mg/kg body weight) were achieved by dissolving tablets in distilled water [19].

Chemical composition of the shilajit extract

Shilajit is a complex mixture composed of several minerals, organic compounds, and bioactive substances. The primary component of shilajit is fulvic acid, which accounts for its unique properties. The chemical structure of shilajit can be described as follows:

1. Fulvic acid. A humic substance with a molecular weight of 5,000–10,000 Da, it is a significant part of shilajit and contributes to its therapeutic properties.

2. Minerals. Shilajit contains over 80 minerals, including iron, zinc, magnesium, copper, manganese, calcium, and potassium. These minerals are present in their ionic forms, making them more bioavailable.

3. Dibenzo-alpha-pyrones. These organic compounds are found in small quantities and are thought to contribute to the antioxidant properties of shilajit.

4. Other compounds. Includes amino acids, vitamins (like B-complex), and fatty acids.

Shilajit, due to its mineral and organic complexity, is known to act as a natural adaptogen and bioenhancer, improving the absorption and bioavailability of other nutrients in the body (Fig. 1).

Animal experiment design

From the National Center for Drug Control and Research's Experimental Animal Center, we procured albino mice weighing 20–30 g. Mice were kept in a typical laboratory setting with access to food and water at all times, in a moderately heated environment with adequate ventilation and a regular light/dark cycle [20].

There were 50 mice, and they were randomly put into five groups of ten mice each group:

— group 1. This group serves as the control, administered solely with distilled water;

— group 2. Administered MSG at a dosage of MSG 2 g/kg;

— group 3. Administered MSG at a dosage of 4 g/kg of body weight;

— group 4. Administered MSG at a dosage of 2 g/kg alongside shilajit at a dosage of 100 mg/kg;

— group 5. Administered MSG at a dosage of 4 g/kg in conjunction with shilajit at a dosage of 200 mg/kg.

The medicines were given orally for 14 days in a row using an oral pipette.

Sample collection and biochemical analysis

After the beginning of the 14-day treatment period, blood samples were taken from the mice and placed in tubes that

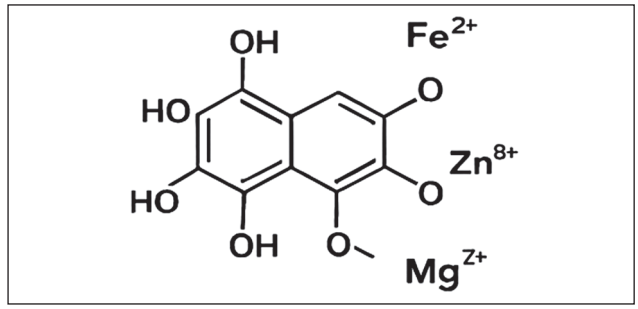

Figure 1. Chemical structure of shilajit

contained anticoagulant medication. In order to separate the serum, the samples were centrifuged for five minutes at a speed of 4,000 revolutions per minute [21]. In order to evaluate the function of the liver, the levels of the following enzymes were measured: ALT, AST, ALP, and GGT. In addition, assessments of kidney function included the measurement of urea and creatinine. Every test was carried out using ELISA kits purchased from Cusabio in the United States [22].

Statistical analysis

The results were represented using both the mean and the standard error (mean ± SE). A one-way analysis of variance (ANOVA) was conducted to determine the least significant difference (LSD) among the groups. The LSD was found to be statistically significant at a probability threshold of $P < 0.05$ [23], suggesting that the observed difference holds statistical relevance.

Results

Liver functions

Efficacy of shilajit against the impact of monosodium glutamate on AST and GGT

The treated groups differed significantly from the control group (G1) at the probability level ($P < 0.05$), as indicated in Table 1. The second group (G2), which got 2 g/kg of MSG, and the fourth group (G4), which got 4 g/kg of MSG, both had significantly elevated AST levels. Two groups that received shilajit treatment — group 3 (G3: MSG 2 g + Shi 100 mg) and group 5 (G5: MSG 4 g + Shi 200 mg) — exhibited a marked reduction in enzyme levels when contrasted with the groups that received MSG alone. This suggests that shilajit protects against hepatotoxicity caused by MSG.

Comparing the treated groups with the control group revealed significant differences at a significance level of $P < 0.05$, according to the findings in the same table. In the fifth group (G5, which consisted of 4 grams of MSG and 200 milligrams of Shi), enzyme levels dropped significantly, eventually matching those in the control group (G1). In contrast, the enzyme levels in the third group (MSG 2 g + Shi 100 mg, G3) were significantly higher than in the other groups, proving that medium dosages of shilajit were helpful and that low doses were ineffective in this setting.

Effectiveness of shilajit in counteracting the impact of monosodium glutamate on ALT and ALP levels

Table 2 indicates notable differences that are statistically significant at the $P \leq 0.05$ level when the treated groups are compared to the control group (G1). The table demonstrated that the fifth group (MSG 4 g + Shi 200 mg, G5) showed a significant decrease in the measured index, closely matching the values of the control group (G1). The third group (MSG 2 g + Shi 100 mg, G3) exhibited a significant increase in the same index relative to the other groups. The findings indicate that the low dose of shilajit failed to demonstrate a protective effect when compared to the effects of MSG ($P \leq 0.05$).

Table 2 presents a significant rise in the indicators for the treated groups relative to the control group, reaching a significance level of $P \leq 0.05$. Upon comparison of the treated groups, it was noted that the fifth group (MSG 4 g + Shi 200 mg, G5) demonstrated a significant reduction when contrasted with the fourth group, which received only MSG at a dosage of 4 g (G4). The third group (MSG 2 g + Shi 100 mg, G3) exhibited a significant increase relative to the second group (MSG 2 g, G2), while preserving the same level of significance ($P \leq 0.05$). The previous statistical evaluation highlights the notable protective effect of shilajit at the highest dosage (200 mg) in reducing the negative effects of MSG.

Renal function

Urea and creatinine

The information shown in Table 3 reveals significant variations at $P \leq 0.05$ when analyzing the treated groups

Table 1. Effect of shilajit versus MSG on AST and GGT levels in rat serum (mean ± SE)

Groups	N	AST	GGT
G1 (control — distilled water)	10	31.03 ± 1.20	161.12 ± 6.42
G2 (MSG 2 g/kg)	10	34.30 ± 1.09	295.67 ± 19.40
G3 (MSG 2 g + Shi 100 mg)	10	33.09 ± 0.51	385.33 ± 27.40
G4 (MSG 4 g/kg)	10	34.72 ± 1.15	193.64 ± 5.14
G5 (MSG 4 g + Shi 200 mg)	10	33.31 ± 0.91	159.73 ± 9.32

Table 2. Effect of shilajit versus MSG on ALT and ALP levels in rat serum (mean ± SE)

Groups	N	ALT	ALP
G1 (control — distilled water)	10	18.73 ± 0.28	101.72 ± 2.18
G2 (MSG 2 g/kg)	10	33.64 ± 1.47	149.54 ± 3.13
G3 (MSG 2 g + Shi 100 mg)	10	36.63 ± 0.75	151.46 ± 5.74
G4 (MSG 4 g/kg)	10	25.60 ± 0.95	127.60 ± 1.01
G5 (MSG 4 g + Shi 200 mg)	10	18.93 ± 0.57	111.56 ± 3.15

in relation to the control group, with urea levels showing a marked increase in the MSG-treated groups. An in-depth analysis of the groups revealed that the fifth group (MSG 4 g + Shi 200 mg, G5) exhibited a significant decrease in urea concentration relative to the other groups, reaching levels similar to those found in the control group (G1). The third group (MSG 2 g + Shi 100 mg, G3) demonstrated a significant increase in urea levels compared to the second group (MSG 2 g, G2), with consistent statistical significance ($P \leq 0.05$).

The findings presented in Table 3 indicate notable alterations in kidney function indicators when the experimental groups are compared to the control group (G1), with a significance level of $P \leq 0.05$. Both the second group (MSG 2 g, G2) and the fourth group (MSG 4 g, G4) exhibited a significant increase in the studied indicator relative to the control group, suggesting a distinct toxic effect of MSG. The third group (MSG 2 g + Shi 100 mg, G3) and the fifth group (MSG 4 g + Shi 200 mg, G5) demonstrated a significant decrease in the same indicator relative to the two MSG-only groups (G2 and G4), while preserving the same significance level ($P \leq 0.05$).

Discussion

Glutamate is an amino acid that occurs naturally in many foods in different levels. However, there is a difference between free glutamate and glutamate that is attached to proteins. Protein-bound glutamate, which is included in foods like meat and tomatoes, is not as harmful as free glutamate because it is absorbed into tissues, particularly muscle, over a longer period of time and breaks down more slowly in the gut. Compared to protein-bound glutamate, free glutamate which is included in taste enhancers like MSG — is more dangerous because it is quickly absorbed and causes a dramatic increase in blood glutamate concentrations [24]. This study's findings suggest that MSG inhibits antioxidant defenses, speeds up glucose metabolism, and increases cellular reactive oxygen species (ROS) generation, all of which harm DNA, proteins, and lipids. One of the long-term effects of MSG exposure is apoptosis, which occurs when cell membranes undergo lipid peroxidation due to the oxidation of unsaturated fatty acids. This, in turn, disrupts the structure and function of cell membranes, leading to cell death or permanent damage. This compound's free radicals degrade mitochondrial function and tamper with genetic information inside cells [9].

Exposure to environmental and dietary chemicals, such as MSG, makes the liver particularly vulnerable to damage [25]. The liver is one of the most affected vital organs by food poisoning because of its central role in regulating metabolism, storing glycogen, synthesizing plasma proteins, producing bile (essential for fat digestion), and filtering toxins and harmful chemicals from the blood.

Consistent with other studies, this one also utilized two dosages of MSG (40 and 120 mg/kg), which had similar outcomes [26]. Functional damage to the liver was indicated by a rise in ALT and AST levels and a significant drop in total protein levels. After 28 days of MSG administration, another research found that laboratory rats' liver enzymes (AST, ALT, GGT) increased. This was thought to be because MSG exposure caused alterations in the liver's histology. Within the same framework, research [27], shown that male mice given a daily oral gavage dosage of MSG (2 g/kg) for four weeks had significantly higher body weight and blood ALT and AST levels than the control group, with a statistically significant difference at ($P < 0.001$) as recorded in [28].

Thirty found that ALT, AST, ALP, and GGT levels were significantly elevated after four weeks of treatment with MSG at a dosage of 1 mg/kg. Oxidative stress, DNA damage, and detrimental effects on liver function from PCNA and p53 protein gene expression were established. The activity of the liver cell membrane damage markers ALT and AST in serum may be used to measure MSG-induced hepatotoxicity, according to scientific research. The breakdown of cell membranes containing unsaturated fatty acids causes oxidative stress, which in turn causes enzymes normally contained in mitochondria and plasma membranes to seep into the circulation [29, 30]. Several studies have shown that MSG exposure, whether with a single large dosage [31–33], or with repeated low doses [34–36], significantly elevates ALT and AST enzymes. Our results are in line with these previous findings. All of this research showed that MSG is bad for your liver because it alters enzyme markers.

Chronic exposure to MSG causes physiological changes in the liver and kidneys, according to a study [8], which found that mice given two doses of MSG (0.6 and 1.6 mg/g of body weight) for 14 days had a marked increase in body weight and relative weight of the organs. In addition to its hepatotoxic effects, the present investigation demonstrated that MSG negatively impacts kidney function. This is shown by a significant rise in blood urea and creatinine levels, which suggest a decrease in renal efficiency [37]. Hypothesized that this rise in creatinine was due to either a decrease in renal tubular function or an interference between creatinine metabolism and MSG, which caused the latter to accumulate in the blood.

Table 3. Effect of shilajit versus MSG on urea and creatinine levels in rat serum (mean ± SE)

Groups	N	Urea	Creatinine
G1 (control — distilled water)	10	25.51 ± 1.08	0.390 ± 0.009
G2 (MSG 2 g/kg)	10	31.29 ± 1.32	0.590 ± 0.020
G3 (MSG 2 g + Shi 100 mg)	10	32.63 ± 2.18	0.490 ± 0.012
G4 (MSG 4 g/kg)	10	28.25 ± 1.16	0.520 ± 0.018
G5 (MSG 4 g + Shi 200 mg)	10	23.62 ± 0.89	0.490 ± 0.010

A number of studies have linked the oxidative stress that monosodium glutamate (MSG) induces in renal tissue to negative impacts on kidney function. Research has shown that consuming MSG on a regular basis might lead to renal fibrosis, with oxidative stress playing a major role in kidney damage [38, 39]. The overproduction of free radicals, especially reactive oxygen species (ROS), or a breakdown in their intracellular elimination mechanisms is known as oxidative stress [40].

The development of oxidative stress inside the body is facilitated by a multitude of physiological and pathological processes, including metabolic pathways, cellular and noncellular components such hormones and cytokines, and detoxification systems [41–43]. To put it another way, prolonged MSG exposure raises renal glutamate metabolism, which in turn increases ROS generation. Research in rats has shown that long-term exposure to MSG causes a decline in antioxidant enzyme levels and an increase in the buildup of lipid peroxidation products in the kidneys [44, 45]. High amounts of glutamate cause immediate cytotoxicity, as shown in experiments with cultivated kidney cells *in vitro* [46]. Kidney tissue is especially vulnerable to oxidative stress damage because it has a high concentration of long-chain polyunsaturated fatty acids [47]. Cell death results from a cascade of events that begin with lipid peroxidation and progress via protein modification, DNA damage, and cell death itself [48–50]. Reactive oxygen species are known to have a crucial role in producing pathological alterations in the kidneys, namely in the glomeruli, tubules, and interstitium [51, 52].

One of the main aims of the research was to find strategies to lessen or eliminate the harmful effects of MSG after the findings indicated that the fifth group did better than the control group in minimizing liver and kidney damage. According to the data, the shilajit aqueous extract is efficient because it contains physiologically active compounds such fulvic acids, over 40 minerals, and the conjugated alpha-pyrone it releases [12]. Shilajit is a mineral supplement that includes over 20 different elements, including fulvic and humic acids, as well as minerals like calcium, magnesium, salt, iron, chromium, and lead. In addition to minerals accounting for around 15–20 % of its composition, it also includes organic substances such as hydrocarbons, proteins, carbs, fatty acids, amino acids, and alcohols. The variety of plant chemicals it contains, together with its powerful antioxidant capabilities, contribute to its great efficacy and the significant protective impact it has on human health [53].

One research found that shilajit, whether taken either orally or rectally, could lessen the severity of liver damage caused by ulcerative colitis [54]. This was accomplished by raising serum albumin levels, decreasing concentrations of direct and total bilirubin, and decreasing levels of liver enzymes (SGPT, SGOT, ALP). By bringing the control group's liver enzyme levels back to near-normal levels, oral gavage of shilajit proved to be more protective than rectal administration. This might be because shilajit's active components are better absorbed, because it acts directly on the liver before systemic effects manifest, or because it acts indirectly by regulating gastrointestinal secretions.

Keep in mind that this medication does come with a few unwanted side effects. Fulvic acid and dibenzoalpha-pyrone are the main components of shilajit extract that are responsible for its antioxidant activities [55]. The shilajit aqueous extract showed a DPPH free radical scavenging capability of 11.9 μg/ml [56], as per an additional investigation. Additionally, shilajit's ability to scavenge free radicals was assessed by means of a rat liver culture model of oxidative stress caused by carbon tetrachloride (CCl_4), with lipid peroxidation serving as the marker for this kind of stress. The findings demonstrated that shilajit enhanced the rat model of antioxidant enzyme activity [57]. Another research looked at the effects of shilajit on liver and kidney tissue after bone cancer (osteosarcoma) spread in a rat model, and how it may work in conjunction with chemotherapy treatments to lessen those detrimental effects. The effects of two shilajit dosages (low and high) on biomarkers including bilirubin, ALT, ALP, and AST were assessed. Albumin and total protein levels were found to have increased significantly. When it came to bringing biomarker levels back to normal, the high dosage of shilajit worked better than the low dose. Similarly, uric acid, creatinine, and urea levels caused by bone cancer were significantly reduced when shilajit was used with chemotherapy procedures (CMF cocktail). Researchers observed that the lower dosage of shilajit had less impact on kidney function markers than the larger dose [12]. Many different active chemicals are responsible for shilajit's efficiency. These include aromatic carboxylic acids, terpenes, gum, sterols, phenolic compounds, polyphenols, gum, albumin, latex, and an extra active substance [58]. In addition to minerals, vitamins, fulvic and humic acids, trace elements, carbs, and plant components, shilajit also includes a number of other useful substances. Shilajit is a good herbal treatment because its pharmacological effects are enhanced by its integrated makeup. Its active plant components have a number of pharmaceutical uses, including immune system regulation, antiviral effects, protection against oxidative stress, and inflammation reduction. Any researcher with an interest in shilajit would do well to consult this scientific review. Investigating potential synergistic effects with other herbs could lead to useful nano-formulations, and the food and nutritional supplement industries could use it to create bioactive supplement products that promote health [53].

Limitation

The chemical components analysis performed to identify humic acids, fulvic acids, or mineral content were not identified in this study, but were based on previous studies. The positive effect of each component will be analyzed and studied separately. The current study did not include a histological study, but we thank you for this scientific proposal, and it will be studied in future research.

Conclusions

Conversely, the study found that shilajit aqueous extract effectively protected against MSG toxicity, leading to improved biomarkers and lower levels of liver and kidney enzymes, particularly at higher doses (200 mg/kg). Thanks to its antioxidant components, trace minerals, and fulvic acids,

shilajit has this effect. Based on these findings, shilajit shows promise as an adjuvant to mitigate the harmful effects of some industrial food additives, such MSG. To validate these results in human and animal models and to comprehend the exact molecular pathways of its impact, more research is suggested.

Ethical approval and study participation

This study was approved by the Ethical Committee of Thi-Qar University under Protocol No. 8795438.

Availability of data and materials

The data used or analyzed during this study are available from the corresponding author upon formal request.

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Роль шиладжиту у зменшенні токсичного впливу глутамату натрію на рівень ферментів печінки та функцію нирок у білих мишей

Резюме. Актуальність. Глутамат натрію (MSG) широко використовується в харчовій промисловості як підсилювач смаку. Хоча в багатьох дослідженнях підтверджено, що тривале споживання MSG може спричинити оксидативний стрес у тварин, особливо в печінці та нирках, у цій роботі оцінювали біохімічні ефекти, пов'язані з гепатитом і запаленням нирок, спричиненими різними дозами MSG, а також вивчали захисну дію водного екстракту шиладжиту в білих мишей. **Мета:** оцінити біохімічну токсичність різних доз глутамату натрію щодо функціонального стану нирок і печінки в білих мишей. **Матеріали та методи.** П'ятдесят дорослих мишей були випадково поділені на 5 груп (десять тварин у кожній). Контрольна група (G1) отримувала чисту воду, тоді як експериментальна група (G2) — MSG у дозі 2 г/кг маси тіла. Третій групі (G3) давали таку саму дозу MSG плюс 100 мг/кг екстракту шиладжиту. Четверта група (G4) отримувала підвищену дозу MSG (4 г/кг), а п'ята (G5) — підвищену дозу MSG разом із 200 мг/кг шиладжиту. Лікування здійснювалося перорально щодня протягом 14 діб. На 15-й день тварин умертвили для біохімічного аналізу зразків, включно з показниками функції нирок (сечовина, креатинін) і рівнями ферментів печінки (AST, ALT, ALP, GGT). **Результати.** У групах G2 і G4, які отримували лише MSG, спостерігалося значне ($P \leq 0,05$) підвищення вмісту ферментів печінки (ALP, AST, ALT), що свідчить про її істотне ураження. Натомість екстракт шиладжиту сприяв значному зниженню цих показників, демонструючи потенційну захисну дію проти токсичності MSG. **Висновки.** Високі дози глутамату натрію викликають порушення функцій печінки та нирок, що проявляються збільшенням рівня ферментів печінки і показників функції нирок, які свідчать про тканинні й функціональні ушкодження на тлі оксидативного стресу. Шиладжит може відігравати захисну роль при таких станах.

Ключові слова: глутамат натрію; шиладжит; печінка; нирки; ферменти печінки; функція нирок