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Original article

Alterations of Cardiac Enzymes Induced by Ketoprofen and the Potential Therapeutic Role of *Ganoderma lucidum* in Male Albino Rats

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Abstract
Ketoprofen (KP) is a widely prescribed non-steroidal anti-inflammatory drug generally used to relieve pain and decrease inflammation. In contrast, Ganoderma lucidum, known as the Reishi mushroom, is valued as a medicinal fungus rich in bioactive complexes that contribute to its nutritional and therapeutic potential. This study explored the potential protective role of G. lucidum (GL) extract against KP-induced alterations in cardiac function. The assessment covered changes in cardiac enzyme activity in both serum and tissue, in addition to related cardiac indicators such as cortisol and calcium levels, along with lactate dehydrogenase and anti-cardiolipin IgG. 28 adult male rats were employed, and they were divided into four groups at random (n = 7 per group). No treatment was given to the control group. For four weeks, the GL group received oral G. lucidum extract at a dose of 300 mg/kg b. w./d. For two weeks, the KP group was given 50 mg/kg b. w./d. of KP orally. The combination group (KP+GL) received oral G. lucidum for four weeks in addition to KP at the same dose for two weeks. The results displayed that KP exposure caused significant elevations in serum and tissue cardiac enzymes, lactate dehydrogenase, and anti-cardiolipin IgG levels; at the same time, it caused a significant decrease in blood calcium levels. On the other side, G. lucidum supplementation in the combination group demonstrated significant improvements in these parameter levels. This study concluded that G. lucidum extract has therapeutic potential in mitigating KP-induced cardiac dysfunctions.
Keywords. *Ganoderma Lucidum, Ketoprofen, Cardiac Enzymes, Rat.*

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Introduction

Ketoprofen (KP), a member of the propionic acid class of medications, is well known for its antipyretic, analgesic, and anti-inflammatory qualities [1]. It is categorized among nonsteroidal anti-inflammatory drugs (NSAIDs), whose therapeutic actions are primarily mediated through inhibition of the cyclooxygenase (COX) pathway involved in arachidonic acid metabolism [2]. Arachidonic acid serves as a key precursor for eicosanoid synthesis and is one of the most important fatty acids involved in inflammatory processes. It is unconfined from membrane phospholipids, which complete the enzymatic activity of phospholipase A_2, after which it is metabolized into various prostaglandins and related compounds that play central roles in inflammation and pain signaling. NSAIDs are generally prescribed for the management of musculoskeletal disorders, including osteoarthritis, rheumatoid arthritis, and pain following injury. Despite their efficacy, systemic usage is frequently linked to significant side effects, especially in the gastrointestinal, renal, and cardiovascular systems [3,4]. To minimize these systemic complications, alternative routes of administration have gained attention. In this context, KP is increasingly utilized in topical formulations rather than oral forms. When applied as gels, creams, or sprays, it can penetrate underlying tissues and exert its effects locally while still allowing limited systemic distribution. At present, KP is available in multiple dosage forms, including topical preparations, injectable solutions, capsules or tablets, and suppositories [5].

Traditional Chinese medicine and many Asian nations have utilized *Ganoderma lucidum*, a basidiomycetous fungus, as a medicinal remedy for the past two millennia [6]. *G. lucidum* has attracted considerable attention due to its assorted biological actions and beneficial properties. Studies have reported that it exhibits an extensive spectrum of properties, including immunological modulation function, antioxidant and anti-inflammatory actions, and protective roles against conditions such as atherosclerosis, hypertension, fibrosis, and cancer. In addition, it has been associated with antimicrobial, antiviral, and hepatoprotective properties, along with beneficial effects on glucose and lipid metabolism [7]. Other reported activities include antiplatelet, antithrombotic, antiulcer, analgesic, and radioprotective effects [8-10]. Reishi's ability to help manage complicated and progressing illnesses has drawn more attention in recent years [7], including cancer, diabetes, seizures, hyperlipidemia, and various immune-related disorders [11]. In parallel with this

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https://razi.edu.ly/rmj/index.php/hm

growing interest, its extracts have been developed into a wide variety of commercially available products, such as teas, powders, and dietary supplements, which are marketed for their potential health benefits [12]. The current study aimed to explore whether *G. lucidum* exerts a protective effect against KP-induced cardiac dysfunction through a comprehensive evaluation of cardiac enzyme alterations in an experimental rat model.

Materials and Methods

Tested compounds

- *G. lucidum* was obtained from Malaysia in the form of *Reishi mushroom* powder, supplied in a 70 g container.
- 50 mg/kg b. w./d of ketoprofen was administered. "The European Egyptian Pharmaceutical Industries Company" produced the pills, which were acquired from a nearby drugstore.

Animals

Twenty-eight healthy adult male albino rats, each weighing approximately 170–200 g, were obtained from the animal house of the Department of Zoology, Faculty of Science, Omar Al-Mukhtar University. These animals served as the experimental model for the present investigation. All animals were given two weeks to acclimate to the lab environment before the experiment to avoid complications during the experiment. The rats were kept in room temperature boxes, fed with a laboratory diet, and drank fresh water every day. Before the experiment and upon completion, the weight of each rat was measured and documented.

Ethical Approval

The experimental protocol involving animals was reviewed and authorized by the relevant ethical bodies, including the "Libyan Authority for Scientific Research, the Libyan National Committee for Biosafety and Bioethics, and the Al-Mukhtar Bioethics Committee at Omar Al-Mukhtar University, Al-Bayda, Libya" (approval no. NBC: 007.A.24.16).

Experimental procedure

The 28 rats were randomly allocated into four equal groups (n =7 animals).
Group 1; the normal control (NC), which was maintained under standard laboratory conditions without any treatment throughout the experimental period.
Group 2; (GL) received *G. lucidum* orally via gavage at a dose of 300 mg/kg b. w./d. for four weeks, administered in the early morning [13].
Group 3; (KP) was treated with ketoprofen at a dose of 50 mg/kg b. w. / d. orally for two weeks, also given in the early morning [14].
Group 4; (KP+GL) received ketoprofen at 50 mg/kg b. w./ d. for the first two weeks. This was followed by the administration of *G. lucidum* at 300 mg/kg b. w./ d. for an additional four weeks via oral gavage.
All animals were weighed at the conclusion of the experiment and 24 hours after the last treatment before being humanely slaughtered. Jugular vein punctures were used to obtain blood samples for hematological and biochemical testing.

Body weight

Body weight (BW) for each rat was measured at two time points: before the start of the experiment (initial BW) and at the end of the study period (final BW), using a high-precision digital balance. The percentage variation in body weight was subsequently determined following the approach of Abd Allah *et al.* [15] as expressed in the equation below:

$$\text{Percentage of change in the BW} = \frac{\text{final BW} - \text{initial BW}}{\text{initial BW}} \text{ x } 100$$

Biochemical assays

Biochemical tests were performed on coagulated blood; the blood was collected and coagulated in a plain tube for 20 minutes at room temperature. Then the Serum was obtained by centrifuging the collected blood samples at 860 × g / 20 minutes. After being carefully collected, the separated serum was kept at -20 °C until additional biochemical examination could be carried out.

Estimation level of cardiac enzymes

Razi Med J. 2026;2(2):319-327
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Razi Medical Journal
https://razi.edu.ly/rmj/index.php/hm

Lactate dehydrogenase (LDH), creatine kinase (CK), and creatine kinase-MB (CK-MB) activities in both serum and tissue samples were quantitatively determined using commercially available kits. The analysis was performed through a highly specific enzyme immunoassay, following the methodology described by [16].

Estimation level of anti-cardiolipin IgG

This assay is based on an enzyme immunoassay (EIA) technique designed for the qualitative and quantitative determination of IgG and IgM antibodies against cardiolipin in serum, following the method described by Harris *et al.* [17]. The test is primarily applied as a supportive tool in evaluating the potential risk of thrombotic disorders.

Estimation level of calcium

Calcium levels were determined according to the procedure described by Orci *et al.* [18], using a ready-to-use-use commercial kit (Fluitest® CA CPC, Analyticon, Lichtenfels, Germany).

Estimation concentration of cortisol

75 µl of the sample mixture was drawn and loaded into a cartridge. Insert the loaded cartridge into the incubator (25°C), leave it for 10 minutes, and then insert it into the ichroma™ Tests [19].

Statistical analysis

GraphPad Prism and Minitab software (version 17) were used for all statistical analyses. Data distribution was first examined to ensure normality before applying parametric tests. Tukey's post hoc test was performed for multiple comparisons after one-way analysis of variance (ANOVA) was utilized to examine differences between experimental groups. Results were considered statistically significant at a probability level of $P < 0.05$. The data are displayed as mean ± standard error of the mean (SE), and statistical differences between groups within the same row are indicated by superscript letters. Significant differences are shown by different letters, while no significant change is indicated by identical letters [20].

Results

Effect of GL, KP, and their combination on BW

The variations in body weight of male rats treated with KP, GL, and their combined administration are presented in (Table 1). In the control group, an important increase ($P < 0.05$) in final body weight (324 ± 14.67 g) was observed compared with initial body weight (278 ± 12.69 g). A similar pattern of significant elevation was also recorded in the KP group, where final BW (290.6 ± 10.35 g) increased compared with the initial BW (266.4 ± 9.67g). In contrast, treatment with GL alone resulted in no significant change ($P > 0.05$) in body weight, with final BW (313.8 ± 5.96 g) remaining comparable to initial BW (311.2 ± 10.14 g). Likewise, the combined treatment group (KP + GL) showed no significant difference between final BW (265.4 ± 15.70 g) and initial BW (256.8 ± 7.22 g).

Table* 1. *The alterations in body and heart weights of experimental groups (Mean ± SEM)

Experimental groups	Body Weight (gm)		Absolute heart weight (gm)
	Initial BW	Final BW	
Control (Mean ± SE)	$278.0±12.69^{B}$	$324.0± 14.67^{A}$	$1.70±0.075^{A}$
GL (Mean ± SE)	$311.2±10.14^{A}$	$313.8±5.96^{A}$	$2.05 ± 0.10^{A}$
KP (Mean ± SE)	$266.4±9.67^{B}$	$290.6±10.35^{A}$	$1.95±0.087^{A}$
KP+GL (Mean ± SE)	$256.8±7.22^{A}$	$265.4±15.70^{A}$	$1.57±0.084^{A}$

The data are presented as means ± SEM, with a sample size of 7 for each group. Significant differences ($P < 0.05$) between averages in the same row are indicated by different elevated script letters (A, B & C). While averages with identical elevated script letters indicate no significant change ($P < 0.05$).

Effect of GL, KP, and their combination on heart weight

Razi Med J. 2026;2(2):319-327
https://doi.org/10.69667/rmj.26223
Razi Medical Journal
https://razi.edu.ly/rmj/index.php/hm

The mean absolute heart weights across all experimental groups are obtainable in (Figure 1). When comparing the treated groups to the control, no significant alterations were seen overall. Although slight variations in values were recorded, KP administration did not produce a noteworthy change in heart weight relative to normal rats. Similarly, GL treatment alone showed no meaningful alteration compared to the controls. In the combined treatment group (KP + GL), heart weight values remained comparable to those of the KP group, with no important differences detected. As illustrated in (Figure 1), all groups shared the same statistical notation, confirming the absence of significant variation in cardiac weight between experimental conditions.

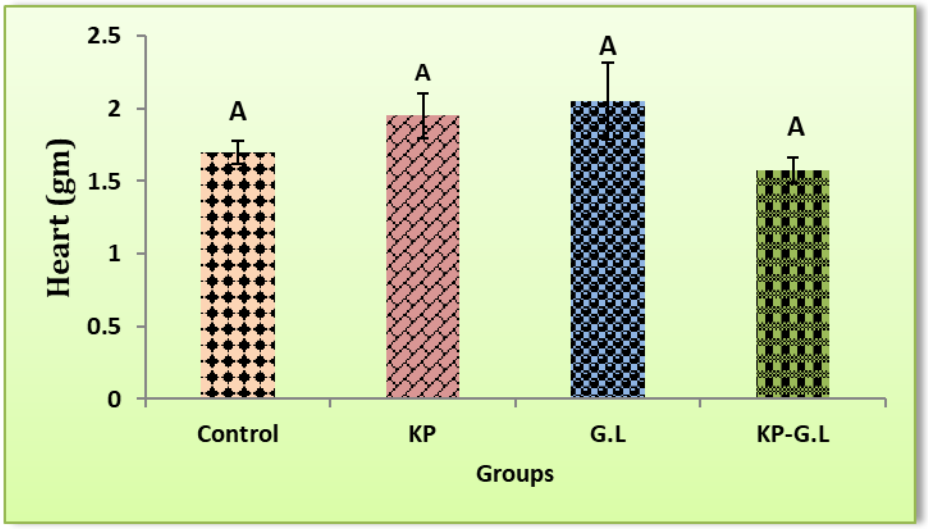

Figure 1. Changes in mean values of heart weight (g) of male rats in control and experimental groups.

Effect of GL, KP, and their combination on cardiac enzymes

The CK activity in serum and heart tissue

The mean values of CK activity are presented in (Table 2) and (Figures 2 and 3). The GL-treated group showed no significant change in CK levels in serum (95.00 ±4.36) and cardiac tissue (370.8 ±50.7) compared with the control group (92.00±8.57 and 307.40±21.76, respectively). In contrast, KP administration resulted in a notable increase in CK activity in both serum (213.00±7.65) and tissue (962.8±57.8) relative to controls. However, combined treatment (KP+GL) led to an important reduction in CK levels in serum (177.20±12.01) and tissue (618.2±68.2) related to the KP group.

The CK-MB activity in serum and heart tissue

As shown in (Table 2) and (Figures 4 and 5), CK-MB activity in the GL group showed no discernible differences from the control group, with serum and tissue values of (16.60±2.97) and (34.60±4.28), respectively, compared to (13.20±2.28) and (37.00±5.83) in controls. Conversely, KP treatment caused a significant elevation in CK-MB levels in serum (34.40±4.16) and tissue (76.80±4.76). In the combination group (KP+GL), CK-MB activity showed a significant decrease to (26.00±3.16) in serum and (60.60±2.88) in tissue when compared with the KP group.

The LDH activity in serum and heart tissue

The data in (Table 2) and (Figures 6 and 7) indicate that LDH activity remained statistically unchanged in the GL group, with serum and tissue values of (1177.8±91.8) and (177.2±28.0), respectively, compared with the control group (1104.0±83.6 and 194.4±24.5). In contrast, KP administration induced a significant increase in LDH activity in both serum (1645.4±124.5) and tissue (394.00±16.79). Notably, treatment with GL in the combination group resulted in a marked reduction in LDH levels, reaching (1332.6±83.7) in serum and (264.6±33.7) in tissue compared with the KP group.

Table 2. The alterations in serum and tissue cardiac enzymes of experimental groups (Mean± SE).

Razi Med J. 2026;2(2):319-327
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Razi Medical Journal
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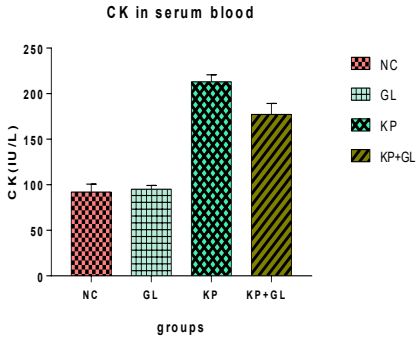
Groups / Parameter		Control Mean± SEM	GL Mean± SEM	KP Mean± SEM	KP+GL Mean ± SEM
CK (IU/L)	serum	92.00±8.75 C	95.00 ±4.36 C	213.00 ±7.65 A	177.20±12.01 B
CK (IU/L)	tissue	307.4±21.76 C	370.8±50.7 C	962.8 ±57.8 A	618.2 ±68.2 B
CK-MB (IU/L)	serum	13.20 ±2.28 C	16.60 ±2.97 C	34.40 ±4.16 A	26.00 ± 3.16 B
CK-MB (IU/L)	tissue	37.00±5.83 C	34.60 ±4.28 C	76.80 ± 4.76 A	60.60 ±2.88 B
LDH IU/L)	serum	1104.0±83.6 C	1177.8 ±91.8 BC	1645.4 ±124.5 A	1332.6 ±83.7 B
LDH (IU/L)	tissue	194.4±24.5 C	177.2±28.0 C	394.00 ±16.79 A	264.6 ±33.7 B

The data are presented as means ± SEM, with a sample size of 7 for each group. Significant differences ($P < 0.05$) between averages in the same row are indicated by different elevated script letters (A, B & C). While averages with identical elevated script letters indicate no significant change ($P < 0.05$).



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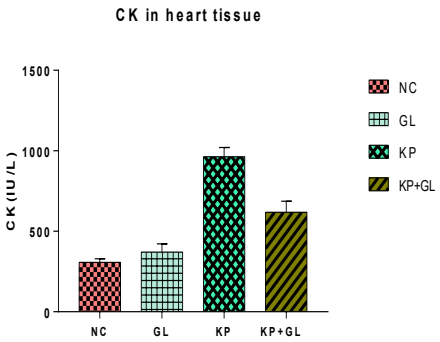

Figure 3. The alteration in tissue CK

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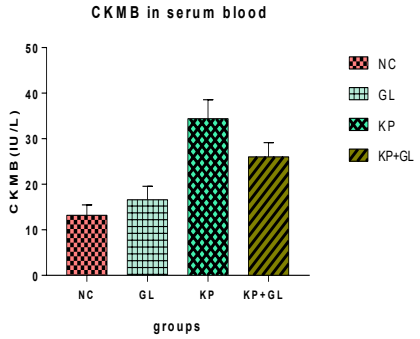

Figure 4. The alteration in serum CK- MB

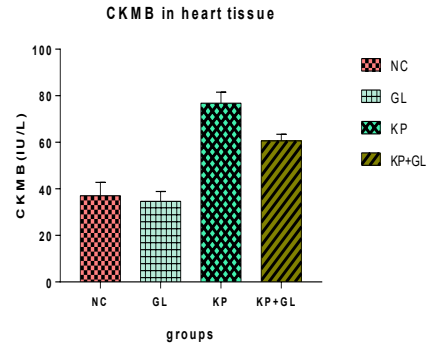

Figure 5. The alteration in tissue CK- MB

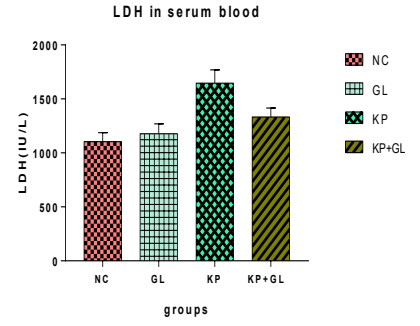

Figure 6. The alteration in serum LDH

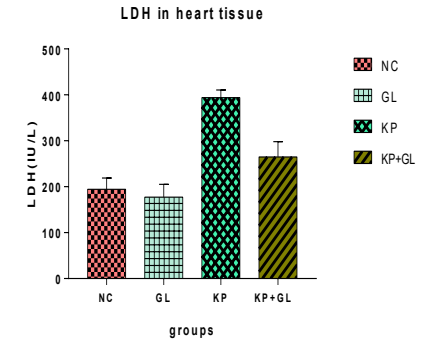

Figure 7. The alteration in tissue LDH

Razi Med J. 2026;2(2):319-327
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Effect of GL, KP, and their combination on anti-cardiolipin IgG (ACA-IgG)

As presented in (Table 3) and (Figure 9), the level of ACA-IgG in the GL-treated group (1.740±0.336) remained comparable to that of the control group (1.640±0.53), with no statistically significant difference. In contrast, rats exposed to KP exhibited a marked and highly significant elevation in ACA-IgG levels (5.040±0.503) relative to controls. Notably, co-treatment with GL (KP+GL) resulted reduction in ACA-IgG (2.620±0.746) compared with the KP group, with values approaching those of the control.

Effect of GL, KP, and their combination on calcium levels

The results summarized in (Table 3) and (Figure 8) indicate a significant decline in serum calcium in the KP group (5.86±0.06) when associated with the controls (8.98±0.277). In the combination group (KP+GL), calcium levels (7.18±0.39) were meaningfully higher than those observed in the KP group and closer to normal values. Meanwhile, the GL-only group showed a slight, significant reduction in calcium levels (8.26±0.404) relative to the control.

Effect of GL, KP, and their combination on cortisol concentration

Data shown in (Table 3) and (Figure 9) demonstrate that cortisol levels in the GL group (46.80±4.55) were comparable to the control group's (45.00±3.39), with no significant difference detected. Conversely, KP administration resulted in a highly significant rise in cortisol concentration (58.80±5.26) in contrast to the control. In the combination group (KP+GL), cortisol levels (56.80±4.87) showed0. a slight decrease relative to the KP group; this decrease was not statistically significant, though.

Table 3. The alterations in serum Anti-Cardiolipin IgG, Calcium, and Cortisol of experimental groups (Mean± SEM).

Groups / Parameters	Control Mean± SEM	GL Mean± SEM	KP Mean± SEM	KP+GL Mean ± SEM
Anti-Cardiolipin lgG (IU/mL)	1.640 ±0.532 ^{B}	1.740 ±0.336 ^{B}	5.040 ±0.503^{A}	2.620 ± 0.746 ^{B}
Calcium (mg/dl)	8.980 ± 0.277 ^{A}	8.260 ± 0.404 ^{B}	5.8600 ± 0.152 ^{D}	7.180 ± 0.390 ^{C}
Cortisol (µg/dL)	45.00 ±3.39 ^{B}	46.80 ±4.55 ^{B}	58.80 ±5.26^{A}	56.80 ± 4.87 ^{A}

The data are presented as means ± SEM, with a sample size of 7 for each group. Significant differences ($P < 0.05$) between averages in the same row are indicated by different elevated script letters (A, B, C & D). While averages with identical elevated script letters indicate no significant change ($P < 0.05$).

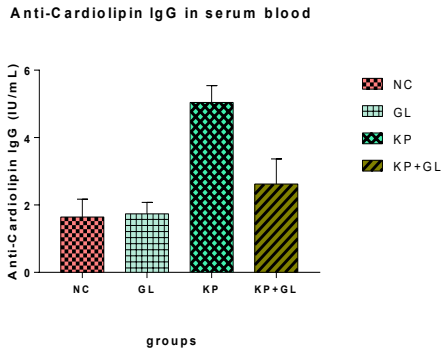

Figure 8. The alteration in serum Anti-Cardiolipin lgG

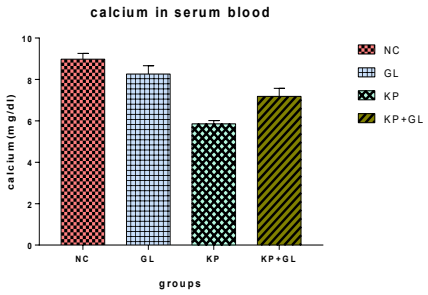

Figure 9. The alteration in serum calcium

Razi Med J. 2026;2(2):319-327
https://doi.org/10.69667/rmj.26223
Razi Medical Journal
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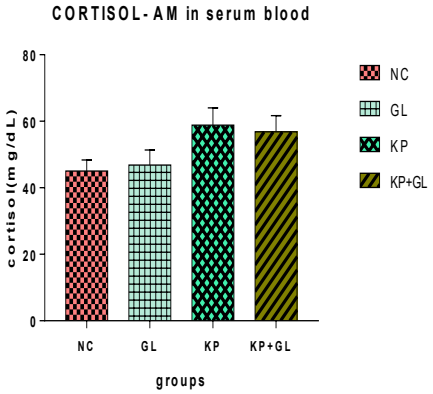

Figure 10. The alteration in serum cortisol

Discussion

This research was intended to evaluate the preventive efficiency of *G. lucidum* against cardio-enzymatic disorders and the imbalance of some biochemical indicators of clotting and stress caused by the administration of KP in white male rats.

In our findings, the KP administration of male rats led to a significant elevation in all enzymes associated with heart function, including CK, CK-MB, and LDH, in both serum and heart tissue. Also, anti-Cardiolipin-IgG levels and cortisol concentration were markedly elevated in the KP group, along with a noticeable reduction in calcium levels, all of which were compared to the control group. A meta-analysis that found NSAID users had a 17% higher risk of heart failure than nonusers supports our findings [21], and the link between NSAID use and cardiovascular adverse effects is likely multifactorial. The historical cardiovascular risk associated with COX-2-specific inhibitors, as different from nonselective NSAIDs, was thought to be due to the preserved platelet-aggregating function of TXA2 [22]. Another proposed mechanism for increased cardiovascular risk is the generation of reactive oxygen species (ROS) in myocardium cells by NSAIDs [23]. Production of ROS with the use of NSAIDs leads to upregulation of specific signaling pathways, one of these being apoptosis. This programmed cell death could ultimately lead to cardiovascular damage and disease. In addition, inhibition of prostaglandins leads to vasoconstriction of the peripheral and renal vasculature with resultant reabsorption of sodium and water in the kidney, and high cortisol levels due to stress, which may contribute to elevations in blood pressure and fluid retention [21]. NSAIDs are known to suppress prostaglandin synthesis, a mechanism that can negatively influence platelet function [24]. Beyond this effect, their use has been associated with disturbances in immune homeostasis, including impaired thymocyte development and suppression of bone marrow activity, which may lead to reduced production of leukocytes involved in immune defense. In addition, NSAIDs can modulate the activity of immune cells such as macrophages, granulocytes, and extrathymic T lymphocytes. Under certain conditions, excessive activation of these cells may promote cytotoxic responses directed against host tissues, potentially contributing to tissue injury and the elevation of autoantibodies such as anti-cardiolipin IgG [25-27]. Moreover, the observed decline in calcium levels may be attributed to ketoprofen-induced renal dysfunction or impaired gastrointestinal absorption, both of which can interfere with normal calcium homeostasis [28].

On the other hand, co-treatment with *G. lucidum* extract in the current study significantly improved the activity of all cardiac enzymes in both serum and heart tissue, anti-cardiolipin-IgG, cortisol concentration, and calcium levels. Several studies lend support to these findings. For instance, Wong *et al*. [29] demonstrated that *G. lucidum* possesses marked antioxidant capacity, evidenced by its ability to inhibit lipid peroxidation and scavenge superoxide radicals in mouse heart homogenates. Similarly, experimental work has shown that ethanol-induced cardiac injury is associated with elevated malondialdehyde levels, whereas treatment with *G. lucidum* attenuates this increase, indicating a protective effect against oxidative damage. These comments suggest that the cardioprotective properties of *G. lucidum* may be largely attributed to its antioxidant activity, which helps limit oxidative stress–mediated injury in cardiac tissue. By reducing oxidative damage, it may also contribute to lowering the production of anti-cardiolipin antibodies and stabilizing cortisol levels through attenuation of physiological stress responses. Furthermore, evidence indicates that *G. lucidum* exerts immunomodulatory effects, potentially enhancing immune function through improved bone marrow activity and regulation of immune cell production [30]. Numerous studies have revealed the broad pharmacological potential of *G. lucidum*. In particular, its bioactive constituents, including polysaccharides and triterpenoids, have been

linked to positive outcomes for lipid metabolism, blood pressure regulation, and thrombosis prevention [31]. Furthermore, experimental evidence suggests that *G. lucidum* can mitigate cardiac injury in a range of pathological models, such as streptozotocin-induced diabetes, high-fat diet–induced metabolic dysfunction, isoprenaline-induced cardiac hypertrophy, ethanol-related cardiotoxicity, and pressure overload conditions. These findings collectively support its proposed role in both the prevention and adjunct organization of cardiovascular disorders [32]. In addition, in vitro studies have confirmed the strong antioxidant capacity of *G. lucidum* using different radical scavenging assays, including superoxide, hydroxyl, nitric oxide, and phosphomolybdenum-based methods. This antioxidant potential has been linked to its ability to counteract serotonin-induced cardiac damage in carcinoid heart disease models, likely through the neutralization of free radicals and decrease of oxidative stress [33]. Moreover, *G. lucidum* has been reported to exhibit antiplatelet activity comparable to aspirin, while certain lipid-lowering agents such as simvastatin also share similar inhibitory effects on platelet aggregation [34]. In addition, hot-water extracts of the mushroom have demonstrated anticoagulant activity, particularly through interference with the intrinsic coagulation pathway, suggesting potential future application as a natural anticoagulant agent [35]. Interestingly, partial normalization of calcium levels has also been observed following *G. lucidum* administration, which may indicate a supportive role in renal protection and gastrointestinal regulation [7] Similar findings have been reported in different experimental models, where cardiac injury induced by various toxic agents was associated with elevated cardiac enzyme levels, while treatment with natural and biological agents resulted in significant attenuation of these alterations, and drug-induced cardiac toxicity models have demonstrated comparable patterns of enzyme elevation followed by improvement after administration of protective agents [36,37].

Conclusion

The present study demonstrates that KP induces clear cardiotoxic effects, evidenced by alterations in cardiac enzymes, stress markers, immune parameters, and calcium balance in male rats. In contrast, *G. lucidum* exhibited a significant protective effect against these disturbances, likely through its antioxidant, anti-inflammatory, and immunomodulatory properties. Overall, the findings suggest that *G. lucidum* may serve as a potential natural cardioprotective agent against NSAID-induced cardiac injury.

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Conflicts of Interest

The authors declare no conflicts of interest.

References

1. Chawla G, Ranjan C, Kumar J, Siddiqui AA. Chemical modifications of ketoprofen (NSAID) in search of better lead compounds: A Review of literature from 2004-2016. Mini Rev Med Chem. 2016;15(3):154-177.
2. Kantor TG. Ketoprofen: a review of its pharmacologic and clinical properties. Pharmacotherapy. 1986;6(3):93-102.
3. Adachi H, Ioppolo F, Paoloni M, Santilli V. Physical characteristics, pharmacological properties and clinical efficacy of the ketoprofen patch: a new patch formulation. Eur Rev Med Pharmacol Sci. 2011;15(7):779-784.
4. Alshailabi EMA. Effects of omeprazole on healing of non-steroidal anti-inflammatory drug (NSAID)-induced peptic ulceration in rats and protective role of indole-3-carbinol. J Sci Humanit Stud. 2016;12:1-15. doi: 10.37376/1571-000-012-010.
5. Kuczyńska J, Nieradko-Iwanicka B. Future prospects of ketoprofen in improving the safety of the gastric mucosa. Biomed Pharmacother. 2021;139:111608.
6. Yun TK. Update from Asia: Asian studies on cancer chemoprevention. Ann N Y Acad Sci. 1999;889(1):157-192.
7. Alshailabi EM, Suleiman HM. Effect of hepatoprotective of aqueous extract of Ganoderma lucidum against ketoprofen-induced damage in male rats. Int Innov J Appl Sci. 2024;1:1-6.
8. Eo SK, Kim YS, Lee CK, Han SS. Antiviral activities of various water and methanol soluble substances isolated from Ganoderma lucidum. J Ethnopharmacol. 1999;68(1-3):129-136.
9. Wang SY, Hsu ML, Hsu HC, Lee SS, Shiao MS, Ho CK. The anti-tumor effect of Ganoderma lucidum is mediated by cytokines released from activated macrophages and T lymphocytes. Int J Cancer. 1997;70(6):699-705.
10. Wasser SP. Reishi or ling zhi (Ganoderma lucidum). In: Coates PM, Blackman MR, Cragg GM, Levine M, Moss J, White JD, editors. Encyclopedia of Dietary Supplements. New York: Marcel Dekker; 2005. p. 603-622.

11. Davis CM. Animal models of drug abuse: place and taste conditioning. In: Conn PM, editor. Animal models for the study of human disease. San Diego: Academic Press; 2013. p. 681-707.
12. de Mattos-Shipley KM, Ford KL, Alberti F, Banks A, Bailey AM, Foster GD. The good, the bad and the tasty: the many roles of mushrooms. Stud Mycol. 2016;85(1):125-157.
13. Hossain S, Bhowmick S, Islam S, Rozario L, Jahan S, Hassan M, et al. Oral Administration of Ganoderma lucidum to Lead-Exposed Rats Protects Erythrocytes against Hemolysis: Implicates to Anti-Anemia. Evid Based Complement Alternat Med. 2015;2015:463703.
14. Fadhil SR, Jebur HB. The Intraperitoneal-Ketoprofen-Histopathological Induced Alterations in the Wistar Rat Kidneys. Indian J Forensic Med Toxicol. 2020;14(4):2891-2895.
15. Abd Allah ES, Makboul R, Mohamed AO. Role of serotonin and nuclear factor-kappa B in the ameliorative effect of ginger on acetic acid-induced colitis. Pathophysiology. 2016;23(1):35-42.
16. Vennila L, Pugalendi KV. Protective effect of sesamol against myocardial infarction caused by isoproterenol in Wistar rats. Redox Rep. 2010;15(1):36-42.
17. Harris EN, Gharavi AE, Hughes GR, Kernodle GW Jr, Allen NB, Kredich DD. Anticardiolipin antibody testing: the need for standardization. Arthritis Rheum. 1987;30(7):835-837.
18. Orci L, Glick BS, Rothman JE. A new type of coated vesicular carrier that appears not to contain clathrin: its possible role in protein transport within the Golgi stack. Cell. 1986;46(2):171-184.
19. Al-Fayyadh MSM, Ismael KH, Al-Saady AJ. Study of insulin resistance, cortisol hormone and some biochemical parameters in Iraqi type 2 diabetic patients. Univ Thi-Qar J Sci. 2023;10(2):68-72.
20. Osili UO, Paulson AL. Institutions and financial development: Evidence from international migrants in the United States. Rev Econ Stat. 2008;90(3):498-517.
21. Ungprasert P, Srivali N, Thongprayoon C. Nonsteroidal anti-inflammatory drugs and risk of incident heart failure: a systematic review and meta-analysis of observational studies. Clin Cardiol. 2016;39(2):111-118.
22. Curiel RV, Katz JD. Mitigating the cardiovascular and renal effects of NSAIDs. Pain Med. 2013;14(Suppl 1):S23-S28.
23. Ghosh R, Alajbegovic A, Gomes AV. NSAIDs and cardiovascular diseases: role of reactive oxygen species. Oxid Med Cell Longev. 2015;2015:536962.
24. Niemi T, Taxell C, Rosenberg P. Comparison of the effect of intravenous ketoprofen, ketorolac and diclofenac on platelet function in volunteers. Acta Anaesthesiol Scand. 1997;41(10):1353-1358.
25. Aronson JK. Meyler's side effects of analgesics and anti-inflammatory drugs. Amsterdam: Elsevier; 2009.
26. Park SH, Cho CS, Lee OY, Jun JB, Lin SR, Zhou LY, et al. Comparison of prevention of NSAID-induced gastrointestinal complications by rebamipide and misoprostol: a randomized, multicenter, controlled trial-STORM STUDY. J Clin Biochem Nutr. 2007;40(2):148-155.
27. Yamamura S, Arai K, Toyabe S, Takahashi HE, Abo T. Simultaneous activation of granulocytes and extrathymic T cells in number and function by excessive administration of nonsteroidal anti-inflammatory drugs. Cell Immunol. 1996;173(2):303-11.
28. Vostinaru O. Adverse effects and drug interactions of the non-steroidal anti-inflammatory drugs. In: Vostinaru O, editor. Nonsteroidal Anti-Inflammatory Drugs. Rijeka, Croatia: InTech Open; 2017. p. 17-31.
29. Wong KL, Chao HH, Chan P, Chang LP, Liu CF. Antioxidant activity of Ganoderma lucidum in acute ethanol-induced heart toxicity. Phytother Res. 2004;18(12):1024-1026.
30. Yang Y, Yu T, Tang H, Ren Z, Li Q, Jia J, et al. Ganoderma lucidum immune modulator protein rLZ-8 could prevent and reverse bone loss in glucocorticoids-induced osteoporosis rat model. Front Pharmacol. 2020;11:731.
31. Gao Y, Chan E, Zhou S. Immunomodulating activities of Ganoderma, a mushroom with medicinal properties. Food Rev Int. 2004;20(2):123-161.
32. Meng J, Yang B. Protective effect of Ganoderma (Lingzhi) on cardiovascular system. In: Lin Z, Yang B, editors. Ganoderma and Health: Pharmacology and Clinical Application. Singapore: Springer; 2019. p. 181-199.
33. Priya SS, Sankaran R, Ramalingam S, Sairam T, Somasundaram L. Genotype phenotype correlation of genetic polymorphism of PPAR gamma gene and Therapeutic response to pioglitazone in type 2 diabetes mellitus-a pilot study. J Clin Diagn Res. 2016;10(2):FC11-FC15.
34. Shulman B, Sharma A, Cosley D. Predictability of popularity: Gaps between prediction and understanding. In: Proceedings of the 10th International AAAI Conference on Web and Social Media (ICWSM 2016); 2016 May 17-20; Cologne, Germany. Palo Alto (CA): AAAI Press; 2016. p. 348-357.
35. San Pedro A, Mangansat JM, Peria NT. Philippine wild medicinal mushroom, Ganoderma lucidum (Curtis: Fr.) P. Karst., exhibits anticoagulative effect in intrinsic pathway. Adv Environ Biol. 2016;10(4):92-96.
36. Alshailabi EMA, Al-Zail NI, Alsalhin AA. Effects of exposure cigarette smoke on the cardiac tissues in male albino rats and the improvement role of Sidr honey. Bani Waleed Univ J Humanit Appl Sci. 2023;8(3):261-270.
37. Elduob REA, Alshailabi EMA, Efkeren SM. Cardioprotective effects of rutin and mesenchymal stem cells on acetaminophen induced cardiac enzymatic damage in rats. Glob Libyan J. 2023;3(70):1–14.