

Indonesian Journal on Health Science and Medicine
Vol. 3 No. 1 (2026): July

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo
Copyright © Author(s). This is an open-access article distributed under the terms of
the Creative Commons Attribution License (CC-BY).
<https://doi.org/10.21070/ijhsm.v3i1.388>

**Nano-Extract of *Epimedium alpinum* Preserves Testicular
Histology During Levofloxacin Exposure**

prof. Dr. Jabbar Abadi Mohammed ¹⁾, prof. Dr. Sukayna Jabbar Mushattat ²⁾, Eelaf kareem abd ali ³⁾
Saja Hassan Abdul-Kadhim⁴⁾
^{1, 2)} Kufa University /Faculty of sciences. Iraq-Baghdad.
³⁾Kufa University /Faculty of Education for Women.Iraq-Baghdad.
⁴⁾Kufa University / Faculty of Nursing.Iraq-Baghdad.

*Email: jabbara.alaridhi@uokufa.edu.iq

Abstract. General Background: Antibiotics such as levofloxacin are widely prescribed but have been associated with reproductive tissue alterations following prolonged administration. **Specific Background:** Plant-derived nanomaterials, particularly nano-extracts from medicinal plants, have gained attention due to their bioactive compounds with antioxidant and anti-inflammatory properties. **Knowledge Gap:** Limited experimental evidence exists regarding the histological response of testicular tissue to concurrent administration of levofloxacin and *Epimedium alpinum* nano-extract. **Aim:** This study examined the histological structure of testes in mice treated with levofloxacin and varying concentrations (5 and 10 mg/kg) of *Epimedium alpinum* nano-extract. **Results:** Levofloxacin administration for 30 days resulted in seminiferous tubule degeneration, reduced sperm count, and structural disruption, whereas groups receiving the nano-extract alone maintained normal architecture. Co-administration groups demonstrated preservation of seminiferous tubule integrity and improved spermatogenic organization. **Novelty:** The study provides experimental histological evidence supporting the tissue-preserving role of *Epimedium alpinum* nano-extract against antibiotic-associated alterations. **Implications:** These findings highlight the potential application of plant-based nanophytotherapeutics as supportive agents in treatments involving antibiotics with reproductive risks.

Highlights:

- Levofloxacin administration induced seminiferous tubule degeneration and reduced sperm count.
- *Epimedium alpinum* nano-extract maintained normal testicular architecture.
- Combined treatment preserved spermatogenic organization during antibiotic exposure.

Keywords: Epimedium Alpinum, Nano-Extract, Levofloxacin, Testicular Histology, Spermatogenesis

Published : 12-02-2026

Commented [sa1]: Pertama, abstrak sudah informatif tetapi dapat diringkas agar lebih padat dan langsung menonjolkan temuan kunci tanpa pengulangan detail angka yang terlalu banyak. Kedua, klaim kebaruan dalam kesimpulan perlu ditegaskan secara lebih spesifik agar tidak terkesan umum. Ketiga, implikasi praktis dapat diperjelas dengan menyebutkan batasan penelitian dan arah riset lanjutan secara lebih konkret.

Commented [sa2]: Pertama, abstrak sudah informatif tetapi dapat diringkas agar lebih padat dan langsung menonjolkan temuan kunci tanpa pengulangan detail angka yang terlalu banyak. Kedua, klaim kebaruan dalam kesimpulan perlu ditegaskan secara lebih spesifik agar tidak terkesan umum. Ketiga, implikasi praktis dapat diperjelas dengan menyebutkan batasan penelitian dan arah riset lanjutan secara lebih konkret.

Commented [sa3]: Pertama, abstrak sudah informatif tetapi dapat diringkas agar lebih padat dan langsung menonjolkan temuan kunci tanpa pengulangan detail angka yang terlalu banyak. Kedua, klaim kebaruan dalam kesimpulan perlu ditegaskan secara lebih spesifik agar tidak terkesan umum. Ketiga, implikasi praktis dapat diperjelas dengan menyebutkan batasan penelitian dan arah riset lanjutan secara lebih konkret.

Indonesian Journal on Health Science and Medicine

Vol. 3 No. 1 (2026): July

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo
Copyright © Author(s). This is an open-access article distributed under the terms of
the Creative Commons Attribution License (CC-BY).

<https://doi.org/10.21070/ijhsm.v3i1.388>

Introduction

Epimedium is used in traditional medicine and is characterized by the presence of flavonoids, which are among its most important components [1]. One of the important compounds in this plant is the alkaloid quaternary apoperphine (magnoflurin) [2],[3],[4]. Only two species of Epimedium are found in Europe [5],[6].

Zinc oxide (ZnO) possesses properties that make it an important agent for many applications, in addition to its use in cosmetics and numerous other uses [7], [8], [9]. Levofloxacin is an anti-inflammatory drug used to treat conditions such as complicated urinary tract infections caused by various types of bacteria, as well as other complicated infections of the urinary tract [10][11][12][13][14]. Levofloxacin is considered the optimal treatment option because other antibiotics are either insensitive or have not been successful in treating complex and severe infections. In addition, it is used as a pain reliever and fever reducer, as well as an anti-inflammatory in cases of osteoporosis., rheumatism, and gout [15][16]. It is possible that this treatment may have effects on the digestive tract, as it is the main target of these drugs, especially levofloxacin, because it is characterized by its rapid absorption of substances through the digestive system, especially when taken orally [17].

Nanotechnology is one of the modern methods for constructing modern structures and systems [18]. Nanoscience is the science of manipulating matter at the nanoscale. The importance of nanotechnology lies in materials with extremely small nanoscale dimensions, called nanoparticles, which range in length from 1 to 100 nanometers [19], [20]. Nanoparticles are manufactured using various methods and possess unique properties [21]. **Aim of study** to investigate the effect of Epimedium alpinum extract on the histological structure of the testes of mice treated with antibiotics.

Indonesian Journal on Health Science and Medicine

Vol. 3 No. 1 (2026): July

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo
Copyright © Author(s). This is an open-access article distributed under the terms of
the Creative Commons Attribution License (CC-BY).

<https://doi.org/10.21070/ijhsm.v3i1.388>

Method

The experiment involved the use of 36 laboratory mice. The animals weighed between (27-29 g) and were between (10-12) weeks old. The experiment was conducted from (4/12/2024 to 4/4/2025). The animals were placed in the animal house with all the appropriate experimental conditions provided, including temperature, humidity, and suitable rearing cages made of plastic. The mice were divided into 6 groups, (6) per group, and distributed as follows: G1 and G4 as a control group treated with levofloxacin (1.2 mg/kg, G3 and G4 which were treated with the extract group at two concentrations (5 and

10 mg/kg). While G5, G6 with extract n (5 and 10 mg/kg) + levofloxacin respectively, for a period of (30 days).

Plant extract of *Epimedium alpinum* prepared according to [22],[23]. After that The nano-extract was prepared according to the method of [24] [25].

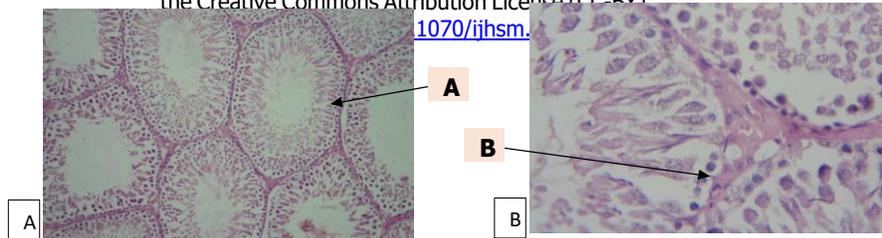
The animals were dissected and anesthetized after the experiment. The testes were removed from the albino rats, Approval was obtained from the Central Committee for Bioethics at the University of Kufa, as per their letter No. 1348 dated November 15, 2024..

Result and Discussion

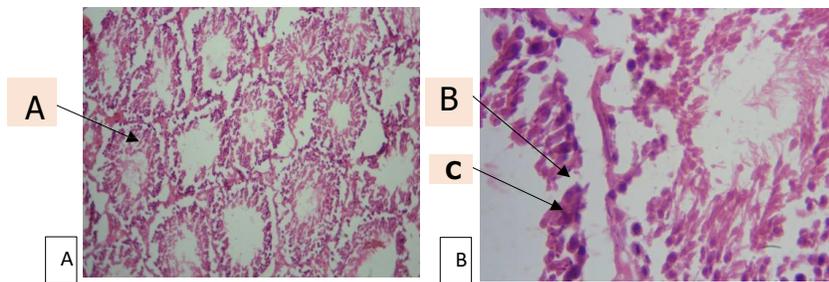
The study showed that microscopic examination revealed normal testicular structure in male mice in the control group, as shown in Figures 2 and 7. The histological structure of the second group of animals, which were administered levofloxacin at a 1.2 mg/kg, to study the effect on testicular tissue after prolonged administration 30 days) Figure 2,(Testicular atrophy and damage, decreased sperm count, and reduced sperm weight were observed with the use of this drug, particularly with prolonged levofloxacin use. Results from groups 3 and 4 treated with the extract 5 and 10 mg/kg body weight, respectively, showed normal tissue structure with no changes, and minimal effects, as illustrated in the figures. (5,6) , As for groups 5 and 6, which were treated with the nano-extract at two concentrations (5 and 10 mg/kg) respectively + levofloxacin drug at a concentration of (1.2) mg/kg, their results showed a slight effect from the nano-extract alone, as the histological sections of the testicle reduction in the effect of the drug as in Figure (3,4).

Indonesian Journal on Health Science and Medicine
Vol. 3 No. 1 (2026): July

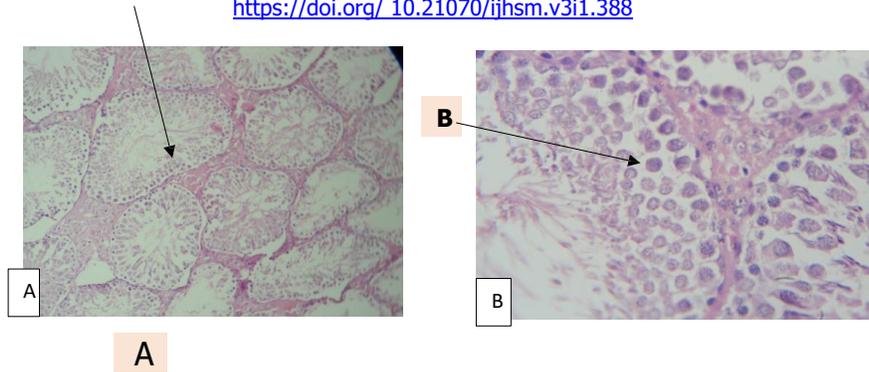
ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo
Copyright © Author(s). This is an open-access article distributed under the terms of
the Creative Commons Attribution Licence (CC-BY)



Fig(1) testicular tissue from a male mouse in the G1 shows testicular tissue, illustrating (A) spermatids at different stages and the presence of Sertoli cells and Leyden cells between the seminiferous, (B) seminiferous tubule. (Hand E 100,400X).



Fig(2) testicular tissue from mice in G2 with the antibiotic levofloxacin shows damage to the seminiferous tubules and sperm, as well as rupture of the seminiferous tubule walls and a low sperm count. (A) Sperm, (B) The breakdown of the tubule walls, low sperm count, and irregularity in the diameter of the seminiferous tubules are evident, (C) Odema. (H and E- 100,400X).



Fig(3) testicular tissue from male rats in the G3 treated with *Epimedium albinum* nano-extract (5 mg/kg) and levofloxacin (1.2 mg/kg). The normal structure of the testis is shown, and large numbers of sperm at various stages of development are observed. (A) Sperm, (B) seminiferous tubule. (H&E-100&400X).

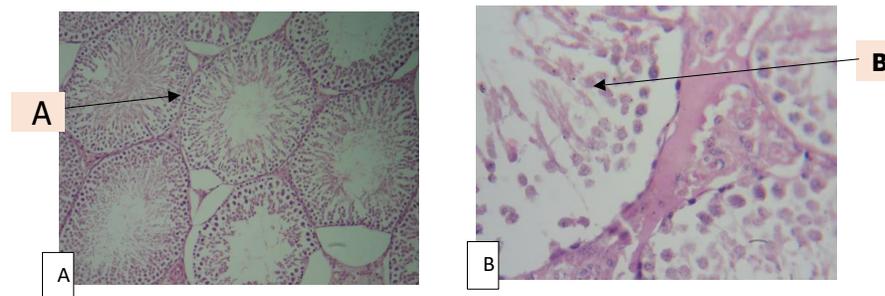
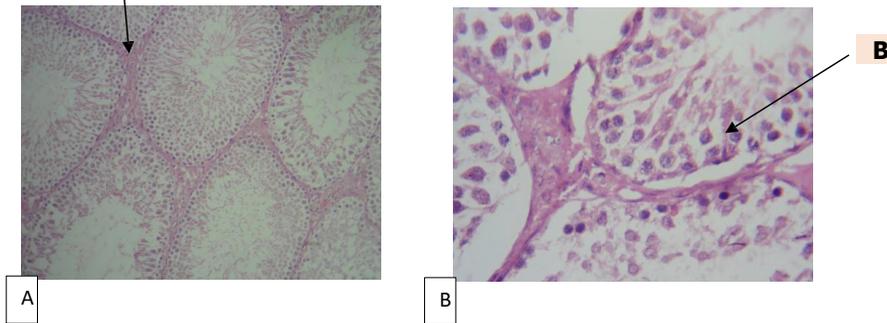


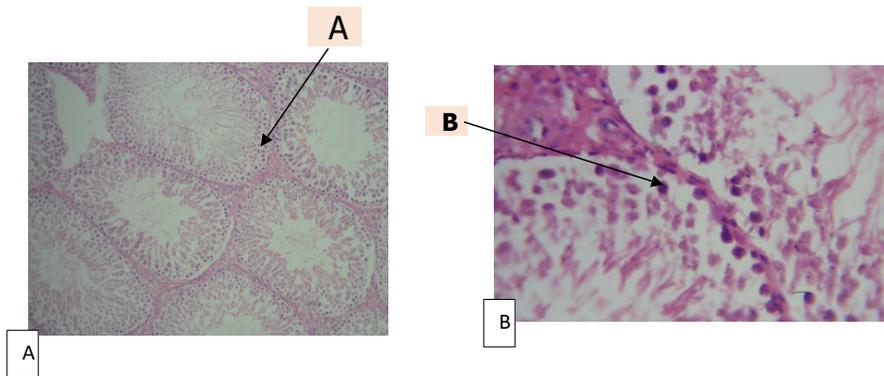
Fig (4) A section of testicular tissue from mice in the G4 treated with *Epimedium æ*extract (10 mg/kg) and levofloxacin (1.2 mg/kg). The normal structure of the testis is shown, and large numbers of sperm at various stages of development are observed. (A) seminiferous tubule, (B)Sperm (HandE-100,400X).

Indonesian Journal on Health Science and Medicine
Vol. 3 No. 1 (2026): July

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo
Copyright © Author(s). This is an open-access article distributed under the terms of
the Creative Commons Attribution License (CC-BY).
<https://doi.org/10.21070/ijhsm.v3i1.388>



Fig(5) testicular tissue from male mice in the G5 treated with *Epimedium albinum* nano-extract (5 mg/kg) The normal structure of the testis is shown, and large numbers of sperm at various stages of development are observed. (A) seminiferous tubule, (B)Sperm. (H and E-100,400X).



Fig(6 :- testicular tissue from male rats in the G6 treated with *Epimedium albinum* nano-extract (10 mg/kg) . The normal structure of the testis is shown, and large numbers of sperm at various stages of development are observed.(A) seminiferous tubule, (B)Sperm. (HandE-100and400X).

Discussion:

The results showed the presence of a normal testicular structure in the male mice in the G1, while the histological structure of the testes in the animals given levofloxacin at a dose of (1.2) mg/kg showed changes in the histological structure of the testes in the white mice after giving it for a long period of (30) days.. A study showed (recorded that this drug caused [26],[27]. Histological changes in tissue structure varied similarly to those shown in the

Indonesian Journal on Health Science and Medicine
Vol. 3 No. 1 (2026): July

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo
Copyright © Author(s). This is an open-access article distributed under the terms of
the Creative Commons Attribution License (CC-BY).

[https://doi.org/ 10.21070/ijhsm.v3i1.388](https://doi.org/10.21070/ijhsm.v3i1.388)

current research, leading to toxic pathological effects. Other studies have also shown that atrophy, destruction, and weight loss in animals, especially with prolonged use of levofloxacin, were observed with this drug, which is consistent with other studies. [28][29][30][31][32]. In the reproductive organs of male mice treated with levofloxacin and in a study [33][34]. Some studies have shown that nano-extracts from different plants are useful in controlling histological changes in the case of drug treatment, and this is due to the presence of active chemicals associated with a diverse structure in one or more parts of these plants [35]. As shown in study [36]. The reason may be attributed to the fact that nano-plant extracts gave a protective role against the drug, as studies showed the protective effect of Epimedium Albinum plant extract and its components on the tissues of some organs, and that the antioxidant and anti-inflammatory effects have a role in maintaining the treated body tissues, and this is consistent with what the current study concluded [37][38]. Histological examination of testes in animals injected with levofloxacin for 30 days showed damage to the walls of the seminiferous tubules and a decrease in sperm count, while histological sections in animals treated with the plant nano-extract and levofloxacin showed no histological changes in the tissue structure of the testes. This result is consistent with [39].

Conclusions

In summary, we demonstrated that histologically, the current therapeutic dose of levofloxacin causes significant degeneration in the male adult mouse testis with tubular damage, loss of tubular architecture, and a decrease in spermatogenic activity. However, both lower and higher doses of Epimedium alpinum nano-extract maintained the typical histological structure of the testes and markedly alleviated testicular damage induced by levofloxacin. Treatment groups receiving both the plant nano-extract showed a marked restorative effect on seminiferous tubule integrity and the organization of sperm cells, demonstrating that the extract appears to have a protective role. In conclusion, the results indicated that the bioactive ingredients of Epimedium alpinum, especially in the nano-extract of Epimedium alpinum, demonstrated antioxidant and anti-inflammatory action that protect reproductive tissues from the toxicity of the concomitant use of antibiotics. From an applied point of view, the findings emphasize the promising feasibility of plant-based nanophytopharmaceuticals to be used as supportive and/or protective agents in pharmacological treatments with established reproductive side effects. Notwithstanding, future studies are needed to clarify the exact molecular mechanism of this protective effect, to evaluate the long-term reproductive effects, and to determine the safety and effectiveness of Epimedium alpinum nano-extracts with alternative dosage regimens and in different clinical settings.

Indonesian Journal on Health Science and Medicine
Vol. 3 No. 1 (2026): July

ISSN 3063-8186. Published by Universitas Muhamamadiyah Sidoarjo
Copyright © Author(s). This is an open-access article distributed under the terms of
the Creative Commons Attribution License (CC-BY).
[https://doi.org/ 10.21070/ijsm.v3i1.388](https://doi.org/10.21070/ijsm.v3i1.388)

References

- [1] C. Chen, M. Sha, S. Yang, and Z. Zhang, "Quantitative Study of Magnoflorine in Epimedium Koreanum Nakai," *Zhongguo Zhong Yao Za Zhi*, vol. 21, pp. 681–682, 1996.
- [2] R. Hegnauer, *Chemotaxonomie Der Pflanzen*, vol. 3. Basel, Switzerland: Birkhäuser Verlag, 1964, pp. 240–254.
- [3] R. Albu, P. Dragomir, and R. Voiosu, "Gastro-Intestinal Lesions Induced by Non-Steroidal Anti-Inflammatory Drugs," *Romanian Journal of Internal Medicine*, vol. 36, nos. 3–4, pp. 145–159, 1998.
- [4] S. J. Mushattat, J. A. Alaridi, and S. Kadhim, "Effect of Some Immunological Markers on the Level of Anti-Müllerian Hormone (AMH) in Women Infected With Toxoplasma Gondii," *Wiadomosci Lekarskie (Medical Advances)*, vol. 77, no. 10, pp. 2020–2026, 2024.
- [5] R. Gupta and G. G. Das, "Toxicity Assessment and Evaluation of Analgesic, Antipyretic and Anti-Inflammatory Activities of Cordia Obliqua Leaf Methanol Extract," *Pharmaceutical Journal*, vol. 9, pp. 856–861, 2017.
- [6] S. M. Irshad et al., "Biosynthesis of ZnO Nanoparticles Using Ocimum Basilicum and Determination of Its Antimicrobial Activity," *Journal of Animal and Plant Sciences*, vol. 30, pp. 185–191, 2020.
- [7] E. M. Jabbar and M. H. Noor, "Effect of Ciprofloxacin (CPX) on the Histological Structure of Albino Rabbit Ovary," *Journal of Global Pharma Technology*, vol. 10, no. 3, pp. 498–508, 2018.
- [8] H. Mori et al., "Principle of the Bark of Phellodendron Amurense to Suppress the Cellular Immune Response," *Planta Medica*, vol. 60, pp. 445–449, 1994.
- [9] M. Ranjbar et al., "Study on Analgesic and Anti-Inflammatory Properties of Cordia Myxa Fruit Hydro-Alcoholic Extract," *Pakistan Journal of Biological Sciences*, vol. 16, no. 24, pp. 2066–2069, 2013.
- [10] H. Wu, E. J. Lien, and L. Lien, "Chemical and Pharmacological Investigations of Epimedium Species: A Survey," *Progress in Drug Research*, vol. 60, pp. 1–57, 2003.
- [11] P. L. Prasanna, K. Renu, and A. V. Gopalakrishnan, "New Molecular and Biochemical

Indonesian Journal on Health Science and Medicine
Vol. 3 No. 1 (2026): July

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo
Copyright © Author(s). This is an open-access article distributed under the terms of
the Creative Commons Attribution License (CC-BY).

[https://doi.org/ 10.21070/iijhm.v3i1.388](https://doi.org/10.21070/iijhm.v3i1.388)

Insights of Levofloxacin-Induced Hepatotoxicity," *Life Sciences*, vol. 250, Art. no. 117599, 2020.

- [12] R. Mete et al., "Protective Effects of Onion (*Allium Cepa*) Extract Against Levofloxacin-Induced Hepatotoxicity in Rats," *Toxicology and Industrial Health*, vol. 32, pp. 551–557, 2016.
- [13] J. Kaur, S. Singla, and N. Kumar, "Protective Effect of Propolis on Levofloxacin-Induced Liver Toxicity in Male Rats," *Toxicology International*, vol. 21, pp. 191–195, 2014.
- [14] W. H. Y. Al-Muhana and J. A. M. Alaridhi, "Protective Role of Nano-Extract of *Cordia Myxa* Fruits Against Indomethacin-Induced Renal Toxicity in Male Rats," *Journal of Chemical Health Risks*, vol. 13, no. 4, pp. 158–165, 2023.
- [15] F. R. Bhatti et al., "Vitamin E Protects Chondrocytes Against Hydrogen Peroxide-Induced Oxidative Stress In Vitro," *Inflammation Research*, vol. 62, pp. 781–789, 2013.
- [16] P. Villani et al., "X-Ray Induced DNA Damage and Repair in Germ Cells of PARP1(-/-) Male Mice," *International Journal of Molecular Sciences*, vol. 14, no. 9, pp. 18078–18092, 2013.
- [17] M. Ahmed, H. Hasan, and A. Kttafah, "Characterization and Antibacterial Activity of Biogenic Iron Nanoparticles Using *Proteus Mirabilis*," *Medical Journal of Babylon*, vol. 21, no. 1, pp. 39–45, 2024.
- [18] E. H. Herman et al., "Comparison of the Protective Effects of Amifostine and Dexrazoxane Against Levofloxacin Toxicity," *Cancer Chemotherapy and Pharmacology*, vol. 45, pp. 329–334, 2000.
- [19] P. J. O'Shaughnessy, "Hormonal Control of Germ Cell Development and Spermatogenesis," *Seminars in Cell & Developmental Biology*, vol. 29, pp. 55–65, 2014.
- [20] J. Das et al., "Taurine Protects Rat Testes Against Levofloxacin-Induced Oxidative Stress and Apoptosis," *Amino Acids*, vol. 42, pp. 1839–1855, 2011.
- [21] H. H. Hagar, "Protective Effect of Taurine Against Cyclosporine A-Induced Oxidative Stress and Hepatotoxicity in Rats," *Toxicology Letters*, vol. 151, pp. 335–343, 2004.
- [22] S. Ayla, I. Seckin, and G. Oktem, "Levofloxacin-Induced Nephrotoxicity: Protective Effect of Nicotinamide," *International Journal of Cell Biology*, vol. 2011, Article ID 123456, 2011.

Indonesian Journal on Health Science and Medicine
Vol. 3 No. 1 (2026): July

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo
Copyright © Author(s). This is an open-access article distributed under the terms of
the Creative Commons Attribution License (CC-BY).

[https://doi.org/ 10.21070/iijhsm.v3i1.388](https://doi.org/10.21070/iijhsm.v3i1.388)

- [23] M. K. Grant et al., "Sexual Dimorphism in Levofloxacin-Induced Systemic Inflammation," *International Journal of Molecular Sciences*, vol. 21, Art. no. 1279, 2020.
- [24] J. Tangpong et al., "Doxorubicin-Induced Central Nervous System Toxicity and Protection by Xanthone Derivative of *Garcinia Mangostana*," *Neuroscience*, vol. 175, pp. 292–299, 2011.
- [25] X. Zhao et al., "Protective Effects of Berberine on Levofloxacin-Induced Hepatotoxicity in Mice," *Biological & Pharmaceutical Bulletin*, vol. 35, pp. 796–800, 2012.
- [26] E. S. Abar and J. A. Alaridhi, "Effect of Aqueous Extract of Ginger (*Zingiber Officinale*) on Histological Structure of Prostate Gland in Male Rabbits," *Plant Archives*, vol. 19, pp. 293–298, 2019.
- [27] J. Li et al., "Hepatoprotective Effects of Berberine via Activation of AMP-Activated Protein Kinase," *Life Sciences*, vol. 98, pp. 24–30, 2014.
- [28] S. J. Mushattat, J. A. Alaridi, and A. B. Hassan, "Histological Changes in the Placenta and Physiological Effects in Aborted Women Infected With *Toxoplasma Gondii*," *Annals of Biology*, vol. 36, no. 1, pp. 22–25, 2020.
- [29] E. A. Amer et al., "Serum Elabela Level as a Reliable Biomarker for Predicting Liver Fibrosis in Iraqi Patients With Chronic Hepatitis C," *Medical Journal of Babylon*, vol. 21, no. 2, pp. 346–352, 2024.
- [30] S. J. Mushattat and J. A. Alaridi, "Effect of Addition of *Nigella Sativa* Extract on Histological and Physiological Changes of Domestic Chickens Experimentally Infected With *Eimeria Maxima*," *Journal of Pharmaceutical Sciences and Research*, vol. 10, no. 8, pp. 1934–1938, 2018.
- [31] E. Niki, "Role of Vitamin E as a Lipid-Soluble Peroxyl Radical Scavenger: In Vitro and In Vivo Evidence," *Free Radical Biology and Medicine*, vol. 66, pp. 3–12, 2014.
- [32] E. G. Schemitt et al., "Effect of Glutamine on Oxidative Stress and Inflammation in a Rat Model of Fulminant Hepatic Failure," *Nutricion Hospitalaria*, vol. 33, p. 92, 2016.
- [33] S. J. Mushattat et al., "Effect of Magnetized Water on Reducing the Histological and Physiological Effects of Experimental Infection With *Ascaridia Galli* in Domestic Chickens," *Journal of Global Pharma Technology*, vol. 10, no. 1, pp. 97–103, 2018.
- [34] Q. Chen, Y. Xue, and J. Sun, "Kupffer Cell-Mediated Hepatic Injury Induced by Silica Nanoparticles In Vitro and In Vivo," *International Journal of Nanomedicine*, vol. 8, pp.

Indonesian Journal on Health Science and Medicine
Vol. 3 No. 1 (2026): July

ISSN 3063-8186. Published by Universitas Muhamamdiyah Sidoarjo
Copyright © Author(s). This is an open-access article distributed under the terms of
the Creative Commons Attribution License (CC-BY).

[https://doi.org/ 10.21070/ijsm.v3i1.388](https://doi.org/10.21070/ijsm.v3i1.388)

1129–1140, 2013.

- [35] J. E. Mohammad and N. M. Hasnawi, "Effect of Ciprofloxacin on the Histological Structure of Albino Rabbit Ovary," *Journal of Global Pharma Technology*, vol. 10, no. 3, pp. 498–508, 2018.
- [36] T. N. Al-Shaybany et al., "Effect of Ethanolic Extracts of *Salvadora Persica* Roots on Female Albino Rats," *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, vol. 7, no. 6, pp. 1115–1125, 2016.
- [37] J. A. M. Al-Ardhil and M. A. Aziz Alshemkhi, "Histological Structure of Thyroid Gland and Its Relationship With Hyperthyroidism and Biochemical Parameters," *International Journal of PharmTech Research*, vol. 9, no. 8, pp. 189–196, 2016.
- [38] M. H. Al-Aamelia, Y. M. Al-Qazwini, and J. A. Mohammed, "Histological Investigation of the Effects of Cinnamon Extract on Skin of Male Sheep Affected by Mange," *Systematic Reviews in Pharmacy*, vol. 11, no. 12, pp. 380–386, 2020.
- [39] B. J. Al-Sabah, *Study of Physiochemical Behavior of Polluted Mineral Elements in Water and Sediments of Shatt Al-Arab River*. Basrah, Iraq: University of Basrah, 2007.