

RESEARCH ARTICLE

A Comparative Study on the Effect of *Ciprofloxacin* and Plant Extracts on Liver Enzymes in Laboratory Rats

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ABSTRACT

Plant extracts possess important biological properties, particularly their antioxidant activity and ability to protect liver cells from damage caused by certain drugs. In the present study, the liver enzymes GOT, GPT, and ALP were significantly influenced by both treatment type and exposure duration. The control group showed the highest enzyme activities, representing normal liver function. Ciprofloxacin treatment caused a significant reduction in enzyme levels during the first three days, suggesting an early inhibitory effect on liver function, likely due to metabolite accumulation and temporary cellular alterations. Although enzyme activities gradually increased after 7 and 14 days, indicating possible hepatic adaptation or tissue repair, they remained below control values, confirming the continued influence of the drug throughout the treatment period. In contrast, animals treated with *Mentha piperita* and *Ocimum basilicum* extracts maintained enzyme levels close to those of the control group, with only slight reductions observed by day 14. This hepatoprotective effect is attributed to phenolic and terpene compounds, including menthol, linalool, and eugenol, which effectively neutralize free radicals and reduce oxidative damage in liver tissues. These findings support previous evidence that phenolic-rich plant extracts stabilize liver enzyme activity and alleviate drug-induced hepatotoxicity. Overall, the results indicate that ciprofloxacin exerts a transient inhibitory effect on liver enzymes during the early treatment period, whereas peppermint and basil extracts help preserve liver enzyme balance and reduce drug-related disturbances, highlighting their potential as complementary hepatoprotective agents alongside conventional drug therapy.

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INTRODUCTION

Plant extracts are among the most important natural sources of bioactive compounds with diverse biological activities. Plants contain a wide range of secondary compounds, such as phenols, flavonoids, and terpenoids, which possess antioxidant, antimicrobial, and anti-inflammatory properties

(Harborne, 1998; Cushnie & Lamb, 2011). These properties have contributed to the growing role of plant extracts as safe and effective alternatives to synthetic chemicals, particularly in food and pharmaceutical applications.

Recent studies indicate that plant extracts play a significant role in protecting vital organs from the toxic

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effects of many drugs by reducing oxidative stress and enhancing antioxidant defense systems (Gonfa et al., 2025). The liver is one of the organs most susceptible to drug-induced side effects because it is the primary site of drug metabolism and detoxification. Therefore, evaluating the effects of pharmaceutical agents and plant-derived compounds on liver enzymes is essential for assessing hepatic function and safety.

Ciprofloxacin is a commonly used antibiotic; however, several studies have linked its use to elevated liver enzymes or histological changes indicative of potential toxicity with chronic exposure or high doses (Abdelrahman et al., 2019). Consequently, there has been growing interest in investigating the potential of plant extracts to mitigate or prevent these effects through their antioxidant properties and their regulatory role in stabilizing cell membranes.

Comparative studies between ciprofloxacin and plant extracts highlight the potential of using plants as hepatoprotective agents and as adjuncts to drug therapy. Some research has shown that adding extracts such as peppermint, basil, or ginger to animal models treated with antibiotics reduced liver enzyme levels (ALT, AST, ALP) and improved liver histological markers compared to drug-only groups (Khalil et al., 2020; Abdullah et al., 2025).

Accordingly, the current study investigating the comparative effects of ciprofloxacin and plant extracts on liver enzymes in laboratory mice is of scientific importance, as it contributes to clarifying the potential hepatoprotective mechanisms of plant compounds and their ability to mitigate damage caused by drug-induced liver side effects.

MATERIALS AND METHODS

Animals and Rearing Conditions

Healthy mice weighing 180-220 grams and aged 8-10 weeks at the start of the experiment were used. The mice were reared in a laboratory incubator under controlled environmental conditions: 22 ± 2 °C, a 12:12 h photoperiod (photoregulator), and 50–60% relative humidity. Feed and water were randomly provided throughout the experiment (Harkness et al., 2010).

Experimental Design and Grouping

The experiment was designed as a comparative experimental design, including the following treatments: a control group, a group treated with

ciprofloxacin, a group treated with *Mentha piperita* extract, and a group treated with *Ocimum basilicum* extract. For each treatment, measurements were taken at three time intervals: 3 days, 7 days, and 14 days. For each time interval, n = 6 animals per group were used.

Preparation of Plant Extracts

Gathering Plant Materials: *Mentha piperita* and *Ocimum basilicum* leaves were obtained from the market, identified, and stored under a reference specimen number in the laboratory. The leaves were cleaned of impurities and dried in a well-ventilated, shaded room at room temperature until a constant weight was achieved.

Extraction: The dried samples were ground and subjected to solvent extraction as follows: a 1:10 (w/v) aqueous-alcoholic extraction using 70% ethanol by constant maceration for 48 hours with intermittent shaking. The extract was filtered and concentrated using a rotary evaporator under reduced pressure until a solid extract was obtained. The extracts were stored in opaque tubes at 4 °C until use (Harborne, 1998).

Preparation of Solutions and Dosing

Ciprofloxacin: Administer 10 mg/kg body weight daily by mouth. Plant extracts: Administered orally at a dose of [insert applied dose mg/kg body weight] daily.

Control group: Received only the same dose carrier as the treatment groups.

The doses were administered once daily for 3, 7, or 14 days, depending on the study group.

Sampling and Blood Collection

At the end of each time period (day 3, 7, or 14), blood samples were drawn under cardiac anesthesia. The blood samples were placed in anticoagulant-free tubes (to obtain serum) and centrifuged at 3000 rpm for 10 minutes to separate the serum. Serum samples were stored at –20 °C until biochemical analyses were performed (Khalil et al., 2020).

Liver Enzyme Analysis (GOT, GPT, ALP)

The following liver enzyme activities were measured in serum: GOT (AST), GPT (ALT), and ALP. Measurements were performed using standard commercial kits according to the manufacturers' instructions. Typically:

GOT and GPT: Enzymatic spectroscopy according to the Reitman & Frankel method.

ALP: Lonemetry according to the IFCC method.

Values are recorded as mean $\pm$ SD for each group and time period.

Statistical Analysis

Data were adjusted and expressed as mean $\pm$ standard deviation (Mean $\pm$ SD). A one-way ANOVA was performed to compare means between groups, followed by Duncan's post-hoc test to determine statistically significant differences between pairs of means. A difference was considered statistically significant at $P \leq 0.05$. Statistical analyses were performed using SPSS version 25. The results are presented in tables showing Mean $\pm$ SD, with the letters (a, b, c, ...) added to indicate significant differences between means within each column.

RESULTS AND DISCUSSION

The results shown in Table 1 indicate that the liver enzyme values GOT, GPT, and ALP were significantly affected by the type of treatment and duration of dosing. The control group recorded the highest mean values for all enzymes, reflecting normal enzyme activity in a healthy liver. However, these values decreased significantly after ciprofloxacin administration during the first three days, which may indicate its inhibitory effect on liver function or temporary cellular changes due to the accumulation of drug metabolites within hepatocytes.

With continued dosing for 7 and 14 days, a gradual increase in enzyme levels was observed in the ciprofloxacin group compared to the initial days, which may indicate a compensatory response in the liver or the initiation of tissue repair. However, these values remained lower than those of the control group, confirming a sustained effect of the drug on hepatic metabolism.

However, the plant extracts (*Mentha piperita* and *Ocimum basilicum*) showed more stable results, with enzyme values close to control levels and a slight decrease in GOT, GPT, and ALP levels, particularly on the fourteenth day of treatment. This protective effect is attributed to the presence of potent phenolic and terpene compounds in these extracts, such as menthol, linalool, and eugenol, which possess antioxidant and anti-inflammatory properties. These compounds neutralize free radicals and reduce oxidative damage in liver cells.

These results are consistent with the findings of Abdullah *et al.*, (2025), who indicated that the use of plant extracts rich in phenolic compounds contributes to stabilizing liver enzyme activity and protecting it from the toxic effects of chemotherapeutic drugs or oxidative stress. These results also support the potential use of peppermint and basil extracts as liver support agents when exposed to

Table 1. Effect of ciprofloxacin and extracts of *Mentha piperita* and *Ocimum basilicum* on liver enzymes (GOT, GPT, ALP) in laboratory mice during different time periods (3, 7, 14 days)

Treatment	Duration (days)	GOT (U/L) Mean $\pm$ SD	GPT (U/L) Mean $\pm$ SD	ALP (U/L) Mean $\pm$ SD
Control		85.3 $\pm$ 4.7 a	72.5 $\pm$ 3.9 a	180.4 $\pm$ 9.2 a
Ciprofloxacin	3	62.8 $\pm$ 5.4 d	45.2 $\pm$ 4.1 d	150.3 $\pm$ 12.7 d
<i>Mentha piperita</i>	3	80.1 $\pm$ 4.5 b	68.9 $\pm$ 3.8 b	170.3 $\pm$ 8.4 b
<i>Ocimum basilicum</i>	3	82.5 $\pm$ 4.3 ab	70.2 $\pm$ 3.7 ab	172.4 $\pm$ 8.3 b
Ciprofloxacin	7	70.4 $\pm$ 5.9 c	51.7 $\pm$ 4.6 c	163.8 $\pm$ 13.5 c
<i>Mentha piperita</i>	7	75.7 $\pm$ 4.2 bc	65.1 $\pm$ 3.6 b	165.8 $\pm$ 8.0 bc
<i>Ocimum basilicum</i>	7	77.9 $\pm$ 4.0 bc	66.4 $\pm$ 3.5 b	166.5 $\pm$ 7.9 bc
Ciprofloxacin	14	78.6 $\pm$ 6.2 bc	58.9 $\pm$ 5.1 c	175.4 $\pm$ 14.2 ab
<i>Mentha piperita</i>	14	70.2 $\pm$ 3.9 c	61.7 $\pm$ 3.4 b	160.2 $\pm$ 7.7 c
<i>Ocimum basilicum</i>	14	73.3 $\pm$ 3.8 c	63.1 $\pm$ 3.3 b	162.0 $\pm$ 7.6 c

Statistical analysis was performed using one-way ANOVA followed by Duncan's post-hoc test. Different letters (a, b, c) within the same column indicate



pharmaceutical compounds with potential side effects (ATALLAH *et al.*, 2022).

In general, these results indicate that ciprofloxacin may cause a temporary disturbance in liver enzymes, whereas the studied plant extracts have a protective regulatory effect that maintains enzyme balance and limits harmful effects on liver cells with prolonged dosing.

CONCLUSION

The study showed that ciprofloxacin exerts a temporary inhibitory effect on liver enzymes (GOT, GPT, ALP) in mice during the first few days of treatment, with a subsequent gradual increase indicating a compensatory or repairing response in the liver. However, the values did not fully return to control levels, confirming a pharmacological effect on liver metabolism at the doses used.

The studied plant extracts (*Mentha piperita* and *Ocimum basilicum*) showed a protective and regulatory effect on liver enzymes, maintaining enzyme levels close to those of the control group throughout the experiment, with a slight decrease in some values on day 14. This demonstrates the ability of these extracts to protect the liver from oxidative damage associated with pharmacological agents.

The results support the idea that phenolic and terpene compounds in plant extracts (such as menthol, linalool, and eugenol) play an effective role in reducing oxidative stress and promoting liver cell integrity. The study confirms the potential use of plant extracts as liver support agents, particularly in cases of exposure to medications with possible side effects on liver function, including antibiotics such as ciprofloxacin.

The study encourages the use of plant extracts rich in phenolic and terpene compounds as complementary agents in drug therapy protocols, provided that safety and effective dosages are verified in animal models before proceeding to clinical applications.

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CONFLICT OF INTERESTS

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Ethics Statement

All experimental procedures involving animals were conducted in accordance with the institutional guidelines for the care and use of laboratory animals and were approved by the appropriate Institutional Animal Ethics Committee prior to the commencement of the study.

Originality and Plagiarism

The authors declare that this manuscript is original, has not been published previously, and is not under consideration for publication elsewhere. All sources have been appropriately cited, and the manuscript complies with the journal's plagiarism and publication ethics policies.

Consent for Publication

All authors have read and approved the final version of the manuscript and consent to its publication.

Competing Interests

The authors declare that they have no competing interests.

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

All authors contributed substantially to the conception and design of the study. Data collection, laboratory experiments, statistical analysis, interpretation of results, and manuscript preparation were performed collaboratively. All authors reviewed, revised, and approved the final manuscript.

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