

Anti-ulcer Activity of Berberine Isolated from *Berberis aristata* in Wistar Albino Rats

Ashwini S. Gawade^{1*}, Tanuja N. Bhalerao¹, Prachi D. Bhor¹, Nupur A. Barve¹, Anshuvar A. Dhainje¹, Sanika P. Kokate², Snehal A. Mahadar², Dr. Kiran C. Mahajan², Dr. Ganesh Y. Dama³

¹Department of Pharmacology, SGMSPM's Sharadchandra Pawar College of Pharmacy, Dumbarwadi (Otur), Tal-Junnar, Dist-Pune, Maharashtra, India, 401504.

²Department of Pharmaceutics, SGMSPM's Sharadchandra Pawar College of Pharmacy, Dumbarwadi (Otur), Tal-Junnar, Dist-Pune, Maharashtra, India, 401504.

³Department of Pharmacognosy, SGMSPM's Sharadchandra Pawar College of Pharmacy, Dumbarwadi (Otur), Tal-Junnar, Dist-Pune, Maharashtra, India, 401504.

Corresponding author:

Ashwini S. Gawade,

Department of Pharmacology,

SGMSPM's Sharadchandra Pawar College of Pharmacy, Dumbarwadi (Otur), Tal-Junnar, Dist-Pune, Maharashtra, India, 401504.

E-mail id: gawadeashwini15@gmail.com

DOI: <https://doi.org/10.63001/tbs.2026.v21.i02.pp864-872>

KEYWORDS

Peptic ulcer disease, Berberine, *Berberis aristata*, Ethanol-induced ulcer, Gastroprotective activity, Omeprazole, Wistar albino rats.

Received on:

22-04-2026

Accepted on:

10-05-2026

Published on:

21-05-2026

Abstract

Peptic ulcer disease (PUD) is a multifactorial gastrointestinal disorder associated with excessive gastric acid secretion, oxidative stress, *Helicobacter pylori* infection, alcohol consumption, and prolonged use of non-steroidal anti-inflammatory drugs. Herbal compounds possessing antioxidant and cytoprotective properties have gained attention as safer alternatives for ulcer management. The present study investigated the anti-ulcer activity of berberine isolated from *Berberis aristata* using an ethanol-induced gastric ulcer model in Wistar albino rats. Acute oral toxicity studies were conducted according to OECD guideline 425, and berberine was found to be safe at the selected dose range. Animals were divided into five groups consisting of normal control, ethanol control, standard treatment with omeprazole (20 mg/kg), berberine low dose (50 mg/kg), and berberine high dose (100 mg/kg). Gastric parameters including ulcer index, percentage ulcer inhibition, gastric volume, gastric pH, and total acidity were evaluated. Histopathological examination of gastric tissues was also performed. Berberine treatment significantly reduced ulcer index and gastric acidity while improving gastric pH and mucosal integrity compared with the ethanol control group. The high-dose berberine group showed gastroprotective activity comparable to omeprazole. Histopathological findings further confirmed reduced mucosal erosion and inflammation in berberine-treated animals. The study demonstrates that berberine possesses significant anti-ulcer activity, possibly mediated through antioxidant and cytoprotective mechanisms.

Introduction:

Peptic ulcer disease is a chronic gastrointestinal disorder characterized by disruption of the gastric or duodenal mucosal lining due to an imbalance

between aggressive and defensive factors of the gastrointestinal tract¹.

Aggressive factors include gastric acid, pepsin, ethanol, *Helicobacter pylori*

infection, and non-steroidal anti-inflammatory drugs² whereas defensive factors include mucus secretion, bicarbonate production, prostaglandins, and mucosal blood flow³.

Globally, peptic ulcer disease affects millions of individuals and remains a significant healthcare burden². Although proton pump inhibitors and H₂ receptor antagonists are widely used for treatment, long-term administration may produce adverse effects, recurrence, and drug interactions³. Therefore, there is growing interest in plant-derived bioactive compounds with improved safety profiles and therapeutic efficacy⁴.

Berberis aristata, commonly known as Daruharidra, is an important medicinal plant extensively used in Ayurvedic medicine for the treatment of inflammatory disorders, infections, liver diseases, and gastrointestinal conditions⁵. Berberine, the principal isoquinoline alkaloid present in *Berberis aristata*, exhibits antioxidant, antimicrobial, anti-inflammatory, antidiabetic, and gastroprotective properties⁶.

Previous studies have demonstrated the anti-ulcer potential of several medicinal plants and alkaloids in experimental ulcer models². However, limited experimental evidence is available regarding the gastroprotective activity of isolated

berberine from *Berberis aristata* in ethanol-induced gastric ulceration⁷.

Therefore, the present study was designed to evaluate the anti-ulcer activity of berberine isolated from *Berberis aristata* in ethanol-induced gastric ulcer models in Wistar albino rats⁶.

Materials and Methods:

Plant Material and Chemicals:

Berberis aristata root extract containing berberine was procured from a certified herbal supplier and used for the experimental study⁵. Omeprazole was used as the standard anti-ulcer drug⁸. Analytical grade chemicals and reagents including ethanol, hydrochloric acid, sodium hydroxide, chloroform, diethyl ether, ferric chloride, lead acetate solution, and sulfuric acid were used throughout the study⁹.

Experimental Animals:

Healthy Wistar albino rats weighing between 150–220 g were selected for the study¹⁰. Animals were maintained under standard laboratory conditions with controlled temperature and humidity and were provided standard pellet diet and water *ad libitum*⁸. The animals were acclimatized to laboratory conditions before initiation of the experiment⁹.

Acute Oral Toxicity Study:

The acute oral toxicity study was performed according to OECD guideline 425¹¹. Female Wistar rats were fasted for 24 hours

before administration of the test compound while water was provided freely¹⁰. Berberine extract was administered orally at a limit dose of 2000 mg/kg body weight¹¹. Animals were observed continuously during the first 2 hours and periodically for 24 hours for behavioral, neurological, and autonomic responses¹⁰. Mortality and general physical condition were monitored daily for 14 days¹¹.

Experimental Design:

Thirty Wistar albino rats were randomly divided into five groups containing six animals in each group⁷.

Group I: Normal control receiving distilled water⁸

Group II: Ethanol control receiving absolute ethanol¹²

Group III: Standard group receiving omeprazole (20 mg/kg)⁸

Group IV: Test group receiving berberine extract (50 mg/kg)⁶

Group V: Test group receiving berberine extract (100 mg/kg)⁷

All treatments were administered orally for seven consecutive days¹⁰.

Induction of Gastric Ulcer:

Gastric ulceration was induced using the ethanol-induced ulcer model¹². Animals in ulcer control and treatment groups received absolute ethanol orally to produce gastric mucosal injury¹³. After completion of treatment, animals were sacrificed by cervical dislocation and stomachs were

isolated for biochemical and histopathological evaluation¹⁰.

Evaluation of Gastric Parameters:

Ulcer Index:

The stomachs were opened along the greater curvature and examined for gastric lesions⁸. Ulcer severity was scored according to standard grading criteria, and ulcer index was calculated.⁷

Percentage Ulcer Inhibition:

Percentage ulcer inhibition was calculated using the following formula:

$$\begin{aligned}
 &[(\text{gastric mucosal injury index of} \\
 &\text{model control group} - \text{gastric} \\
 &\text{mucosal injury} \\
 &\text{index of treatment group}) / \text{gastric} \\
 &\text{mucosal injury index of model} \\
 &\text{group}] \times 100 \quad ^7.
 \end{aligned}$$

Determination of Gastric Volume and pH:

Gastric contents were collected into a graduated measuring cylinder and gastric volume was recorded⁸. The pH of gastric juice was determined using a calibrated digital pH meter¹⁰.

Determination of Total Acidity:

An aliquot of gastric juice was diluted with distilled water and titrated against 0.01 N sodium hydroxide using phenolphthalein as an indicator⁸. Total acidity was expressed in mEq/L⁷.

Histopathological Examination:

Stomach tissues were washed with normal saline and fixed in 10% formalin solution¹⁰. The tissues were processed, embedded in paraffin wax, sectioned, and stained with hematoxylin and eosin¹². Histopathological changes were observed under a light microscope to evaluate mucosal damage and protective effects of treatment¹³.

Results & Discussion:

Acute Toxicity Study:

No mortality or significant behavioral abnormalities were observed in animals treated with berberine at 2000 mg/kg. The findings indicated that berberine was safe within the tested dose range.

Table No 1: Acute Toxicity Study Observation

No .of animals	Dose/Treatment	Parameter		Observation
3 Female wistar rat	Plant extract BA(2000mg/kg)	Behavioral profile	Alertness	Normal
			Restlessness	Normal
			Irritability	Normal
			Fearfulness	Normal
		Physical state	Lacrimation	Normal
			Loss of appetite	Normal
			Salivation	Normal
		Mortality		All three animals were survive

Effect of Berberine on Ulcer Index:

Ethanol administration produced severe gastric ulceration in the control group with a high ulcer index value. Treatment with berberine significantly reduced ulcer formation in a dose-dependent manner. The 100 mg/kg dose exhibited marked gastroprotective activity comparable to omeprazole.

Table No 2: Determination of % ulcer index, % ulcer protection, % ulcer inhibition

Group	Treatment	Ulcer Index(Mean±SEM)	% Ulcer Protection	% Ulcer Inhibition
Group I	Normal control	0.92 ± 0.12	--	--

Group II	Ethanol control	17.24 ± 1.31	--	--
Group III	Omeprazole (20mg/kg)	3.18 ± 0.36	81.85 %	81.55 %
Group IV	Berberine (50mg/kg)	7.42 ± 0.58	56.96 %	56.96 %
Group V	Berberine (100 mg/kg)	4.06 ± 0.41	76.45 %	76.45 %

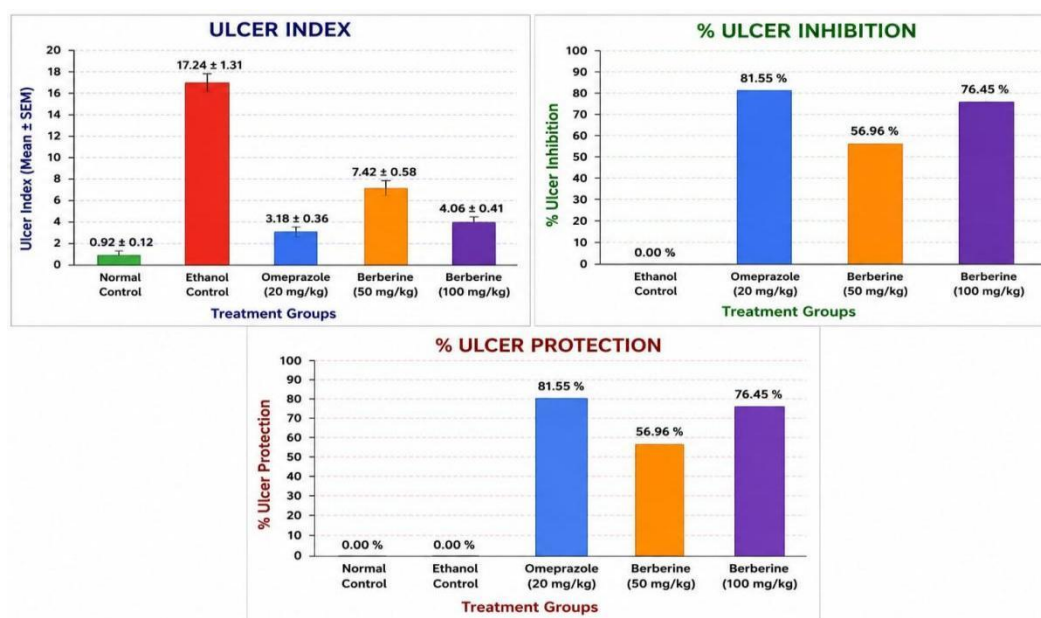


Figure 1: Comparative evaluation of ulcer index (Mean $\pm$ SEM), % ulcer inhibition, and % ulcer protection in normal control, ethanol control, omeprazole-treated, and berberine-treated groups in ethanol-induced gastric ulcer rats.

Effect on Gastric Parameters:

Berberine significantly decreased gastric volume and total acidity while increasing

gastric pH compared with the ethanol control group. The high-dose group showed improved gastric protection.

Table No 3: Effect of Berberine on Gastric Parameters

Group	Gastric Volume (mL)	Gastric pH	Total Acidity(mEq/L)
-------	---------------------	------------	----------------------

Normal control	1.74 ± 0.18	4.68 ± 0.21	32.84 ± 2.16
Ethanol control	6.12 ± 0.42	1.62 ± 0.12	92.48 ± 4.22
Omeprazole	2.08 ± 0.24	5.02 ± 0.18	36.14 ± 2.74
Berberine (50 mg/kg)	3.84 ± 0.28	3.56 ± 0.16	58.22 ± 3.42
Berberine (100 mg/kg)	2.52 ± 0.20	4.22 ± 0.19	42.68 ± 2.95

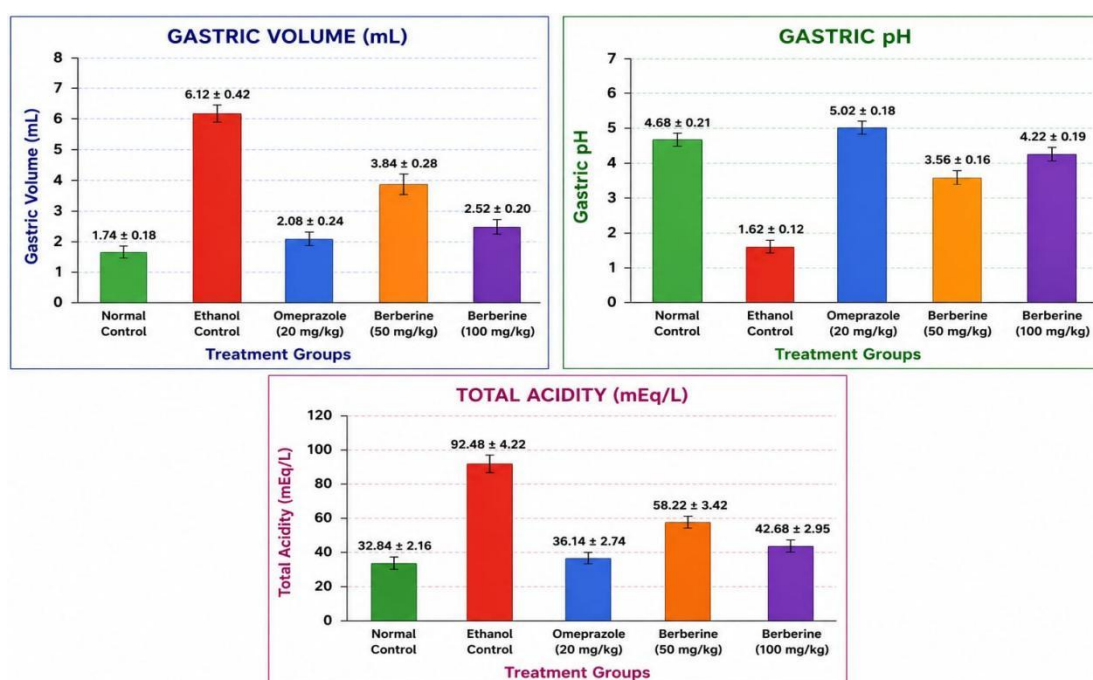


Figure 2: Comparative evaluation of gastric volume (mL), gastric pH, and total acidity (mEq/L) in normal control, ethanol control, omeprazole-treated, and berberine-treated groups in ethanol-induced gastric ulcer rats.

Histopathological Findings:

Histopathological examination of ethanol-treated gastric tissues revealed severe mucosal erosion, edema, and inflammatory cell infiltration. Berberine-treated groups

showed reduced gastric damage and preservation of mucosal architecture. The protective effect was more prominent in the high-dose berberine group.

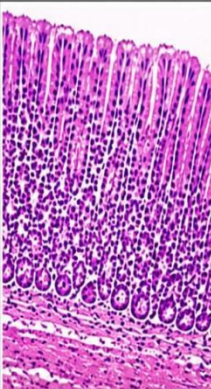
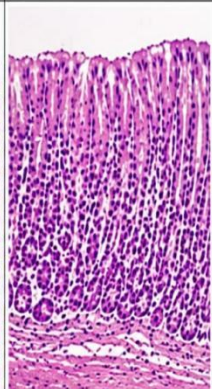
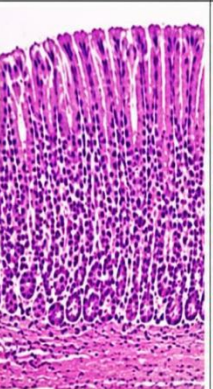
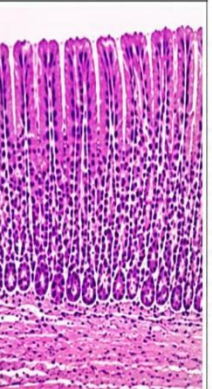
Normal Control	Ethanol Control	Omeprazole (20 mg/kg)	Berberine (50 mg/kg)	Berberine (100 mg/kg)
				
Intact gastric mucosa with normal epithelial lining, well arranged gastric glands and absence of inflammatory cells.	Severe epithelial erosion, necrosis, edema and inflammatory cell infiltration. Disruption of gastric glands.	Mild mucosal damage with reduced inflammatory cells and partial restoration of gastric glands.	Moderate reduction in mucosal damage with restoration of epithelial architecture and decrease in inflammatory cells.	Nearly normal gastric mucosa with intact epithelium and minimal inflammatory changes.

Figure 3: Histopathological examination of stomach tissue sections showing the protective effect of omeprazole and berberine against ethanol-induced gastric mucosal damage (Hematoxylin and Eosin stain, 400× magnification).

The present investigation demonstrated significant anti-ulcer activity of berberine isolated from *Berberis aristata* against ethanol-induced gastric ulcers in Wistar albino rats. Ethanol-induced ulceration is a commonly employed experimental model that produces gastric mucosal injury through oxidative stress, inflammation, lipid peroxidation, and excessive acid secretion.

The reduction in ulcer index observed in berberine-treated groups indicates substantial gastroprotective activity. The high-dose berberine group demonstrated

better efficacy than the low-dose group, suggesting a dose-dependent protective effect. Improvement in gastric pH and reduction in gastric acidity further support the antisecretory action of berberine.

Berberine possesses antioxidant and anti-inflammatory activities that may contribute to gastric mucosal protection. Previous reports have demonstrated that berberine modulates oxidative stress pathways, suppresses inflammatory mediators, and improves tissue healing.

Conclusion:

In conclusion, the present study revealed that berberine isolated from *Berberis aristata* exhibited significant gastroprotective and anti-ulcer activity in ethanol-induced gastric ulcer models in Wistar albino rats. Treatment with berberine notably decreased ulcer

formation, gastric acidity, and gastric volume while improving gastric pH and preserving the integrity of the gastric mucosa in a dose-dependent manner. The higher dose of berberine showed protective effects comparable to the standard drug omeprazole, which was further supported by histopathological findings showing reduced mucosal damage and inflammation. The observed activity may be associated with the antioxidant, anti-inflammatory, and cytoprotective properties of berberine. These findings indicate that berberine has potential as a natural and safe therapeutic agent for the management of peptic ulcer disease, although further pharmacological and clinical studies are required to confirm its effectiveness and mechanism of action.

References:

- 1) ie X, Ren K, Zhou Z, Dang C, Zhang H. The global, regional and national burden of peptic ulcer disease from 1990 to 2019: A population-based study. *BMC Gastroenterology*. 2022;22(1):58.
- 2) harmani P, Palit G. Exploring Indian medicinal plants for antiulcer activity. *Indian Journal of Pharmacology*. 2006;38(2):95-99.
- 3) howmik D, Chiranjib, Tripathi KK, Pankaj, Sampath Kumar KP. Recent trends of treatment and medication peptic ulcerative disorder. *International Journal of PharmTech Research*. 2010;2(1):970-980.
- 4) imla G, Gricilda Shoba F. A review on antiulcer activity of few Indian medicinal plants. *International Journal of Microbiology*. 2014;2014:519590.
- 5) harma K, Bairwa R, Chauhan N, Shrivastava B, Saini NK. *Berberis aristata*: A review. *International Journal of Research in Ayurveda and Pharmacy*. 2011;2(2):383-388.
- 6) umar A, Ekavali, Chopra K, Mukherjee M, Pottabathini R, Dhull DK. Current knowledge and pharmacological profile of berberine: An update. *European Journal of Pharmacology*. 2015;761:288-297.
- 7) amdeo P, Pandole M, Singh P. Antiulcerogenic effect of methanolic root extract of *Berberis lycium* Linn by pylorus ligation and ethanol induced ulceration. *Journal of Drug Delivery and Therapeutics*. 2021;11(4-S):9-14.

- 8) ighoniya P, Shukla A, Singh CS, Gotiya P. Comparative anti-ulcerogenic study of pantoprazole formulation with and without sodium bicarbonate buffer on pyloric ligated rats. *Journal of Pharmacology and Pharmacotherapeutics*. 2011;2(3):179-184.
- 9) atapathy T, Sen K, Sahu S, et al. Experimental animal models for gastric ulcer/peptic ulcer: An overview. *Journal of Drug Delivery and Therapeutics*. 2024;14(1):182-192.
- 10) elayneh YM, Amare GG, Meharie BG, Kifle ZD. Evaluation of the antiulcerogenic activity of hydromethanol extracts of *Solanum incanum* L. leaves and roots in mice: Single and repeated dose study. *Metabol Open*. 2021;11:100119.
- 11) rganisation for Economic Co-operation and Development (OECD). OECD guideline for the testing of chemicals: Acute oral toxicity—up-and-down procedure (OECD Guideline 425). Paris: OECD Publishing; 2008.
- 12) hazaei M, Salehi H. Protective effect of *Falcaria vulgaris* extract on ethanol-induced gastric ulcer in rats. *Iranian Journal of Pharmacology and Therapeutics*. 2006;5(1):43-46.
- 13) ang X, Yang L, Pan D, Liu H, Xia H, Wang S, et al. Wheat peptide protects against ethanol-induced gastric mucosal damage through downregulation of TLR4 and MAPK. *Journal of Functional Foods*. 2020;75:104271.