

Pharmacogenetic Evaluation and Antiulcer Activity of *Acacia arabica* Leaves in Experimental Rat Models

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ABSTRACT

Background: Gastric ulcer remains a prevalent gastrointestinal disorder, primarily associated with lifestyle changes, stress, and dietary factors. Although conventional antiulcer agents, for example, proton pump inhibitors, are effective, their long-term use is often limited by adverse effects and economic constraints. Consequently, there is growing interest in identifying plant-based therapeutics with improved safety and efficacy profiles.

Objectives: The present study aimed to establish the pharmacognostic characteristics of *Acacia arabica* (syn. *Acacia nilotica*) leaves, evaluate their phytochemical composition, and investigate their antiulcer activity using validated experimental models.

Methods: Leaves of *A. arabica* were subjected to comprehensive pharmacognostic evaluation, including macroscopic, microscopic, and physicochemical analyses. An ethanolic extract was prepared and screened for major phytochemical constituents. Antiulcer activity was assessed in Wistar rats using pylorus ligation-induced and ethanol-induced gastric ulcer models. The extract was administered orally at doses of 200 and 400 mg/kg. Ulcer index, percentage gastroprotection, and gastric mucosal integrity were evaluated, with omeprazole used as the reference standard.

Results: Phytochemical screening discovered the incidence of alkaloids, carbohydrates, and phenolic compounds in the ethanolic extract. Treatment with the extract produced a significant, dose-dependent reduction in gastric lesions in both experimental models ($p < 0.05$). The higher dose exhibited marked gastroprotective activity, significantly reducing the ulcer index and preserving gastric mucosal architecture, with effects comparable to those of omeprazole.

Conclusion: The findings demonstrate that the ethanolic leaf extract of *Acacia arabica* possesses significant gastroprotective and antiulcer activity, supporting its traditional medicinal use. These effects may be attributed to its phenolic constituents and warrant further studies to isolate and characterise the bioactive compounds responsible for the observed activity.

Keywords: *Acacia arabica*, Antiulcer activity, Ethanolic extract, Experimental ulcer models, Gastroprotective effect, Pharmacognostic evaluation, Phytochemical screening.

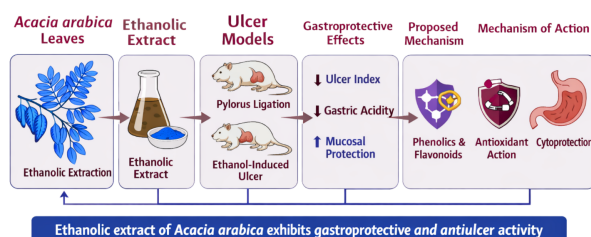
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Graphical Abstract



Introduction

Gastric and Peptic Ulcer Disease

Gastric and duodenal ulcers are localized erosions of the gastrointestinal mucosa caused by an imbalance between aggressive factors, such as gastric acid and pepsin, and protective mechanisms, including mucus–bicarbonate secretion, prostaglandins, mucosal blood flow, and epithelial regeneration. Approximately 98–99% of ulcers occur in the stomach or proximal duodenum, with duodenal ulcers more prevalent than gastric ulcers. Clinically, peptic ulcer disease (PUD) presents with epigastric pain, bloating, dyspepsia, and, in severe cases, gastrointestinal bleeding manifesting as melena or hematemesis [1,2]. The pathogenesis of peptic ulcers involves continuous exposure of the gastric mucosa to injurious agents such as *Helicobacter pylori*, non-steroidal anti-inflammatory drugs (NSAIDs), bile salts, alcohol, and dietary irritants. Lifestyle-related factors, including psychological stress, smoking, poor nutrition, and prolonged drug use, further exacerbate mucosal vulnerability, increasing ulcer incidence and recurrence [3].

Regulation of Gastric Acid Secretion

Gastric acid secretion is a tightly controlled physiological procedure mediated primarily by the parietal cell H^+/K^+ -ATPase. Acid secretion is stimulated by histamine, acetylcholine, and gastrin, acting through H_2 , muscarinic (M_3), and CCK-B receptors, respectively. These signaling pathways converge to activate the proton pump, thereby increasing hydrogen ion secretion into the gastric lumen. Conversely, endogenous inhibitors such as somatostatin modulate acid output and maintain mucosal integrity. Disruption of this regulatory balance predisposes the gastric epithelium to acid-induced injury and ulcer formation [4,5].

Epidemiology and Etiopathogenesis

Peptic ulcer disease remains an important global health problem, distressing more than 10% of the adult population during their lifetime. The disease commonly manifests between 20 and 60 years of age and is associated with substantial morbidity and healthcare burden [6]. Epidemiological studies demonstrate that *H. pylori* contamination is present in approximately 90–95% of intestinal ulcers and 80–85% of gastric ulcers, while NSAID use accounts for a substantial proportion of remaining cases.

The lifetime risk of developing an ulcer in individuals infected with *H. pylori* is estimated at 10–15% [7,8]. Despite advances in pharmacotherapy, current antiulcer regimens, including proton pump inhibitors, H_2 -receptor antagonists, and antibiotic-based eradication therapies, are often limited by adverse effects, rising antimicrobial resistance, high relapse rates, and long-term dependency. These limitations highlight the need for alternative therapeutic approaches with improved safety and efficacy profiles [9].

Role of Herbal Medicines in Ulcer Management

Herbal medicines have been used for centuries as primary therapeutic agents and continue to play a vital role in modern healthcare systems, particularly in developing countries. According to the World Health Organisation, nearly 75% of the worldwide population depends on plant-based treatments for their primary healthcare needs. Medicinal plants contain diverse bioactive phytoconstituents, including phenolics, flavonoids, tannins, and alkaloids, which exhibit antioxidant, anti-inflammatory, cytoprotective, and anti-secretory properties relevant to ulcer healing [10]. India, recognised as one of the world's richest reservoirs of medicinal plant biodiversity, has a long history of herbal medicine, as replicated in systems such as Ayurveda. Among these plants, *Acacia arabica* (syn. *Acacia nilotica*) has been traditionally used to treat gastrointestinal disorders, inflammation, and wound healing. However, systematic pharmacognostic standardisation and experimental validation of its antiulcer potential remain limited, necessitating scientific investigation to substantiate its traditional use.

Plant Profile (*Acacia arabica*).

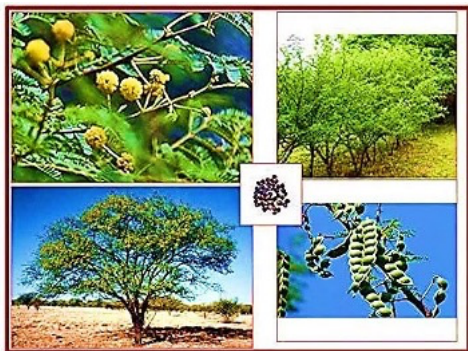
Category	Information
Kingdom	Plantae
Order	Fabales
Family	Fabaceae
Genus	<i>Acacia</i>
Species	<i>Acacia arabica</i>
Vernacular Name	Babul

Morphological features.

Linnaeus first described *Acacia* in 1773, and the genus now includes nearly 1,380 species worldwide, with about two-thirds native to Australia. In India, *Acacia* is commonly found as a medium-sized evergreen tree featuring a relatively quick trunk and a rounded, feathery crown. The tree generally reaches about 15 meters in height and has an average girth of around 1.2 meters, although some specimens may grow up to 30 meters tall with a girth of nearly 3 meters [11]. The bark is hard, dark brown to almost black, and

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shows deep longitudinal fissures. Leaves are bipinnate, measuring 2.5–5 cm in length, and bear slender, elongated pinnae. The tree produces bright yellow, fragrant flowers arranged in dense, globose heads. Fruiting pods are typically 7.5–15 cm long, flat, and constricted between the seeds, giving them a moniliform appearance. Flowering occurs mainly from June to September too again from December to January. The fruits are tracked, and each pod usually contains 8–12 seeds. The pods mature between May and June [12,13]



Chemical Constituents. Bark:

The bark comprises various bioactive polyphenolic compounds, including (+)-catechin, (+)- and (–)-epigallocatechin-7-gallate, (–) epigallocatechin-5,7-digallate, (–)-epicatechin, (+) dicatechin, (+)-quercetin, (+)-leucocyanidin, sugars, and (+)-catechin-5-gallate. It is notably abundant in tannins, with a content of approximately 12–20%, rendering it a significant source of astringent phytochemicals.

Gum:

The gum is composed of galactose, L-rhamnose, and four aldobiouronic acids. These include derivatives such as D-galactose 6-O-(4-O-methyl-β-D-glucopyranosyluronic acid)-D-galactose 6-O-(β-D-glucopyranosyluronic acid)-D-galactose and 4-O-(4-O-methyl-α-D-galactose)-D-galactose.. These complex polysaccharide structures contribute to the gum's viscosity and medicinal utility.

Fruit:

The fruits contain a high proportion of m-digallic acid, gallic acid, and their methyl ethyl esters. They also contain leucocyanidin and m-digallic flavonol derivatives, including 3,4,5,7 3,4,5,7-tetrahydroxyflavan-3-ol, oligomers of 3,4,7-trihydroxyflavan-3,4-diol, and epicatechol. In addition to these phenolics, adhesive compounds and saponins are present. The fruit contains about 32% tannins.

Flowers and Pods:

Flowers and pods include stearic acid, kaempferol-3-

glucoside, and leucocyanidin. The tannin content in the pods ranges from 12–19% in whole pods and 18–27% after seed removal. Wood also contains tannins (approx. 22.44%) when expressed as oxalic acid equivalents, along with chlorides. Seeds typically contain 18–19% sugars, 14% moisture, and 3–4% ash.

Leaves:

The leaves are rich in flavonoids such as apigenin, rutin, and 6,8-bis-D-glucoside, and contain approximately 32% tannins [14,15,16].

Pharmacological Studies Antidiabetic Activity:

Wadood et al. reported the seeds of *Acacia arabica* contain bioactive constituents that lower blood glucose levels in normoglycemic rabbits. However, this effect was not observed in alloxan-induced diabetic animals. This suggests that the antihyperglycemic mechanism may involve stimulation of insulin secretion from pancreatic β-cells. Decoction of *A. arabica* bark (20 mg/kg) has also been shown to potentiate the hypoglycemic action of tolbutamide in moderately alloxanized rabbits following 18-hour fasting. In normal rats, glucose levels decreased by approximately 25%, while alloxan-treated rats exhibited no significant response. The hypoglycemic potential of *Acacia* pods is attributed to direct or indirect activation of β-cells, thereby promoting improved insulin release from the Islets of Langerhans [17].

Antimutagenic Activity:

Methanolic extracts of *A. arabica* demonstrated antimutagenic potential by reversing pyrimidine dimer formation in *Escherichia coli* WP-2 strains exposed to UV radiation, indicating protection against UV-induced genetic mutations [18].

Anti-proteolytic Activity:

Studies on *Acacia* pods revealed inhibitory effects on human and bovine pancreatic proteolytic enzymes, particularly trypsin and chymotrypsin. The activity was more potent against human proteases, suggesting potential therapeutic relevance.

Antifertility Activity:

Aqueous extracts of *Acacia* flowers induced teratogenic effects and early fetal resorption in approximately 11.5% of pregnant rats, though pregnancy was not completely terminated. Stem bark extract exhibited mild spermicidal activity, leading to precipitation of semen proteins [19].

General Pharmacology:

Various extracts of *Acacia* species have demonstrated multiple pharmacological actions in isolated pig ileum, rat cervix, and cardiac tissues. Stem bark extracts

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contain a quaternary alkaloid picrate with pharmacological similarities to choline. Ethanolic (50%) extracts of the stem bark exhibit cardiovascular effects, antispasmodic action, central nervous system depressant activity, and antiprotozoal properties [20].

Antimicrobial Activity:

Vigorous antimicrobial activity has been reported against *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhi*, and fungal strains, including *Aspergillus niger* and *Candida albicans*. The bark and pods of *A. catechu* and *A. nilotica* are rich in secondary metabolites, such as tannins, flavonoids, saponins, and alkaloids, which contribute to their broad-spectrum antimicrobial activity [21,22].

Antibacterial Activity:

Extracts of *Acacia nilotica* exhibited significant antibacterial activity tested against *Streptococcus viridans*, *Staphylococcus aureus*, *E. coli*, *Bacillus subtilis*, and *Fusarium oxysporum* using agar diffusion assays. *B. subtilis* was the most sensitive, while *C. Candida albicans* was highly resistant. Methanolic extracts of *A. nilotica* demonstrated results comparable to synthetic antibiotics such as gentamicin, streptomycin, and tetracycline against human pathogenic strains and phytopathogens [23].

Antifungal Activity:

Polyphenolic fractions of *Acacia* bark exhibited strong antifungal properties, with 50% inhibition of *Fusarium oxysporum* growth and 65% suppression of *Alternaria solani* conidial germination after 10 hours. Leaf extracts inhibited the mycelial growth of *Sarocladium oryzae* and *Fusarium* species by up to 69%, whereas ethanolic extracts showed 51% inhibition of *Rhizoctonia solani* [24].

Antidiarrhoeal Activity:

In traditional medicine, particularly in Kaduna State, Nigeria, *A. nilotica* is widely used for treating diarrhoea. In experimental models, aqueous methanolic extracts

$$\% \text{ Yield} = \frac{\text{Weight of withdrawal (gm)} \times 100}{\text{Weight of withdrawal (gm)}}$$

Physico-Chemical Parameters of Plant.

Determination of LOD

Loss on drying measures the moisture content and volatile substances in the sample. One gram of the powdered drug was placed in a pre-weighed evaporating dish and dried at 105 °C for 6 hours. Afterward, the dish was weighed again, and drying continued until a stable weight was reached, defined as About 3 g of powdered drug was precisely weighed

(0.5–3.0 mg/mL) effectively reduced castor oil-induced diarrhoea in mice. Isolated rabbit jejunum preparations exhibited initial relaxation followed by characteristic contractions at a 3.0 mg/mL concentration.

Antiviral Activity:

Leaf extracts from *A. arabica* exhibited in vitro antiviral activity against Turnip Mosaic Virus in *Chenopodium amaranticolor*. Additionally, bark extracts showed inhibitory effects against potato viruses, suggesting their potential for botanical antiviral Development [25].

Collection And Authentication of Plant Material.

The *Acacia arabica* sample was collected from Mohanlal Ganj Road in Lucknow, Uttar Pradesh, India, near a nearby primary school. The plant was scientifically identified and verified at the National Botanical Research Institute (NBRI), Lucknow. A voucher specimen was then created and stored in the department's herbarium for future reference and documentation.

Ethanolic Extraction

The stem material was air-dried under shade for several weeks and then ground into a fine powder. The powdered plant material was passed through a 100-mesh sieve and kept in a wrapped polythene bag until further use. Defatting was performed using petroleum ether (60–80 °C), after which the marc was extracted with 50% ethanol. The solvent was detached under reduced pressure using a rotary evaporator (*Büchi R-200, Schwabach*) at a controlled temperature of 50 ± 2 °C. The resulting extract was concentrated to obtain a thick, viscous residue. The percentage yield of the various extracts was calculated based on the dried extract weight [26].

Percentage Yield

The extractive yield value was calculated using the following formula.

two consecutive measurements differing by no more than 0.25% [27].

Ash Values

Ash values were assessed to quantify the total inorganic content of the plant material. These parameters include **total ash** and **acid-insoluble ash**, which together provide information on the presence of inorganic salts, silica, and extraneous matter [28].

Total Ash

into a pre-ignited, tared silica crucible. The sample

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was spread evenly and incinerated at a temperature no higher than 450 °C until the residue was completely carbon-free. The crucible was cooled, weighed, and reheated until a constant weight was obtained. Total ash content, comprising carbonates, phosphates, silicates, and both physiological and non-physiological ash, was expressed as a percentage of the air-dried plant material [28].

Acid Insoluble Ash.

The total ash was boiled with 25 mL of 2 M hydrochloric acid for 5 minutes. The insoluble residue was filtered on ashless paper, washed with hot water, ignited, cooled in a desiccator, and weighed. Acid-insoluble ash was then expressed as a percentage of the dried plant sample [29].

Determination of Water-Soluble Ash.

Water-soluble ash was determined by boiling the obtained ash in 25 mL of water for 5 minutes. The insoluble part was filtered using ashless filter paper, washed with hot water, and then ignited at a temperature not above 450 °C. The weight of the insoluble residue was subtracted from the total ash weight, and the remaining amount was considered the water-soluble ash. Results were expressed as a percentage of the air-dried plant material [30].

Extractive Values.

Extractive values provide an estimate of the types and amounts of chemical constituents present in crude plant material. These include **alcohol-soluble** and **water-soluble** extractives [31].

Alcohol-Soluble Extractive.

Five grams of coarsely powdered, air-dried drug were soaked in 100 mL of 95% ethanol in a sealed container for 24 hours, with occasional shaking during the first 6 hours, then left to stand for 18 hours. The mixture was filtered carefully to prevent solvent loss, and 25 mL of the filtrate was evaporated to dryness in a pre-weighed flat dish. The residue was dried at 105 °C, weighed, and the ethanol-soluble extractive percentage was calculated based on the initial air-dried drug [32].

Water-Soluble Extractive.

To determine water-soluble extractives, 5 g of powdered drug was combined with 50 mL of water at 80 °C in a stoppered flask. The mixture was shaken thoroughly and left to stand for 10 minutes. After cooling, 2 g of kieselguhr was added, and the mixture was filtered. A 5 mL sample of the filtrate was evaporated using a water bath, then dried for 30 minutes, followed by 2 hours in a steam oven. The

dried residue was weighed to determine the percentage of water-soluble extractive [32,33].

Preliminary Phytochemical Screening

Qualitative phytochemical tests were performed on the **50% ethanolic extract** of *Acacia arabica* leaves to identify major phytoconstituent groups, including alkaloids, carbohydrates, flavonoids, glycosides, saponins, steroids, and tannins [33,34].

Chromatographic Studies

Thin Layer Chromatography (TLC).

TLC was performed based on the principle of adsorption, in which components separate according to their differential affinities for the stationary phase. Precoated silica gel plates (aluminium/polyester backing) were used. Samples were applied as small spots, and plates were developed in a suitable solvent system by capillary action.

The developed chromatograms were observed under UV light (254 nm) to determine the number of constituents [38].

Retention factor (R_f) values were calculated via the formula:

Distance travelled by the compound

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Rf values can vary depending on adsorbent particle size, solvent composition, chamber saturation, plate activation, and thickness of the stationary layer.

Pharmacological Screening.

Animals and Environmental Conditions

Sprague–Dawley rats (150 ± 20 g) of either sex were obtained from the National Laboratory Animal Center (NLAC), Central Drug Research Institute (CDRI), Lucknow. They were acclimated for one week prior to the experiment and kept in the departmental animal facility.

Under standard laboratory conditions. The room was well-ventilated and maintained at 25 ± 2°C with 44–56% relative humidity, following a 10–14 h light–dark cycle.

Animals were fed a standard rodent pellet diet (Amrut, India). Food was withheld for 18–24 hours prior to the study, with water available ad libitum. All procedures complied with CPCSEA guidelines and received approval from the Institutional Animal Care and Ethics Committee (IACEC).

All chemicals employed in the study were of analytical grade, obtained from reputable commercial suppliers. Double-distilled water was used throughout the experiments. A standard gastric cannula was utilized for oral administration of test substances [35].

Preparation of Suspension

For pharmacological evaluation, the ethanolic extract (50%) was prepared as a suspension using 1% w/v carboxymethyl cellulose (CMC) in double-distilled water. *Acacia arabica* was also individually dispersed in the same CMC solution to obtain a uniform suspension [35].

Safety Profile

Acute toxicity of the 50% ethanolic extract of *Acacia arabica* was evaluated in Swiss albino mice (20–25 g) using the OECD up-and-down method. Two groups (3 males, three females) received 2 g/kg orally. Animals were monitored for four h post-dosing, and mortality was checked at 24 h. Survivors were observed daily for 13 days for any delayed toxic effects [36].

Determination of Anti-Ulcer Activity in the Rat Pyloric Ligation Model

Wistar albino rats were divided into five groups, with six rats in each. Groups 1 and 2 received a vehicle solution (10 ml/kg) daily for five days. Groups 3 and 4 were given the test extract at doses of 200 mg/kg and 400 mg/kg, respectively. Group 5 was treated with

omeprazole (10 mg/kg) as the reference anti-ulcer medication. All doses were based on body weight and administered orally.

On day 5, animals, after 36 hours of fasting, were pre-treated for one hour and then anesthetized with pentobarbitone (35 mg/kg, I.P.). The abdomen was opened, and the pylorus was ligated without disrupting blood flow. The stomach was then replaced, and the incision was closed in two layers. Four hours later, the stomachs were collected, opened along the greater curvature, and assessed for ulcer index. Gastric juice was titrated with 0.01 N NaOH using Topfer's reagent to measure both free and total acidity [37].

Ethanol-Induced Ulcer Model in Rats.

Ethanol-induced gastric ulcers were created using standard methods. Rats were divided into four groups (n = 6). Group 1 received distilled water (standard control), while Group 2 received Ethanol was used solely for ulcer control. Groups 3 and 4 were given oral treatments of *Acacia arabica* leaf extract at doses of 200 mg/kg and 400 mg/kg, respectively. A fifth group received omeprazole at 20 mg/kg as the standard anti-ulcer medication.

Ulcers were caused by administering 1 ml of absolute ethanol (90%) per 200 g orally. Test extract or omeprazole was administered 45 minutes before ethanol. Animals were housed in separate cages to prevent coprophagia during the study. After one hour, animals were anesthetized with ether, the abdomen was opened, and the stomach was removed and examined for ulceration [38,39].

Calculation of Ulcer Inhibition and Ulcer Protection

$$\text{Ulcer Inhibition (\%)} = \frac{\text{Control Mean Ulcer Index} - \text{Test Mean Ulcer Index}}{\text{Ulcer Index}} \times 100$$

$$\text{Ulcer Protection (\%)} = \frac{\text{Control Mean Ulcer Index} - \text{Test Mean Ulcer Index}}{\text{Control Mean Ulcer Index}} \times 100$$

Ulcer Scoring System

- The severity of gastric lesions was evaluated using a standardized scoring method. Each stomach was examined macroscopically, and lesions were graded for intensity as shown below [40].

Table 1. Score of ulcers representing severity.

S. No.	Ulcer Severity Description	Ulcer Score
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1	Normal stomach without visible injury	0
2	Presence of spot ulcers	1
3	Hemorrhagic streaks	1.5
4	Deep or penetrating ulcers	2
5	Perforated lesions	3

Biochemical Analysis of Gastric Juice

- Biochemical parameters evaluated included gastric volume, pH, free acidity, total acidity, pepsin activity, total protein, and mucin content.

Gastric pH

- A milliliter of gastric juice was diluted with an equal amount of distilled water, and its pH was measured using a calibrated pH meter.

Gastric Volume

- Gastric contents were centrifuged at 1000 rpm for 20 minutes, and the volume of the supernatant was recorded.

Free and Total Acidity

- One milliliter of supernatant was diluted with 10 mL of distilled water and titrated with 0.01N NaOH in the presence of Topfer's chemical and phenolphthalein.
 - Free acidity:** Volume of NaOH required to change the color to orange.
 - Total acidity:** Additional NaOH needed until a pink color reappeared.

♣ Acidity was calculated using:

$$\text{Acidity} = (\text{Volume of NaOH} \times \text{Normality} \times 100) / 0.1 \text{ mEq/L}/100 \text{ g.}$$

Ulcer Count

Gastric mucosa was examined under 10× magnification, and the number of superficial ulcers, deep ulcers, and perforations was recorded for each rat (Anand et al., 2014).

Pepsin Estimation

Gastric contents (20 µL) were incubated with 500 µL of albumin solution (5 mg/ml, 0.06 N HCl) at 37°C for 10 minutes. The reaction was halted using 10% TCA, and the mixture was centrifuged at 1500 g for 20 minutes. The supernatant was then combined with sodium carbonate and Folin's reagent. After 30 minutes, absorbance was measured at 660 nm, and pepsin levels were calculated using a standard curve.

Total Protein

Total protein content was determined from alcohol precipitates created by mixing gastric juice with a 9:1 ratio of 90% ethanol. The precipitate was then dissolved in 0.1 N NaOH, and 0.05 ml of this solution was treated with an alkaline reagent. The absorbance was measured at 610 nm, and the protein concentration was calculated based on a bovine albumin standard curve.

Mucin Estimation

Everted stomachs were immersed for 2 hours in a 0.1% Alcian Blue (8GX) solution prepared in a 0.16 M sucrose and 0.05 M sodium acetate buffer, with the pH adjusted using HCl (Sharath et al., 2015).

Statistical Analysis

Data are presented as mean ± SEM (n = 6). Statistical significance was determined using one-way ANOVA followed by Dunnett's test, with p < 0.05 considered statistically significant.

Histopathological Evaluation (Compressed)

Gastric tissues were collected, fixed in 10% neutral buffered formalin for 24 hours, processed for formalin, embedded in paraffin, and sectioned at 4–5 µm. Sections were stained with hematoxylin and eosin and examined under a light microscope for edema, erosion, and hemorrhage. Histological changes were graded on an arbitrary scale, and representative images were captured [41].

RESULTS

Fresh leaves of *Acacia arabica* were collected from Mohanlal Ganj Road, Lucknow, and taxonomically authenticated at NBRI, Lucknow. The leaves remained shade-dried, pulverized hooked on a coarse powder, and subjected to physicochemical and phytochemical evaluations in accordance with standard procedures. These analyses provided the fundamental characterization required for further experimental studies [42, 43].

Table 2. Morphological Evaluation of the *Acacia arabica* leaf.

Parameter	Leaf Characteristics
Colour	Green
Odour	Odourless
Taste	Bland, mucilaginous
Arrangement	Alternate
Type	Even pinnately compound

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Shape	Linear
Margins	Entire
Texture	Fine
Size	Leaflets measuring 2–5 mm, arranged in 10–20 pairs

Table 3. Physical content of *Acacia arabica* leaf.

S. No.	Physical Constants	Observation (% w/w)
I. Extractive Values		
1	Alcohol-soluble extractive	28.2
2	Water-soluble extractive	10.5
II. Ash Values		
1	Total ash	3.76
2	Acid-insoluble ash	1.98
3	Water-soluble ash	0.56
III.	Loss on Drying (Moisture Content)	10.52

Table 4. Microscopic Characteristics of *Acacia arabica* Leaf

S. No.	Microscopic Features Observed
1	Presence of cork cells
2	Axial parenchyma is well differentiated.
3	Calcium oxalate crystals are present.
4	Vessels distinctly visible
5	Fibers abundant
6	Medullary rays are clearly observed.
7	Latex vessel

Table 5. Extraction Characteristics of Extracts

S. No.	Solvent	Extraction Time (hrs)	Colour	Weight of Extract (g)	% Yield
1	Petroleum Ether	32	Dark green	2.69	95.30%
2	Alcohol	32	Light green	2.68	98.90%

Table 6. Quantitative chemical investigation of *Acacia arabica*.

S. No.	Chemical Test	Observation / Colour Change	Petroleum Ether Extract	Alcoholic Extract
.				

I. Carbohydrates				
1	Fehling's test	Brick-red precipitate	–ve	+ve
2	Benedict's test	Yellow/green/red precipitate	+ve	+ve
II. Reducing Sugar				
	(Covered above)			
III. Alkaloids				
1	Dragendorff's test	Orange-brown precipitate	–ve	+ve
2	Mayer's test	Cream/white precipitate	+ve	+ve
3	Wagner's test	Reddish-brown precipitate	+ve	+ve
IV. Glycosides				
1	Baljet's test	Yellow to orange	–ve	–ve
2	Legal's test	Pink to red	–ve	–ve
V. Saponins				
		Foam formation	+ve	+ve
VI. Flavonoids				
1	Shinoda test	Pink colour	–ve	–ve

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VII	Tannins	Deep blue colour with 10% ethanolic FeCl ₃	-ve	+ve
	/ Phenolics			

(+) = Present, (-) = Absent.

Pharmacological Screening. Anti-ulcer Activity

- The anti-ulcer potential of *Acacia arabica* leaf extracts was assessed using the pyloric ligation method to determine their effectiveness in reducing gastric ulcers.

Effect of Distilled Water in Pylorus Ligation-Induced Ulcer

- In the control group, rats received distilled water (10 mL/kg, p.o.) one hour before pylorus ligation. Ligation resulted in a gastric secretion volume of 2.5 mL with a pH of 3.2. Total and free acidity were 4950 and 3160 meq/L, respectively. The ulcer score, number of ulcers, and ulcer index were 2.10, 5.43, and 17, respectively.

Effect of Omeprazole in Pylorus Ligation-Induced Ulcer.

- Rats in the standard group were given omeprazole (10 mg/kg, p.o.) one hour prior to pylorus ligation. This pretreatment notably ($p < 0.05$) lowered gastric secretion volume to 2.10 ml and raised gastric pH to 5.96 compared to the control. Additionally, total acidity, free acidity, ulcer score, number of ulcers, and ulcer index were all significantly reduced ($p < 0.05$) relative to the control group.

Effect of Ethanolic Leaf Extract of *Acacia arabica* in Pylorus Ligation-Induced Ulcer

- Pretreatment with *Acacia arabica* leaf extract (200 and 400 mg/kg, p.o.) one hour before pylorus ligation significantly ($p < 0.05$) decreased gastric secretion volumes to 2.2 and 2.3 ml, respectively. The gastric pH rose significantly ($p < 0.05$) to 3.9 at the higher dose. Both total and free acidity levels declined in a dose-dependent manner. Additionally, the extract significantly lowered the number of ulcers, ulcer score, and ulcer index compared to the control group.

Effect of Distilled Water (Control) on ethanol-induced gastric ulcer.

- Distilled water (5 mL/kg, p.o.) administered 1 hour before ethanol (1 mL/200 g, p.o.) resulted in a mean ulcer count of 6.33, ulcer score of 2.16, and ulcer index of 18.

Effect of Omeprazole (Standard) on ethanol-induced gastric ulcer.

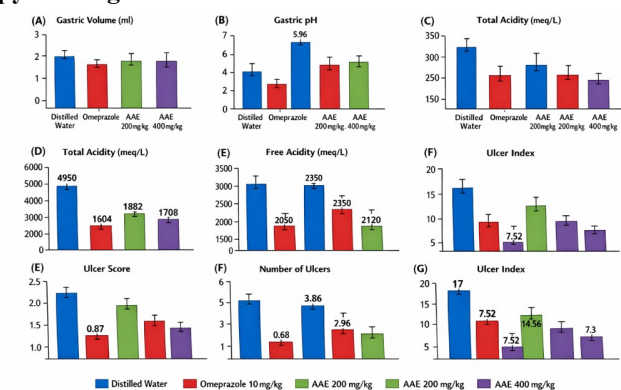
- Omeprazole (20 mg/kg, p.o.) given 1 hour prior to ethanol significantly ($p < 0.05$) reduced ulcer number, ulcer score, and ulcer index to 0.596, 0.732, and 7.63, respectively.

Effect of Ethanolic Leaf Extract of *Acacia arabica* (200 mg/kg, p.o.) in ethanol-induced ulcer.

- Administration of *Acacia arabica* leaf extract 1 hour before ethanol significantly ($p < 0.05$) decreased ulcer number to 1.86, ulcer score to 1.02, and ulcer index to 9.73 compared to the control group.

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Table 7. Effect of ethanolic leaf extract of *Acacia arabica* on gastric secretory parameters and ulcer indices in pylorus-ligated rats



Treatment	Dose (p.o.)	Gastric Volume (ml)	Gastric pH	Total Acidity (meq/L)	Free Acidity (meq/L)	Ulcer Score	No. of Ulcers	Ulcer Index
Distilled water	10 ml/kg	2.50 ± 0.07	3.20 ± 0.08	4950 ± 77.52	3160 ± 43.6	2.10 ± 0.05	5.43 ± 0.36	17.00 ± 1.92
Omeprazole	10 mg/kg	2.10 ± 0.05	5.96 ± 0.25	1604 ± 56.02	2050 ± 66.89	0.87 ± 0.05	0.68 ± 0.03	7.52 ± 2.12
AAE-I	200 mg/kg	2.20 ± 0.11	3.60 ± 0.19	1882 ± 66.26	2350 ± 34.92	1.53 ± 0.01	3.86 ± 0.20	14.56 ± 1.86
AAE-II	400 mg/kg	2.30 ± 0.32	3.90 ± 0.15	1708 ± 27.78	2120 ± 42.63	1.02 ± 0.06	2.96 ± 0.15	7.30 ± 1.97

Values are expressed as Mean ± SEM (n = 6).

SEM (n = 6).

AAE-I: *Acacia arabica* ethanolic extract (200 mg/kg)

AAE-II: *Acacia arabica* ethanolic extract (400 mg/kg)

Fig. 1. Effect of ethanolic leaf extract of *Acacia arabica* on gastric secretory parameters and ulcer indices in pylorus-ligated rats.

The Figure shows changes in gastric volume, gastric pH, total acidity, ulcer score, number of ulcers, and ulcer index following oral administration of *Acacia arabica* ethanolic extract (200 and 400 mg/kg) compared with a distilled water control and omeprazole (10 mg/kg). values are articulated as Mean SEM (n=6).

Table 8. Effect of ethanolic leaf extract of *Acacia arabica* on ulcer parameters in ethanol-induced gastric ulcer in rats

Treatment	Dose (p.o.)	Number of Ulcers	Ulcer Score	Ulcer Index
Distilled water	5 ml/kg	5.20 ± 0.26	2.56 ± 0.08	1.62 ± 0.12
Omeprazole (Standard)	20 mg/kg	0.60 ± 0.35*	0.73 ± 0.19*	7.63 ± 0.35*
AAE-I (<i>Acacia arabica</i>)	200 mg/kg	1.86 ± 0.35*	1.02 ± 0.04*	9.73 ± 0.35*

AAE-II (<i>Acacia arabica</i>)	400 mg/kg	1.20 ± 0.31*	0.96 ± 0.03*	8.23 ± 1.31*
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Values are expressed as Mean ± SEM (n = 6).

AAE-I: Ethanolic leaf extract of *Acacia arabica* (200 mg/kg)

AAE-II: Ethanolic leaf extract of *Acacia arabica* (400 mg/kg)

*P < 0.05 compared with the distilled water control group.

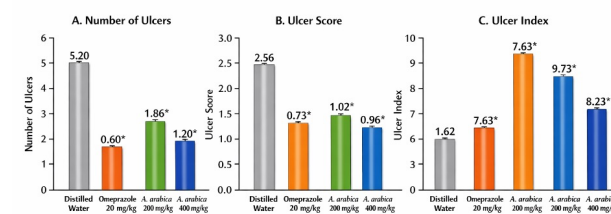


Fig. 2. Effect of ethanolic leaf extract of *Acacia arabica* on ulcer parameters in ethanol-induced gastric ulcer in rats. The Figure illustrates changes in the number of ulcers, ulcer score, and ulcer index following oral administration of distilled water (5ml/kg), omeprazole (20 mg/kg), the standard drug, and the ethanolic leaf extract of *Acacia arabica* (200 and 400 mg/kg). All treatments were administered one hour prior to ulcer induction. Data are expressed as Mean + SEM (n=6). *P < 0.05 was considered statistically significant, associated with the control group.

Chromatographic Studies:

The successive ethanol extracts of *Acacia arabica* were evaluated using Thin Layer Chromatography (TLC).

- **Stationary phase:** Silica gel G
- **Mobile phase:** Toluene: Ethyl Acetate: Methanol (4.4:5:0.6)

Table 9. TLC Profile.

Extract	Observations		Rf Value
	No. of Spot	Colour of Spot	
Ethanol	1	Purple	0.78

Fig 3. TLC ethanolic extract of the plant.

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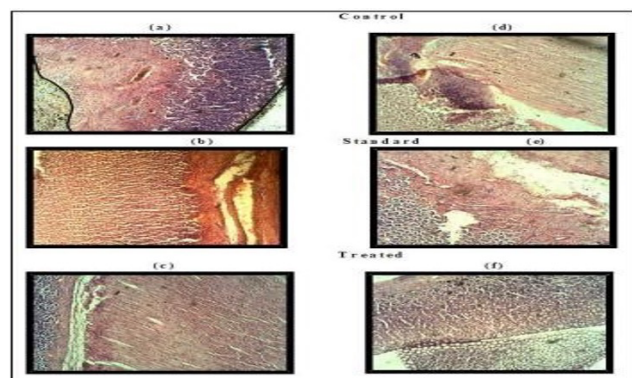
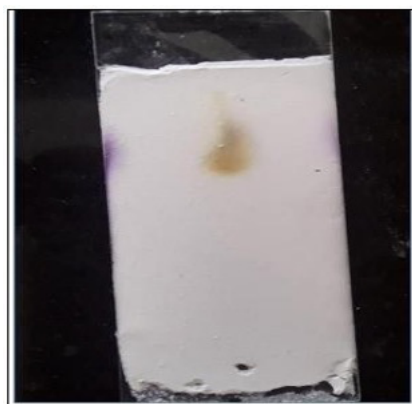


Fig 4. Histopathological section of stomach mucosa of Wistar rat using pylorus ligation-induced ulcer (a, b & c) and ethanol-induced ulcer (d, e & f).

Table 10. Histopathological Evaluation of Stomach Mucosa

Group	Treatment	Observation
Control	Distilled water (10 ml/kg, p.o.)	Haemorrhage, disruption in the lining epithelium, and hyperplastic mucosal glands.
Standard	Omeprazole (20 mg/kg, p.o.)	No ulcer formation, mild hyperplastic mucosa, no edema
Treated	<i>Acacia arabica</i> extract (200 mg/kg, p.o.)	No ulcer formation, small atrophic glands, thick muscularis, edematous submucosa with inflammatory infiltrate

Result

Detailed findings are presented for the pharmacognostic evaluation, including macroscopic and microscopic characteristics, physical constants, extractive values, phytochemical screening, and quantitative chemical

analyses. The antiulcer activity of the ethanolic leaf extract of *Acacia arabica* is demonstrated in pylorus-ligation and ethanol-induced ulcer models by assessing gastric secretory parameters and ulcer indices.

Discussion

The results are discussed in relation to the antisecretory and cytoprotective mechanisms of the ethanolic leaf extract of *Acacia arabica*. The observed gastroprotective effects are interpreted in light of the experimental ulcer models, supporting the potential role of the extract in reducing gastric acid secretion and enhancing mucosal defense.

Conclusion.

The present study establishes the pharmacognostic identity, phytochemical composition, and antiulcer potential of *Acacia arabica* leaves. A comprehensive pharmacognostic evaluation provides essential quality-control parameters for the authentication and standardization of plant material. Phytochemical analysis revealed bioactive constituents, including flavonoids, tannins, saponins, alkaloids, and phenolic compounds, which are known to contribute to gastroprotective effects. The ethanolic leaf extract of *A. arabica* demonstrated significant, dose-dependent antiulcer activity in both pylorus ligation-induced and ethanol-induced gastric ulcer models in Wistar rats. The observed reductions in ulcer index, gastric acidity, and mucosal damage suggest that the extract exerts protective effects through a combination of antisecretory and cytoprotective mechanisms. These effects may be attributed to enhanced mucosal defense, antioxidant activity, and preservation of gastric epithelial integrity. Overall, the findings provide experimental evidence supporting the traditional use of *Acacia arabica* in the management of gastric disorders and highlight its potential as a natural antiulcer agent. Further studies focusing on the isolation, characterization, and mechanistic evaluation of the active phytoconstituents are warranted to facilitate the development of standardized herbal formulations for ulcer therapy.

DECLARATIONS

Ethics Approval

All experimental procedures involving animals were conducted in accordance with CPCSEA guidelines and internationally accepted ethical standards for the use of laboratory animals. The study protocol was reviewed and approved by the Institutional Animal Ethics Committee (IAEC).

Availability of Data and Materials

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All data generated or analysed during the present study are available from the corresponding author upon reasonable request.

Conflict of Interests

The author declares no competing or financial interests.

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Authors' Contributions

Goldi Singh and Brijesh Shukla were involved in study supervision and provided critical scientific inputs. Mohd Azeem and Akash Sharma conceptualised the research, designed the experimental methodology, conducted laboratory investigations, performed data analysis, and prepared the original manuscript. All authors reviewed and approved the final version of the manuscript.

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Abbreviations:

PUD: Peptic ulcer disease; NSAIDs: Non-steroidal anti-inflammatory drugs; CCK-B: Cholecystokinin-B; NBRI: National Botanical Research Institute; NLAC: National Laboratory Animal Center; CDRI: Central Drug Research Institute; CPCSEA: Committee for Control and Supervision of Experiments on Animals; IAEC: Institutional Animal Ethics Committee; CMC: Carboxymethyl cellulose; OECD: Organisation for Economic Co-operation and Development; TLC: Thin-layer chromatography; UV: Ultraviolet; Rf: Retention factor; SEM: Standard error of the mean; ANOVA: Analysis of variance; HCl: Hydrochloric acid; NaOH: Sodium hydroxide; TCA: Trichloroacetic acid; AAE: *Acacia arabica* extract.

Summary

This study establishes pharmacognostic and phytochemical standards for *Acacia arabica* leaves. Experimental findings show that the ethanolic leaf extract of *Acacia arabica* significantly reduces gastric ulceration in rats in both pylorus ligation and ethanol-induced ulcer models. The observed antiulcer activity may be attributed to antisecretory and cytoprotective mechanisms, thereby scientifically validating its traditional medicinal use.

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