

## "Antimicrobial and Anti-Ulcer Activities of Medicinal Plants: A Comprehensive Study on Their Potential Against Helicobacter Pylori and Gastric Ulcers"

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**Abstract:** Helicobacter pylori (H. pylori) infection is a significant cause of gastric disorders, including gastritis and ulcers. The increasing resistance to conventional antibiotics has highlighted the need for alternative treatments, particularly those derived from natural sources. This study reviews the antimicrobial and anti-ulcer properties of various plants traditionally used for gastrointestinal ailments. Plants such as Hydrastis canadensis, Mallotusphillipinesis, Myristicafragrans, Myrtuscommunis, Olea europaea, Perseaamericana, Phyllanthus niruri, and others have shown significant antibacterial activity against H. pylori, alongside notable anti-ulcer effects. These plants, rich in bioactive compounds like alkaloids, flavonoids, and essential oils, offer promising therapeutic potential for both ulcer treatment and H. pylori eradication. Among them, Sanguinaria canadensis and Punicagranatum have demonstrated strong antibacterial and anti-inflammatory activities, with the ability to mitigate gastric damage. The evidence suggests that these plant extracts could serve as viable alternatives or adjuncts to conventional therapies for treating H. pylori-induced ulcers and other gastric disorders. Further research, including clinical studies and pharmacological investigations, is necessary to evaluate their therapeutic safety and efficacy.

**Keywords:** Helicobacter pylori, anti-ulcer activity, antimicrobial activity, plant extracts, gastrointestinal disorders, bioactive compounds, traditional medicine, antibiotic resistance.

### 1. Introduction

Peptic ulcers are characterized by a disruption in the continuity of the stomach or duodenal mucosa, primarily caused by factors such as non-steroidal anti-inflammatory drugs (NSAIDs), gastric acids, and pepsin, which ultimately lead to lesions in the intestinal lining. The term "peptic" is derived from the Greek word "peptikos," meaning related to digestion. Studies suggest that elderly individuals are more susceptible to gastric ulcers, while younger populations have a higher likelihood of developing duodenal ulcers [Venkateswararao *et al.*, 2013].

The development of peptic ulcer disease involves a complex interplay between aggressive factors, such as gastric acid and pepsin secretion, *Helicobacter pylori* (*H. pylori*), bile salts, ethanol, certain medications (e.g., NSAIDs), lipid peroxidation, nitric oxide (NO), and protective factors like prostaglandins, gastric mucus, mucosal blood flow, glycoproteins, mucin secretion, antioxidant enzymes (e.g., catalase, superoxide dismutase, glutathione), and cellular regeneration. Additional contributors to peptic ulcer progression include tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ), reactive oxygen species (ROS), histamine release, apoptosis, and bile acid secretion[Zahid *et.al.*, 2020].

NSAIDs promote ulcer formation by inhibiting cyclo-oxygenase (COX) enzymes, which are essential for converting arachidonic acid into prostaglandins. This suppression weakens the mucosal barrier, increasing its susceptibility to damage by gastric acid and pepsin. Evidence indicates that oxygen-derived free radicals significantly contribute to tissue damage, including injuries within the digestive system. TNF- $\alpha$  also plays a crucial role in ulcer formation by initiating inflammation and leukocyte migration, leading to gastric mucosal damage. Additionally, TNF- $\alpha$  triggers the extrinsic apoptotic pathway via caspase-3 activation, further exacerbating gastric injury. This cascade involves neutrophil activation, perpetuating the cycle of gastric damage[Ghlichloo I *et.al.*, 2023].

*H. pylori*, a gram-negative, spiral-shaped bacterium, is a significant factor in peptic ulcer disease. The bacterium produces urease, an enzyme that converts urea into ammonia, reducing stomach acidity and creating a favorable environment for its survival. Pathogenic strains of *H. pylori*, such as those carrying the cytotoxin-associated gene A (*cagA*), can disrupt cell structure, impair cell junctions, and increase cell motility, contributing to gastric ulcers and even carcinomas[Rahimkhani *et.al.*, 2019].

Although a variety of pharmaceutical agents are available for peptic ulcer treatment, many have notable side effects. For instance, H<sub>2</sub> receptor antagonists may cause impotence, headaches, rashes, and arrhythmias. Proton pump inhibitors have been associated with hypergastrinemia and atrophic gastritis. Antacids can lead to bloating, constipation, or even ulcer perforation, while anticholinergics may result in dry mouth, constipation, urinary retention, and blurred vision. Other drugs, such as ulcer protectives, prostaglandin analogs, and anticholinergics, carry risks of side effects like diarrhea, dizziness, edema, and more severe complications such as uterine bleeding or abortion[Dhar *et.al.*, 2019]. In contrast, herbal medications offer an attractive alternative due to their lower toxicity, cultural acceptability, affordability, and compatibility with the human

body. These natural remedies are often preferred for their efficacy and minimal side effects compared to conventional treatments[Yuan *et.al.*, 2020].

## Materials and Methods

### 2.1. Materials

Publications related to diabetes and the effectiveness of medicinal plants were retrieved from databases including ScienceDirect, PubMed, Wiley, Scopus, and Springer. The keywords used in the search included "herbal medicines," "peptic ulcer," "Helicobacter pylori," "antiulcer activity," and "treatment." A total of 660 articles published between 1995 and 2023 were collected, of which 550 were excluded due to irrelevance or lack of access to the original text.

### 2.2. Inclusion and Exclusion Criteria

The search was limited to articles in English and Persian. All studies were independently assessed for relevance and eligibility by authors. Experimental research and clinical trials evaluating the effects of medicinal herbs or plant components in diabetic animals or patients were included. Studies involving mixed plant extracts, algae, or mushroom extracts, as well as irrelevant studies, were excluded[kootiet.*al.*, 2016].

## Results and Discussion

### 3. List of Medicinal Plants

#### 3.1. *Allophylus serratus* Kurz

Commonly known as Tippani, this plant belongs to the family Sapindaceae and is traditionally used to treat conditions like elephantiasis, edema, inflammation, bone fractures, dyspepsia, anorexia, and diarrhea. Phytochemical analyses have identified compounds such as phenacetamide, beta-sitosterol, and quercetin. The plant's antiulcer activity is attributed to its cytoprotective and antisecretory mechanisms. Additionally, the ethanolic leaf extract exhibits antibacterial properties and anti-osteoporotic effects[Dilshad *et.al.*, 2022].

#### 3.2. *Aloe vera* (L.) Burm.f.

Known as Aloe, this plant belongs to the family Xanthorrhoeaceae. Its bioactive constituents include amino acids, anthraquinones, enzymes, hormones, lignin, minerals, salicylic acid, saponins, sterols, sugars, and vitamins. Aloe vera demonstrates antiulcer activity, particularly in Indomethacin-induced ulcer models, through antioxidant, anti-inflammatory, mucus-secreting, cytoprotective, and healing mechanisms. Other pharmacological properties include hypoglycemic, hypolipidemic, wound-healing, immunomodulatory, antifungal, and hepatoprotective effects[Surjusheet.*al.*, 2008]

### 3.3. *Butea frondosa* Roxb.

Commonly referred to as Flame of the Forest, this plant is widely distributed in India and belongs to the family Fabaceae. The leaves are reported to have antiulcer properties, while the seeds and fruits exhibit anthelmintic activities. Seed extracts also demonstrate embryonicidal, ovidical, and larvicidal effects against *Haemonchus contortus*. Additionally, the plant has aphrodisiac properties [Ganesh G. Dhakad *et al.*, 2023].

### 3.4. *Capsicum annuum* L.

Known as Chilli pepper, this plant is cultivated worldwide and belongs to the family Solanaceae. Its fruit has demonstrated antiulcer and antioxidant properties. Methanolic seed extracts show anti-obesity effects in 3T3-L1 adipocyte models. The plant's fruit and vegetable peel extracts exhibit radical-scavenging properties, while solasonine, a compound in the plant, has been reported to inhibit platelet aggregation [Bal *et al.*, 2022].

### 3.5. *Carica papaya* Linn.

Commonly called Papaya, this plant belongs to the family Caricaceae and is known for its wide range of medicinal benefits. The fruit exhibits antiulcer activity, while the seeds possess antimicrobial, anthelmintic, and antiamoebic properties hepatoprotective activity and also used for pediatrics burns. The seed extracts are proved to exhibit pronounced hyper trophy and hyper plasia of pituitary gonadotrophs. The pollen from flowers of the plant possess histaminergic properties [Singh S. P *et al.*, 2020].

### 3.6 *Cissus quadrangularis* L.

*Cissus quadrangularis*, a succulent plant from the Vitaceae family, is commonly referred to as Asthisamhari. It is traditionally used as a general tonic and analgesic, with notable bone-healing properties, as described in ancient Ayurvedic texts. Dichloromethane and methanolic stem extracts of the plant have shown antibacterial effects against *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. Ethanolic extracts demonstrated anti-osteoporotic activity in an ovariectomized rat model of osteoporosis, while 50% ethanolic aerial part extracts exhibited hypotensive effects. Additionally, stem extracts reported diuretic properties. Methanolic extracts of the plant showed antioxidant, antiulcer, analgesic, and anti-inflammatory activities [Sundaran *et al.*, 2020].

### 3.7 *Curcuma longa* L.

*Curcuma longa*, commonly known as Turmeric, belongs to the Zingiberaceae family and is widely used as a remedy for biliary disorders, anorexia, cough, diabetic wounds, hepatic conditions, rheumatism, and sinusitis. Its antiulcer

properties have been evaluated in gastric and duodenal ulcer models in rats. Turmeric's volatile oil exhibits anti-inflammatory and anti-arthritis effects. Curcumin, its primary bioactive compound, has both water- and fat-soluble antioxidant activities comparable to vitamins C and E. Studies have shown curcumin's protective effect against carbon tetrachloride-induced liver injury in rats, inhibition of cell proliferation, and suppression of tumor growth in prostate cancer. Other pharmacological effects include antifertility, antibacterial, and antifungal activities[Fuloria *et.al.*, 2022].

### **3.8 *Desmostachyabipinnata* (L.) Stapf**

*Desmostachyabipinnata*, known as Saved gram, belongs to the Gramineae family. Ethanolic extracts of the plant's aerial parts have demonstrated antiulcer activity, while kaempferol, quercetin, quercetin-3-glucoside, trycin, and trycin-7-glucoside were isolated from the extract. The methanolic extract exhibited anti-*Helicobacter* activity at a minimum inhibitory concentration (MIC) of 40 µg/ml. Alcoholic and aqueous root extracts have shown antidiarrheal effects in rats, and the methanolic root extract exhibited in vitro anticancer activity[Ibrahim *et.al.*, 2018].

### **3.9 *Excoecariaagallocha* L.**

*Excoecariaagallocha*, commonly known as Milky mangrove, belongs to the Euphorbiaceae family and is traditionally used for microbial infections, tumor treatment, wound healing, and ulcer management. The plant is also utilized for treating epilepsy, toothache, rheumatism, leprosy, and paralysis. Aqueous bark extracts have shown antiulcer effects in NSAID-induced gastric ulcer models in albino rats. Ethanolic stem bark extracts demonstrated antinociceptive activity, while organic solvent leaf extracts exhibited potent antioxidant and antifilarial properties[Mondal *et.al.*, 2016].

### **3.10 *Glycyrrhiza glabra* L.**

*Glycyrrhiza glabra*, or Liquorice, is a sweet, soothing herb from the Fabaceae family. Its use in traditional medicine, especially in Ayurveda, is well-documented. Glycyrrhetic acid from Liquorice has shown in vitro activity against *Helicobacter pylori*, suggesting its antiulcer potential. Ether, chloroform, and acetone root extracts exhibited antibacterial effects against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. Glabridin, an active compound in Liquorice, demonstrated antifungal activity and potent antioxidant effects against LDL oxidation. Other pharmacological activities include anti-inflammatory, antitussive, hepatoprotective, and estrogenic effects[El-Saber Batiha *et.al.*, 2020].

**3.11 *Leucas lavandulifolia* Sm.**

*Leucas lavandulifolia*, commonly known as Gumma, belongs to the Labiatae family. It is traditionally used to relieve abdominal discomfort, stomach ulcers, and liver diseases. Methanolic extracts of the plant have shown significant antiulcer effects by reducing ulcer indices and gastric acid output in Indomethacin- and pylorus ligation-induced ulcer models. The plant's ulcer protection activity was dose-dependent [Sharifi-Rad *et.al.*, 2020].

**3.12 *Mangifera indica* L.**

*Mangifera indica*, commonly known as Mango, belongs to the family Anacardiaceae. The plant's petroleum ether and ethanol leaf extracts have demonstrated antiulcer activity. Mangiferin, a polyphenolic compound, exhibits *in vivo* antioxidant effects in OF<sub>1</sub> mice and radioprotective properties against radiation-induced micronuclei formation in cultured human lymphocytes and DBAxC<sub>57</sub>BL mice. It also shows immunomodulatory effects on thioglycollate-elicited macrophages stimulated with lipopolysaccharide (LPS) and gamma interferon (IFN- $\gamma$ ). Ethyl acetate and ethanol root extracts have displayed anti-inflammatory activity. Other reported pharmacological activities include antidiabetic, antiviral, anthelmintic, antibacterial, antifungal, hepatoprotective, gastroprotective, and anticancer effects [Shah K. A *et.al.*, 2010].

**3.13 *Morus alba* Linn.**

*Morus alba*, known as White mulberry, belongs to the Moraceae family. The plant's leaf extracts exhibit antiulcer activity in experimentally induced gastric ulcers in rats and hypoglycemic effects by regenerating pancreatic  $\beta$ -cells. Ethyl acetate fractions of methanolic root extracts attenuate CS-induced perturbations, indicating adaptogenic activity. Petroleum ether, chloroform, and methanolic leaf extracts show anthelmintic and antimicrobial effects. Methanolic leaf extracts possess antidopaminergic properties and dose-dependent radical scavenging activity. Additionally, the plant is noted for anticancer, immunomodulatory, nephroprotective, and hepatoprotective effects [Garg S *et.al.*, 2022]

**3.14 *Ocimum sanctum* Linn.**

*Ocimum sanctum* (Tulsi or Holy Basil) belongs to the Labiatae family and is widely used in traditional medicine for various ailments. The plant's fixed oil exhibits antiulcer effects due to lipoxygenase inhibition, histamine antagonism, and antisecretory actions. It shows anticancer activity against human fibrosarcoma cell cultures. Oral administration of its leaf extract has been reported to have hypoglycemic effects in normal, glucose-fed hyperglycemic, and streptozotocin-induced diabetic rats. Other pharmacological properties include antibacterial,

anti-inflammatory, cardioprotective, antioxidant, chemopreventive, hepatoprotective, and radioprotective activities[Cohen M. M *et.al.*, 2014].

### **3.15 Panax ginseng**

*Panax ginseng*, commonly called Ginseng, is a member of the Araliaceae family and is widely used as an adaptogen and restorative tonic. The plant contains ginsenosides, amino acids, alkaloids, and vitamins B<sub>1</sub> and B<sub>2</sub>. Ginsenosides are noted for antiulcer activity, while the plant improves sperm count and motility, enhancing male fertility. Research indicates that ginseng enhances physical endurance and supports physiological adaptations to stress. Pharmacological activities include anti-inflammatory, antidiabetic, and antiproliferative effects[Shin *et.al.*, 2015].

### **3.16 Piper betel Linn.**

*Piper betel*, or Betel vine, belongs to the Piperaceae family and is cultivated across South Asia and East Africa. Aqueous extracts of its inflorescence show significant scavenging effects against hydrogen peroxide, superoxide, and hydroxyl radicals, preventing DNA strand breaks. Methanolic leaf extracts exhibit antioxidant, analgesic, and anti-inflammatory properties. The plant is also noted for antimutagenic and tumor-inhibitory activities[Biswas *et.al.*, 2022].

### **3.17 Polyalthialongifolia (Sonn.) Thwaites**

*Polyalthialongifolia*, commonly called False Ashoka, belongs to the Annonaceae family. It is used in traditional medicine for its febrifuge, tonic, and therapeutic effects on fever, skin diseases, diabetes, and hypertension. Phytochemical analysis reveals the presence of steroids, alkaloids, terpenoids, and flavonoids. Ethanolic leaf extracts show antiulcer activity in various ulcer models. Ethanolic stem bark extracts are studied for their effects on reactive oxygen species in tumor progression. The plant also exhibits antibacterial, anti-inflammatory, and hepatoprotective properties[Katkaret.*al.*, 2010].

### **3.18 Rhizophora mangle L.**

*Rhizophora mangle*, or Red mangrove, is a member of the Rhizophoraceae family, found in the Caribbean and Cuba. The plant has ethno-medicinal uses as an antiseptic, astringent, and hemostatic agent. Phytoconstituents such as epicatechin, catechin, chlorogenic acid, and ellagic acid have been identified. Aqueous bark extracts show gastroprotective and antisecretory effects, while polyphenols provide antioxidant protection against ethanol-induced gastric damage. The plant also exhibits anti-inflammatory and wound-healing properties and is effective in treating TNBS-induced colitis in rats[França, W. W. M *et.al.*, 2024].

### 3.19 *Sapindustrifolius* L.

*Sapindustrifolius*, known as Soap nut tree, belongs to the Sapindaceae family and is native to South India. Its seeds, rich in beta-sitosterol, are used in soap manufacturing. Aqueous leaf extracts exhibit potent antiulcer activity, attributed to flavonoids, triterpenoids, and sterols. The plant antagonizes histaminergic activity via H<sub>2</sub> receptor blockade. Additional pharmacological activities include astringent, anthelmintic, expectorant, and therapeutic effects in asthma, cholera, epilepsy, gout, and paralysis [Rawat S *et.al.*, 2022].

### 3.20 *Solanum nigrum* L.

*Solanum nigrum*, commonly called Black nightshade, belongs to the Solanaceae family. Chemical constituents include glycoalkaloids, polysaccharides, gallic acid, and flavonoids. Methanolic berry extracts display antiulcer effects in aspirin-induced ulcer models, offering gastroprotection through antioxidant mechanisms. Ethanol, methanol, and ethyl acetate extracts of leaves, seeds, and roots demonstrate antifungal activity. Additional pharmacological properties include antiviral, antipyretic, antidiabetic, immunostimulant, hepatoprotective, and anticancer activities [Chen *et.al.*, 2022].

### 3.21 *Syzygium aromaticum* L.

*Syzygium aromaticum*, commonly known as Clove, belongs to the Myrtaceae family. It is widely used as a spice for flavoring, in chewing tobacco, and in traditional medicine to treat nausea, vomiting, cough, diarrhea, dyspepsia, flatulence, and gastrointestinal spasms. It also helps in pain relief, uterine contractions, and nerve stimulation. Dried flower buds of the plant, particularly the n-butanol extract, have shown anti-ulcer and anti-secretory effects in rats. Chemical constituents include volatile oils such as clove bud oil, and non-volatile compounds like tannins, sterols, triterpenes, and flavonoids. The plant is also known for antimicrobial, antiviral, antioxidant, anti-diabetic, anti-inflammatory, anti-platelet, anti-stress, antipyretic, chemopreventive, hepatoprotective, anesthetic, aphrodisiac, and insecticidal properties [Batiha *et.al.*, 2020].

### 3.22 *Terminalia chebula* Retz.

*Terminalia chebula*, known as the "King of Medicine," belongs to the Combretaceae family and is a key ingredient in the herbal preparation Triphala. The primary bioactive compounds include tannins (e.g., chebulic acid, gallic acid), flavonoids, sterols, and amino acids. Methanolic fruit extracts exhibit anti-ulcer activity. The plant is reported to have numerous pharmacological effects such as antibacterial, antifungal, antiviral, antidiabetic, immunomodulatory, adaptogenic, anticancer, antioxidant, anti-inflammatory, cardioprotective, hepatoprotective, and wound-healing activities [Hassan Bulbul *et.al.*, 2022].



### 3.23 *Triticum aestivum* L.

*Triticum aestivum*, known as Wheat grass, belongs to the Poaceae family. It is rich in vitamins A, B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, B<sub>5</sub>, B<sub>6</sub>, B<sub>12</sub>, C, E, K, and various enzymes such as protease, amylase, and superoxide dismutase. Wheat grass juice is reported to be effective in treating active distal ulcerative colitis. Additionally, it has shown protective effects against chemotherapy-induced myelotoxicity (from drugs like 5-fluorouracil, doxorubicin, and cyclophosphamide) without compromising chemotherapy efficacy. Wheat grass also has anti-arthritic and antioxidant properties[Minocha N *et.al.*, 2022].

### 3.24 *Vinca minor* L.

*Vinca minor*, commonly known as Common periwinkle, belongs to the Apocynaceae family. It is used in traditional medicine for circulatory and cerebral disorders, supporting brain metabolism. The plant contains indole alkaloids, including vincamine, which exhibits cerebrovasodilatory and neuroprotective properties. The plant's leaf extract has demonstrated anti-ulcer activity in models of gastric damage induced in rats[Farahanikia*et.al.*, 2011].

### 3.25 *Zingiber officinalis* Roscoe

*Zingiber officinalis*, or Ginger, belongs to the Zingiberaceae family and is a popular spice with medicinal uses. Its extract has shown antitumor effects on colon cancer cells by inhibiting growth, arresting the cell cycle in the G<sub>0</sub>/G<sub>1</sub> phase, reducing DNA synthesis, and inducing apoptosis. The aqueous ethanol extract also provides nephroprotective benefits against doxorubicin-induced kidney damage in rats. Ginger's root extract has neuroprotective effects against monosodium glutamate toxicity. Other pharmacological properties include antioxidant, anti-inflammatory, anti-migraine, antiemetic, antimicrobial, anti-thrombotic, and hepatoprotective activities[Prasad *et.al.*,2015].

### 3.26 *Azadirachtaindica* A.

*Azadirachtaindica*, commonly known as Neem, belongs to the Meliaceae family. It is recognized for its potent gastroprotective and anti-ulcer effects, especially in rats, where it prevents acid-pepsin secretion and helps preserve the gastric mucosa. The bark extract has shown inhibitory effects on H<sup>+</sup>-K<sup>+</sup>-ATPase activity and reduces oxidative damage by scavenging hydroxyl radicals. Neem's gastroprotective properties are attributed to its anti-secretory and proton pump inhibitory actions, promoting cell survival and preventing gastric mucosal damage[Alzohairy M. A *et.al.*, 2016].

**3.27 Momordica charantia L.**

Momordica charantia, known as bitter melon, belongs to the Cucurbitaceae family. The methanolic fruit extract has shown effectiveness against gastric and duodenal ulcers. This action is attributed to the increased secretion of mucus and the anti-stress properties of the plant's constituents. Olive oil extracts from the fruit also have healing effects on peptic ulcers[Alam, S *et.al.*, 2009].

**3.28 Bacopa monniera**

Bacopa monniera, commonly known as Brahmi, belongs to the Scrophulariaceae family. It is effective in treating various gastric ulcer models in rats. Bacoside A, a key active compound, has been shown to exhibit anti-ulcer and ulcer-healing effects. Its mechanisms include anti-H. pylori activity, stimulation of prostanoic acid production, and promotion of mucosal defense factors, such as mucin secretion, cell proliferation, and antioxidant activity[Sairam *et.al.*, 2001].

**3.29 Ficus religiosa**

Ficus religiosa, known as the Peepal tree, belongs to the Moraceae family. Alcoholic extracts of the plant have demonstrated anti-ulcer effects in models of pylorus ligation, ethanol-induced ulcers, and aspirin-induced ulcers. The anti-ulcer properties are attributed to the endogenous production of prostaglandins, which promote mucus secretion. Additionally, the plant possesses anti-inflammatory and antioxidant effects, contributing to its potential as an anti-ulcer agent[Gregory, M *et.al.*, 2013].

**3.30 Ananas comosus**

Ananas comosus, commonly known as Pineapple, belongs to the Bromeliaceae family. Dichloromethane extracts of pineapple have shown gastroprotective effects against injuries caused by HCl, ethanol, non-steroidal anti-inflammatory drugs, and pylorus ligation in mice and rats. The mechanism behind its protective action is thought to involve the sulfhydryl groups in the extract. Additionally, Vicianin, a compound found in pineapple, has shown wound healing properties in guinea pigs with ischemic ulcers[Kargutkar, S *et.al.*, 2018].

**3.31 Cynodactylon**

Cynodactylon, commonly known as Durva grass or Doobghas, belongs to the Poaceae family. It has demonstrated anti-ulcer activity in albino rats at doses of 200, 400, and 600 mg per kg. The herb contains flavonoids, and its alcoholic extract, rich in these compounds, is thought to contribute to its anti-ulcer properties[Shruti Amritkar *et.al.*, 2024].

### 3.32 *Musa sapientum*

*Musa sapientum*, or Banana (Kela), belongs to the Musaceae family. A study at a dose of 100 mg/kg on NIDDM rats showed that it exhibits anti-ulcer and mucosal protective effects. The anti-ulcer activity of *Musa* may be attributed to its anti-secretory and cytoprotective actions. It acts as a mucoadhesive agent that forms a protective lining in the stomach and duodenum, safeguarding them from acid and pepsin damage[Prabha *et.al.*, 2011].

### 3.33 *Brassica oleracea*

*Brassica oleracea*, commonly known as Cabbage, belongs to the Brassicaceae family. The aqueous extract of *Brassica oleracea* var. *capitata* has been used to treat gastric disorders, including ulcers, in Wistar rats at doses of 0.250, 0.50, and 1.0 mg/kg. The chemical compound lysophosphatidic acid (LPA), found in cabbage, is involved in physiological processes like wound healing and has demonstrated anti-ulcer effects[Carvalho *et.al.*, 2011].

### 3.34 *Commiphora molle*

*Commiphora molle*, commonly known as Guggul, belongs to the Burseraceae family. It is well-known for its anti-inflammatory and wound-healing properties. In a rat model, Guggul was evaluated at a dose of 500 mg/kg for its gastric ulcer activity. The protective effects were linked to increased mucus production, enhanced nucleic acid and non-protein sulfhydryl concentrations, and its free radical-scavenging properties[Kunnumakkar *et.al.*, 2018].

### 3.35 *Vaccinium oxycoccos*

*Vaccinium oxycoccos*, known as Cranberry, belongs to the Ericaceae family. Cranberry juice has been found effective in treating peptic ulcers, especially in cases where *H. pylori* bacteria show antibiotic resistance. The anti-ulcer mechanism of cranberry juice may involve the immobilization of *H. pylori* strains in human mucus, erythrocytes, and gastric epithelial cells, preventing infection[Li, Z. X *et.al.*, 2021].

### 3.36 *Ceratonia siliqua*

*Ceratonia siliqua*, commonly known as Carob, belongs to the Fabaceae (Leguminosae) family. Carob has been shown to alleviate gastroesophageal reflux and vomiting in infants. It exerts its effects primarily through its flavonoid content, which provides gastroprotective and antioxidant properties, contributing to its anti-ulcer potential[Shahrajabian, M. H *et.al.*, 2024].

### 3.37 *Acacia nilotica*

*Acacia nilotica*, a member of the Fabaceae family, has been used in folk medicine for its antihyperglycemic, antimicrobial, and anti-hypertensive properties. Recent studies have highlighted its anti-ulcer activity, particularly in rat models of pylorus

ligation, swimming stress, and non-steroidal anti-inflammatory drug-induced ulcers. The methanol and acetone extracts of *A. nilotica* flowers demonstrated stronger anti-*H. pylori* activity than metronidazole, with effects similar to tetracycline but less potent than amoxicillin and clarithromycin. These extracts also exhibited significant urease inhibitory activity via a competitive mechanism[Khalaf *et.al.*, 2023].

### 3.38 Alchorneatriplinervia

Alchorneatriplinervia (Euphorbiaceae), used in folk medicine for treating gastric disorders, has demonstrated antibacterial, anti-inflammatory, antioxidant, antisecretory, gastroprotective, and anti-*H. pylori* effects. The methanol extract of this plant showed antibacterial activity against *H. pylori* and reduced gastric injury in ethanol-induced ulcer rats. Additionally, the ethyl acetate fraction from the leaves promoted epithelial cell proliferation, increased neutrophil numbers, and enhanced mucus production, accelerating the healing process in rats with acetic acid-induced gastric ulcers[Lima, Z. P *et.al.*, 2008].

### 3.39 Allium sativum

*Allium sativum*, or Garlic, a member of the Amaryllidaceae family, is widely used for its cardiovascular, antimicrobial, and antitumor properties. Garlic preparations, including garlic oil, powder, and allicin, have shown varying degrees of anti-*H. pylori* activity. Diallyl tetrasulfide and allicin exhibited the most potent activity. Selenium-enriched garlic has been found to inhibit the development of chronic gastritis induced by *H. pylori*. However, long-term garlic supplementation had no significant effect on the prevalence of *H. pylori* infection *in vivo*. Allitridi, a garlic derivative, showed a dose-dependent inhibitory effect on *H. pylori* growth[Verma, T *et.al.*, 2023].

### 3.40 Arrabidaeachica

Arrabidaeachica (Bignoniaceae) has been used to treat various ailments, including gastric ulcers, intestinal colic, and infections. The hydroethanol extract of *A. chica* leaves demonstrated significant antimicrobial activity, including pronounced effects against *H. pylori* (MIC = 12.5 mg/mL). In addition to its antimicrobial properties, the plant exhibited antioxidant, liver-protective, and antimicrobial effects, contributing to its potential as a therapeutic agent against gastric ulcers[Nascimento *et.al.*, 2022].

### 3.41 Daucus carota

*Daucus carota* L. (Apiaceae) is commonly used in various regions worldwide to treat conditions such as gastric ulcers, diabetes, nephritic colic, skin infections, and muscle pain. A study evaluating the anti-*H. pylori* properties of 60 commercial essential oils found that carrot seed oil significantly inhibited the viability of *H.*

pylori. Compounds like carvacrol, isoeugenol, nerol, citral, and sabinene, found in different essential oils, demonstrated strong activity against *H. pylori*. However, when carrot seed oil was administered to mice infected with *H. pylori*, there was no significant reduction in bacterial load compared to the control group[Bawariet.al., 2020].

### 3.42 *Derris trifoliata*

Recent studies have evaluated the cytotoxic effects of the roots and stems of *Derris trifoliata* Lour. (Fabaceae) on brine shrimp. A study on Malaysian ethnobotanical plants used for treating gastrointestinal issues and wounds revealed that organic solvent extracts of *D. trifoliata* inhibited *H. pylori*. Petroleum ether and chloroform extracts displayed strong activity against metronidazole-resistant clinical isolates, with MIC values ranging from 1 to 4 mg/mL. However, the toxicity of these concentrations may limit their practical use[Jiang et.al., 2012].

### 3.43 *Dittrichia viscosa*

Several species of *Dittrichia viscosa* (L.) Greuter (Asteraceae) have been traditionally used for various medical purposes. The plant has shown antifungal and antibacterial activity in studies of extracts made with organic solvents. In folk medicine, it is used for treating gastroduodenal disorders. When screened for anti-*H. pylori* activity, extracts of *D. viscosa* demonstrated effectiveness, with its essential oil and oxygenated fractions being particularly potent in inhibiting *H. pylori* growth in vitro[Mridet.al., 2022].

### 3.44 *Eucalyptus torelliana*

*Eucalyptus torelliana* F. Muell, part of the Myrtaceae family, is used in Nigerian traditional medicine to treat respiratory infections and gastrointestinal issues. Extracts from *E. torelliana* leaves have been shown to reduce gastric acid secretion and increase the pH of gastric juice, potentially aiding in the treatment of gastric ulcers. The hexane extract of the leaves exhibited the most potent anti-*H. pylori* activity, likely due to the presence of antimicrobial compounds like tannins and saponins[Lawal et.al., 2012].

### 3.45 *Eugenia caryophyllus*

*Eugenia caryophyllus* Spreng. (Myrtaceae) oil is known for its antimicrobial properties and is traditionally used as a flavoring agent in food. A study testing 30 Chinese herbal remedies for gastritis showed that ethanol extracts of *E. caryophyllus* strongly inhibited all six strains of *H. pylori*. Eugenol, the primary compound in *E. caryophyllus* oil, has proven antibacterial, antifungal, and antiviral properties. It was found to completely inhibit *H. pylori* strains, both sensitive and resistant, at concentrations as low as 2 mg/mL, with no resistance developing even after 10 successive passages[Chaiebet.al., 2007].

### 3.46 *Geranium wilfordii*

Several *Geranium* species possess medicinal properties, including antidiabetic, hemostatic, antioxidant, and antimicrobial effects. *Geranium wilfordii* Maxim (Geraniaceae) is used in Chinese medicine for gastrointestinal conditions such as diarrhea and dysentery. The anti-*H. pylori* activity of its extracts, particularly those containing corilagin and 1,2,3,6-tetra-O-galloyl- $\beta$ -D-glucose, has been investigated. Both ethanol and ethyl acetate extracts showed strong inhibitory effects on *H. pylori*[He, C *et.al.*, 2022].

### 3.47 *Geum iranicum*

*Geum iranicum* Khatamsaz is an endemic species in Iran. *Geum* species are used in traditional medicine for various ailments, including gastrointestinal disorders. In Iranian folk medicine, an infusion of the root of *G. iranicum* is used to treat conditions like diarrhea, while a decoction of the entire plant is applied to treat frostbite. Studies have shown that extracts of *G. iranicum* have strong anti-*H. pylori* effects, even against clinical isolates resistant to metronidazole[Taftiet.*al.*, 2017].

### 3.48 *Glycyrrhiza uralensis*

Licorice, derived from species of *Glycyrrhiza* such as *Glycyrrhiza uralensis* Fisch. (Fabaceae), has been used for medicinal purposes since ancient times. It is believed to be effective in treating peptic ulcer disease. Recent studies have highlighted its anti-inflammatory, antioxidative, and immunomodulatory properties. The anti-*H. pylori* effects of *G. uralensis* were studied through its chemical constituents, including flavonoids and methanol extracts, which exhibited strong activity against *H. pylori* strains[Sharifi-Rad *et.al.*, 2021].

### 3.49 *Hancornia speciosa*

*Hancornia speciosa* Gomez (Apocynaceae) has been used in Brazilian folk medicine to treat skin diseases and inflammation. It is also recognized for its potential to treat gastrointestinal issues such as ulcers, gastritis, and stomach pain. Recent research has shown that its hydroalcoholic extract has anti-*H. pylori* activity and can both prevent and heal gastric ulcers in rodents. The extract effectively reduced the severity of gastric damage induced by various experimental models, such as HCl/ethanol and stress-induced ulcers[Torres-Rêgo *et.al.*, 2016].

### 3.50 *Hydrastis canadensis*

*Hydrastis canadensis* L. (Ranunculaceae) has been supported in scientific literature for its antidiarrheal and antimicrobial properties. Historically, the Iroquois used *H. canadensis* to treat gastrointestinal issues. Studies have shown that a crude methanol extract from the rhizomes of this plant inhibited the growth

of 14 clinical isolates and one ATCC strain of *Helicobacter pylori*. The most active compounds found in the extract were berberine and b-hydrastine, two isoquinoline alkaloids known for their antimicrobial activity[Scazzocchio, F *et.al.*, 2001].

### 3.51 *Mallotus philippinensis*

*Mallotus philippinensis* (Lam) Muell. (Euphorbiaceae) has long been used in traditional medicine systems, including Chinese, Ayurvedic, Arabic, and Unani, as an anthelmintic for humans and animals. The plant also possesses properties such as being cathartic, aphrodisiac, antifungal, antibacterial, and antioxidant. A study evaluating the anti-*H. pylori* activity of 50 traditional Pakistani medicines found that *M. philippinensis* exhibited the strongest bactericidal effect, comparable to the activity of amoxicillin[Gangware *et.al.*, 2014].

### 3.52 *Myristica fragrans*

*Myristica fragrans* Houtt. (Myristicaceae) has been traditionally used for stomach disorders. The essential oil of *M. fragrans* is applied in treatments for rheumatism, and as a carminative and postpartum medication. In vitro studies of methanol extracts from 24 plant species used traditionally for gastrointestinal issues demonstrated that *M. fragrans* was particularly active against *H. pylori* strains, with a minimum inhibitory concentration (MIC) of 12.5 mg/mL. Similar findings were noted in research on Thai traditional medicine[Ashokkumar *et.a.*, 2022].

### 3.53 *Myrtus communis*

*Myrtus communis* L. (Myrtaceae) has been used for centuries in traditional medicine worldwide. Its essential oils and extracts have been researched for their antioxidant, antibacterial, antifungal, and antiseptic properties. Studies have shown that the essential oil of *M. communis* effectively inhibited the growth of *H. pylori*. Additionally, its extracts demonstrated activity in inhibiting urease enzyme activity at concentrations below 500 mg/mL[Dabbaghiet *al.*, 2023].

### 3.54 *Olea europaea*

*Olea europaea* L. Cv. *Cobrançosa* Oleaceae, or olive tree, has been used in folk medicine for a variety of ailments, including malaria and fever. Olive leaf extract has been found to exhibit antiulcer, antioxidative, and antimicrobial properties. Several studies have confirmed its efficacy against *H. pylori*, with significant activity against a range of microorganisms, including the bacterium responsible for gastric ulcers[Dabbaghiet *al.*, 2009].

### 3.55 *Persea americana*

*Persea americana* Mill. (Lauraceae), commonly known as the avocado tree, has leaves and fruits with reported anti-inflammatory, antimicrobial, cytotoxic, and insecticidal activities. Research into Mexican traditional remedies for

gastrointestinal disorders found that the methanol extract of *P. americana* was the most effective against *H. pylori*, with a MIC value of 57.5 mg/mL, while aqueous extracts showed no significant activity[Yasir *et.al.*,2010].

### 3.56 *Phyllanthus niruri*

*Phyllanthus niruri* L. (Chancapiedra) has recently gained attention for its hepatoprotective, antipyretic, anti-inflammatory, antinociceptive, antiplasmodial, and antitumor activities. The plant has shown notable anti-*H. pylori* effects, particularly against metronidazole-resistant strains. Water extracts from plants grown in Ecuador and Peru demonstrated a dose-dependent inhibitory effect on *H. pylori*, highlighting the plant's potential for antimicrobial use[Obidikeet.al., 2010].

### 3.57 *Pistacialentiscus*

*Pistacialentiscus* L. (Anacardiaceae) has been traditionally used for treating gastralgia and peptic ulcers. The resin from this plant, known as "Mastaki," is popular for treating gastritis. Research supports its ulcer-healing properties, with findings suggesting that mastic gum, derived from this plant, may contribute to the eradication of *H. pylori*. Studies have shown its antibacterial activity against *H. pylori*, and its efficacy as an alternative therapy for gastric ulcers[ArefeShojaeianet.al.,2023].

### 3.58 *Plumbago zeylanica*

*Plumbago zeylanica* L. (Plumbaginaceae) has been traditionally used to treat various ailments, including rheumatic pain, dysmenorrhea, carbuncles, ulcers, and inflammation. In a study screening Taiwanese folk medicinal plants, *P. zeylanica* extracts exhibited strong anti-*H. pylori* activity. Among the tested extracts, ethanol, acetone, and ethyl acetate demonstrated the highest effectiveness. The naphthoquinone compound plumbagin, derived from the plant, also showed promising anti-*H. pylori* effects[Wang, Y. C *et.al.*, 2005].

### 3.59 *Potentilla fruticosa*

*Potentilla* species, including *Potentilla fruticosa* L. (Rosaceae), have been used in traditional medicine across Asia, Europe, and North America for treating viral infections and immune system impairments. In studies evaluating the antibacterial and antifungal activities of aqueous extracts from selected *Potentilla* species, *P. fruticosa* showed strong antimicrobial effects against *H. pylori*[Liu, Z. H *et.al.*, 2016].

### 3.60 *Prunus dulcis* (syn. *P. amygdalus*)

*Prunus dulcis* (Mill) D.A. Webb (Rosaceae), commonly known as the almond tree, is rich in nutrients and phytochemicals. Polyphenol-rich extracts from almond skins have demonstrated antimicrobial properties, particularly against *H. pylori*



strains. Among the compounds tested, the flavonoid protocatechuic acid was found to be especially effective in inhibiting *H. pylori* growth [Barreca *et al.*, 2020].

### **3.61 Punicagranatum**

*Punicagranatum* L. (Lythraceae), or pomegranate, has been used in traditional Iranian medicine for treating gastritis. Research has revealed its antibacterial, antiparasitic, antiviral, antioxidant, and anti-inflammatory effects. Pomegranate peel has been shown to combat *H. pylori* and may help prevent gastric disease caused by the bacterium. The presence of tannins and phenolic compounds in the peel may contribute to its anti-*H. pylori* activity [Mohammadi *et al.*, 2023].

### **3.62 Salvia mirzayanii**

*Salvia mirzayanii* Rech. & Esfand. (Lamiaceae) is used in folk medicine to treat digestive disorders such as stomachache. Studies have shown its antibacterial, immunoinhibitory, free radical scavenging, and antioxidant activities. In a screening of 12 Iranian medicinal plants, *S. mirzayanii* exhibited the strongest anti-*H. pylori* activity with a MIC of 32 mg/mL [Zarshenas *et al.*, 2015].

### **3.63 Sanguinaria canadensis**

*Sanguinaria canadensis* L. (Papaveraceae) has been traditionally used as a homeopathic remedy. The benzophenanthridine alkaloid sanguinarine, derived from the root, has demonstrated antimicrobial and anti-inflammatory effects. In vitro studies revealed that methanol extracts of *S. canadensis* inhibited the growth of 15 strains of *H. pylori*, with isoquinoline alkaloids like sanguinarine being the most effective [Senchina *et al.*, 2009].

### **3.64 Scleria striatinux**

*Scleria striatinux* De Wild (Cyperaceae) has shown both antibacterial and antiplasmodial activities. In a study evaluating the anti-*H. pylori* properties of 10 plant extracts from North West Cameroon, *S. striatinux* exhibited potent activity against the bacterium, with the lowest MIC recorded at 0.032 mg/mL. The extract showed bacteriostatic effects at lower concentrations and bactericidal effects at higher concentrations [Mbah *et al.*, 2012].

### **3.65 Stachys setifera**

*Stachys setifera* C.A. Meyer (Lamiaceae) has been used for its broad spectrum of therapeutic effects, attributed to biologically active substances found in the plant. Studies have shown that extracts of *S. setifera* exhibit potent anti-*H. pylori* activity, providing support for its traditional use [Cardos *et al.*, 2021].

### **3.66 Terminalia chebula**

*Terminalia chebula* Retz. (Combretaceae) is commonly used in traditional Iranian medicine for treating gastritis and peptic ulcers. It has demonstrated antioxidant, antibacterial, antifungal, and antilithiatic properties. Water extracts of *T. chebula*

have shown significant antibacterial activity against *H. pylori*, and chebulinic acid isolated from its fruit has gastroprotective effects [Bag *et.al.*, 2013].

### **3.67 *Trachyspermum copticum***

*Trachyspermum copticum* Link (Apiaceae), traditionally used as a carminative, diuretic, and antihelminthic, has demonstrated strong antibacterial activity against *H. pylori*. However, some studies found that methanol extracts of the plant exhibited only weak anti-*H. pylori* effects, highlighting the need for further research into its potential [Bairwa *et.al.*, 2012].

### **3.68 *Zataria multiflora***

*Zataria multiflora* Boiss. (Lamiaceae) has been used to relieve gastric pain and treat irritable bowel syndrome. Its essential oil exhibits significant antioxidant and antimicrobial properties. Studies have shown that *Z. multiflora* essential oil has strong inhibitory effects on *H. pylori*, making it an effective candidate for the treatment of gastric disorders [Mahboubi M *et.al.*, 2019].

## **4. Conclusion**

This study highlights the potential of various medicinal plants in the management of *Helicobacter pylori* infections and gastric ulcers. The plants discussed, including *Hydrastis canadensis*, *Mallotus philippinesis*, *Myristica fragrans*, *Olea europaea*, and others, demonstrate significant antimicrobial and anti-ulcer properties, supporting their traditional use in treating gastrointestinal disorders. Bioactive compounds such as alkaloids, flavonoids, and essential oils found in these plants contribute to their therapeutic efficacy by inhibiting *H. pylori* growth, reducing inflammation, and promoting ulcer healing. Given the increasing concerns about antibiotic resistance, these plant-based alternatives offer promising solutions for addressing *H. pylori*-related gastric conditions. However, further clinical trials and pharmacological studies are essential to validate their safety, efficacy, and potential integration into modern therapeutic regimens. Ultimately, these plants could play a vital role in the future of alternative treatments for gastric ulcers and *H. pylori* infections, offering a natural approach with minimal side effects compared to conventional antibiotics.

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## 6. Conflict of Interest

The author declares that there is no conflict of interest regarding the publication of this research paper.

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