

Review Article

Anti-Ulcer Activity of Methanolic Extract of *Lagenaria Siceraria*: A Review

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A B S T R A C T

Lagenaria siceraria, commonly known as bottle gourd, has been traditionally used in various cultures for its medicinal properties. One of its notable therapeutic potentials is its anti-ulcer activity, which has gained attention in recent research. This review aims to comprehensively analyze the scientific literature on the anti-ulcer properties of methanolic extracts derived from *L. siceraria*. It discusses the phytochemical composition, mechanisms of action, experimental models used for evaluation, and the overall therapeutic potential of *L. siceraria* in ulcer management.

Keywords: *Lagenaria siceraria*, Anti-ulcer, Methanolic Extract

Introduction

Peptic ulcers, including gastric and duodenal ulcers, are prevalent gastrointestinal disorders that affect a substantial portion of the global population. These conditions are characterized by the erosion of the gastrointestinal mucosa, leading to symptoms such as pain, bleeding, and in severe cases, perforation. The pathogenesis of peptic ulcers involves an imbalance between aggressive factors, such as gastric acid and pepsin, and defensive mechanisms, including mucus and bicarbonate secretion, prostaglandins, and mucosal blood flow.¹ Conventional treatments for peptic ulcers, such as proton pump inhibitors and H₂-receptor antagonists, aim to reduce gastric acidity and enhance mucosal defense. However, these therapies often come with side effects and the potential for relapse. Consequently, there is a growing interest in exploring natural alternatives for ulcer management. One such promising candidate is *Lagenaria siceraria*, commonly known as bottle gourd. This plant, belonging to the Cucurbitaceae family, has been traditionally used in various cultures for its medicinal properties. Recent scientific investigations have highlighted the anti-ulcer potential of methanolic extracts derived from *L. siceraria*, attributing these effects to its rich phytochemical

composition, including triterpenoids, flavonoids, saponins, alkaloids, and phenolic compounds. This review aims to provide a comprehensive analysis of the anti-ulcer activity of *L. siceraria* methanolic extract, examining its phytochemical profile, mechanisms of action, experimental evidence, and clinical relevance. By consolidating current knowledge, this review seeks to underscore the therapeutic potential of *L. siceraria* in the context of ulcer management and encourage further research into its application as a natural remedy.^{2,3}

Botanical and Phytochemical Overview: *Lagenaria siceraria*, commonly known as bottle gourd, is a versatile plant belonging to the Cucurbitaceae family. Widely cultivated in tropical and subtropical regions, it is recognized for its nutritional and medicinal benefits. The plant is characterized by its large, bottle-shaped fruits, which are rich in vitamins, minerals, and bioactive compounds.⁴ Traditionally, various parts of *L. siceraria*, including the fruits, seeds, and leaves, have been used in folk medicine for their purported therapeutic properties, such as diuretic, cardioprotective, hepatoprotective, and anti-inflammatory effects. Recent phytochemical analyses have identified a diverse array of compounds in *L. siceraria*, which are believed to contribute to its medicinal properties. Notably, the methanolic extract

of *L. siceraria* is rich in triterpenoids, flavonoids, saponins, alkaloids, and phenolic compounds. These bioactive constituents exhibit a range of pharmacological activities, including antioxidant, anti-inflammatory, and antimicrobial effects, which are pertinent to its anti-ulcer potential.⁵

The anti-ulcer activity of *L. siceraria* methanolic extract is primarily attributed to its phytochemical composition. Triterpenoids, for instance, have been shown to enhance mucosal defense by promoting mucus secretion and inhibiting acid secretion, thereby protecting the gastric mucosa from erosive damage. Flavonoids and phenolic compounds, known for their potent antioxidant properties, play a crucial role in scavenging free radicals and reducing oxidative stress, which is a significant factor in the pathogenesis of ulcers. [6] Saponins and alkaloids, on the other hand, contribute to the anti-ulcer effects by exhibiting anti-inflammatory properties and enhancing the repair processes of the gastric lining. Experimental studies have demonstrated that the methanolic extract of *L. siceraria* significantly reduces ulcer indices in animal models, suggesting its efficacy in preventing and healing gastric lesions. This comprehensive phytochemical profile underscores the therapeutic potential of *L. siceraria* methanolic extract as a natural remedy for ulcer management, providing a scientific basis for its traditional use and encouraging further research into its clinical applications.⁷

Anti-ulcer Activity: Numerous studies have investigated the anti-ulcer potential of *L. siceraria* extracts, particularly methanolic extracts. Experimental models such as ethanol-induced gastric ulcer, pyloric ligation-induced ulcer, and NSAID-induced ulcer have been used to evaluate its efficacy. The extracts have consistently demonstrated significant reduction in ulcer index, gastric acid secretion, and enhancement of mucosal defense mechanisms. Mechanistic studies suggest that the anti-ulcer effects may involve enhancement of mucosal prostaglandin synthesis, reduction of oxidative stress, modulation of gastric mucus secretion, and inhibition of H⁺/K⁺-ATPase activity.^{8,9}

Enhancement of Mucosal Defense

One of the primary mechanisms by which *L. siceraria* methanolic extract exerts its anti-ulcer activity is through the enhancement of mucosal defense. The triterpenoids present in the extract have been shown to stimulate the secretion of gastric mucus, which acts as a protective barrier against the corrosive effects of gastric acid and pepsin. This mucus layer traps bicarbonate ions, creating a neutral microenvironment that protects the epithelial cells of the stomach lining.

Antioxidant Activity

Oxidative stress plays a crucial role in the pathogenesis of ulcers, where an excess of reactive oxygen species (ROS)

leads to lipid peroxidation, protein denaturation, and DNA damage in gastric mucosal cells. The flavonoids and phenolic compounds in *L. siceraria* methanolic extract exhibit potent antioxidant properties. These compounds neutralize ROS, thereby reducing oxidative stress and preventing cellular damage. The Folin-Ciocalteu method has demonstrated significant phenolic content in the extract, correlating with its high antioxidant capacity.¹⁰

Anti-inflammatory Effects

Inflammation is a key component in the development and exacerbation of ulcers. The methanolic extract of *L. siceraria* contains saponins and alkaloids that possess strong anti-inflammatory properties. These bioactive compounds inhibit the synthesis of pro-inflammatory cytokines and enzymes such as cyclooxygenase-2 (COX-2) and lipoxygenase. By reducing the inflammatory response, the extract mitigates mucosal damage and promotes healing of existing ulcers.¹¹

Suppression of Gastric Acid Secretion

Excessive gastric acid secretion is a major factor in the development of peptic ulcers. The methanolic extract of *L. siceraria* has been observed to reduce gastric acid secretion, thereby lowering the overall acidity in the stomach. This acid-suppressive effect is beneficial in creating a less hostile environment for the healing of gastric lesions. The exact phytochemicals responsible for this effect are still under investigation, but their presence contributes significantly to the extract's overall gastroprotective activity.

Antimicrobial Activity Against *Helicobacter pylori*

Helicobacter pylori infection is a well-established cause of peptic ulcers. The antimicrobial properties of *L. siceraria* methanolic extract play a crucial role in its anti-ulcer activity. Studies have shown that the extract exhibits significant antibacterial activity against *H. pylori*, thereby addressing one of the root causes of ulcer formation. This antimicrobial effect is attributed to the diverse phytochemical profile of the extract, including saponins, flavonoids, and phenolic acids.^{12,13}

Experimental Evidence

Several experimental studies have provided substantial evidence supporting the anti-ulcer activity of *L. siceraria* methanolic extract. Animal models, such as ethanol-induced, pylorus-ligated, and aspirin-induced ulcer models in rats, have been used to evaluate the efficacy of the extract. These studies consistently demonstrate a significant reduction in ulcer index, indicating the extract's effectiveness in both preventing and healing gastric ulcers.

For instance, in ethanol-induced ulcer models, pre-treatment with *L. siceraria* methanolic extract resulted in a marked decrease in ulcer formation. This effect was associated with increased gastric mucus secretion and reduced oxidative stress markers. Similarly, in pylorus-ligated models, the

extract significantly reduced gastric acid output and ulcer formation, highlighting its acid-suppressive properties.

Comparative Studies and Phytochemical Correlations

Comparative studies have shown that the anti-ulcer activity of *L. siceraria* methanolic extract is comparable to standard anti-ulcer drugs such as ranitidine and omeprazole. The extract's ability to modulate multiple pathways, including mucosal defense, oxidative stress, inflammation, and microbial infection, provides a comprehensive approach to ulcer management.¹⁴

Phytochemical analysis of the extract has revealed a rich composition of bioactive compounds, with phenolic and flavonoid contents being particularly noteworthy. These compounds not only confer antioxidant and anti-inflammatory properties but also contribute to the extract's antimicrobial and mucoprotective effects. The high phenolic content, measured using the Folin-Ciocalteu method, correlates with the extract's potent antioxidant capacity, which is crucial for mitigating oxidative stress in ulcerative conditions.

Clinical Relevance and Potential Applications: While most research has been conducted in animal models, preliminary clinical studies and ethnopharmacological evidence support the traditional use of *L. siceraria* in treating gastric disorders. Clinical trials are needed to validate its efficacy and safety in humans. The plant's availability, affordability, and relatively low toxicity profile make it an attractive candidate for further development as an anti-ulcer agent.^[15]

Clinical Relevance

Complementary Therapy: The methanolic extract of *Lagenaria siceraria* holds significant potential as a complementary therapy for patients with peptic ulcers. Current treatments for peptic ulcers primarily include proton pump inhibitors (PPIs), H2 receptor antagonists, and antibiotics for *Helicobacter pylori* infection. However, long-term use of these medications can lead to side effects such as nutrient malabsorption, increased risk of fractures, and antibiotic resistance. The natural origin and multi-targeted mechanisms of *L. siceraria* extract offer a safer and potentially more holistic alternative.

Gastroprotective Benefits: The ability of *L. siceraria* methanolic extract to enhance mucosal defense, reduce gastric acid secretion, and exhibit antioxidant and anti-inflammatory properties addresses the primary causes and exacerbating factors of peptic ulcers. This comprehensive approach can significantly improve patient outcomes, especially in those who may not respond adequately to conventional therapies.¹⁶

Management of *H. pylori* Infection: Given its antimicrobial activity against *Helicobacter pylori*, *L. siceraria* extract can be particularly beneficial in the management of *H. pylori*-induced ulcers. The inclusion of this extract in treatment regimens may enhance the eradication rates of *H. pylori*, reduce the recurrence of ulcers, and minimize the development of antibiotic resistance.

Safety and Tolerability: Natural products are generally perceived as safer with fewer adverse effects compared to synthetic drugs. The use of *L. siceraria* extract could potentially reduce the side effects associated with long-term use of standard ulcer medications, thereby improving patient adherence to treatment protocols and overall quality of life.¹⁷

Potential Applications

Phytopharmaceutical Development: The bioactive compounds in *L. siceraria*, such as triterpenoids, flavonoids, saponins, and phenolic acids, provide a rich source for the development of new phytopharmaceuticals. These compounds can be isolated, characterized, and used as lead molecules for designing novel anti-ulcer drugs. Standardizing the methanolic extract and conducting rigorous clinical trials could pave the way for its approval as a herbal medicine.

Functional Foods and Nutraceuticals: The incorporation of *L. siceraria* extract into functional foods and nutraceuticals is another promising application. Products such as fortified beverages, dietary supplements, and herbal teas containing the extract could provide preventive health benefits and support ulcer management. These products could be marketed to individuals at high risk of developing ulcers, such as those with chronic NSAID use, high stress levels, or a history of gastrointestinal disorders.

Topical Formulations: Exploring the use of *L. siceraria* extract in topical formulations for oral ulcers or gastritis could be a novel application. The anti-inflammatory and antioxidant properties of the extract could help soothe and heal mucosal lesions when applied directly to the affected areas.^{18,19,20}

Integrative Medicine: Integrative medicine combines conventional medical treatments with alternative therapies to address the whole person—body, mind, and spirit. *L. siceraria* extract can be integrated into such practices, providing a natural adjunct to conventional ulcer treatments. Its use in integrative medicine could be particularly appealing to patients seeking holistic and non-pharmaceutical approaches to health.

Veterinary Applications: The anti-ulcer properties of *L. siceraria* extract could also be explored in veterinary medicine. Animals, particularly those subjected to stress or

medications that irritate the gastrointestinal tract, could benefit from the gastroprotective effects of the extract.^{6,7}

Challenges and Future Perspectives

Despite promising results, challenges such as standardization of extracts, bioavailability of active compounds, and translational research from preclinical to clinical settings remain. Future research should focus on elucidating the specific mechanisms underlying its anti-ulcer effects, conducting well-designed clinical trials, exploring potential synergistic effects with conventional therapies, and developing standardized herbal formulations.

Challenges

Standardization of Extracts: One of the major challenges in the use of *Lagenaria siceraria* methanolic extract for anti-ulcer therapy is the standardization of the extract. The concentration of bioactive compounds can vary significantly depending on factors such as the geographical origin of the plant, harvesting time, and extraction methods. Ensuring consistent and reproducible therapeutic effects requires rigorous standardization protocols.

Quality Control: Maintaining high-quality control throughout the production process is essential to ensure the safety and efficacy of the extract. This includes the accurate identification of plant material, elimination of contaminants, and verification of the extract's chemical composition. Implementing stringent quality control measures can be resource-intensive and requires specialized expertise.

Regulatory Hurdles: The regulatory approval process for herbal medicines can be complex and time-consuming. Herbal products are often subjected to different regulatory standards compared to conventional pharmaceuticals. Navigating these regulatory frameworks, which can vary significantly between countries, poses a significant challenge to bringing *L. siceraria* extract to the market.

Clinical Evidence: While preclinical studies have demonstrated promising anti-ulcer activity, there is a need for robust clinical trials to confirm these effects in humans. Conducting large-scale, randomized, controlled trials to evaluate the efficacy, safety, and dosage of *L. siceraria* extract is critical. The lack of comprehensive clinical data can hinder its acceptance in mainstream medical practice.

Mechanism of Action: Although several mechanisms of action have been proposed for the anti-ulcer activity of *L. siceraria* extract, a thorough understanding of these mechanisms is still lacking. Detailed mechanistic studies are needed to elucidate how the various bioactive compounds in the extract contribute to its gastroprotective effects. This knowledge is essential for optimizing the therapeutic potential of the extract.

Bioavailability and Pharmacokinetics: The bioavailability and pharmacokinetics of *L. siceraria* extract and its active constituents need to be thoroughly investigated. Understanding how these compounds are absorbed, distributed, metabolized, and excreted in the body will help in optimizing their delivery and enhancing their therapeutic effects.^{21,22}

Future Perspectives

Advanced Extraction Techniques: The development and application of advanced extraction techniques, such as supercritical fluid extraction or microwave-assisted extraction, could improve the yield and purity of bioactive compounds from *L. siceraria*. These techniques could enhance the standardization and consistency of the extracts.

Formulation Development: Research into novel delivery systems, such as nanoparticles, liposomes, or transdermal patches, could improve the bioavailability and therapeutic efficacy of *L. siceraria* extract. These advanced formulations could help overcome challenges related to poor solubility and stability of the bioactive compounds.

Synergistic Formulations: Combining *L. siceraria* extract with other complementary herbal extracts or conventional anti-ulcer drugs could result in synergistic effects, enhancing the overall therapeutic outcome. Research into such combination therapies could provide new insights into more effective ulcer treatments.

Genomic and Metabolomic Approaches: Integrating genomic and metabolomic approaches in the study of *L. siceraria* could help identify the genetic and metabolic pathways involved in its anti-ulcer activity. This holistic approach could lead to the discovery of new bioactive compounds and therapeutic targets.

Sustainability and Cultivation: Developing sustainable cultivation practices for *L. siceraria* can ensure a reliable supply of high-quality plant material. This includes optimizing agricultural practices, developing pest-resistant varieties, and ensuring environmentally friendly farming methods.

Interdisciplinary Research: Collaboration between botanists, pharmacologists, chemists, and clinical researchers is essential to advance the understanding and application of *L. siceraria* extract. Interdisciplinary research can lead to comprehensive insights into its therapeutic potential and accelerate its integration into clinical practice.

Public Awareness and Acceptance: Educating healthcare providers and the public about the potential benefits and safety of *L. siceraria* extract is crucial for its acceptance and use. Public awareness campaigns and professional training programs can help bridge the gap between traditional herbal medicine and modern medical practice.[18,19,20]

Conclusion

The review of the anti-ulcer activity of methanolic extract of *Lagenaria siceraria* highlights its promising therapeutic potential in the treatment of peptic ulcers. The extract's rich phytochemical profile, including saponins, flavonoids, tannins, and triterpenoids, contributes to its gastroprotective effects through various mechanisms. These include antioxidative properties that reduce oxidative stress, enhancement of mucosal defense, and inhibition of gastric acid secretion. The cumulative evidence from various studies underscores the efficacy of *Lagenaria siceraria* in alleviating ulcer symptoms and promoting gastric healing, making it a viable natural alternative for ulcer management. Further clinical studies are warranted to fully elucidate its therapeutic potential and ensure its safety and efficacy in human populations.

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